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National Park
Service

Soil Survey of Hawaii Volcanoes National Park, Hawaii



How To Use This Soil Survey

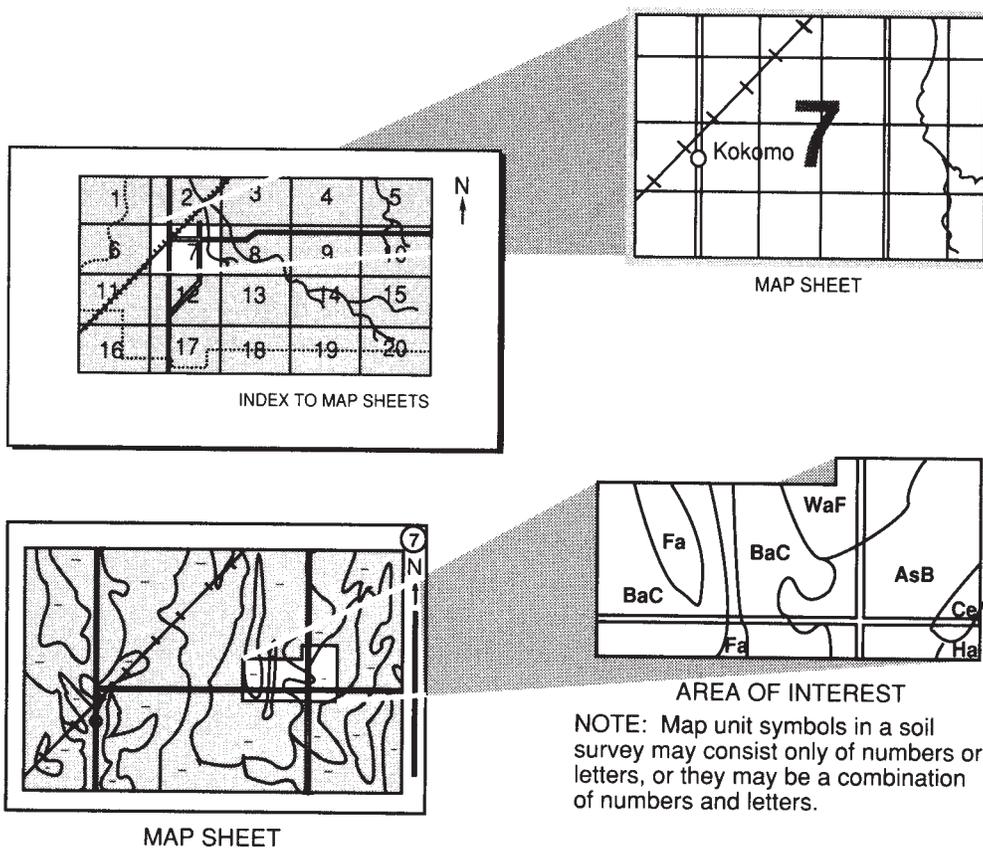
Detailed Soil Maps

The detailed soil maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.



National Cooperative Soil Survey

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey. This survey was made cooperatively by the Natural Resources Conservation Service and the United States Department of the Interior, National Park Service and United States Geological Survey.

Major fieldwork for this soil survey was completed in 2005. Soil names and descriptions were approved in 2008. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 2005. The most current official data are available on the Internet.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale. The soil maps are in digital form. The digitizing of the maps was completed in accordance with the Soil Survey Geographic (SSURGO) database standards. The digital SSURGO-certified maps are considered the official maps for the survey area and are part of the FOTG at the local field office of the Natural Resources Conservation Service.

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Cover Caption

View of Kilauea Iki Crater, looking towards Mauna Loa. Vegetation in the foreground grows on Puhimau and Manu soils along the rim of the crater.

Additional information about the Nation's natural resources is available online from the Natural Resources Conservation Service at <http://www.nrcs.usda.gov>.

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Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. The location of each map unit is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

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Soil Survey of Hawaii Volcanoes National Park, Hawaii

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General Nature of the Survey Area

Hawaii Volcanoes National Park is in the southern part of the Big Island of Hawaii (fig. 1). It includes the summit and parts of the southeastern and southwestern slopes of the Mauna Loa Volcano and most of the Kilauea Volcano. Both volcanoes are active in ejecting basaltic lava flows and ash. Hilo, the nearest city, is about 25 miles to the northeast of the park. The total acreage surveyed is 368,375 acres (about 576 square miles). Elevation in the survey area ranges from sea level to 13,679 feet.

The paragraphs that follow describe the climate and vegetation in the survey area.

Climate

The climate varies considerably within Hawaii Volcanoes National Park. Both the average annual precipitation and the average annual temperature vary widely with changes in geographic location. The average annual temperature at a given location is largely related to the elevation of the site.

The average annual air temperature can be expected to drop about 3.6 degrees F for each 1,000-foot increase in elevation from sea level to the park headquarters and about 2.2 degrees for each 1,000-foot increase from the park headquarters to the summit of Mauna Loa (Giambelluca and Schroeder, 1998). The average annual air temperature in the park ranges from about 75 degrees F at sea level to about 37 degrees F at the summit of Mauna Loa. By National Cooperative Soil Survey convention, the temperature of the soil is taken at a depth of 20 inches or directly above bedrock if the soil is less than 20 inches deep over bedrock. The average annual soil temperature is about 2 degrees F warmer than the average annual air temperature in the tropics; therefore, the average annual soil temperatures in the park range as widely as the average annual air temperatures do. The soils have been grouped into specific soil temperature categories. Individual soil types are assigned only one category.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

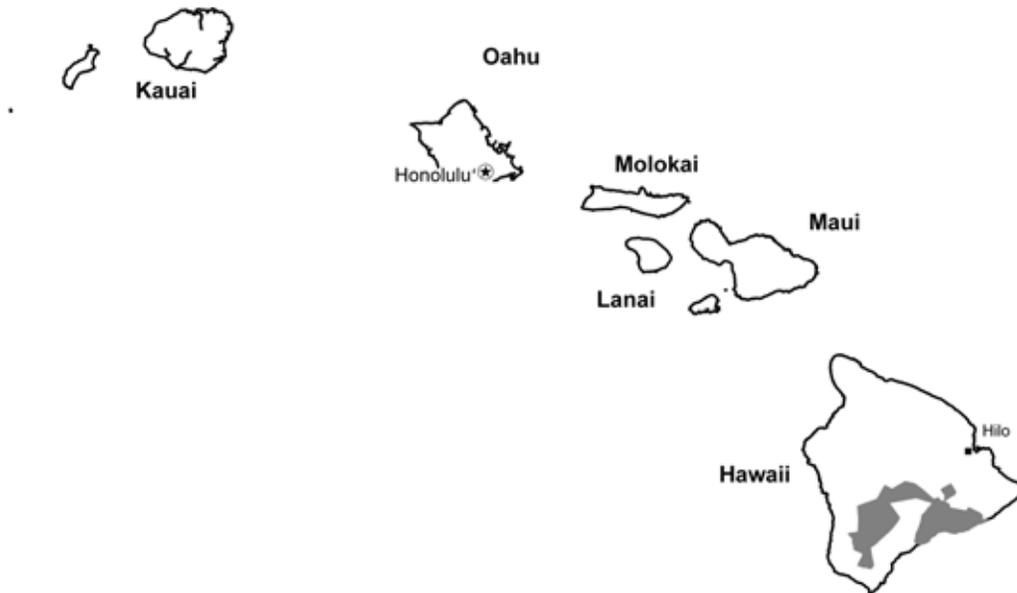


Figure 1.—Location of Hawaii Volcanoes National Park.

Three soil temperature categories or regimes are recognized in the park. The warmest soil temperature category, named isohyperthermic, includes soils with average annual soil temperatures of more than 72 degrees F and with temperature variations of less than 6 degrees from summer to winter. In Hawaii Volcanoes National Park, these soils occur below an elevation of about 1,000 feet. Geothermal heating of the earth's surface occurs in the park. In a few places, this heating was significant enough to disrupt the vegetation and the area heated was large enough to be delineated. These areas are recognized on the maps as they occurred at the time of major fieldwork in 1999. No attempt was made to measure the soil temperatures of the geothermal-heated areas. In other places, geothermal heating occurred inconsistently and only in small, local areas. These areas were not delineated.

Soils in the isothermic soil temperature regime have average annual soil temperatures between 59 and 72 degrees F. These soils occur between elevations of about 1,000 and 4,000 feet in the park.

Soils in the isomesic soil temperature regime, the coolest in the park, have average annual soil temperatures between 49 and 59 degrees F. These soils occur between elevations of about 4,000 and 7,500 feet. Areas above 7,500 feet are dominated by lava flows with little or no soil.

Temperatures throughout the park vary little from summer to winter. Soil temperatures for all of the soils in the park vary less than 11 degrees F between summer and winter. Daily air temperatures typically vary about 16 degrees F from the daily maximum to the daily minimum.

The average annual precipitation is highly variable throughout the park. This variation is principally the result of the prevailing easterly trade winds interacting with the mountains in the park. The mountains obstruct, deflect, and accelerate the flow of air. When warm, moist air rises and cools as it flows up the windward slopes, clouds and rain form. The orographic effect of the mountains produces increasing rainfall from sea level up to a maximum at an elevation of about 2,000 to 3,000 feet. Above that elevation, the amount of average annual rainfall decreases. The part of the park that receives the lowest average annual rainfall (about 20 inches) is near the summit of Mauna Loa.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

The highest average annual precipitation in the park occurs at an elevation of 3,300 feet, on the eastern slope of the Kilauea mountain, at the eastern boundary of the Olaa Rain Forest. An arid rain-shadow area occurs at a low elevation on the leeward side of the crest of the Kilauea mountain. This area receives about 30 inches of rain per year, has evapotranspiration exceeding 80 inches, and has soils that are dry more than half of the days in a normal year. In the part of the park with the highest rainfall, evapotranspiration is about 40 inches and the soils have a surplus of moisture in every month during a normal year.

Typically, more precipitation falls during winter than during summer. Winter storms occurring between October and April contribute most of the annual rainfall in dry areas. In the wetter areas, where rainfall comes from both winter storms and trade wind showers, seasonal differences are much smaller. Within a day or a few hours, a winter storm may contribute half of the average annual rainfall in dry areas. A small part of the park in the south Kona district is at the extreme upper elevation of the "Kona" weather pattern. This part of the park receives more rain in summer than in winter.

Snow falls a few times in winter around the summit of Mauna Loa in most years, but it melts within a few days or weeks. The areas at high elevations where snowfall is possible consist of fresh lava flows. No areas containing soil have the potential to receive snowfall.

The total annual precipitation at any given location can vary significantly from year to year. Weather patterns that are typical of the tropics include significant variations in annual precipitation. Another source of annual variation is the particular distribution of local showers for any given location.

No single weather station can represent the entire park. The following information was gathered from a weather station near the park headquarters, at an elevation of 3,970 feet. These data represent the climatological conditions only of areas near the weather station. They are for the period 1949 to 2000. In winter, the average daily maximum temperature is 67 degrees F and the average daily minimum temperature is 50 degrees. The lowest temperature on record, which occurred on January, 18 1978, is 34 degrees F. In summer, the average daily maximum temperature is 71 degrees F and the average daily minimum temperature is 55 degrees F. The highest recorded temperature, which occurred on September 30, 1960, is 85 degrees F. The total annual precipitation is about 109 inches. Of this, 42 inches, or about 38 percent, usually falls during the period April through September. There was no measurable snowfall during that period.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Hawaii Volcanoes National Park Headquarters 54 in the period 1971 to 2000.

Vegetation and Disturbance History

Adapted from Tim Tunison, Director of Resources Management (retired), Hawaii Volcanoes National Park.

There is a wide range of vegetative types within Hawaii Volcanoes National Park. The vegetation in the park is largely correlated with rainfall and elevation. The richness of vegetative types results from broad environmental gradients, particularly elevation and rainfall. Soil depth and age of geological substrate, which also are important factors, account for differences within broad rainfall and elevation zones. Patches of older geological substrates surrounded by younger flows create the pattern of kipukas that is characteristic of the park. A kipuka is an island of older vegetation surrounded by a lava flow or younger vegetation. Frequent lava flows

have had major effects on the vegetation through time. Recent disturbances associated with humans, such as grazing animals, alien plant species, and increased wildfire, also have shaped the vegetation of the park.

The types of vegetation in the park are represented by herb lands, grasslands, shrublands, forests, and mixed communities. The lower elevations are generally dominated by nonnative plant species, whereas the higher elevations are dominated by native species. The relative abundance of native and alien vegetation varies greatly in communities at mid elevations.

Seacoast communities are poorly developed and include small, patchy, and discontinuous coastal dry herb lands and shrublands. Herb lands are strictly associated with the immediate shoreline and are dominated by the low-growing herbs *Fimbristylis cymosa* and *Portulaca* spp. The only coastal dry shrubland of note is represented by naupaka kahakai (*Scaevola sericea*), which is best observed and developed at Apua Point.

Away from the immediate coast, dry grasslands dominate the vegetation below the coastal pali (cliff) system, generally below an elevation of 1,500 feet in the drier western part of the park and 200 feet in the wetter eastern part. Any given site may be dominated by one or two species, such as pili (*Heteropogon contortus*), beardgrass (*Schizachyrium condensatum*) and broomsedge (*Andropogon virginicus*), Natal redtop (*Melinis repens*), and thatching grass (*Hyparrhenia rufa*). The extent of fountaingrass (*Pennisetum setaceum*) is now greatly reduced because of control efforts. Coastal dry grasslands developed with the invasion of alien beardgrass and broomsedge in the early 1960s and the rapid expansion of native pili and the exotic Natal redtop and thatching grass after the removal of feral goats in the early 1970s.

Remnants of dry shrubland persist in the eastern coastal areas below an elevation of 200 feet. Since 1990, much of this shrubland has been covered by lava flows or altered by fire. An extensive dry forest near Kamoamoia was eliminated by lava flows between 1992 and 1997.

Many of the plant communities in the leeward parts of the park above the pali have been greatly impacted by alien plant invasions and by fire. The older flows with ash soil development support ohia (*Metrosideros polymorpha*) stands. Broomsedge and beardgrass invaded these open or closed forests in the early 1960s, fueling fires that have affected nearly three-quarters of the ohia forest. Molassesgrass (*Melinis minutiflora*) has invaded many of these burns and in some cases has formed grasslands with scattered trees and shrubs persisting. Faya tree (*Myrica faya*) invaded many sites in the 1970s and 1980s and now occurs as scattered to closed stands within the forest. Where the invasion is well advanced, little vegetation persists in the understory. An introduced leafhopper has caused a dieback in faya tree and ohia in the central part of the dry ohia area at a low elevation, resulting in the expansion of alien grasses and the loss of forest cover.

The vegetation on the Mauna Loa Strip at elevations of roughly 4,000 to 6,500 feet is characterized by a mosaic of forest, shrubland, and small grassland stands. Removal of cattle in 1948 and of feral goats in the early 1970s has resulted in the rapid spread of koa (*Acacia koa*) by root sprouting into grasslands and shrublands. Mamane (*Sophora chrysophylla*) spread rapidly in grasslands between elevations of 5,000 and 6,000 following the removal of feral goats, and mamane woodlands are beginning to form.

Ohia grows as a tree up to an elevation of about 8,500 feet and forms woodland stands at elevations as high as 7,200 feet. Other tree species drop out at the latter elevation, and subalpine vegetation is dominated by native shrubs. Subalpine shrublands on aa are highly scattered and consist of short-statured individuals. There is little vegetation above an elevation of 10,000 feet on Mauna Loa.

How This Survey Was Made

This survey was made in conjunction with the National Park Service's Soil Inventory and Monitoring Program to provide information about the soils and miscellaneous areas in the Hawaii Volcanoes National Park. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil.

The soils and miscellaneous areas in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change or as they change abruptly at lava flow boundaries. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, including research information and field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a

high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

This survey area was mapped at two levels of detail. At the more detailed level, map units are narrowly defined. Map unit boundaries were plotted and verified at closely spaced intervals. Individual delineations tend to be smaller, reflecting more detail. At the less detailed level, map units are broadly defined. Boundaries were plotted and verified at wider intervals. The detail of mapping was dictated by the accessibility of the terrain. Inaccessible areas, such as the north half of Oloa Rain Forest, were mapped at the less detailed level.

Explanation of the Lines and Symbols on the Soil Maps

The lines and symbols on the soil maps in this survey identify areas of soils with similar characteristics. The soils do not occur randomly across the landscape but rather follow an orderly pattern that is related to the factors of geology, landforms, relief, age, climate, and natural vegetation. The random appearance of the lines can be deciphered into an orderly pattern when each of these factors is considered separately. The factors are not completely separate in their influences on soils, and soil scientists consider them simultaneously when making the maps. An explanation of the placement of the soil lines on the maps can be simplified by considering the factors individually. This section seeks to explain the lines and symbols on the maps by explaining the orderly pattern in which the soil factors occur. Additional information is available in the section "Formation of the Soils."

The lines on the soil maps surround areas having similar properties and separate areas having properties that differ in one or more ways. Soil moisture can vary widely among soils and is a basis for differentiating soils. Some soils are characteristically dry. These soils may be moist following a significant rainfall, but their prevailing dryness most significantly affects their management. Other soils are dominantly saturated because of a high amount of rainfall and a restriction in the lower part of the soils that prevents good drainage. Many soils alternate between moist and dry conditions throughout the year. Some of these soils usually dry, and others are usually moist. There are many combinations of wet, moist, and dry conditions at different times throughout the year and at different soil depths. "Soil Taxonomy" (Soil Survey Staff, 1999) defines several types of soil moisture regimes to which each of the different combinations can be assigned. On a landscape of increasing rainfall, a change from one soil moisture regime to another can be represented by a line that is placed where the soil moisture properties change from those that meet the definition of one soil moisture regime to those that meet the definition of the next soil moisture regime. These types of soil lines commonly are parallel to the lines on a median annual precipitation map. In this way soils with different moisture characteristics are separated from each other. Figure 2 depicts a mountain slope where the median annual precipitation increases with increasing elevation. A line divides the moister soils in the higher rainfall area from the drier soils below.

The temperature of a soil affects the management of that soil. At a high elevation, for example, a soil that has a cool average annual temperature and is subject to periodic frost in winter requires a different set of management options than a soil that is consistently warm throughout the year. By National Cooperative Soil Survey convention, the temperature of the soil is taken at a depth of 20 inches or directly above bedrock if the soil is less than 20 inches deep over bedrock. In this survey

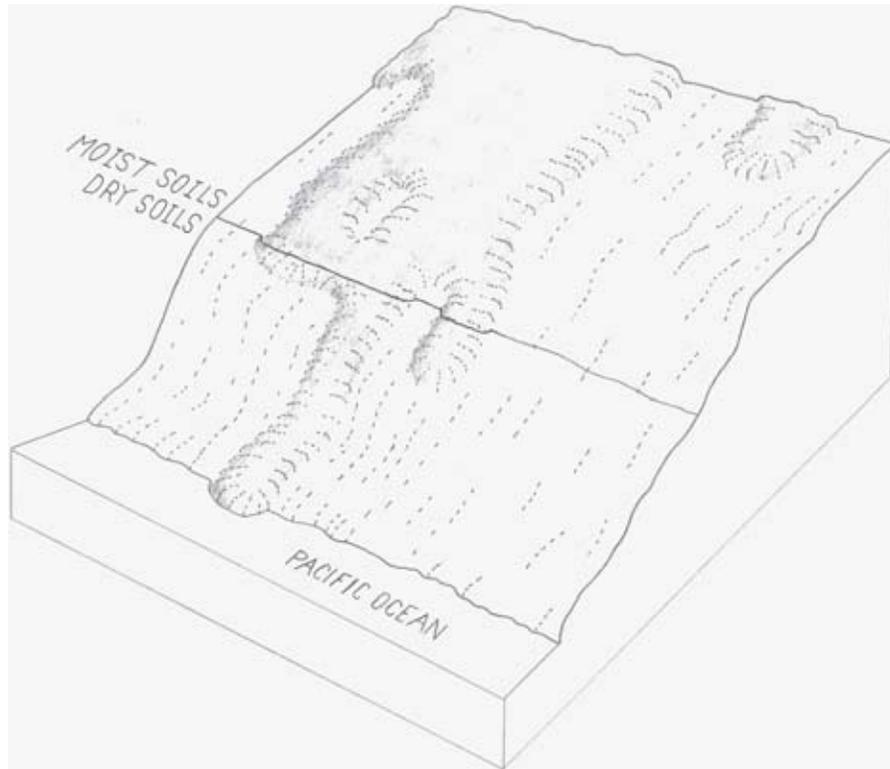


Figure 2.—A line dividing the moister and drier soils on a mountain slope.

area, elevation directly affects soil temperature. The average annual soil temperature can be expected to drop about 3 degrees F per 1,000-foot increase in elevation. “Soil Taxonomy” (Soil Survey Staff, 1999) defines several soil temperature classes or regimes. Although the soil temperature changes gradually across the landscape, the definitions of soil temperature classes create distinct boundaries. On a mountain slope with increasing elevation, a change from one soil temperature regime to another can be represented by a line that is placed where the soil temperature changes from that of one soil temperature regime to that of the next regime. These types of soil lines commonly parallel elevation contour lines. In some areas, a change in soil temperature regime coincides with a change in the soil moisture regime. Figure 3 depicts the same mountain slope as that depicted in figure 2. The average annual soil temperature on this slope decreases with increasing elevation. A line divides the warmer soils at the lower elevations from the cooler soils above.

All of the fine textured mineral soil material in the survey area is derived from volcanic ash. This ash falls vertically and covers the underlying lava flows. In some areas the accumulated ash is so thick that the underlying bedrock is deeper than could be observed during mapping. In other areas the ash occurs as a thin cover over the bedrock. The type of underlying lava flow, whether it is aa or pahoehoe, greatly affects the characteristics of these soils. Thin soils that formed over aa flows are a mixture of soil material and rock fragments from the aa lava. These soils contain 35 to nearly 100 percent rock fragments. Thin soils that formed over pahoehoe flows contain significantly fewer rock fragments and are therefore separated from the soils underlain by aa flows. The change in soil properties will be as abrupt as the edge of the lava flow. Soil lines separating these two types of soils follow the boundary of the lava flow. Lava flow boundaries are commonly curvy with

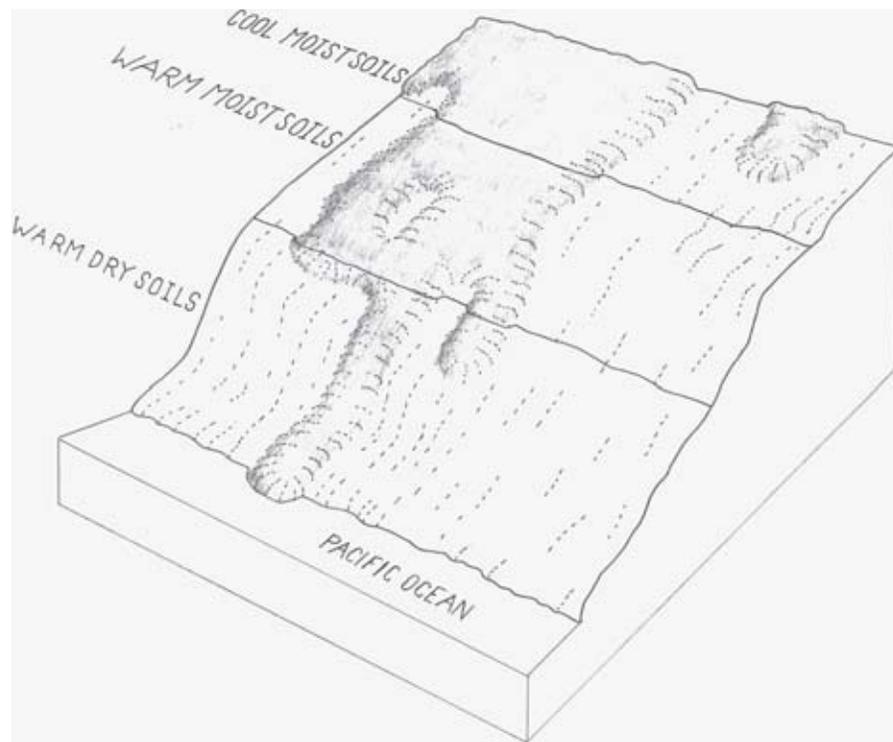


Figure 3.—A line dividing the warmer and cooler soils on the mountain slope.

lobes and run downhill perpendicular to the slope contour. Figure 4 depicts the mountain slope with lines separating soils occurring on different lava flows.

The slope of a soil greatly affects the management of that soil. On steep soils agricultural production, construction, and many other endeavors are difficult. In some areas pedologic soil properties change along with changes in slope. In other areas the soil remains similar on different slopes. Whether or not pedologic changes occur, lines separate soils into different slope classes. On the rolling landscapes typical of lava flows, lines separating soils into different slope classes may not appear to follow visible features. In figure 5 steep soils and less steep soils on the mountain slope are delineated.

In addition to the factors separating soils illustrated above, many other important differentiating factors occur in this survey. Soil lines separate soils on the basis of differences in content of organic matter, flooding hazards, the type and texture of the ash, the presence of cemented layers, potential plant communities, and other factors that affect management. In many areas these lines correspond with visible landform features, but in other areas they do not do so.

Spot symbols on the soil maps identify areas where soil properties contrast with those of the surrounding area. They are used when the contrasting area is too small to be delineated and to be identified by a map symbol representing a specific map unit. Areas smaller than 5 acres cannot be delineated on maps at a scale of 1:24,000. By design, this survey is limited in the detail of the maps. Because of these limitations in detail, not all small contrasting areas that could be identified by spot symbols have been identified. A contrasting area may be too small, or it may be so obscured by vegetation, topography, or land use that it was not identified when the maps were made. For example, a certain area on the maps may have several symbols identifying "wet spots." The soil survey user should not assume that all of the wet spots in the

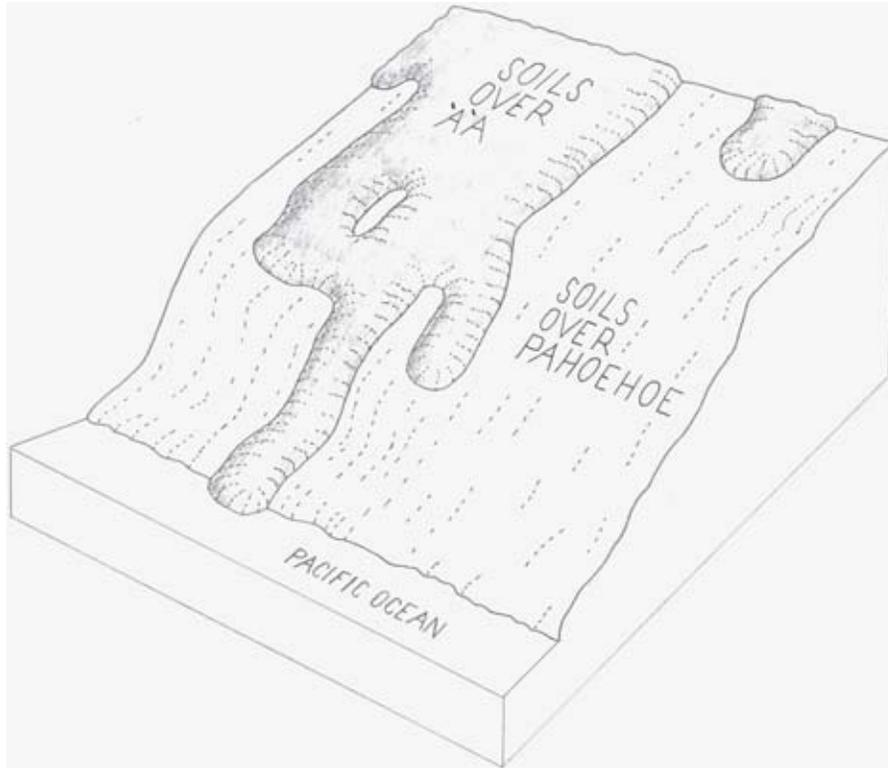


Figure 4.—Lines separating different lava flows on the mountain slope.

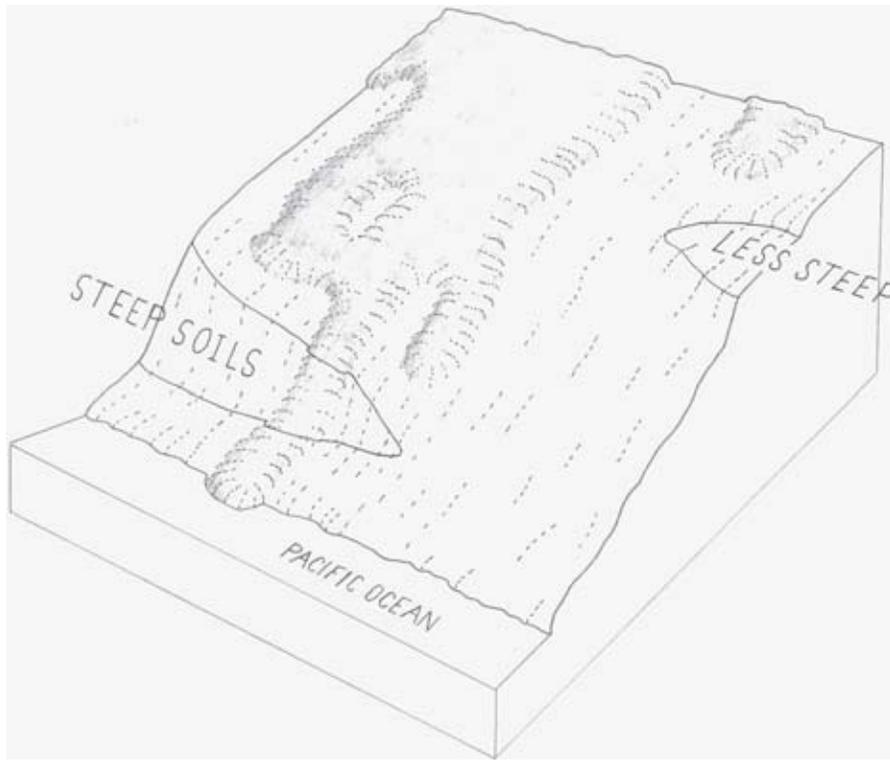


Figure 5.—Steep and less steep soils on the mountain slope.

area have been identified. A detailed onsite investigation should be conducted if detailed information is needed. Figure 6 depicts the mountain slope with soil lines and a spot symbol, and figure 7 shows soil lines, map symbols, and a spot symbol on the same slope.

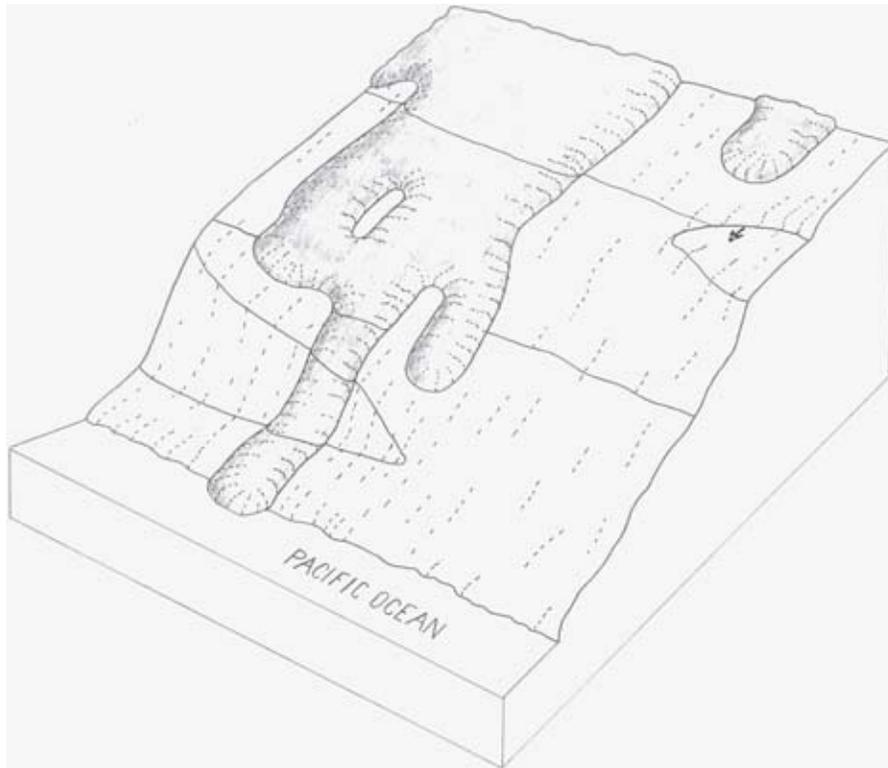


Figure 6.—A depiction of the mountain slope with soil lines and a spot symbol.

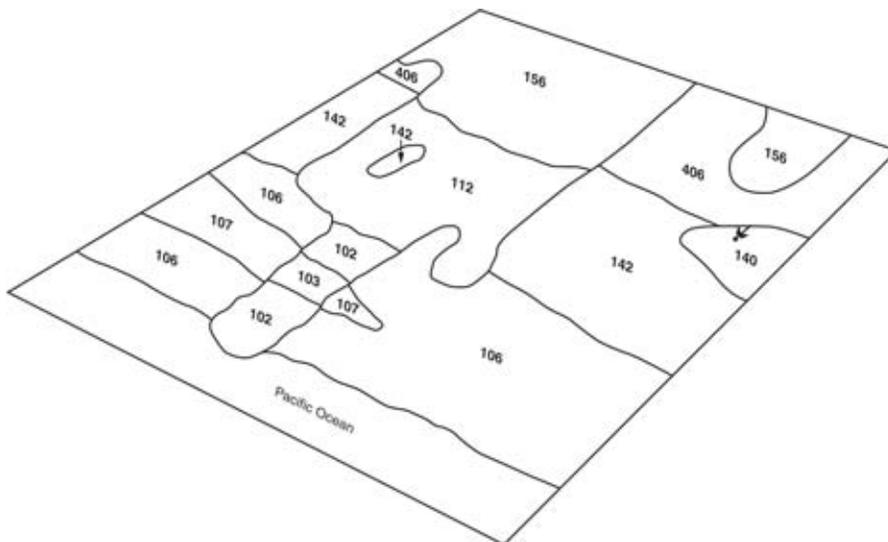


Figure 7.—A depiction of the mountain slope that includes soil lines, map symbols, and a spot symbol.

Detailed Soil Map Units

The map units delineated on the detailed soil maps in this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about the map units is given under the heading "Use and Management of the Soils."

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The contrasting components are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Halemaumau extremely gravelly ashy coarse sand, 2 to 10 percent slopes, is a phase of the Halemaumau series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes or associations.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Puauulu-Hao complex, 2 to 20 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Pahipa-Puali association, 2 to 20 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Cinder land, 20 to 40 percent slopes, is an example.

Table 2 gives the acreage and proportionate extent of each map unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

10—Lava flows, aa, 2 to 20 percent slopes

Map unit setting

General location: All aspects of the Hualalai, Kilauea, Mauna Loa, and Mauna Kea Volcanoes

Geomorphic setting: All hillslope positions of undulating to hilly aa lava flows

Elevation: 0 to 13,680 feet (0 to 4,170 meters)

Mean annual rainfall: 7 to 80 inches (177 to 2,032 millimeters)

Mean annual air temperature: 41 to 86 degrees F (5 to 30 degrees C)

Frost-free period: 180 to 365 days

Map unit composition

Lava flows, aa—100 percent

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on shield volcanoes

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse, angular gravel; 35 to 55 percent by angular cobbles; and 10 to 25 percent by angular stones

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Excessively drained

Use and management

Major use(s): Recreation and wildlife habitat
Major management consideration(s): No soil and poor footing (too jagged and loose)

12—Lava flows, pahoehoe, 2 to 20 percent slopes

Map unit setting

General location: All aspects of the Hualalai, Kilauea, and Mauna Loa Volcanoes
Geomorphic setting: All hillslope positions of nearly level to moderately steep pahoehoe flows
Elevation: 0 to 13,680 feet (0 to 4,170 meters)
Mean annual rainfall: 7 to 80 inches (177 to 2,032 millimeters)
Mean annual air temperature: 41 to 86 degrees F (5 to 30 degrees C)

Map unit composition

Lava flows, pahoehoe—100 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on shield volcanoes
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 2 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: Occasional, extremely brief
Ponding: None
Wetness: None noted
Drainage class: Excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No soil

14—Lava flows complex, 2 to 20 percent slopes

Map unit setting

General location: All aspects of the Hualalai, Kilauea, and Mauna Loa Volcanoes

Geomorphic setting: Mingled or composite lava flows

Elevation: 0 to 13,680 feet (0 to 4,170 meters)

Mean annual rainfall: 7 to 80 inches (177 to 2,032 millimeters)

Mean annual air temperature: 41 to 86 degrees F (5 to 30 degrees C)

Map unit composition

Lava flows, aa—40 to 60 percent

Lava flows, pahoehoe—40 to 60 percent

Characteristics of Lava flows, aa, and Lava flows, pahoehoe

Geomorphic setting: Pahoehoe and aa lava flows on shield volcanoes

Kind of material: Pahoehoe and aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: Pahoehoe—high; aa—very low

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse,
subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Use and management

Major use(s): Wildlife habitat

Major management consideration(s): No soil

15—Cinder land, 2 to 20 percent slopes

Map unit setting

General location: All aspects of the Mauna Kea, Hualalai, Kilauea, and Mauna Loa
Volcanoes

Geomorphic setting: All hillslope positions of nearly level to moderately steep cinder
cones and the adjacent lava flows

Elevation: 0 to 13,680 feet (0 to 4,170 meters)

Mean annual rainfall: 7 to 80 inches (177 to 2,032 millimeters)

Mean annual air temperature: 41 to 86 degrees F (5 to 30 degrees C)

Map unit composition

Cinder land—100 percent

Characteristics of Cinder land

Geomorphic setting: Cinder cones on shield volcanoes

Kind of material: Cinders

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 75 to 80 percent by coarse,
subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 79 inches

Slowest permeability in the cinders: Very rapid

Most rapid permeability in the cinders: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.8 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No soil

16—Cinder land, 20 to 40 percent slopes

Map unit setting

General location: All aspects of the Mauna Kea, Hualalai, Kilauea, and Mauna Loa
Volcanoes

Geomorphic setting: All hillslope positions of steep cinder cones and the adjacent
lava flows

Elevation: 0 to 13,680 feet (0 to 4,170 meters)

Mean annual rainfall: 7 to 80 inches (177 to 2,032 millimeters)

Mean annual air temperature: 41 to 86 degrees F (5 to 30 degrees C)

Map unit composition

Cinder land—100 percent

Characteristics of Cinder land

Geomorphic setting: Cinder cones

Kind of material: Cinders

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 20 to 40 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 75 to 80 percent by coarse,
subangular gravel

Depth to a restrictive feature: Lithic bedrock—40 to 354 inches

Slowest permeability in the cinders: Very rapid

Most rapid permeability in the cinders: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.8 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No soil and loose and unstable material

19—Riverwash, 2 to 10 percent slopes

Map unit setting

General location: The lower elevation, windward slopes on the Kilauea Volcano

Geomorphic setting: Flood plains

Elevation: 0 to 1,000 feet (0 to 305 meters)

Mean annual rainfall: 20 to 30 inches (510 to 760 millimeters)

Mean annual air temperature: 72 to 75 degrees F (22 to 24 degrees C)

Map unit composition

Riverwash—85 to 100 percent

Kanohina and similar soils—0 to 15 percent

Characteristics of Riverwash

Geomorphic setting: Flood plains

Kind of material: Unstabilized sediment that is occasionally flooded and reworked by intermittent streams, including sandy and gravelly alluvium over pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 to 65 percent by coarse, subangular gravel; 0 to 65 percent by subangular cobbles; 0 to 15 percent by subangular stones; 0 to 15 percent by subangular boulders

Depth to a restrictive feature: Lithic bedrock—20 to 157 inches

Slowest permeability in the riverwash: Very rapid

Most rapid permeability in the riverwash: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: Occasional, very brief

Ponding: None

Wetness: None noted
Drainage class: Excessively drained

Estimated minor components

Kanohina and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: Areas not flooded, pahoehoe lava flows (400 to 1,500 years old) on a shield volcano

Use and management

Major use(s): Wildlife habitat
Major management consideration(s): No soil and flooding

24—Badland, geothermal, 2 to 40 percent slopes

Map unit setting

General location: Mid elevation, windward slopes on the Kilauea Volcano
Geomorphic setting: Near volcanic calderas or vents
Elevation: 3,395 to 4,000 feet (1,036 to 1,220 meters)
Mean annual rainfall: 60 to 90 inches (1,525 to 2,285 millimeters)
Mean annual air temperature: 57 to 61 degrees F (14 to 16 degrees C)

Map unit composition

Badland, geothermal—85 to 100 percent
Manu and similar soils—0 to 10 percent
Heake and similar soils—0 to 10 percent

Characteristics of Badland, geothermal

Geomorphic setting: Geothermally heated volcanic fields
Kind of material: Volcanic ash or volcanic rock
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 2 to 40 percent
Surface runoff class: Low
Percentage of the surface covered by rock fragments: 0 percent
Restrictive feature: None noted
Slowest permeability in the material: Not assigned
Most rapid permeability in the material: Not assigned
Salinity: Not saline
Sodicity: Not sodic

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Estimated minor components

Manu and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Heake and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Isolated areas that are not geothermally heated and have soil over pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation

Major management consideration(s): No soil and high ground temperature

26—Lava flows association, 40 to 99 percent slopes

Map unit setting

General location: The lower and mid elevation, windward slopes on the Kilauea Volcano

Geomorphic setting: Escarpment (pali) slopes

Elevation: 400 to 2,495 feet (122 to 762 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,525 millimeters)

Mean annual air temperature: 68 to 75 degrees F (20 to 24 degrees C)

Map unit composition

Lava flows, aa, sparsely vegetated—0 to 100 percent

Lava flows, pahoehoe—0 to 100 percent

Characteristics of Lava flows, aa, sparsely vegetated

Geomorphic setting: Areas of aa lava flow on escarpments on a shield volcano

Kind of material: Aa lava

Ecological site: Low Elevation Makai Range, R161AY008HI

Slope: 40 to 99 percent

Surface runoff class: Negligible

Percentage of the surface covered by rock fragments: 10 to 25 percent by angular stones; 35 to 55 percent by coarse, angular gravel; 35 to 55 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on escarpments on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 40 to 99 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No soil and slope

117—Kapua-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 20 to 60 inches (508 to 1,520 millimeters)

Mean annual air temperature: 63 to 72 degrees F (17 to 22 degrees C)

Map unit composition

Kapua soil—50 to 70 percent

Lava flows, aa—30 to 50 percent

Kali and similar soils—0 to 5 percent

Nanaia and similar soils—0 to 5 percent

Characteristics of the Kapua soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Parent material: Organic material mixed with aa lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 20 to 40 percent by angular cobbles, 20 to 40 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—40 to 60 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.5 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Typical profile

Oa1/2C1—0 to 6 inches; very cobbly highly decomposed plant material

2C2/Oa2—6 to 18 inches; extremely cobbly highly decomposed plant material

2C3—18 to 60 inches; fragmental material

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse,
angular gravel; 35 to 55 percent by angular cobbles; 10 to 25 percent by angular
stones

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Estimated minor components

Kali and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Nanaia and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat, irrigated orchard crops, and livestock grazing

Major management consideration(s): Loss of organic soil after land clearing; short,
steep slopes; and low available water capacity

**130—Mawae very cobbly highly decomposed plant
material, 2 to 10 percent slopes**

Map unit setting

General location: Upper elevation, southwest-facing, leeward slopes on the Mauna
Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows
Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)
Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)
Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Mawae soil—85 to 100 percent
Lava flows, aa—0 to 15 percent
Kealoaha and similar soils—0 to 5 percent
Puukala and similar soils—0 to 5 percent

Characteristics of the Mawae soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano
Parent material: Organic material mixed with aa lava
Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.
Percentage of the surface covered by rock fragments: 50 to 80 percent by angular cobbles
Depth to a restrictive feature: Lithic bedrock—20 to 40 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Oa/2C1—0 to 5 inches; very cobbly highly decomposed plant material
2C2—5 to 40 inches; fragmental material
2R—40 to 44 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Kealoaha and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

131—Mawae very cobbly highly decomposed plant material, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southwest-facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Mawae soil—85 to 100 percent

Lava flows, aa—0 to 15 percent

Kealoha and similar soils—0 to 5 percent

Puukala and similar soils—0 to 5 percent

Characteristics of the Mawae soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Parent material: Organic material mixed with aa lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 20 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 50 to 80 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa/2C1—0 to 5 inches; very cobbly highly decomposed plant material

2C2—5 to 40 inches; fragmental material

2R—40 to 44 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kealoha and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

132—Mawae-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southwest-facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Mawae soil—50 to 70 percent

Lava flows, aa—30 to 50 percent

Kealoha and similar soils—0 to 5 percent

Puukala and similar soils—0 to 5 percent

Characteristics of the Mawae soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Parent material: Organic material mixed with aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Negligible

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 50 to 80 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa/2C1—0 to 5 inches; very cobbly highly decomposed plant material

2C2—5 to 40 inches; fragmental material

2R—40 to 44 inches; bedrock

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 10 to 25 percent by angular stones, 35 to 55 percent by angular cobbles, 35 to 55 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Estimated minor components

Kealoa and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

133—Mawae-Lava flows complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southwest-facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows
Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)
Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)
Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Mawae soil—50 to 70 percent
Lava flows, aa—30 to 50 percent
Kealoha and similar soils—0 to 5 percent
Puukala and similar soils—0 to 5 percent

Characteristics of the Mawae soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano
Parent material: Organic material mixed with aa lava
Ecological site: Mauna Loa Savannah, R161AY010HI
Slope: 10 to 20 percent
Surface runoff class: Low
Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.
Percentage of the surface covered by rock fragments: 50 to 80 percent by angular cobbles
Depth to a restrictive feature: Lithic bedrock—20 to 40 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Oa/2C1—0 to 5 inches; very cobbly highly decomposed plant material
2C2—5 to 40 inches; fragmental material
2R—40 to 44 inches; bedrock

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano
Kind of material: Aa lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 10 to 20 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse, angular gravel; 35 to 55 percent by angular cobbles; 10 to 25 percent by angular stones
Depth to a restrictive feature: Lithic bedrock—20 to 60 inches
Slowest permeability in the lava: Very rapid
Most rapid permeability in the lava: Very rapid
Permeability of the underlying bedrock: Very slow

Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Excessively drained

Estimated minor components

Kealoaha and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat
Major management consideration(s): Loss of organic soil after land clearing

137—Kekake-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, leeward slopes that face west-southwest, on the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows
Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)
Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)
Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Kekake soil—50 to 70 percent
Lava flows, pahoehoe—30 to 50 percent
Mawae and similar soils—0 to 5 percent
Puukala and similar soils—0 to 5 percent

Characteristics of the Kekake soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano
Parent material: Organic material over pahoehoe lava
Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI
Slope: 2 to 10 percent
Surface runoff class: High
Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.
Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 5 inches; gravelly highly decomposed plant material

2R—5 to 9 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse,
subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Estimated minor components

Mawae and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

138—Kekake-Lava flows complex, 10 to 25 percent slopes

Map unit setting

General location: Upper elevation, leeward slopes that face west-southwest, on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Kekake soil—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Mawae and similar soils—0 to 5 percent

Puukala and similar soils—0 to 5 percent

Characteristics of the Kekake soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Organic material over pahoehoe lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 25 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 5 inches; gravelly highly decomposed plant material

2R—5 to 9 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 25 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Moderately slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Estimated minor components

Mawae and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 25 percent

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 25 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

161—Kekake-Mawae complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southwest facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows and hilly aa flows

Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Kekake soil—50 to 70 percent

Mawae soil—30 to 50 percent

Lava flows, pahoehoe—0 to 15 percent

Lava flows, aa—0 to 15 percent

Characteristics of the Kekake soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Organic material over pahoehoe lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of

organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 5 inches; gravelly highly decomposed plant material

2R—5 to 9 inches; bedrock

Characteristics of the Mawae soil

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Parent material: Organic material mixed with aa lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 20 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 50 to 80 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa/2C1—0 to 5 inches; very cobbly highly decomposed plant material

2C2—5 to 40 inches; fragmental material

2R—40 to 44 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 15 percent

Slope: 10 to 20 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

163—Lava flows-Kekake complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, leeward slopes that face west-southwest, on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Lava flows, pahoehoe—60 to 80 percent

Kekake soil—20 to 40 percent

Mawae and similar soils—0 to 5 percent

Puukala and similar soils—0 to 5 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Characteristics of the Kekake soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Organic material over pahoehoe lava

Ecological site: Pahoehoe Shrubland, R161AY011HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 5 inches; gravelly highly decomposed plant material

2R—5 to 9 inches; bedrock

Estimated minor components

Mawae and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

164—Lava flows-Kekake complex, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, west-facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level to moderately steep pahoehoe flows

Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Lava flows, pahoehoe—80 to 100 percent

Kekake soil—0 to 20 percent

Mawae and similar soils—0 to 5 percent

Puukala and similar soils—0 to 5 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular
cobble, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Characteristics of the Kekake soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Organic material over pahoehoe lava

Ecological site: Pahoehoe Shrubland, R161AY011HI

Slope: 2 to 20 percent

Surface runoff class: High

Surface feature(s): The soil is hydrophobic when dry because of a high content of
organic matter. After land clearing, as much as half the organic matter is lost
because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 5 to 15 percent by coarse,
subangular gravel, 0 to 10 percent by subangular cobble

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 5 inches; gravelly highly decomposed plant material

2R—5 to 9 inches; bedrock

Estimated minor components

Mawae and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 20 percent

Geomorphic setting: 0.75 to 3 ka aa lava flows on a shield volcano

Puukala and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 20 percent

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Loss of organic soil after land clearing

169—Iwalani-Lava flows complex, moist, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in nearly level and gently sloping pahoehoe flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Iwalani soil, moist—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Characteristics of Iwalani soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 3 inches; medial very fine sandy loam
A'—3 to 5 inches; medial loamy sand
B'w—5 to 10 inches; medial very fine sandy loam
2R—10 to 14 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular
cobble, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Shallow depth to bedrock

179—Iwalani-Lava flows complex, moist, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna
Loa Volcano

Geomorphic setting: Depressions in strongly sloping and moderately steep pahoehoe
flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Iwalani soil, moist—60 to 80 percent

Lava flows, pahoehoe—20 to 40 percent

Characteristics of Iwalani soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over pahoehoe lava

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 3 inches; medial very fine sandy loam

A'—3 to 5 inches; medial loamy sand

B'w—5 to 10 inches; medial very fine sandy loam

2R—10 to 14 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Shallow depth to bedrock

205—Ihuanu very cobbly medial silt loam, moist, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Ihuanu soil, moist—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of Ihuanu soil, moist

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam

2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam

2C3—20 to 22 inches; extremely gravelly coarse sand

2R—22 to 26 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Slope; short, steep slopes in some areas; a poor filtering capacity; and large stones

206—Ihuanu very cobbly medial silt loam, moist, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Ihuanu soil, moist—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of Ihuanu soil, moist

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam

2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam

2C3—20 to 22 inches; extremely gravelly coarse sand

2R—22 to 26 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Short, steep slopes in some areas; a poor filtering capacity; and large stones

211—Kapulehu very cobbly medial silt loam, moist, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Kapulehu soil, moist—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of Kapulehu soil, moist

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 15 to 25 percent by coarse, subangular gravel, 25 to 45 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Seasonal dryness

212—Kapulehu very cobbly medial silt loam, moist, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Kapulehu soil, moist—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of Kapulehu soil, moist

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 25 to 45 percent by angular cobbles, 15 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Seasonal dryness

213—Nanaia-Lava flows complex, moist, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in nearly level and gently sloping pahoehoe flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Nanaia soil, moist—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Keaa and similar soils—0 to 15 percent

Characteristics of Nanaia soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 10 to 20 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.7 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; gravelly medial silt loam

Bw—2 to 6 inches; medial silt loam

2R—6 to 10 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat and livestock grazing

214—Lava flows-Nanaia complex, moist, 2 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: Depressions in nearly level to moderately steep pahoehoe flows
Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)
Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)
Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Lava flows, pahoehoe—50 to 70 percent
Nanaia soil, moist—30 to 50 percent
Keaa and similar soils—0 to 15 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 2 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular cobbles, 0 to 25 percent by coarse, subangular gravel
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Characteristics of Nanaia soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 10 to 20 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.7 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; gravelly medial silt loam

Bw—2 to 6 inches; medial silt loam

2R—6 to 10 inches; bedrock

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 20 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat and livestock grazing

215—Keaa cobbly medial loam, moist, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Keaa soil, moist—85 to 100 percent

Nanaia and similar soils—0 to 5 percent

Lava flows, pahoehoe—0 to 5 percent

Characteristics of Keaa soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam

Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam

Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam

2R—18 to 22 inches; bedrock

Estimated minor components

Nanaia and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat, building site development, and orchard crops

Major management consideration(s): Shallow depth to bedrock, very low available water capacity, and high phosphorus retention

216—Keaa cobbly medial loam, moist, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Keaa soil, moist—85 to 100 percent

Nanaia and similar soils—0 to 5 percent

Lava flows, pahoehoe—0 to 5 percent

Characteristics of Keaa soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam

Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam

Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam

2R—18 to 22 inches; bedrock

Estimated minor components

Nanaia and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat, building site development, and orchard crops

Major management consideration(s): Shallow depth to bedrock, slope, very low available water capacity, and high phosphorus retention

217—Kapulehu-Keaa complex, moist, 20 to 40 percent slopes

Map unit setting

General location: Mid elevation, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of steep aa flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Kapulehu soil, moist—50 to 70 percent

Keaa soil, moist—30 to 50 percent

Characteristics of Kapulehu soil, moist

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 20 to 40 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 15 to 25 percent by coarse, subangular gravel, 25 to 45 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Characteristics of Keaa soil, moist

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 20 to 40 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam

Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam

Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam

2R—18 to 22 inches; bedrock

Use and management

Major use(s): Livestock grazing and wildlife habitat

218—Kiolakaa medial loam, moist, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Kiolakaa soil, moist—85 to 100 percent

Keaa and similar soils—0 to 15 percent

Characteristics of Kiolakaa soil, moist

Geomorphic setting: 5 to 10 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial loam

AB—6 to 10 inches; cobbly medial fine sandy loam

Bw1/2C1—10 to 15 inches; very cobbly medial loam

Bw2/2C2—15 to 25 inches; very cobbly medial loam

2R—25 to 29 inches; bedrock

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing

219—Kiolakaa-Keaa complex, moist, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 2,400 to 4,590 feet (732 to 1,400 meters)

Mean annual rainfall: 53 to 59 inches (1,350 to 1,500 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Map unit composition

Kiolakaa soil—50 to 70 percent

Keaa soil—30 to 50 percent

Characteristics of the Kiolakaa soil

Geomorphic setting: 5 to 10 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial loam

AB—6 to 10 inches; cobbly medial fine sandy loam

Bw1/2C1—10 to 15 inches; very cobbly medial loam

Bw2/2C2—15 to 25 inches; very cobbly medial loam

2R—25 to 29 inches; bedrock

Characteristics of the Keaa soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam

Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam

Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam

2R—18 to 22 inches; bedrock

Use and management

Major use(s): Livestock grazing

275—Kapulehu-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (762 to 1,524 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Kapulehu soil—50 to 70 percent

Lava flows, aa—30 to 50 percent

Characteristics of the Kapulehu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 25 to 45 percent by angular cobbles, 15 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse, angular gravel; 10 to 25 percent by angular stones; 35 to 55 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None
Wetness: None noted
Drainage class: Excessively drained

Use and management

Major use(s): Livestock grazing and wildlife habitat

276—Kapulehu very cobbly medial silt loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (762 to 1,524 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Kapulehu soil—90 to 100 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Kapulehu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 15 to 25 percent by coarse, subangular gravel, 25 to 45 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

277—Kapulehu very cobbly medial silt loam, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (762 to 1,524 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Kapulehu soil—90 to 100 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Kapulehu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 10 to 20 percent

Surface runoff class: Low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 15 to 25 percent by coarse, subangular gravel, 25 to 45 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.7 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly medial silt loam

2C2/Bw—10 to 26 inches; extremely cobbly medial loam

2R—26 to 30 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

280—Nanaia-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in nearly level and gently sloping pahoehoe flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,524 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Nanaia soil—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Keaa and similar soils—0 to 15 percent

Characteristics of the Nanaia soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 10 to 20 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.7 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; gravelly medial silt loam

Bw—2 to 6 inches; medial silt loam

2R—6 to 10 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular cobbles, 0 to 25 percent by coarse, subangular gravel
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat and livestock grazing

281—Lava flows-Nanaia complex, 2 to 20 percent slopes

Map unit setting

General location: Mid elevation, south- and southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: Depressions in nearly level to moderately steep pahoehoe flows
Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)
Mean annual rainfall: 30 to 60 inches (760 to 1,524 millimeters)
Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Lava flows, pahoehoe—50 to 70 percent
Nanaia soil—30 to 50 percent
Keaa and similar soils—0 to 15 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 2 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Characteristics of the Nanaia soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 10 to 20 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.7 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; gravelly medial silt loam

Bw—2 to 6 inches; medial silt loam

2R—6 to 10 inches; bedrock

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 20 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat and livestock grazing

290—Keaa cobbly medial loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,524 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Keaa soil—85 to 100 percent
Nanaia and similar soils—0 to 5 percent
Lava flows, pahoehoe—0 to 5 percent

Characteristics of the Keaa soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano
Parent material: Basic volcanic ash over pahoehoe lava
Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI
Slope: 2 to 10 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel
Depth to a restrictive feature: Lithic bedrock—10 to 20 inches
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam
Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam
Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam
2R—18 to 22 inches; bedrock

Estimated minor components

Nanaia and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat, building site development, and orchard crops
Major management consideration(s): Shallow depth to bedrock, very low available water capacity, and high phosphorus retention

292—Keaa-Kiolakaa complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,524 millimeters)

Mean annual air temperature: 64 to 72 degrees F (18 to 22 degrees C)

Map unit composition

Keaa soil—50 to 70 percent

Kiolakaa soil—30 to 50 percent

Nanaia and similar soils—0 to 5 percent

Characteristics of the Keaa soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 10 to 20 percent by subangular cobbles, 5 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; cobbly medial loam

Bw1/2C1—4 to 10 inches; very cobbly medial very fine sandy loam

Bw2/2C2—10 to 18 inches; very cobbly medial very fine sandy loam

2R—18 to 22 inches; bedrock

Characteristics of the Kiolakaa soil

Geomorphic setting: 5 to 10 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial loam

AB—6 to 10 inches; cobbly medial fine sandy loam

Bw1/2C1—10 to 15 inches; very cobbly medial loam

Bw2/2C2—15 to 25 inches; very cobbly medial loam

2R—25 to 29 inches; bedrock

Estimated minor components

Nanaia and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Wildlife habitat, building site development, and orchard crops

Major management consideration(s): Shallow depth to bedrock, very low available water capacity, and high phosphorus retention

300—Kamaoa medial loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south- and southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping lava flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,524 millimeters)

Mean annual air temperature: 64 to 72 degrees F (18 to 22 degrees C)

Map unit composition

Kamaoa soil—85 to 100 percent

Kiolakaa and similar soils—0 to 15 percent

Kapulehu and similar soils—0 to 15 percent

Characteristics of the Kamaoa soil

Geomorphic setting: 5 ka lava flows on a shield volcano

Parent material: Basic volcanic ash

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—60 to 79 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 7.7 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 7 inches; medial loam

BA—7 to 21 inches; medial loam

Bw1—21 to 47 inches; medial silty clay loam

Bw2—47 to 68 inches; medial silt loam

2R—68 to 72 inches; bedrock

Estimated minor components

Kiolakaa and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: 5 to 10 ka pahoehoe lava flows on a shield volcano

Kapulehu and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing

305—Kiolakaa medial loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south- and southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 1,000 to 3,500 feet (305 to 1,067 meters)

Mean annual rainfall: 30 to 60 inches (762 to 1,524 millimeters)

Mean annual air temperature: 64 to 72 degrees F (18 to 22 degrees C)

Map unit composition

Kiolakaa soil—85 to 100 percent

Keaa and similar soils—0 to 15 percent

Characteristics of the Kiolakaa soil

Geomorphic setting: 5 to 10 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Kona Weather Pattern Dry Forest, F161BY501HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial loam

AB—6 to 10 inches; cobbly medial fine sandy loam

Bw1/2C1—10 to 15 inches; very cobbly medial loam

Bw2/2C2—15 to 25 inches; very cobbly medial loam

2R—25 to 29 inches; bedrock

Estimated minor components

Keaa and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing

395—Hokukano-Lava flows complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, west-facing, leeward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 3,500 to 6,995 feet (1,067 to 2,133 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Map unit composition

Hokukano soil—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Puukala and similar soils—0 to 15 percent

Characteristics of the Hokukano soil

Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 5 to 10 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 2.5 inches (very low)

Hydrologic properties

Flash flooding: Occasional, extremely brief
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial silt loam
Bw1—6 to 10 inches; cobbly medial silt loam
Bw2—10 to 20 inches; cobbly medial silt loam
2R—20 to 24 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI
Slope: 10 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse,
subangular gravel, 0 to 25 percent by subangular cobbles
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Estimated minor components

Puukala and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 10 to 20 percent
Geomorphic setting: 3 to 5 ka pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing

401—Ihuanu-Lava flows complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, south- and southeast-facing, windward slopes on
the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of hilly aa flows

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Ihuanu soil—50 to 70 percent

Lava flows, aa—30 to 50 percent

Characteristics of the Ihuanu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 10 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam

2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam

2C3—20 to 22 inches; extremely gravelly coarse sand

2R—22 to 26 inches; bedrock

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse, angular gravel; 35 to 55 percent by angular cobbles; 10 to 25 percent by angular stones

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Use and management

Major use(s): Wildlife habitat and building site development

Major management consideration(s): Slope; short, steep slopes in some areas; a poor filtering capacity; and large stones

402—Ihuanu very cobbly medial silt loam, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Ihuanu soil—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of the Ihuanu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 10 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam

2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam

2C3—20 to 22 inches; extremely gravelly coarse sand

2R—22 to 26 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Slope; short, steep slopes in some areas; a poor filtering capacity; and large stones

403—Ihuanu very cobbly medial silt loam, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Ihuanu soil—90 to 100 percent

Lava flows, aa—0 to 5 percent

Characteristics of the Ihuanu soil

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam

2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam

2C3—20 to 22 inches; extremely gravelly coarse sand

2R—22 to 26 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Short, steep slopes in some areas; a poor filtering capacity; and large stones

406—Lava flows-Iwalani complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, south- and southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in strongly sloping and moderately steep pahoehoe flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Lava flows, pahoehoe—60 to 80 percent

Iwalani soil—20 to 40 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular cobbles, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Characteristics of the Iwalani soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Slope: 10 to 20 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 3 inches; medial very fine sandy loam

A'—3 to 5 inches; medial loamy sand

B'w—5 to 10 inches; medial very fine sandy loam

2R—10 to 14 inches; bedrock

Use and management

Major use(s): Wildlife habitat and building site development

Major management consideration(s): Slope and shallow depth to bedrock

407—Iwalani-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in nearly level and gently sloping pahoehoe flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Iwalani soil—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Characteristics of the Iwalani soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 3 inches; medial very fine sandy loam

A'—3 to 5 inches; medial loamy sand

B'w—5 to 10 inches; medial very fine sandy loam

2R—10 to 14 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular cobbles, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Shallow depth to bedrock

408—Iwalani-Lava flows complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in strongly sloping and moderately steep pahoehoe flows

Elevation: 3,500 to 5,400 feet (1,067 to 1,646 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Iwalani soil—60 to 80 percent

Lava flows, pahoehoe—20 to 40 percent

Characteristics of the Iwalani soil

Geomorphic setting: 1.5 to 3 ka pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash and cinders over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 10 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 3 inches; medial very fine sandy loam

A'—3 to 5 inches; medial loamy sand

B'w—5 to 10 inches; medial very fine sandy loam

2R—10 to 14 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 10 to 20 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular cobbles, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Use and management

Major use(s): Building site development and wildlife habitat

Major management consideration(s): Shallow depth to bedrock

461—Hapuu very gravelly medial silt loam, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, west-facing, leeward slopes on the undissected upland of the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of hilly aa flows

Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Hapuu soil, very gravelly—85 to 100 percent

Kealoha and similar soils—0 to 15 percent

Lava flows, aa—0 to 15 percent

Characteristics of Hapuu soil, very gravelly

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI

Slope: 10 to 20 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 30 to 40 percent by coarse, subangular gravel, 5 to 15 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—40 to 60 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.6 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 4 inches; very gravelly medial silt loam

2C2/Bw—4 to 6 inches; extremely gravelly loamy sand

2C3—6 to 14 inches; extremely gravelly sand
2C4—14 to 43 inches; extremely gravelly sand
2R—43 to 47 inches; bedrock

Estimated minor components

Kealoha and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 10 to 20 percent
Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent
Slope: 10 to 20 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

463—Hapuu extremely gravelly medial silt loam, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, west-facing, leeward slopes on the undissected upland of the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of hilly aa flows
Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)
Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Map unit composition

Hapuu soil, extremely gravelly—85 to 100 percent
Kealoha and similar soils—0 to 15 percent
Lava flows, aa—0 to 15 percent

Characteristics of Hapuu soil, extremely gravelly

Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano
Parent material: Basic volcanic ash over aa lava
Ecological site: Koa-Sandalwood-Mamane Forest, F161BY503HI
Slope: 10 to 20 percent
Surface runoff class: Low
Percentage of the surface covered by rock fragments: 5 to 15 percent by angular cobbles, 55 to 65 percent by coarse, subangular gravel
Depth to a restrictive feature: Lithic bedrock—40 to 60 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None

Wetness: None noted
Drainage class: Well drained

Typical profile

2C1/A—0 to 4 inches; extremely gravelly medial silt loam
2C2/Bw—4 to 6 inches; extremely gravelly loamy sand
2C3—6 to 14 inches; extremely gravelly sand
2C4—14 to 43 inches; extremely gravelly sand
2R—43 to 47 inches; bedrock

Estimated minor components

Kealoaha and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 10 to 20 percent
Geomorphic setting: 1.5 to 3 ka aa lava flows on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent
Slope: 10 to 20 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

511—Akihi very cobbly hydrous silt loam, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of hilly aa flows
Elevation: 1,200 to 4,000 feet (366 to 1,220 meters)
Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)
Mean annual air temperature: 61 to 68 degrees F (16 to 20 degrees C)

Map unit composition

Akihi soil—100 percent

Characteristics of the Akihi soil

Geomorphic setting: Areas of aa lava flow on a shield volcano
Parent material: Basic volcanic ash over aa lava
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 10 to 20 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 20 to 30 percent by angular cobbles, 5 to 15 percent by coarse, angular gravel
Depth to a restrictive feature: Lithic bedrock—20 to 40 inches
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 3.8 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly hydrous silt loam

Bw/2C2—10 to 35 inches; very cobbly hydrous silty clay loam

2R—35 to 39 inches; bedrock

Use and management

Major use(s): Forestland, wildlife habitat, orchard crops, and livestock grazing

Major management consideration(s): Short, steep slopes in some areas; susceptibility to compaction; and high phosphorus retention

512—Akihi very cobbly hydrous silt loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa flows

Elevation: 1,200 to 4,000 feet (366 to 1,220 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 61 to 68 degrees F (16 to 20 degrees C)

Map unit composition

Akihi soil—100 percent

Characteristics of the Akihi soil

Geomorphic setting: Areas of aa lava flow on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 5 to 15 percent by coarse, angular gravel, 20 to 30 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.8 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A/2C1—0 to 10 inches; very cobbly hydrous silt loam

Bw/2C2—10 to 35 inches; very cobbly hydrous silty clay loam
2R—35 to 39 inches; bedrock

Use and management

Major use(s): Forestland, wildlife habitat, orchard crops, and livestock grazing

Major management consideration(s): Short, steep slopes in some areas;
susceptibility to compaction; and high phosphorus retention

513—Hilea hydrous silty clay loam, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the upland of the Mauna Loa and Kilauea Volcanoes

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep pahoehoe flows

Elevation: 1,000 to 4,000 feet (305 to 1,220 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Hilea soil—100 percent

Characteristics of the Hilea soil

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 5 to 15 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—8 to 20 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.6 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa—0 inches; highly decomposed plant material

A—0 to 8 inches; hydrous silty clay loam

Bw—8 to 19 inches; hydrous silty clay loam

2R—19 to 23 inches; bedrock

Use and management

Major use(s): Forestland, wildlife habitat, and livestock grazing

Major management consideration(s): Very strongly acid reaction

514—Hilea hydrous silty clay loam, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the upland of the Mauna Loa and Kilauea Volcanoes

Geomorphic setting: All hillslope positions of nearly level and gently sloping pahoehoe flows

Elevation: 1,000 to 4,000 feet (305 to 1,220 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Hilea soil—100 percent

Characteristics of the Hilea soil

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 3 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 5 to 15 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—8 to 20 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.6 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa—0 inches; highly decomposed plant material

A—0 to 8 inches; hydrous silty clay loam

Bw—8 to 19 inches; hydrous silty clay loam

2R—19 to 23 inches; bedrock

Use and management

Major use(s): Forestland, wildlife habitat, and livestock grazing

Major management consideration(s): Very strongly acid reaction

515—Pahipa-Puali association, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of nearly level to moderately steep pahoehoe flows and undulating to hilly aa flows

Elevation: 4,000 to 6,000 feet (1,220 to 1,829 meters)

Mean annual rainfall: 60 to 100 inches (1,524 to 2,540 millimeters)

Mean annual air temperature: 52 to 59 degrees F (11 to 15 degrees C)

Map unit composition

Pahipa soil—40 to 50 percent

Puali soil—40 to 50 percent

Aquands and similar soils—0 to 15 percent

Characteristics of the Pahipa soil

Geomorphic setting: Areas of aa lava flow on a shield volcano

Parent material: Basic volcanic ash over aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 5 to 10 percent by angular cobbles, 5 to 10 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately slow

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 5.1 inches (moderate)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oe—0 to 2 inches; moderately decomposed plant material

A—2 to 8 inches; hydrous silty clay loam

2A—8 to 16 inches; gravelly highly organic hydrous silt loam

2Bw1/3C1—16 to 30 inches; very cobbly hydrous silty clay loam

3C2/2Bw2—30 to 39 inches; extremely cobbly hydrous silty clay loam

3R—39 to 43 inches; bedrock

Characteristics of the Puali soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.4 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted
Drainage class: Well drained

Typical profile

Oe—0 to 4 inches; moderately decomposed plant material
A—4 to 10 inches; highly organic hydrous silt loam
Bw—10 to 18 inches; cobbly hydrous silty clay loam
2R—18 to 22 inches; bedrock

Estimated minor components

Aquands and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 8 percent
Geomorphic setting: Depressions and gently sloping areas in pahoehoe lava flows

Use and management

Major use(s): Forestland and wildlife habitat

516—Alapai hydrous silty clay loam, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, windward slopes on the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of gently sloping lava flows
Elevation: 1,595 to 3,995 feet (487 to 1,219 meters)
Mean annual rainfall: 90 to 150 inches (2,286 to 3,810 millimeters)
Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Alapai soil—100 percent

Characteristics of the Alapai soil

Geomorphic setting: More than 10 ka lava flows on a shield volcano
Parent material: Basic volcanic ash over basalt
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 3 to 10 percent
Surface runoff class: Medium
Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel
Restrictive feature: None noted
Slowest permeability in the soil: Moderate
Most rapid permeability in the soil: Moderately rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 11.8 inches (very high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Ap1—0 to 7 inches; hydrous silty clay loam

Ap2—7 to 15 inches; hydrous silty clay loam
B/A—15 to 27 inches; hydrous silty clay loam
Bw1—27 to 36 inches; hydrous silty clay loam
Bw2—36 to 43 inches; hydrous silty clay loam
Bw3—43 to 50 inches; hydrous silty clay loam
Bw4—50 to 57 inches; hydrous silty clay loam
Bw5—57 to 66 inches; hydrous silty clay loam
Bw6—66 to 70 inches; hydrous silty clay loam
Bw7—70 to 74 inches; hydrous silty clay loam

Use and management

Major use(s): Orchard crops, agroforestry, and livestock grazing

Major management consideration(s): Very strongly acid reaction and high phosphorus retention

517—Alapai hydrous silty clay loam, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep lava flows

Elevation: 1,595 to 4,000 feet (487 to 1,220 meters)

Mean annual rainfall: 90 to 150 inches (2,286 to 3,810 millimeters)

Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Alapai soil—100 percent

Characteristics of the Alapai soil

Geomorphic setting: More than 10 ka lava flows on a shield volcano

Parent material: Basic volcanic ash over basalt

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 10 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Restrictive feature: None noted

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 11.8 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Ap1—0 to 7 inches; hydrous silty clay loam

Ap2—7 to 15 inches; hydrous silty clay loam

B/A—15 to 27 inches; hydrous silty clay loam
Bw1—27 to 36 inches; hydrous silty clay loam
Bw2—36 to 43 inches; hydrous silty clay loam
Bw3—43 to 50 inches; hydrous silty clay loam
Bw4—50 to 57 inches; hydrous silty clay loam
Bw5—57 to 66 inches; hydrous silty clay loam
Bw6—66 to 70 inches; hydrous silty clay loam
Bw7—70 to 74 inches; hydrous silty clay loam

Use and management

Major use(s): Orchard crops, agroforestry, and livestock grazing

Major management consideration(s): Very strongly acid reaction and high phosphorus retention

518—Alapai hydrous silty clay loam, 20 to 35 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of steep lava flows

Elevation: 1,595 to 4,000 feet (487 to 1,220 meters)

Mean annual rainfall: 90 to 150 inches (2,286 to 3,810 millimeters)

Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Alapai soil—100 percent

Characteristics of the Alapai soil

Geomorphic setting: More than 10 ka lava flows on a shield volcano

Parent material: Basic volcanic ash over basalt

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 20 to 35 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, subangular gravel

Restrictive feature: None noted

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 11.8 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Ap1—0 to 7 inches; hydrous silty clay loam

Ap2—7 to 15 inches; hydrous silty clay loam

B/A—15 to 27 inches; hydrous silty clay loam

Bw1—27 to 36 inches; hydrous silty clay loam

Bw2—36 to 43 inches; hydrous silty clay loam
Bw3—43 to 50 inches; hydrous silty clay loam
Bw4—50 to 57 inches; hydrous silty clay loam
Bw5—57 to 66 inches; hydrous silty clay loam
Bw6—66 to 70 inches; hydrous silty clay loam
Bw7—70 to 74 inches; hydrous silty clay loam

Use and management

Major use(s): Orchard crops, agroforestry, and livestock grazing

Major management consideration(s): Very strongly acid reaction, slope, and high phosphorus retention

519—Lalau very cobbly highly decomposed plant material, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of undulating and rolling aa lava flows

Elevation: 1,000 to 7,000 feet (305 to 2,134 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 52 to 59 degrees F (11 to 15 degrees C)

Map unit composition

Lalau soil—90 to 100 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Lalau soil

Geomorphic setting: 0.75 ka and younger aa lava flows on a shield volcano

Parent material: Organic material mixed with minor amounts of basic volcanic ash in aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 35 to 60 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—40 to 60 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa/2C1—0 to 3 inches; very cobbly highly decomposed plant material
2C2—3 to 53 inches; fragmental material
2R—53 to 57 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Forestland, wildlife habitat, and livestock grazing

Major management consideration(s): Loss of organic soil after land clearing and very strongly acid reaction

525—Alapai hydrous silty clay loam, low precipitation, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of strongly sloping and moderately steep lava flows

Elevation: 1,000 to 1,900 feet (305 to 580 meters)

Mean annual rainfall: 60 to 90 inches (1,524 to 2,286 millimeters)

Mean annual air temperature: 61 to 70 degrees F (16 to 21 degrees C)

Map unit composition

Alapai soil, low precipitation—100 percent

Characteristics of Alapai soil, low precipitation

Geomorphic setting: Lava flows

Parent material: Pahala basaltic volcanic ash

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 10 to 20 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 percent

Restrictive feature: None noted

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderately rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 11.8 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Ap—0 to 9 inches; hydrous silty clay loam

Bw1—9 to 17 inches; hydrous silty clay loam

Bw2—17 to 23 inches; hydrous silty clay loam
Bw3—23 to 31 inches; hydrous silty clay loam
Bw4—31 to 40 inches; hydrous silty clay loam
Bw5—40 to 48 inches; hydrous silty clay loam
Bw6—48 to 54 inches; hydrous silty clay loam
Bw7—54 to 65 inches; hydrous silty clay loam
Bw8—65 to 74 inches; hydrous silty clay loam

Use and management

Major use(s): Livestock grazing, agroforestry, and orchard crops

Major management consideration(s): Very strongly acid reaction and high phosphorus retention

534—Kahaluu-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward mountain slopes on the Mauna Loa Volcano

Geomorphic setting: Depressions in nearly level and gently sloping pahoehoe lava flows

Elevation: 3,500 to 7,000 feet (1,067 to 2,134 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 52 to 57 degrees F (11 to 14 degrees C)

Map unit composition

Kahaluu soil—50 to 70 percent

Lava flows, pahoehoe—30 to 50 percent

Characteristics of the Kahaluu soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Organic material over pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 20 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—1 to 10 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.1 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oa—0 to 5 inches; highly decomposed plant material

2R—5 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 25 percent by subangular
cobble, 0 to 25 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Use and management

Major use(s): Forestland and wildlife habitat

555—Kuanene-Lava flows complex, 20 to 35 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna
Loa Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 1,495 to 4,500 feet (457 to 1,372 meters)

Mean annual rainfall: 61 to 118 inches (1,550 to 3,000 millimeters)

Mean annual air temperature: 59 to 72 degrees F (15 to 22 degrees C)

Map unit composition

Kuanene soil—35 to 75 percent

Lava flows, pahoehoe—25 to 65 percent

Characteristics of the Kuanene soil

Geomorphic setting: Mauna Loa pahoehoe lava flows

Parent material: Basaltic volcanic ash over pahoehoe lava, 750 to 3,000 years old

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 20 to 35 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—10 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.7 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oi—0 to 1 inch; slightly decomposed plant material

A—1 to 6 inches; medial loam

2A—6 to 7 inches; medial fine sandy loam

2C—7 to 12 inches; ashy loamy fine sand

3Bw—12 to 17 inches; cobbly medial fine sandy loam

4R—17 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Mauna Loa pahoehoe lava flows

Parent material: Pahoehoe lava 750 to 3,000 years old

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 20 to 35 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—0 to 1 inch

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: Rare, extremely brief

Ponding: None

Wetness: None noted

Use and management

Major use(s): Forestland, livestock grazing, wildlife habitat, and recreation

Major management consideration(s): Moderate acidity and moderate or high phosphorus retention

574—Ihuanu-Lava flows complex, 10 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Pahoehoe lava flows with a patchy cover of ash

Elevation: 6,495 to 7,995 feet (1,981 to 2,438 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 50 to 54 degrees F (10 to 12 degrees C)

Frost-free period: 270 to 300 days

Map unit composition

Ihuanu soil—30 to 70 percent
Lava flows, pahoehoe—15 to 50 percent
Iwalani and similar soils—0 to 15 percent

Characteristics of the Ihuanu soil

Geomorphic setting: Areas of aa lava flow
Parent material: Basic volcanic ash and cinders over aa lava
Ecological site: Mauna Loa Savannah, R161AY010HI
Slope: 10 to 20 percent
Surface runoff class: Medium
Percentage of the surface covered by rock fragments: 15 to 35 percent by angular cobbles, 15 to 35 percent by coarse, angular gravel
Depth to a restrictive feature: Lithic bedrock—20 to 40 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.4 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A/2C1—0 to 2 inches; very cobbly medial silt loam
2C2/Bw—2 to 20 inches; extremely cobbly medial sandy loam
2C3—20 to 22 inches; extremely gravelly coarse sand
2R—22 to 26 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Areas of pahoehoe lava flow
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI
Slope: 10 to 20 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—0 to 1 inch
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted

Estimated minor components

Iwalani and similar soils

Extent of component in mapped areas: 0 to 15 percent

Slope: 10 to 20 percent

Geomorphic setting: Pahoehoe lava flows with a thin cover of ash

Use and management

Major use(s): Wildlife habitat and recreation

Major management consideration(s): Seasonal dryness and a low capacity to supply natural potassium

575—Durustands medial loam, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Kipukas with a moderately deep accumulation of ash

Elevation: 6,395 to 7,050 feet (1,950 to 2,150 meters)

Mean annual rainfall: 40 to 50 inches (1,016 to 1,270 millimeters)

Mean annual air temperature: 50 to 54 degrees F (10 to 12 degrees C)

Frost-free period: 270 to 300 days

Map unit composition

Durustands—85 to 100 percent

Lava flows, pahoehoe—0 to 15 percent

Characteristics of Durustands

Geomorphic setting: Kipukas on pahoehoe lava flows

Parent material: Pahala volcanic ash over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 to 15 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately slow

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 4.9 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; medial loam

2Bw—4 to 6 inches; medial very fine sandy loam

3A—6 to 7 inches; medial silt loam

3Bw—7 to 11 inches; medial silt loam

3Bs—11 to 13 inches; cemented silt loam

4Bw—13 to 26 inches; hydrous silty clay loam
5R—26 to 36 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 15 percent

Slope: 6 to 15 percent

Geomorphic setting: Occasional outcrops of pahoehoe lava flow

Use and management

Major use(s): Wildlife habitat and recreation

576—Puali-Puu Oo-Pahipa association, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Areas with mixed lava flow types and ages

Elevation: 4,500 to 6,495 feet (1,372 to 1,981 meters)

Mean annual rainfall: 60 to 100 inches (1,524 to 2,540 millimeters)

Mean annual air temperature: 55 to 59 degrees F (13 to 15 degrees C)

Frost-free period: 180 to 365 days

Map unit composition

Puali soil—30 to 50 percent

Puu Oo soil—30 to 50 percent

Pahipa soil—20 to 35 percent

Aquands and similar soils—0 to 5 percent

Characteristics of the Puali soil

Geomorphic setting: Pahoehoe lava flows with a shallow cover of ash

Parent material: Basic volcanic ash over pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.7 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oe—0 to 4 inches; moderately decomposed plant material

A—4 to 10 inches; highly organic hydrous silt loam

Bw—10 to 18 inches; cobbly hydrous silty clay loam
2R—18 to 22 inches; bedrock

Characteristics of the Puu Oo soil

Geomorphic setting: Large kipukas
Parent material: Basaltic volcanic ash
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 2 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—39 to 79 inches
Slowest permeability in the soil: Moderate
Most rapid permeability in the soil: Moderately rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 9.0 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam
A2—3 to 6 inches; medial silt loam
2Bw1—6 to 9 inches; hydrous silty clay loam
2Bw2—9 to 16 inches; hydrous silty clay loam
2Bw3—16 to 22 inches; hydrous silty clay loam
2Bw4—22 to 27 inches; hydrous silty clay loam
3Bw5—27 to 50 inches; medial sandy clay loam

Characteristics of the Pahipa soil

Geomorphic setting: Areas of aa lava flow with a cover of volcanic ash
Parent material: Basic volcanic ash over aa lava
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 2 to 20 percent
Surface runoff class: Medium
Percentage of the surface covered by rock fragments: 5 to 10 percent by angular cobbles, 5 to 10 percent by coarse, angular gravel
Depth to a restrictive feature: Lithic bedrock—20 to 40 inches
Slowest permeability in the soil: Moderately slow
Most rapid permeability in the soil: Rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 4.8 inches (low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

- Oe—0 to 2 inches; moderately decomposed plant material
- A—2 to 8 inches; hydrous silty clay loam
- 2A—8 to 16 inches; gravelly highly organic hydrous silt loam
- 2Bw1/3C1—16 to 30 inches; very cobbly hydrous silty clay loam
- 3C2/2Bw2—30 to 39 inches; extremely cobbly hydrous silty clay loam
- 3R—39 to 43 inches; bedrock

Estimated minor components

Aquands and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 8 percent

Geomorphic setting: Depressions and gently sloping areas in pahoehoe lava flows

Use and management

Major use(s): Wildlife habitat, recreation, and forestland

Major management consideration(s): Very high phosphorus retention

577—Pahipa-Puu Oo association, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Areas with aa lava flows and large kipukas

Elevation: 4,500 to 6,495 feet (1,372 to 1,981 meters)

Mean annual rainfall: 60 to 100 inches (1,524 to 2,540 millimeters)

Mean annual air temperature: 55 to 59 degrees F (13 to 15 degrees C)

Frost-free period: 180 to 365 days

Map unit composition

Pahipa soil—55 to 80 percent

Puu Oo soil—20 to 40 percent

Puali and similar soils—0 to 10 percent

Characteristics of the Pahipa soil

Geomorphic setting: Areas of aa lava flow with a cover of volcanic ash

Parent material: Basic volcanic ash over aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 5 to 10 percent by coarse, angular gravel, 5 to 10 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 40 inches

Slowest permeability in the soil: Moderately slow

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 4.8 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

Oe—0 to 2 inches; moderately decomposed plant material
A—2 to 8 inches; hydrous silty clay loam
2A—8 to 16 inches; gravelly highly organic hydrous silt loam
2Bw1/3C1—16 to 30 inches; very cobbly hydrous silty clay loam
3C2/2Bw2—30 to 39 inches; extremely cobbly hydrous silty clay loam
3R—39 to 43 inches; bedrock

Characteristics of the Puu Oo soil

Geomorphic setting: Large kipukas
Parent material: Basaltic volcanic ash
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 2 to 20 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—39 to 79 inches
Slowest permeability in the soil: Moderate
Most rapid permeability in the soil: Moderately rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 9.0 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam
A2—3 to 6 inches; medial silt loam
2Bw1—6 to 9 inches; hydrous silty clay loam
2Bw2—9 to 16 inches; hydrous silty clay loam
2Bw3—16 to 22 inches; hydrous silty clay loam
2Bw4—22 to 27 inches; hydrous silty clay loam
3Bw5—27 to 50 inches; medial sandy clay loam

Estimated minor components

Puali and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 20 percent
Geomorphic setting: Pahoehoe lava flows with a shallow cover of ash

Use and management

Major use(s): Wildlife habitat, recreation, and forestland
Major management consideration(s): Very high phosphorus retention

605—Kaholimo-Ki complex, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Pahoehoe lava flows covered with ash, which varies in thickness
Elevation: 4,265 to 4,590 feet (1,300 to 1,400 meters)
Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)
Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)
Frost-free period: 360 to 365 days

Map unit composition

Kaholimo soil—55 to 65 percent
Ki soil—30 to 45 percent
Lava flows, pahoehoe—0 to 5 percent

Characteristics of the Kaholimo soil

Geomorphic setting: Intermingled areas of Mauna Loa pahoehoe lava flow 200 to 3,000 years old
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 3 to 10 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, rounded gravel, 0 to 10 percent by rounded cobbles
Depth to a restrictive feature: Lithic bedrock—2 to 20 inches
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Moderately rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.9 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam
A2—2 to 4 inches; medial silt loam
Bw1—4 to 7 inches; medial loam
Bw2—7 to 10 inches; medial loam
Bw3—10 to 12 inches; medial loam
2A—12 to 13 inches; medial loam
3R—13 inches; bedrock

Characteristics of the Ki soil

Geomorphic setting: Mauna Loa kipukas about 1,000 years old
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 3 to 10 percent
Surface runoff class: Low
Percentage of the surface covered by rock fragments: 0 percent
Restrictive feature: None noted
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Rapid
Salinity: Not saline
Sodicity: Not sodic

Available water capacity: About 9.6 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 4 inches; medial loam

C1—4 to 5 inches; ashy very fine sandy loam

C2—5 to 6 inches; gravelly ashy coarse sand

2A1—6 to 9 inches; very gravelly ashy very fine sandy loam

2A2—9 to 13 inches; gravelly ashy fine sandy loam

2Bw—13 to 15 inches; very gravelly medial sandy loam

3A—15 to 19 inches; very gravelly medial sandy loam

3AB—19 to 23 inches; medial loam

3Bw1—23 to 26 inches; medial loam

3Bw2—26 to 30 inches; gravelly medial loam

3Bw3—30 to 32 inches; medial silt loam

3Bw4—32 to 36 inches; very gravelly medial loam

4Bw5—36 to 38 inches; medial loam

4Bw6—38 to 41 inches; very gravelly medial loamy sand

4C—41 to 43 inches; stratified very gravelly medial fine sand to very gravelly medial sand

5Bw1—43 to 48 inches; gravelly medial loam

5Bw2—48 to 52 inches; very gravelly medial very fine sandy loam

5Bw3—52 to 60 inches; medial silt loam

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 5 percent

Slope: 3 to 10 percent

Geomorphic setting: Mauna Loa pahoehoe lava flows less than 750 years old

Use and management

Major use(s): Forestland, wildlife habitat, recreation, and livestock grazing

607—Kaholimo-Ki complex, 10 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Pahoehoe lava flows covered with ash, which varies in thickness

Elevation: 4,265 to 4,590 feet (1,300 to 1,400 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Kaholimo soil—50 to 70 percent

Ki soil—20 to 50 percent

Lava flows, pahoehoe—0 to 5 percent

Characteristics of the Kaholimo soil

Geomorphic setting: Intermingled areas of Mauna Loa pahoehoe lava flow 200 to 3,000 years old

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, rounded gravel, 0 to 10 percent by rounded cobbles

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Moderately rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.9 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam

A2—2 to 4 inches; medial silt loam

Bw1—4 to 7 inches; medial loam

Bw2—7 to 10 inches; medial loam

Bw3—10 to 12 inches; medial loam

2A—12 to 13 inches; medial loam

3R—13 inches; bedrock

Characteristics of the Ki soil

Geomorphic setting: Mauna Loa kipukas about 1,000 years old

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 10 to 20 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 percent

Restrictive feature: None noted

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 9.6 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam

Bw—2 to 4 inches; medial loam

C1—4 to 5 inches; ashy very fine sandy loam

C2—5 to 6 inches; gravelly ashy coarse sand
2A1—6 to 9 inches; very gravelly ashy very fine sandy loam
2A2—9 to 13 inches; gravelly ashy fine sandy loam
2Bw—13 to 15 inches; very gravelly medial sandy loam
3A—15 to 19 inches; very gravelly medial sandy loam
3AB—19 to 23 inches; medial loam
3Bw1—23 to 26 inches; medial loam
3Bw2—26 to 30 inches; gravelly medial loam
3Bw3—30 to 32 inches; medial silt loam
3Bw4—32 to 36 inches; very gravelly medial loam
4Bw5—36 to 38 inches; medial loam
4Bw6—38 to 41 inches; very gravelly medial loamy sand
4C—41 to 43 inches; stratified very gravelly medial fine sand to very gravelly medial sand
5Bw1—43 to 48 inches; gravelly medial loam
5Bw2—48 to 52 inches; very gravelly medial very fine sandy loam
5Bw3—52 to 60 inches; medial silt loam

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 5 percent

Slope: 10 to 20 percent

Geomorphic setting: Mauna Loa pahoehoe lava flows less than 750 years old

Use and management

Major use(s): Forestland, wildlife habitat, recreation, and livestock grazing

610—Piionua hydrous silty clay loam, 0 to 3 percent slopes

Map unit setting

General location: Upper elevation, east-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a very thick mantle of ash

Elevation: 3,995 to 5,600 feet (1,219 to 1,707 meters)

Mean annual rainfall: 1 to 118 inches (18 to 3,000 millimeters)

Mean annual air temperature: 54 to 61 degrees F (12 to 16 degrees C)

Frost-free period: 364 to 365 days

Map unit composition

Piionua soil—100 percent

Characteristics of the Piionua soil

Geomorphic setting: Lava flows 5,000 to 10,000 years old; on a shield volcano

Parent material: Highly weathered basaltic volcanic ash over aa lava and/or pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 0 to 3 percent

Surface runoff class: High

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—40 to 61 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Moderate

Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 11.9 inches (very high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Oa—0 to 2 inches; highly decomposed plant material
A—2 to 7 inches; hydrous silty clay loam
Bw1—7 to 16 inches; hydrous silty clay loam
Bw2—16 to 22 inches; hydrous silty clay loam
Bw3—22 to 28 inches; hydrous silty clay loam
Bw4—28 to 47 inches; hydrous silty clay loam
2R—47 to 59 inches; bedrock

Use and management

Major use(s): Forestland, wildlife habitat, recreation, and livestock grazing

613—Kiloa extremely cobbly highly decomposed plant material, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 1,000 to 4,500 feet (305 to 1,372 meters)

Mean annual rainfall: 60 to 150 inches (1,524 to 3,810 millimeters)

Mean annual air temperature: 52 to 66 degrees F (11 to 19 degrees C)

Map unit composition

Kiloa soil—90 to 100 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Kiloa soil

Geomorphic setting: 0.75 ka and younger aa lava flows

Parent material: Organic material over aa lava

Ecological site: Shallow Wet Ohia-Olapa Forest, F162XY503HI

Slope: 3 to 10 percent

Surface runoff class: Negligible

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter. After land clearing, as much as half the organic matter is lost because of oxidation and lower organic inputs.

Percentage of the surface covered by rock fragments: 0 to 15 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—40 to 60 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 2.1 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

2C1/Oa—0 to 10 inches; extremely cobbly highly decomposed plant material
2C2—10 to 60 inches; fragmental material
2R—60 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Forestland, wildlife habitat, and building site development
Major management consideration(s): Short, steep slopes in some areas; loss of organic soil because of land clearing; and very high phosphorus retention

621—Eheuiki-Pekailio complex, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: All hillslope positions of aa lava flows
Elevation: 2,995 to 4,500 feet (914 to 1,372 meters)
Mean annual rainfall: 67 to 165 inches (1,700 to 4,190 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Frost-free period: 300 to 365 days

Map unit composition

Eheuiki soil—50 to 70 percent
Pekailio soil—30 to 50 percent

Characteristics of the Eheuiki soil

Geomorphic setting: Mauna Loa aa lava flows 5,000 to 10,000 years old; on a shield volcano
Parent material: Basaltic volcanic ash over aa lava
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 3 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 0 percent
Restrictive feature: None noted
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Very rapid
Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 10.2 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat poorly drained

Typical profile

A1—0 to 4 inches; medial silt loam

A2—4 to 9 inches; medial silt loam

Bw1—9 to 13 inches; medial silty clay loam

Bw2—13 to 15 inches; medial silty clay loam

2Bw1—15 to 19 inches; medial silty clay loam

2Bw2—19 to 23 inches; medial silty clay loam

3A—23 to 26 inches; medial silty clay loam

3Bw1—26 to 28 inches; medial silty clay loam

4C3/Bw2—28 to 60 inches; extremely cobbly medial silty clay loam

Characteristics of the Pekailio soil

Geomorphic setting: Mauna Loa aa lava flows 1,500 to 3,000 years old

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 3 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 5 to 20 percent by subangular stones

Depth to a restrictive feature: Lithic bedrock—39 to 79 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 8.4 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 5 inches; stony medial loam

Bw1—5 to 12 inches; stony medial loam

2C1/Bw2—12 to 22 inches; extremely cobbly medial loam

2C2/Bw3—22 to 34 inches; extremely cobbly medial loam

2C3—34 to 60 inches; extremely stony ashy coarse sand

Use and management

Major use(s): Forestland, wildlife habitat, recreation, orchard crops, agroforestry, and livestock grazing

Major management consideration(s): Short, steep slopes in some areas and somewhat poor drainage in the Eheuiki soil

625—Hao medial loam, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a thick mantle of ash

Elevation: 1,200 to 3,280 feet (366 to 1,000 meters)

Mean annual rainfall: 105 to 300 inches (2,667 to 7,620 millimeters)

Mean annual air temperature: 61 to 72 degrees F (16 to 22 degrees C)

Frost-free period: 363 to 365 days

Map unit composition

Hao soil—75 to 100 percent

Ohia and similar soils—0 to 10 percent

Characteristics of the Hao soil

Geomorphic setting: Lava flows with a thick mantle of ash; on a shield volcano

Parent material: Basaltic volcanic ash over aa lava and/or pahoehoe lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 3 to 10 percent

Surface runoff class: Medium

Surface feature(s): Where the surface is disturbed by any means (tractor or dozer, hoof, or foot), the erosion class is 3 or 4 rather than 0.

Percentage of the surface covered by rock fragments: 0 to 10 percent subrounded gravel

Depth to restrictive features: Placic material—15 inches; dense material—39 inches

Slowest permeability in the soil: Moderately slow

Most rapid permeability in the soil: Moderate

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.9 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

Oa—0 to 2 inches; highly decomposed plant material

A—2 to 8 inches; medial loam

Bw1—8 to 15 inches; medial loam

Bsm—15 to 21 inches; medial sandy loam

Bw2—21 to 41 inches; medial silty clay loam

Estimated minor components

Ohia and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Lava flows 5,000 to more than 10,000 years old

Use and management

Major use(s): Recreation, wildlife habitat, forestland, livestock grazing, forage, and cropland

Major management consideration(s): Cemented pan, a high water table, high susceptibility to erosion, poor trafficability when the soil is moist, susceptibility to compaction, a low capacity to supply natural potassium, moderate acidity, and moderate or high phosphorus retention

631—Kapapala medial loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a thick mantle of ash

Elevation: 3,280 to 4,500 feet (1,000 to 1,372 meters)

Mean annual rainfall: 59 to 70 inches (1,500 to 1,778 millimeters)

Mean annual air temperature: 57 to 64 degrees F (14 to 18 degrees C)

Frost-free period: 364 to 365 days

Map unit composition

Kapapala soil—85 to 100 percent

Nanaia medial loam and similar soils—0 to 10 percent

Ohaikea and similar soils—0 to 10 percent

Characteristics of the Kapapala soil

Geomorphic setting: Mauna Loa pahoehoe lava flows 2,000 to 6,000 years old; on a shield volcano

Parent material: Moderately weathered basic volcanic ash over pahoehoe lava

Ecological site: Soapberry-Koa Kipuka Forest, F160XY500HI

Slope: 2 to 10 percent

Surface runoff class: Negligible

Surface feature(s): The soil is hydrophobic when dry because of a high content of organic matter.

Percentage of the surface covered by rock fragments: 5 to 20 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—39 to 59 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 10.2 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 3 inches; medial loam

Bw—3 to 9 inches; medial sandy loam

2C—9 to 13 inches; medial sandy loam

3Bw1—13 to 21 inches; medial loam

3Bw2—21 to 29 inches; medial sandy loam

3Bw3—29 to 43 inches; medial loam

R—43 inches; bedrock

Estimated minor components

Nanaia medial loam and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Mauna Loa pahoehoe lava flows 2,000 to 5,000 years old; on a shield volcano

Ohaieka and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Mauna Loa pahoehoe lava flows 2,000 to 5,000 years old; on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

Major management consideration(s): Seasonal dryness

657—Malama-Lava flows complex, dry, 2 to 40 percent slopes

Map unit setting

General location: The lower elevation, southeast-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope components of aa lava flows

Elevation: 0 to 1,200 feet (0 to 366 meters)

Mean annual rainfall: 60 to 120 inches (1,524 to 3,048 millimeters)

Mean annual air temperature: 72 to 73 degrees F (22 to 23 degrees C)

Map unit composition

Malama soil—15 to 85 percent

Lava flows, aa—15 to 85 percent

Characteristics of the Malama soil

Geomorphic setting: Areas of aa lava flow less than 1,000 years old

Parent material: Organic material over aa lava

Ecological site: Lama-Alahee-Pandanus Coastal Forest, F162XY501HI

Slope: 2 to 40 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 10 to 85 percent by subangular cobbles, 0 to 15 percent by subangular stones

Depth to a restrictive feature: Lithic bedrock—40 to 60 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.5 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

2C1/Oa—0 to 3 inches; extremely cobbly highly decomposed plant material

2C2—3 to 60 inches; fragmental material

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 40 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 35 to 55 percent by coarse,
angular gravel; 35 to 55 percent by angular cobbles; 10 to 25 percent by angular
stones

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Use and management

Major use(s): Forestland, wildlife habitat, orchard crops, and livestock grazing

Major management consideration(s): Slope; short, steep slopes in some areas;
moderate acidity; and loss of organic soil because of land clearing

**709—Lava flows-Lithic Ustipsamments complex, 2 to 10
percent slopes**

Map unit setting

General location: Mid elevation, south- and southwest-facing, windward slopes on the
Kilauea Volcano

Geomorphic setting: Lava plains

Elevation: 2,000 to 4,000 feet (610 to 1,220 meters)

Mean annual rainfall: 30 to 60 inches (760 to 1,525 millimeters)

Mean annual air temperature: 63 to 70 degrees F (17 to 21 degrees C)

Map unit composition

Lava flows, pahoehoe—50 to 80 percent

Lithic Ustipsamments—20 to 50 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Areas of pahoehoe lava flow

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: Occasional, extremely brief

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Characteristics of Lithic Ustipsamments

Geomorphic setting: Sandy drifts on pahoehoe lava flows less than 750 years old

Parent material: Ashy eolian sands over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): About 35 percent of the surface has a brittle crust. Where the surface crust occurs, vegetation cannot be established. Plants grow in gullied areas where a surface crust does not occur and pH values favor plant growth.

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soils: Slow

Most rapid permeability in the soils: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.0 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Typical profile

Cmq—0 inches; duripan

C2—0 to 2 inches; ashy sand

C3—2 to 10 inches; ashy sand

2R—10 inches; bedrock

Use and management

Major use(s): Wildlife habitat and recreation

Major management consideration(s): A low capacity to supply natural potassium and seasonal dryness

711—Lava flows-Apuki complex, 2 to 20 percent slopes

Map unit setting

General location: The lower elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 0 to 1,000 feet (0 to 305 meters)

Mean annual rainfall: 40 to 60 inches (1,015 to 1,525 millimeters)

Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)

Map unit composition

Lava flows, pahoehoe—50 to 85 percent

Apuki soil—15 to 55 percent

Kalapana and similar soils—0 to 10 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Characteristics of the Apuki soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Sandy eolian material and basaltic volcanic ash over pahoehoe lava

Ecological site: Lama-Alahee-Pandanus Coastal Forest, F162XY501HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.9 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None
Wetness: None noted
Drainage class: Somewhat excessively drained

Typical profile

C1—0 inches; ashy sand
C2—0 to 6 inches; ashy sand
C3—6 to 7 inches; ashy loamy sand
2R—7 inches; bedrock

Estimated minor components

Kalapana and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas where sandy eolian material has not been deposited on pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): A low capacity to supply natural potassium

713—Lithic Haplustands-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 2,495 to 3,500 feet (762 to 1,067 meters)

Mean annual rainfall: 40 to 80 inches (1,015 to 2,030 millimeters)

Mean annual air temperature: 63 to 70 degrees F (17 to 21 degrees C)

Map unit composition

Lithic Haplustands, cindery substratum—35 to 70 percent

Lithic Haplustands, loamy surface—0 to 70 percent

Lava flows, pahoehoe—20 to 65 percent

Characteristics of Lithic Haplustands, cindery substratum

Geomorphic setting: Kilauea pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Parent material: Basaltic volcanic ash over cinders over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 67 to 80 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soils: Rapid

Most rapid permeability in the soils: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.8 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 2 inches; extremely gravelly ashy loamy sand

C1—2 inches; ashy loamy sand

C2—2 to 3 inches; very gravelly ashy sand

C3—3 to 4 inches; ashy fine sand

C4—4 to 5 inches; stratified ashy fine sand

C5—5 to 6 inches; ashy loamy sand

C6—6 to 8 inches; very gravelly ashy coarse sand

2R—8 inches; bedrock

Characteristics of Lithic Haplustands, loamy surface

Geomorphic setting: Kilauea pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 35 to 60 coarse, subrounded gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soils: Rapid

Most rapid permeability in the soils: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.2 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 4 inches; very gravelly medial loam

2A2—4 to 5 inches; ashy sandy loam

2C1—5 to 6 inches; very gravelly ashy loamy coarse sand

2C2—6 to 7 inches; stratified ashy loamy sand and sand

2C3—7 to 8 inches; very gravelly ashy coarse sandy loam

2C4—8 to 10 inches; gravelly ashy loamy sand

2C5—10 to 13 inches; very gravelly ashy loamy coarse sand

3R—13 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Kilauea pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse, subangular gravel, 0 to 25 percent by subangular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): Seasonal dryness

715—Alahapa-Heake complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southwest- and south-facing, windward slopes on the Kilauea and Mauna Loa Volcanoes

Geomorphic setting: All hillslope positions of aa and pahoehoe lava flows

Elevation: 3,395 to 4,000 feet (1,036 to 1,220 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 61 to 64 degrees F (16 to 18 degrees C)

Map unit composition

Alahapa soil—50 to 80 percent

Heake soil—10 to 30 percent

Lava flows, aa—0 to 10 percent

Lava flows, pahoehoe—0 to 10 percent

Characteristics of the Alahapa soil

Geomorphic setting: Areas of aa lava flow less than 750 years old; on shield volcanoes

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Surface feature(s): A brittle crust 1 centimeter (0.5 inch) thick covers 0 to 25 percent of the surface.

Percentage of the surface covered by rock fragments: 25 to 55 percent by very angular stones; 15 to 40 percent by very angular cobbles; 5 to 15 percent by coarse, very angular gravel; 5 to 20 percent by very angular boulders

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour), the surface runoff class is very high, and the hydrologic soil group is D.

Typical profile

2C1/A—0 to 3 inches; extremely stony ashy sandy loam

2C2/C—3 to 17 inches; extremely cobbly ashy loam

2C3—17 to 36 inches; extremely cobbly ashy sand

2C4—36 to 60 inches; extremely stony ashy coarse sand

Characteristics of the Heake soil

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 3 to 15 percent by medium, subrounded gravel

Depth to restrictive features: Lithic bedrock—1 to 8 inches; dense material—2 to 5 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.8 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour) and the hydrologic soil group is D.

Typical profile

A—0 to 1 inch; ashy loam

Bw—1 to 4 inches; ashy loamy fine sand

C1—4 to 7 inches; stratified ashy loamy fine sand

C2—7 to 8 inches; ashy loam

Cd1—8 to 10 inches; stratified ashy sandy loam

Cd2—10 to 12 inches; stratified ashy loamy fine sand, ashy fine sand, ashy sand, and ashy coarse sand

2C—12 to 14 inches; paragravel

3R—14 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Kilauea aa lava flows less than 750 years old; on a shield volcano

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Kilauea pahoehoe lava flows less than 750 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

716—Alahapa extremely stony ashy sandy loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south- and southwest-facing, windward slopes on the Kilauea and Mauna Loa Volcanoes

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 3,605 to 4,000 feet (1,100 to 1,220 meters)

Mean annual rainfall: 40 to 60 inches (1,015 to 1,525 millimeters)

Mean annual air temperature: 61 to 64 degrees F (16 to 18 degrees C)

Map unit composition

Alahapa soil—85 to 95 percent

Heake and similar soils—0 to 10 percent

Lava flows, aa—5 to 15 percent

Characteristics of the Alahapa soil

Geomorphic setting: Areas of aa lava flow on shield volcanoes

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 5 to 20 percent by very angular boulders, 25 to 55 percent by very angular stones, 15 to 40 percent by very angular cobbles, 5 to 15 percent by coarse, very angular gravel

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour), the hydrologic soil group is D, and the surface runoff class is very high.

Typical profile

2C1/A—0 to 3 inches; extremely stony ashy sandy loam

2C2/C—3 to 17 inches; extremely cobbly ashy loam

2C3—17 to 36 inches; extremely cobbly ashy sand

2C4—36 to 60 inches; extremely stony ashy coarse sand

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 5 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on shield volcanoes

Heake and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium

717—Alahapa-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south- and southwest-facing, windward slopes on the Kilauea and Mauna Loa Volcanoes

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 2,805 to 3,600 feet (855 to 1,098 meters)

Mean annual rainfall: 40 to 60 inches (1,015 to 1,525 millimeters)

Mean annual air temperature: 63 to 64 degrees F (17 to 18 degrees C)

Map unit composition

Alahapa soil—45 to 80 percent

Lava flows, aa—20 to 55 percent

Lava flows, pahoehoe—0 to 10 percent

Heake and similar soils—0 to 10 percent

Characteristics of the Alahapa soil

Geomorphic setting: Areas of aa lava flow on shield volcanoes

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 15 to 40 percent by very angular cobbles, 5 to 20 percent by very angular boulders, 25 to 55 percent by very angular stones, 5 to 15 percent by coarse, very angular gravel

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.4 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour), the surface runoff class is very rapid, and the hydrologic soil group is D.

Typical profile

2C1/A—0 to 3 inches; extremely stony ashy sandy loam

2C2/C—3 to 17 inches; extremely cobbly ashy loam

2C3—17 to 36 inches; extremely cobbly ashy sand

2C4—36 to 60 inches; extremely stony ashy coarse sand

Characteristics of Lava flows, aa

Geomorphic setting: Areas of aa lava flow on shield volcanoes

Kind of material: Aa lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 15 to 55 percent by coarse, angular gravel; 35 to 55 percent by angular cobbles; 10 to 25 percent by angular stones; 5 to 15 percent by angular boulders

Depth to a restrictive feature: Lithic bedrock—20 to 60 inches

Slowest permeability in the lava: Very rapid

Most rapid permeability in the lava: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Heake and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on shield volcanoes

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium

**718—Halemaumau extremely gravelly ashy coarse sand,
2 to 10 percent slopes**

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 3,495 to 3,795 feet (1,066 to 1,158 meters)

Mean annual rainfall: 60 to 80 inches (1,525 to 2,032 millimeters)

Mean annual air temperature: 59 to 63 degrees F (15 to 17 degrees C)

Map unit composition

Halemaumau soil—85 to 100 percent

Cinder land—0 to 10 percent

Lava flows, pahoehoe—0 to 10 percent

Characteristics of the Halemaumau soil

Geomorphic setting: Kilauea pahoehoe lava flows less than 750 years old; on a shield volcano

Parent material: Cinders over basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Low

Surface feature(s): Cinders, less than 10 inches deep, originating from Kilauea Iki

Percentage of the surface covered by rock fragments: 60 to 80 percent by coarse, angular gravel (cinders); 0 to 30 percent by coarse, angular gravel (pumice)

Depth to restrictive features: Dense material—6 to 14 inches; lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.6 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

C—0 to 6 inches; extremely gravelly ashy coarse sand

- 2A—6 to 7 inches; gravelly ashy sandy loam
- 2C1—7 to 10 inches; extremely gravelly ashy coarse sand
- 2C2—10 to 13 inches; ashy loam
- 2C3—13 to 20 inches; very gravelly ashy fine sand and very gravelly ashy sand
- 2C4—20 to 23 inches; ashy fine sand
- 2Cd—23 to 27 inches; ashy sandy loam
- 2C5—27 to 35 inches; extremely gravelly ashy coarse sand
- 3R—35 inches; bedrock

Estimated minor components

Cinder land

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas near Kilauea Iki with cinders ranging from 30 to more than 100 inches deep over a soil similar to the Halemaumau soil; cinder cones on pahoehoe lava flows

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): High acidity

719—Heake ashy loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southwest-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 3,395 to 3,805 feet (1,035 to 1,160 meters)

Mean annual rainfall: 50 to 80 inches (1,270 to 2,030 millimeters)

Mean annual air temperature: 55 to 64 degrees F (13 to 18 degrees C)

Map unit composition

Heake soil—85 to 95 percent

Lava flows, pahoehoe—0 to 15 percent

Halemaumau and similar soils—0 to 15 percent

Characteristics of the Heake soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 3 to 15 percent by medium, subrounded gravel

Depth to restrictive features: Dense material—6 to 12 inches; lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained
Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour) and the hydrologic soil group is D.

Typical profile

A—0 to 1 inch; ashy loam
Bw—1 to 4 inches; ashy loamy fine sand
C1—4 to 7 inches; stratified ashy loamy fine sand
C2—7 to 8 inches; ashy loam
Cd1—8 to 10 inches; stratified ashy sandy loam
Cd2—10 to 12 inches; stratified ashy coarse sand, ashy sand, ashy fine sand, and ashy loamy fine sand
2C—12 to 14 inches; paragravel
3R—14 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Halemaumau and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland
Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

720—Heake-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southwest-facing, windward slopes on the Kilauea Volcano
Geomorphic setting: All hillslope positions of pahoehoe lava flows
Elevation: 3,395 to 3,805 feet (1,035 to 1,160 meters)
Mean annual rainfall: 50 to 80 inches (1,270 to 2,030 millimeters)
Mean annual air temperature: 55 to 64 degrees F (13 to 18 degrees C)

Map unit composition

Heake soil—20 to 80 percent
Lava flows, pahoehoe—15 to 60 percent

Alahapa and similar soils—0 to 10 percent
Lava flows, aa—0 to 10 percent

Characteristics of the Heake soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava, less than 750 years old

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 3 to 15 percent subrounded gravel

Depth to restrictive features: Dense material—6 to 12 inches; lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour) and the hydrologic soil group is D.

Typical profile

A—0 to 1 inch; ashy loam

Bw—1 to 4 inches; ashy loamy fine sand

C1—4 to 7 inches; stratified ashy loamy fine sand

C2—7 to 8 inches; ashy loam

Cd1—8 to 10 inches; stratified ashy sandy loam

Cd2—10 to 12 inches; stratified ashy loamy fine sand, ashy fine sand, ashy sand, and ashy coarse sand

2C—12 to 14 inches; paragravel

3R—14 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Estimated minor components

Alahapa and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

722—Kilauea very gravelly ashy sand, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south- and southwest-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 3,490 to 3,690 feet (1,065 to 1,125 meters)

Mean annual rainfall: 40 to 60 inches (1,015 to 1,525 millimeters)

Mean annual air temperature: 61 to 63 degrees F (16 to 17 degrees C)

Map unit composition

Kilauea—85 to 95 percent

Lava flows, pahoehoe—0 to 10 percent

Lithic Ustipsamments and similar soils—0 to 5 percent

Characteristics of the Kilauea soil

Geomorphic setting: Pahoehoe lava flows 200 to 750 years old; on a shield volcano

Parent material: Pyroclastic material and reworked eolian and alluvial basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): About 10 percent of the surface is covered by a brittle crust 1 centimeter (0.5 inch) thick.

Percentage of the surface covered by rock fragments: 35 to 65 percent subrounded gravel

Restrictive feature: None noted

Slowest permeability in the soil: Impermeable

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 9.6 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Excessively drained

Altered hydrology: Where a cemented crust occurs, the saturated permeability of the most limiting layer and the initial infiltration rate of the soil surface are very slow (less than 0.06 inch per hour), the hydrologic soil group is D, and the surface runoff class is very high.

Typical profile

Cm—0 to 0.5 inch; duripan

C1—0.5 inch to 3 inches; stratified very gravelly ashy sand

C2—3 to 5 inches; ashy sandy loam

C3—5 to 7 inches; stratified very gravelly ashy sand

C4—7 to 10 inches; very gravelly ashy loamy sand

C5—10 to 20 inches; stratified very gravelly ashy coarse sand and very gravelly ashy loamy sand

C6—20 to 23 inches; gravelly ashy sand

C7—23 to 38 inches; stratified ashy very fine sand and ashy sand

C8—38 to 40 inches; gravelly ashy sand

C9—40 to 56 inches; ashy very fine sand

C10—56 to 75 inches; ashy coarse sand

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Lithic Ustipsamments and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): Intermittent extremely acid surface crust and high acidity

724—Lava flows-Kaholimo-Puiwa complex, 2 to 15 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 5,495 to 7,495 feet (1,675 to 2,285 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)
Frost-free period: 360 to 365 days

Map unit composition

Lava flows, pahoehoe—30 to 60 percent
Kaholimo soil, uneroded—15 to 25 percent
Kaholimo soil, eroded—5 to 25 percent
Puiwa soil, uneroded—10 to 25 percent
Puiwa soil, eroded—0 to 15 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI
Slope: 2 to 15 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 to 35 percent by angular
cobbles, 0 to 35 percent by coarse, angular gravel
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)
Hydrologic properties
Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Somewhat excessively drained

Characteristics of Kaholimo soil, uneroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years
old; on a shield volcano
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 2 to 15 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse,
rounded gravel, 0 to 10 percent by rounded cobbles
Depth to a restrictive feature: Lithic bedrock—2 to 20 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 3.2 inches (low)
Hydrologic properties
Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam
A2—2 to 4 inches; medial silt loam
Bw1—4 to 7 inches; medial loam
Bw2—7 to 10 inches; medial loam
Bw3—10 to 12 inches; medial loam
2A—12 to 13 inches; medial loam
3R—13 inches; bedrock

Characteristics of Kaholimo soil, eroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 15 percent

Surface runoff class: Very high

Surface feature(s): The surface has many pedestals (areas of original soil standing higher than the eroded soil). All or part of the A horizon is truncated, apparently because of historic overgrazing by goats.

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, rounded gravel, 10 to 35 percent by rounded cobbles

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.5 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A2—0 to 2 inches; cobbly medial loam
Bw1—2 to 5 inches; medial loam
Bw2—5 to 8 inches; medial loam
Bw3—8 to 10 inches; medial loam
2A—10 to 11 inches; medial loam
3R—11 inches; bedrock

Characteristics of Puiwa soil, uneroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 15 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 to 10 percent by rounded gravel, 0 to 10 percent by rounded cobbles

Depth to a restrictive feature: Lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 9.5 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 4 inches; medial loam
A2—4 to 7 inches; medial loam
A3—7 to 9 inches; stratified medial silt loam and medial loam
C—9 to 11 inches; medial fine sand
2Bw1—11 to 17 inches; medial silt loam
2Bw2—17 to 25 inches; medial silt loam
2Bw3—25 to 38 inches; cobbly medial silt loam
3R—38 inches; bedrock

Characteristics of Puiwa soil, eroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 15 percent

Surface runoff class: Low

Surface feature(s): The surface has many pedestals (areas of original soil standing higher than the eroded soil). All or part of the A horizon is truncated, apparently because of historic overgrazing by goats.

Percentage of the surface covered by rock fragments: 10 to 35 percent by rounded cobbles, 0 to 15 percent by coarse, rounded gravel

Depth to a restrictive feature: Lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 8.4 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A2—0 to 3 inches; cobbly medial loam
A3—3 to 6 inches; stratified medial silt loam and medial loam
C—6 to 7 inches; medial fine sand
2Bw1—7 to 13 inches; medial silt loam
2Bw2—13 to 21 inches; medial silt loam
2Bw3—21 to 34 inches; cobbly medial silt loam
3R—34 inches; bedrock

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing

Major management consideration(s): Moderate or high phosphorus retention and high susceptibility to erosion

725—Lava flows-Kaholimo complex, 2 to 15 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 5,495 to 7,495 feet (1,675 to 2,285 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Lava flows, pahoehoe—50 to 70 percent

Kaholimo soil, eroded—5 to 35 percent

Kaholimo soil, uneroded—5 to 25 percent

Puiwa and similar soils—0 to 15 percent

Kulalio and similar soils—0 to 10 percent

Wahi and similar soils—0 to 5 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Kilauea pahoehoe lava flows less than 750 years old; on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 15 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Characteristics of Kaholimo soil, eroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 15 percent

Surface runoff class: Very high

Surface feature(s): The surface has many pedestals (areas of original soil standing higher than the eroded soil). All or part of the A horizon is truncated, apparently because of overgrazing by goats.

Percentage of the surface covered by rock fragments: 0 to 10 percent by coarse, rounded gravel, 0 to 10 percent by rounded cobbles

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.5 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A2—0 to 2 inches; cobbly medial loam

Bw1—2 to 5 inches; medial loam

Bw2—5 to 8 inches; medial loam

Bw3—8 to 10 inches; medial loam

2A—10 to 11 inches; medial loam

3R—11 inches; bedrock

Characteristics of Kaholimo soil, uneroded

Geomorphic setting: Intermingled areas of pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 15 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 10 percent by rounded cobbles, 0 to 10 percent by coarse, rounded gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.2 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam

A2—2 to 4 inches; medial silt loam

Bw1—4 to 7 inches; medial loam
Bw2—7 to 10 inches; medial loam
Bw3—10 to 12 inches; medial loam
2A—12 to 13 inches; medial loam
3R—13 inches; bedrock

Estimated minor components

Puiwa and similar soils

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 15 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kulalio and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: Areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Wahi and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: Areas of aa lava flow less than 750 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing
Major management consideration(s): Moderate or high phosphorus retention and high susceptibility to erosion

726—Kulalio medial silt loam, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: All hillside positions of aa lava flows
Elevation: 4,500 to 7,000 feet (1,372 to 2,134 meters)
Mean annual rainfall: 50 to 60 inches (1,270 to 1,524 millimeters)
Mean annual air temperature: 50 to 59 degrees F (10 to 15 degrees C)
Frost-free period: 360 to 365 days

Map unit composition

Kulalio soil—85 to 100 percent
Maunaiu and similar soils—5 to 10 percent
Akelelu and similar soils—0 to 5 percent

Characteristics of the Kulalio soil

Geomorphic setting: Mauna Loa aa lava flows 3,000 to 5,000 years old; on a shield volcano
Parent material: Basaltic volcanic ash over aa lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 0 to 5 percent by angular boulders, 0 to 15 percent by angular stones

Restrictive feature: None noted
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Very rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 4.7 inches (low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam
A2—3 to 7 inches; cobbly medial silt loam
Bw1/2C1—7 to 11 inches; very gravelly medial loam
Bw2/2C2—11 to 16 inches; very gravelly medial loamy sand
2C3/Bw3—16 to 25 inches; extremely gravelly ashy loamy sand
3C4—25 to 60 inches; extremely gravelly ashy loamy sand

Estimated minor components

Maunaiu and similar soils

Extent of component in mapped areas: 5 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Akelelu and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing
Major management consideration(s): Moderate or high phosphorus retention

727—Puaulu hydrous silt loam, 2 to 20 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: Lava flows with a very thick mantle of ash
Elevation: 3,195 to 4,495 feet (975 to 1,371 meters)
Mean annual rainfall: 110 to 150 inches (2,795 to 3,810 millimeters)
Mean annual air temperature: 55 to 61 degrees F (13 to 16 degrees C)

Map unit composition

Puaulu soil—85 to 100 percent
Hao and similar soils—0 to 10 percent
Eheuiki and similar soils—0 to 10 percent

Characteristics of the Puaulu soil

Geomorphic setting: Lava flows 10,000 years old; on a shield volcano

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Parent material: Basaltic volcanic ash

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Low

Surface feature(s): Where the surface is disturbed by any means (tractor or dozer, hoof, or foot), the erosion class is 3 or 4 rather than 0.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular gravel

Depth to a restrictive feature: Dense material—8 to 16 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.4 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A—0 to 3 inches; hydrous silt loam

Bw—3 to 9 inches; medial silt loam

Cg—9 to 12 inches; ashy sandy loam

Cd1—12 to 15 inches; ashy sand

Cd2—15 to 19 inches; ashy sand

2A/Bw—19 to 20 inches; medial silt loam

3A—20 to 22 inches; medial silt loam

3Bw1—22 to 24 inches; medial silt loam

3Bw2—24 to 28 inches; medial sandy clay loam

4A—28 to 30 inches; hydrous silt loam

4Bw—30 to 31 inches; medial silty clay loam

5A—31 to 32 inches; medial silty clay loam

5Bw—32 to 34 inches; medial silt loam

6A—34 to 35 inches; medial silt loam

6Bw—35 to 37 inches; very gravelly medial sandy clay loam

7A—37 to 38 inches; hydrous silt loam

7Bw1—38 to 41 inches; extremely gravelly medial sandy clay loam

8Bw2—41 to 43 inches; hydrous silty clay loam

9Bw3—43 to 48 inches; medial silty clay loam

10Bw4—48 to 51 inches; medial sandy clay loam

11Bw5—51 to 53 inches; medial sandy clay loam

12Bw6—53 to 55 inches; medial sandy clay loam

Estimated minor components

Hao and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Pahoehoe lava flows about 10,000 years old; on a shield volcano

Eheuiki and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas of aa lava flows 3,000 to 10,000 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, livestock grazing, forage, and cropland

Major management consideration(s): Slope, high susceptibility to erosion, poor trafficability when the soil is moist, susceptibility to compaction, moderate acidity, and moderate or high phosphorus retention

728—Puaulu-Hao complex, 2 to 20 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a thick mantle of ash

Elevation: 3,195 to 4,500 feet (975 to 1,372 meters)

Mean annual rainfall: 110 to 160 inches (2,795 to 4,065 millimeters)

Mean annual air temperature: 55 to 61 degrees F (13 to 16 degrees C)

Map unit composition

Puaulu soil—50 to 75 percent

Hao soil—20 to 45 percent

Eheuiki and similar soils—0 to 10 percent

Characteristics of the Puaulu soil

Geomorphic setting: Lava flows with a thick mantle of ash; on a shield volcano

Parent material: Basaltic volcanic ash

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Low

Surface feature(s): Where the surface is disturbed by any means (tractor or dozer, hoof, or foot), the erosion class is 3 or 4 rather than 0.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular gravel

Depth to a restrictive feature: Dense material—8 to 16 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.4 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A—0 to 3 inches; hydrous silt loam

Bw—3 to 9 inches; medial silt loam

Cg—9 to 12 inches; ashy sandy loam

Cd1—12 to 15 inches; ashy sand

Cd2—15 to 19 inches; ashy sand
2A/Bw—19 to 20 inches; medial silt loam
3A—20 to 22 inches; medial silt loam
3Bw1—22 to 24 inches; medial silt loam
3Bw2—24 to 28 inches; medial sandy clay loam
4A—28 to 30 inches; hydrous silt loam
4Bw—30 to 31 inches; medial silty clay loam
5A—31 to 32 inches; medial silty clay loam
5Bw—32 to 34 inches; medial silt loam
6A—34 to 35 inches; medial silt loam
6Bw—35 to 37 inches; very gravelly medial sandy clay loam
7A—37 to 38 inches; hydrous silt loam
7Bw1—38 to 41 inches; extremely gravelly medial sandy clay loam
8Bw2—41 to 43 inches; hydrous silty clay loam
9Bw3—43 to 48 inches; medial silty clay loam
10Bw4—48 to 51 inches; medial sandy clay loam
11Bw5—51 to 53 inches; medial sandy clay loam
12Bw6—53 to 55 inches; medial sandy clay loam

Characteristics of the Hao soil

Geomorphic setting: Lava flows with a thick mantle of ash; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava and/or aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Medium

Surface feature(s): Where the surface is disturbed by any means (tractor or dozer, hoof, or foot), the erosion class is 3 or 4 rather than 0.

Percentage of the surface covered by rock fragments: 0 to 10 percent subrounded gravel

Depth to restrictive features: Placic material—2 to 6 inches; placic material—6 to 12 inches; dense material—39 to 79 inches

Slowest permeability in the soil: Slow

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.1 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A1—0 to 2 inches; medial silt loam

A2—2 to 3 inches; medial silt loam

Bs—3 to 6 inches; stratified medial sandy clay loam and medial silt loam

Bw—6 to 8 inches; medial silty clay loam

2A—8 to 9 inches; medial silty clay loam

2Bs—9 to 10 inches; medial sandy clay loam

3A1—10 to 12 inches; medial silty clay loam

3A2—12 to 13 inches; medial silty clay loam

3Bs—13 to 15 inches; medial sandy clay loam

3Bw1—15 to 18 inches; medial silty clay loam

3Bw2—18 to 21 inches; medial silty clay loam
3Bw3—21 to 23 inches; medial sandy clay loam
3Bg—23 to 24 inches; medial fine sandy loam
4A1—24 to 25 inches; medial silty clay loam
4A2—25 to 30 inches; medial silty clay loam
4Bw/5Cm1—30 to 41 inches; medial silty clay loam
5Cm2—41 to 60 inches; medial silty clay loam

Estimated minor components

Eheuiki and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas of deep ash over aa lava flows; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, livestock grazing, forage, and cropland

Major management consideration(s): Slope, a high water table, high susceptibility to erosion, poor trafficability when the soil is moist, susceptibility to compaction, a low capacity to supply natural potassium, moderate acidity, and moderate or high phosphorus retention

729—Eheuiki-Puauolu complex, 2 to 20 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a thick mantle of ash

Elevation: 3,195 to 4,500 feet (975 to 1,372 meters)

Mean annual rainfall: 110 to 165 inches (2,795 to 4,190 millimeters)

Mean annual air temperature: 55 to 61 degrees F (13 to 16 degrees C)

Map unit composition

Eheuiki soil—30 to 75 percent

Puauolu soil—15 to 70 percent

Characteristics of the Eheuiki soil

Geomorphic setting: Lava flows with a thick mantle of ash; on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 percent

Restrictive feature: None noted

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 10.2 inches (very high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat poorly drained

Typical profile

A1—0 to 4 inches; medial silt loam
A2—4 to 9 inches; medial silt loam
Bw—9 to 13 inches; medial silty clay loam
Bg—13 to 15 inches; medial silty clay loam
2Bw1—15 to 19 inches; medial silty clay loam
2Bw2—19 to 23 inches; medial silty clay loam
3A—23 to 26 inches; medial silty clay loam
3Bw1—26 to 28 inches; medial silty clay loam
4C3/Bw2—28 to 60 inches; extremely cobbly medial silty clay loam

Characteristics of the Puaulu soil

Geomorphic setting: Lava flows with a thick mantle of ash; on a shield volcano

Parent material: Basaltic volcanic ash

Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI

Slope: 2 to 20 percent

Surface runoff class: Low

Surface feature(s): Where the surface is disturbed by any means (tractor or dozer, hoof, or foot), the erosion class is 3 or 4 rather than 0.

Percentage of the surface covered by rock fragments: 0 to 10 percent by subangular gravel

Depth to a restrictive feature: Dense material—8 to 16 inches

Slowest permeability in the soil: Moderate

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.4 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A—0 to 3 inches; hydrous silt loam
Bw—3 to 9 inches; medial silt loam
Cg—9 to 12 inches; ashy sandy loam
Cd1—12 to 15 inches; ashy sand
Cd2—15 to 19 inches; ashy sand
2A/Bw—19 to 20 inches; medial silt loam
3A—20 to 22 inches; medial silt loam
3Bw1—22 to 24 inches; medial silt loam
3Bw2—24 to 28 inches; medial sandy clay loam
4A—28 to 30 inches; hydrous silt loam
4Bw—30 to 31 inches; medial silty clay loam
5A—31 to 32 inches; medial silty clay loam
5Bw—32 to 34 inches; medial silt loam
6A—34 to 35 inches; medial silt loam
6Bw—35 to 37 inches; very gravelly medial sandy clay loam
7A—37 to 38 inches; hydrous silt loam
7Bw1—38 to 41 inches; extremely gravelly medial sandy clay loam

8Bw2—41 to 43 inches; hydrous silty clay loam
9Bw3—43 to 48 inches; medial silty clay loam
10Bw4—48 to 51 inches; medial sandy clay loam
11Bw5—51 to 53 inches; medial sandy clay loam
12Bw6—53 to 55 inches; medial sandy clay loam

Use and management

Major use(s): Recreation, wildlife habitat, forestland, livestock grazing, forage, and cropland

Major management consideration(s): Slope, high susceptibility to erosion, poor trafficability when the soil is moist, susceptibility to compaction, a low capacity to supply natural potassium, moderate acidity, and moderate or high phosphorus retention

731—Kahalii-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 2,000 to 3,195 feet (610 to 975 meters)

Mean annual rainfall: 70 to 90 inches (1,778 to 2,286 millimeters)

Mean annual air temperature: 63 to 66 degrees F (17 to 19 degrees C)

Map unit composition

Kahalii soil—45 to 70 percent

Lava flows, pahoehoe—25 to 50 percent

Puhimau and similar soils—0 to 8 percent

Characteristics of the Kahalii soil

Geomorphic setting: Kilauea pahoehoe lava flows 200 to 400 years old; on a shield volcano

Parent material: Mauna Ulu cinders over basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): Most of the soil surface is covered by cinders deposited during the Maunu Ulu eruption.

Percentage of the surface covered by rock fragments: 50 to 80 percent by coarse, subangular gravel (cinders), 10 to 50 percent by coarse, subangular gravel (pumice)

Depth to a restrictive feature: Lithic bedrock—6 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.9 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

- C—0 to 4 inches; extremely gravelly ashy coarse sand
- 2A—4 to 5 inches; gravelly ashy loamy sand
- 2C—5 to 7 inches; very gravelly ashy coarse sand
- 3Bw—7 to 9 inches; very gravelly ashy sandy loam
- 3C—9 inches; ashy fine sand
- 4C—9 to 11 inches; very gravelly ashy coarse sand
- 5Cr—11 to 12 inches; very fine sandy loam
- 5R—12 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by angular
cobbles, 0 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Estimated minor components

Puhimau and similar soils

Extent of component in mapped areas: 0 to 8 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium

734—Kanoehina-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Low elevation, coastal, south-facing, windward slopes on the
Kilauea Volcano

Geomorphic setting: Depressions in nearly level and gently sloping lava flows

Elevation: 0 to 1,000 feet (0 to 305 meters)

Mean annual rainfall: 20 to 50 inches (508 to 1,270 millimeters)

Mean annual air temperature: 72 to 75 degrees F (22 to 24 degrees C)

Map unit composition

Kanohina soil—50 to 70 percent
Lava flows, pahoehoe—30 to 50 percent

Characteristics of the Kanohina soil

Geomorphic setting: 0.75 to 1.5 ka pahoehoe lava flows on a shield volcano
Parent material: Basic volcanic ash over pahoehoe lava
Ecological site: Low Elevation Makai Range, R161AY008HI
Slope: 2 to 10 percent
Surface runoff class: Low
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—2 to 20 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.6 inch (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A—0 to 1 inch; ashy very fine sandy loam
Bw—1 to 3 inches; ashy sandy loam
C—3 to 6 inches; ashy loamy sand
2R—6 to 10 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Kind of material: Pahoehoe lava
Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI
Slope: 2 to 10 percent
Surface runoff class: High
Percentage of the surface covered by rock fragments: 0 to 25 percent by coarse,
subangular gravel, 0 to 25 percent by subangular cobbles
Depth to a restrictive feature: Lithic bedrock—0 to 2 inches
Slowest permeability in the lava: Very slow
Most rapid permeability in the lava: Moderately slow
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Use and management

Major use(s): Wildlife habitat

735—Puhimau ashy silt loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 2,995 to 4,000 feet (914 to 1,220 meters)

Mean annual rainfall: 80 to 120 inches (2,030 to 3,050 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Map unit composition

Puhimau soil—85 to 90 percent

Lithic Haplustands—0 to 5 percent

Lava flows, pahoehoe—0 to 10 percent

Manu and similar soils—0 to 5 percent

Characteristics of the Puhimau soil

Geomorphic setting: Pahoehoe lava flows less than 400 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Shallow Wet Ohia-Olapa Forest, F162XY503HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 3.1 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A—0 to 3 inches; ashy silt loam

Bw—3 to 6 inches; very gravelly ashy loamy coarse sand

C—6 to 8 inches; ashy loam

2Bw—8 to 11 inches; ashy silt loam

2C—11 to 13 inches; ashy loam

3R—13 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Lithic Haplustands and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Manu and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): High acidity and high susceptibility to erosion

736—Manu medial silt loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, east-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillside positions of pahoehoe lava flows

Elevation: 3,805 to 4,000 feet (1,160 to 1,220 meters)

Mean annual rainfall: 80 to 120 inches (2,032 to 3,048 millimeters)

Mean annual air temperature: 57 to 61 degrees F (14 to 16 degrees C)

Map unit composition

Manu soil—85 to 95 percent

Cinder land—0 to 8 percent

Puhimau and similar soils—0 to 5 percent

Characteristics of the Manu soil

Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Parent material: Keanakakaoi and subsequent pyroclastics and basaltic volcanic ash over pahoehoe lava

Ecological site: Shallow Wet Ohia-Olapa Forest, F162XY503HI

Slope: 2 to 10 percent

Surface runoff class: Low

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 6.0 inches (moderate)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Moderately well drained

Typical profile

A—0 to 3 inches; medial silt loam

C1—3 to 4 inches; extremely gravelly ashy sandy loam

2C—4 to 6 inches; ashy loam
3C—6 to 9 inches; very gravelly ashy sand
4Bw—9 to 11 inches; ashy sandy loam
4C—11 to 13 inches; ashy loamy sand
5C—13 to 15 inches; ashy loamy fine sand
6A—15 to 17 inches; ashy silt loam
6Bw—17 to 18 inches; ashy silt loam
6C1—18 to 20 inches; ashy loamy sand
6C2—20 to 21 inches; very gravelly ashy sandy loam
6C3—21 to 26 inches; very gravelly ashy loamy sand
7C—26 to 32 inches; ashy loamy sand
8Cg—32 to 34 inches; ashy silt loam
9R—34 inches; bedrock

Estimated minor components

Cinder land

Extent of component in mapped areas: 0 to 8 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas of cinders from Kilauea Iki, ranging from 30 to more than 100 inches deep; cinder cones on pahoehoe lava flows

Puhimau and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows less than 400 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, livestock grazing, forage, and cropland

Major management consideration(s): Limited available water capacity; sandy textures; stoniness, which hinders tillage; moderate or high phosphorus retention; and high susceptibility to erosion

737—Nakanui-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 1,000 to 2,795 feet (305 to 853 meters)

Mean annual rainfall: 40 to 50 inches (1,015 to 1,270 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Map unit composition

Nakanui soil—50 to 70 percent

Lava flows, pahoehoe—20 to 45 percent

Ahiu and similar soils—0 to 10 percent

Characteristics of the Nakanui soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Parent material: Gravel and basaltic volcanic ash over pahoehoe lava

Ecological site: Low Elevation Makai Range, R161AY008HI

Slope: 2 to 10 percent

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.6 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 4 inches; medial loam

2A—4 to 6 inches; very gravelly medial sandy loam

2Bw—6 to 7 inches; very gravelly medial sandy loam

3A—7 to 9 inches; very gravelly medial loamy coarse sand

3C—9 to 11 inches; very gravelly medial loamy coarse sand

4Bw1—11 to 12 inches; gravelly medial loam

4Bw2—12 to 16 inches; very gravelly medial sandy loam

5Bw—16 to 18 inches; medial loam

6R—18 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Estimated minor components

Ahiu and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

738—Vitric Haplustands, 2 to 20 percent slopes

Map unit setting

General location: Mid and lower elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 0 to 3,000 feet (0 to 915 meters)

Mean annual rainfall: 20 to 40 inches (510 to 1,015 millimeters)

Mean annual air temperature: 70 to 79 degrees F (21 to 26 degrees C)

Map unit composition

Vitric Haplustands—85 to 95 percent

Lava flows, aa—0 to 15 percent

Ahiu and similar soils—0 to 10 percent

Characteristics of Vitric Haplustands

Geomorphic setting: Kilauea aa lava flows generally 450 to 1,500 years old; on a shield volcano

Parent material: Varying amounts of basaltic volcanic ash over aa lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 5 to 25 percent by angular stones; 35 to 65 percent by angular cobbles; 10 to 60 percent by coarse, angular gravel; 5 to 15 percent by angular boulders

Depth to a restrictive feature: Lithic bedrock—39 to 79 inches

Slowest permeability in the soils: Rapid

Most rapid permeability in the soils: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Typical profile

3C1/A—0 to 3 inches; extremely cobbly ashy very fine sandy loam

3C2/Bw—3 to 16 inches; extremely cobbly ashy very fine sandy loam

2C3/2C1—16 to 33 inches; extremely cobbly ashy loamy fine sand

3C4/2C2—33 to 35 inches; extremely stony ashy loamy fine sand

3C5—35 to 59 inches; extremely cobbly coarse sand

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Ahiu and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas above an elevation of 1,000 feet where the soils are underlain by pahoehoe lava flows; on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): A low capacity to supply natural potassium

741—Ahiu-Lava flows complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 1,685 to 3,000 feet (515 to 915 meters)

Mean annual rainfall: 25 to 35 inches (635 to 890 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Map unit composition

Ahiu soil—50 to 80 percent

Lava flows, pahoehoe—20 to 45 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Ahiu soil

Geomorphic setting: Kilauea pahoehoe lava flows 400 to 1,500 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Mid-Elevation Mauka Range, R161AY009HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Surface feature(s): On about 40 percent of the area, 50 to 100 percent of the surface horizon is eroded, apparently because of overgrazing by goats and the influence of feral pigs.

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Moderately rapid

Most rapid permeability in the soil: Rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 4.0 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 3 inches; ashy silt loam

Bw—3 to 6 inches; ashy silt loam
C—6 to 11 inches; stratified ashy fine sand and ashy loamy fine sand
2A—11 to 12 inches; ashy loam
2Bw—12 to 13 inches; ashy loam
3R—13 to 17 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by angular cobbles, 0 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): High susceptibility to erosion

743—Pakini medial very fine sandy loam, 2 to 10 percent slopes

Map unit setting

General location: South- and east-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of nearly level and gently sloping lava flows

Elevation: 0 to 1,000 feet (0 to 305 meters)

Mean annual rainfall: 15 to 30 inches (380 to 760 millimeters)

Mean annual air temperature: 72 to 75 degrees F (22 to 24 degrees C)

Map unit composition

Pakini soil—90 to 100 percent

Kaalualu and similar soils—0 to 10 percent

Characteristics of the Pakini soil

Geomorphic setting: More than 10 ka kipuka on lava flow on a shield volcano
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Desert Grassland, R157XY001HI
Slope: 2 to 10 percent
Surface runoff class: Low
Percentage of the surface covered by rock fragments: 2 to 20 percent by fine, subrounded gravel
Restrictive feature: None noted
Slowest permeability in the soil: Moderate
Most rapid permeability in the soil: Moderately rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 8.1 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Ap—0 to 3 inches; medial very fine sandy loam
A1—3 to 8 inches; medial very fine sandy loam
A2—8 to 16 inches; medial very fine sandy loam
Bw1—16 to 29 inches; medial loam
Bw2—29 to 45 inches; medial loam
Ck—45 to 59 inches; medial very fine sandy loam

Estimated minor components

Kaalualu and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: More than 5 ka aa lava flows on a shield volcano

Use and management

Major use(s): Livestock grazing and wildlife habitat

744—Haa-Keamoku complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano
Geomorphic setting: Intermingled aa lava flows and pahoehoe lava flows
Elevation: 4,100 to 5,000 feet (1,250 to 1,525 meters)
Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)
Mean annual air temperature: 50 to 59 degrees F (10 to 15 degrees C)
Frost-free period: 360 to 365 days

Map unit composition

Haa soil—25 to 75 percent
Keamoku soil—25 to 75 percent
Kulalio and similar soils—0 to 10 percent
Maunaiu and similar soils—0 to 10 percent

Ki and similar soils—0 to 10 percent
Akelelu and similar soils—0 to 10 percent
Oneula and similar soils—0 to 10 percent

Characteristics of the Haa soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—39 to 60 inches
Slowest permeability in the soil: Moderate
Most rapid permeability in the soil: Moderately rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 10.9 inches (very high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam
A2—3 to 7 inches; medial silt loam
Bw1—7 to 10 inches; medial loam
2Bw2—10 to 14 inches; medial loam
2Bw3—14 to 20 inches; medial silt loam
2Bw4—20 to 25 inches; medial silt loam
3A1—25 to 30 inches; medial silt loam
3A2—30 to 36 inches; cobbly medial loam
3Bw—36 to 43 inches; cobbly medial loam
4R—43 inches; bedrock

Characteristics of the Keamoku soil

Geomorphic setting: Areas of aa lava flow on a shield volcano
Parent material: Basaltic volcanic ash over aa lava
Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 0 percent
Restrictive feature: None noted
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 6.5 inches (moderate)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

- A1—0 to 3 inches; medial silt loam
- A2—3 to 10 inches; medial silt loam
- Bw1—10 to 14 inches; medial loam
- Bw2/3C1—14 to 21 inches; very gravelly medial loam
- 3C2/2A—21 to 35 inches; extremely cobbly ashy loam
- 3C3/2Bw1—35 to 50 inches; stratified extremely cobbly medial loam
- 3C4/2Bw2—50 to 60 inches; extremely cobbly medial loam

Estimated minor components

Kulalio and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Maunaiu and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Ki and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: A kipuka approximately 10,000 years old

Akelelu and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Oneula and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow less than 750 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing

Major management consideration(s): Moderate or high phosphorus retention and high susceptibility to erosion

745—Maunaiu-Akelelu complex, 3 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillside positions of pahoehoe lava flows

Elevation: 4,395 to 5,610 feet (1,340 to 1,710 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 54 to 59 degrees F (12 to 15 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Maunaiu soil—50 to 70 percent
Akelelu soil—25 to 50 percent
Lava flows, pahoehoe—0 to 10 percent
Kulalio and similar soils—0 to 10 percent
Keamoku and similar soils—0 to 10 percent
Haa and similar soils—0 to 10 percent

Characteristics of the Maunaiu soil

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 3 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 5.7 inches (moderate)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam

A2—2 to 6 inches; medial silt loam

Bw1—6 to 9 inches; medial silt loam

Bw2—9 to 14 inches; medial silt loam

Bw3—14 to 19 inches; medial silt loam

2R—19 inches; bedrock

Characteristics of the Akelelu soil

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 3 to 10 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 9.5 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 4 inches; medial silt loam

A2—4 to 7 inches; medial silt loam

Bw—7 to 15 inches; medial loam

2Bw1—15 to 18 inches; medial loam

2Bw2—18 to 21 inches; medial fine sandy loam

2Bw3—21 to 27 inches; medial fine sandy loam

3Bw1—27 to 30 inches; medial loam

3Bw2—30 to 34 inches; medial loam

4R—34 to 38 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kulalio and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Keamoku and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Haa and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing

Major management consideration(s): A low capacity to supply natural potassium, moderate acidity, moderate or high phosphorus retention, and high susceptibility to erosion

746—Kulalio-Maunaiu-Akelelu complex, 3 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Intermingled aa lava flows and pahoehoe lava flows

Elevation: 4,395 to 5,610 feet (1,340 to 1,710 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 50 to 59 degrees F (10 to 15 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Kulalio soil—30 to 50 percent

Maunaiu soil—30 to 45 percent

Akelelu soil—15 to 25 percent

Lava flows, pahoehoe—0 to 10 percent

Lava flows, aa—0 to 10 percent

Characteristics of the Kulalio soil

Geomorphic setting: Areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 3 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 to 5 percent by angular boulders, 0 to 15 percent by angular stones

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 4.7 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam

A2—3 to 7 inches; cobbly medial silt loam

Bw1/2C1—7 to 11 inches; very gravelly medial loam

Bw2/2C2—11 to 16 inches; very gravelly medial loamy sand

2C3/Bw3—16 to 25 inches; extremely gravelly ashy loamy sand

2C4—25 to 60 inches; extremely gravelly ashy loamy sand

Characteristics of the Maunaiu soil

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 3 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 5.7 inches (moderate)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam

A2—2 to 6 inches; medial silt loam

Bw1—6 to 9 inches; medial silt loam

Bw2—9 to 14 inches; medial silt loam

Bw3—14 to 19 inches; medial silt loam

2R—19 inches; bedrock

Characteristics of the Akelelu soil

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 3 to 10 percent

Surface runoff class: Medium

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—20 to 39 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 9.5 inches (high)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A1—0 to 4 inches; medial silt loam

A2—4 to 7 inches; medial silt loam

Bw—7 to 15 inches; medial loam

2Bw1—15 to 18 inches; medial loam

2Bw2—18 to 21 inches; medial fine sandy loam

2Bw3—21 to 27 inches; medial fine sandy loam

3Bw1—27 to 30 inches; medial loam

3Bw2—30 to 34 inches; medial loam

4R—34 to 38 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 20 percent

Geomorphic setting: Pahoehoe lava flows 3,000 to 5,000 years old; on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 3 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, forestland, and livestock grazing

Major management consideration(s): Moderate acidity, moderate or high phosphorus retention, and high susceptibility to erosion

747—Oneula extremely stony medial loam, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 4,495 to 6,000 feet (1,371 to soil meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 50 to 61 degrees F (10 to 16 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Oneula soil—85 to 95 percent

Kulalio and similar soils—0 to 5 percent

Maunaiu and similar soils—0 to 5 percent

Lava flows, aa—5 to 15 percent

Characteristics of the Oneula soil

Geomorphic setting: Mauna Loa aa lava flows less than 750 years old; on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 15 to 35 percent by very angular stones; 35 to 60 percent by very angular cobbles; 5 to 15 percent by coarse, very angular gravel; 5 to 15 percent by very angular boulders

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

2C1/A—0 to 2 inches; extremely stony medial loam

2C2—2 to 60 inches; extremely cobbly sand

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 5 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kulalio and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Kipuka areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Maunau and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Kipuka areas of pahoehoe lava flow 3,000 to 5,000 years old; on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): No significant limitations affect the major uses.

748—Lava flows-Menehune complex, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Pahoehoe lava flows

Elevation: 5,000 to 7,000 feet (1,525 to 2,135 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Lava flows, pahoehoe—60 to 80 percent

Menehune soil—15 to 25 percent

Lava flows, aa—0 to 10 percent

Kulalio and similar soils—0 to 10 percent

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development, R161AY999HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by coarse, angular gravel, 0 to 35 percent by angular cobbles

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Slowest permeability in the lava: Very slow

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Somewhat excessively drained

Characteristics of the Menehune soil

Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Transition Zone Ohia-Koa-Mamane Forest, F161AY500HI

Slope: 2 to 20 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 percent

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.9 inch (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

Oa—0 to 2 inches; highly decomposed plant material

C—2 inches; medial sandy loam

2A—2 to 3 inches; medial loam

2C1—3 to 5 inches; stratified medial loamy very fine sand

2C2—5 to 7 inches; stratified medial loam

2C3—7 to 7 inches; stratified medial loamy sand

2C4—7 to 8 inches; stratified medial loamy very fine sand

2C5—8 to 14 inches; stratified medial fine sand and medial loamy fine sand

3R—14 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kulalio and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 20 percent

Geomorphic setting: Kipuka areas with aa lava flows on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

749—Wahi extremely cobbly medial loam, 2 to 20 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 6,695 to 7,610 feet (2,042 to 2,320 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,524 millimeters)

Mean annual air temperature: 50 to 57 degrees F (10 to 14 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Wahi soil—70 to 95 percent

Lava flows, aa—5 to 15 percent

Kaholimo soil, eroded, and similar soils—0 to 10 percent

Kulalio and similar soils—0 to 10 percent

Puiwa and similar soils—0 to 10 percent

Characteristics of the Wahi soil

Geomorphic setting: Mauna Loa aa lava flows less than 750 years old; on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 20 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 15 to 35 percent by coarse, very angular gravel; 35 to 60 percent by very angular cobbles; 5 to 15 percent by very angular stones; 0 to 15 percent by very angular boulders

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 4.1 inches (low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Typical profile

3C1/A1—0 to 2 inches; extremely cobbly medial loam

3C2/A2—2 to 5 inches; extremely cobbly medial loam

3C3/2A—5 to 10 inches; extremely cobbly medial loam

3C4/2Bw1—10 to 12 inches; extremely cobbly medial loam

3C5/2Bw2—12 to 14 inches; extremely cobbly medial loam

3C6—14 to 60 inches; extremely stony medial loam

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 5 to 15 percent

Slope: 2 to 20 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Kaholimo soil, eroded, and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 15 percent

Geomorphic setting: Intermingled areas of Mauna Loa pahoehoe lava flow 200 to 3,000 years old; on a shield volcano

Kulalio and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Kipuka areas of aa lava flow 3,000 to 5,000 years old; on a shield volcano

Puiwa and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 15 percent

Geomorphic setting: Pahoehoe lava flows 200 to 3,000 years old; on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No significant limitations affect the major uses.

750—Ki medial loam, 3 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Lava flows with a very thick mantle of ash

Elevation: 3,900 to 4,590 feet (1,190 to 1,400 meters)

Mean annual rainfall: 59 to 79 inches (1,500 to 2,000 millimeters)

Mean annual air temperature: 55 to 59 degrees F (13 to 15 degrees C)

Map unit composition

Ki soil—85 to 100 percent

Haa and similar soils—0 to 10 percent

Keamoku and similar soils—0 to 10 percent

Lava flows, aa—0 to 5 percent

Oneula and similar soils—0 to 5 percent

Characteristics of the Ki soil

Geomorphic setting: Mauna Loa kipukas about 1,000 years old; on lava flows on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Soapberry-Koa Kipuka Forest, F160XY500HI

Slope: 3 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 0 percent

Restrictive feature: None noted

Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 9.6 inches (high)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A—0 to 2 inches; medial loam
Bw—2 to 4 inches; medial loam
C1—4 to 5 inches; ashy very fine sandy loam
C2—5 to 6 inches; gravelly ashy coarse sand
2A1—6 to 9 inches; very gravelly ashy very fine sandy loam
2A2—9 to 13 inches; gravelly ashy fine sandy loam
2Bw—13 to 15 inches; very gravelly medial sandy loam
3A—15 to 19 inches; very gravelly medial sandy loam
3AB—19 to 23 inches; medial loam
3Bw1—23 to 26 inches; medial loam
3Bw2—26 to 30 inches; gravelly medial loam
3Bw3—30 to 32 inches; medial silt loam
3Bw4—32 to 36 inches; very gravelly medial loam
4Bw5—36 to 38 inches; medial loam
4Bw6—38 to 41 inches; very gravelly medial loamy sand
4C—41 to 43 inches; stratified very gravelly medial fine sand and very gravelly medial sand
5Bw1—43 to 48 inches; gravelly medial loam
5Bw2—48 to 52 inches; very gravelly medial very fine sandy loam
5Bw3—52 to 60 inches; medial silt loam

Estimated minor components

Haa and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 3 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Keamoku and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 3 to 10 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Lava flows, aa

Extent of component in mapped areas: 0 to 5 percent
Slope: 3 to 10 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Oneula and similar soils

Extent of component in mapped areas: 0 to 5 percent
Slope: 3 to 10 percent
Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium

751—Oneula extremely stony medial loam, low elevation, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: All hillslope positions of aa lava flows

Elevation: 4,000 to 4,590 feet (1,220 to 1,400 meters)

Mean annual rainfall: 50 to 60 inches (1,270 to 1,525 millimeters)

Mean annual air temperature: 57 to 61 degrees F (14 to 16 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Oneula soil, low elevation—85 to 95 percent

Ki and similar soils—0 to 10 percent

Keamoku and similar soils—0 to 5 percent

Characteristics of Oneula soil, low elevation

Geomorphic setting: Areas of aa lava flow on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 5 to 15 percent by very angular boulders, 15 to 35 percent by very angular stones, 35 to 60 percent by very angular cobbles, 5 to 15 percent by coarse, very angular gravel

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

2C1/A—0 to 2 inches; extremely stony medial loam

2C2—2 to 60 inches; extremely cobbly sand

Estimated minor components

Ki and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: A kipuka approximately 10,000 years old; on lava flows on a shield volcano

Keamoku and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): No significant limitations affect the major uses.

752—Oneula-Keamoku-Maunaiu complex, 2 to 10 percent slopes

Map unit setting

General location: Upper elevation, southeast-facing, windward slopes on the Mauna Loa Volcano

Geomorphic setting: Intermingled aa lava flows and pahoehoe lava flows

Elevation: 4,000 to 4,590 feet (1,220 to 1,400 meters)

Mean annual rainfall: 50 to 80 inches (1,270 to 2,030 millimeters)

Mean annual air temperature: 57 to 61 degrees F (14 to 16 degrees C)

Frost-free period: 360 to 365 days

Map unit composition

Oneula soil—20 to 60 percent

Keamoku soil—15 to 45 percent

Maunaiu soil—15 to 30 percent

Lava flows, aa—0 to 15 percent

Ki and similar soils—0 to 5 percent

Characteristics of the Oneula soil

Geomorphic setting: Areas of aa lava flow on a shield volcano

Parent material: Basaltic volcanic ash over aa lava

Ecological site: Mauna Loa Savannah, R161AY010HI

Slope: 2 to 10 percent

Surface runoff class: Very low

Percentage of the surface covered by rock fragments: 5 to 15 percent by coarse, very angular gravel; 5 to 15 percent by very angular boulders; 15 to 35 percent by very angular stones; 35 to 60 percent by very angular cobbles

Restrictive feature: None noted

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 2.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

2C1/A—0 to 2 inches; extremely stony medial loam

2C2—2 to 60 inches; extremely cobbly sand

Characteristics of the Keamoku soil

Geomorphic setting: Areas of aa lava flow on a shield volcano

Parent material: Basaltic volcanic ash over aa lava
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 0 percent
Restrictive feature: None noted
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 6.5 inches (moderate)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 3 inches; medial silt loam
A2—3 to 10 inches; medial silt loam
Bw1—10 to 14 inches; medial loam
Bw2/3C1—14 to 21 inches; very gravelly medial loam
3C2/2A—21 to 35 inches; extremely cobbly ashy loam
3C3/2Bw1—35 to 50 inches; stratified extremely cobbly medial loam
3C4/2Bw2—50 to 60 inches; extremely cobbly medial loam

Characteristics of the Maunaiu soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Ohia-Koa/Hapuu-Kanawao Forest, F159BY500HI
Slope: 2 to 10 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—1 to 20 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 4.3 inches (low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A1—0 to 2 inches; medial silt loam
A2—2 to 6 inches; medial silt loam
Bw1—6 to 9 inches; medial silt loam
Bw2—9 to 14 inches; medial silt loam
Bw3—14 to 19 inches; medial silt loam
2R—19 inches; bedrock

Estimated minor components

Lava flows, aa

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: Areas of aa lava flow on a shield volcano

Ki and similar soils

Extent of component in mapped areas: 0 to 5 percent

Slope: 2 to 10 percent

Geomorphic setting: A kipuka approximately 10,000 years old; on Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): High susceptibility to erosion

753—Kalapana medial coarse sandy loam, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 1,495 to 2,705 feet (457 to 825 meters)

Mean annual rainfall: 75 to 100 inches (1,900 to 2,550 millimeters)

Mean annual air temperature: 63 to 66 degrees F (17 to 19 degrees C)

Map unit composition

Kalapana soil—85 to 95 percent

Lava flows, pahoehoe—0 to 15 percent

Makaopuhi and similar soils—0 to 10 percent

Characteristics of the Kalapana soil

Geomorphic setting: Pahoehoe lava flows less than 750 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Lama-Alahee-Pandanus Coastal Forest, F162XY501HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.6 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial coarse sandy loam

C—6 to 7 inches; medial sand

2R—7 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 15 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Makaopuhi and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation, wildlife habitat, and forestland

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

754—Kalapana-Lava flows complex, dry, 2 to 10 percent slopes

Map unit setting

General location: The lower elevation, southeast-facing, windward slopes on the Kilauea Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 1,000 to 2,540 feet (305 to 775 meters)

Mean annual rainfall: 50 to 75 inches (1,270 to 1,905 millimeters)

Mean annual air temperature: 66 to 72 degrees F (19 to 22 degrees C)

Map unit composition

Kalapana soil, dry—45 to 75 percent

Lava flows, pahoehoe—20 to 50 percent

Characteristics of Kalapana soil, dry

Geomorphic setting: Mountain flanks of Kilauea pahoehoe lava flows less than 750 years old; on a shield volcano

Parent material: Basaltic volcanic ash over pahoehoe lava

Ecological site: Lama-Alahee-Pandanus Coastal Forest, F162XY501HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 15 percent by coarse, subangular gravel

Depth to a restrictive feature: Lithic bedrock—2 to 20 inches

Slowest permeability in the soil: Rapid

Most rapid permeability in the soil: Very rapid

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.6 inch (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Well drained

Typical profile

A—0 to 6 inches; medial coarse sandy loam

C—6 to 7 inches; medial sand

2R—7 inches; bedrock

Characteristics of Lava flows, pahoehoe

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kind of material: Pahoehoe lava

Ecological site: Miscellaneous Area With Minimal Vegetative Development,
R161AY999HI

Slope: 2 to 10 percent

Surface runoff class: Very high

Percentage of the surface covered by rock fragments: 0 to 35 percent by angular
cobble, 0 to 35 percent by coarse, angular gravel

Depth to a restrictive feature: Lithic bedrock—0 to 2 inches

Most rapid permeability in the lava: Moderately slow

Permeability of the underlying bedrock: Very slow

Salinity: Not saline

Sodicity: Not sodic

Available water capacity: About 0.0 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): A low capacity to supply natural potassium and
high susceptibility to erosion

**755—Makaopuhi very paragravelly highly decomposed
plant material, 2 to 10 percent slopes**

Map unit setting

General location: Mid elevation, southeast-facing, windward slopes on the Kilauea
Volcano

Geomorphic setting: All hillslope positions of pahoehoe lava flows

Elevation: 2,195 to 2,900 feet (670 to 885 meters)

Mean annual rainfall: 100 to 120 inches (2,540 to 3,050 millimeters)

Mean annual air temperature: 61 to 68 degrees F (16 to 20 degrees C)

Map unit composition

Makaopuhi soil—85 to 95 percent

Lava flows, pahoehoe—0 to 15 percent

Kalapana and similar soils—0 to 10 percent

Characteristics of the Makaopuhi soil

Geomorphic setting: Pahoehoe lava flows on a shield volcano
Parent material: Organic material over basaltic volcanic ash over pahoehoe lava
Ecological site: Shallow Wet Ohia-Olapa Forest, F162XY503HI
Slope: 2 to 10 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—2 to 20 inches
Slowest permeability in the soil: Rapid
Most rapid permeability in the soil: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.1 inches (very low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Somewhat poorly drained

Typical profile

Oa—0 to 2 inches; very paragravelly muck
A—2 to 6 inches; medial silt loam
2R—6 inches; bedrock

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 15 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano

Kalapana and similar soils

Extent of component in mapped areas: 0 to 10 percent
Slope: 2 to 10 percent
Geomorphic setting: Pahoehoe lava flows on a shield volcano; areas with less organic accumulation

Use and management

Major use(s): Recreation, wildlife habitat, and forestland
Major management consideration(s): A low capacity to supply natural potassium

756—Ahiu-Vitric Haplustands complex, 2 to 10 percent slopes

Map unit setting

General location: Mid elevation, south-facing, windward slopes on the Kilauea Volcano
Geomorphic setting: All hillslope positions of aa and pahoehoe lava flows
Elevation: 1,695 to 2,990 feet (517 to 912 meters)
Mean annual rainfall: 25 to 35 inches (635 to 890 millimeters)
Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Map unit composition

Ahiu soil—20 to 80 percent
Vitric Haplustands—20 to 80 percent
Lava flows, pahoehoe—0 to 10 percent
Nakanui and similar soils—0 to 10 percent

Characteristics of the Ahiu soil

Geomorphic setting: Mountain flanks of Kilauea pahoehoe lava flows 400 to 1,500 years old; on a shield volcano
Parent material: Basaltic volcanic ash over pahoehoe lava
Ecological site: Mid-Elevation Mauka Range, R161AY009HI
Slope: 2 to 10 percent
Surface runoff class: Very high
Percentage of the surface covered by rock fragments: 0 percent
Depth to a restrictive feature: Lithic bedrock—2 to 20 inches
Slowest permeability in the soil: Moderately rapid
Most rapid permeability in the soil: Rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 4.0 inches (low)

Hydrologic properties

Flash flooding: None
Ponding: None
Wetness: None noted
Drainage class: Well drained

Typical profile

A—0 to 3 inches; ashy silt loam
Bw—3 to 6 inches; ashy silt loam
C—6 to 11 inches; stratified ashy fine sand and ashy loamy fine sand
2A—11 to 12 inches; ashy loam
2Bw—12 to 13 inches; ashy loam
3R—13 to 17 inches; bedrock

Characteristics of Vitric Haplustands

Geomorphic setting: Mountain flanks of Kilauea aa lava flows generally 450 to 1,500 years old; on a shield volcano
Parent material: Varying amounts of basaltic volcanic ash over aa lava
Ecological site: Mid-Elevation Mauka Range, R161AY009HI
Slope: 2 to 10 percent
Surface runoff class: Very low
Percentage of the surface covered by rock fragments: 35 to 65 percent by angular cobbles, 5 to 15 percent by angular boulders, 5 to 25 percent by angular stones, 10 to 60 percent by coarse, angular gravel
Depth to a restrictive feature: Lithic bedrock—39 to 79 inches
Slowest permeability in the soils: Rapid
Most rapid permeability in the soils: Very rapid
Permeability of the underlying bedrock: Very slow
Salinity: Not saline
Sodicity: Not sodic
Available water capacity: About 1.3 inches (very low)

Hydrologic properties

Flash flooding: None

Ponding: None

Wetness: None noted

Drainage class: Somewhat excessively drained

Typical profile

3C1/A—0 to 3 inches; extremely cobbly ashy very fine sandy loam

3C2/Bw—3 to 16 inches; extremely cobbly ashy very fine sandy loam

3C3/2C1—16 to 33 inches; extremely cobbly ashy loamy fine sand

3C4/2C2—33 to 35 inches; extremely stony ashy loamy fine sand

3C5—35 to 59 inches; extremely cobbly coarse sand

Estimated minor components

Lava flows, pahoehoe

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Nakanui and similar soils

Extent of component in mapped areas: 0 to 10 percent

Slope: 2 to 10 percent

Geomorphic setting: Pahoehoe lava flows on a shield volcano

Use and management

Major use(s): Recreation and wildlife habitat

Major management consideration(s): A low capacity to supply natural potassium and high susceptibility to erosion

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and forestland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and as wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the survey area for various uses. Many of the tables identify the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use. Terms for the limitation classes are *no limitations* and *limitations*, or they are *slight*, *moderate*, and *severe*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact

on the use and the point at which the soil feature is not a limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Rangeland and Forestland

Loretta J. Metz, Pacific Islands Area State Rangeland Management Specialist, and David Clausnitzer, Ph.D., Pacific Islands Area Forest Ecologist, Natural Resources Conservation Service, prepared this section.

Rangeland has native or naturalized vegetation consisting of grasses, grasslike plants, forbs, shrubs, and trees with a total tree canopy cover of less than 25 percent. In contrast, forestland has the ability to support woody species, specifically trees with more than 25 percent canopy cover and a height of more than 13 feet (4 meters) at maturity. The vegetation on rangeland and forestland provides many habitat components, aids in controlling soil erosion, is available to meet wildlife needs, and offers scenic and recreational opportunities. The rangeland may be suitable for grazing or browsing by domestic animals. Both rangeland and forestland are important environmentally and economically.

Characterization and Management

Rangeland and forestland are subject to many uses; therefore, it is important to characterize both on the basis of their ability to produce various kinds, proportions, and amounts of plants. In tropical and subtropical regions, the plant communities are largely dependent on climate and soil characteristics. To a much lesser extent, the topography, aspect, slope, and other abiotic features of the landscape also have an effect on the composition and production of the plant community. To assist in the understanding of soil-plant interaction and the effect of selected management practices, the Natural Resources Conservation Service classifies rangeland and forestland into ecological sites. An ecological site is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation (USDA, 1997). Because the growing season in tropical and subtropical areas is throughout the year, it is very difficult to determine the total annual production of woody species. Instead, tree productivity is quantified in terms of cubic feet per acre of standing wood at the time it was measured. We do not reference that amount of standing wood to any temporal limits (e.g., 1 year or 5 years). Likewise, the total annual production of shrub species is not collected; rather, shrubs and trees are described for the forestland ecological site (and some rangeland ecological sites) in terms of percent canopy cover, not total annual production.

Soil types and plant communities are correlated and serve as the basis for the development of each ecological site description. Soil properties that affect moisture supply and plant nutrients, such as texture, depth, and content of rock fragments, have the greatest influence on the productivity of rangeland plants and on the composition and distribution of the plant community. Soil reaction, salt content, fog drip, and a seasonal high water table also are important. Geography and climate influence the location of plant communities across the landscape and affect various soil properties. Climatic factors include the timing and amount of precipitation and the evaporation rates. Areas with a high evaporation rate and a low precipitation rate support more droughty plant communities with less total annual production and/or canopy cover. Areas with a low evaporation rate and a high precipitation rate can support more mesic plant communities and a higher amount of annual production and/or canopy cover. Differences in the soil properties that affect the composition,

production, and distribution of the plant community are considered in correlating ecological sites to individual soil map unit components.

Table 3 shows, for each major soil component in a map unit, the ecological site; the total annual production of vegetation on rangeland ecological sites; the amount of standing live wood of all native trees (in cubic feet per acre) on the forestland ecological sites; and the native tree or shrub species that are suited to the site. Native herbaceous species (grasses and forbs) are not listed in the table. Refer to the ecological site description for a more complete list of plants adapted to the ecological site. An explanation of the column headings in the table follows.

An *ecological site* is the product of all the environmental factors responsible for its development. It has characteristic soils that have developed over time; a characteristic hydrology, particularly infiltration and runoff; and a characteristic plant community (kind and amount of vegetation). The hydrology of the site is influenced by the soil and plant community. The vegetation, soils, and hydrology are all interrelated. Each is influenced by the others and influences the development of the others. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species or in total production. Most of the plant community assemblages in Hawaii have been altered by historic and current anthropogenic influences, including the introduction of grazing animals, the introduction of nonnative species for forage production, windbreaks or crop production, and the introduction of fire. Because of all of the anthropogenic inputs, it is difficult to determine and describe the “natural plant community.” For this reason, many of the rangeland ecological site descriptions focus on the “interpretive plant community” and naturalized plant communities that are currently on each site. It is somewhat easier to determine the potential natural plant community of the forestland ecological sites. The results of extensive fieldwork, collection of field data, and literature reviews by the Natural Resources Conservation Service can be used as a basis for quantifying and describing these plant communities.

Range productivity refers to the amount of vegetation that can be expected to grow annually in a well managed area that supports the naturalized plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year’s growth of leaves, culms, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation. The “Low-Rv-High” values are quantified on the basis of the average range of values for the ecological site. “Rv” means representative value.

Yields are adjusted to a common percent of air-dry moisture content. The total production figures can be used to calculate carrying capacity and stocking rates for management of domestic animals or wildlife and to determine fuel loading for prescribed burn plans or fire modeling.

The column *standing live wood of native trees* shows the total volume of standing wood in tree boles of native species at the time measured. Measurements were taken during the calendar years 2004 through 2007 at multiple field locations and aggregated into final values for each ecological site. The volume of wood in twigs and branches is not included. The “Low-Rv-High” values are quantified on the basis of the average range of values for the ecological site. “Rv” means representative value. The range of values is less dependent on annual weather variations than the range productivity amounts.

Native trees or shrubs to manage include the native shrubs and/or trees that are either known to grow or expected to grow as part of the natural plant community of the site. The species are listed by common Hawaiian name (see table 4). All of the plant names are correlated directly with the NRCS PLANTS Database (<http://plants.usda.gov>).

Overview of NRCS Ecological Site Concepts

Vegetated landscapes are divided into ecological sites for the purposes of inventory, evaluation, and management. An ecological site is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation.

The native plant community for a site is the plant community that has evolved under natural ecological processes and disturbances and is considered to be the highest natural potential for the site under the current climate. It has developed on the site as a result of all site-forming factors and is best adapted to the unique combination of environmental factors associated with the site. Natural disturbances, such as fire, drought, herbivory, and flooding, were inherent in the development and maintenance of the native plant communities. Naturalized plant communities that are or have been subject to anthropogenic disturbances or physical site deterioration or have been protected from their natural disturbance regimes do not typify the native plant community and may occur in a stable or steady state that is different from the native plant community.

The native or naturalized plant community described for a given ecological site is not a precise assemblage of species for which the proportions are the same from place to place or from year to year. In all plant communities, variability is apparent in the productivity, occurrence, and/or canopy cover of individual species. Boundaries of the communities can be recognized by characteristic patterns of species composition, association, and community structure. Generally, one species or group of species dominates the site, and the stability within the natural dynamics or disturbances of the site allows the species to be the distinguishing factor that differentiates one site from another.

At times, less frequently occurring plants may increase in extent on a site or plants not formerly occurring in the native or naturalized plant community may invade the site. The presence or abundance of these plants may fluctuate greatly because of the ability of the plant to adapt to differences in the microenvironment, weather conditions, soil alterations, or human actions. Using these species for site identification can be misleading; thus, they should not be used to differentiate sites.

The following ecological site inventory methods are used in determining the characteristic plant communities of an ecological site:

1. Identification and evaluation of reference and/or relict sites with similar plant communities and associated soils.
2. Interpolation and extrapolation of plant, soil, and climatic data from existing historic reference areas along a continuum to other points on that continuum for which no suitable reference community is available.
3. Evaluation and comparison of the same ecological site in different areas that have experienced different levels of disturbance and management. Further comparison is made with areas that are not disturbed.
4. Evaluation and interpretation of research data dealing with the ecology, management, and soils of plant communities.
5. Review of historical accounts, survey and military records, and botanical literature of the area.

The initial description of the reference state (the native or naturalized plant community) should be considered as an approximation subject to modification as additional knowledge is gained or discovered.

Plant communities change along environmental gradients. Where changes in soils, climate, aspect, or topography are abrupt, the plant community boundaries are reasonably distinct. Boundaries are less distinct or apparent where the plant communities change gradually over wide environmental gradients of relatively uniform soils and climate. Thus, the need for site differentiation may not be readily

apparent until the cumulative impact of soil, climate, topography, and hydrology is examined over a broad area. Frequently, such differences are reflected first in production and second in the kinds and proportions of a plant species making up the core of the plant community. In some areas the boundaries that are drawn between ecological sites along a continuum of closely related soils and a gradually changing climate are somewhat arbitrary.

The following criteria are used to differentiate one ecological site from another:

1. Significant differences in the species or groups of species that are in the characteristic plant community.
2. Significant differences in the relative proportion of species or groups of species in the characteristic plant community.
3. Significant differences in the total annual production or site index of the characteristic plant community.
4. Soil and climate factors that determine plant production and composition, the hydrology of the site, and the functioning of the ecological process of the water cycle, mineral cycles, and energy flow.

Differences in the kind, proportion, and production of plants are the result of differences in soil, climate, elevation, topography, and other environmental factors. Slight variations in these factors are not criteria for site differentiation. Individual environmental factors are frequently associated with significant differences in reference plant communities. For a distinct site to be differentiated, the differences in the environmental factors must be great enough to affect the kinds, amounts, and proportions of the plant community.

General Characteristics of Ecological Sites in the Survey Area

The following paragraphs describe the ecological sites in the survey area. A complete description of the ecological sites can be obtained from the local office of the Natural Resources Conservation Service or can be downloaded from the NRCS electronic Field Office Technical Guide (http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=HI) or from the Ecological Site Information System Web site (<http://esis.sc.egov.usda.gov/>). See table 3 for the specific soils in the survey area that are correlated to each ecological site and table 5 for a list of the ecological sites in the area.

Ohia-Koa/Hapuu-Kanawao Forest (F159BY500HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Metrosideros polymorpha*-*Acacia koa*/*Cibotium glaucum*-*Broussaisia arguta*/*Dryopteris wallichiana*. It occurs on Mauna Loa mountain slopes in areas where the annual precipitation is 50 to 130 inches (1,270 to 3,302 millimeters). Afternoon cloud cover and fog drip are common. The site is a tall-stature rain forest with an open or closed overstory of ohia (*Metrosideros polymorpha*) and in some areas koa (*Acacia koa*), a secondary canopy of olapa (*Cheirodendron trigynum*) and other species, a tertiary canopy of hapuu (*Cibotium* spp.), and a diverse ground layer of shrubs and small ferns (fig. 8). Vines, particularly ieie (*Freydenetia arborea*), are common. The soils formed in ash and are shallow to very deep. Slopes range from 1 to 60 percent. Elevations range dominantly from 1,200 to 6,000 feet (366 to 1,830 meters). The soil temperature regime is isothermic or isomesic, and the soil moisture regime is udic.

Soapberry-Koa Kipuka Forest (F160XY500HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Sapindus saponaria*-*Acacia koa*/*Pipturus albidus*/*Microlepis strigosa*. It occurs within numerous kipukas on Mauna Loa in areas where the annual precipitation is 55 to 75 inches (1,397 to 1,905 millimeters). The site is a tall-stature forest with an open or closed overstory of ohia (*Metrosideros polymorpha*), soapberry (*Sapindus saponaria*), and koa (*Acacia koa*); a diverse secondary canopy of olopua (*Nestegis sandwicensis*) and other

species; and a diverse ground layer of shrubs, grasses, and small ferns. The soils formed in ash and are deep or very deep. Slopes range from 4 to 30 percent. Elevations range dominantly from 3,300 to 4,600 feet (1,006 to 1,403 meters). The soil temperature regime is isomesic, and the soil moisture regime is moist ustic.

Transition Zone Ohia-Koa-Mamane Forest (F161AY500HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Metrosideros polymorpha*-*Acacia koa*/*Sophora chrysophylla*-*Dodonaea viscosa*/*Pteridium aquilinum*. It occurs on Mauna Loa mountain slopes in areas where the annual precipitation is 45 to 65 inches (1,397 to 1,905 millimeters). The site is a tall-stature forest with an open or closed overstory of ohia (*Metrosideros polymorpha*) and koa (*Acacia koa*); a secondary canopy of mamane (*Sophora chrysophylla*), sandalwood (*Santalum paniculatum*), and naio (*Myoporum sandwicense*); and a ground layer of shrubs and small ferns (fig. 9). The soils formed in ash and are very shallow to very deep. Slopes range from 3 to 35 percent. Elevations range dominantly from 2,300 to 7,000 feet (701 to 2,135 meters). The soil temperature regime is isomesic, and the soil moisture regime is ustic.

Kona Weather Pattern Dry Forest (F161BY501HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Diospyros sandwicensis*-*Psydrax odorata*/*Osteomeles anthyllidifolia*-*Dodonaea viscosa*/*Peperomia*. It occurs on Mauna Loa mountain slopes in areas where the annual precipitation is 30 to 60 inches (762 to 1,524 millimeters). The site is a low- or medium-stature forest with an open or closed overstory of ohia (*Metrosideros polymorpha*), lama (*Diospyros sandwicensis*), or a variable mixture of both. Many other dry forest tree species may occur; diversity and dominance apparently vary with variations in the age of lava flows. The fairly sparse understory consists of shrubs, vines, herbs, and grasses. The soils formed either in volcanic ash or highly decomposed organic material and are very shallow to deep. Slopes range from 2 to 99 percent. Elevations range dominantly from 50 to 2,500 feet (15 to 762 meters). The soil temperature regime is isohyperthermic to isothermic, and the soil moisture regime is ustic.



Figure 8.—An area of the Ohia-Koa/Hapuu-Kanawao Forest (F159BY500HI) ecological site.



Figure 9.—An area of the Transition Zone Ohia-Koa-Mamane Forest (F161AY500HI) ecological site.

Koa-Sandalwood-Mamane Forest (F161BY503HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Acacia koa-Santalum paniculatum/Osteomeles anthyllidifolia-Dodonaea viscosa/Deschampsia nubigena*. It occurs on Mauna Loa and Hualalai mountain slopes in areas where the annual precipitation is 25 to 40 inches (635 to 1,016 millimeters). The site is a tall-stature forest with an open or closed overstory of ohia (*Metrosideros polymorpha*) and koa (*Acacia koa*); a secondary canopy of mamane (*Sophora chrysophylla*), sandalwood (*Santalum paniculatum*), and naio (*Myoporum sandwicense*); and a ground layer of shrubs, grasses, and small ferns. The soils formed in highly decomposed organic material or in volcanic ash and are very shallow to deep. Slopes range from 2 to 55 percent. Elevations range dominantly from 2,000 to 7,000 feet (610 to 2,135 meters). The soil temperature regime is isomesic, and the soil moisture regime is ustic.

Lama-Alahee-Pandanus Coastal Forest (F162XY501HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Pandanus tectorius-Diospyros sandwicensis/Psydrax odorata-Osteomeles anthyllidifolia/Peperomia*. It occurs on Kilauea mountain slopes in areas where the annual precipitation is 70 to 110 inches (1,778 to 2,794 millimeters). The site is a low-stature forest with an open or nearly closed overstory of lama (*Diospyros sandwicensis*), a low-stature secondary canopy of alahee (*Psydrax odorata*), and a sparse understory of shrubs, herbs, and vines. Hala (*Pandanus tectorius*) is a major component of the overstory in areas at low elevations. The soils formed in highly decomposed organic material or in volcanic ash and are very shallow to deep. Slopes range from 2 to 40 percent. Elevations range dominantly from 20 to 2,600 feet (6 to 793 meters). The soil temperature regime is isohyperthermic or isothermic, and the soil moisture regime is ustic or udic.

Shallow Wet Ohia-Olapa Forest (F162XY503HI).—This ecological site also is referenced by the scientific names of the dominant plants: *Metrosideros polymorpha-Cheirodendron trigynum/Cibotium glaucum-Cyrtandra/Freycinetia arborea*. It occurs on Kilauea mountain slopes in areas where the annual precipitation is 75 to 175 inches (1,905 to 4,445 millimeters). The site is a medium- or tall-stature forest with an

open or nearly closed overstory of ohia (*Metrosideros polymorpha*); a secondary canopy of hapuu (*Cibotium* spp.), olapa (*Cheirodendron trigynum*), and other tree species; and an understory of shrubs and small ferns (fig. 10). Vines are common. The soils formed in volcanic ash or highly decomposed organic material and are very shallow to moderately deep. Slopes range from 2 to 20 percent. Elevations range dominantly from 1,200 to 4,000 feet (366 to 1,220 meters). The soil temperature regime is isothermic, and the soil moisture regime is udic.



Figure 10.—An area of the Shallow Wet Ohia-Olapa Forest (F162XY503HI) ecological site.

Desert Grassland (R157XY001HI).—This ecological site has an aspect of open grassland (fig. 11) consisting dominantly of a continuous cover of buffelgrass (*Pennisetum ciliare*). It generally occurs on nearly level to gently rolling coastal plains, but it may also occur in moderately steep areas on low mountain slopes. Slopes range from 0 to 15 percent. Elevations range from 0 to 2,500 feet (0 to 758 meters). The soils formed in ash, have a texture of sandy loam to loam, and are moderately deep or deep. The soil temperature regime is isohyperthermic, and the soil moisture regime is aridic.

Low Elevation Makai Range (R161AY008HI).—This ecological site occurs at low elevations on coastal plains of Mauna Loa. It consists of introduced grass and shrub species (fig. 12). The most common grasses are thatching grass (*Hyparrhenia rufa*), molassesgrass (*Melinis minutiflora*), Natal redtop (*Melinis repens*), and pilgrass (*Heteropogon contortus*). Shrubs include lantana (*Lantana camara*). The soils formed in ash and are shallow or moderately deep over pahoehoe lava flows. Slopes range from 0 to 15 percent but generally are less than 10 percent. Elevations range from 0 to 2,000 feet (0 to 606 meters). The soil temperature regime is isohyperthermic or isothermic, and the soil moisture regime is ustic.

Mid-Elevation Mauka Range (R161AY009HI).—This ecological site occurs on mid-elevation mountain slopes of Mauna Loa. It consists of introduced grass and shrub species (fig. 13). The most common plants are pitted beardgrass (*Bothriochloa*



Figure 11.—An area of the Desert Grassland (R157XY001HI) ecological site.



Figure 12.—An area of the Low Elevation Makai Range (R161AY008HI) ecological site.

pertusa), broomsedge (*Andropogon virginicus*), and sparse shrub assemblages of pukiawe (*Styphelia tameiameia*), aalii (*Dodonaea viscosa*), and ohia (*Metrosideros polymorpha*). The soils are of varying depths. They generally overlie pahoehoe lava flows, but in a few areas they overlie aa lava flows. Slopes range from 0 to 10 percent. Elevations range from 2,000 to 4,000 feet (606 to 1,212 meters). The soil temperature regime is isothermic, and the soil moisture regime is ustic.



Figure 13.—An area of the Mid-Elevation Mauka Range (R161AY009HI) ecological site.

Mauna Loa Savannah (R161AY010HI).—This ecological site occurs on Mauna Loa mountain slopes in areas where the annual precipitation is 40 to 70 inches (1,016 to 1,778 millimeters). Afternoon cloud cover and fog drip are rather common. The site is an open shrubland savannah aspect (fig. 14). The dominant plants are pukiawe (*Styphelia tameiameia*), aalii (*Dodonaea viscosa*), ohia (*Metrosideros polymorpha*), ohelo (*Vaccinium reticulatum*), hairgrass (*Deschampsia nubigena*), and alien grasses. The soils formed in ash and are shallow to very deep. Slopes range from 4 to 15 percent. Elevations range dominantly from 4,000 to 7,500 feet (1,212 to 2,273 meters). The soil temperature regime is isomesic, and the soil moisture regime is ustic or dry udic.

Pahoehoe Shrubland (R161AY011HI).—This ecological site occurs on Hualalai and, in a few areas, Mauna Loa mountain slopes in areas where the annual precipitation is 20 to 30 inches (508 to 762 millimeters). Some fog drip accumulation may be common. The site occurs as shrubland of low-growing plants. The dominant plants are mountain pili (*Coprosma montana*), aalii (*Dodonaea viscosa*), sandalwood (*Santalum paniculatum*), ulei (*Osteomeles anthyllidifolia*), pukiawe (*Styphelia tameiameia*), ohia (*Metrosideros polymorpha*), and alien grasses. The soils are organic and overlie pahoehoe lava. Slopes range from 0 to 15 percent. Elevations range from 5,000 to 8,500 feet (1,515 to 2,575 meters). The soil temperature regime is isomesic, and the soil moisture regime is ustic.



Figure 14.—An area of the Mauna Loa Savannah (R161AY010HI) ecological site.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 6. This list does not constitute a recommendation for a particular land use. On map unit 631 (Kapapala medial loam, 2 to 10 percent slopes), measures that overcome droughtiness are needed. Onsite evaluation is needed to determine

whether or not this limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 2. The location is shown on the detailed soil maps. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Recreation

The soils of the survey area are rated in tables 7a and 7b according to limitations that affect their suitability for recreation. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. A rating of *no limitations* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Limitations* with numerical ratings of less than 1.00 can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Limitations* with numerical ratings of 1.00 generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the tables are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The information in tables 7a and 7b can be supplemented by other information in this survey, for example, interpretations for building site development.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Playgrounds require soils that are nearly level, are free of stones, and can withstand intensive foot traffic. The ratings are based on the soil properties that affect the ease of developing playgrounds and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of playgrounds. For good trafficability, the surface of the playgrounds should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Paths and trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Building Site Development

This section provides information for building site development. The ratings are based on observed performance of the soils and on the data in the tables described under the heading "Soil Properties."

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about particle-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 7 feet of the surface, soil wetness, depth to a water table, ponding, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting building site development.

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Tables 8a and 8b show the degree and kind of soil limitations that affect dwellings without basements, small commercial buildings, local roads and streets, and shallow excavations.

The ratings in the tables are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building

site development. *Slight* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Moderate* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Severe* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the tables indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), liquefaction, and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may

restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Selected Soil and Site Features

Table 9 provides information about soil and site features important in the management of National parks. This table indicates the *slope* and *elevation* of the map unit components in the survey area. This information is followed by information about the average annual precipitation, landscape, landform, parent material, and ecological site of the components.

The *average annual rainfall* is an average of the total annual liquid precipitation over the latest standard “normal” period of 30 years.

Landscape is a group of spatially related, natural landforms in a relatively large area. The landscape is the land surface that the eye can comprehend in a single view.

Landform is any recognizable physical form or feature on the earth’s surface that has a characteristic shape and composition and is produced by natural causes. A landform can span a wide area.

Parent material is the unconsolidated and more-or-less chemically weathered mineral or organic material in which a soil forms.

An *ecological site* is an area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey.

Soil properties are ascertained by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Soil sampling and subsequent laboratory analyses were conducted on many soils in the survey area. The sampling procedures set forth by National Cooperative Soil Survey were followed. All laboratory analyses were conducted at the National Cooperative Soil Survey Laboratory in Lincoln, Nebraska. Laboratory data for soils sampled in the survey area can be accessed on the Internet (<http://ssldata.nrcs.usda.gov/>).

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties are shown in tables. They include engineering index properties, physical and chemical properties, and pertinent soil features.

The properties affecting plant growth are described in the text of this section.

Soil Properties Affecting Plant Growth

Each different type of soil has physical and chemical properties that are intrinsic. Viable management options are constrained by these properties. This section describes the intrinsic physical and chemical properties of the soils in the survey area. The properties considered are those that are thought to have important effects on the growth of desirable plants.

Statements about intrinsic fertility and other characteristics can be made both about the soils in the survey area as a collective group and as individual soil types. As a group, all of the soils have certain characteristics in common. One of the most important characteristics is a low level of naturally occurring potassium. About half of the individual soil types are considered to have critically low levels of potassium and are described as such in this section. Nearly all of the remaining soil types have low levels of potassium, although the levels are not thought to be below the critical threshold. Slow-growing perennial vegetation (as opposed to an annual crop) can often tolerate low amounts of nutrients, which have time to accumulate and bio-cycle, but the growth rate is reduced.

Another characteristic of all the soils is how pH is distributed in the profile. All of the soils have lower pH values at the surface than below the surface. The initial pH of the parent material is approximately neutral. High rainfall and acid rain cause leaching of bases from the surface and thus result in acidification. The subsoil is less affected by leaching and tends to be less acid than the surface layer. In areas near acid rain sources, acidification of the upper part of the surface layer can be significant enough

to hinder seed germination. Mechanical mixing of this part of the surface layer with the soil below can dilute the acid and facilitate normal germination. Mixing to a depth of 20 centimeters should result in enough dilution. Amending the soils with lime or dolomite raises the pH.

To some extent, all of the soils in the survey area share a similar distribution of moisture throughout the year. The individual soil types vary greatly in how much moisture they typically have. This section identifies which soil types are droughty during typical years. Despite the individual variations in the ability of the soils to hold water, all of the soils have more moisture in winter than in summer during typical years. Throughout the survey area, rainfall is higher during winter and evapotranspiration is lower. The moisture in the soils generally reflects rainfall and evapotranspiration patterns. The soils in the eastern part of the survey area are not dry during any month, and the soils in the western part, which is at a low elevation, are dry about 6 months in most years, usually during summer.

Each individual soil type in the survey area was evaluated in regard to plant growth. The evaluation took fertility, erodibility, and crusts into account.

The individual soil types in the survey area each have unique inherent fertility characteristics. Each soil type was evaluated with regard to those characteristics. To facilitate the evaluation, the "Fertility Capability Classification System" (FCC) of C.W. Smith (1989) was used. FCC is a technical soil classification system relating pedon characterization data to inherent fertility characteristics. It evaluates soil characteristics to a depth of 50 centimeters. The FCC system has been designed to group soils that have similar inherent fertility-related properties and to provide recommendations of the appropriate technology designed to help alleviate limitations. Each of the soils in the survey area has been classified according to the FCC system. The FCC rating is available on request at the State Office of the Natural Resources Conservation Service in Honolulu, Hawaii.

The individual soil types in the survey area have unique inherent erodibility characteristics. Each soil type was evaluated with regard to those characteristics. This evaluation is based on the criteria for highly erodible land outlined in the "National Food Security Act Manual" (USDA, 2004). These criteria identify soils that are highly susceptible to erosion. The factors considered are the rainfall intensity zone in which the soils occur, the difficulty of the soils to replenish themselves after soil loss, the slope length typical for the landform of the soils, and the inherent ability of the soil particles to resist being dislodged by water. The criteria were used to calculate the slope at which the individual soil type is highly susceptible to erosion. The calculation applies to unconsolidated soil conditions, such as freshly prepared construction sites.

Another individual soil property is the presence of a crust on the surface of the soils. A few soils had regularly occurring intermittent crusts on the surface. These crusts are understood to have formed primarily through mineralogical rather than biological processes. They can be very slowly penetrable by water and can be extremely acid. As a result, seed germination is unlikely.

Ahiu Soils

These loamy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall and shallow soil depth limit the success of seedling germination to winter and spring. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Akelelu Soils

These loamy soils are deep over bedrock. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 5 percent.

Akihi Soils

These clayey soils have too many rocks to be suitable for periodic cultivation. The soils are moderately acid or highly acid. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 14 percent.

Alahapa Soils

These soils consist of loamy over sandy soil material within many aa fragments. A high content of rock fragments results in droughty conditions, and the pattern of seasonal rainfall limits the success of seedling germination and survival. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Alapai Soils

These clayey soils are deep over bedrock. The level of acidity is moderate or high. The capacity to supply natural potassium is low. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 22 percent.

Apuki Soils

These sandy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall, sandy texture, and shallow soil depth limit the success of seedling germination to winter and spring. The nutrient-holding capacity is low. If soil amendments are applied, quantities should be reduced and timing spaced so that loss through leaching is minimized. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Aquands

These clayey soils are shallow over bedrock. They frequently have a high water table, which can adversely affect the plants that are not adapted to wet conditions. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 8 percent.

Durustands

These loamy soils have a cemented layer that limits the rooting depth in the subsurface layers. Climatic conditions result in seasonal dryness. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 14 percent.

Eheuiki Soils

These loamy soils are deep over bedrock. Moderate acidity in the surface layer can adversely affect plants. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 9 percent.

Haa Soils

These loamy soils are deep over bedrock. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 6 percent.

Halemaumau Soils

These loamy soils have gravel in the surface layer and are deep over bedrock. They are highly acid in the surface layer. Climatic conditions result in seasonal dryness. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 1 percent.

Hao Soils

These loamy soils are deep over bedrock. They are saturated in the root zone for periods long enough to adversely affect the plants that are not adapted to wet conditions. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent.

Hapuu Soils

These soils consist of very rocky, loamy material overlying extremely rocky, sandy material. They are not suitable for periodic cultivation. Seasonal dryness, sandy textures, and a high content of rock fragments help to create frequent droughty conditions. Success of seedling germination is limited to spring or summer. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 12 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Heake Soils

These loamy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall and shallow soil depth limit the success of seedling germination to winter and spring. Moderate acidity in the surface layer can adversely affect plants. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 1 percent.

Hilea Soils

These clayey soils are shallow to pahoehoe. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent.

Hokukano Soils

These loamy soils have some rock fragments in the subsurface layers and are less than 20 inches deep to pahoehoe. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Ihuanu Soils

These loamy soils have too many rock fragments to be suitable for periodic cultivation. Seasonal dryness and a high content of rock fragments result in droughty conditions during some time in most years. The capacity to supply natural potassium is low. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 12 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Iwalani Soils

These loamy soils are less than 10 inches deep to pahoehoe. Seasonal dryness and very shallow soil depth result in droughty conditions during some time in most years. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kaalualu Soils

These loamy soils have too many rock fragments to be suitable for periodic cultivation. Prolonged dryness and a high content of rock fragments result in droughty conditions much of the year. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 4 percent.

Kahalii Soils

These sandy soils are gravelly and are shallow to pahoehoe. The pattern of seasonal rainfall, sandy texture, and shallow soil depth limit the success of seedling germination to winter and spring. The nutrient-holding capacity is low. If soil amendments are applied, quantities should be reduced and timing spaced so that loss through leaching is minimized. Moderate acidity in the surface layer can adversely affect plants. The capacity to supply natural potassium is low.

Kahaluu Soils

These organic soils are very shallow to pahoehoe. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 13 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kaholimo Soils

These loamy soils are shallow to pahoehoe. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Kalapana Soils

These sandy soils are shallow to pahoehoe. The pattern of seasonal rainfall, sandy texture, and shallow soil depth limit the success of seedling germination to winter and spring. Moderate acidity in the surface layer can adversely affect plants. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 2 percent.

Kali Soils

These soils consist of a thin layer of rocky, dry organic material over pahoehoe bedrock. Seasonal dryness and very shallow soil depth result in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 8 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kamaoa Soils

These loamy soils are very deep. Seasonal dryness results in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 16 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kanohina Soils

These loamy soils are shallow to pahoehoe. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 1 percent.

Kapapala Soils

These deep soils have a loamy surface layer and sandy subsurface layers. Seasonal dryness results in droughty conditions during some time in most years. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 16 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kapua Soils

These soils have a surface layer of dry, organic material in between aa rock fragments and subsurface layers of aa rock fragments. They have too many rock fragments and too little soil material to be suitable for periodic cultivation. Land clearing causes loss of organic matter. Seasonal dryness and a high content of rock fragments result in frequent droughty conditions. Success of seedling germination is limited to spring or summer. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Kapulehu Soils

These loamy soils have too many rock fragments to be suitable for periodic cultivation. Seasonal dryness and a high content of rock fragments result in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 12 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Keaa Soils

These loamy soils have too many rock fragments to be suitable for periodic cultivation. They are less than 20 inches deep to pahoehoe. Seasonal dryness and a high content of rock fragments result in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kealoha Soils

These loamy soils have too many rock fragments to be suitable for periodic cultivation. Seasonal dryness and a high content of rock fragments result in droughty conditions during some time in most years. Moderate acidity in the surface layer can adversely affect some plants. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 12 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Keamoku Soils

These loamy soils are deep over bedrock and have a high content of rock fragments in the subsurface layers. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 6 percent.

Kekake Soils

These soils consist of a thin layer of rocky, dry organic material over pahoehoe bedrock. Seasonal dryness and very shallow soil depth result in droughty conditions during some time in most years. Moderate acidity in the surface layer can adversely affect some plants. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 8 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Ki Soils

These gravelly, loamy soils are deep over bedrock. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Kilauea Soils

These sandy, gravelly soils are deep over bedrock. They are highly acid. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall and sandy texture limit the success of seedling germination to winter and spring. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils commonly have a hard crust on about half of the surface. The crust is extremely acid. It interferes with seed germination and alters rainfall infiltration patterns.

Kiloa Soil

These soils have a thin surface layer of dry organic material in between aa rock fragments and subsurface layers of aa rock fragments. Land clearing causes loss of organic matter. The soils are moderately acid or highly acid. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Kiolakaa Soils

These soils have a loamy surface layer and very rocky, loamy subsurface layers. Seasonal dryness results in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Kuanene Soils

These loamy soils are shallow to pahoehoe. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 1 percent.

Kulalio Soils

These gravelly, loamy soils are deep over bedrock. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Lalau Soils

These soils have a thin surface layer of dry organic material in between aa rock fragments and subsurface layers of aa rock fragments. Land clearing causes loss of organic matter. The soils are moderately acid or highly acid. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Lithic Haplustands, Cindery Substratum

These sandy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall, sandy texture, and shallow soil depth limit the success of seedling germination to winter and spring. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Lithic Haplustands, Loamy Surface

These very gravelly, loamy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall, rockiness, and shallow soil depth limit the success of seedling germination to winter and spring. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Lithic Ustipsamments

These sandy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall, sandy texture, and shallow soil depth limit the success of seedling germination to winter and spring. The nutrient-holding capacity is low. If soil amendments are applied, quantities should be reduced and timing spaced so that loss through leaching is minimized. The capacity to supply natural potassium is low. The shallow soil depth affects the susceptibility to erosion.

Makaopuhi Soils

These loamy soils are shallow to pahoehoe. Moderate acidity in the surface layer can adversely affect plants. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 2 percent.

Malama Soils

These soils have a thin surface layer of dry organic material in between aa rock fragments and subsurface layers of aa rock fragments. Land clearing causes loss of organic matter. The soils are moderately acid or highly acid. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Manu Soils

These sandy soils are deep over bedrock and have gravel in the surface layer. Because of adequate rainfall throughout most of the year and a tendency of the soils to perch water temporarily in the subsurface layer, moisture stress is not probable. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Maunaiu Soils

These loamy soils are shallow to pahoehoe. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be very low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 2 percent.

Mawae Soils

These soils have a surface layer of dry organic material in between aa rock fragments and subsurface layers of aa rock fragments. Seasonal dryness and a high content of rock fragments result in frequent droughty conditions. Success of seedling germination is limited to spring or summer. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Menehune Soils

These loamy soils are shallow to pahoehoe. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be very low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 14 percent.

Nakanui Soils

These gravelly, loamy soils are shallow to pahoehoe. Climatic conditions result in seasonal dryness. The pattern of seasonal rainfall and shallow soil depth limit the success of seedling germination to winter and spring. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be very low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Nanaia Soils

These loamy soils are less than 10 inches deep to pahoehoe. Seasonal dryness and very shallow soil depth result in droughty conditions during some time in most years. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent. The soils exhibit hydrophobicity, which can cause

reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Ohaikea Soils

These loamy soils are moderately deep over bedrock. Seasonal dryness results in droughty conditions during some time in most years. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 2 percent.

Ohia Soils

These clayey soils are deep over bedrock. They have a low nutrient-holding capacity. Soil amendments tend to leach through the soils. The level of acidity is moderate or high. The capacity to supply natural potassium is low. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 6 percent.

Oneula Soils

These soils have a bouldery, sandy surface layer and extremely cobbly, sandy subsurface layers. The pattern of seasonal rainfall and sandy, bouldery or cobbly texture limit the success of seedling germination to winter and spring. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Pahipa Soils

These soils have a clayey surface layer and very rocky, clayey subsurface layers. They are deep over bedrock. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 21 percent.

Pakini Soils

These loamy soils are deep over bedrock. Climatic conditions result in consistent droughtiness. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Pekailio Soils

These loamy soils are very rocky and are deep over bedrock. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Piihonua Soils

These clayey soils are deep over bedrock. They have a low nutrient-holding capacity. Soil amendments tend to leach through the soils. The level of acidity is moderate or high. The capacity to supply natural potassium is low. The level of phosphorus retention is very high, but available levels are likely to be low. The soils

are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent.

Puali Soils

These soils have a dry organic cap and a clayey surface layer. They are shallow to pahoehoe. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent.

Puulu Soils

These soils have a loamy surface layer and sandy subsurface layers. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 7 percent.

Puhimau Soils

These loamy soils are shallow to pahoehoe. They are highly acid in the surface layer. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 1 percent.

Puiwa Soils

These loamy soils are deep over bedrock. The level of phosphorus retention is moderate or high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 3 percent.

Puu Oo Soils

These soils have a loamy surface layer and clayey subsurface layers. They are deep over bedrock. The nutrient-holding capacity is low. Soil amendments tend to leach through the soils. The soils are moderately acid or highly acid. The capacity to supply natural potassium is low. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 17 percent.

Puukala Soils

These soils have a cobbly, loamy surface layer and very cobbly, loamy subsurface layers. They are less than 20 inches deep to pahoehoe. Seasonal dryness, a high content of rock fragments, and shallow soil depth result in common droughty conditions. Success of seedling germination is limited to spring or summer. The level of phosphorus retention is very high, but available levels are likely to be low. The soils are highly susceptible to erosion if vegetation is removed from areas where slopes exceed 2 percent. The soils exhibit hydrophobicity, which can cause reduced water infiltration and increased runoff and erosion. Hydrophobicity is greatly accentuated if the soils are cleared of vegetation and allowed to air-dry.

Vitric Haplustands

These loamy soils are deep over bedrock and have a high content of rock fragments. Climatic conditions result in seasonal dryness. The capacity to supply natural potassium is low. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Wahi Soils

These extremely cobbly, loamy soils are deep over bedrock. Moderate acidity in the surface layer can adversely affect plants. The level of phosphorus retention is moderate or high, but available levels are likely to be low.

Engineering Index Properties

Table 10 gives the engineering classifications and the range of index properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Apparent field texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. Many soils in this survey area have amorphous clays, which are noncrystalline and do not behave as individual particles. These clays cannot be effectively quantified by laboratory methods. Placement of such soils into USDA texture classes cannot be substantiated with laboratory measurements. When amorphous clays occur, the field method of estimating USDA texture is used. The field-estimated textures are referred to as "apparent field textures." If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly." When a soil has high water retention, a modifier is placed before the texture name to indicate this property. An example is the word "hydrous" placed before a texture name, as in "gravelly hydrous loam."

Textural terms are defined in the Glossary. The abbreviations used in the texture column are explained in table 11.

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SC-SM.

In Hawaii Volcanoes National Park, some soils have andic soil properties that effectively limit use of the soils for engineering purposes. Suffixes were added to the Unified class symbols to identify the soils with andic soil properties. The suffix "A" was added to identify the amorphous property. The suffix "T" was added to identify a thixotropic property.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the

other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of particle-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is generally omitted in the table.

Physical Properties

Table 12 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Moist bulk density is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $\frac{1}{3}$ -bar (33kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ability of a soil to transmit water or air. The term "permeability," as used in soil surveys, indicates saturated hydraulic conductivity Ksat. The estimates in the table indicate the rate of water movement, in micrometers per second ($\mu\text{m}/\text{sec}$), when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture of the whole soil (including rock fragments). Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties

that affect retention of water. The most important properties are the content of organic matter, texture of the whole soil (including rock fragments), bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Fifteen-bar water is the water contained in an undried soil sample at 15-bar suction, which corresponds to approximately the amount of suction plant roots can exert on the soil. It is a measure of how much water is contained in the soil that is not available for plant use. Because of the correlation between allophane content and 15-bar water, it is also used as a criterion in "Soil Taxonomy" (Soil Survey Staff, 1999). Figures are expressed as percent water content by weight in undried samples in relation to oven-dried soil by weight. Samples are tested without drying prior to the procedure to avoid the effects of irreversible shrinkage caused by drying.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 12, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Chemical Properties

Table 13 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils. They are based on the fraction of the soil less than 2 millimeters in size.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0). Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Effective cation-exchange capacity refers to the sum of exchangeable cations plus aluminum expressed in terms of milliequivalents per 100 grams of soil. It is determined for soils that have pH of less than 5.5.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Extractable Al by KCl is a measure of acidity in soils. The Al (aluminum) extracted by 1 N KCl (potassium chloride) approximates exchangeable Al and is a measure of the "active" acidity in soils with a 1:1 water pH of less than 5.5. The more extractable Al in a soil, the more adversely plant growth is affected.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at

representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Soil Features

Table 14 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1998 and 1999). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 15 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Andisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udand (*Ud*, meaning humid, plus *and*, from Andisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludands (*Hapl*, meaning minimal horizonation, plus *udand*, the suborder of the Andisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Hapludands.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is medial-skeletal, amorphic, isomesic Typic Hapludands.

SERIES. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile.

Soil series are named by the soil scientists who first discover them and who describe the ranges of their respective properties. Soils can be named after a nearby geographic feature, or the name can be coined. An example is the Wahi series. Table 16 shows the English and Hawaiian spellings of the soils in this survey area.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" (Soil Survey Division Staff, 1993). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (Soil Survey Staff, 1999) and in "Keys to Soil Taxonomy" (Soil Survey Staff, 1998). Unless otherwise indicated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

Almost all of the soils in this survey area formed in multiple kinds of parent materials. For this reason, the sequence of horizon designations can be complicated. To ensure a consistent application of horizon designations, the following conventions are used.

Following are conventions for horizon designations that include initial Arabic numerals:

1. Organic soil or volcanic ash over pahoehoe lava.—The organic soil or the ash is indicated by an unwritten numeral 1, and the pahoehoe is a 2R horizon.

2. Organic soil or volcanic ash over aa lava.—The organic soil or the ash is indicated by an unwritten numeral 1, aa clinkers are a 2C horizon, and bluerock is a 2R horizon. The organic material or ash and the clinkers are not always two distinct horizons. At the soil surface, the two materials are mixed as the soil material fills the voids within the clinker layer of the aa lava. Given a soil with an organic-clinker horizon and a clinker horizon over bluerock, the horizon designations would be Oa/2C1, 2C2, and 2R. For the volcanic ash soil, the horizon sequence could be A, Bw1/2C1, Bw2/2C2, 2C3, and 2R, where the ash dominates the surface layer but the clinkers dominate the lowest soil horizon.

Following are conventions for when and how a slash (/) is used:

1. If rock fragments from lava make up more than 35 percent of the horizon (i.e., the material is skeletal), then a slash is used to indicate that the horizon is made up of two distinct kinds of parent material.

2. The soil is listed first (e.g., Bw/2C) unless the rock fragments make up more than 65 percent of the horizon. An extremely gravelly or cobbly horizon would then be 2C/Bw.

Following are conventions for when and how the prime (') and buried (b) symbols are used:

Some soils clearly consist of buried soils. In this survey area, the Puaulu series is recognized as having formed in three main ash packets. Keanakakoi ash (1790 AD) overlies Uwekahuna ash (2-3 ka), which overlies Pahala ash (20-30 ka). The Uwekahuna ash has four or five buried soils. Each of the main ash packets would be assigned a different Arabic numeral, and within the Uwekahuna ash the prime symbol would be used to differentiate soils. The soil horizon sequence for this soil could be A, Bw, C1, C2, 2A'/B'w, 2A', 2B'w1, 2B'w2, 2A'', 2B''w, 2A''', 2B'''w1, 2B'''w2, 3Bw1, 3Bw2, where the unwritten 1 indicates Keanakakoi ash, 2 indicates Uwekahuna ash, and 3 indicates Pahala ash. This designation system lets the soil survey user know which horizons are related to which ash packet while still differentiating buried soils within the Uwekahuna ash packet.

In the example of the Puaulu series, just using the buried soil designation (b) instead of numeral prefixes would mask the boundary between two ash packets that have different properties.

Ahiu Series

The Ahiu series consists of shallow and very shallow, well drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava (fig. 15). Slopes range from 2 to 10 percent. The mean annual rainfall is about 760 millimeters (30 inches), and the mean annual air temperature is about 18 degrees C (65 degrees F).

Taxonomic classification: Ashy, amorphic, isothermic Lithic Haplustands.

Typical pedon

Ahiu soil in an area of Ahiu-Lava flows complex, 2 to 10 percent slopes, under scattered ohia trees with a grass understory; located in Hawaii Volcanoes National Park; from Crater Rim Drive, travel 2.2 miles southeast (downhill) on Chain of Craters Road, then 8.1 miles southwest on Hilina Pali Road; park on north side of road; walk at a heading of 270 degrees magnetic for approximately 74 meters (240 feet) to type location; Kau Desert Quadrangle; lat. 19 degrees 18 minutes 14.97 seconds N. and long. 155 degrees 18 minutes 31.08 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 35 feet.)

- A—0 to 8 centimeters (0 to 3 inches); black (10YR 2/1) ashy silt loam, brown (10YR 4/3) dry; moderate and strong fine and medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.5); abrupt wavy boundary. (3 to 13 centimeters [1 to 5 inches] thick.)
- Bw—8 to 15 centimeters (3 to 6 inches); black (10YR 2/1) ashy silt loam, dark grayish brown (10YR 4/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; slightly acid (pH 6.5); abrupt wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- C—15 to 28 centimeters (6 to 11 inches); alternating layers of ashy fine sand and ashy loamy fine sand 3 to 5 centimeters (1 to 2 inches) thick; colors are lithochromic light olive brown (2.5Y 5/3), very dark grayish brown (10YR 3/2) dry,



Figure 15.—Profile of Ahiu soils.

and lithochromic olive brown (2.5Y 4/4), very dark brown (10YR 2/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; at a depth of 25 centimeters (10 inches), moderately hard, friable, noncemented plates 0.6 centimeter ($\frac{1}{4}$ inch) thick; brittle, nonsticky and nonplastic and breaking down to loamy fine sand; neutral (pH 7.1); abrupt wavy boundary. (3 to 18 centimeters [1 to 7 inches] thick.)

2A—28 to 30 centimeters (11 to 12 inches); black (10YR 2/1) ashy loam, very dark grayish brown (10YR 3/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; neutral (pH 7.1); abrupt broken boundary. (0 to 5 centimeters [0 to 2 inches] thick.)

2Bw—30 to 33 centimeters (12 to 13 inches); very dark brown (7.5YR 2.5/2) ashy loam, brown (7.5YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial pores; neutral (pH 7.3); abrupt broken boundary. (0 to 5 centimeters [0 to 2 inches] thick.)

3R—33 centimeters (13 inches); hard basic pahoehoe lava.

Range in characteristics

Depth to bedrock: 10 to 50 centimeters (4 to 20 inches).

Mean annual soil temperature: 20 to 22 degrees C (68 to 72 degrees F).

Soil reaction: Very strongly acid or strongly acid in the surface layer and moderately acid to neutral in the underlying layers.

A and 2A horizons

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Ashy silt loam or ashy loam.

Structure: Granular, subangular blocky, or platy.

Bw and 2Bw horizons

Hue: 5YR, 7.5YR, 10YR, or 2.5Y.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Ashy silt loam or ashy loam.

Structure: Subangular blocky or massive.

C horizon

Hue: 10YR or 2.5Y.

Value: 4 or 5 moist.

Chroma: 3 or 4 moist.

Texture: Ashy fine sand, ashy loamy fine sand, ashy very fine sandy loam, or ashy loamy very fine sand.

Structure: Massive with thin discontinuous platelike structure in a few pedons.

Akelelu Series

The Akelelu series consists of moderately deep, well drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava. Slopes range from 3 to 10 percent. The mean annual rainfall is about 1,295 millimeters (51 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Eutric Pachic Fulvudands.

Typical pedon

Akelelu soil in an area of Maunaiu-Akelelu complex, 3 to 10 percent slopes, under koa trees and a grass understory; located in Hawaii Volcanoes National Park; from the intersection of State Highway 11 and Mauna Loa Strip Road, travel 5.6 miles north on Mauna Loa Strip Road and park on north (right) side of road; walk at a heading of 30 degrees magnetic for 15 meters (50 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 27 minutes 38.65 seconds N. and long. 155 degrees 20 minutes 28.95 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 350 feet.)

- A1—0 to 10 centimeters (0 to 4 inches); black (10YR 2/1) medial silt loam, very dark brown (10YR 2/2) dry; strong fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.4); abrupt wavy boundary.
- A2—10 to 18 centimeters (4 to 7 inches); black (10YR 2/1) medial silt loam, very dark brown (10YR 2/2) dry; weak medium subangular blocky structure parting to moderate fine and medium granular; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.6); abrupt wavy boundary. (Combined thickness of the A horizons ranging from 5 to 25 centimeters [2 to 10 inches].)
- Bw1—18 to 38 centimeters (7 to 15 inches); dark brown (7.5YR 3/2) medial loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine to medium and few coarse roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); abrupt wavy boundary. (10 to 25 centimeters [4 to 10 inches] thick.)
- 2Bw2—38 to 46 centimeters (15 to 18 inches); dark reddish brown (5YR 3/4) medial loam, yellowish red (5YR 4/6) dry; weak medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine to medium and few coarse roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; moderately acid (pH 6.0); abrupt broken boundary.
- 2Bw3—46 to 53 centimeters (18 to 21 inches); very dark brown (7.5YR 2.5/2) fine sandy loam, dark brown (7.5YR 3/4) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine to medium and few coarse roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; slightly acid (pH 6.2); clear wavy boundary.
- 2Bw4—53 to 69 centimeters (21 to 27 inches); dark reddish brown (5YR 2.5/2) medial fine sandy loam, dark brown (7.5YR 3/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine to medium and few coarse roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); clear wavy boundary. (Combined thickness of the 2Bw horizons ranging from 13 to 40 centimeters [5 to 15 inches].)
- 3Bw5—69 to 76 centimeters (27 to 30 inches); very dark brown (7.5YR 2.5/2) medial loam, dark yellowish brown (10YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); clear wavy boundary.
- 3Bw6—76 to 86 centimeters (30 to 34 inches); very dark brown (7.5YR 2/3) medial loam, dark yellowish brown (10YR 4/6) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine interstitial pores; 5 percent angular pahoehoe gravel; slightly acid (pH 6.2); abrupt wavy boundary. (Combined thickness of the 3Bw horizons ranging from 13 to 40 centimeters [5 to 15 inches].)
- 4R—86 centimeters (34 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 50 to 100 centimeters (20 to 40 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: Less than 15 percent throughout the profile.

Soil reaction: Strongly acid to slightly acid.

A horizon

Texture: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

Smeariness: Nonsmeary or weakly smeary.

B horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 4 moist.

Texture: Medial fine sandy loam, medial loam, or medial silt loam.

Structure: Subangular blocky or massive.

Content of rock fragments: Less than 15 percent in some horizons.

Akihi Series

The Akihi series consists of moderately deep, well drained soils that formed in basic volcanic ash in aa lava. Slopes range from 2 to 20 percent slopes. The mean annual rainfall is about 2,540 millimeters (100 inches), and the mean annual air temperature is about 17 degrees C (63 degrees F).

Taxonomic classification: Hydrous-skeletal, ferrihydritic, isothermic Typic Hydrudands.

Typical pedon

Akihi cobbly hydrous silt loam, on a south-facing, convex slope of 12 percent, under forest vegetation, at an elevation of 744 meters (2,440 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on November 28, 2000, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; from State Highway 11, drive north to the end of Lorenzo Road. Enter macadamia nut orchard, and drive to the northern boundary of orchard area and Kau Forest Reserve. Pedon is located in forest at an elevation of 744 meters (2,440 feet). Kahuku Ranch Quadrangle; lat. 19 degrees 5 minutes 7.9 seconds N. and long. 155 degrees 40 minutes 2.9 seconds W., old Hawaiian datum (GPS PLGR).

A/2C1—0 to 25 centimeters (0 to 10 inches); black (10YR 2/1) cobbly hydrous silt loam, very dark grayish brown (10YR 3/2) dry; strong fine and medium granular structure; hard, firm, slightly sticky and slightly plastic; moderately smeary; many very fine and fine and common medium roots; many fine and medium interstitial and irregular pores; 25 percent cobbles and 10 percent gravel; moderately acid (pH 5.6); abrupt wavy boundary. (13 to 25 centimeters [5 to 10 inches] thick.)
Bw/2C2—25 to 89 centimeters (10 to 35 inches); very dark brown (7.5YR 2.5/2) very cobbly hydrous silty clay loam, strong brown (7.5YR 4/6) dry; moderate fine and medium subangular blocky structure; hard, firm, moderately sticky and moderately plastic; strongly smeary; common very fine and fine and few medium roots; many very fine and fine irregular pores; 40 percent cobbles and 10 percent

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gravel; slightly acid (pH 6.2); abrupt irregular boundary. (25 to 75 centimeters [10 to 30 inches] thick.)

2R—89 centimeters (35 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 16 to 22 degrees C (61 to 71 degrees F).

Content of rock fragments: 35 to 65 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A/2C1 horizon

Hue: 5YR to 10YR.

Texture: Cobbly hydrous silt loam or silty clay loam, hydrous silt loam, or silty clay loam.

Smeariness: Nonsmeary to moderately smeary.

Moist consistence: Friable or firm.

Soil reaction: Strongly acid or moderately acid (pH 5.1 to 6.0).

Bw/2C1 horizon

Hue: 5YR or 7.5YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Cobbly, very cobbly, or very gravelly hydrous silty clay loam or silt loam.

Wet consistence: Slightly sticky or sticky and slightly plastic or plastic.

Smeariness: Moderately smeary or strongly smeary.

Alahapa Series

The Alahapa series consists of very deep, somewhat excessively drained soils that formed in basic volcanic ash deposited over basic aa lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,270 millimeters (50 inches), and the mean annual air temperature is about 16 degrees C (60 degrees F).

Taxonomic classification: Fragmental, mixed, isothermic Typic Ustivitrands.

Typical pedon

Alahapa extremely stony ashy sandy loam, 2 to 10 percent slopes, under scattered ohia trees and shrubs; located in Hawaii Volcanoes National Park; turn west on ranch access road directly southwest of marker 34 on State Highway 11; park midway between State Highway 11 and locked gate; soil pit is along ridge about 15 meters (50 feet) to the southwest, about 7 meters (21 feet) from State Highway 11; Kilauea Crater Quadrangle; lat. 19 degrees 24 minutes 35 seconds N. and long. 155 degrees 19 minutes 55 seconds W. (Position measured by GPS PLGR using old Hawaiian datum.)

2C1/A—0 to 8 centimeters (0 to 3 inches); very dark grayish brown (2.5Y 3/2) extremely stony ashy sandy loam, light olive brown (2.5Y 5/4) dry; moderate medium platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 15 percent 0.3- to 1-centimeter ($\frac{1}{8}$ - to $\frac{3}{8}$ -inch), rounded, soft to hard accretionary lapilli throughout; 85 percent fragmental aa lava (10 percent boulders, 40 percent stones, 25 percent cobbles, and 10 percent gravel); slightly acid (pH 6.1); abrupt wavy boundary. (3 to 13 centimeters [1 to 5 inches] thick.)

2C2/C—8 to 43 centimeters (3 to 17 inches); very dark grayish brown (10YR 3/2) extremely cobbly ashy loam, grayish brown (2.5Y 5/2) dry; weak medium

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subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; 15 percent 0.3- to 1-centimeter ($1/8$ - to $3/8$ -inch), rounded, soft to hard accretionary lapilli throughout; few gravel-size pieces of reticulite; 75 percent fragmental aa lava (5 percent stones, 50 percent cobbles, and 20 percent gravel); neutral (pH 7.2); abrupt broken boundary.

2C3—43 to 91 centimeters (17 to 36 inches); black (10YR 2/1) extremely cobbly sand, dark gray (10YR 4/1) dry; single grain; loose when dry and moist, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 1 percent broken strands of Pele's hair; 85 percent fragmental aa lava (5 percent stones, 40 percent cobbles, and 40 percent gravel); 5 percent coarse and very coarse primary packing voids; slightly alkaline (pH 7.4); gradual wavy boundary.

2C4—91 to 152 centimeters (36 to 60 inches); dark brown (7.5YR 3/2) extremely stony coarse sand, dark brown (7.5YR 3/2) dry; single grain; loose when dry and moist, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 85 percent fragmental aa lava (30 percent stones, 15 percent cobbles, and 40 percent gravel); 10 percent coarse and very coarse primary packing voids; slightly alkaline (pH 7.4). (Combined thickness of the 2C horizons is more than 152 centimeters [60 inches].)

Range in characteristics

Mean annual soil temperature: 15 to 20 degrees C (59 to 68 degrees C).

Surface crust: Reddish brown (5YR 4/3) brittle crust, 1 centimeter (0.5 inch) thick, occurring in 0 to 25 percent of the area.

Content of rock fragments: Averaging 85 to 90 percent in the particle-size control section.

Voids: Particle-size control section averaging 5 to 10 percent coarse and very coarse primary packing voids.

Stratified material: Occurring in pockets within the upper horizons (2C1/A and 2C2/C) in most pedons.

Accretionary lapilli: Commonly occurring in the upper horizons (2C1/A and 2C2/C).

A horizon

Hue: 10YR, 5YR, or 2.5Y; 5YR or 7.5YR in the surface crust.

Chroma: 2 to 6 moist.

Texture in the fine-earth fraction: Ashy sandy loam, ashy fine sandy loam, or ashy loam.

Soil reaction: Strongly acid to slightly acid (pH 5.1 to 6.5); extremely acid or very strongly acid (pH 3.5 to 5.0) in the crust.

Content of rock fragments: 50 to 90 percent.

C horizon

Hue: 10YR, 7.5YR, 5YR, 2.5Y, or N.

Value: 0 or 2 to 5 moist.

Chroma: 1 to 3 moist.

Texture in the fine-earth fraction: Ashy fine loamy sand, ashy fine sand, sand, or coarse sand.

Structure: Platy, stratified, massive, or single grain.

Reticulite: Occurring in the 2C2/C horizon in some pedons.

2C horizon

Lava fragments: Sand- to boulder-size aa fragments.

Alapai Series

The Alapai series consists of very deep, well drained soils that formed in basic volcanic ash. Slopes range from 3 to 35 percent. The mean annual rainfall is about 3,048 millimeters (120 inches), and the mean annual air temperature is about 18 degrees C (65 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, isothermic Typic Hydudands.

Typical pedon

Alapai hydrous silty clay loam, on a southeast-facing, convex slope of 6 percent, under abandoned sugarcane, at an elevation of 666 meters (2,185 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii County, Hawaii; from Naalehu town, drive 1.9 miles north on Kaalaiki Road, turn west and drive 2.1 miles to elevation of 640 meters (2,100 feet), turn southwest at road junction and drive 0.4 mile. Pedon is located 48 meters (158 feet) upslope of road at an elevation of 666 meters (2,185 feet); Naalehu Quadrangle; lat. 19 degrees 5 minutes 22 seconds N. and long. 155 degrees 36 minutes 32 seconds W. (Old Hawaiian datum.)

Ap1—0 to 18 centimeters (0 to 7 inches); very dark brown (10YR 2/2) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common roots; common very fine pores; 1 percent olivine crystals less than 1 millimeter in diameter; 2 percent firm and very firm, dark red (2.5YR 3/6), 1- to 4-millimeter weathered cinders; very strongly acid (pH 4.7); abrupt wavy boundary. (13 to 23 centimeters [5 to 9 inches] thick.)

Ap2—18 to 38 centimeters (7 to 15 inches); dark reddish brown (5YR 3/3) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; friable, slightly sticky and moderately plastic; weakly smeary; common roots; common fine and very fine pores; common thin gelatinlike coatings on faces of peds; moderately acid (pH 5.9); clear wavy boundary. (15 to 28 centimeters [6 to 11 inches] thick.)

B/A—38 to 69 centimeters (15 to 27 inches); 50 percent dark brown (7.5YR 3/2) and 50 percent dark reddish brown (7.5YR 3/3) hydrous silty clay loam; moderate medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable, slightly sticky and moderately plastic; weakly smeary; common roots; many very fine and fine pores; common thin gelatinlike coatings on faces of peds; 2 percent firm and very firm, dark red (2.5YR 3/6), 1- to 4-millimeter weathered cinders; neutral (pH 6.6); abrupt wavy boundary. (23 to 36 centimeters [9 to 14 inches] thick.)

Bw1—69 to 91 centimeters (27 to 36 inches); dark reddish brown (5YR 3/4) hydrous silty clay loam; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; friable, slightly sticky and moderately plastic; moderately smeary; few roots; many very fine and fine, common medium, and few coarse pores; few thin gelatinlike coatings on faces of peds; 2 percent firm and very firm, dark reddish brown (2.5YR 3/4), 1- to 4-millimeter weathered cinders; slightly acid (pH 6.3); abrupt wavy boundary. (15 to 23 centimeters [6 to 9 inches] thick.)

Bw2—91 to 109 centimeters (36 to 43 inches); 50 percent dark brown (7.5YR 3/4) and 50 percent dark reddish brown (5YR 3/4) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; friable, slightly sticky and moderately plastic; moderately smeary; few roots; many very fine and fine, common medium, and few coarse pores; few thin gelatinlike coatings on faces of peds; 2 percent firm, dark reddish brown (2.5YR 3/4), 1- to 4-millimeter

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- weathered cinders; slightly acid (pH 6.5); abrupt smooth boundary. (15 to 20 centimeters [6 to 8 inches] thick.)
- Bw3—109 to 127 centimeters (43 to 50 inches); 80 percent dark reddish brown (5YR 3/4) and 20 percent dark brown (7.5YR 3/3) hydrous silty clay loam; moderate medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable, slightly sticky and moderately plastic; moderately smeary; few roots; many very fine and fine, common medium, and few coarse pores; few thin gelatinlike coatings on faces of peds; 10 percent firm and very firm, dark reddish brown (2.5YR 3/4), 1- to 4-millimeter weathered cinders; neutral (pH 6.7); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)
- Bw4—127 to 145 centimeters (50 to 57 inches); 50 percent dark reddish brown (5YR 3/4) and 50 percent dark brown (7.5YR 3/4) hydrous silty clay loam; moderate medium subangular blocky structure parting to moderate fine and very fine subangular blocky; friable, slightly sticky and moderately plastic; moderately smeary; few roots; many very fine and fine, common medium, and few coarse pores; common thin gelatinlike coatings on faces of peds; common gray and black specks; 10 percent firm and very firm, dark reddish brown (2.5YR 3/4), 1- to 4-millimeter weathered cinders; neutral (pH 6.8); abrupt smooth boundary. (15 to 18 centimeters [6 to 7 inches] thick.)
- Bw5—145 to 168 centimeters (57 to 66 inches); stratified bands of dark brown (7.5YR 3/3), reddish brown (5YR 4/4), and dark brown (10YR 3/3) hydrous silty clay loam; moderate medium and coarse subangular blocky structure parting to moderate fine and very fine subangular blocky; friable, slightly sticky and moderately plastic; strongly smeary; few roots; many very fine and fine and common medium and coarse pores; 10 percent fine, dark reddish brown (2.5YR 3/3) mottles; common thick gelatinlike coatings on faces of peds; neutral (pH 6.8); abrupt smooth boundary. (20 to 25 centimeters [8 to 10 inches] thick.)
- Bw6—168 to 178 centimeters (66 to 70 inches); dark reddish brown (2.5YR 2/4) hydrous silty clay loam; massive parting to weak medium and fine subangular blocky structure; very firm, slightly sticky and moderately plastic; strongly smeary; few roots; many very fine and fine and common medium pores; common thick gelatinlike coatings on faces of peds; neutral (pH 6.7); abrupt smooth boundary. (8 to 13 centimeters [3 to 5 inches] thick.)
- Bw7—178 to 188 centimeters (70 to 74 inches); 25 percent dark reddish brown (2.5YR 3/4), 25 percent dark brown (7.5YR 4/4), 25 percent strong brown (7.5YR 4/6), and 25 percent yellowish brown (10YR 5/6) hydrous silty clay loam; moderate medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable, slightly sticky and moderately plastic; strongly smeary; few roots; many very fine and fine and common medium pores; common thick gelatinlike coatings on faces of peds; slightly acid (pH 6.3).

Range in characteristics

Depth to bedrock: More than 152 centimeters (60 inches).

Mean annual soil temperature: 16 to 20 degrees C (61 to 68 degrees F).

Content of rock fragments: 0 to 10 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Medial or hydrous silt loam or silty clay loam.

Stickiness: Slightly sticky or moderately sticky.

Plasticity: Slightly plastic or moderately plastic.

Bw horizons

Hue: 5YR to 10YR.

Chroma: 2 to 4 moist.

Stickiness: Slightly sticky or moderately sticky.

Smeariness: Moderately smeary or strongly smeary.

Mottles: 1 to 10 percent in the lower Bw horizons.

Weathered cinders: 2 to 10 percent, firm or very firm, and dark reddish brown (2.5YR 3/4) to dark red (2.5YR 3/6).

Soil reaction: Slightly acid or neutral (pH 6.1 to 6.8).

Apuki Series

The Apuki series consists of very shallow and shallow, somewhat excessively drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is 1,270 millimeters (50 inches), and the mean annual air temperature is 23 degrees C (73 degrees F).

Taxonomic classification: Ashy, glassy, isohyperthermic Lithic Ustivitrands.

Typical pedon

Apuki soil in an area of Lava flows-Apuki complex, 2 to 20 percent slopes, under scattered shrubs and grasses; located in Hawaii Volcanoes National Park; take Chain of Craters Drive to Holei Sea Arch; continue on Chain of Craters Road to gate, about 1/4 mile; from gatepost on upslope side of road, follow a heading of 60 degrees magnetic for approximately 111 meters (360 feet) to type location; lat. 19 degrees 18 minutes 05.06 seconds N. and long. 155 degrees 05 minutes 23.13 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 24 feet.)

C1—0 to 1 centimeter (0 to 0.5 inch); lithochromic black (N 2/0) ashy sand; weak or moderate medium platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; extremely acid (pH 4.3); clear wavy boundary. (0 to 1 centimeter [0 to 0.5 inch] thick.)

C2—1 to 15 centimeters (0.5 inch to 6 inches); lithochromic black (N 2/0) ashy sand; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.2); clear wavy boundary. (5 to 50 centimeters [2 to 20 inches] thick.)

C3—15 to 18 centimeters (6 to 7 inches); lithochromic black (10YR 2/1) ashy loamy sand; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); clear wavy boundary. (0 to 3 centimeters [0 to 1 inch] thick.)

2R—18 centimeters (7 inches); hard basaltic pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 2 to 20 inches.

Mean annual soil temperature: 22 to 24 degrees C (72 to 76 degrees F).

Content of rock fragments: Less than 15 percent throughout the profile.

Soil reaction: Extremely acid or very strongly acid in the surface layer and slightly acid or neutral in the subsoil.

C horizon

Hue: N or 10YR.

Chroma: 0 to 2.

Texture: Ashy sand or ashy loamy sand.

Aquands

The Aquands in this survey area consist of very shallow and shallow, poorly drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 8 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, nonacid, isomesic Lithic Endoaquands.

Typical pedon

Aquands in an area of Pahipa-Puali association, 2 to 20 percent slopes, under forest vegetation, at an elevation of 1,357 meters (4,450 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on December 15, 1999, the soil was wet to bedrock.) Island of Hawaii, Hawaii County, Hawaii; Puu O Keokeo Quadrangle; lat. 19 degrees 9 minutes 9.3 seconds N. and long. 155 degrees 40 minutes 46.4 seconds W. (GPS PLGR; old Hawaiian datum.)

- Oe—0 to 10 centimeters (0 to 4 inches); moderately decomposed plant material; abrupt smooth boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- A—10 to 25 centimeters (4 to 10 inches); black (10YR 2/1) highly organic hydrous silt loam; moderate fine and medium granular structure; very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and few medium roots; many very fine and fine irregular and many very fine vesicular pores; moderately acid (pH 5.8); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)
- Bg—25 to 46 centimeters (10 to 18 inches); 7.5YR 3/2 cobbly hydrous silty clay loam; moderate very fine and fine subangular blocky structure; friable, moderately sticky and moderately plastic; moderately smeary; common very fine and fine and few coarse roots; many very fine and fine irregular and common very fine tubular pores; many coarse prominent irregular dark bluish gray (5B 4/1) iron depletions with sharp boundaries; 5 percent subangular gravel and 15 percent subangular cobbles; slightly acid (pH 6.1); abrupt irregular boundary. (20 to 25 centimeters [8 to 10 inches] thick.)
- 2R—46 centimeters (18 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Depth to aquic conditions: 10 to 46 centimeters (4 to 18 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: 5 to 20 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Chroma: 1 or 2 moist.

Texture: Highly organic hydrous silt loam or silty clay loam.

Structure: Weak or strong granular.

Smeariness: Weakly smeary or moderately smeary.

Bg horizon

Hue: 7.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Smeariness: Weakly smeary or moderately smeary.

Durustands

The Durustands in this survey area consist of moderately deep, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual precipitation is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 11 degrees C (52 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Humic Durustands.

Typical pedon

Durustands, on a southeast-facing slope of 2 to 10 percent, under a cover of grasses, at an elevation of 2,050 meters (6,726 feet). (Colors are for moist soil unless otherwise noted.) Hawaii County, Hawaii; lat. 19 degrees 19 minutes 54 seconds N. and long. 155 degrees 32 minutes 16 seconds W. (Old Hawaiian datum.)

A—0 to 10 centimeters (0 to 4 inches); medial loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; friable, slightly sticky and moderately plastic; weakly smeary; common fine irregular pores; abrupt smooth boundary.

2Bw—10 to 14 centimeters (4 to 6 inches); medial fine sandy loam, dark brown (10YR 3/3) moist; single grain; slightly sticky and moderately plastic; weakly smeary; common very fine tubular pores; abrupt smooth boundary.

3A—14 to 19 centimeters (6 to 7 inches); medial silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; friable, slightly sticky and moderately plastic; weakly smeary; common fine irregular pores; abrupt smooth boundary.

3Bw—19 to 28 centimeters (7 to 11 inches); medial silt loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; friable, slightly sticky and moderately plastic; weakly smeary; common very fine irregular pores; abrupt smooth boundary.

3Bs—28 to 33 centimeters (11 to 13 inches); cemented silt loam, reddish brown (5YR 4/4) moist; massive; very firm, cemented by iron and silica; common very fine tubular pores; abrupt smooth boundary.

4Bw—33 to 66 centimeters (13 to 26 inches); hydrous silty clay loam, 20 percent very dark brown (10YR 2/2), 30 percent very dark grayish brown (10YR 3/2), and 50 percent dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; very friable, slightly sticky and moderately plastic; moderately smeary; common very fine vesicular pores; abrupt smooth boundary.

5R—66 centimeters (26 inches); very strongly cemented basalt bedrock.

Eheuiki Series

The Eheuiki series consists of deep, somewhat poorly drained soils that formed in basic volcanic ash deposited over basic aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 3,685 millimeters (145 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, ferrihydritic, isothermic Typic Hapludands.

Typical pedon

Eheuiki soil in an area of Eheuiki-Puauolu complex, 2 to 20 percent slopes, under rain forest vegetation; located in Hawaii Volcanoes National Park; from State Highway 11, drive northwest on State Highway 148 (Wright Road) to Amuumau Road, turn north (right) and drive for 1.6 miles to cul-de-sac, continue driving straight on gravel road

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for 0.2 mile to hunter check-in station, take trail leading north for approximately 200 meters (650 feet), take first trail north-northwest (right) for approximately 1,000 meters (3,280 feet) to Hawaii Volcanoes National Park fence, turn northwest (left and uphill) and go 1,940 meters (6,360 feet) to where a Hawaii Volcanoes National Park fence joins a Hawaii Department of Land and Natural Resources fence, turn north-northeast (right) and follow fence and trail for 21 metal fence standards/posts (3 standards after 50-meter flag), and walk at a heading of 160 degrees magnetic for approximately 7 meters (22 feet) to type location; Kulani Quadrangle; lat. 19 degrees 30 minutes 30.18 seconds N. and long. 155 degrees 16 minutes 37.08 seconds W. (Location measured by GPS PLGR using old Hawaiian datum.)

- A1—0 to 9 centimeters (0 to 4 inches); black (7.5YR 2.5/1) medial silt loam; moderate medium subangular blocky structure parting to moderate fine granular; friable, slightly sticky and slightly plastic; weakly smeary; many very fine to medium and few coarse roots; many very fine to medium interstitial pores; very strongly acid (pH 4.6); clear wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- A2—9 to 22 centimeters (4 to 9 inches); black (7.5YR 2.5/1) medial silt loam; moderate medium subangular blocky structure parting to weak fine granular; friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine to medium interstitial pores; strongly acid (pH 5.4); abrupt wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- Bw—22 to 32 centimeters (9 to 13 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and few medium roots; many very fine and fine interstitial pores; 5 percent dusky red (10R 3/3), slightly hard or hard reticulitelike pebbles; 5 percent gravel; strongly acid (pH 5.4); abrupt wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- Bg—32 to 38 centimeters (13 to 15 inches); 60 percent dark brown (7.5YR 3/3) and 40 percent very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; firm, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine to medium interstitial pores; common fine distinct black (10YR 2/1) irregular redoximorphic concentrations throughout; 8 percent gravel-size bodies of dark gray (10YR 4/1), hard, firm sand; very strongly acid (pH 4.6); abrupt wavy boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- 2Bw1—38 to 48 centimeters (15 to 19 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; few very fine to coarse roots; many very fine and fine and few medium interstitial pores; strongly acid (pH 5.2); clear wavy boundary. (5 to 15 centimeters [2 to 6 inches] thick.)
- 2Bw2—48 to 58 centimeters (19 to 23 inches); very dusky red (2.5YR 2.5/2) medial silty clay loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; strongly acid (pH 5.4); clear wavy boundary. (8 to 13 centimeters [3 to 5 inches] thick.)
- 3A—58 to 66 centimeters (23 to 26 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; friable, moderately sticky and moderately plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; strongly acid (pH 5.4); clear wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 3Bw1—66 to 71 centimeters (26 to 28 inches); dark reddish brown (5YR 2.5/2) medial silty clay loam; weak medium subangular blocky structure; friable, moderately sticky and moderately plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 5 percent gravel; moderately acid (pH 5.7); abrupt wavy boundary. (3 to 15 centimeters [1 to 6 inches] thick.)

4C/3Bw2—71 to 152 centimeters (28 to 60 inches); dark reddish brown (5YR 3/3) extremely cobbly medial silty clay loam; massive; friable, moderately sticky and moderately plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine and common medium and coarse interstitial pores; 80 percent fragmental aa lava (15 percent stones, 40 percent cobbles, and 25 percent gravel); moderately acid (pH 5.7).

Range in characteristics

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

Content of rock fragments: Average of less than 35 percent in the control section and 70 to 85 percent below a depth of 20 inches.

Soil reaction: Very strongly acid to moderately acid.

A horizon

Hue: 7.5YR or 10YR.

Texture: Medial loam, medial silt loam, or medial silty clay loam.

Structure: Granular or subangular blocky.

B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial silt loam or medial silty clay loam.

Structure: Subangular blocky or massive.

2B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial silt loam or medial silty clay loam.

Structure: Subangular blocky or massive.

3A horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial silt loam or medial silty clay loam.

3B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial silt loam or medial silty clay loam.

Content of rock fragments: 0 to 10 percent.

4C/3B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture: Extremely cobbly medial silt loam or medial silty clay loam.

Content of rock fragments: 60 to 85 percent aa clinkers.

Haa Series

The Haa series consists of deep, well drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava (fig. 16). Slopes range from 2 to 10 percent.

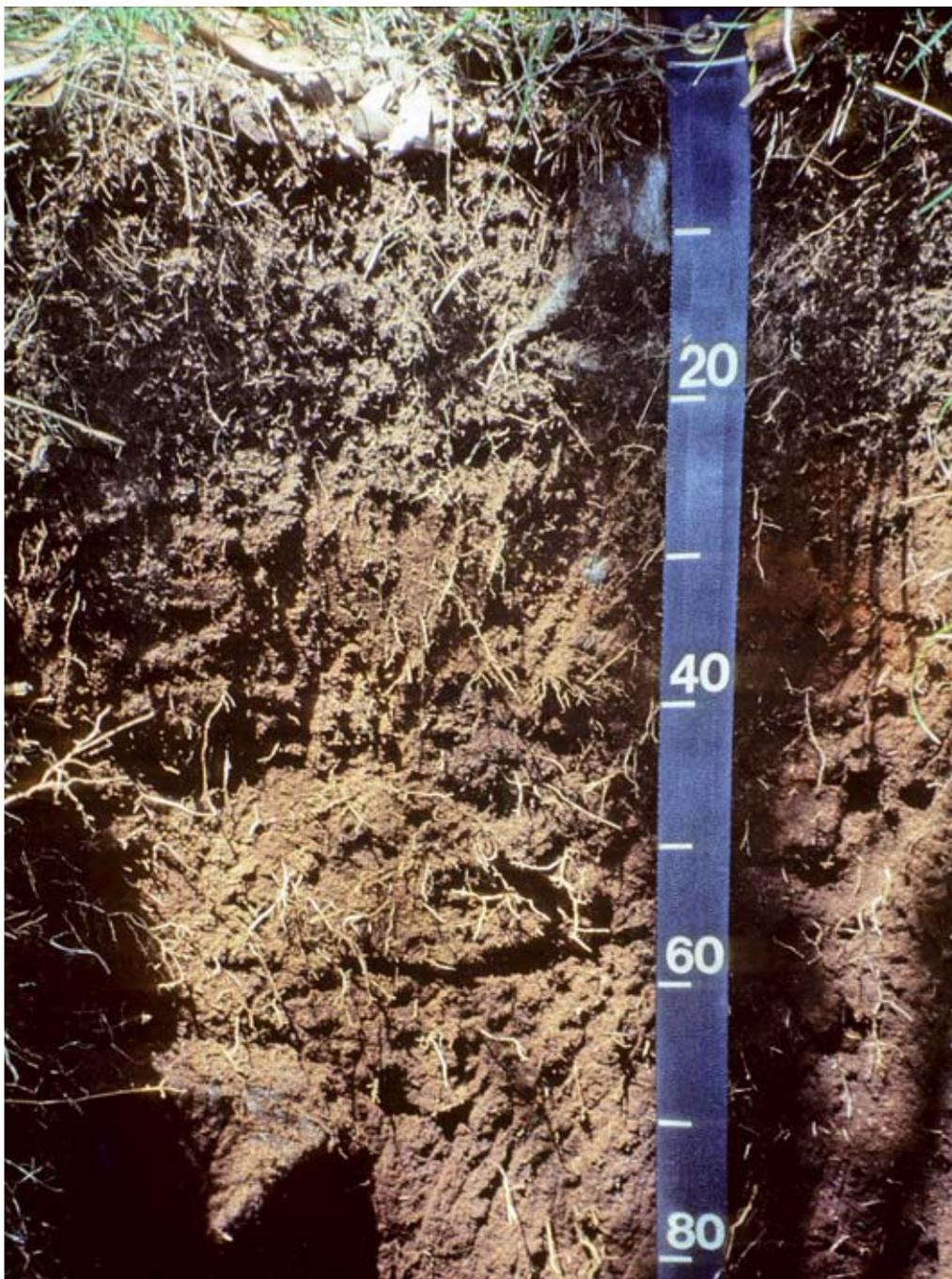


Figure 16.—Profile of Haa soils. On the tape, depth is marked in centimeters.

The mean annual rainfall is about 1,295 millimeters (51 inches), and the mean annual air temperature is about 13 degrees C (57 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Typic Hapludands.

Typical pedon

Haa medial silt loam in an area of Haa-Keamoku complex, 2 to 10 percent slopes, under koa trees and a grass understory, located in Hawaii Volcanoes National Park;

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from State Highway 11, turn north onto Mauna Loa Strip Road; follow Mauna Loa Strip Road approximately 5.8 miles to intersecting Power Line Road; turn left, pass through locked gate, and drive for 0.5 mile; walk at a heading of 110 degrees magnetic for 11 meters (36 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 27 minutes 22.35 seconds N. and long. 155 degrees 20 minutes 52.52 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 52 feet.)

- A1—0 to 8 centimeters (0 to 3 inches); black (10YR 2/1) medial silt loam; strong fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine interstitial pores; 3 percent subrounded gravel; moderately acid (pH 6.0); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- A2—8 to 18 centimeters (3 to 7 inches); black (10YR 2/1) medial silt loam; moderate fine and medium granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; neutral (pH 6.6); abrupt wavy boundary. (3 to 13 centimeters [1 to 5 inches] thick.)
- Bw1—18 to 25 centimeters (7 to 10 inches); very dark brown (7.5YR 2.5/3) medial loam; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine to coarse roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; slightly acid (pH 6.4); clear wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- 2Bw2—25 to 36 centimeters (10 to 14 inches); very dark brown (7.5YR 2.5/2) medial loam; massive; slightly hard, friable, nonsticky and nonplastic; common very fine to coarse roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; slightly acid (pH 6.4); abrupt wavy boundary.
- 2Bw3—36 to 51 centimeters (14 to 20 inches); very dark brown (7.5YR 2.5/2) medial silt loam; massive; slightly hard, friable, nonsticky and nonplastic; common very fine to coarse roots; many very fine and fine interstitial pores; 5 percent subrounded cobbles and 2 percent subrounded gravel; slightly acid (pH 6.4); clear wavy boundary.
- 2Bw4—51 to 64 centimeters (20 to 25 inches); black (7.5YR 2.5/1) medial silt loam; massive; slightly hard, friable, nonsticky and nonplastic; few very fine to coarse roots; many very fine and fine interstitial pores; 5 percent subrounded cobbles; slightly acid (pH 6.4); clear wavy boundary. (Combined thickness of the 2Bw horizons ranging from 25 to 64 centimeters [10 to 25 inches].)
- 3A1—64 to 76 centimeters (25 to 30 inches); very dark brown (10YR 2/2) medial silt loam; massive; soft, friable, nonsticky and nonplastic; few very fine to coarse roots; many very fine and fine interstitial pores; few flecks of charcoal, 2 centimeters by 0.5 centimeter (0.75 by 0.25 inch) in size; 5 percent subrounded cobbles; slightly acid (pH 6.4); clear wavy boundary.
- 3A2—76 to 91 centimeters (30 to 36 inches); black (10YR 2/1) cobbly medial loam; massive; slightly hard, friable, nonsticky and nonplastic; few very fine to coarse roots; many very fine and fine interstitial pores; 10 percent subrounded pahoehoe cobbles and 5 percent subrounded pahoehoe gravel; neutral (pH 6.6); clear wavy boundary. (Combined thickness of the 3A horizons ranging from 0 to 51 centimeters [0 to 20 inches].)
- 3Bw—91 to 109 centimeters (36 to 43 inches); black (7.5YR 2.5/1) very cobbly medial loam; massive; slightly hard, friable, nonsticky and nonplastic; few very fine to coarse roots; many very fine and fine interstitial pores; 20 percent subrounded pahoehoe cobbles and 5 percent subrounded pahoehoe gravel; neutral (pH 6.6); abrupt wavy boundary. (0 to 25 centimeters [0 to 10 inches] thick.)
- 4R—109 centimeters (43 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 100 to 150 centimeters (40 to 60 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Soil reaction: Moderately acid to neutral.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 or 2 moist.

Texture: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 6 moist.

Texture: Medial loam or medial silt loam.

Structure: Subangular blocky or massive.

3A horizon

Hue: 7.5YR or 10YR.

Texture in the fine-earth fraction: Medial loam or medial silt loam.

Content of rock fragments: 0 to 15 percent.

3B horizon

Hue: 7.5YR or 10YR.

Texture in the fine-earth fraction: Medial loam or medial silt loam.

Content of rock fragments: 15 to 30 percent.

Halemaumau Series

The Halemaumau series consists of moderately deep, well drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,650 millimeters (65 inches), and the mean annual air temperature is about 16 degrees C (60 degrees F).

Taxonomic classification: Ashy, glassy, isothermic Typic Ustivitrands.

Typical pedon

Halemaumau extremely gravelly ashy coarse sand, 2 to 10 percent slopes, under scattered ohia trees and shrubs; located in Hawaii Volcanoes National Park; from Keanakakoi crater lookout on Crater Rim Drive, travel east 0.2 mile, turn south on gravel service road for 0.7 mile; where main track goes west, travel south on less used track 0.15 mile to end of track and type location; Kilauea Crater Quadrangle; lat. 19 degrees 23 minutes 39.20 seconds N. and long. 155 degrees 15 minutes 49.45 seconds W. (Position measured by GPS PLGR using old Hawaii datum +/- 65 feet.)

A—0 to 8 centimeters (0 to 3 inches); very dark gray (10YR 3/1) extremely gravelly ashy coarse sand; strong medium platy structure parting to moderate fine granular; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 20 percent gravel; extremely acid (pH 4.0); abrupt wavy boundary. (3 to 13 centimeters [1 to 5 inches] thick.)

C1—8 to 25 centimeters (3 to 10 inches); very dark grayish brown (10YR 3/2) ashy loamy sand; massive; slightly hard, very friable, brittle, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 10 percent

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- 0.1- to 0.4-centimeter ($1/8$ - to $3/8$ -inch), rounded, soft to hard accretionary lapilli throughout; 10 percent gravel; neutral (pH 7.2); abrupt wavy boundary.
- Cd—25 to 29 centimeters (10 to 12 inches); very dark grayish brown (2.5Y 3/2) ashy loamy very fine sand; strong thin platy structure resulting from geologic stratification; very hard, very firm, brittle, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent 0.1- to 0.4-centimeter ($1/8$ - to $3/8$ -inch), rounded, soft to hard accretionary lapilli; neutral (pH 7.2); abrupt wavy boundary.
- C2—29 to 33 centimeters (12 to 13 inches); 90 percent very dark gray (7.5YR 3/1) and 10 percent dusky red (10R 3/3) ashy loamy fine sand; moderate thin platy structure resulting from geologic stratification; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt wavy boundary.
- C3—33 to 38 centimeters (13 to 15 inches); very dark grayish brown (2.5Y 3/2) ashy loamy fine sand; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt wavy boundary.
- C4—38 to 41 centimeters (15 to 16 inches); 90 percent very dark gray (7.5YR 3/1) and 10 percent dusky red (10R 3/3) ashy fine sand; weak thin platy structure resulting from geologic stratification; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt wavy boundary.
- C5—41 to 43 centimeters (16 to 17 inches); very dark grayish brown (2.5Y 3/2) ashy loamy fine sand; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt wavy boundary.
- C6—43 to 46 centimeters (17 to 18 inches); 90 percent black (N 2/0) and 10 percent dusky red (10R 3/3) ashy fine sand; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 2 percent yellow-green coarse sand-size olivine crystals; neutral (pH 7.2); abrupt wavy boundary.
- C7—46 to 48 centimeters (18 to 19 inches); 70 percent very dark grayish brown (2.5Y 3/2) and 30 percent black (N 2/0) ashy loamy sand and ashy coarse sand; moderate thin platy structure resulting from geologic stratification; soft, very friable, nonsticky and nonplastic; many very fine and fine, common medium, and few coarse and very coarse roots; many very fine and fine interstitial pores; 2 percent yellow-green coarse sand-size olivine crystals; neutral (pH 7.2); abrupt wavy boundary.
- C8—48 to 61 centimeters (19 to 24 inches); 50 percent black (N 2/0) and 50 percent dark olive gray (5Y 3/2) ashy coarse sand; single grain; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 10 percent gravel-size dark olive gray (5Y 3/2) pumice; neutral (pH 7.2); clear wavy boundary. (Combined thickness of the C horizons ranging from 51 to 74 centimeters [20 to 29 inches].)
- 2C9—61 to 71 centimeters (24 to 28 inches); reticulite (pumicelike volcanic glass); mildly alkaline (pH 7.5); abrupt wavy boundary. (0 to 13 centimeters [0 to 5 inches] thick.)
- 3R—71 centimeters (28 inches); hard, unweathered pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 50 to 100 centimeters (20 to 40 inches).

Mean annual soil temperature: 15 to 20 degrees C (59 to 68 degrees F).

Surface crust: In as much as 30 percent of the pedons, a brittle crust, 1 centimeter (0.5 inch) thick; 1 to 10 percent thin white coatings on the underside of the crust.

Soil reaction: Extremely acid to neutral.

A horizon

Hue: 2.5YR to 10YR; 5YR or 7.5YR in the crust.

Value: 2 to 3 moist.

Texture: Gravelly ashy sandy loam or, less commonly, gravelly ashy loam or gravelly ashy fine sandy loam.

Soil reaction: Very strongly acid or strongly acid.

C horizon

Hue: 2.5YR to 10YR, 2.5Y, 5Y, or N.

Value: 0, 2, or 3 moist.

Texture: Ashy loam, ashy very fine sandy loam, ashy fine sandy loam, ashy sandy loam, ashy loamy fine sand, ashy loamy sand, ashy fine sand, ashy sand, or ashy coarse sand.

Soil reaction: Slightly acid or neutral.

Accretionary lapilli: Occurring in most pedons.

Olivine crystals: Occurring in some pedons.

Reticulite: Occurring in most pedons.

Hao Series

The Hao series consists of deep and very deep, moderately well drained soils that formed in volcanic ash. Slopes range from 2 to 20 percent. The mean annual rainfall is about 3,680 millimeters (145 inches), and the mean annual air temperature is about 14 degrees C (58 degrees F).

Taxonomic classification: Medial, ferrihydritic, isothermic Typic Placaquands.

Typical pedon

Hao soil in an area of Puauulu-Hao complex, 2 to 20 percent slopes, under rain forest vegetation; located in Hawaii Volcanoes National Park; from State Highway 11, drive 2.2 miles northwest on State Highway 148 (Wright Road) to the Oloo tract of Hawaii Volcanoes National Park; walk east along Park boundary fence approximately 2 miles to where the fence turns north; walk north along fence approximately 900 meters (3,000 feet); type location is 4 meters (12 feet) northwest of the fence; Volcano Quadrangle; lat. 19 degrees 28 minutes 47.52 seconds N. and long. 155 degrees 13 minutes 32.85 seconds W. (Position measured by GPS PLGR using old Hawaiian datum.)

- A1—0 to 4 centimeters (0 to 2 inches); black (10YR 2/1) medial silt loam; moderate medium platy structure parting to moderate medium subangular blocky; friable, slightly sticky and slightly plastic; weakly smeary; many very fine to medium roots; many very fine and fine interstitial and tubular and few medium and coarse interstitial pores; 2 percent gravel; strongly acid (pH 5.4); abrupt wavy boundary.
- A2—4 to 8 centimeters (2 to 3 inches); black (7.5YR 2.5/1) medial silt loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; few very fine to medium roots between peds and matted at the bottom of the horizon; many very fine and fine interstitial pores; moderately acid (pH 5.7); abrupt wavy boundary. (Combined thickness of the A horizons ranging from 5 to 13 centimeters [2 to 5 inches].)
- Bs—8 to 15 centimeters (3 to 6 inches); very dark brown (7.5YR 2.5/2) medial sandy clay loam over medial silt loam; massive; firm, moderately sticky and moderately plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; 0.3- to 0.6-centimeter ($\frac{1}{8}$ - to $\frac{1}{4}$ -inch), dark red (2.5YR 3/6) and black (N 2/0) ironstone sheet, mainly at the top of the horizon; few fine irregular

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- black (N 2/0) shotlike nodules; throughout the horizon few fine and medium prominent black (N 2/0) redoximorphic concentrations that do not react with hydrogen peroxide; moderately acid (pH 5.7); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- Bw—15 to 20 centimeters (6 to 8 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine to medium roots; many very fine and fine interstitial pores; common fine and medium prominent black (N 2/0) redoximorphic concentrations throughout; moderately acid (pH 6.0); clear wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)
- 2A—20 to 23 centimeters (8 to 9 inches); black (10YR 2/1) medial silty clay loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 2 percent gravel; moderately acid (pH 6.0); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 2Bs—23 to 25 centimeters (9 to 10 inches); very dark brown (7.5YR 2.5/1) medial sandy clay loam; massive; firm, moderately sticky and moderately plastic; weakly smeary; common very fine and fine and few medium roots; many very fine to medium interstitial pores; common fine and medium irregular black (5YR 2.5/1) and dark reddish brown (5YR 3/3) masses of ironstone at the top of the horizon; common dark brown (7.5YR 3/3) gravel-size sand masses near the top of the horizon; slightly acid (pH 6.3); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3A1—25 to 30 centimeters (10 to 12 inches); very dark brown (7.5YR 2/2) medial silty clay loam; massive; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few very coarse roots; many very fine and fine interstitial pores; common fine to coarse prominent black (N 2/0) redoximorphic concentrations throughout; slightly acid (pH 6.3); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3A2—30 to 34 centimeters (12 to 13 inches); dark reddish brown (5YR 2.5/2) medial silty clay loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; common fine to coarse distinct black (10YR 2/1) redoximorphic concentrations throughout; slightly acid (pH 6.3); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3Bs—34 to 38 centimeters (13 to 15 inches); dark reddish brown (5YR 2.5/2) medial sandy clay loam; massive; firm, moderately sticky and moderately plastic; weakly smeary; common very fine to medium roots; many very fine and fine interstitial pores; few fine irregular black (5YR 2.5/1) and dark reddish brown (5YR 3/3) masses of ironstone at the top of the horizon; many fine to coarse faint dark reddish brown (5YR 3/3) redoximorphic concentrations throughout; slightly acid (pH 6.3); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3Bw1—38 to 46 centimeters (15 to 18 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; few distinct patchy black (N 2/0) organic coatings in root channels; many very fine and fine interstitial pores; many fine to coarse prominent black (N 2/0) redoximorphic concentrations at a depth of 16 inches and common fine prominent dark red (10R 3/6) redoximorphic concentrations under the black redoximorphic concentrations; slightly acid (pH 6.3); clear wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- 3Bw2—46 to 53 centimeters (18 to 21 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent

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- gravel; common medium prominent black (N 2/0) and common fine and medium prominent red (2.5YR 4/6) redoximorphic concentrations throughout; slightly acid (pH 6.3); abrupt wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- 3Bw3—53 to 58 centimeters (21 to 23 inches); very dark brown (7.5YR 2.5/3) medial sandy clay loam; massive; firm, moderately sticky and moderately plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; few fine irregular black (N 2/0) hard masses; many fine and medium distinct yellowish red (5YR 4/6) and few fine and medium prominent black (N 2/0) redoximorphic concentrations throughout; slightly acid (pH 6.3); abrupt wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)
- 3Bg—58 to 61 centimeters (23 to 24 inches); gray (N 6/0) medial fine sandy loam; massive; friable, nonsticky and nonplastic; nonsmeary; few very fine and fine roots; many very fine and fine interstitial pores; many fine to coarse prominent red (2.5YR 4/6) threads of redoximorphic concentrations throughout; slightly acid (pH 6.3); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 4A1—61 to 64 centimeters (24 to 25 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; friable, moderately sticky and moderately plastic; moderately smeary; few very fine and fine roots; many very fine and fine interstitial pores; few fine irregular black (N 2/0) hard masses; neutral (pH 6.6); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 4A2—64 to 76 centimeters (25 to 30 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; friable, slightly sticky and slightly plastic; moderately smeary; few very fine and fine roots; many very fine and fine interstitial pores; very few distinct thin continuous black (10YR 2/1) clay films in root channels and pores; 10 percent indurated ash; common fine and medium prominent black (N 2/0) and few medium prominent yellowish red (5YR 4/6) redoximorphic concentrations throughout; neutral (pH 6.6); clear wavy boundary. (8 to 15 centimeters [3 to 6 inches] thick.)
- 4Bw/5Cm—76 to 104 centimeters (30 to 41 inches); very dark brown (7.5YR 2.5/2) medial silty clay loam; massive; friable, slightly sticky and slightly plastic; moderately smeary; few very fine and fine roots; many very fine and fine interstitial pores; few faint patchy very dark brown (7.5YR 2.5/2) clay films on horizontal faces of peds and few distinct continuous very dark brown (7.5YR 2.5/2) clay films in root channels and pores; 30 percent dark reddish brown (5YR 3/4) indurated ash; common fine and medium prominent black (N 2/0) and common prominent yellowish red (5YR 4/6) redoximorphic concentrations throughout; neutral (pH 6.2); diffuse wavy boundary.
- 5Cm—104 to 152 centimeters (41 to 60 inches); dark reddish brown (5YR 3/4) indurated ash. (Combined thickness of the Cm horizon is more than 50 centimeters [20 inches].)

Range in characteristics

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

Depth to indurated ash: 104 to 137 centimeters (41 to 54 inches).

Soil reaction: Strongly acid to slightly acid.

A horizon

Hue: 5YR to 10YR.

Texture: Medial silt loam and medial loam.

Structure: Granular or subangular blocky.

B horizon

Hue: 10R, 2.5YR to 10YR.

Texture: Medial sandy loam, medial sandy clay loam, medial loam, medial silt loam, or medial silty clay loam.

Structure: Subangular blocky or massive.

Nodules: Fine shotlike hard black masses that do not effervesce with hydrogen peroxide occur in most horizons.

Hapuu Series

The Hapuu series consists of deep, well drained soils that formed in aa lava and basic volcanic ash. Slopes range from 10 to 20 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Sandy-skeletal, isotic, isomesic Udic Ustorthents.

Typical pedon

Hapuu extremely gravelly medial silt loam, on a southwest-facing, slightly concave slope of 20 percent, under grazed forest vegetation, at an elevation of 1,414 meters (4,640 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on July 21, 1997, the soil was slightly moist throughout.) Island of Hawaii, Hawaii County, Hawaii; on Kealia Ranch; from Big Hill Camp road junction at an elevation of about 1,417 meters (4,650 feet), drive north 0.75 mile; pedon is located 8 meters (25 feet) upslope of road; a major fence line that runs up and down the slope is 69 meters (225 feet) to the north; Kaunene Quadrangle; lat. 19 degrees 24 minutes 46.5 seconds N. and long. 155 degrees 48 minutes 52.5 seconds W. (GPS PLGR; old Hawaiian datum.)

2C1/A—0 to 10 centimeters (0 to 4 inches); black (5YR 2.5/1) extremely gravelly medial silt loam, brown (7.5YR 5/2) dry; strong fine granular structure; friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine interstitial pores; 60 percent angular gravel and 10 percent angular cobbles; moderately acid (pH 5.9); abrupt wavy boundary. (8 to 15 centimeters [3 to 6 inches] thick.)

2C2/Bw—10 to 15 centimeters (4 to 6 inches); very dusky red (2.5YR 2.5/2) extremely gravelly loamy sand, reddish brown (5YR 5/4) dry; moderate very fine granular structure; very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; many very fine interstitial pores; 65 percent angular gravel and 10 percent angular cobbles; moderately acid (pH 5.7); clear irregular boundary. (3 to 8 centimeters [1 to 3 inches] thick.)

2C3—15 to 36 centimeters (6 to 14 inches); very dusky red (2.5YR 2.5/2) extremely gravelly sand, brown (7.5YR 5/3) dry; single grain; loose, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine interstitial pores; 65 percent angular gravel and 10 percent angular cobbles; moderately acid (pH 5.7); clear wavy boundary.

2C4—36 to 109 centimeters (14 to 43 inches); very dusky red (2.5YR 2.5/2) extremely gravelly sand, gray (5YR 5/1) dry; single grain; loose, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine interstitial pores; 65 percent angular gravel and 10 percent angular cobbles; slightly acid (pH 6.4); abrupt irregular boundary.

2R—109 centimeters (43 inches); hard, massive bluerock.

Range in characteristics

Depth to bedrock: 102 to 152 centimeters (40 to 60 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 35 to 75 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

2C1/A horizon

Hue: 2.5YR to 10YR.

Value: 2 to 5 moist and dry.

Chroma: 1 or 2 moist, 1 to 4 dry.

Texture: Extremely or very gravelly or cobbly medial silt loam or loamy sand.

Structure: Weak or strong granular.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

2C2/Bw horizon

Hue: 2.5YR or 7.5YR.

Value: 2 to 3 moist, 3 to 5 dry.

Chroma: 1 or 2 moist, 1 to 4 dry.

Texture: Extremely gravelly or cobbly sandy loam or loamy sand.

Structure: Weak or moderate granular or subangular blocky.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

2C horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist, 3 to 5 dry.

Chroma: 1 or 2 moist, 1 to 3 dry.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

Heake Series

The Heake series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash deposited over basic pahoehoe lava (fig. 17). Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,650 millimeters (65 inches), and the mean annual air temperature is about 16 degrees C (60 degrees F).

Taxonomic classification: Ashy, glassy, isothermic Lithic Ustivitrands.

Typical pedon

Heake soil in an area of Heake-Lava flows complex, 2 to 10 percent slopes, under scattered ohia trees and shrubs with a grass understory; located in Hawaii Volcanoes National Park; from State Highway 11, travel 0.1 mile north on Mauna Loa Strip Road, then 0.1 mile east on Tree Molds Road, then 0.2 mile north on a service road; at fork, veer west (left) and travel 50 feet; at second fork, veer west (left) and travel 0.35 mile; site is 10 feet to the south (left) in the lower portion of a bowl-like depression; Kilauea Crater Quadrangle; lat. 19 degrees 26 minutes 25.58 seconds N. and long. 155 degrees 17 minutes 22.63 seconds W. (Position measured by GPS PLGR using old Hawaiian datum.)

A—0 to 3 centimeters (0 to 1 inch); very dark brown (10YR 2/2) ashy loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure parting to strong fine subangular blocky; hard, firm, nonsticky and nonplastic; many very fine and fine and few medium roots; many very fine and fine interstitial pores; 10 percent gravel; very strongly acid (pH 5.2); abrupt wavy boundary. (2 to 10 centimeters [1 to 4 inches] thick.)

Bw—3 to 10 centimeters (1 to 4 inches); very dark brown (10YR 2/2) ashy loamy fine sand, 80 percent brown (10YR 5/3) and 20 percent black (N 2/0) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic;



Figure 17.—Profile of Heake soils. On the tape, depth is marked in centimeters.

- common very fine and fine and few medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); abrupt wavy boundary. (2 to 10 centimeters [1 to 4 inches] thick.)
- C1—10 to 18 centimeters (4 to 7 inches); lithochromic black (10YR 2/1) ashy loamy fine sand, grayish brown (10YR 5/2) dry; finely stratified; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 10 percent rounded pebbles 2 to 5 millimeters in size; slightly acid (pH 6.7); abrupt wavy boundary. (2 to 10 centimeters [1 to 4 inches] thick.)
- C2—18 to 20 centimeters (7 to 8 inches); lithochromic dark brown (7.5YR 3/2) ashy loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; slightly smeary; few very fine to medium roots; many very fine and fine interstitial pores; few fine broken strands of Pele's hair; neutral (pH 6.8); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- Cd1—20 to 25 centimeters (8 to 10 inches); lithochromic very dark grayish brown (10YR 3/2) ashy sandy loam, 80 percent light olive brown (2.5Y 5/4) and 20 percent black (N 2/0) dry; finely stratified; hard, firm, brittle, nonsticky and nonplastic; few very fine to medium roots; few very fine and fine interstitial pores; 35 percent 0.3- to 1-centimeter ($\frac{1}{8}$ - to $\frac{3}{8}$ -inch), rounded, soft to hard accretionary lapilli; neutral (pH 6.8); abrupt wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)
- Cd2—25 to 30 centimeters (10 to 12 inches); lithochromic very dark brown (10YR 2/2) ashy loamy fine sand, ashy fine sand, ashy sand, and ashy coarse sand, 80 percent grayish brown (2.5Y 5/2) and 20 percent black (N 2/0) dry; stratified; hard, friable, nonsticky and nonplastic; few very fine to medium roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt wavy boundary. (2 to 10 centimeters [1 to 4 inches] thick.)
- 2C—30 to 36 centimeters (12 to 14 inches); dark brown (10YR 3/3) reticulite (pumicelike volcanic glass), light olive brown (2.5Y 5/4) dry; abrupt wavy boundary. (0 to 23 centimeters [0 to 9 inches] thick.)
- 3R—36 centimeters (14 inches); hard, basaltic pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 15 to 18 degrees C (59 to 65 degrees F).

Surface crust: On as much as 20 percent of the pedons, a brittle crust, 1.5 centimeter (0.5 inch) thick; 1 to 10 percent thin white coatings on the underside of the crust.

A horizon

Value: 2 to 3 moist.

Chroma: 1 to 4 moist.

Texture: Ashy loam, ashy fine sandy loam, or ashy sandy loam.

Rock fragments: 0 to 35 percent of the surface covered with gravel.

Soil reaction: Very strongly acid or strongly acid.

C horizon

Hue: 2.5YR to 10YR or 2.5Y.

Value: 2 to 3 moist.

Texture: Ashy loam, ashy fine sandy loam, ashy sandy loam, ashy loamy fine sand, ashy fine sand, or ashy sand.

Soil reaction: Slightly acid or neutral.

Accretionary lapilli: Occurring in most pedons.

Olivine crystals: Occurring in some pedons.

Reticulite: Occurring in most pedons; ranging in size from 2 millimeters to 25 centimeters.

Hilea Series

The Hilea series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 3 to 20 percent slopes. The mean annual rainfall is about 2,540 millimeters (100 inches), and the mean annual air temperature is about 18 degrees C (64 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, isothermic Lithic Hydrudands.

Typical pedon

Hilea hydrous silty clay loam, on an east-facing slope of 4 percent, under forest vegetation, at an elevation of 640 meters (2,120 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii County, Hawaii; from the village of Naalehu at State Highway 11, follow Kaalaiki road 2 miles northeast, upslope, past an old airstrip; at 2 miles, turn left (northwest) and proceed upslope approximately 2.2 miles; turn right (northeast), proceed 0.4 mile, and park; hike due north to type location; Naalehu Quadrangle; lat. 19 degrees 34 minutes 25 seconds N. and long. 155 degrees 6 minutes 50 seconds W. (Old Hawaiian datum.)

Oa—0 to 1 centimeter (0 to 0.5 inch); highly decomposed plant material; abrupt smooth boundary.

A—1 to 20 centimeters (0.5 inch to 8 inches); very dark grayish brown (10YR 3/2) hydrous silty clay loam; strong medium and fine subangular blocky structure; friable, slightly sticky and moderately plastic; strongly smeary; many roots; many medium and fine pores; 10 percent cobbles; very strongly acid (pH 4.8); abrupt smooth boundary. (15 to 20 centimeters [6 to 8 inches] thick.)

Bw—20 to 48 centimeters (8 to 19 inches); dark brown (7.5YR 3/3) hydrous silty clay loam; moderate medium and fine subangular blocky structure; friable, moderately sticky and moderately plastic; strongly smeary; many roots; many very fine and

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fine pores; thick gelatinlike coatings on faces of peds; strongly acid (pH 5.4); abrupt wavy boundary. (25 to 31 centimeters [10 to 12 inches] thick.)
2R—48 centimeters (19 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 16 to 22 degrees C (61 to 72 degrees F).

Content of rock fragments: 5 to 25 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Hue: 5YR to 10YR.

Texture: Hydrous silt loam or silty clay loam.

Structure: Moderate or strong granular or subangular blocky.

Stickiness: Slightly sticky or moderately sticky.

Plasticity: Slightly plastic or moderately plastic.

Smeariness: Weakly smeary to strongly smeary.

Rupture resistance: Very friable or firm.

Bw horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Cobbly or noncobbly hydrous silty clay loam.

Smeariness: Moderately smeary or strongly smeary.

Rupture resistance: Friable or firm.

Hokukano Series

The Hokukano series consists of shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Lithic Fulvudands.

Typical pedon

Hokukano medial silt loam, on a west-facing, slightly concave slope of 5 percent, in a pasture, at an elevation of 1,839 meters (6,035 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with electrode in 1:1 water. When described on July 30, 1997, the soil was slightly moist throughout.) Island of Hawaii, Hawaii County, Hawaii; on Kealia Ranch, drive 1.0 mile north of Komakawai waterholes; pedon is located 21 meters (70 feet) west of a ranch road and 49 meters (160 feet) south of the next aa flow; Kaunene Quadrangle; lat. 19 degrees 24 minutes 53.3 seconds N. and long. 155 degrees 46 minutes 31.9 seconds W. (GPS PLGR; old Hawaiian datum.)

A—0 to 15 centimeters (0 to 6 inches); very dark brown (7.5YR 2.5/2) medial silt loam, brown (7.5YR 4/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine, few fine, and very few medium roots; many very fine interstitial pores; 5 percent subangular cobbles; slightly acid (pH 6.2); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)

Bw1—15 to 25 centimeters (6 to 10 inches); dark reddish brown (2.5YR 3/4) cobbly medial silt loam, red (2.5YR 4/6) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common

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very fine and few fine roots; many very fine interstitial pores; 10 percent subangular cobbles and 5 percent subangular gravel; slightly acid (pH 6.2); clear wavy boundary.

Bw2—25 to 50 centimeters (10 to 20 inches); dark reddish brown (5YR 3/3) cobbly medial silt loam, brown (7.5YR 4/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly smeary; many very fine and fine roots; many very fine interstitial pores; 15 percent subangular cobbles and 5 percent subangular gravel; moderately acid (pH 5.6); abrupt wavy boundary. (Combined thickness of the Bw horizons ranging from 15 to 41 centimeters [6 to 16 inches].)

2R—50 centimeters (20 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 25 to 50 centimeters (10 to 20 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 0 to 15 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist, 3 or 4 dry.

Chroma: 1 or 2 moist, 2 or 3 dry.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Soil reaction: Strongly acid to slightly acid (pH 5.6 to 6.5).

Bw horizon

Chroma: 2 to 4 moist, 4 to 6 dry.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

Continuity: This horizon is discontinuous in some pedons.

Ihuanu Series

The Ihuanu series consists of moderately deep, well drained soils that formed in basic volcanic ash and cinders in aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Humic Haplustands.

Typical pedon

Ihuanu very cobbly medial silt loam, on a south-facing, slightly convex slope of 15 percent, under dry-land forest vegetation, at an elevation of 1,326 meters (4,350 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on September 4, 1997, the soil was dry to a depth of 5 centimeters [2 inches] and slightly moist below that depth.) Island of Hawaii, Hawaii County, Hawaii; in Hawaii Ocean View Estates, drive to the northeast end of Palm Parkway; pedon is located 0.2 mile southwest from the end of Palm Parkway and 15 meters (50 feet) makai (downslope) of road; Puu O Keokeo Quadrangle; lat. 19 degrees 8 minutes 31.7 seconds N. and long. 155 degrees 43 minutes 30.3 seconds W. (Old Hawaiian datum.)

A/2C1—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) very cobbly medial silt loam, very dark grayish brown (10YR 3/2) dry; strong very fine granular structure; soft, friable, nonsticky and nonplastic; nonsmeary; many very fine and fine and few medium roots; many very fine interstitial pores; 20 percent subangular gravel

and 20 percent angular cobbles; strongly acid (pH 5.2); abrupt wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)

2C2/Bw—5 to 50 centimeters (2 to 20 inches); very dark brown (10YR 2/2) extremely cobbly medial sandy loam, dark yellowish brown (10YR 3/4) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; nonsmeary; common very fine and fine and few medium roots; many very fine interstitial pores; 25 percent subangular gravel and 40 percent angular cobbles; slightly acid (pH 6.1); abrupt wavy boundary. (38 to 50 centimeters [5 to 20 inches] thick.)

2C3—50 to 56 centimeters (20 to 22 inches); very dark brown (10YR 2/2) extremely gravelly coarse sand, brown (10YR 4/3) dry; single grain; loose when dry and moist, nonsticky and nonplastic; nonsmeary; many very fine interstitial pores; 70 percent gravel; slightly acid (pH 6.1); abrupt wavy boundary. (5 to 8 centimeters [2 to 3 inches] thick.)

2R—56 centimeters (22 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 35 to 60 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

Surface crust: Occurring in 10 to 20 percent of the area.

A/2C1 horizon

Hue: 10YR or 7.5YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Very cobbly medial loam or silt loam.

Dry consistence: Mainly soft, but hard if there is a surface crust.

Soil reaction: Strongly acid or moderately acid (pH 5.1 to 6.0).

2C2/Bw horizon

Hue: 10YR or 7.5YR.

Value: 2 to 4 moist and dry.

Chroma: 2 to 4 moist and dry.

Texture: Extremely gravelly or cobbly medial sandy loam or loamy sand.

Dry consistence: Soft or loose.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5) in the Bw horizon.

2C3 horizon

Hue: 10YR or 7.5YR.

Value: 2 to 4 moist and dry.

Chroma: 2 to 4 moist and dry.

Texture: Extremely gravelly or cobbly loamy sand or sand.

Iwalani Series

The Iwalani series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash and cinders over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Lithic Haplustands.

Typical pedon

Iwalani medial loam, on a southwest-facing, slightly concave slope, under dry-land forest vegetation, at an elevation of 1,295 meters (4,250 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on September 10, 1997, the soil was dry to a depth of 5 centimeters [2 inches] and slightly moist below that depth.) Island of Hawaii, Hawaii County, Hawaii; in Hawaii Ocean View Estates, at the intersection of Mahimahi Drive and Plumeria Lane, drive 0.2 mile northeast on Mahimahi Drive; pedon is located 24 meters (80 feet) makai (downslope) of road between Plumeria Lane and Pineapple Parkway; Papa Quadrangle; lat. 19 degrees 8 minutes 28.4 seconds N. and long. 155 degrees 45 minutes 2.4 seconds W. (Old Hawaiian datum.)

- A—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) medial loam, very dark grayish brown (10YR 3/2) dry; strong medium platy structure parting to weak fine and medium granular; hard, very firm, nonsticky and nonplastic; nonsmeary; many very fine and fine roots; many very fine and fine interstitial pores; very strongly acid (pH 4.8); hydrophobic when dry; abrupt smooth boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- Bw—5 to 8 centimeters (2 to 3 inches); dark brown (7.5YR 2/2) medial very fine sandy loam, dark brown (7.5YR 3/3) dry; strong thick platy structure parting to weak fine and medium subangular blocky; hard, very firm, nonsticky and nonplastic; nonsmeary; few very fine and fine roots; many very fine and fine interstitial and common fine tubular pores; slightly acid (pH 6.4); abrupt smooth boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- A'—8 to 13 centimeters (3 to 5 inches); black (5YR 2/1) medial loamy sand, very dark brown (7.5YR 2/2) dry; single grain; loose when dry and moist, nonsticky and nonplastic; nonsmeary; common very fine and fine roots; many very fine and fine interstitial pores; 10 percent gravel; slightly acid (pH 6.2); abrupt broken boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- B'w—13 to 25 centimeters (5 to 10 inches); dark brown (10YR 2/2) medial very fine sandy loam, dark brown (7.5YR 3/3) dry; moderate very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; nonsmeary; common very fine and fine and few coarse roots; many very fine and fine interstitial pores; 2 percent gravel and 5 percent cobbles; neutral (pH 6.6); abrupt broken boundary. (0 to 15 centimeters [0 to 6 inches] thick.)
- 2R—25 centimeters (10 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 25 centimeters (2 to 10 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 0 to 35 percent, by volume, gravel and cobbles in the pedon as a whole.

Surface crust: A hard crust on 10 to 20 percent of the surface.

A horizon

Hue: 7.5YR or 10YR.

Texture: Medial loam or silt loam.

Structure: Strong platy or weak granular.

Dry consistence: Mainly soft, but hard if there is a surface crust.

Soil reaction: Very strongly acid or strongly acid (pH 4.5 to 5.4).

Bw horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 to 3 moist and dry.

Texture: Medial loam, very fine sandy loam, or loamy sand.
Structure: Strong platy or moderate subangular blocky.
Soil reaction: Slightly acid or neutral (pH 6.1 to 7.3).

Kaalualu Series

The Kaalualu series consists of moderately deep, somewhat excessively drained soils that formed in basic volcanic ash over aa lava. Slopes range from 2 to 70 percent. The mean annual rainfall is about 640 millimeters (25 inches), and the mean annual air temperature is about 23 degrees C (74 degrees F).

Taxonomic classification: Medial-skeletal over fragmental or cindery, amorphous over mixed, isohyperthermic Typic Haplotorrands.

Typical pedon

Kaalualu cobbly medial loamy sand, 2 to 10 percent slopes, in a pasture, at an elevation of 140 meters (460 feet). (Colors are for dry soil unless otherwise noted. All textures are "apparent field textures." When described on November 21, 2000, the soil was dry throughout.) Island of Hawaii, Hawaii County, Hawaii; about 1.4 miles northeast of the abandoned air force tracking station near South Point; Ka Lae Quadrangle; lat. 18 degrees 57 minutes 25 seconds N. and long. 155 degrees 40 minutes 9 seconds W. (Old Hawaiian datum.)

- A1—0 to 5 centimeters (0 to 2 inches); dark yellowish brown (10YR 4/4) cobbly medial loamy sand, dark brown (7.5YR 3/2) moist; single grain; loose, nonsticky and nonplastic; many very fine and fine roots; nonsmeary; many fine pores; 15 percent angular cobbles and 10 percent angular gravel; 25 percent olivine sand; neutral (pH 6.6); abrupt smooth boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- A2—5 to 13 centimeters (2 to 5 inches); dark yellowish brown (10YR 4/4) cobbly medial loam, dark brown (7.5YR 3/3) moist; weak medium and fine granular structure; soft, friable, nonsticky and nonplastic; nonsmeary; many very fine and fine roots; many fine pores; 30 percent angular cobbles and 10 percent angular gravel; neutral (pH 7.1); clear smooth boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- Bw/2C1—13 to 61 centimeters (5 to 24 inches); dark yellowish brown (10YR 3/4) very cobbly medial silt loam, dark brown (7.5YR 3/3) moist; weak coarse prismatic structure; soft, friable, nonsticky and nonplastic; nonsmeary; many very fine and fine roots; many fine pores; 50 percent angular cobbles and 10 percent angular gravel; slightly effervescent; neutral (pH 7.1); clear wavy boundary. (38 to 76 centimeters [15 to 30 inches] thick.)
- 2C2—61 to 99 centimeters (24 to 39 inches); fragmental aa lava with very little soil material and patchy coatings of calcium carbonate that are slightly effervescent; 20 percent angular stones, 60 percent angular cobbles, and 10 percent angular gravel; abrupt irregular boundary. (35 to 40 centimeters [14 to 16 inches] thick.)
- 2R—99 centimeters (39 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 100 centimeters (20 to 40 inches).

Mean annual soil temperature: 22 to 24 degrees C (72 to 76 degrees F).

Content of rock fragments: 35 to 75 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Hue: 7.5YR or 10YR.

Value: 3 or 4 moist and dry.

Chroma: 2 or 3 moist, 3 or 4 dry.

Texture: Cobbly to extremely cobbly medial loamy sand, sandy loam, or loam.

Structure: Single grain or weak granular.

Bw/2C horizon

Hue: 7.5YR or 10YR.

Value: 3 or 4 moist and dry.

Chroma: 2 or 3 moist, 3 or 4 dry.

Texture: Cobbly to extremely cobbly medial loamy sand, sandy loam, loam, or silt loam.

Structure: Single grain or weak granular.

Kahalii Series

The Kahalii series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash and pumice deposited over basic pahoehoe lava (fig. 18). Slopes range from 2 to 10 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 17 degrees C (62 degrees F).

Taxonomic classification: Ashy, amorphic, isothermic Lithic Udivitrands.

Typical pedon

Kahalii soil in an area of Kahalii-Lava flows complex, 2 to 10 percent slopes, under scattered shrubs and grasses; located in Hawaii Volcanoes National Park; on Chain of Craters Road, drive past the sign indicating an elevation of 3,000 feet and to the Kipuka Kahalii parking area; from the information sign describing a cinder fall on the east side of the road, walk west (across the road) on a heading of 230 degrees for 74



Figure 18.—Profile of Kahalii soils. On the tape, depth is marked in centimeters.

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meters (240 feet) to the type location; Makaopuhi Crater Quadrangle; lat. 19 degrees 20 minutes 52.72 seconds N. and long. 155 degrees 12 minutes 57.31 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 43 feet.)

- C—0 to 10 centimeters (0 to 4 inches); 75 percent lithochromic black (N 2/0) glassy cinders and 20 percent light yellowish brown (2.5Y 6/4) pumice; extremely gravelly (cindery) coarse sand; single grain; loose moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to coarse interstitial pores; 3 percent Pele's hair; strongly acid (pH 5.4); clear wavy boundary. (2.5 to 12.5 centimeters [1 to 5 inches] thick.)
- 2A—10 to 13 centimeters (4 to 5 inches); black (7.5YR 2/1) gravelly ashy loamy sand, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine and few medium interstitial pores; 20 percent subrounded gravel; strongly acid (pH 5.4); clear wavy boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- 2C—13 to 18 centimeters (5 to 7 inches); 75 percent lithochromic black (10YR 2/1) and 25 percent very dark brown (10YR 2/2) very gravelly ashy coarse sand, 40 percent very dark grayish brown (10YR 3/2), 30 percent very dark gray (10YR 3/1), and 30 percent dark brown (10YR 3/3) dry; single grain; loose moist and dry, nonsticky and nonplastic; common very fine to medium roots; many very fine to coarse interstitial pores; 50 percent subrounded gravel; slightly acid (pH 6.3); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 3Bw—18 to 23 centimeters (7 to 9 inches); very dark brown (7.5YR 2.5/2) very gravelly ashy sandy loam, brown (7.5YR 4/4) dry; weak thin platy structure; slightly hard, very friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine and few medium and coarse interstitial pores; 40 percent subrounded gravel; moderately acid (pH 6.0); abrupt wavy boundary. (0 to 10 centimeters [0 to 4 inches] thick.)
- 3C—23 to 24 centimeters (9 to 9.5 inches); lithochromic black (N 2/0) ashy fine sand, black (N 2/0) dry; moderate thin platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine interstitial pores; neutral (pH 6.6); clear broken boundary. (0 to 2.5 centimeters [0 to 1 inch] thick.)
- 4C—24 to 28 centimeters (9.5 to 11 inches); 90 percent lithochromic very dark brown (10YR 2/2) and 10 percent dark reddish brown (5YR 3/3) very gravelly ashy coarse sand, brown (7.5YR 5/4) dry; single grain; loose moist and dry, nonsticky and nonplastic; many very fine to medium roots; many very fine to medium interstitial pores; 85 percent subrounded gravel; neutral (pH 6.6); clear wavy boundary. (2.5 to 15 centimeters [1 to 6 inches] thick.)
- 5Cr—28 to 30 centimeters (11 to 12 inches); slightly weathered pahoehoe; clear broken boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- 5R—30 centimeters (12 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 15 to 50 centimeters (6 to 20 inches).

Mean annual soil temperature: 17 to 19 degrees C (62 to 65 degrees F).

Percentage of the surface covered by rock fragments: 95 percent by cinders and pumice.

Placic material, which is like ironstone: Occurring in some pedons.

Profile feature: A horizon of loam above the 5Cr horizon in some pedons.

Soil reaction: Strongly acid to slightly acid.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture in the fine-earth fraction: Ashy fine loamy sand, ashy loamy sand, ashy very fine sandy loam, ashy fine sandy loam, ashy sandy loam, or ashy loam.

Structure: Granular, subangular blocky, or massive.

Content of rock fragments: 10 to 30 percent.

B horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Ashy very fine sandy loam, ashy fine sandy loam, ashy sandy loam, or ashy loam.

Structure: Platy or massive.

Content of rock fragments: 10 to 25 percent.

C horizon

Hue: 5YR, 7.5YR, 10YR, or N.

Value: 2 to 3 moist.

Chroma: 0 to 4 moist.

Texture in the fine-earth fraction: Ashy coarse sand, ashy sand, ashy fine sand, ashy fine loamy sand, ashy loamy sand, ashy very fine sandy loam, ashy fine sandy loam, ashy sandy loam, or ashy loam.

Structure: Massive, platy, or single grain.

Content of rock fragments: 0 to 85 percent.

Kahaluu Series

The Kahaluu series consists of very shallow, well drained soils that formed in organic material overlying pahoehoe lava. These soils are on high elevation, windward slopes on the Mauna Loa and Kilauea Volcanoes. Slopes range from 2 to 10 percent. The mean annual rainfall is about 3,048 millimeters (120 inches), and the mean annual air temperature is about 14 degrees C (57 degrees F).

Taxonomic classification: Euic, isomesic Lithic Udifolists.

Typical pedon

Kahaluu highly decomposed plant material, under an ohia lehua/fern forest, on a slope of 3 percent, at an elevation of 1,463 meters (4,800 feet). (Colors are for moist soil unless otherwise noted. When described on March 19, 2003, the soil was moist throughout. All textures are "apparent field textures." pH was measured using organic dyes.) Island of Hawaii; from Hilo, follow State Highway 11 to the village of Mountain View, turn right (north) on North Kulani Road and proceed to a dead end at Stainback Highway, turn left (west) on Stainback Highway and proceed approximately 11 miles to the Kulani correctional facility boundary fence; follow the fence line south 0.25 mile, turn due west and proceed 150 feet; Kulani Quadrangle; lat. 19 degrees 33 minutes 15.3 seconds N. and long. 155 degrees 17 minutes 20.1 seconds W. (Old Hawaiian datum, 12 feet; measured by Garmin GPS.)

Oa—0 to 19 centimeters (0 to 8 inches); very dark brown (10YR 2/2) highly decomposed plant material, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine roots; common fine tubular pores; very strongly acid (pH 4.8); abrupt smooth boundary. (5 to 51 centimeters [2 to 20 inches] thick.)

2R—19 centimeters (8 inches); pahoehoe lava.

Range in characteristics

Depth to pahoehoe lava: 5 to 51 centimeters (2 to 20 inches).

Content of rock fragments: 0 to 25 percent in the control section.

Soil reaction: Very strongly acid to moderately acid

Soil moisture: The soils are typically moist throughout.

Precipitation: Exceeds evapotranspiration in all months of normal years.

Oa horizon

Texture: Highly decomposed plant material or cobbly highly decomposed plant material

Chroma: 1 or 2

Kaholimo Series

The Kaholimo series consists of very shallow and shallow, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,499 millimeters (59 inches), and the mean annual air temperature is about 12 degrees C (54 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Lithic Hapludands.

Typical pedon

Kaholimo soil in an area of Lava flows-Kaholimo-Puiwa complex, 2 to 15 percent slopes, under scattered ohia trees, shrubs, and grasses; located in Hawaii Volcanoes National Park; from State Highway 11, drive to north end of Mauna Loa Strip Road; from picnic shelter, walk downhill on a heading of 130 degrees magnetic for about 5 minutes to a rock wall; cross the rock wall and walk along south side to two small fenced enclosures; from the southeast corner of lowest enclosure, walk on a heading of 340 degrees magnetic for about 27 meters (90 feet); type location is near the south side of the rock wall; Kipuka Pakekake Quadrangle; lat. 19 degrees 29 minutes 41.6 seconds N. and long. 155 degrees 23 minutes 10.9 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 250 feet.)

A1—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) medial silt loam; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine and fine interstitial pores; strongly acid (pH 5.4); abrupt wavy boundary. (0 to 10 centimeters [0 to 4 inches] thick.)

A2—5 to 10 centimeters (2 to 4 inches); black (10YR 2/1) medial silt loam; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.6); clear wavy boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)

Bw1—10 to 18 centimeters (4 to 7 inches); 1- to 2-centimeter (0.5-inch) bands of black (10YR 2/1) medial loam alternating with 2-centimeter (1-inch) bands of very dark brown (7.5YR 2.5/2) medial loam; weak coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; few flecks of charcoal at the top of the horizon; slightly acid (pH 6.2); clear wavy boundary.

Bw2—18 to 25 centimeters (7 to 10 inches); 1- to 2-centimeter (0.5-inch) bands of black (10YR 2/1) medial loam alternating with 2-centimeter (1-inch) bands of very dark brown (7.5YR 2.5/2) medial loam; massive; soft, very friable, nonsticky and

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nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); clear wavy boundary.

Bw3—25 to 30 centimeters (10 to 12 inches); dark brown (7.5YR 3/3) medial loam; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); abrupt wavy boundary. (Combined thickness of the Bw horizons ranging from 10 to 30 centimeters [4 to 12 inches].)

2A—30 to 33 centimeters (12 to 13 inches); black (10YR 2/1) medial loam; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)

3R—33 centimeters (13 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 2 to 20 inches.

Mean annual soil temperature: 12 to 14 degrees C (54 to 57 degrees F).

Soil reaction: Strongly acid to slightly acid.

A horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial loam, medial silt loam, or cobbly medial loam.

Structure: Granular or subangular blocky.

Bw horizon

Hue: 2.5YR to 10YR.

Value: 2 to 6 moist.

Chroma: 1 to 6 moist.

Texture: Medial fine sandy loam, medial loam, or medial silt loam.

Structure: Subangular blocky or massive.

Kalapana Series

The Kalapana series consists of very shallow and shallow, well drained soils that formed in basic ash deposited over basic pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is 2,160 millimeters (85 inches), and the mean annual air temperature is 19 degrees C (66 degrees F).

Taxonomic classification: Medial, ferrihydritic, isothermic Lithic Udivitrands.

Typical pedon

Kalapana medial coarse sandy loam, 2 to 10 percent slopes, under uluhe (false staghorn fern) and firetree; located in Hawaii Volcanoes National Park; drive on Chain of Craters Road to the Kealakomo picnic shelter parking lot; take Naulu Trail upslope for 2 miles to its intersection with Kalapana Trail; take Kalapana Trail for approximately 200 meters (650 feet) to type location, on the north side of the trail; Makaopuhi Crater Quadrangle; lat. 19 degrees 20 minutes 45.16 seconds N. and long. 155 degrees 9 minutes 48.63 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 58 feet.)

A—0 to 15 centimeters (0 to 6 inches); very dark brown (10YR 2/2) medial coarse sandy loam; strong fine and medium granular structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; 5 percent angular pahoehoe gravel; strongly acid (pH 5.5); abrupt wavy boundary. (3 to 25 centimeters [1 to 10 inches] thick.)

- C—15 to 18 centimeters (6 to 7 inches); very dark brown (10YR 2/2), dark reddish brown (5YR 2/2), very dusky red (2.5YR 2/2), and black (N 2/0) medial sand; single grain; loose dry and moist, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; abrupt wavy boundary. (0 to 3 centimeters [0 to 1 inch] thick.)
- 2R—18 centimeters (7 inches); hard pahoehoe bedrock.

Range in characteristics

Mean annual soil temperature: 18 to 21 degrees C (64 to 70 degrees F).

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

A horizon

Hue: 7.5YR or 10YR.

Chroma: 1 or 2.

Texture: Medial coarse sandy loam to medial loam.

Content of rock fragments: 0 to 15 percent gravel.

C horizon

Texture: Medial sand to medial loam.

Structure: Massive, single grain, or subangular blocky.

Content of rock fragments: 0 to 15 percent gravel.

Kali Series

The Kali series consists of very shallow, well drained soils that formed in organic material mixed with minor amounts of basic volcanic ash. These soils are underlain by pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,020 millimeters (40 inches), and the mean annual air temperature is about 20 degrees C (68 degrees F).

Taxonomic classification: Euic, isothermic, micro Lithic Ustifolists.

Typical pedon

Kali soil in area of Kali-Lava flows complex, 10 to 20 percent slopes, under forest vegetation, at an elevation of 550 meters (1,805 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on March 27, 1997, the soil was moist to a depth of 5 centimeters [2 inches] and dry below that depth.) Island of Hawaii, Hawaii County, Hawaii; from State Highway 11, at Papa Homesteads in South Kona, drive east for 305 meters (1,000 feet) to the second bend in the road; enter the forest at telephone pole 6 and walk west-northwest (300 degrees) for 91 meters (300 feet) along a rock wall; pedon is located 55 meters (180 feet) to the north-northeast (30 degrees); Papa Quadrangle; lat. 19 degrees 13 minutes 0.0 seconds N. and long. 155 degrees 52 minutes 17.8 seconds W. (GPS PLGR; old Hawaiian datum.)

- Oa—0 to 13 centimeters (0 to 5 inches); black (10YR 2/1) cobbly highly decomposed plant material, dark brown (7.5YR 3/2) dry; strong very fine and fine granular structure; hard, friable, nonsticky and nonplastic; many very fine to medium and few coarse roots; many very fine and fine interstitial pores; 10 percent subangular gravel and 20 percent subangular cobbles; slightly acid (pH 6.4); abrupt wavy boundary. (5 to 25 centimeters [2 to 10 inches] thick.)
- 2R—13 centimeters (5 inches); hard, massive pahoehoe lava; class 2 (10-45 cm) joint fractures.

Range in characteristics

Depth to bedrock: 5 to 25 centimeters (2 to 10 inches).

Mean annual soil temperature: 19 to 22 degrees C (67 to 72 degrees F).

Content of rock fragments: 15 to 65 percent, by volume; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

Content of organic carbon (by weight): 25 to 30 percent in the soil material less than 2.0 millimeters in size.

Oa horizon

Hue: N, 7.5YR, or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 0 to 2 moist and dry.

Texture: Cobbly or very cobbly highly decomposed plant material.

Kamaoa Series

The Kamaoa series consists of very deep, well drained soils that formed in basic volcanic ash. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 20 degrees C (68 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Humic Haplustands.

Typical pedon

Kamaoa medial loam, on a south-facing slope of 10 percent, in a pasture, at an elevation of 579 meters (1,900 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii County, Hawaii; about 0.4 mile south of Kahuku Ranch office; Kahuku Ranch Quadrangle; lat. 19 degrees 3 minutes 5 seconds N. and long. 155 degrees 41 minutes 35 seconds W. (Old Hawaiian datum.)

A—0 to 18 centimeters (0 to 7 inches); dark brown (7.5YR 3/2) medial loam, brown (10YR 5/3) dry; strong medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine irregular pores; moderately acid (pH 5.7); abrupt wavy boundary. (15 to 23 centimeters [6 to 9 inches] thick.)

BA—18 to 53 centimeters (7 to 21 inches); dark reddish brown (5YR 3/4) medial loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many very fine tubular pores; neutral (pH 6.8); clear wavy boundary. (20 to 43 centimeters [8 to 17 inches] thick.)

Bw1—53 to 119 centimeters (21 to 47 inches); dark brown (7.5YR 3/3) medial silty clay loam, strong brown (7.5YR 5/8) dry; weak fine subangular blocky structure; hard, very friable, slightly sticky and moderately plastic; many fine roots; many very fine tubular pores; neutral (pH 6.9); abrupt smooth boundary.

Bw2—119 to 173 centimeters (47 to 68 inches); dark brown (7.5YR 3/3) medial silt loam, yellowish brown (10YR 5/8) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; many very fine and fine roots; many very fine and fine tubular pores; neutral (pH 7.3); abrupt wavy boundary. (Combined thickness of the Bw horizons ranging from 102 to 122 centimeters [40 to 48 inches].)

2R—173 centimeters (68 inches); hard, massive bedrock.

Range in characteristics

Depth to bedrock: Generally more than 152 centimeters (60 inches) but as shallow as 102 centimeters (40 inches) in some pedons.

Mean annual soil temperature: 19 to 22 degrees C (67 to 72 degrees F).

Content of rock fragments: 0 to 20 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist, 3 to 5 dry.

Chroma: 2 or 3 moist, 3 or 4 dry.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

BA horizon

Hue: 5YR or 7.5YR.

Value: 3 or 4 moist, 4 or 5 dry.

Chroma: 3 or 4 moist, 5 or 6 dry.

Texture: Medial silt loam or loam.

Plasticity: Slightly plastic or moderately plastic.

Soil reaction: Neutral or slightly alkaline (pH 6.6 to 7.8).

Bw horizons

Hue: 7.5YR or 10YR.

Value: 3 or 4 moist, 4 or 5 dry.

Chroma: 3 or 4 moist, 6 to 8 dry.

Texture: Medial silt loam or loam.

Plasticity: Slightly plastic or moderately plastic.

Soil reaction: Neutral or slightly alkaline (pH 6.6 to 7.8).

Kanohina Series

The Kanohina series consists of shallow and very shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 760 millimeters (30 inches), and the mean annual air temperature is about 23 degrees C (73 degrees F).

Taxonomic classification: Ashy, amorphic, isohyperthermic Lithic Ustivitrands.

Typical pedon

Kanohina ashy very fine sandy loam, on a west-facing, slightly concave slope of 5 percent, under grasses, at an elevation of 219 meters (720 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on October 17, 1991, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; 3.1 miles south of Highway 11, on Kona Garden Drive, 9 meters (30 feet) west of the road; Pohue Bay Quadrangle; lat. 19 degrees 3 minutes 15 seconds N. and long. 155 degrees 49 minutes 2 seconds W. (Old Hawaiian datum.)

A—0 to 3 centimeters (0 to 1 inch); very dark brown (10YR 2/2) ashy very fine sandy loam; moderate very fine and fine granular structure; friable, nonsticky and nonplastic; many very fine roots; many very fine irregular and tubular pores; slightly acid (pH 6.5); abrupt smooth boundary. (2 to 8 centimeters [1 to 3 inches] thick.)

Bw—3 to 8 centimeters (1 to 3 inches); very dark brown (10YR 2/2) ashy sandy loam; moderate very fine and fine subangular blocky structure; friable, nonsticky and nonplastic; few very fine roots; many very fine irregular and tubular pores; neutral (pH 7.0); abrupt smooth boundary. (0 to 8 centimeters [0 to 3 inches] thick.)

C—8 to 15 centimeters (3 to 6 inches); very dark grayish brown (10YR 3/2) ashy loamy sand; single grain; friable, nonsticky and nonplastic; few very fine roots;

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many very fine pores; neutral (pH 7.0); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
2R—15 centimeters (6 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 23 to 26 degrees C (74 to 78 degrees F).

Content of rock fragments: 0 to 30 percent, by volume; ranging in size from gravel- to cobble-size lava rocks.

Soil reaction: Extremely acid to neutral (pH 4.0 to 7.3).

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 2 or 3 moist and dry.

Texture: Ashy loam, very fine sandy loam, or fine sandy loam.

Structure: Granular, subangular blocky, or platy.

B horizon (where present)

Value: 2 to 4 moist and dry.

Chroma: 2 or 3 moist and dry.

Texture: Ashy loam, very fine sandy loam, or fine sandy loam.

C horizon

Value: 2 to 4 moist and dry.

Chroma: 2 or 3 moist and dry.

Texture: Ashy loam, loamy sand, or very gravelly or gravelly loamy sand.

Kapapala Series

The Kapapala series consists of deep, well drained soils that formed in basic volcanic ash deposited over pahoehoe lava. These soils are on uplands. Slopes range from 2 to 40 percent. The mean annual rainfall is about 1,524 millimeters (60 inches), and the mean annual air temperature is about 15 degrees C (59 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Typic Haplustands.

Typical pedon

Kapapala medial loam, on a southeast-facing slope of 2 percent, in an upland pasture, at an elevation of 1,185 meters (3,880 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured using an Oakton microprocessor based pH meter, 1:1 soil to water ratio. When described on October 5, 2005, the soil was moist from a depth of 0 to 110 centimeters [0 to 43 inches].) Island of Hawaii; from the entrance to Volcanoes National Park, follow State Highway 11 to the west about 11 miles to Ainahou Trail and the entrance to Kapapala ranch; proceed through the gate and follow a ranch road to the northeast; at approximately 0.5 mile, the road forks; continue northeast, following the power line, approximately 0.9 mile to the type location; Kilauea Quadrangle; lat. 19 degrees 23 minutes 55.8 seconds N. and long. 155 degrees 22 minutes 18.5 seconds W. (Old Hawaiian datum, 12 feet; measured by Garmin GPS.)

A—0 to 7 centimeters (0 to 3 inches); black (10YR2/1) medial loam, very dark grayish brown (10YR 3/2) dry; weak medium granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine roots; common very fine vesicular pores; slightly acid (pH 6.3); abrupt smooth boundary. (5 to 11 centimeters [2 to 4 inches] thick.)

- Bw—7 to 23 centimeters (3 to 9 inches); very dark brown (10YR 2/2) medial sandy loam, brown (10YR 4/3) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; common very fine vesicular pores; slightly acid (pH 6.3); abrupt smooth boundary. (13 to 19 centimeters [5 to 8 inches] thick.)
- 2C—23 to 33 centimeters (9 to 13 inches); black (7.5YR 2.5/1) ashy coarse sand, very dark gray (7.5YR3/1) dry; single grain; loose, nonsticky and nonplastic; nonsmeary; few fine roots; few very fine irregular pores; slightly acid (pH 6.3); abrupt smooth boundary. (5 to 14 centimeters [2 to 6 inches] thick.)
- 3Bw1—33 to 54 centimeters (13 to 21 inches); very dark brown (10YR 2/2) medial loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; few fine irregular pores; neutral (pH 7.3); abrupt smooth boundary. (7 to 21 centimeters [3 to 9 inches] thick.)
- 3Bw2—54 to 74 centimeters (21 to 29 inches); very dark brown (10YR 2/2) medial sandy loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; few very fine tubular pores; 2 percent subrounded paragravel and 2 percent subangular charcoal; neutral (pH 7.2); abrupt smooth boundary. (18 to 37 centimeters [7 to 15 inches] thick.)
- 3Bw3—74 to 110 centimeters (29 to 43 inches); very dark brown (10YR 2/2) medial loam, dark brown (10YR 3/3) dry; moderate coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; 2 percent subrounded paragravel; neutral (pH 7.3). (10 to 16 inches thick.)
- 3R—110 centimeters (43 inches); pahoehoe lava.

Range in characteristics

Depth to bedrock: 100 to 145 centimeters (40 to 57 inches).

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

Content of rock fragments: 0 to 5 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Texture: Highly organic medial loam or medial loam.

Bw horizons

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 or 2 moist.

Texture: Medial loam, medial silt loam, medial sandy loam, or cindery silt loam.

C horizon (where present)

Hue: 7.5YR or 10YR.

Value: 2 to 3.

Texture: Ashy fine sand or ashy coarse sand.

Kapua Series

The Kapua series consists of deep, somewhat excessively drained soils that formed in organic material mixed with minor amounts of basic volcanic ash. These soils are in areas of aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 889 millimeters (35 inches), and the mean annual air temperature is about 19 degrees C (67 degrees F).

Taxonomic classification: Euic, isothermic Typic Ustifolists.

Typical pedon

Kapua very cobbly highly decomposed plant material, on a west-facing, slightly concave slope of 9 percent, under forest vegetation, at an elevation of 427 meters (1,400 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with electrode in 1:1 water. When described on December 9, 1992, the soil was slightly moist.) Island of Hawaii, Hawaii County, Hawaii; about 2.5 miles north of Mac Farms of Hawaii headquarters and 31 meters (100 feet) west of Highway 11; Papa Quadrangle; lat. 19 degrees 10 minutes 50 seconds N. and long. 155 degrees 51 minutes 59 seconds W. (Old Hawaiian datum.)

Oa1/2C1—0 to 15 centimeters (0 to 6 inches); black (10YR 2/1) very cobbly highly decomposed plant material, very dark brown (10YR 2/2) dry; strong very fine and fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine and fine and few medium roots; common very fine irregular pores; hydrophobic when dry; 30 percent angular gravel and 20 percent angular cobbles; slightly acid (pH 6.1); clear wavy boundary. (10 to 20 centimeters [4 to 8 inches] thick.)

2C2/Oa2—15 to 46 centimeters (6 to 18 inches); very dark brown (10YR 2/2) extremely gravelly highly decomposed plant material, very dark grayish brown (10YR 3/2) dry; moderate very fine and fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine and fine roots; common very fine irregular pores; slightly hydrophobic when dry; 50 percent angular gravel and 20 percent angular cobbles; neutral (pH 6.6); gradual wavy boundary. (20 to 31 centimeters [8 to 12 inches] thick.)

2C3—46 to 152 centimeters (18 to 60 inches); fragmental aa lava with very little soil material in voids.

Range in characteristics

Depth to bedrock: 102 to 152 centimeters (40 to 60 inches).

Mean annual soil temperature: 18 to 22 degrees C (65 to 72 degrees F).

Content of rock fragments: 35 to 85 percent, by volume; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

Content of organic carbon (by weight): 25 to 30 percent in the soil material less than 2.0 millimeters in size.

Oa1/2C1 and 2C2/Oa2 horizons

Hue: 5YR to 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Very cobbly or extremely cobbly highly decomposed plant material or moderately decomposed plant material.

Soil reaction: Slightly acid or neutral (pH 6.1 to 7.3).

Kapulehu Series

The Kapulehu series consists of moderately deep, well drained soils that formed in basic volcanic ash in aa lava. Slopes range from 2 to 40 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 21 degrees C (69 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isothermic Humic Haplustands.

Typical pedon

Kapulehu very cobbly medial silt loam, on a south-facing, convex slope of 6 percent, at an elevation of 415 meters (1,360 feet). (Colors are for dry soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on January 6, 1999, the soil was dry throughout.) Island of Hawaii, Hawaii County, Hawaii; from Kamaoa Road, enter Discovery Harbour subdivision at the eastern entrance, take the first right, then the next left; pedon is located 3 meters (10 feet) to the west of the end of a cul-de-sac; Kahuku Ranch Quadrangle; lat. 19 degrees 2 minutes 13.8 seconds N. and long. 155 degrees 38 minutes 22.7 seconds W. (Old Hawaiian datum.)

A/2C1—0 to 25 centimeters (0 to 10 inches); very dark grayish brown (10YR 3/2) very cobbly medial silt loam, black (10YR 2/1) moist; strong fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; few medium and common very fine and fine roots; many fine interstitial pores; hydrophobic when dry; 20 percent subangular gravel and 35 percent angular cobbles; slightly acid (pH 6.2); diffuse wavy boundary. (13 to 25 centimeters [5 to 10 inches] thick.)

2C2/Bw—25 to 66 centimeters (10 to 26 inches); very dark brown (7.5YR 2/3) extremely cobbly medial loam, black (5YR 2/1) moist; moderate very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine interstitial pores; hydrophobic when dry; 15 percent subangular gravel and 60 percent angular cobbles; slightly acid (pH 6.4); abrupt wavy boundary. (40 to 76 centimeters [15 to 30 inches] thick.)

2R—66 centimeters (26 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 21 to 22 degrees C (69 to 72 degrees F).

Content of rock fragments: 35 to 65 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

A/2C1 horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist, 2 or 3 dry.

Texture: Very or extremely cobbly or gravelly medial silt loam, sandy loam, or loam.

Structure: Granular or subangular blocky.

Soil reaction: Slightly acid or neutral (pH 6.1 to 7.3).

2C2/Bw horizon

Hue: 5YR, 7.5YR, or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist, 2 or 3 dry.

Texture: Extremely gravelly or cobbly medial silt loam, sandy loam, or loam.

Keaa Series

The Keaa series consists of shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 40 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 20 degrees C (68 degrees F).

Taxonomic classification: Medial-skeletal, amorphous, isothermic Lithic Haplustands.

Typical pedon

Keaa cobbly medial loam, on a south-facing slope of 15 percent, under forest vegetation, at an elevation of 354 meters (1,160 feet). (Colors are for dry soil unless otherwise noted. All textures are "apparent field textures." pH measured with electrode in 1:1 water. When described on January 7, 1999, the soil was dry throughout.) Island of Hawaii, Hawaii County, Hawaii; from Waiohinu town, drive south on Kamaoa Road for 0.9 mile; pedon is located 15 meters (50 feet) uphill from the road; Naalehu Quadrangle; lat. 19 degrees 03 minutes 41.5 seconds N. and long. 155 degrees 37 minutes 25.5 seconds W. (GPS PLGR; old Hawaiian datum.)

A—0 to 10 centimeters (0 to 4 inches); very dark grayish brown (10YR 3/2) cobbly medial loam, black (10YR 2/1) moist; strong very fine and fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 10 percent gravel and 15 percent cobbles; moderately acid (pH 5.8); abrupt smooth boundary. (8 to 13 centimeters [3 to 5 inches] thick.)

Bw1/2C1—10 to 25 centimeters (4 to 10 inches); dark yellowish brown (7.5YR 3/4) very cobbly medial very fine sandy loam, very dark grayish brown (7.5YR 3/2) moist; moderate very fine and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; 20 percent gravel and 25 percent cobbles; moderately acid (pH 6.0); clear wavy boundary. (13 to 18 centimeters [5 to 7 inches] thick.)

Bw2/2C2—25 to 46 centimeters (10 to 18 inches); dark yellowish brown (7.5YR 3/4) very cobbly medial very fine sandy loam, very dark grayish brown (7.5YR 3/2) moist; weak very fine and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; 10 percent gravel and 40 percent cobbles; slightly acid (pH 6.4); abrupt wavy boundary. (18 to 23 centimeters [7 to 9 inches] thick.)

2R—46 centimeters (18 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 25 to 50 centimeters (10 to 20 inches).

Mean annual soil temperature: 19 to 22 degrees C (67 to 72 degrees F).

Content of rock fragments: 35 to 60 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Cobbly or gravelly medial loam or silt loam.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Bw/2C horizon

Chroma: 2 to 4 moist and dry.

Texture: Very cobbly medial very fine sandy loam, loam, or silt loam.

Kealoha Series

The Kealoha series consists of deep, well drained soils that formed in basic volcanic ash over aa lava. Slopes range from 2 to 50 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Pachic Haplustands.

Typical pedon

Kealoha very gravelly medial silt loam, 10 to 20 percent slopes, in a pasture, at an elevation of 1,405 meters (4,610 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on July 23, 1997, the soil was moist to a depth of 26 inches and dry below that depth.) Island of Hawaii, Hawaii County, Hawaii; on Kealia Ranch, at Big Hill Camp, turn left at the first gate and drive north through two gates for 1.0 mile; pedon is located 15 meters (50 feet) downslope from 4WD road; Kaunene Quadrangle; lat. 19 degrees 24 minutes 54.9 seconds N. and long. 155 degrees 50 minutes 8.5 seconds W. (GPS PLGR; old Hawaiian datum.)

- A/2C1—0 to 13 centimeters (0 to 5 inches); black (5YR 2/1) very gravelly medial silt loam; moderate fine subangular blocky structure; friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 30 percent subangular gravel and 5 percent angular cobbles; strongly acid (pH 5.4); abrupt wavy boundary. (10 to 15 centimeters [4 to 6 inches] thick.)
- Bw1/2C2—13 to 33 centimeters (5 to 13 inches); dark brown (7.5YR 3/2) very gravelly medial loam; moderate fine subangular blocky structure; friable, nonsticky and nonplastic; many very fine and fine roots; many very fine interstitial pores; 50 percent subangular gravel and 5 percent angular cobbles; moderately acid (pH 5.8); abrupt wavy boundary. (20 to 33 centimeters [8 to 13 inches] thick.)
- Bw2/2C3—33 to 41 centimeters (13 to 16 inches); black (N 2/0) very gravelly medial loam; moderate fine subangular blocky structure; friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine interstitial pores; 45 percent subangular gravel and 5 percent angular cobbles; moderately acid (pH 6.0); abrupt broken boundary. (0 to 15 centimeters [0 to 6 inches] thick.)
- 2C4/Bw3—41 to 66 centimeters (16 to 26 inches); dark reddish brown (5YR 3/2) extremely gravelly medial loam; weak very fine subangular blocky structure; friable, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 55 percent subangular gravel, 15 percent angular cobbles, and 5 percent angular stones; moderately acid (pH 6.0); clear wavy boundary. (8 to 25 centimeters [3 to 10 inches] thick.)
- 2C5—66 to 76 centimeters (26 to 30 inches); lithochromic very dusky red (2.5YR 2/2) extremely gravelly sand; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; many very fine interstitial pores; 55 percent subangular gravel, 15 percent angular cobbles, and 5 percent angular stones; slightly acid (pH 6.2); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 2C6—76 to 127 centimeters (30 to 50 inches); lithochromic very dusky red (2.5YR 2/2) extremely gravelly sand; single grain; loose, nonsticky and nonplastic; few very fine and fine and few medium roots; many very fine interstitial pores; 55 percent subangular gravel, 15 percent angular cobbles, and 5 percent angular stones; slightly acid (pH 6.2).

Range in characteristics

Depth to bedrock: 102 to 152 centimeters (40 to 60 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 35 to 65 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones.

A/2C1 horizon

Hue: 5YR or N.

Value: 2 or 2.5 moist, 2 or 3 dry.

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Chroma: 0 or 1 moist, 1 or 2 dry.

Texture: Cobbly, very cobbly, or very gravelly medial silt loam or silty clay loam.

Structure: Weak or moderate granular or subangular blocky.

Soil reaction: Strongly acid or moderately acid (pH 5.1 to 6.0) in the A part of the horizon.

Bw/2C horizon

Hue: N, 5YR, or 7.5YR.

Value: 2 to 3 moist and dry.

Chroma: 2 to 4 moist and dry.

Texture: Very gravelly, extremely gravelly, or very cobbly medial silt loam, loam, or loamy sand.

Structure: Weak or moderate subangular blocky.

Soil reaction: Moderately acid to neutral (pH 5.6 to 7.3) in the Bw part of the horizon.

2C horizon

Hue: 2.5YR or 5YR.

Texture: Very gravelly or extremely gravelly medial loamy sand or sand.

Structure: Massive or single grain.

Soil reaction: Moderately acid to neutral (pH 5.6 to 7.3).

Keamoku Series

The Keamoku series consists of deep, well drained soils that formed in basic volcanic ash deposited over basic aa lava (fig. 19). Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,400 millimeters (55 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Typic Hapludands.

Typical pedon

Keamoku soil in an area of Haa-Keamoku complex, 2 to 10 percent slopes, under koa trees and a grass understory; located in Hawaii Volcanoes National Park; from State Highway 11, turn north onto Mauna Loa Strip Road; travel for 2.15 miles and park at pullout; walk to cattle crossing guard; from south side of cattle guard, follow fence south for 20 fenceposts; walk on a heading of 100 degrees magnetic for 24 meters (77 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 26 minutes 42.18 seconds N. and long. 155 degrees 19 minutes 42.54 seconds W. (Location measured by GPS PLGR using old Hawaiian datum +/- 55 feet.)

A1—0 to 8 centimeters (0 to 3 inches); black (10YR 2/1) medial silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine to medium roots; many very fine and fine interstitial pores; strongly acid (pH 5.2); clear wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)

A2—8 to 25 centimeters (3 to 10 inches); black (10YR 2/1) medial silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine to coarse roots; many very fine and fine interstitial pores; moderately acid (pH 5.8); abrupt wavy boundary. (0 to 20 centimeters [0 to 8 inches] thick.)

Bw1—25 to 36 centimeters (10 to 14 inches); very dark brown (7.5YR 2.5/2) medial loam, dark brown (7.5YR 3/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine to medium roots; many very fine and fine interstitial pores; 10 percent subangular aa gravel;



Figure 19.—Profile of Keamoku soils.

moderately acid (pH 6.0); clear wavy boundary. (0 to 13 centimeters [0 to 5 inches] thick.)

Bw2/3C1—36 to 53 centimeters (14 to 21 inches); 90 percent very dark brown (7.5YR 2.5/2) and 10 percent reddish brown (5YR 4/4) very gravelly medial loam, yellowish red (5YR 4/6) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine to medium roots; many very fine and fine interstitial pores; 5 percent subangular aa cobbles and 45

percent subangular aa gravel; slightly acid (pH 6.2); clear wavy boundary. (0 to 25 centimeters [0 to 10 inches] thick.)

3C2/2A—53 to 89 centimeters (21 to 35 inches); black (10YR 2/1) extremely cobbly medial loam, very dark grayish brown (10YR 3/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine to medium roots; many very fine and fine interstitial pores; 85 percent fragmental aa lava (25 percent stones, 55 percent cobbles, and 5 percent gravel); slightly acid (pH 6.2); clear wavy boundary. (25 to 50 centimeters [10 to 20 inches] thick.)

3C3/2Bw1—89 to 127 centimeters (35 to 50 inches); very dark brown (7.5YR 2.5/2) extremely cobbly medial loam, dark brown (7.5YR 3/2) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine to medium roots; many very fine and fine interstitial pores; 85 percent fragmental aa lava (25 percent stones, 55 percent cobbles, and 5 percent gravel); slightly acid (pH 6.4); abrupt wavy boundary. (25 to 102 centimeters [10 to 40 inches] thick.)

3C4/2Bw2—127 to 152 centimeters (50 to 60 inches); 90 percent dark reddish brown (5YR 2.5/2) and 10 percent reddish brown (5YR 4/4) extremely cobbly medial loam, 80 percent brown (7.5YR 4/4) and 20 percent yellowish red (5YR 4/6) dry; massive; soft, very friable, slightly sticky and slightly plastic; few very fine to medium roots; many very fine and fine interstitial pores; 95 percent fragmental aa lava (10 percent stones, 80 percent cobbles, and 5 percent gravel); slightly acid (pH 6.4). (25 to 50 centimeters [10 to 20 inches] thick.)

Range in characteristics

Mean annual soil temperature: 10 to 15 degrees C (50 to 59 degrees F).

Rock fragments: Occurring below a depth of 10 to 50 centimeters (4 to 20 inches).

Soil reaction: Strongly acid to slightly acid.

A horizon

Hue: 7.5YR or 10YR.

Texture: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 2 to 6 moist.

Texture in the fine-earth fraction: Dominantly medial but may be ashy loam or ashy silt loam.

Structure: Subangular blocky or massive.

Content of rock fragments: 10 to 50 percent; averages more than 35 percent where mixed with the C horizon.

C horizon

Texture in the fine-earth fraction: Coarse sand or sand derived from aa lava.

Structure: Massive or single grain.

Content of rock fragments: 50 to 85 percent; derived from aa lava.

Kekake Series

The Kekake series consists of very shallow, moderately well drained soils that formed in organic material mixed with minor amounts of basic volcanic ash. These soils are underlain by pahoehoe lava. Slopes range from 2 to 25 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Euic, isomesic, micro Lithic Ustifolists.

Typical pedon

Kekake gravelly highly decomposed plant material, on a west-facing, slightly concave slope of 14 percent, in a pasture, at an elevation of 1,417 meters (4,650 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on July 23, 1997, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; on Kealia Ranch, drive 0.1 mile north from the first left gate at Big Hill Camp; site is 6 meters (20 feet) south from the next fence line and 15 meters (50 feet) mauka (upslope) of 4WD road; Kaunene Quadrangle; lat. 19 degrees 24 minutes 8.9 seconds N. and long. 155 degrees 48 minutes 52.5 seconds W. (GPS PLGR; old Hawaiian datum.)

Oa—0 to 13 centimeters (0 to 5 inches); black (5YR 2.5/1) gravelly highly decomposed plant material; strong fine granular structure; friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine pores; 15 percent gravel and 7 percent cobbles; strongly acid (pH 5.4); abrupt wavy boundary.

2R—13 centimeters (5 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 25 centimeters (2 to 10 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 5 to 35 percent, by volume, gravel and cobbles.

Content of organic carbon (by weight): 25 to 30 percent in the soil material less than 2.0 millimeters in size.

Oa horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Cobbly or gravelly highly decomposed plant material.

Soil reaction: Very strongly acid or strongly acid (pH 4.5 to 5.5).

Ki Series

The Ki series consists of very deep, well drained soils that formed in basic volcanic ash. Slopes range from 3 to 20 percent. The mean annual rainfall is about 1,550 millimeters (61 inches), and the mean annual air temperature is about 15 degrees C (59 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Eutric Thaptic Hapludands.

Typical pedon

Ki medial loam, 3 to 10 percent slopes, under grasses and ferns; located in Hawaii Volcanoes National Park; from State Highway 11, travel Mauna Loa Strip Road 2.3 miles; turn north (right) and follow 4WD road 0.05 mile; take a heading of 94 degrees magnetic for 24 feet to type location; Kilauea Crater Quadrangle; lat. 19 degrees 26 minutes 39.57 seconds N. and long. 155 degrees 18 minutes 41.03 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 250 feet.)

A—0 to 6 centimeters (0 to 2 inches); black (10YR 2/1) medial loam, very dark grayish brown (10YR 3/2) dry; strong fine, medium, and coarse granular structure; soft and moderately hard, friable, nonsticky and nonplastic; many very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; 2 percent strands of Pele's hair; moderately acid (pH 5.8); abrupt wavy boundary. (6 to 15 centimeters [2 to 6 inches] thick.)

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- Bw—6 to 10 centimeters (2 to 4 inches); very dark grayish brown (10YR 3/2) medial loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 25 percent round, very dark grayish brown (10YR 3/2), soft to hard accretionary lapilli 0.25 to 0.75 centimeter in diameter; slightly acid (pH 6.4); clear wavy boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- C1—10 to 13 centimeters (4 to 5 inches); lithochromic black (N 2/0) ashy very fine sandy loam, black (10YR 2/1) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 5 percent strands of Pele's hair; neutral (pH 6.6); abrupt wavy boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- C2—13 to 16 centimeters (5 to 6 inches); lithochromic 70 percent brown (7.5YR 5/3) and 30 percent black (10YR 2/1) gravelly ashy coarse sand, yellowish brown (10YR 5/4) and dark grayish brown (10YR 4/2) dry; single grain; loose when dry and moist, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 15 percent pumicelike gravel; neutral (pH 6.6); clear wavy boundary. (3 to 5 centimeters [1 to 2 inches] thick.)
- 2A1—16 to 23 centimeters (6 to 9 inches); very dark brown (10YR 2/2) and brown (7.5YR 4/4) very gravelly ashy very fine sandy loam; massive with 10 percent moderate medium platy structure; slightly hard, friable, nonsticky and nonplastic; in the part with platy structure, moderately hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 40 percent subrounded basaltic gravel; neutral (pH 6.7); diffuse wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 2A2—23 to 32 centimeters (9 to 13 inches); black (7.5YR 2.5/1) gravelly ashy fine sandy loam, dark brown (7.5YR 3/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 30 percent subrounded basaltic gravel; neutral (pH 6.7); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 2Bw—32 to 39 centimeters (13 to 15 inches); very dark brown (7.5YR 2.5/3) very gravelly medial sandy loam, brown (7.5YR 4/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 45 percent subrounded basaltic gravel; neutral (pH 6.8); abrupt wavy boundary. (5 to 8 centimeters [2 to 3 inches] thick.)
- 3A—39 to 47 centimeters (15 to 19 inches); black (10YR 2/1) very gravelly medial sandy loam, very dark brown (7.5YR 2/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 45 percent subrounded basaltic gravel; neutral (pH 6.9); abrupt wavy boundary. (8 to 13 centimeters [3 to 5 inches] thick.)
- 3AB—47 to 58 centimeters (19 to 23 inches); very dark brown (10YR 2/2) medial loam, very dark grayish brown (10YR 3/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 10 percent subrounded basaltic gravel; neutral (pH 6.9); clear wavy boundary. (8 to 13 centimeters [3 to 5 inches] thick.)
- 3Bw1—58 to 67 centimeters (23 to 26 inches); very dark brown (7.5YR 2.5/2) medial loam, brown (7.5YR 4/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent subrounded basaltic gravel; neutral (pH 6.9); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 3Bw2—67 to 76 centimeters (26 to 30 inches); very dark brown (7.5YR 2.5/3) gravelly medial loam, brown (7.5YR 5/4) dry; massive; slightly hard, very friable,

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- nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 35 percent subrounded basaltic gravel; neutral (pH 6.9); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 3Bw3—76 to 82 centimeters (30 to 32 inches); black (7.5YR 2.5/1) medial silt loam, dark brown (7.5YR 3/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 2 percent subrounded basaltic gravel; neutral (pH 6.9); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 3Bw4—82 to 92 centimeters (32 to 36 inches); very dark brown (7.5YR 2.5/2) very gravelly medial loam, dark yellowish brown (10YR 3/4) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 45 percent subrounded basaltic gravel; neutral (pH 6.9); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 4Bw5—92 to 97 centimeters (36 to 38 inches); very dark brown (7.5YR 2.5/3) medial loam, strong brown (7.5YR 4/6) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 2 percent subrounded basaltic gravel; neutral (pH 7.0); clear wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)
- 4Bw6—97 to 105 centimeters (38 to 41 inches); very dark brown (7.5YR 2.5/2) very gravelly medial loamy sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 35 percent subrounded basaltic gravel; neutral (pH 7.0); abrupt wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)
- 4C—105 to 110 centimeters (41 to 43 inches); dark reddish brown (2.5YR 2.5/3) extremely gravelly medial fine sand and extremely gravelly medial sand; single grain; loose when dry and moist, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 70 percent subrounded pumice; neutral (pH 7.0); diffuse wavy boundary. (3 to 8 centimeters [1 to 3 inches] thick.)
- 5Bw1—110 to 121 centimeters (43 inches to 48 inches); very dark brown (7.5YR 2.5/2) gravelly medial loam; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 25 percent subrounded basaltic gravel; neutral (pH 7.1); clear wavy boundary. (5 to 15 centimeters [2 to 6 inches] thick.)
- 5Bw2—121 to 131 centimeters (48 to 52 inches); dark brown (10YR 3/3) very gravelly medial very fine sandy loam; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 40 percent subrounded basaltic gravel; neutral (pH 7.1); clear wavy boundary. (5 to 15 centimeters [2 to 6 inches] thick.)
- 5Bw3—131 to 152 centimeters (52 to 60 inches); dark brown (7.5YR 3/2) medial silt loam; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent subrounded basaltic gravel; neutral (pH 7.1). (10 to 40 centimeters [4 to 16 inches] thick.)

Range in characteristics

Depth to bedrock: 152 to 254 centimeters (60 to 100 inches) or more.

Mean annual soil temperature: 13 to 15 degrees C (56 to 59 degrees F).

Soil reaction: Strongly acid to neutral.

A horizon

Texture: Very fine sandy loam, sandy loam, loam, or silt loam; dominantly medial but may be ashy, especially the coarser textures.

B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture in the fine-earth fraction: Medial silt loam, medial loam, or medial sandy loam.

Structure: Granular, subangular blocky, or massive.

Soil reaction: Slightly acid or neutral.

Content of rock fragments: 0 to 45 percent; control section averages less than 35 percent.

C horizon

Hue: 7.5YR, 10YR, or N.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture in the fine-earth fraction: Ashy coarse sand to ashy very fine sandy loam.

Structure: Single grain or massive.

Soil reaction: Slightly acid or neutral.

Content of rock fragments: 0 to 40 percent.

Kilauea Series

The Kilauea series consists of deep and very deep, excessively drained soils that formed in basic pyroclastic material and reworked eolian and alluvial sediment over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,270 millimeters (50 inches), and the mean annual air temperature is about 16 degrees C (60 degrees F).

Taxonomic classification: Ashy, ferrihydritic, nonacid, isothermic Udic Ustorthents.

Typical pedon

Kilauea very gravelly ashy sand, 2 to 10 percent slopes, under sparse ohia trees and shrubs; located in Hawaii Volcanoes National Park; from the park headquarters, travel 4.1 miles south on Crater Rim Drive (past Volcano Observatory) to a road pullout; turn west onto gravel track and drive south and parallel to road for 0.1 mile; turn west, following road marked by cairns, and travel 0.2 mile; walk 4 meters (12 feet) south to crack; Kilauea Crater Quadrangle; lat. 19 degrees 24 minutes 11.99 seconds N. and long. 155 degrees 17 minutes 58.45 seconds W. (Position measured by GPS PLGR using old Hawaiian datum.)

Cm—0 to 1 centimeter (0 to 0.5 inch); cemented crust; reddish brown (5YR 4/2) very gravelly sandy loam, dark reddish gray (5YR 4/3) dry; 10 percent thin white coatings on the underside of the crust; 65 percent subrounded pyroclastic gravel; ultra acid (pH 3.1); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)

C1—1 to 8 centimeters (0.5 inch to 3 inches); black (10YR 2/1) very gravelly ashy sand, dark gray (10YR 4/1) dry; stratified; soft, loose, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 60 percent subrounded pyroclastic gravel; strongly acid (pH 5.4); abrupt wavy boundary.

C2—8 to 13 centimeters (3 to 5 inches); very dark grayish brown (10YR 3/2) ashy sandy loam, grayish brown (10YR 5/2) dry; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent subrounded pyroclastic gravel; neutral (pH 6.9); abrupt wavy boundary.

C3—13 to 18 centimeters (5 to 7 inches); black (10YR 2/1) very gravelly ashy sand, dark gray (10YR 4/1) dry; stratified; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial

- pores; 40 percent subrounded pyroclastic gravel; neutral (pH 6.9); abrupt wavy boundary.
- C4—18 to 25 centimeters (7 to 10 inches); dark brown (7.5YR 3/2) very gravelly ashy loamy sand, reddish gray (5YR 5/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots, matted at bottom of horizon; many very fine and fine interstitial pores; 40 percent subrounded pyroclastic gravel; neutral (pH 6.9); abrupt wavy boundary.
- C5—25 to 51 centimeters (10 to 20 inches); strata of very gravelly ashy coarse sand and very gravelly ashy loamy sand; 50 percent black (7.5YR 2/1) moist and grayish brown (10YR 5/2) dry and 50 percent very dark brown (10YR 2/2) moist and dark yellowish brown (10YR 4/4) dry; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 60 percent subrounded pyroclastic gravel; neutral (pH 7.2); abrupt wavy boundary.
- C6—51 to 58 centimeters (20 to 23 inches); black (10YR 2/1) gravelly ashy sand, gray (10YR 5/1) dry; massive; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 20 percent subrounded pyroclastic gravel; neutral (pH 7.2); abrupt wavy boundary.
- C7—58 to 96 centimeters (23 to 38 inches); very dark grayish brown (2.5Y 3/2) ashy very fine sand and ashy sand, dark grayish brown (2.5Y 4/2) dry; stratified; soft and slightly hard, loose, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; slightly alkaline (pH 7.5); abrupt wavy boundary. (2.5 to 63 centimeters [1 to 25 inches] thick.)
- C8—96 to 102 centimeters (38 to 40 inches); black (N 2/0) gravelly ashy sand, dark brown (10YR 3/3) dry; massive; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 20 percent subrounded pyroclastic gravel; slightly alkaline (pH 7.5); abrupt wavy boundary. (5 to 20 centimeters [2 to 8 inches] thick.)
- C9—102 to 142 centimeters (40 to 56 inches); very dark grayish brown (2.5Y 3/2) and olive brown (2.5Y 4/3) ashy very fine sand; massive; soft, loose, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; slightly alkaline (pH 7.5); abrupt wavy boundary. (38 to 102 centimeters [15 to 40 inches] thick.)
- C10—142 to 190 centimeters (56 to 75 inches); black (N 2/0) ashy coarse sand, gray (10YR 5/1) dry; platy and massive; soft, loose, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; few prominent patchy sulphur coatings on the lower surface of peds or pebbles; 10 percent subrounded pyroclastic gravel; slightly alkaline (pH 7.5).

Range in characteristics

Mean annual soil temperature: 17 or 18 degrees C (63 or 64 degrees F).

Surface crust: Covers 65 to 80 percent of the soil surface.

Depth to bedrock: 100 to 190 centimeters (40 to 75 inches) or more.

Soil reaction: Ultra acid to strongly acid in the upper 3 inches and slightly acid to slightly alkaline in the underlying layers.

C horizon

Texture in the fine-earth fraction: Ashy sandy loam to ashy coarse sand.

Structure: Platy, single grain, or massive.

Content of rock fragments: 15 to 40 percent in the upper 25 centimeters (10 inches); 20 to 35 percent in the control section.

Olivine crystals: Occurring in most pedons.

Sulphur coatings: Occurring in a few pedons.

Kilua Series

The Kilua series consists of deep and very deep, well drained soils that formed in organic material overlying aa lava. These soils are on slopes of the Mauna Loa Volcano. Slopes range from 3 to 10 percent. The mean annual rainfall is 3,050 millimeters (120 inches), and the mean annual air temperature is about 18 degrees C (65 degrees F).

Taxonomic classification: Euic, isothermic Typic Udifolists.

Typical pedon

Kilua extremely cobbly highly decomposed plant material, on a slope of 3 percent, under ohia lehua/guava forest, at an elevation of 572 meters (1,880 feet). (Colors are for moist soil unless otherwise noted. When described, the soil was moist throughout. All textures are "apparent field textures." pH was measured using organic dyes.) Hawaii County, Hawaii; from State Highway 11, turn southwest on Stainback Highway, proceed 4.5 miles, and park; proceed south of highway approximately 30 feet to type location; Puu Makaala Quadrangle; lat. 19 degrees 35 minutes 50 seconds N. and long. 155 degrees 08 minutes 49 seconds W.

2C1/Oa—0 to 25 centimeters (0 to 10 inches); very dark brown (7.5YR 2/2) extremely cobbly highly decomposed plant material; weak fine subangular blocky structure; soft, friable, nonsticky and slightly plastic; nonsmeary; many fine roots; many interstitial pores; 25 percent subangular aa gravel, 30 percent subangular aa cobbles, and 5 percent subangular aa stones; strongly acid (pH 5.2); abrupt wavy boundary. (8 to 30 centimeters [3 to 12 inches] thick.)

2C2—25 to 128 centimeters (10 to 50 inches); fragmental aa lava with a small amount of material from the horizon above in spaces between rocks; 20 percent subangular aa stones, 45 percent subangular aa cobbles, and 30 percent subangular aa gravel.

Range in characteristics

Oa horizon

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 or 2.

Content of rock fragments: 15 to 85 percent.

2C2 horizon

Content of rock fragments: 85 to 95 percent aa lava.

Kiolakaa Series

The Kiolakaa series consists of moderately deep, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 20 degrees C (68 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Humic Haplustands.

Typical pedon

Kiolakaa medial loam, on a south-facing, slightly convex slope of 8 percent, in a pasture, at an elevation of 628 meters (2,060 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with electrode in 1:1 water. When described on July 1, 1993, the soil was moist

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throughout.) Island of Hawaii, Hawaii County, Hawaii; 610 meters (2,000 feet) north of Highway 11 and 122 meters (400 feet) east of ranch road on Kahuku Ranch; Kahuku Ranch Quadrangle; lat. 19 degrees 4 minutes 1 second N. and long. 155 degrees 40 minutes 46 seconds W. (Old Hawaiian datum.)

- A—0 to 15 centimeters (0 to 6 inches); black (10YR 2/1) medial loam, dark brown (7.5YR 3/2) dry; moderate fine granular structure; firm, slightly sticky and slightly plastic; many fine roots; many very fine interstitial pores; 3 percent gravel; strongly acid (pH 5.4); gradual wavy boundary. (15 to 20 centimeters [6 to 8 inches] thick.)
- AB—15 to 25 centimeters (6 to 10 inches); very dark brown (10YR 2/2) cobbly medial fine sandy loam, dark yellowish brown (10YR 3/4) dry; moderate fine subangular blocky structure; friable, nonsticky and nonplastic; common fine roots; few fine interstitial and tubular pores; 20 percent cobbles and 10 percent gravel; slightly acid (pH 6.1); clear wavy boundary. (8 to 13 centimeters [3 to 5 inches] thick.)
- Bw1/2C1—25 to 38 centimeters (10 to 15 inches); dark brown (7.5YR 3/2) very cobbly medial loam, brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; many fine tubular pores; 35 percent cobbles and 5 percent gravel; slightly acid (pH 6.1); clear wavy boundary.
- Bw2/2C2—38 to 64 centimeters (15 to 25 inches); dark brown (7.5YR 3/4) very cobbly medial loam, brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; many fine tubular pores; 40 percent cobbles and 5 percent gravel; slightly acid (pH 6.3); abrupt wavy boundary. (Combined thickness of the Bw horizons ranging from 38 to 50 centimeters [15 to 20 inches].)
- 2R—64 centimeters (25 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 19 to 22 degrees C (67 to 72 degrees F).

Content of rock fragments: 15 to 35 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist, 2 or 3 dry.

Texture: Medial silt loam or loam.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Soil reaction: Strongly acid (pH 5.1 to 5.5).

AB horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist and dry.

Chroma: 2 or 3 moist, 3 or 4 dry.

Texture in the fine-earth fraction: Medial fine sandy loam, loam, or silt loam.

Bw/2C horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist, 3 or 4 dry.

Chroma: 2 to 4 moist, 4 to 6 dry.

Texture: Cobbly or very cobbly medial sandy loam, loam, or silt loam.

Soil reaction: Slightly acid (pH 6.1 to 6.5).

Kuanene Series

The Kuanene series consists of shallow, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 40 percent. The mean annual rainfall is about 2,159 millimeters (85 inches), and the mean annual air temperature is about 19 degrees C (66 degrees F).

Taxonomic classification: Medial over ashy, aniso, amorphic, isothermic Lithic Hapludands.

Typical pedon

Kuanene medial loam, on a slope of 14 percent, in an open forest, at an elevation of 768 meters (2,520 feet). (Colors are for moist soil unless otherwise noted. When described on October 4, 2001, the soil was moist throughout. All textures are "apparent field textures." pH was determined by organic dyes.) Island of Hawaii; from Kapapala Ranch headquarters, drive east on prominent old sugarcane road approximately 1.8 miles, turn left onto an unmarked two-track road, travel about 150 feet; pit is located 40 feet mauka (upslope) of the two-track road; Wood Valley Quadrangle; lat. 19 degrees 18 minutes 19 seconds N. and long. 155 degrees 26 minutes 37 seconds W. (Old Hawaiian datum; measured by GPS PLGR.)

- Oi—0 to 2 centimeters (0 to 1 inch); slightly decomposed grass litter; abrupt smooth boundary. (0 to 3 centimeters [0 to 1 inch] thick.)
- A—2 to 15 centimeters (1 to 6 inches); black (10YR 2/1) medial loam, dark brown (10YR 3/3) dry; moderate medium granular structure; slightly hard, friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine, common medium, and few coarse and very coarse roots throughout; few fine irregular pores between peds; very strongly acid (pH 4.6); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)
- 2A—15 to 18 centimeters (6 to 7 inches); very dark brown (10YR 2/2) medial fine sandy loam, dark yellowish brown (10YR 3/4) dry; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine subangular blocky peds are firm; common very fine, fine, and medium and few coarse and very coarse roots throughout; very strongly acid (pH 4.8); abrupt smooth boundary. (0 to 4 centimeters [0 to 2 inches] thick.)
- 2C—18 to 30 centimeters (7 to 12 inches); lithochromic black (10YR 2/1) ashy loamy fine sand, olive brown (2.5Y 4/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine and common medium to very coarse roots throughout; few fine dendritic pores throughout; 5 percent dark brown (7.5YR 3/4) areas along root channels; very strongly acid (pH 5.0); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)
- 3Bw—30 to 43 centimeters (12 to 17 inches); very dark brown (10YR 2/2) cobbly medial fine sandy loam, dark brown (7.5YR 3/4) dry; weak very fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; moderately smeary; few very fine and fine and common medium to very coarse roots throughout; few fine dendritic pores throughout; coarse-sized patches of 10 percent dark brown (7.5YR 3/4) and 5 percent black (10YR 2/1) colors; 5 percent angular pahoehoe gravel and 10 percent angular pahoehoe cobbles; strongly acid (pH 5.5); abrupt smooth boundary. (10 to 33 centimeters [4 to 13 inches] thick.)
- 4R—43 centimeters (17 inches); hard, massive Mauna Loa pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 25 to 50 centimeters (10 to 20 inches).

Thickness of the medial material: 8 to 18 centimeters (5 to 7 inches).

Thickness of the ashy material: 5 to 15 centimeters (5 to 7 inches).

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Content of rock fragments: 0 to 20 percent total volume for the soil profile; in a typical area, mostly cobbles concentrated in the deepest horizon.

Soil reaction: Very strongly acid to moderately acid.

Mean annual rainfall: 1,500 to 3,000 millimeters (59 to 118 inches).

Soil moisture: The soils are typically moist, but the control section may undergo periodic drying, most likely in summer.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Medial fine sandy loam, medial very fine sandy loam, or medial loam.

Ap horizon (where present)

This horizon is similar to the A horizon but commonly is mixed with the underlying ashy material.

Bw horizon (where present)

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Medial fine sandy loam, medial very fine sandy loam, or medial loam.

2A horizon (where present)

Hue: 10YR or 2.5Y.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Medial fine sandy loam or medial loamy very fine sand.

2C horizon

Hue: 10YR or 2.5Y.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Ashy loamy fine sand, ashy loamy very fine sand, or ashy loamy sand.

3A or 3Bw horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 2 to 4 moist.

Texture: May be cobbly or very cobbly; the fine-earth fraction is medial fine sandy loam, medial very fine sandy loam, or medial loam.

Kulalio Series

The Kulalio series consists of very deep, well drained soils that formed in volcanic ash deposited over aa lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,295 millimeters (51 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Eutric Pacific Fulvudands.

Typical pedon

Kulalio medial silt loam, 2 to 10 percent slopes, under koa trees and shrubs; located in Hawaii Volcanoes National Park; from State Highway 11, drive 7.5 miles on Mauna Loa Strip Road; turn east (right) onto grass track and go straight 0.05 mile and park; walk on the left side of pukiawe bush and follow trail about 30 meters (100 feet) to

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type location; Kilauea Crater Quadrangle; lat. 19 degrees 28 minutes 28.90 seconds N. and long. 155 degrees 21 minutes 32.88 seconds W. (Position measured by GPS PLGR using old Hawaiian datum.)

- A1—0 to 8 centimeters (0 to 3 inches); black (7.5YR 2.5/1) medial silt loam; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine and fine interstitial and tubular pores; 10 percent subangular aa stones; strongly acid (pH 5.1); abrupt wavy boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)
- A2—8 to 18 centimeters (3 to 7 inches); black (5YR 2.5/1) cobbly medial silt loam; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine to medium roots; many very fine and fine interstitial and tubular pores; 30 percent subangular aa fragments (20 percent cobbles and 10 percent gravel); strongly acid (pH 5.3); abrupt wavy boundary. (0 to 10 centimeters [0 to 4 inches] thick.)
- Bw1/2C1—18 to 27 centimeters (7 to 11 inches); black (5YR 2.5/1) very gravelly medial loam; 20 percent dark reddish brown (5YR 3/4) material in pockets with an abrupt broken boundary; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine to very coarse roots; many very fine and fine interstitial pores; 40 percent subangular aa fragments (10 percent stones, 10 percent cobbles, and 20 percent gravel); moderately acid (pH 5.8); clear irregular boundary.
- Bw2/2C2—27 to 41 centimeters (11 to 16 inches); dark reddish brown (5YR 2.5/2) very gravelly medial loamy sand with 15 percent black (2.5YR 2.5/1) material in pockets that have abrupt broken boundary; massive; soft, very friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine interstitial pores; 60 percent subangular aa fragments (40 percent gravel, 10 percent cobbles, and 10 percent stones); moderately acid (pH 6.0); abrupt broken boundary.
- 2C3/Bw3—41 to 64 centimeters (16 to 25 inches); dark reddish brown (5YR 3/3) extremely gravelly ashy loamy sand; massive; loose when dry and moist, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine and fine and common medium and coarse interstitial pores; 85 percent subangular aa fragments (55 percent gravel, 20 percent cobbles, and 10 percent stones); neutral (pH 6.7); clear irregular boundary. (Combined thickness of the Bw/C horizons ranging from 0 to 51 centimeters [0 to 20 inches].)
- 2C4—64 to 152 centimeters (25 to 60 inches); lithochromic dark brown (7.5YR 3/4) and 10 percent black (N 2/0) extremely cobbly ashy loamy sand; massive; loose when dry and moist, nonsticky and nonplastic; few very fine to coarse roots; many very fine and fine and common medium and coarse interstitial pores; 85 percent subangular aa fragments (35 percent gravel, 40 percent cobbles, and 10 percent stones); neutral (pH 6.7).

Range in characteristics

Mean annual soil temperature: 12 to 18 degrees C (54 to 59 degrees F).

Depth to bedrock: 150 centimeters (60 inches) or more.

Content of rock fragments: Averages 50 to 90 percent in the control section.

A horizon

Hue: 7.5YR or 10YR.

Texture in the fine-earth fraction: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

Content of rock fragments: 0 to 35 percent.

Soil reaction: Very strongly or strongly acid.

B/C horizon

Hue: 2.5YR to 10YR.

Chroma: 1 to 2 moist.

Texture in the fine-earth fraction: Loam or silt loam; dominantly medial but may be ashy.

Structure: Subangular blocky or massive.

Content of rock fragments: 35 to 65 percent.

Soil reaction: Medium or slightly acid.

C horizon

Hue: 2.5YR, 7.5YR, 10YR, or N.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Structure: Massive or single grain.

Content of rock fragments: 65 to 90 percent.

Lalau Series

The Lalau series consists of deep, well drained soils that formed in organic material mixed with minor amounts of basic volcanic ash. These soils are in areas of aa lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 3,048 millimeters (120 inches), and the mean annual air temperature is about 14 degrees C (57 degrees F).

Taxonomic classification: Euic, isomesic Typic Udifolists.

Typical pedon

Lalau very cobbly highly decomposed plant material, under forest vegetation, at an elevation of 1,463 meters (4,800 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes.) Island of Hawaii; from Hilo, follow State Highway 11 to the village of Mountain View; turn right (north) on North Kulani Road and proceed to a dead end at Stainback Highway; turn left (west) on Stainback Highway and proceed approximately 11 miles; walk to type location due north of the road; Kulani Quadrangle; lat. 19 degrees 33 minutes 17.0 seconds N. and long. 155 degrees 17 minutes 9.0 seconds W. (Old Hawaiian datum +/- 12 feet; measured by Garmin GPS.)

Oa/2C1—0 to 8 centimeters (0 to 3 inches); very dark brown (10YR 2/2) very cobbly highly decomposed plant material; weak very fine granular structure; friable, slightly sticky and slightly plastic; strongly smeary; many roots; many fine pores; very strongly acid (pH 4.8); 50 percent angular cobbles; abrupt wavy boundary. (5 to 20 centimeters [2 to 8 inches] thick.)

2C2—8 to 135 centimeters (3 to 53 inches); fragmental aa lava with very little soil material in voids.

Range in characteristics

Depth to bedrock: 102 to 152 centimeters (40 to 60 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: 65 to 90 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

Oa horizon

Chroma: 1 or 2 moist.

Texture: Very cobbly or extremely cobbly highly decomposed or moderately decomposed plant material.

Smeariness: Moderately smeary or strongly smeary.
Rupture resistance: Very friable or friable.
Stickiness: Slightly sticky or moderately sticky.
Plasticity: Nonplastic or slightly plastic.

Lithic Haplustands, Cindery Substratum

Lithic Haplustands, cindery substratum, in this survey area consist of very shallow and shallow, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,651 millimeters (65 inches), and the mean annual air temperature is about 21 degrees C (70 degrees F).

Taxonomic classification: Lithic Haplustands.

Reference pedon

Lithic Haplustands, cindery substratum, in an area of Lithic Haplustands-Lava flows complex, 2 to 10 percent slopes; located in Hawaii Volcanoes National Park; from Chain of Craters Road, travel 2 miles down Hilina Pali Road; turn south onto gravel track and travel .05 mile to water tank; from south side of water tank, travel 30 meters (95 feet) to type location; Kau Desert Quadrangle; lat. 19 degrees 21 minutes 25.3 seconds N. and long. 155 degrees 15 minutes 17.4 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 26 feet.)

- A—0 to 5 centimeters (0 to 2 inches); 50 percent black (10YR 2/1) and 50 percent very dark brown (10YR 2/2) extremely gravelly ashy loamy sand; weak medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 5 percent Pele's hair; 70 percent subrounded basaltic gravel; very strongly acid (pH 4.6); abrupt wavy boundary.
- C1—5 to 6 centimeters (2 to 2.5 inches); ashy loamy sand that is 75 percent very dark brown (7.5YR 2.5/2) moist, brown (7.5YR 4/4) dry, and 25 percent black (N 2/0) moist and dry; moderate medium platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.2); abrupt wavy boundary.
- C2—6 to 8 centimeters (2.5 to 3 inches); 50 percent black (10YR 2/1), 45 percent very dark brown (10YR 2/2), and 5 percent yellowish red (5YR 4/6) very gravelly ashy sand; single grain; loose when moist and dry, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 40 percent subrounded basaltic gravel; slightly acid (pH 6.2); clear wavy boundary.
- C3—8 to 10 centimeters (3 to 4 inches); ashy fine sand that is 50 percent very dark brown (10YR 2/2) moist, yellowish brown (10YR 5/4) dry, and 50 percent black (N 2/0) moist and dry; weak medium platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); clear wavy boundary.
- C4—10 to 13 centimeters (4 to 5 inches); ashy fine sand that is 50 percent very dark brown (10YR 2/2) moist, dark yellowish brown (10YR 4/4) dry, and 50 percent black (N 2/0) moist and dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); clear wavy boundary.
- C5—13 to 15 centimeters (5 to 6 inches); very dark brown (10YR 2/2) ashy loamy sand, dark yellowish brown (10YR 4/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); abrupt wavy boundary.

2C6—15 to 20 centimeters (6 to 8 inches); black (N 2/0) extremely gravelly ashy coarse sand; massive; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; many very fine to medium interstitial pores; 80 percent gravel-size cinders; neutral (pH 6.8); abrupt wavy boundary.

3R—20 centimeters (8 inches); hard pahoehoe lava.

The reference pedon is an example of the soils within this category. Because of the highly variable nature of these soils, the pedon is not necessarily representative of the soils throughout the survey area.

Range in characteristics

Elevation: 760 to 1,065 meters (2,500 to 3,500 feet).

Mean annual air temperature: 17 to 22 degrees C (62 to 72 degrees F).

Mean annual rainfall: 1,015 to 2,030 millimeters (40 to 80 inches).

Mean annual pan evaporation: 1,650 to 2,030 millimeters (65 to 80 inches).

Depth to bedrock: 5 to 50 centimeters (2 to 20) inches.

Soil reaction: Very strongly acid to neutral.

A horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Ashy coarse sandy loam, ashy sandy loam, ashy loamy coarse sand, ashy loamy sand, ashy fine sand, or ashy sand.

Structure: Granular, platy, subangular blocky, or massive.

C horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Structure: Granular, platy, subangular blocky, massive, or single grain.

Texture in the fine-earth fraction: Ashy coarse sandy loam, ashy sandy loam, ashy loamy coarse sand, ashy loamy sand, ashy fine sand, or ashy sand.

Lithic Haplustands, Loamy Surface

Lithic Haplustands, loamy surface, in this survey area consist of very shallow and shallow, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,651 millimeters (65 inches), and the mean annual air temperature is about 21 degrees C (70 degrees F).

Taxonomic classification: Lithic Haplustands.

Reference pedon

Lithic Haplustands in an area of Lithic Haplustands-Lava flows complex, 2 to 10 percent slopes; located in Hawaii Volcanoes National Park; from Chain of Craters Road, travel down Hilina Pali Road to escarpment with cattle ramp; travel up cattle ramp and along fence for approximately 15 to 30 minutes to type location; Kau Desert Quadrangle; lat. 19 degrees 20 minutes 48.52 seconds N. and long. 155 degrees 15 minutes 43.52 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 26 feet.)

A1—0 to 10 centimeters (0 to 4 inches); black (10YR 2/1) very gravelly medial loam; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; common very fine

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- and fine interstitial pores; 40 percent subangular basaltic gravel; strongly acid (pH 5.2); clear wavy boundary.
- 2A2—10 to 13 centimeters (4 to 5 inches); very dark grayish brown (10YR 3/2) ashy sandy loam; weak to strong very thick platy structure; nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 5 percent subangular basaltic gravel; slightly acid (pH 6.2); abrupt wavy boundary.
- 2C1—13 to 15 centimeters (5 to 6 inches); very dark brown (10YR 2/2) very gravelly ashy loamy coarse sand; single grain; loose when moist and dry, nonsticky and nonplastic; common very fine and fine roots; many very fine to medium interstitial pores; 55 percent subangular basaltic gravel; slightly acid (pH 6.2); abrupt wavy boundary.
- 2C2—15 to 18 centimeters (6 to 7 inches); very dark brown (7.5YR 2/2) ashy loamy sand; moderate thick platy structure; stratified with thin layers of black (N 2/0) sand; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); clear wavy boundary.
- 2C3—18 to 20 centimeters (7 to 8 inches); 50 percent dark brown (7.5YR 3/2) and 50 percent black (7.5YR 2/1) very gravelly ashy coarse sandy loam; single grain; loose when moist and dry, nonsticky and nonplastic; common very fine and fine roots; many very fine to medium interstitial pores; 50 percent subangular basaltic gravel; slightly acid (pH 6.4); clear wavy boundary.
- 2C4—20 to 25 centimeters (8 to 10 inches); 80 percent dark brown (7.5YR 3/2), 10 percent reddish brown (5YR 4/3), and 10 percent black (N 2/0) gravelly ashy loamy sand; moderate very thick platy structure; nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 25 percent subangular basaltic gravel; neutral (pH 6.6); clear wavy boundary.
- 2C5—25 to 33 centimeters (10 to 13 inches); 70 percent very dark brown (7.5YR 2/2), 20 percent black (N 2/0), and 10 percent dark reddish brown (5YR 3/4) very gravelly ashy loamy coarse sand; single grain; loose when moist and dry, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine to medium interstitial pores; 80 percent subangular basaltic gravel; neutral (pH 6.8); abrupt wavy boundary.
- 3R—33 centimeters (13 inches); hard pahoehoe lava.

The reference pedon is an example of the soils within this category. Because of the highly variable nature of the soils, the pedon is not necessarily representative of these soils throughout the survey area.

Range in characteristics

Elevation: 760 to 915 meters (2,500 to 3,000 feet).

Mean annual air temperature: 17 to 22 degrees C (62 to 72 degrees F).

Mean annual rainfall: 1,015 to 2,030 millimeters (40 to 80 inches).

Mean annual pan evaporation: 1,650 to 2,030 millimeters (65 to 80 inches).

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Soil reaction: Very strongly acid to neutral.

A horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Ashy loam, ashy sandy loam, ashy loamy sand, ashy fine sand, or ashy sand.

C horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Ashy coarse sandy loam, ashy sandy loam, ashy loamy sand, ashy loamy coarse sand, ashy fine sand, ashy sand, or ashy coarse sand.

Lithic Ustipsamments

Lithic Ustipsamments in this survey area consist of very shallow and shallow soils in areas of pahoehoe lava. These soils formed in volcanic base surge and volcanic ash reworked by wind and water. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,015 millimeters (40 inches), and the mean annual air temperature is about 18 degrees C (65 degrees F).

Taxonomic classification: Lithic Ustipsamments.

Reference pedon

Lithic Ustipsamments in an area of Lava flows-Lithic Ustipsamments complex, 2 to 10 percent slopes; Hawaii Volcanoes National Park; from State Highway 11, follow Kau Desert Trail to where lava type changes from aa to pahoehoe; travel northeast approximately 1 mile; Kilauea Crater Quadrangle; lat. 19 degrees 22 minutes 43.14 seconds N. and long. 155 degrees 20 minutes 49.31 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 59 feet.)

- Cm—0 to 0.25 centimeter (0 to 0.1 inch); lithochromic brown (7.5YR 4/2) cemented sand crust, brown (10YR 5/3) dry; moderate and strong medium platy structure; hard, firm, brittle, nonsticky and nonplastic; few prominent patchy coatings on the bottom of plates, white (10YR 8/1) dry; strongly acid (pH 5.2); clear wavy boundary. (0 to 1 centimeter [0 to 0.5 inch] thick.)
- C1—0.25 centimeter to 4 centimeters (0.1 inch to 2 inches); lithochromic dark grayish brown (10YR 4/2) ashy sand, light brownish gray (10YR 6/2) dry; single grain; loose when moist and dry, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; common coarse to extremely coarse, rounded, dark grayish brown (10YR 4/2), soft to very hard accretionary lapilli; slightly acid (pH 6.4); abrupt wavy boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- C2—4 to 25 centimeters (2 to 10 inches); lithochromic 50 percent black (N 2/0) and 50 percent very dark grayish brown (2.5Y 3/2) ashy sand; fine stratification; single grain; loose when moist and dry, nonsticky and nonplastic; few very fine to medium roots; many very fine and fine interstitial pores; neutral (pH 6.6); abrupt wavy boundary. (5 to 50 centimeters [2 to 20 inches] thick.)
- 2R—25 centimeters (10 inches); hard pahoehoe lava.

The reference pedon is an example of the soils within this category. Because of the highly variable nature of the soils, the pedon is not necessarily representative of these soils throughout the survey area.

Range in characteristics

Elevation: 305 to 1,220 meters (1,000 to 4,000 feet).

Mean annual air temperature: 16 to 22 degrees C (61 to 72 degrees F).

Median annual rainfall: 760 to 1,525 millimeters (30 to 60 inches); about 85 percent of the rainfall occurring between September and April.

Mean annual pan evaporation: 1,525 to 2,030 millimeters (60 to 80 inches).

Surface crust (Cm horizon): Brittle crust (fig. 20), 1 centimeter (0.5 inch) thick, occurring in 15 percent of the area; this percentage decreases with distance from the Halemaumau Crater.

Cm horizon (where present)

Hue: 5YR or 7.5YR.

Value: 2.5 to 4 moist.

Chroma: 2.5 to 4 moist.

Percentage of the surface covered by rock fragments: 0 to 60 percent gravel.

Soil reaction: Extremely acid to strongly acid.

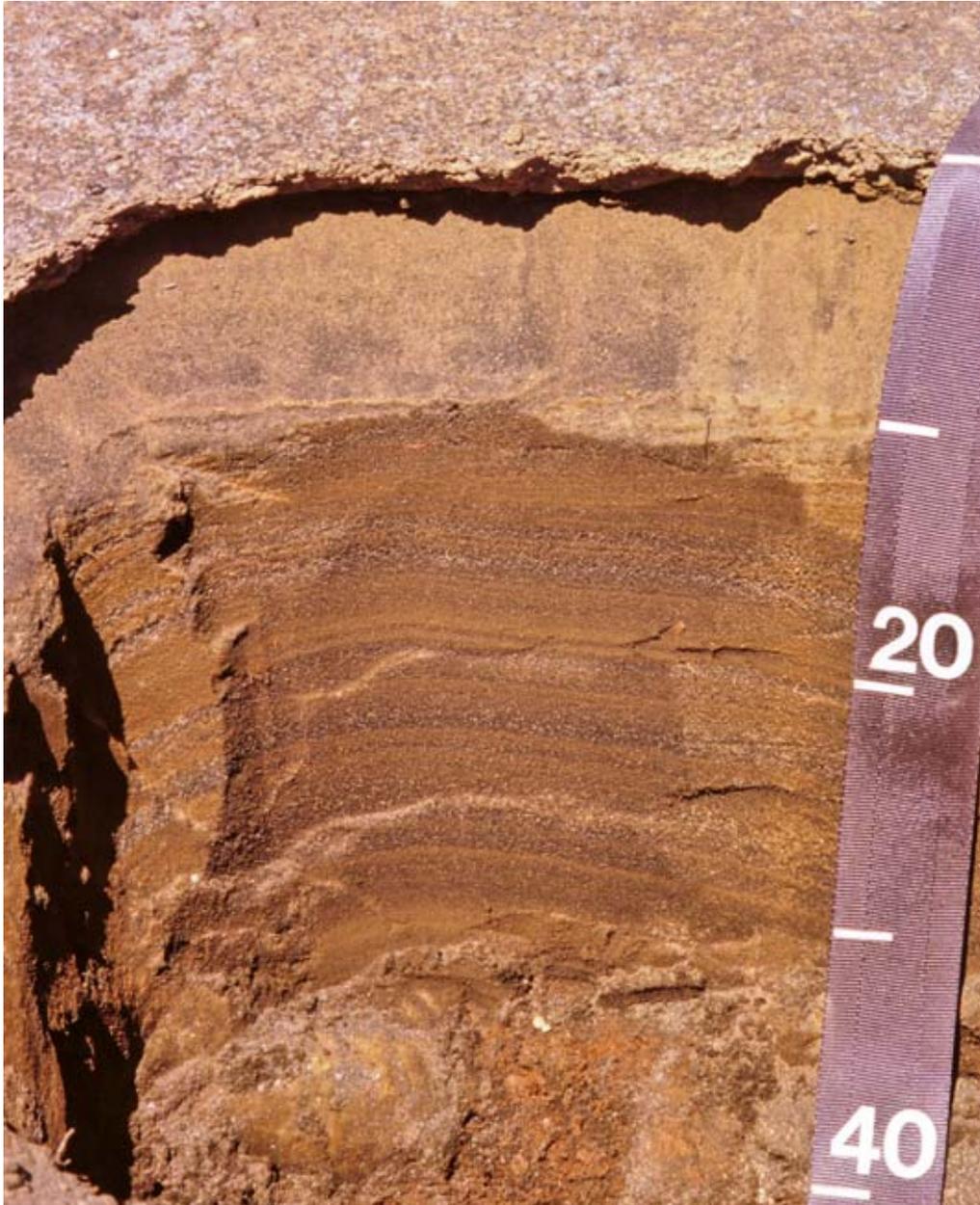


Figure 20.—Profile of Lithic Ustipsamments, which have a thin cemented surface crust. On the tape, depth is marked in centimeters.

C horizon

Hue: 5YR to 10YR, 2.5Y, or N.

Value: 2 or 2.5 to 8 moist.

Chroma: 0 to 6 moist.

Texture: Ashy loamy fine sand, ashy fine sand, ashy sand, or ashy coarse sand.

Structure: Massive or single grain.

Accretionary lapilli: Occurring in some pedons.

Olivine crystals: Occurring in most pedons.

Makaopuhi Series

The Makaopuhi series consists of very shallow and shallow, somewhat poorly drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is 2,800 millimeters (110 inches), and the mean annual air temperature is 18 degrees C (64 degrees F).

Taxonomic classification: Medial, ferrihydritic, isothermic Lithic Hapludands.

Typical pedon

Makaopuhi very paragravelly highly decomposed plant material, 2 to 10 percent slopes, under rain forest vegetation; located in Hawaii Volcanoes National Park; from the northwest corner of the Pulu Factory on the south side of Napau Crater Trail, walk east on trail for about 28 meters (90 feet); type location is 1 meter (3 feet) south of trail; Makaopuhi Crater Quadrangle; lat. 19 degrees 22 minutes 24.15 seconds N. and long. 155 degrees 09 minutes 24.60 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 64 feet.)

- Oa—0 to 5 centimeters (0 to 2 inches); black (7.5YR 2/1) very paragravelly muck; strong fine granular structure; very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and common medium roots; many very fine and fine interstitial pores; 50 percent angular gravel-size pumice; extremely acid (pH 4.0); abrupt smooth boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- A—5 to 15 centimeters (2 to 6 inches); very dark brown (7.5YR 2/2) very paragravelly medial silt loam; weak fine and medium subangular blocky structure; very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 5 percent subrounded basalt gravel; strongly acid (pH 5.4); abrupt wavy boundary. (5 to 30 centimeters (2 to 12 inches) thick).
- 2R—15 centimeters (6 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 5 to 30 centimeters (2 to 12 inches).

Mean annual soil temperature: 17 to 20 degrees C (63 to 68 degrees F).

Soil reaction: Very strongly acid or strongly acid.

O horizon

Hue: 7.5YR or 10YR.

A horizon

Hue: 7.5YR or 10YR.

Texture in the fine-earth fraction: Medial silt loam, medial loam, or medial sandy loam.

Structure: Granular, subangular, or massive.

Content of rock fragments: 0 to 15 percent basalt gravel; 35 to 65 percent pumicelike paragravel.

C horizon (where present)

Thickness: 0 to 3 centimeters (0 to 1 inch).
Hue: 2.5YR to 10YR.
Chroma: 1 or 2.
Texture: Sand to loam.
Structure: Massive or single grain.
Content of rock fragments: 0 to 15 percent basalt gravel.

Malama Series

The Malama series consists of deep and very deep, well drained soils that formed in organic material overlying aa lava with little soil material in fragmental voids in the lava. These soils are on uplands. Slopes range from 2 to 40 percent. The mean annual rainfall is about 2,159 millimeters (85 inches), and the mean annual air temperature is about 22 degrees C (72 degrees F).

Taxonomic classification: Euic, isohyperthermic Typic Udifolists.

Typical pedon

Malama extremely cobbly highly decomposed plant material under ohia lehua and guava forest. (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii; 1 mile north of Isaac Hale Park off of Pohoiki Road in Pohoiki; Kapoho Quadrangle; lat. 19 degrees 28 minutes 05 seconds N. and long. 154 degrees 51 minutes 15 seconds W. (Old Hawaiian datum.)

2C1/Oa—0 to 8 centimeters (0 to 3 inches); very dark brown (7.5YR 2.5/2) extremely cobbly highly decomposed plant material; moderate medium and fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; many roots; many fine pores; cobble- and stone-size aa lava fragments making up 40 to 80 percent of the soil mass; strongly acid (pH 5.4); abrupt smooth boundary. (5 to 30 centimeters [2 to 12 inches] thick.)

2C2—8 to 127 centimeters (3 to 50 inches); fragmental aa lava.

Range in characteristics

Depth to fragmental aa lava: 5 to 30 centimeters (2 to 12 inches).

Depth to bedrock: More than 102 centimeters (40 inches).

Content of rock fragments: 60 to 89 percent total volume for the soil profile; typically dominated by cobbles.

Soil reaction: Extremely acid to moderately acid (pH 4.0 to 6.0).

Mean annual rainfall: 1,524 to 3,048 millimeters (60 to 120 inches).

Mean annual soil temperature: 21 to 23 degrees C (70 to 74 degrees F).

Oe or Oi horizon (where present)

Hue: 7.5YR or 10YR.
Value: 2 to 3 moist.
Chroma: 1 or 2 moist.
Texture: Moderately decomposed or slightly decomposed plant material.
Smeariness: Nonsmeary.
Structure: Granular or structureless.

2C1/Oa horizon

Hue: N, 7.5YR, or 10YR.
Value: 2 to 3 moist.
Chroma: 0 to 2 moist.
Texture in the fine-earth fraction: Highly decomposed plant material.
Smeariness: Nonsmeary or weakly smeary.

Structure: Granular or subangular blocky.

Content of rock fragments: 60 to 89 percent; roughly two-thirds cobbles and one-third stones.

Manu Series

The Manu series consists of moderately deep, moderately well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 2,489 millimeters (98 inches), and the mean annual air temperature is about 16 degrees C (61 degrees F).

Taxonomic classification: Ashy, amorphic, isothermic Aquic Hapludands.

Typical pedon

Manu medial silt loam, 2 to 10 percent slopes, under rain forest vegetation; located in Hawaii Volcanoes National Park; from the main entrance, take an immediate left after toll booth and continue to stop sign; turn left and follow road less than $\frac{1}{4}$ mile to where a power line crosses the road; walk under power line and climb steep bank to the north; follow power line 5 meters (17 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 25 minutes 36.29 seconds N. and long. 155 degrees 15 minutes 05.53 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 89 feet.)

- A—0 to 8 centimeters (0 to 3 inches); black (7.5YR 2.5/1) medial silt loam; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and few medium to very coarse roots; many very fine and fine interstitial and tubular pores; very strongly acid (pH 5.0); abrupt wavy boundary. (8 to 15 centimeters [3 to 6 inches] thick.)
- C1—8 to 10 centimeters (3 to 4 inches); lithochromic black (7.5YR 2.5/1) extremely gravelly ashy sandy loam; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium to very coarse roots; many very fine and fine interstitial pores; 90 percent rounded pyroclastic gravel; slightly acid (pH 6.2); abrupt wavy boundary. (2.5 to 5 centimeters [1 to 2 inches] thick.)
- 2C2—10 to 16 centimeters (4 to 6 inches); lithochromic very dark grayish brown (10YR 3/2) ashy loam; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine and few medium to very coarse roots; common very fine and fine interstitial pores; few fine distinct dark yellowish brown (10YR 4/6) threads of redoximorphic concentrations in root channels and pores; slightly acid (pH 6.2); clear broken boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- 3C3—16 to 24 centimeters (6 to 9 inches); lithochromic 50 percent very dark brown (10YR 2/2) and 50 percent black (N 2/0) very gravelly ashy sand; massive; soft, very friable, nonsticky and nonplastic; common very fine to medium roots; many very fine and fine interstitial pores; 50 percent subrounded pyroclastic gravel; slightly acid (pH 6.3); clear wavy boundary. (5 to 8 centimeters [2 to 3 inches] thick.)
- 4Bw—24 to 27 centimeters (9 to 11 inches); very dark brown (7.5YR 2.5/2) ashy sandy loam; massive; slightly hard, very friable, moderately sticky and moderately plastic; few very fine and fine roots; many very fine and fine interstitial pores; 5 percent subrounded gravel; neutral (pH 6.7); abrupt wavy boundary. (0 to 2.5 centimeters [0 to 1 inch] thick.)
- 4C1—27 to 33 centimeters (11 to 13 inches); lithochromic very dark grayish brown (10YR 3/2) ashy loamy sand; massive; slightly hard and hard, friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; common fine distinct dark yellowish brown (10YR 4/6) threads of

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- redoximorphic concentrations in root channels and pores; neutral (pH 6.7); abrupt wavy boundary. (5 to 8 centimeters [2 to 3 inches] thick.)
- 5C2—33 to 39 centimeters (13 to 15 inches); lithochromic 92 percent very dark brown (10YR 2/2), 5 percent black (N 2/0), and 3 percent red (10R 4/6) ashy loamy fine sand; massive; soft and slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; neutral (pH 6.9); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 6A—39 to 42 centimeters (15 to 16 inches); black (N 2/0) ashy silt loam; massive; soft, very friable, slightly sticky and slightly plastic; moderately smeary; few very fine to medium roots; many very fine to medium interstitial pores; neutral (pH 6.9); abrupt wavy boundary. (0 to 2.5 centimeter [0 to 1 inch] thick.)
- 6Bw—42 to 46 centimeters (16 to 18 inches); very dark brown (7.5YR 2.5/2) ashy silt loam; massive; slightly hard and hard, friable, moderately sticky and moderately plastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.9); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 6C1—46 to 51 centimeters (18 to 20 inches); lithochromic 50 percent black (10YR 2/1) and 50 percent very dark brown (10YR 2/2) ashy loamy sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 10 percent subrounded pyroclastic gravel; neutral (pH 7.1); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 6C2—51 to 53 centimeters (20 to 21 inches); lithochromic very dark brown (7.5YR 2.5/3) very gravelly ashy sandy loam; massive; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine interstitial pores; few fine distinct dark yellowish brown (10YR 4/6) threads of redoximorphic concentrations in root channels and pores; 50 percent subrounded pyroclastic gravel; neutral (pH 7.1); clear wavy boundary. (0 to 2.5 centimeters [0 to 1 inch] thick.)
- 6C3—53 to 65 centimeters (21 to 25 inches); lithochromic very dark grayish brown (10YR 3/2) very gravelly ashy loamy sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 50 percent subrounded pyroclastic gravel; neutral (pH 7.1); clear wavy boundary. (0 to 13 centimeters [0 to 5 inches] thick.)
- 7C4—65 to 81 centimeters (25 to 32 inches); reticulite (pumicelike volcanic glass); few very fine and fine roots; neutral (pH 7.2); clear wavy boundary. (0 to 18 centimeters [0 to 7 inches] thick.)
- 8Cg—81 to 86 centimeters (32 to 34 inches); very dark gray (10YR 3/1) ashy silt loam; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine and fine interstitial pores; 2 percent Pele's hair; common fine prominent dark yellowish brown (10YR 4/6) threads of redoximorphic concentrations; neutral (pH 7.2); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 9R—86 centimeters (34 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 50 to 100 centimeters (20 to 40 inches).

Mean annual soil temperature: 15 to 17 degrees C (59 to 63 degrees F).

Buried A horizons: Occurring in most pedons.

Redoximorphic concentrations: Occurring in most pedons.

Brittle horizons: Occurring in some pedons.

Soil reaction: Strongly acid to neutral.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Texture: Medial loam or medial silt loam.
Structure: Granular or subangular blocky.
Content of rock fragments: 0 to 10 percent.

C horizon

Hue: 7.5YR, 10YR, 10R, or N.
Value: 2 to 4 moist.
Chroma: 1 to 6 moist.
Texture in the fine-earth fraction: Ashy coarse sand, ashy sand, ashy loamy sand, ashy loamy fine sand, ashy sandy loam, or ashy loam.
Content of rock fragments: 0 to 90 percent in individual horizons; control section averages 5 to 30 percent.

Maunaiu Series

The Maunaiu series consists of shallow, well drained soils that formed in volcanic ash over pahoehoe lava. Slopes range from 3 to 10 percent. The mean annual rainfall is about 1,296 millimeters (51 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Eutric Lithic Fulvudands.

Typical pedon

Maunaiu soil in an area of Maunaiu-Akelelu complex, 3 to 10 percent slopes, under koa trees and grasses; located in Hawaii Volcanoes National Park; from State Highway 11, turn north onto Mauna Loa Strip Road; travel 5.6 miles and park on the north (right) side of the road; walk at a heading of 32 degrees magnetic 13 meters (45 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 27 minutes 36.65 seconds N. and long. 155 degrees 20 minutes 28.95 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 350 feet.)

- A1—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) medial silt loam, very dark brown (10YR 2/2) dry; strong fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial and tubular pores; strongly acid (pH 5.4); abrupt wavy boundary.
- A2—5 to 15 centimeters (2 to 6 inches); black (10YR 2/1) medial silt loam, very dark brown (10YR 2/2) dry; weak medium subangular blocky structure parting to moderate fine and medium granular; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine and fine and few coarse roots; many very fine and fine interstitial pores; moderately acid (pH 5.7); clear wavy boundary. (Combined thickness of the A horizons ranging from 5 to 20 centimeters [2 to 8 inches].)
- Bw1—15 to 24 centimeters (6 to 10 inches); black (7.5YR 2.5/1) medial silt loam, dark brown (7.5YR 3/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); clear wavy boundary.
- Bw2—24 to 36 centimeters (10 to 14 inches); black (7.5YR 2.5/1) medial silt loam, strong brown (7.5YR 4/6) dry; massive; soft, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); clear wavy boundary.
- Bw3—36 to 48 centimeters (14 to 19 inches); very dark brown (7.5YR 2.5/2) medial silt loam, dark yellowish brown (10YR 4/6) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; moderately acid (pH 6.0); abrupt wavy

boundary. (Combined thickness of the Bw horizons ranging from 13 to 38 centimeters [5 to 15 inches].)
2R—48 centimeters (19 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: 0 to 15 percent.

Soil reaction: Strongly acid or moderately acid.

A horizon

Hue: 7.5YR or 10YR.

Texture: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

Content of rock fragments: 0 to 5 percent.

Smeariness: Nonsmeary or weakly smeary.

B horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 4 moist.

Texture: Medial sandy loam, medial loam, or medial silt loam.

Structure: Subangular blocky or massive.

Accretionary lapilli: Occurring in few pedons at the lower elevations.

Platelike fragments: 0 to 40 percent in the upper 5 centimeters (2 inches) in few pedons at the lower elevations.

Content of rock fragments: 0 to 15 percent.

C horizon (where present)

Hue: 7.5YR, 10YR, or N.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Ashy coarse sand to medial loam.

Mawae Series

The Mawae series consists of moderately deep, well drained soils that formed in organic material mixed with minor amounts of basic volcanic ash. These soils are in areas of aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Euic, isomesic Typic Ustifolists.

Typical pedon

Mawae very cobbly highly decomposed plant material on a west-facing, slightly convex slope of 12 percent, under forest vegetation, at an elevation of 1,393 meters (4,570 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on February 18, 1997, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; from Gaspar's Dairy (northwest quadrant of Kaunene Quadrangle), drive northeast 0.4 mile, turn east onto 4WD road and drive 0.2 mile; pedon is located 72 meters (235 feet) southwest of 4WD road; Kaunene Quadrangle; lat. 19 degrees 29 minutes 9.3 seconds N. and long. 155 degrees 49 minutes 4.0 seconds W. (Old Hawaiian datum.)

Oa/2C1—0 to 13 centimeters (0 to 5 inches); black (5YR 2.5/1) very cobbly highly decomposed plant material; weak very fine and fine granular structure; very friable, slightly sticky and slightly plastic; moderately smeary; many roots; many very fine pores; 50 percent angular cobbles; moderately acid (pH 5.8); clear irregular boundary. (5 to 25 centimeters [2 to 10 inches] thick.)

2C2—13 to 102 centimeters (5 to 40 inches); fragmental aa lava with very little soil material.

2R—102 centimeters (40 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 13 to 15 degrees C (55 to 59 degrees F).

Content of rock fragments: 60 to 90 percent, by volume, in the pedon as a whole; ranging in size from gravel to stones, but occurring primarily as gravel- and cobble-size lava rocks.

Content of organic carbon (by weight): 25 to 30 percent in the soil material less than 2.0 millimeters in size.

Oa/2C1 horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Very cobbly or extremely cobbly highly decomposed plant material.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

Menehune Series

The Menehune series consists of shallow and very shallow, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,295 millimeters (51 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Lithic Hapludands.

Typical pedon

Menehune soil in an area of Lava flows-Menehune complex, 2 to 20 percent slopes, under scattered ohia trees and shrubs; Hawaii Volcanoes National Park; from State Highway 11, drive 4.3 miles north on Mauna Loa Strip Road; turn south-southwest (left) through locked gate onto a power line road and continue about 1.5 miles to a ranch road; turn west (right) through locked gate onto a ranch road that parallels the Hawaii Volcanoes National Park fence; drive to end of road; walk along fence to round cemented-in pole of old fence angling off from newer fence; follow a heading of 250 degrees magnetic for 39 meters (125 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 27 minutes 08.50 seconds N. and long. 155 degrees 23 minutes 07.92 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 310 feet.)

Oa—0 to 5 centimeters (0 to 2 inches); dark reddish brown (5YR 2.5/2) muck; strong medium platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium and coarse roots growing horizontally at the bottom of the horizon; many very fine and fine interstitial pores; 2 percent strands of Pele's hair; very strongly acid (pH 4.6); clear wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)

C—5 to 6 centimeters (2 to 2.5 inches); lithochromic very dark brown (10YR 2/2) medial sandy loam; strong thin platy structure; moderately hard, firm, nonsticky

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- and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; strongly acid (pH 5.4); abrupt wavy boundary. (0 to 1 centimeter [0 to 0.5 inch] thick.)
- 2A—6 to 7 centimeters (2.5 to 3 inches); very dark brown (7.5YR 2.5/2) medial loam; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; strongly acid (pH 5.2); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 2C1—7 to 13 centimeters (3 to 5 inches); stratified deposits of lithochromic very dark grayish brown (10YR 3/2) medial loamy very fine sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 2C2—13 to 17 centimeters (5 to 7 inches); stratified deposits of lithochromic dark grayish brown (10YR 4/2) medial loam; weak very thin platy structure; moderately hard, firm, nonsticky and nonplastic; common very fine and fine roots between pedis; common very fine and fine interstitial pores; neutral (pH 6.6); clear wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 2C3—17 to 18 centimeters (7 to 7.5 inches); stratified deposits of lithochromic very dark brown (50 percent 7.5YR 2.5/2 and 50 percent 10YR 2/2) medial loamy sand; massive; moderately hard, firm, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt broken boundary. (0 to 1 centimeter [0 to 0.5 inch] thick.)
- 2C4—18 to 20 centimeters (7.5 to 8 inches); stratified deposits of lithochromic very dark grayish brown (10YR 3/2) medial loamy very fine sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.2); abrupt broken boundary. (0 to 2 centimeters [0 to 1 inch] thick.)
- 2C5—20 to 36 centimeters (8 to 14 inches); lithochromic 25 percent black (N 2/0), 40 percent very dark brown (10YR 2/2), and 35 percent very dark brown (7.5YR 2.5/2) medial loamy fine sand and medial fine sand; weak thin platy structure; moderately hard, firm, nonsticky and nonplastic; few very fine and fine roots growing horizontally between plates; many very fine and fine interstitial pores between plates; slightly alkaline (pH 7.5); abrupt broken boundary. (0 to 16 centimeters [0 to 6 inches] thick.)
- 3R—36 centimeters (14 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 5 to 38 centimeters (2 to 15 inches).

Mean annual soil temperature: 12 to 15 degrees C (53 to 59 degrees F).

Content of rock fragments: 0 to 35 percent.

Soil reaction: Strongly acid to slightly acid.

2A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Medial sandy loam, medial loam, or medial silt loam.

Structure: Platy, subangular blocky, or granular.

2C horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 2 to 6 moist.

Texture: Medial loam, medial sandy loam, or medial fine sand.

Structure: Massive or platy.

Nakanui Series

The Nakanui series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash and gravel over basic pahoehoe lava (fig. 21). Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,016 millimeters (40 inches), and the mean annual air temperature is about 20 degrees C (68 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Lithic Haplustands.

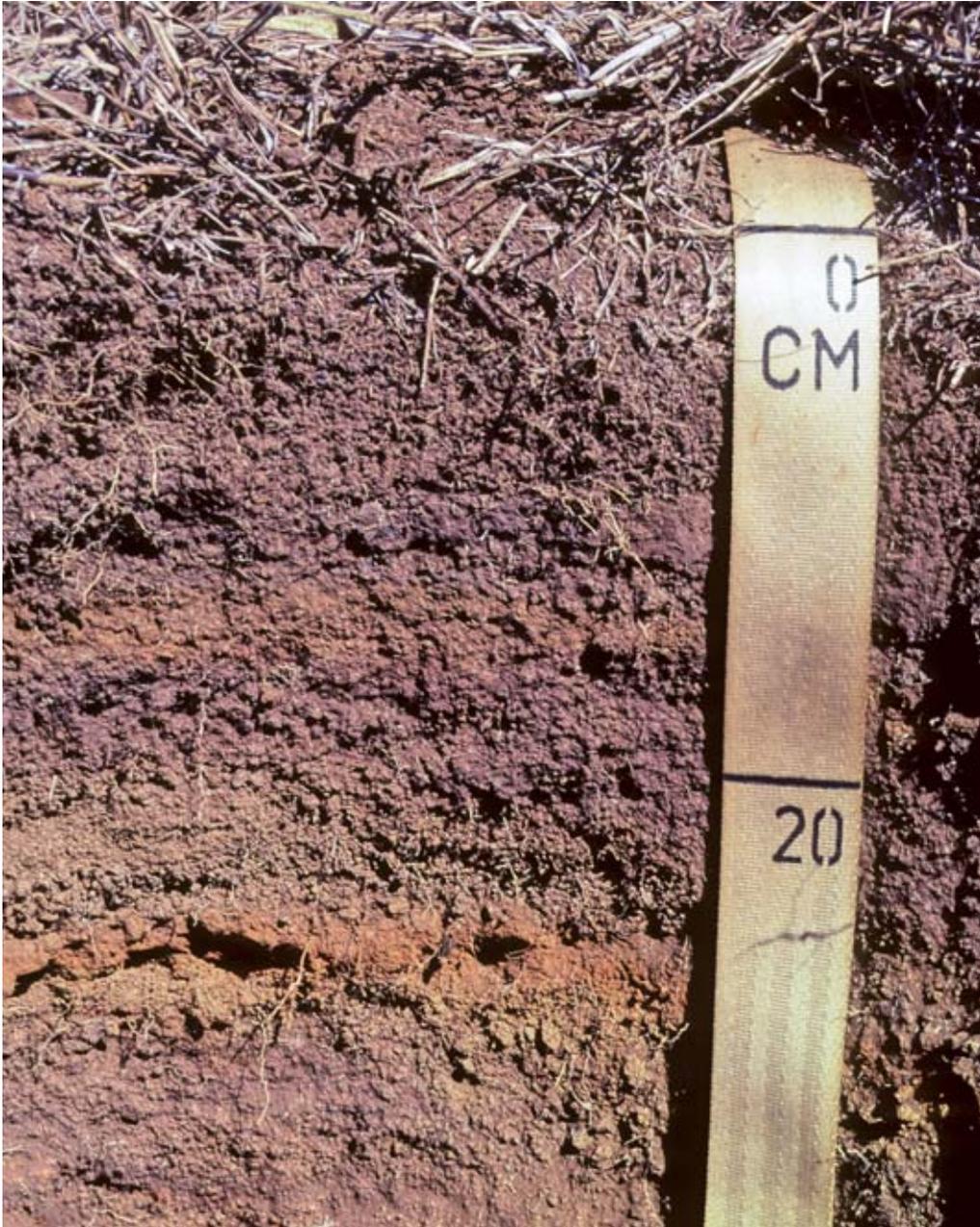


Figure 21.—Profile of Nakanui soils.

Typical pedon

Nakanui soil in an area of Nakanui-Lava flows complex, 2 to 10 percent slopes, under scattered trees and shrubs and a grass understory; located in Hawaii Volcanoes National Park; from the intersection of Crater Rim Drive and Chain of Craters Road, travel 4.3 miles southeast (down) on Chain of Craters Road; turn southwest on unnamed paved road and travel through gate; follow gravel road 0.85 mile to intersection; take south (left) fork and continue 1.7 miles to next intersection; take west (right) fork on firebreak road and travel 2.75 miles toward Kipuka Nene to Halape trailhead; travel on a heading of 200 degrees for 16 meters (26 feet) to type location; Kau Desert Quadrangle; lat. 19 degrees 19 minutes 25.75 seconds N. and long. 155 degrees 15 minutes 22.14 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 36 feet.)

- A—0 to 10 centimeters (0 to 4 inches); black (10YR 2/1) medial loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 5 percent subangular gravel; moderately acid (pH 5.8); abrupt wavy boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)
- 2A—10 to 15 centimeters (4 to 6 inches); black (10YR 2/1) very gravelly medial sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 40 percent subangular gravel; neutral (pH 6.7); abrupt wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 2Bw—15 to 18 centimeters (6 to 7 inches); black (7.5YR 2.5/1) very gravelly medial sandy loam, dark yellowish brown (10YR 3/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 50 percent subangular gravel; neutral (pH 6.7); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3A—18 to 23 centimeters (7 to 9 inches); black (10YR 2/1) very gravelly medial loamy coarse sand, very dark grayish brown (10YR 3/2) dry; massive; loose when moist and dry, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 55 percent subangular gravel; neutral (pH 7.0); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 3C—23 to 28 centimeters (9 to 11 inches); very dark brown (7.5YR 2.5/2) very gravelly medial loamy coarse sand, dark brown (10YR 3/3) dry; massive; loose when moist and dry, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 60 percent subangular gravel; neutral (pH 7.0); abrupt wavy boundary. (2.5 to 5 centimeters [1 to 2 inches] thick.)
- 4Bw1—28 to 30 centimeters (11 to 12 inches); dark brown (7.5YR 3/3) gravelly medial loam, strong brown (7.5YR 4/6) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 15 percent subangular gravel; neutral (pH 7.1); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 4Bw2—30 to 41 centimeters (12 to 16 inches); black (7.5YR 2.5/1) very gravelly medial sandy loam, very dark brown (7.5YR 2.5/3) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 45 percent subangular gravel; neutral (pH 7.1); abrupt wavy boundary. (0 to 5 centimeters [0 to 2 inches] thick.)
- 5Bw—41 to 46 centimeters (16 to 18 inches); 90 percent very dark brown (7.5YR 2.5/2) and 10 percent dark brown (7.5YR 3/4) medial loam, dark brown (7.5YR 3/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 10 percent subangular pahoehoe gravel, dominantly along the contact with the underlying

bedrock; neutral (pH 7.1); clear broken boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
6R—46 centimeters (18 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 4 to 20 inches

Mean annual soil temperature: 18 to 21 degrees C (64 to 70 degrees F).

Content of rock fragments: Average of less than 35 percent in the control section.

Soil reaction: Strongly acid to slightly acid.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 3 moist.

Texture in the fine-earth fraction: Medial loam, medial very fine sandy loam, or medial sandy loam.

Structure: Platy, subangular blocky, or granular.

Soil reaction: Strongly acid to slightly acid.

Content of rock fragments: 0 to 30 percent.

Content of Pele's hair: 0 to 5 percent, generally on the surface.

B horizon

Hue: 7.5YR or 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Medial loam, medial sandy loam, medial loamy sand, or medial fine sand.

Structure: Massive or subangular blocky.

Soil reaction: Moderately acid or slightly acid.

Content of rock fragments: 15 to 60 percent.

C horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Medial loam, medial sandy loam, medial loamy sand, medial loamy coarse sand, or medial fine sand.

Content of rock fragments: 15 to 60 percent.

Soil reaction: Moderately acid or slightly acid.

Buried 5A horizon

Occurring in depressional areas.

Nanaia Series

The Nanaia series consists of very shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,140 millimeters (45 inches), and the mean annual air temperature is about 21 degrees C (69 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Lithic Haplustands.

Typical pedon

Nanaia gravelly medial silt loam, on a west-facing, slightly concave slope of 2 percent, under grasses, at an elevation of 640 meters (2,100 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH

measured with electrode in 1:1 water. When described on July 1, 1993, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; about 1 mile west of Kahuku Ranch headquarters and 15 meters (50 feet) north of old highway; 152 meters (500 feet) east of bench mark 2097; Kahuku Quadrangle; lat. 19 degrees 4 minutes 8 seconds N. and long. 155 degrees 42 minutes 14 seconds W. (Old Hawaiian datum.)

A—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) gravelly medial silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; friable, slightly sticky and slightly plastic; many very fine and fine roots; 15 percent gravel; slightly acid (pH 6.4); clear wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)

Bw—5 to 15 centimeters (2 to 6 inches); very dark gray (10YR 3/1) medial silt loam, dark brown (7.5YR 3/2) dry; moderate fine subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine and fine roots; neutral (pH 6.8); abrupt wavy boundary. (2 to 20 centimeters [1 to 8 inches] thick.)

2R—15 centimeters (6 inches); hard pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 25 centimeters (2 to 10 inches).

Mean annual soil temperature: 19 to 22 degrees C (67 to 72 degrees F).

Content of rock fragments: 15 to 35 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Value: 2 to 3 moist and dry.

Chroma: 1 or 2 moist and dry.

Texture: Gravelly or cobbly medial silt loam or medial loam.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Soil reaction: Slightly acid or neutral (pH 6.1 to 7.3).

Bw horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist, 3 or 4 dry.

Chroma: 1 or 2 moist, 2 or 3 dry.

Texture: Medial silt loam or gravelly medial silt loam.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Ohaikea Series

The Ohaikea series consists of moderately deep, well drained soils that formed in basic volcanic ash deposited over pahoehoe lava. These soils are on the south-facing slopes of the Mauna Loa Volcano. Slopes range from 2 to 70 percent. The mean annual rainfall is about 1,524 millimeters (60 inches), and the mean annual air temperature is about 15 degrees C (59 degrees F).

Taxonomic classification: Medial, amorphic, isothermic Typic Haplustands.

Typical pedon

Ohaikea highly organic medial loam, on a slope of 5 percent, in an area of range with aalii shrubs, at an elevation of 1,372 meters (4,500 feet). (Colors are for moist soil unless otherwise noted. When described on December 14, 2005, the soil was moist throughout. All textures are "apparent field textures." pH was measured using an Oakton microprocessor based pH tester, 1:1 soil to water.) Island of Hawaii; from State Highway 11 in Kau, travel northwest on Mauna Loa Scenic Road approximately 5.5 miles to the second cattle grate; turn southeast onto a power line road and

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proceed 1.5 mile to gate for the Kapapala ranch; go through gate and proceed 400 feet; park and walk due east 170 feet to type location; Kilauea Crater Quadrangle; lat. 19 degrees 26 minutes 27.5 seconds N. and long. 155 degrees 21 minutes 07.5 seconds W. (Old Hawaiian datum; measured by Garmin GPS.)

- A—0 to 7 centimeters (0 to 3 inches); black (10YR 2/1) highly organic medial loam, very dark grayish brown (10YR 3/2) dry; moderate very fine granular structure; soft, friable, nonsticky and slightly plastic; many very fine and fine roots; common fine irregular pores; moderately smeary; slightly acid (pH 6.5); abrupt smooth boundary. (4 to 22 centimeters [2 to 9 inches] thick.)
- 2A—7 to 16 centimeters (3 to 6 inches); black (10YR 2/1) medial loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; moderately smeary; few very fine and fine roots; many very fine irregular pores; 2 percent subrounded gravel-size pumice; slightly acid (pH 6.3); abrupt smooth boundary. (6 to 9 centimeters [2 to 10 inches] thick.)
- 2Bw—16 to 30 centimeters (6 to 12 inches); very dark brown (10YR 2/2) medial sandy loam, brown (10YR 4/3) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine irregular pores; 2 percent subrounded gravel-size pumice; slightly acid (pH 6.3); abrupt wavy boundary. (4 to 14 centimeters [2 to 6 inches] thick.)
- 2Bw2—30 to 41 centimeters (12 to 16 inches); very dark brown (7.5YR 2.5/2) medial sandy loam, dark yellowish brown (10YR 4/4) dry; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine irregular and tubular pores; 10 percent subrounded gravel-size pumice; slightly acid (pH 6.3); abrupt wavy boundary. (4 to 6 centimeters [2 to 3 inches] thick.)
- 3A—41 to 49 centimeters (16 to 19 inches); black (10YR 2/1) medial silt loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; moderately smeary; few very fine and fine roots; common very fine irregular pores; slightly acid (pH 6.4); abrupt smooth boundary. (5 to 11 centimeters [2 to 4 inches] thick.)
- 3Bw1—49 to 58 centimeters (19 to 23 inches); very dark brown (7.5YR 2.5/2) medial loam, dark yellowish brown (10YR 4/6) dry; moderate very fine subangular blocky structure; soft, very friable, slightly sticky and plastic; moderately smeary; few fine roots; few very fine tubular pores; 10 percent subrounded gravel-size pumice; slightly acid (pH 6.4); abrupt smooth boundary. (7 to 10 centimeters [3 to 4 inches] thick.)
- 4A—58 to 75 centimeters (23 to 30 inches); black (10YR 2/1) medial silt loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; moderately smeary; few fine roots; few very fine tubular pores; 2 percent subrounded gravel-size pumice and 2 percent subangular cobbles; slightly acid (pH 6.5); abrupt smooth boundary. (6 to 17 centimeters [2 to 7 inches] thick.)
- 5R—75 centimeters (30 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 53 to 99 centimeters (21 to 39 inches).

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

Content of rock fragments: 15 to 30 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizons

Hue: 10YR or N.

Value: 2 or 2.5 moist.

Chroma: 0 to 2 moist.

Texture: Mucky medial loam, medial loam, medial silt loam, or medial sandy loam.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic.

Bw horizons

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 to 3 moist.

Texture: Medial loam, medial silt loam, medial sandy loam, or medial loamy sand.

Wet consistence: Nonsticky or slightly sticky and nonplastic or slightly plastic

Ohia Series

The Ohia series consists of deep, well drained soils that formed in volcanic ash over pahoehoe or aa lava. Slopes range from 3 to 10 percent. The mean annual rainfall is about 4,064 millimeters (160 inches), and the mean annual air temperature is about 19 degrees C (66 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, isothermic Acrudoxic Hydrudands.

Typical pedon

Ohia hydrous silty clay loam, on a slope of 5 percent, in a pasture, at an elevation of 603 meters (1,980 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, on Kubojiri farm, about 1.6 miles southwest of Mountain View Post Office; Puu Makaala Quadrangle; lat. 19 degrees 31 minutes 56 seconds N. and long. 155 degrees 08 minutes 4 seconds W. (Old Hawaiian datum.)

Ap1—0 to 15 centimeters (0 to 6 inches); dark brown (7.5YR 3/2) hydrous silty clay loam; moderate medium and very fine subangular blocky structure; friable, slightly sticky and moderately plastic; weakly smeary; matted roots; many medium and fine pores; extremely acid (pH 4.1); clear wavy boundary.

Ap2—15 to 23 centimeters (6 to 9 inches); dark brown (7.5YR 3/2) hydrous silty clay loam; common fine distinct dark reddish brown (5YR 3/4) mottles; moderate fine and very fine subangular blocky structure; friable, slightly sticky and moderately plastic; weakly smeary; many roots; many very fine and fine pores; extremely acid (pH 4.3); abrupt wavy boundary. (Combined thickness of the Ap horizons ranging from 18 to 25 centimeters [7 to 10 inches].)

Bw1—23 to 33 centimeters (9 to 13 inches); dark reddish brown (5YR 3/3) hydrous silty clay loam; weak fine subangular blocky structure; friable, slightly sticky and moderately plastic; strongly smeary; many roots; many very fine to coarse pores; strongly acid (pH 5.1); abrupt wavy boundary.

Bw2—33 to 58 centimeters (13 to 23 inches); dark reddish brown (5YR 3/3) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; friable, moderately sticky and moderately plastic; strongly smeary; common roots; common very fine pores; moderately acid (pH 5.7); abrupt wavy boundary.

Bw3—58 to 81 centimeters (23 to 32 inches); dark reddish brown (5YR 3/4) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; friable, moderately sticky and moderately plastic; strongly smeary; common roots; common fine and very fine pores; moderately acid (pH 6.0); clear wavy boundary.

Bw4—81 to 157 centimeters (32 to 62 inches); dark brown (7.5YR 3/2) hydrous silty clay loam; moderate fine and very fine subangular blocky structure; firm, slightly sticky and moderately plastic; strongly smeary; few roots; common very fine pores; common firm and very firm volcanic ash fragments; moderately acid (pH

6.0); abrupt smooth boundary. (Combined thickness of the Bw horizons ranging from 75 to more than 135 centimeters [30 to more than 53 inches].)
2R—157 centimeters (62 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 102 to more than 152 centimeters (40 to more than 60 inches).

Content of rock fragments: 0 to 30 percent, by volume, throughout the profile; typically, cobbles concentrated in the lower horizons.

Volcanic ash: Some pedons have thin bands of highly weathered, weakly cemented volcanic ash at a depth of 51 to 127 centimeters (20 to 50 inches).

Soil reaction: Extremely acid to slightly acid.

Mean annual soil temperature: 16 to 22 degrees C (61 to 72 degrees F).

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Medial or hydrous silt loam or silty clay loam.

Smeariness: Weakly smeary or moderately smeary.

Soil reaction: Extremely acid to moderately acid (pH 4.0 to 5.6).

Mottles: May or may not occur.

Bw horizons

Hue: 2.5YR to 7.5YR.

Value: 3 or 4 moist.

Chroma: 2 to 4 moist.

Texture in the fine-earth fraction: Hydrous silt loam, silty clay loam, or loam.

Smeariness: Moderately smeary or strongly smeary.

Soil reaction: Strongly acid to slightly acid (pH 5.1 to 6.5).

Content of rock fragments: 0 to 65 percent below a depth of 60 centimeters (24 inches).

Oneula Series

The Oneula series consists of very deep, somewhat excessively drained soils that formed in basic volcanic ash deposited over basic aa lava. Slopes range from 2 to 10 percent. The mean annual rainfall is about 1,400 millimeters (55 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Sandy-skeletal, mixed, isomesic Vitrandic Udorthents.

Typical pedon

Oneula extremely stony medial loam, 2 to 10 percent slopes, under scattered ohia trees and shrubs; located in Hawaii Volcanoes National Park; from State Highway 11, follow Mauna Loa Strip Road north 4.3 miles to power line road; follow power line road south approximately 1.5 miles to ranch road; turn west (right) through locked gate onto ranch road paralleling Hawaii Volcanoes National Park fence; follow ranch road approximately 0.4 mile to big ohia tree on north (right) side of road; then travel on a heading of 205 degrees magnetic for about 20 meters (65 feet) to type location; Kilauea Crater Quadrangle; lat. 19 degrees 26 minutes 44.27 seconds N. and long. 155 degrees 21 minutes 47.07 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 320 feet.)

2C1/A—0 to 5 centimeters (0 to 2 inches); black (10YR 2/1) extremely stony medial loam, brown (10YR 4/3) dry; weak medium subangular blocky structure parting to

weak medium granular; slightly hard, friable, nonsticky and nonplastic; many very fine to medium and common coarse roots; many very fine and fine interstitial pores; 90 percent subrounded aa fragments (10 percent boulders, 30 percent stones, 45 percent cobbles, and 5 percent gravel); slightly acid (pH 6.4); clear irregular boundary. (0 to 10 centimeters [0 to 4 inches] thick.)

2C2—5 to 152 centimeters (2 to 60 inches); black (7.5YR 2/1) very cobbly sand, 50 percent dark reddish brown (5YR 2.5/2), 30 percent black (N 2/0), and 20 percent red (10R 4/6) dry; single grain; loose when dry and moist, nonsticky and nonplastic; common very fine and fine roots; many very fine to coarse interstitial pores; 85 percent subrounded aa fragments (5 percent stones, 40 percent cobbles, and 40 percent gravel); slightly acid (pH 6.4).

Range in characteristics

Mean annual soil temperature: 10 to 15 degrees C (50 to 59 degrees F).

Content of rock fragments: 80 to 90 percent.

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture in the fine-earth fraction: Medial sandy loam, medial loam, or medial silt loam.

Structure: Mainly subangular blocky or granular; less commonly platy.

C horizon

Hue: 2.5YR to 10YR, 10R, or N.

Value: 2 to 4 moist.

Chroma: 0 to 6 moist.

Texture in the fine-earth fraction: Sand or coarse sand derived from aa lava.

Pahipa Series

The Pahipa series consists of moderately deep, well drained soils that formed in basic volcanic ash in aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Hydrous-skeletal, ferrihydritic, isomesic Thaptic Hydrudands.

Typical pedon

Pahipa hydrous silty clay loam, on a south-facing, slightly convex slope of 4 percent, under forest vegetation, at an elevation of 1,429 meters (4,687 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on December 15, 1999, the soil was moist throughout.) Island of Hawaii, Hawaii County, Hawaii; from Kahuku Ranch headquarters, drive 0.9 mile east on State Highway 11, turn north onto ranch road and drive upslope 6.8 miles, and turn east and drive 1.3 miles to eastern edge of 1926 lava flow; pedon is located 168 meters (550 feet) east in Kau Forest Reserve at an elevation of 1,429 meters (4,687 feet); Puu O Keokeo Quadrangle; lat. 19 degrees 9 minutes 35.2 seconds N. and long. 155 degrees 40 minutes 54.0 seconds W. (GPS PLGR +/- 45 feet, old Hawaiian datum.)

Oe—0 to 5 centimeters (0 to 2 inches); moderately decomposed plant material; abrupt smooth boundary. (3 to 8 centimeters [1 to 3 inches] thick.)

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- A—5 to 20 centimeters (2 to 8 inches); dark brown (7.5YR 3/2) hydrous silty clay loam; strong very fine and fine granular structure; very friable, slightly sticky and slightly plastic; moderately smeary; many very fine and fine and common medium roots; many very fine interstitial and irregular pores; 5 percent angular gravel and 5 percent angular cobbles; slightly acid (pH 6.1); clear wavy boundary. (15 to 23 centimeters [6 to 9 inches] thick.)
- 2A—20 to 41 centimeters (8 to 16 inches); black (10YR 2/1) gravelly highly organic hydrous silt loam; moderate very fine and fine subangular blocky structure; very friable, moderately sticky and moderately plastic; moderately smeary; common very fine and fine roots; few very fine irregular pores; 15 percent angular gravel and 5 percent angular cobbles; moderately acid (pH 5.8); clear smooth boundary.
- 2Bw1/3C1—41 to 76 centimeters (16 to 30 inches); dark brown (10YR 3/3) very cobbly hydrous silty clay loam; moderate fine subangular blocky structure; friable, moderately sticky and moderately plastic; moderately smeary; common very fine and fine roots; common very fine irregular and vesicular pores; 20 percent angular gravel and 30 percent angular cobbles; slightly acid (pH 6.2); gradual wavy boundary.
- 3C2/2Bw2—76 to 99 centimeters (30 to 39 inches); dark brown (10YR 3/3) extremely cobbly hydrous silty clay loam; weak very fine and fine subangular blocky structure; friable, moderately sticky and moderately plastic; moderately smeary; few very fine and fine roots; common very fine irregular and vesicular pores; 30 percent angular gravel and 35 percent angular cobbles; slightly acid (pH 6.2); abrupt wavy boundary. (Combined thickness of the Bw horizons ranging from 50 to 80 centimeters [20 to 31 inches].)
- 3R—99 centimeters (39 inches); hard, massive aa bluerock.

Range in characteristics

Depth to bedrock: 50 to 102 centimeters (20 to 40 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: 35 to 65 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Chroma: 1 or 2 moist.

Texture: Highly organic hydrous silt loam, cobbly hydrous silt loam, or hydrous silty clay loam.

Structure: Weak or strong granular.

Smeariness: Weakly smeary or moderately smeary.

Rupture resistance: Very friable or friable.

Stickiness: Slightly sticky or moderately sticky.

Plasticity: Nonplastic or slightly plastic.

2A horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Rupture resistance: Very friable or friable.

Plasticity: Slightly plastic or moderately plastic.

2Bw1/3C1 and 3C2/2Bw2 horizons

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Texture: Very cobbly or extremely cobbly hydrous silty clay loam.

Pakini Series

The Pakini series consists of deep and very deep, well drained soils that formed in basic volcanic ash. Slopes range from 2 to 10 percent. The mean annual rainfall is about 640 millimeters (25 inches), and the mean annual air temperature is about 23 degrees C (74 degrees F).

Taxonomic classification: Medial, amorphic, isohyperthermic Typic Haplotorrands.

Typical pedon

Pakini medial very fine sandy loam, 2 to 10 percent slopes, in a pasture; located on Island of Hawaii, Hawaii; about 274 meters (900 feet) east of the old tracking station near South Point, Kau; Ka Lae Quadrangle; lat. 18 degrees 56 minutes 30 seconds N. and long. 155 degrees 40 minutes 57 seconds W.

Ap—0 to 8 centimeters (0 to 3 inches); dark grayish brown (10YR 4/2) medial very fine sandy loam, very dark brown (10YR 2/2) moist; weak medium platy structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; 5 percent gravel; neutral (pH 7.1); abrupt smooth boundary. (5 to 10 centimeters [2 to 4 inches] thick.)

A1—8 to 20 centimeters (3 to 8 inches); dark yellowish brown (10YR 4/4) medial very fine sandy loam, dark brown (7.5YR 3/3) moist; weak medium and coarse prismatic structure; slightly hard, friable, nonsticky and nonplastic; many fine roots; 5 percent gravel; neutral (pH 7.1); clear wavy boundary. (10 to 13 centimeters [4 to 5 inches] thick.)

A2—20 to 41 centimeters (8 to 16 inches); yellowish brown (10YR 5/4) medial very fine sandy loam, brown (7.5YR 4/4) moist; weak coarse prismatic structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; 5 percent gravel; neutral (pH 7.2); clear wavy boundary. (18 to 25 centimeters [7 to 10 inches] thick.)

Bw1—41 to 74 centimeters (16 to 29 inches); strong brown (7.5YR 5/6) medial loam, brown (7.5YR 4/4) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common olivine sand; slightly alkaline (pH 7.6); gradual wavy boundary. (25 to 46 centimeters [10 to 18 inches] thick.)

Bw2—74 to 114 centimeters (29 to 45 inches); yellowish brown (10YR 5/6) medial loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; 2 percent gravel; few distinct white coatings of calcium carbonate on vertical prism faces and in pores; slightly alkaline (pH 7.7); gradual wavy boundary. (31 to 51 centimeters [12 to 20 inches] thick.)

Ck—114 to 152 centimeters (45 to 60 inches); yellowish brown (10YR 5/6) medial very fine sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; slightly effervescent and, in a few pockets, violently effervescent; the amount of calcium carbonate increases with increasing depth; slightly alkaline (pH 7.7).

Range in characteristics

Depth to bedrock: 102 to 152 centimeters (40 to 60 inches) or more.

Depth to the Ck horizon: 76 to 140 inches (30 to 55 inches).

Mean annual soil temperature: 22 to 24 degrees C (72 to 76 degrees F).

Content of rock fragments: 0 to 15 percent, by volume, gravel and cobbles in the pedon as a whole.

Sand: Thin layers high in content of olivine sand are common at a depth of 25 to 125 centimeters (10 to 50 inches).

A horizon

Hue: 7.5YR or 10YR.
Value: 2 to 4 moist, 4 or 5 dry.
Chroma: 2 to 4 moist and dry.
Structure: Weak platy or weak prismatic.
Soil reaction: Neutral or slightly alkaline.

Bw horizon

Value: 3 to 5 moist and dry.
Chroma: 4 to 6 moist and dry.

Ck horizon

Effervescence: Slightly effervescent to violently effervescent.

Pekailio Series

The Pekailio series consists of deep and very deep, well drained soils that formed in basic volcanic ash deposited over aa lava. These soils are on slopes of the Mauna Loa Volcano. Slopes range from 3 to 20 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 15 degrees C (59 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isothermic Typic Hapludands.

Typical pedon

Pekailio stony medial loam, on a slope of 14 percent, in an area of range with occasional ohia lehua trees and shrubs, at an elevation of 1,315 meters (4,315 feet). (Colors are for moist soil unless otherwise noted. When described on August 9, 2000, the soil was moist throughout. All textures are "apparent field textures." pH was measured using organic dyes.) Island of Hawaii; from State Highway 11 in Kau, travel north on Piimauna Road toward Volcano Golf Course for 1.0 mile; at Keauhou Ranch gate, continue straight onto Puu Oo trail for approximately 1.1 miles to a rock-loading chute; pull off on east side of road and park; travel due north over fence for 110 meters (360 feet) to road cut and type location; Kilauea Crater Quadrangle; lat. 19 degrees 27 minutes 42 seconds N. and long. 155 degrees 17 minutes 51 seconds W. (Old Hawaiian datum +/- 12 feet; measured by GPS PLGR.)

- A—0 to 13 centimeters (0 to 5 inches); black (7.5YR 2.5/1) stony medial loam, very dark brown (7.5YR 2.5/2) dry; moderate fine and medium subangular blocky structure parting to weak fine granular; soft, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and common medium roots; many very fine and fine interstitial and tubular pores; 5 percent dark reddish brown (2.5YR 3/4 and 5YR 3/4), soft to hard, gravel-size cinders; 15 percent subangular aa stones, and 5 percent subangular aa gravel; strongly acid (pH 5.4); abrupt smooth boundary. (5 to 25 centimeters [2 to 10 inches] thick.)
- Bw1—13 to 30 centimeters (5 to 12 inches); black (7.5YR 2.5/1) stony medial loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; weakly smeary; common very fine to medium roots; many very fine and fine interstitial and tubular pores; 5 percent dark reddish brown (2.5YR 3/4 and 5YR 3/4), soft to hard, gravel-size cinders; 15 percent subangular aa stones, 5 percent subangular aa cobbles, and 5 percent subangular aa gravel; moderately acid (pH 5.8); abrupt wavy boundary. (5 to 23 centimeters [2 to 9 inches] thick.)
- 2C1/Bw2—30 to 56 centimeters (12 to 22 inches); black (7.5YR 2.5/1) extremely cobbly medial loam, dark brown (7.5YR 3/4) dry; weak fine granular structure;

soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; 5 percent dark reddish brown (2.5YR 3/4 and 5YR 3/4), soft to hard, gravel-size cinders; 10 percent aa stones, 45 percent subangular aa cobbles, and 20 percent subangular aa gravel; moderately acid (pH 6.0); abrupt wavy boundary. (5 to 41 centimeters [2 to 16 inches] thick.)

2C2/Bw3—56 to 86 centimeters (22 to 34 inches); black (7.5YR 2.5/1) extremely gravelly medial loam, dark brown (7.5YR 3/4) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; 5 percent dark reddish brown (2.5YR 3/4 and 5YR 3/4), soft to hard, gravel-size cinders; 10 percent aa stones, 30 percent subangular aa cobbles, and 40 percent subangular aa gravel; moderately acid (pH 6.0); clear wavy boundary. (5 to 41 centimeters [2 to 16 inches] thick.)

2C—86 to 152 centimeters (34 to 60 inches); very dark brown (7.5YR 2.5/2) extremely stony ashy coarse sand, dark grayish brown (10YR 4/2) dry; single grain; loose when dry and moist, nonsticky and nonplastic; nonsmeary; few very fine and fine roots; many very fine and fine and common medium and coarse interstitial pores; 30 percent subangular aa stones, 30 percent angular aa cobbles, and 35 percent subangular aa gravel; neutral (pH 6.8). (23 to 127 centimeters [9 to 50 inches] thick.)

Range in characteristics

Depth to bedrock: 102 to more than 152 centimeters (40 to more than 60 inches).

Content of rock fragments: Average of 50 to 85 percent in the control section.

Soil reaction: Strongly acid in the surface horizon and moderately acid to neutral in underlying horizons.

Soil moisture: The soils are typically moist, but the control section may undergo periodic drying, most likely in summer.

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

A horizon

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 or 2 moist.

Texture: Medial loam, cobbly medial loam, or stony medial loam

Bw horizon

Hue: 7.5YR or 10YR.

Value: 1 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Stony, cobbly, or gravelly medial loam or medial sandy loam; very stony, cobbly, or gravelly medial loam or medial sandy loam; extremely stony, cobbly, or gravelly medial loam or medial sandy loam.

C horizon

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 2 moist.

Texture: Extremely stony or cobbly or gravelly ashy coarse sand.

Content of rock fragments: 35 to 95 percent.

Voids: 0 to 10 percent.

Piihonua Series

The Piihonua series consists of deep and very deep, well drained soils that formed in volcanic ash. These soils are on uplands. Slopes range from 0 to 35 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, isomesic Acrudoxic Hydudands.

Typical pedon

Piihonua hydrous silty clay loam, on a slope of 10 percent, under forest vegetation, at an elevation of 1,682 meters (5,518 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Hawaii County, Hawaii; from the main administrative building at the Kulani honor camp, follow the Kulani cone road south toward the cinder cone with a tower on top; stop at dead end, turn west, and follow road around the side of and to the top of the cone; type location is 20 meters south of the tower; Kulani Quadrangle; lat. 19 degrees 31 minutes 24 seconds N. and long. 155 degrees 18 minutes 7 seconds W. (Old Hawaiian datum +/- 12 feet; measured by Garmin GPS.)

A—0 to 18 centimeters (0 to 7 inches); very dark brown (10YR 2/2) hydrous silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; strongly smeary; common very fine and fine roots throughout; common very fine and fine irregular pores; very strongly acid (pH 4.4 by Bromcresol green); abrupt smooth boundary. (8 to 20 centimeters [3 to 8 inches] thick.)

Bw1—18 to 71 centimeters (7 to 28 inches); very dark brown (7.5YR 2.5/3) hydrous silty clay loam, very dark brown (7.5YR 2.5/2) dry; moderate very fine and fine subangular blocky structure; firm, very friable, slightly sticky and slightly plastic; strongly smeary; 10 percent dark reddish brown (2.5YR 3/4 or 5YR 3/4) angular gravel-size pumice in the lower part of the horizon; common very fine and fine roots throughout; common very fine and fine irregular pores; very strongly acid (pH 4.6 by Bromcresol green); abrupt smooth boundary. (43 to 64 centimeters [17 to 25 inches] thick.)

Bd—71 to 99 centimeters (28 to 39 inches); very dark brown (7.5YR 2.5/3) hydrous silty clay loam, very dark brown (7.5YR 2.5/2) dry; massive; friable, very firm, slightly sticky and slightly plastic; strongly smeary; few fine roots in cracks; few very fine and fine tubular pores; strongly acid (pH 5.2 by Bromcresol green); abrupt smooth boundary. (18 to 30 centimeters [7 to 12 inches] thick.)

Bw2—99 to 152 centimeters (39 to 60 inches); very dark brown (7.5YR 2.5/3) hydrous silty clay loam, strong brown (7.5YR 4/6) dry; weak fine subangular blocky structure; firm, very friable, slightly sticky and slightly plastic; strongly smeary; few fine roots throughout; few very fine and fine tubular pores; strongly acid (pH 5.2 by Bromcresol green); abrupt smooth boundary. (53 to 66 centimeters [21 to 26 inches] thick.)

Range in characteristics

Depth to bedrock: 100 centimeters or more (40 inches or more).

Depth to cemented volcanic ash: 28 to 71 centimeters (11 to 28 inches).

Soil reaction: Very strongly acid to moderately acid.

Soil moisture: The soils are typically moist, but the control section may undergo periodic drying, most likely in the period April to October.

Oa horizon (where present)

Hue: 7.5YR or 10YR.

Value: 2 or 2.5 moist.

Chroma: 1 or 2 moist.
Texture: Highly decomposed plant material.

A horizon

Hue: 7.5YR or 10YR.
Value: 2 or 2.5 moist.
Chroma: 2 or 3 moist.
Texture: Hydrous loam, hydrous silt loam, or hydrous silty clay loam; may be highly organic.

Bw horizons

Hue: 2.5YR or 10YR.
Value: 2.5 or 3 moist.
Chroma: 2 to 6 moist.
Texture: Hydrous silt loam, hydrous loam, or silty clay loam.
Content of pararock fragments: 0 to 15 percent gravel-size pumice

Bd horizon

Hue: 2.5YR to 7.5YR.
Value: 2.5 or 3 moist.
Chroma: 3 or 4 moist.
Texture: Hydrous sandy loam, hydrous silt loam, hydrous loam, or hydrous silty clay loam.
Cementation: Extremely weakly cemented to weakly cemented.

Puali Series

The Puali series consists of very shallow and shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 2,032 millimeters (80 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Hydrous, ferrihydritic, isomesic Lithic Hydrudands.

Typical pedon

Puali highly organic hydrous silt loam, on a southeast-facing, concave slope of 4 percent, under forest vegetation, at an elevation of 1,357 meters (4,450 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures." pH measured with organic dyes. When described on December 15, 1999, the soil was moist to a depth of 41 centimeters [16 inches] and wet below that depth.) Island of Hawaii, Hawaii County, Hawaii; from Kahuku Ranch headquarters, drive 0.9 mile east on Highway 11, turn north onto ranch road and drive upslope 6.8 miles, turn east and drive 1.3 miles to eastern edge of 1926 lava flow, turn south and drive downslope for 0.4 mile; pedon is located 216 meters (710 feet) east in Kau Forest Reserve; Puu O Keokeo Quadrangle; lat. 19 degrees 9 minutes 9.3 seconds N. and long. 155 degrees 40 minutes 46.4 seconds W. (Old Hawaiian datum.)

Oe—0 to 10 centimeters (0 to 4 inches); moderately decomposed plant material; abrupt smooth boundary. (3 to 10 centimeters [1 to 4 inches] thick.)

A—10 to 25 centimeters (4 to 10 inches); black (10YR 2/1) highly organic hydrous silt loam; moderate fine and medium granular structure; very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine and few medium roots; many very fine and fine irregular and many very fine vesicular pores; moderately acid (pH 5.8); abrupt smooth boundary. (13 to 18 centimeters [5 to 7 inches] thick.)

- Bw—25 to 46 centimeters (10 to 18 inches); 75 percent dark brown (7.5YR 3/2) cobbly hydrous silty clay loam; moderate very fine and fine subangular blocky structure; friable, moderately sticky and moderately plastic; moderately smeary; common very fine and fine and few coarse roots; many very fine and fine irregular and common very fine tubular pores; 5 percent subangular gravel and 15 percent subangular cobbles; slightly acid (pH 6.1); abrupt irregular boundary. (20 to 25 centimeters [8 to 10 inches] thick.)
- 2R—46 centimeters (18 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

Content of rock fragments: 5 to 20 percent, by volume, gravel- or cobble-size lava rocks in the pedon as a whole.

A horizon

Chroma: 1 or 2 moist.

Texture: Highly organic hydrous silt loam or silty clay loam.

Structure: Weak or strong granular.

Smeariness: Weakly smeary or moderately smeary.

Rupture resistance: Very friable or friable.

Stickiness: Slightly sticky or moderately sticky.

Plasticity: Nonplastic or slightly plastic.

Bw horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 2 or 3 moist.

Rupture resistance: Very friable or friable.

Plasticity: Slightly plastic or moderately plastic.

Puaulu Series

The Puaulu series consists of deep and very deep, moderately well drained soils that formed in basic volcanic ash deposited over basic lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 3,685 millimeters (145 inches), and the mean annual air temperature is about 14 degrees C (57 degrees F).

Taxonomic classification: Medial over ashy, aniso, ferrihydritic over amorphic, isothermic Aquic Hapludands.

Typical pedon

Puaulu hydrous silt loam, 2 to 20 percent slopes, under rain forest vegetation; from State Highway 11, travel 2.2 miles northwest on State Highway 148 (Wright Road) to the Olaa tract of Hawaii Volcanoes National Park; continue on State Highway 148 for 0.1 mile to "road narrows" sign; walk east to fence, then north along fence for about 25 feet; cross fence at fallen tree and take a heading of 15 degrees magnetic for about 22 feet to type location; Volcano Quadrangle; lat. 19 degrees 27 minutes 38.86 seconds N. and long. 155 degrees 14 minutes 51.84 seconds W. (Old Hawaiian datum; position measured by GPS PLGR.)

A—0 to 8 centimeters (0 to 3 inches); dark reddish brown (5YR 3/2) hydrous silt loam; weak very fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and

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- fine interstitial pores; 10 percent gravel; strongly acid (pH 5.1); abrupt wavy boundary.
- Bw—8 to 22 centimeters (3 to 9 inches); dark reddish brown (5YR 3/2) medial silt loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial pores; 5 percent gravel; strongly acid (pH 5.1); clear wavy boundary.
- Cg—22 to 30 centimeters (9 to 12 inches); dark brown (7.5YR 3/2) ashy sandy loam; massive; friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial pores; common medium prominent irregular red (2.5YR 4/6) redoximorphic concentrations; slightly acid (pH 6.5); abrupt wavy boundary.
- Cd1—30 to 38 centimeters (12 to 15 inches); lithochromic very dark grayish brown (10YR 3/2) ashy sand; massive; firm, nonsticky and nonplastic; nonsmeary; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 7.0); abrupt discontinuous boundary.
- Cd2—38 to 47 centimeters (15 to 18.5 inches); lithochromic black (10YR 2/1) ashy sand; massive; firm, nonsticky and nonplastic; nonsmeary; few very fine and fine roots; many very fine and fine interstitial pores; 10 percent subrounded gravel; neutral (pH 6.9); abrupt smooth boundary.
- 2A/Bw—47 to 52 centimeters (18.5 to 20.5 inches); dark reddish gray (5YR 4/2) medial silt loam; weak very fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); abrupt wavy boundary.
- 3A—52 to 55 centimeters (20.5 to 21.5 inches); black (N 2/0) medial silt loam; weak very fine subangular blocky structure; friable, slightly sticky and slightly plastic; moderately smeary; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.4); clear wavy boundary. (0 to 5 centimeters thick).
- 3Bw1—55 to 61 centimeters (21.5 to 24 inches); black (5YR 2.5/2) medial silt loam; weak very fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.5); abrupt smooth boundary. (3 to 10 centimeters thick).
- 3Bw2—61 to 71 centimeters (24 to 28 inches); dark reddish brown (5YR 2/2) medial sandy clay loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine interstitial pores; 3 percent gravel; neutral (pH 6.6); abrupt smooth boundary.
- 4A—71 to 75 centimeters (28 to 29.5 inches); black (10YR 2/1) hydrous silt loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; neutral (pH 6.6); clear wavy boundary.
- 4Bw—75 to 78 centimeters (29.5 to 31 inches); dark reddish brown (5YR 3/2) medial silty clay loam; weak very fine subangular blocky structure; firm, moderately sticky and slightly plastic; moderately smeary; very few very fine roots; many very fine and fine interstitial pores; common patchy pressure faces; neutral (pH 6.6); clear smooth boundary.
- 5A—78 to 82 centimeters (31 to 32.5 inches); black (5YR 2/1) medial silty clay loam; weak very fine subangular blocky structure; firm, moderately sticky and slightly plastic; moderately smeary; many very fine and common fine roots; many very fine and fine interstitial pores; common distinct dark reddish brown (5YR 3/4) redoximorphic concentrations between peds; neutral (pH 6.6); clear smooth boundary.

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- 5Bw—82 to 86 centimeters (32.5 to 34 inches); dark reddish brown (5YR 3/2) medial silt loam; weak fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; moderately smeary; many very fine and common medium roots; many very fine and fine interstitial pores; 5 percent gravel; moderately acid (pH 6.0); abrupt wavy boundary.
- 6A—86 to 89 centimeters (34 to 35 inches); black (5YR 2/1) medial silt loam; weak fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.7); abrupt wavy boundary.
- 6Bw—89 to 94 centimeters (35 to 37 inches); dark brown (7.5YR 3/3) very gravelly medial sandy clay loam; weak fine and medium subangular blocky structure; friable, moderately sticky and slightly plastic; moderately smeary; few very fine and fine roots; many very fine and fine interstitial pores; common fine and medium prominent yellowish red (5YR 4/6) redoximorphic concentrations in cracks; 50 percent gravel; moderately acid (pH 5.8); abrupt wavy boundary.
- 7A—94 to 96 centimeters (37 to 38 inches); black (5YR 2/1) hydrous silt loam; weak very fine granular structure; friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.6); abrupt broken boundary.
- 7Bw1—96 to 104 centimeters (38 to 41 inches); dark reddish brown (5YR 3/3) extremely gravelly medial sandy clay loam; massive; friable, moderately sticky and slightly plastic; moderately smeary; few very fine and fine roots; many very fine and fine interstitial pores; 70 percent gravel; moderately acid (pH 5.8); abrupt wavy boundary.
- 8Bw2—104 to 110 centimeters (41 to 43.5 inches); dark brown (7.5YR 3/2) hydrous silty clay loam; weak fine subangular blocky structure; friable, moderately sticky and slightly plastic; weakly smeary; few very fine and fine roots; many very fine and fine interstitial pores; many fine and medium faint dark reddish brown (5YR 3/3) redoximorphic concentrations throughout; moderately acid (pH 5.7); clear smooth boundary.
- 9Bw3—110 to 121 centimeters (43.5 to 47.5 inches); dark reddish brown (5YR 2/2) medial silty clay loam; weak fine subangular blocky structure; friable, moderately sticky and slightly plastic; weakly smeary; very few very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.5); clear wavy boundary.
- 10Bw4—121 to 130 centimeters (47.5 to 51 inches); dark brown (7.5YR 3/3) medial sandy clay loam; massive; friable, weakly brittle, moderately sticky and slightly plastic; moderately smeary; very few very fine and fine roots; many very fine and fine interstitial pores; 5 percent gravel; moderately acid (pH 5.6); clear smooth boundary.
- 10Bw5—130 to 135 centimeters (51 to 53 inches); dark brown (7.5YR 3/3) medial sandy clay loam; massive; friable, moderately sticky and slightly plastic; moderately smeary; very few very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.6); clear wavy boundary.
- 10Bw6—135 to 152 centimeters (53 to 60 inches); dark brown (7.5YR 3/3) medial sandy clay loam; weak fine subangular blocky structure; friable, moderately sticky and slightly plastic; moderately smeary; very few very fine and fine roots; many very fine and fine interstitial pores; strongly acid (pH 5.4).

Range in characteristics

Mean annual soil temperature: 15 to 18 degrees C (59 to 64 degrees F).

Content of rock fragments: Typically, less than 10 percent gravel or pumice; as much as 95 percent in some B and C horizons.

Buried horizon: Occurring in all pedons, but not all pedons have the same buried horizons.

Brittle horizon: Occurring in most pedons.

Indurated ash: Occurring in some pedons.

Soil reaction: Strongly acid to extremely acid in the surface and subsurface layers and neutral to strongly acid in the underlying layers.

A horizon

Hue: 5YR, 7.5YR, 10YR, or N.

Value: 2 to 4 moist.

Chroma: 0 to 2 moist.

Structure: Granular or subangular blocky.

B horizon

Hue: 5YR to 10YR.

Value: 2 to 4 moist.

Chroma: 2 to 4 moist.

Texture in the fine-earth fraction: Medial silt loam, medial sandy clay loam, or medial silty clay loam.

Structure: Subangular blocky, granular, or single grain.

Bsm horizon

Occurs in some pedons; stratigraphically located within the 10Bw horizon zone.

C horizon

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Ashy sand or ashy loamy sand.

Structure: Massive or single grain.

Cemented (Cm) horizon

Occurring in some pedons.

Puhimau Series

The Puhimau series consists of very shallow and shallow, moderately well drained soils that formed in volcanic ash deposited over pahoehoe lava (fig. 22). Slopes range from 2 to 10 percent. The mean annual rainfall is about 2,489 millimeters (98 inches), and the mean annual air temperature is about 16 degrees C (61 degrees F).

Taxonomic classification: Ashy, amorphic, isothermic Lithic Hapludands.

Typical pedon

Puhimau ashy silt loam, 2 to 10 percent slopes, under rain forest vegetation; located in Hawaii Volcanoes National Park; from the main entrance, drive south on Crater Rim Drive and continue to Chain of Craters Road; turn south (left), follow Chain of Craters Road to Mauna Ulu Trailhead turnoff; follow road 0.1 mile to escape access road; go through gate and travel 2.8 miles (past the second gate at 2.65 miles); park at pulloff to the west; from west side of parking area, head 220 degrees for approximately 6 meters (19 feet) to type location; Volcano Quadrangle; lat. 19 degrees 24 minutes 00 seconds N. and long. 155 degrees 13 minutes 10 seconds W. (Position determined from USGS topographic quadrangle map.)

A—0 to 8 centimeters (0 to 3 inches); lithochromic black (7.5YR 2.5/1) ashy silt loam; moderate medium subangular blocky structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots; many very fine and fine interstitial and tubular pores; very strongly acid (pH 4.3); abrupt wavy boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)



Figure 22.—Profile of Puhimau soils.

Bw—8 to 14 centimeters (3 to 5.5 inches); 60 percent very dark brown (7.5YR 2.5/2) and 40 percent black (7.5YR 2.5/1) very gravelly ashy loamy coarse sand; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 60 percent subrounded

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- pyroclastic pebbles, half of which are 2 to 5 millimeters in size; slightly acid (pH 6.3); abrupt wavy boundary. (2.5 to 13 centimeters [1 to 5 inches] thick.)
- C—14 to 20 centimeters (5.5 to 8 inches); lithochromic dark grayish brown (10YR 4/2) ashy loam; massive; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; few very fine and fine roots; common very fine and fine interstitial pores; few fine distinct yellowish red (5YR 4/6) (moist) redoximorphic concentrations in root channels; 10 percent subrounded pyroclastic gravel; neutral (pH 6.6); abrupt irregular boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)
- 2Bw—20 to 28 centimeters (8 to 11 inches); dark reddish brown (5YR 3/2) ashy silt loam; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine to coarse roots; many very fine and fine interstitial pores; few fine faint yellowish red (5YR 4/6) redoximorphic concentrations; 1/4-inch, discontinuous, black (N 2/0) band throughout the horizon; 3 percent small fragments of placiclike material; neutral (pH 6.6); abrupt wavy boundary. (2.5 to 10 centimeters [1 to 4 inches] thick.)
- 2C—28 to 33 centimeters (11 to 13 inches); dark grayish brown (10YR 4/2) ashy loam; massive; slightly hard, friable, slightly sticky and nonplastic; many very fine and fine roots; common very fine and fine interstitial and tubular pores; common fine prominent yellowish red (5YR 4/6) redoximorphic concentrations; neutral (pH 6.6); clear wavy boundary. (0 to 15 centimeters [0 to 6 inches] thick.)
- 3R—33 centimeters (13 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 5 to 50 centimeters (2 to 20 inches).

Mean annual soil temperature: 15 to 18 degrees C (59 to 65 degrees F).

Soil reaction: Very strongly acid to slightly acid.

Underlying horizons: 2C and 3C horizons occurring in some pedons.

A horizon

Hue: 5YR, 7.5YR, or 10YR.

Chroma: 1 or 2 moist.

Structure: Granular or subangular blocky.

Bw horizon

Hue: N, 7.5YR, or 10YR.

Chroma: 0 to 2 moist.

Content of rock fragments: 45 to 60 percent gravel; more than half of the pebbles are 2 to 5 millimeters in size in most pedons.

C horizon

Chroma: 1 or 2 moist.

2Bw horizon

Texture: Ashy fine sandy loam, ashy loam, or ashy silt loam.

2C horizon

Value: 2 to 3 moist.

Chroma: 3 or 4 moist.

Placic material: Fragments of placiclike material occurring in some pedons.

3C horizon

Hue: 5YR, 7.5YR, or 10YR.

Value: 2 to 3 moist.

Chroma: 1 or 2 moist.

Texture: Ashy sand, ashy loamy coarse sand, ashy loamy sand, or ashy fine sandy loam.

4C horizon

Texture in the fine-earth fraction: Coarse sand.

Content of cinders: 65 to 90 percent.

Puiwa Series

The Puiwa series consists of moderately deep, well drained soils that formed in volcanic ash deposited over pahoehoe lava. Slopes range from 2 to 15 percent. The mean annual rainfall is about 1,499 millimeters (59 inches), and the mean annual air temperature is about 12 degrees C (54 degrees F).

Taxonomic classification: Medial, amorphic, isomesic Typic Hapludands.

Typical pedon

Puiwa soil in an area of Lava flows-Kaholimo-Puiwa complex, 2 to 15 percent slopes, under scattered trees, shrubs and grasses; located in Hawaii Volcanoes National Park; from State Highway 11, drive 11 miles north on Mauna Loa Strip Road to the end of the road; turn around and from the mileage sign travel 0.35 mile down Mauna Loa Strip Road to pullout; from southeast corner of pullout, take a 290-degree heading for about 22 meters (72 feet) to type location; Kipuka Pakekake Quadrangle; lat. 19 degrees 29 minutes 27.14 seconds N. and long. 155 degrees 23 minutes 19.78 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 49 feet.)

- A1—0 to 10 centimeters (0 to 4 inches); very dark brown (10YR 2/2) medial loam; strong fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine interstitial pores; moderately acid (pH 5.7); abrupt wavy boundary.
- A2—10 to 18 centimeters (4 to 7 inches); black (10YR 2/1) medial loam; moderate medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial pores; moderately acid (pH 5.9); abrupt wavy boundary. (Combined thickness of the A1 and A2 horizons ranging from 3 to 10 centimeters [1 to 4 inches].)
- A3—18 to 24 centimeters (7 to 9.5 inches); 40 percent black (10YR 2/1) and 60 percent very dark brown (10YR 2/2), stratified medial silt loam and medial loam; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine and few medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.0); abrupt broken boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- C—24 to 28 centimeters (9.5 to 11 inches); very dark grayish brown (10YR 3/2) medial fine sand; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.0); abrupt broken boundary. (0 to 8 centimeters [0 to 3 inches] thick.)
- 2Bw1—28 to 43 centimeters (11 to 17 inches); dark brown (7.5YR 3/3) medial silt loam; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine interstitial pores; slightly acid (pH 6.2); abrupt wavy boundary.
- 2Bw2—43 to 64 centimeters (17 to 25 inches); dark brown (7.5YR 3/3) medial silt loam; massive; hard, friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine and fine interstitial pores; 5 percent subrounded pahoehoe gravel; neutral (pH 6.9); abrupt wavy boundary.
- 2Bw3—64 to 96 centimeters (25 to 38 inches); dark brown (7.5YR 3/4) cobbly medial silt loam; massive; slightly hard, friable, slightly sticky and slightly plastic;

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common very fine and fine and few medium roots; common very fine and fine interstitial pores; 15 percent subrounded pahoehoe cobbles and 5 percent subrounded pahoehoe gravel; slightly acid (pH 6.5); clear wavy boundary. (Combined thickness of the Bw horizons ranging from 50 to 89 centimeters [20 to 35 inches].)

3R—96 centimeters (38 inches); hard pahoehoe bedrock.

Range in characteristics

Depth to bedrock: 20 to 40 inches.

Mean annual soil temperature: 11 to 15 degrees C (52 to 59 degrees F).

Soil reaction: Neutral to moderately acid.

A horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial loam or medial silt loam.

Structure: Granular or subangular blocky.

2B horizon

Hue: 2.5YR to 10YR.

Value: 2 to 6 moist.

Chroma: 1 to 6 moist.

Texture in the fine-earth fraction: Medial loam or medial silt loam.

Structure: Subangular blocky or massive.

3Bw horizon

Occurring in some pedons, especially at the lower elevations.

C horizon

A discontinuous C horizon occurs between the A3 and 2Bw horizons in a few pedons.

Puu Oo Series

The Puu Oo series consists of deep, well drained soils that formed in volcanic ash on uplands. Slopes range from 3 to 20 percent. The mean annual rainfall is about 1,780 millimeters (70 inches), and the mean annual air temperature is about 13 degrees C (56 degrees F).

Taxonomic classification: Medial over hydrous, ferrihydritic, isomesic Acrudoxic Hydrudands.

Typical pedon

Puu Oo medial silt loam, in a pasture. (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii; about 0.5 mile south of the corral near the Waipahoehoe gulch on Puu Oo Ranch; Puu Akala Quadrangle; lat. 19 degrees 46 minutes 20 seconds N. and long. 155 degrees 20 minutes 25 seconds W. (Position determined from old Hawaiian datum.)

A1—0 to 8 centimeters (0 to 3 inches); dark reddish brown (5YR 2/2) medial silt loam; moderate fine granular structure; friable, slightly sticky and plastic; weakly smeary; many roots; many very fine pores; strongly acid (pH 5.4); clear smooth boundary.

A2—8 to 15 centimeters (3 to 6 inches); very dark gray (5YR 3/1) medial silt loam; moderate fine subangular blocky structure; friable, slightly sticky and plastic;

weakly smeary; many roots; many fine pores; fine pieces of black charcoal; very strongly acid (pH 4.5); abrupt smooth boundary. (Combined thickness of the A horizons ranging from 13 to 25 centimeters [5 to 10 inches].)

- 2Bw1—15 to 23 centimeters (6 to 9 inches); dark reddish brown (5YR 3/3) hydrous silty clay loam; moderate fine subangular blocky structure; friable, sticky and plastic; moderately smeary; many roots; many fine pores; patchy gelatinlike coatings on faces of peds; extremely acid (pH 4.2); abrupt wavy boundary.
- 2Bw2—23 to 41 centimeters (9 to 16 inches); very dark brown (10YR 2/2) hydrous silty clay loam; moderate fine subangular blocky structure; friable, sticky and plastic; moderately smeary; many roots; many fine pores; thick gelatinlike coatings on faces of peds; very strongly acid (pH 4.8); abrupt smooth boundary.
- 2Bw3—41 to 56 centimeters (16 to 22 inches); variegated very dark brown (10YR 2/2), dark brown (7.5YR 4/4), very dark gray (N 3/0), and dark reddish brown (5YR 3/4) hydrous silty clay loam; massive; friable, sticky and plastic; strongly smeary; common roots; many fine pores; common firm, weakly cemented nodules of ash; very strongly acid (pH 5.0); abrupt smooth boundary.
- 2Bw4—56 to 69 centimeters (22 to 27 inches); very dark grayish brown (10YR 3/2) hydrous silty clay loam; moderate medium and fine subangular blocky structure; friable, sticky and plastic; strongly smeary; common roots; many fine pores; thick gelatinlike coatings on faces of peds; very strongly acid (pH 5.0); abrupt smooth boundary. (Combined thickness of the 2Bw horizons ranging from 46 to 64 centimeters [18 to 25 inches].)
- 3Bw5—69 to 127 centimeters (27 to 50 inches); variegated dark yellowish brown (10YR 3/4) and dark brown (7.5YR 4/4 and 3/2) medial sandy clay loam; massive; extremely firm, slightly sticky and plastic; weakly smeary; few roots; many fine pores; thick gelatinlike coatings on faces of peds; layer of weakly cemented volcanic ash and sand 2 to 4 inches thick; strongly acid (pH 5.3).

Range in characteristics

Depth to bedrock: 100 to 150 centimeters (40 to 60 inches).

Content of rock fragments: 0 to 20 percent, by volume, gravel- or cobble-size lava rocks throughout the profile (generally occurring in the lower part).

A horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture: Medial or hydrous silt loam or silty clay loam.

Bw horizons

Hue: 5YR to 10YR.

Value: 2 to 3 moist.

Chroma: 2 to 4 moist.

Mottle colors: Commonly occurring in the lower Bw horizons.

Puukala Series

The Puukala series consists of shallow, well drained soils that formed in basic volcanic ash over pahoehoe lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 890 millimeters (35 inches), and the mean annual air temperature is about 12 degrees C (53 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Lithic Haplustands.

Typical pedon

Puukala medial silt loam, 10 to 20 percent slopes, in a pasture, at an elevation of 1,311 meters (4,300 feet). (Colors are for moist soil unless otherwise noted. All textures are "apparent field textures.") Island of Hawaii, Hawaii County, Hawaii; from the Holualoa Post Office, drive north 0.5 mile to 4WD road; drive east and mauka (upslope) 4.5 miles; pedon is located 24 meters (80 feet) south of 4WD road; Kailua Quadrangle; lat. 19 degrees 43 minutes 1 second N. and long. 155 degrees 55 minutes 16 seconds W. (GPS PLGR; old Hawaiian datum.)

A1—0 to 8 centimeters (0 to 3 inches); very dark brown (7.5YR 2/2) medial silt loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; friable, slightly sticky and slightly plastic; many roots; many very fine pores; 10 percent cobbles; strongly acid (pH 5.3); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)

A2—8 to 15 centimeters (3 to 6 inches); very dark brown (10YR 2/2) cobbly medial silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine and very fine subangular blocky structure; friable, slightly sticky and slightly plastic; many roots; many fine pores; 30 percent cobbles; strongly acid (pH 5.4); abrupt wavy boundary. (5 to 8 centimeters [2 to 3 inches] thick.)

Bw1/2C1—15 to 36 centimeters (6 to 14 inches); very dark brown (7.5YR 2/2) very cobbly medial silt loam, very dark brown (10YR 2/2) dry; massive; loose, slightly sticky and slightly plastic; weakly smeary; many roots; many fine pores; 45 percent cobbles; moderately acid (pH 5.8); abrupt wavy boundary. (13 to 20 centimeters [5 to 8 inches] thick.)

Bw2/2C2—36 to 46 centimeters (14 to 18 inches); dark reddish brown (5YR 3/2) very cobbly medial silt loam, dark yellowish brown (10YR 3/4) dry; massive; loose, slightly sticky and slightly plastic; weakly smeary; common roots; many very fine pores; 50 percent cobbles; moderately acid (pH 6.0); abrupt wavy boundary. (3 to 10 centimeters [1 to 4 inches] thick.)

2R—46 centimeters (18 inches); hard, massive pahoehoe lava.

Range in characteristics

Depth to bedrock: 25 to 50 centimeters (10 to 20 inches).

Mean annual soil temperature: 11 to 14 degrees C (52 to 58 degrees F).

Content of rock fragments: 35 to 50 percent, by volume, gravel and cobbles in the pedon as a whole.

A horizon

Hue: 5YR to 10YR or N.

Value: 2 to 3 moist and dry.

Chroma: 0 to 2 moist and dry.

Texture: Cobbly medial silt loam or silt loam.

Structure: Strong granular or moderate subangular blocky.

Soil reaction: Strongly acid or moderately acid (pH 5.1 to 6.0).

Bw/2C horizon

Hue: 5YR to 10YR.

Value: 2 to 3 moist, 3 dry.

Chroma: 1 or 2 moist, 3 dry.

Texture: Very cobbly or cobbly medial silt loam.

Smeariness: Weakly smeary or moderately smeary.

Soil reaction: Moderately acid or slightly acid (pH 5.6 to 6.5).

Vitric Haplustands

The Vitric Haplustands in this survey area consist of deep, somewhat excessively drained soils that formed in basic volcanic ash over basic aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 762 millimeters (30 inches), and the mean annual air temperature is about 22 degrees C (72 degrees F).

Taxonomic classification: Vitric Haplustands.

Reference pedon

Vitric Haplustands, 2 to 20 percent slopes; located in Hawaii Volcanoes National Park; from Chain of Craters Road, drive 9 miles to the end of Hilina Pali Road; hike approximately 1.5 hours on Kau Desert Trail towards Pepeiao Cabin, crossing pahoehoe flow to an aa flow; continue on trail to a broad wash; to the northeast (right) are two smaller washes; hike 55 meters (180 feet) up first and smaller wash to type location; Kau Desert Quadrangle; lat. 19 degrees 16 minutes 38.70 seconds N. and long. 155 degrees 20 minutes 46.61 seconds W. (Position measured by GPS PLGR +/- 59 feet; old Hawaiian datum.)

- 3C1/A—0 to 8 centimeters (0 to 3 inches); very dark brown (10YR 2/2) extremely cobbly ashy very fine sandy loam; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 5 percent strands of Pele's hair; 90 percent fragmental aa lava (10 percent boulders, 15 percent stones, 45 percent cobbles, and 15 percent gravel); moderately acid (pH 5.8); abrupt wavy boundary.
- 3C2/Bw—8 to 41 centimeters (3 to 16 inches); very dark brown (10YR 2/2) extremely cobbly ashy very fine sandy loam; weak medium subangular blocky structure grading with increasing depth to massive; soft and slightly hard, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; many very fine and fine interstitial pores; 85 percent fragmental aa lava (5 percent boulders, 5 percent stones, 45 percent cobbles, and 25 percent gravel); moderately acid (pH 6.2); clear irregular boundary.
- 3C3/2C1—41 to 84 centimeters (16 to 33 inches); lithochromic black (10YR 2/1) extremely cobbly ashy loamy fine sand; massive; soft, very friable, nonsticky and nonplastic; many very fine to coarse roots; many very fine and fine interstitial pores; 80 percent fragmental aa lava (5 percent boulders, 5 percent stones, 50 percent cobbles, and 20 percent gravel); slightly acid (pH 6.2); clear irregular boundary.
- 3C4/2C2—84 to 89 centimeters (33 to 35 inches); lithochromic very dark brown (10YR 2/2) extremely stony ashy loamy fine sand; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 90 percent fragmental aa lava (10 percent boulders, 15 percent stones, 35 percent cobbles, and 30 percent gravel); slightly acid (pH 6.2); clear irregular boundary.
- 3C5—89 to 152 centimeters (35 to 60 inches); 65 percent lithochromic black (N 2/0) and 35 percent lithochromic dark reddish brown (2.5YR 3/3) extremely stony coarse sand; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine interstitial pores; 90 percent fragmental aa lava (10 percent boulders, 15 percent stones, 35 percent cobbles, and 30 percent gravel); slightly acid (pH 6.4); clear irregular boundary.

The reference pedon is an example of the soils within this category. Because of the highly variable nature of the soils, the pedon is not necessarily representative of these soils throughout the survey area.

Range in characteristics

Elevation: 0 to 310 meters (sea level to 1,015 feet).

Mean annual air temperature: 17 to 26 degrees C (64 to 79 degrees F).

Mean annual rainfall: 510 to 1,015 millimeters (20 to 40 inches).

Mean annual pan evaporation: 2,035 millimeters (80 inches).

Content of rock fragments: Average of 70 to 90 percent boulders, stones, cobbles, and gravel on the soil surface and throughout the profile.

Soil reaction: Strongly acid to slightly acid (pH 5.1 to 6.5).

A horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 3 moist.

Texture in the fine-earth fraction: Ashy silt loam, ashy loam, or ashy very fine sandy loam.

Structure: Platy, granular, or subangular blocky.

B horizon

Hue: 7.5YR or 10YR.

Value: 2 to 3 moist.

Chroma: 1 to 4 moist.

Texture in the fine-earth fraction: Ashy loam or ashy very fine sandy loam.

Structure: Subangular blocky or massive.

C horizon

Hue: 2.5YR, 7.5YR, 10YR, or N.

Value: 2 to 3 moist.

Chroma: 0 to 6 moist.

Texture in the fine-earth fraction: Ashy fine loamy sand, ashy loamy sand, ashy fine sand, ashy sand, or ashy coarse sand.

Structure: Massive or single grain.

Wahi Series

The Wahi series consists of deep, somewhat excessively drained soils that formed in basic volcanic ash deposited over basic aa lava. Slopes range from 2 to 20 percent. The mean annual rainfall is about 1,473 millimeters (58 inches), and the mean annual air temperature is about 13 degrees C (55 degrees F).

Taxonomic classification: Medial-skeletal, amorphic, isomesic Typic Hapludands.

Typical pedon

Wahi extremely cobbly medial loam, 2 to 20 percent slopes, under scattered ohia trees and shrubs; located in Hawaii Volcanoes National Park; from State Highway 11, drive 11 miles north on Mauna Loa Strip Road to the end of the road; take Mauna Loa Trail to a sign indicating that the elevation is 7,000 feet; walk on heading of 165 degrees magnetic for 30 meters (96 feet) to type location; Puu Ulaula Quadrangle; lat. 19 degrees 30 seconds 20.72 minutes N. and long. 155 degrees 23 minutes 33.02 seconds W. (Position measured by GPS PLGR using old Hawaiian datum +/- 420 feet.)

3C1/A1—0 to 5 centimeters (0 to 2 inches); very dark brown (7.5YR 2.5/2) extremely cobbly medial loam, dark brown (10YR 3/3) dry; moderate thick platy structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 80 percent fragmental aa lava (5

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- percent boulders, 10 percent stones, 45 percent cobbles, and 20 percent gravel); strongly acid (pH 5.2); clear wavy boundary. (5 to 10 centimeters [2 to 4 inches] thick.)
- 3C2/A2—5 to 13 centimeters (2 to 5 inches); dark reddish brown (5YR 2.5/2) extremely cobbly medial loam, dark brown (7.5YR 3/2) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine interstitial pores; 80 percent fragmental aa lava (10 percent stones, 60 percent cobbles, and 10 percent gravel); moderately acid (pH 6.0); clear wavy boundary. (5 to 13 centimeters [2 to 5 inches] thick.)
- 3C3/2A—13 to 25 centimeters (5 to 10 inches); very dark brown (7.5YR 2.5/2) extremely cobbly medial loam, dark brown (7.5YR 3/2) dry; weak medium subangular blocky structure parting to moderate fine and medium granular; slightly hard, friable, nonsticky and nonplastic; many very fine to medium and common coarse roots; many very fine and fine interstitial pores; 80 percent fragmental aa lava (10 percent stones, 60 percent cobbles, and 10 percent gravel); moderately acid (pH 6.0); clear irregular boundary. (0 to 13 centimeters [0 to 5 inches] thick.)
- 3C4/2Bw1—25 to 30 centimeters (10 to 12 inches); very dark brown (7.5YR 2.5/2) extremely cobbly medial loam, strong brown (7.5YR 4/6) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and fine interstitial pores; 65 percent fragmental aa lava (50 percent cobbles and 15 percent gravel); slightly acid (pH 6.2); abrupt wavy boundary.
- 3C5/2Bw2—30 to 36 centimeters (12 to 14 inches); very dark brown (7.5YR 2/3) extremely cobbly medial loam, strong brown (7.5YR 4/6) dry; moderate thin and medium platy structure; slightly hard, friable, nonsticky and nonplastic; common very fine to medium and few coarse roots; many very fine and fine interstitial pores; 65 percent fragmental aa lava (55 percent cobbles and 10 percent gravel); slightly acid (pH 6.2); clear wavy boundary. (Combined thickness of the 3C/2Bw horizons ranging from 0 to 15 centimeters [0 to 6 inches].)
- 3C6—35 to 152 centimeters (14 to 60 inches); very dark brown (7.5YR 2.5/2) extremely stony medial loam, dark brown (7.5YR 3/3) dry; content of fines decreasing with increasing depth; single grain; soft, very friable, nonsticky and nonplastic; common very fine to medium and few coarse roots; many fine and medium and few coarse interstitial pores; 80 percent fragmental aa lava (15 percent boulders, 20 percent stones, 40 percent cobbles, and 5 percent gravel); 5 percent voids; slightly acid (pH 6.4).

Range in characteristics

Content of rock fragments: 65 to 85 percent on both the soil surface and in the control section.

Mean annual soil temperature: 12 to 15 degrees C (54 to 59 degrees F).

A horizon

Hue: 7.5YR or 10YR.

Texture in the fine-earth fraction: Medial loam or medial silt loam.

Structure: Platy, granular, or subangular blocky.

Content of rock fragments: 65 to 90 percent.

Soil reaction: Strongly acid to slightly acid.

B horizon

Hue: 5YR to 10YR.

Chroma: 2 to 4 moist.

Structure: Subangular blocky or platy.

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Content of rock fragments: 65 to 90 percent.
Soil reaction: Slightly acid or neutral.

C horizon

Content of rock fragments: 65 to 90 percent.
Voids: 5 to 10 percent.

Formation of the Soils

By Robert T. Gavenda, Ph.D.; Michael R. Kolman; and Christopher W. Smith, Ph.D.

According to the classical model of soil formation, as devised in the nineteenth century by Russian soil scientists and later refined and expanded by Dr. Hans Jenny (1941), soils form through the action of climate and living organisms on parent material over time. The nature of the topography influences the stability and waterflow characteristics and age.

Aa lava formation is related to the degree of cooling, degassing, and rates of internal shear in flowing lava (Peterson and Tilling, 1980). Walker (1990) correlated aa with high volumetric discharge rates (more than about 5 cubic meters per second). Aa lava has a rough clinker layer consisting of mainly gravel- to boulder-size, jagged, vesicular basalt fragments. This layer overlies a dense layer (locally known as bluerock), which overlies another clinker layer. The thickness of each layer (if present) may range from 0.5 meter to 2 or more meters. Aa landscapes consist of hummocky complex slopes with great spatial variability with respect to extent, thickness, and degree of fracturing of the bluerock. The permeability rate of the upper clinker layer is very high. Runoff can be expected only where a considerable amount of mineral soil has accumulated in the clinker layer or where the clinker layer is shallow to bluerock. In areas of high rainfall, mineral soils on aa appear to be better drained because the hummocks channel water off the landscape. Pahoehoe landscapes, on the other hand, are characterized by less relief, less channeling of water, and thus perched water at the soil-pahoehoe interface.

Pahoehoe lavas have a smooth or ropy surface (fig. 23) and are generally made up of many flows less than 1 or 2 meters thick. The permeability of pahoehoe lava depends on the extent of fractures in the bedrock. When flowing over a steep scarp, pahoehoe may turn into aa lava as the entrapped gas rapidly dissipates. Although aa cannot revert to pahoehoe, pahoehoe lava commonly occurs at the base of scarps. Pahoehoe lava often flows in tubes. The tubes may collapse and leave a characteristic chain of oblong holes on the landscape. These features can be quite large, extending to more than 25 by 100 meters. Lava tubes may collapse when the tube is covered by many later flows. The weight of the subsequent flows causes the collapse.

A pahoehoe flow generally consists of a gently undulating surface with numerous microdepressions that are about 0.1 to 0.5 meter deep and range in area from 1 to about 100 square meters. On very young landscapes and/or in arid areas, soil material may accumulate only in these microdepressions. With time, both mineral and organic soils build up to the point of completely covering the lava flow.

Kipukas are areas of older landscapes surrounded by younger lava flows. They generally occupy low spots because younger lava has built up the surrounding area. In some areas, however, kipukas are on high points. They generally are elongated in the upslope-downslope direction and can be quite small. Those that are 4 acres or larger and that consist of soils unlike the soils in the surrounding area are identified as distinct map units if they can be identified in the field or on aerial photographs.



Figure 23.—In the foreground, typical pahoehoe lava with a ropy surface and short, gently undulating slopes. The dark aa lava in the background has an extremely stony surface and short, complex, steep slopes.

Aa lava is a very effective trap for eolian (windblown) sediments because of the clinker layer. Pahoehoe is not an effective trap, especially in arid, windy areas, so there may be limited sediment and soil accumulation. On landscapes of similar age, soils on aa lava are thicker than soils on pahoehoe lava because of the better sediment-trapping efficiency of aa and because clinker and void space may constitute more than half of the soil volume.

On the Island of Hawaii and particularly in Hawaii Volcano National Park (HAVO), the soil-forming factors are unbalanced in their influence on the soils. In HAVO and on much of the rest of the island, volcanic ash and cinder deposits serve as the parent material of the soils. The underlying lava flow material appears to contribute little to soil formation, with the exception of sand and gravel fragments chipping from aa clinkers and minor weathering of surfaces in areas of high rainfall. Since HAVO represents most of the youngest areas on the island, many of the soils in the park have not had enough time either for the formation of thick ash deposits or for weathering of the primary ash minerals into various secondary clays.

The Heake soil series is an example of soils in which only a thin ash layer has accumulated thus far. Heake soils form in the Keanakakoi base surge and ash 200 to 600 years old. Elsewhere on the Big Island, not in the proximity of volcanic vents, organic soils appear to be the first stage of soil formation as a result of fern and ohia colonization in pahoehoe fractures and between aa clinkers. In HAVO, however, ash and cinders accumulate soon after lava flows, and so all of the soils are identified as mineral soils.

Thick ash deposits on Kilauea landscapes that are still relatively young are represented by the Alahapa series. The mineralogy of Alahapa soils is mixed. In contrast, Puaulu soils on Mauna Loa landscapes are examples of soils that formed in Uwekahuna ash, which is 2,000 to 3,000 years old, over unnamed ash deposits that are about 10,000 years old.

Pahala ash has been redefined to be Kilauea summit eruptions 20,000 to 30,000 years old (Frank Trusdell, personal communication). This ash occurs only in small

areas in the southwest coastal parts of HAVO, as shown on the geologic map compiled by Wolfe and Morris (1996). Puaulu soils have weathered because of moisture from precipitation and because of a sufficient amount of time for the transformation of basaltic ash mostly to ferrihydrite and allophone with some kaolinite. The perennially moist environment preserves a dominance of amorphous, poorly crystalline clay-size minerals. This feature is reflected by the ferrihydritic mineralogy family. Puaulu soils have been leached of base cations and silica. They are a good example of soils that form and then are buried by subsequent deposits, which then form a new soil. Soil formation in the park is episodic. The ability of primary minerals to transform to secondary minerals (primarily in the clay-size fractions) is affected by the amount and seasonality of rainfall.

Landscapes in the southwestern part of the island and on Kahuku Ranch reflect the recent volcanism of the Mauna Loa Volcano and are mainly constructional landscapes minimally modified by erosion. Most of South Kona is covered by lava flows deposited between 1.5 and 4 thousand years ago from Mauna Loa (Lockwood and others, 1988). Landforms consist mostly of gently sloping to moderately steep aa and pahoehoe lava flows with some steep or very steep cinder cones. The type of lava affects soil formation by contributing weathering products, such as sand and rock fragments, to soils in aa lava. It determines the depth to bedrock in lithic, organic soils on pahoehoe lava and in typic, organic soils on aa lava. The adjective "lithic" indicates less than 50 centimeters to bedrock, and "typic" indicates more than 50 centimeters to bedrock (Soil Survey Staff, 1999). The type of lava also influences water movement and the water-holding capacity of soils and determines the topography.

On the southwestern part of the island, shallow, rocky, organic soils with minor amounts of volcanic ash can form in depressions on lava flows less than 3,000 years old. This kind of formation occurs on the upper and middle elevations on mountain slopes with relatively low rainfall. Representative soils are those of the Kekake, Mawae, and Kapua series. At the middle elevations, the mountain slopes can have areas of higher rainfall. The shallow, rocky, organic soils form in large amounts of organic material with minor amounts of volcanic ash. Representative soils are those of the Lalaau series. Map units are consociations of organic soils and complexes of organic soils and basaltic lava outcrops. The soils typically are well drained. Infiltration and permeability rates can be high in lava flows, so little or no surface drainage occurs on these geologically young surfaces. The soils can be hydrophobic when dry. The hydrophobicity can impede infiltration and increase runoff, especially on pahoehoe landforms.

On the southwestern part of the island and on Kahuku Ranch, more volcanic ash has accumulated on lava flows more than 3,000 years old. The upper and middle elevations on the mountain slopes with relatively low rainfall have shallow or moderately deep, mineral soils with thick, dark surface layers characterized by more than 50 percent base saturation (Soil Survey Staff, 1999). Representative soils are those of the Hokukano, Ihuanu, Iwalani, Keaa, Kiolakaa, and Nanaia series. At the upper and middle elevations on the mountain slopes in the southwestern part of the island, slight weathering of primary minerals has occurred in areas of high rainfall. The mountain slopes in these areas have shallow or moderately deep, mineral soils (Udands) with umbric epipedons, which are surface layers having less than 50 percent base saturation (Soil Survey Staff, 1999). Representative soils are those of the Akihi, Alapai, Hilea, Pahipa, and Puali series. The soils are moderately well drained or well drained. They can be hydrophobic when dry. The hydrophobicity can impede water infiltration and increase runoff, especially on pahoehoe landforms. Map units are consociations with at least 90 percent soil, or they are complexes or associations. The geomorphic surfaces are slightly dissected by shallow stream channels created by intermittent streams. They are subject to flash flooding,

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especially on pahoehoe landforms. Intermittent streams develop along lava flow boundaries, in lava channels, and in connected low spots on the landform. Stream channels are actively developing and eroding these geomorphic surfaces.

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Giambelluca, T.W., and T.A. Schroeder. 1998. Climate, *in* S.P. Juvik and J.O. Juvik, eds., Atlas of Hawaii, Third Edition, pp. 49-59.
- Jenny, H. 1941. Factors of soil formation.
- Lockwood, J.P., P.W. Lipman, L.D. Petersen, and F.R. Warhauser. 1998. Generalized ages of surface lava flows of Mauna Loa Volcano, Hawaii. USGS Miscellaneous Investigations Series, Map I-1908.
- Peterson, D.W., and R.I. Tilling. 1980. Transition of basaltic from pahoehoe to aa, Kilauea Volcano, Hawaii; field observations and key factors. *Journal of Volcanology and Geothermal Research* 7: 271-293.
- Smith, C.W. 1989. The fertility capability classification system (FCC), third approximation. Ph.D. Thesis, North Carolina State University.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. <http://soils.usda.gov/technical/>
- Soil Survey Staff. 1998. Keys to soil taxonomy. 8th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.
- United States Department of Agriculture, Natural Resources Conservation Service. 1997. National range and pasture handbook. Title 190, Washington, D.C.
- United States Department of Agriculture, Natural Resources Conservation Service. 2004. National food security act manual. Fourth edition.
- United States Department of Agriculture, Natural Resources Conservation Service. Ecological site information system. <http://esis.sc.egov.usda.gov>
- United States Department of Agriculture, Natural Resources Conservation Service. Electronic Field Office Technical Guide. http://efotg.nrcs.usda.gov/efotg_locator.aspx?map=HI
- United States Department of Agriculture, Natural Resources Conservation Service. PLANTS database. National Plant Data Center. <http://plants.usda.gov>
- Walker, G.P.L. 1990. Geology and volcanology of the Hawaiian Islands. *Pacific Science* 44: 315-347.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Wolfe, E.W., and J. Morris (compilers). 1996. Geologic map of the Island of Hawaii. U.S. Department of the Interior, U.S. Geological Survey Miscellaneous Investigations Series, Map I-2524-A.

Glossary

- Aa.** A Hawaiian term for lava flows typified by rough, jagged, spinose, clinkery surfaces (commonly about 1 meter thick) overlying a hard massive “bluerock” layer (commonly 1 to 3 meters thick).
- AASHTO classification.** A system for classifying soils specifically for geotechnical engineering purposes that is related to highway and airfield construction. It is based on particle-size distribution and Atterberg limits.
- AASHTO group index (GI).** An empirical index number used to evaluate clayey and silty clay material.
- ABC soil.** A soil having an A, a B, and a C horizon.
- AC soil.** A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.
- Accretionary lapilli.** Spheroidal masses of weakly cemented to well cemented ash, generally between 2 and 10 millimeters, but occasionally as much as 30 millimeters or possibly even 60 millimeters, in diameter. Most commonly formed through accretion of particles around a wet nucleus falling through a cloud of ash. The resulting “mud balls” flatten somewhat on striking the ground. Some of them roll on the surface of loose ash and grow like snowballs rolling downhill, thus acquiring a spiral structure.
- Aeration, soil.** The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.
- Aggregate, soil.** Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.
- Alien plant.** A plant that is not part of the original flora of an area.
- Alkalinity.** The concentration of OH negative ions. Alkaline soils have pH values of more than 7.0.
- Allophane.** A semiordered hydrous aluminosilicate that commonly is clay-sized and commonly forms in soils derived from volcanic ash.
- Alluvial.** Pertaining to material that is transported and deposited by running water.
- Alluvial fan.** A low, outspread mass of loose material and/or rock material washed down the sides of mountains and hills. It commonly has gentle slopes and is shaped like an open fan or a segment of a cone. It is deposited by a stream at the place where the stream issues from a narrow mountain valley or where a tributary stream is near or at its junction with the main stream. An alluvial fan is steepest near its apex, which points upstream, and it slopes gently and convexly outward with a gradual decrease in gradient.
- Alluvium.** Material, such as sand, silt, or clay, deposited on land by streams.
- Alpha,alpha-dipyridyl.** A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.
- Amendments.** A substance or product brought in and applied to the soil for beneficial results.

Amorphous. Pertains to noncrystalline constituents that either do not fit the definition of allophone or possibly do not meet allophone criteria.

Andic. A technical term used in "Soil Taxonomy." The term generally applies to soils that formed in volcanic material.

Animal unit month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aridic soil moisture regime. Soils that have an aridic moisture regime are dry for at least one-half of the year. They commonly occur in areas that have an aridic climate. A few are in areas that have a semiarid climate, but they either have physical properties that keep them dry, such as a crusty surface that virtually precludes the infiltration of water, or have steep slopes with a high rate of runoff. Little, if any, leaching occurs in the soils in this moisture regime, and soluble salts accumulate in the soils if there is a source of salts.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (AWC) (available moisture capacity). The volume of water that should be available to plants if the soil, inclusive of fragments, were at field capacity. It is commonly estimated as the difference between the amount of water at field capacity and the amount at wilting point with adjustments for salinity, fragments, and rooting depth. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

AWC. See Available water capacity.

Backslope. The hillslope profile position that forms the steepest and generally linear, middle portion of the slope. In profile, backslopes commonly are bounded by a convex shoulder above and a concave footslope below. They may or may not include cliff segments, or free faces. Backslopes are commonly erosional forms produced by mass movement, colluvial action, and running water.

Badland. A landscape that is intricately dissected and is characterized by a very fine drainage network with high drainage density and short, steep slopes with narrow interfluves. Badland develops on surfaces that have little, if any, vegetative cover, are underlain by unconsolidated or poorly cemented material (clay, silt, or sand), and in some areas have soluble minerals, such as gypsum and halite.

Bar (unit of measure). A unit of measure for pressure; 1 bar is equal to 1×10^5 pascals (N/m^2); 15 bar is regarded as a representative water pressure at which common plants can no longer extract water from the soil and is sometimes called the wilting point. Two days after a soaking rain, water in the soil is often retained at $1/3$ -bar pressure, meaning that a pressure more than $1/3$ bar must be applied to overcome the capillary pressure holding the water in the soil. A soil containing water held at $1/3$ bar is at field capacity.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

- Basaltic.** Relating to or resembling basalt, a dark mafic igneous rock.
- Base saturation.** The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.
- Base slope.** A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).
- Bedrock.** A general term for the solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
- Bedrock-controlled topography.** A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.
- Blowout.** A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.
- Bluerock.** Local term for very hard, nonvesicular, jointed basalt underlying an aa clinker layer, typically from 1 to 5 meters thick.
- Boulders.** Rock fragments larger than 2 feet (60 centimeters) in diameter.
- Breaks.** The steep and very steep broken land at the border of an upland summit that is dissected by ravines.
- Breast height.** An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.
- Bulk density.** A measurement of the oven-dry weight of the soil material that is less than 2 millimeters in diameter per unit volume. Common measurements are taken at $1/3$ -, $1/10$ -, or 15-bar moisture tension. Bulk density influences plant growth and engineering applications. It is used to convert measurements from a weight basis to a volume basis. Within a family particle-size class, bulk density is an indicator of how well plant roots are able to extend into the soil. Bulk density is used to calculate porosity.
- Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.
- Calcic horizon.** A mineral soil horizon of secondary carbonate enrichment that is more than 15 centimeters thick and has a calcium carbonate equivalent of more than 15 percent. The calcium carbonate equivalent is at least 5 percent higher than that of the underlying horizon.
- Calcium carbonate equivalent.** The amount of calcium carbonate in a soil measured by treating the soil sample with hydrochloric acid (HCL). The evolved carbon dioxide (CO₂) is measured, and the amount of carbonate is then calculated as calcium carbonate (CaCO₃).
- Cambic horizon.** A mineral soil horizon that has the texture of loamy very fine sand or finer, has soil structure rather than rock structure, and contains some weatherable minerals. It is characterized by the alteration or removal of mineral material as indicated by mottling or gray color, stronger chroma or redder hue than the underlying horizons, or the removal of carbonates. The cambic horizon lacks cementation or induration and has too little evidence of illuviation to meet the requirements of an argillic horizon.
- Canopy.** The leafy crown of trees or shrubs.
- Canyon.** A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.
- Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

- Cathodic protection.** Control of the electrolytic corrosion of an underground or underwater metallic structure, such as a pipeline, by the application of an electrical current in such a way that the structure acts as the cathode rather than the anode of an electrolytic cell.
- Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.
- Cation-exchange capacity (CEC).** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.
- CEC.** See Cation-exchange capacity.
- Cement rock.** Shaly limestone used in the manufacture of cement.
- Cinders.** Uncemented, vitric, vesicular, pyroclastic material more than 2 millimeters in at least one dimension with apparent specific gravity (including vesicles) of more than 1 and less than 2.
- Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
- Clay depletions.** Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.
- Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.
- Clayey.** Sandy clay, silty clay, and clay.
- Climax plant community.** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.
- Clinker.** A rough, jagged pyroclastic fragment that is loose and detached from the underlying rock. Resembles the clinker or slag from a furnace.
- Coarse fragments.** See Rock fragments.
- Coarse textured soil.** Sand or loamy sand.
- Cobble (or cobblestone).** A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.
- Cobbly soil material.** Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.
- COLE (coefficient of linear extensibility).** See Linear extensibility.
- Colluvium.** Unconsolidated, unsorted earth material transported or deposited on side slopes and/or at the base of slopes by mass movement, or direct gravitational action, and by local unconcentrated runoff.
- Compaction.** The process by which the soil grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing bulk density.
- Complex, soil.** A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.
- Consistence, soil.** Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when

subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Consociation. A map unit made up of one dominant component,

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deep soil. See Depth, soil.

Delineation. The process of drawing or plotting areas on a map with lines and symbols. Also, an individual polygon drawn on the map.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to bedrock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface. Runoff, or surface flow of water, from an area.

Drainageway. A general term for a course or channel along which water moves in draining an area.

Duripan. A subsurface soil horizon that is cemented with illuvial silica, commonly opal or microcrystalline forms, to the degree that less than 50 percent of the volume of air-dry fragments will slake in water or hydrochloric acid.

EC. See Electrical conductivity.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Electrical conductivity (EC). The electrolytic conductivity of an extract from saturated soil paste.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation. A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian material. Material transported and deposited by wind, including earth material, such as dune sand, sand sheets, loess, and clay.

Episaturation. A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building

up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. The term is most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Family, soil. The most specific hierarchical category in soil taxonomy.

Feral. Escaped from cultivation or domestication and existing in the wild.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. The nearly level plain that borders a stream and is subject to inundation under floodstage conditions unless protected artificially. It is commonly a constructional landform consisting of sediment deposited during overflow and lateral migration of a stream.

Fluvial. Of or pertaining to rivers; produced by river action.

Footslope. The position that forms the inner, gently inclined surface at the base of a hillslope. In profile, footslopes are commonly concave. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Fragments. Unattached cemented pieces of bedrock, bedrocklike material, durinodes, concretions, and nodules 2 millimeters in diameter or larger in mineral soils; woody material 20 millimeters in diameter or larger in organic soils.

Fumarole. A hole in a volcanic region from which gases and vapors escape at high temperatures.

Fumarolic. Of or pertaining to fumaroles near volcanoes. (See Fumarole.)

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

- Gravel.** Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.
- Gravelly soil material.** Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.
- Gully.** A small channel with steep sides cut by the concentrated, but intermittent, flow of water commonly during and immediately following heavy rainfall or following icemelt or snowmelt. A gully generally is an obstacle to wheeled vehicles and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.
- Hard bedrock.** Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.
- Hardpan.** A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.
- Head out.** To form a flower head.
- Hemic soil material (mucky peat).** Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the "Soil Survey Manual." The major horizons of mineral soil are as follows:
- O horizon.*—An organic layer of fresh and decaying plant residue.
- A horizon.*—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.
- E horizon.*—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
- B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
- C horizon.*—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
- Cr horizon.*—Soft, consolidated bedrock beneath the soil.
- R layer.*—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.
- Hue.** One scale of the three-scale Munsell system used to describe colors. Hue notation of a color indicates its relation to red, yellow, green, and purple. The other two scales (value and chroma) indicate color lightness and strength.
- Hummock.** Rounded or conical mound or other small rise.
- Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.
- Hydrologic soil groups.** Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting

when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Hydrophobic. Pertaining to material and surfaces that have little or no affinity for water molecules. Hydrophobic soils resist hydration; falling water beads on the surface and tends to runoff from sloping soils.

Hydrophytic vegetation. Vegetation adapted to water or to wet or saturated soils.

Hydrous. Pertaining to a mineral compound containing water. A term used "Soil Taxonomy" for soil material that has andic soil properties and has a water content at 1500 kPa tension (wilting point) of 100 percent or more in undried samples.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Indurated. Pertaining to rock or soil hardened or consolidated by pressure, cementation, or heat.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Interstitial pore. An opening or space between soil aggregates or particles.

Intrusive. Pertaining to igneous rock derived from molten matter (magma) that invaded preexisting rock and cooled below the surface of the earth.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Isohyperthermic. See Temperature regime, soil.

Isomesic. See Temperature regime, soil.

K factor. A measurement of potential soil erodibility caused by detachment of soil particles by water.

Ka. The symbol for kiloannum, a unit of time equal to a thousand years.

Kipuka. An area of land completely surrounded by lava flows.

Ksat. See Saturated hydraulic conductivity.

Lapilli. A small stony or glassy fragment of lava ejected during a volcanic eruption.

Leaching. The removal of soluble material from soil or other material by percolating water.

Leeward. Sheltered or located away from the prevailing wind. Leeward areas are generally located on the southern and western sides of the mountains on all the main Hawaiian islands. See Windward.

LEP. See Linear extensibility percent.

Lime. In agriculture, a soil amendment containing calcium carbonate or calcium oxide; used to neutralize soil acidity and furnish calcium for plant growth. Dolomite or dolomitic lime also contains magnesium carbonate and furnishes magnesium for plant growth.

- Linear extensibility.** Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $1/3$ - or $1/10$ -bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.
- Liquefaction.** The sudden large decrease of the shearing resistance of a cohesionless soil, caused by a collapse of the structure from shock or another type of strain; a temporary transformation of the material into a fluid mass.
- Liquid limit (LL).** The moisture content at which the soil passes from a plastic to a liquid state.
- Lithic.** Pertains to hard rock; bedrock or rock fragments that do not rupture when a 1-inch cube specimen is subject to a force of 160 N (approximately foot pressure by full body weight).
- Lithochromic.** Having the color of the unaltered rock particles, as opposed to the color resulting from the processes of soil formation.
- LL.** See Liquid limit.
- Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.
- Loamy.** Coarse sandy loam, sandy loam, fine sandy loam, very fine sandy loam, loam, silt loam, silt, clay loam, sandy clay loam, and silty clay loam.
- Low strength.** The soil is not strong enough to support loads.
- Magma.** Molten rock material that originates deep in the earth and solidifies to form igneous rock.
- Masses.** Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.
- Medial.** A term used to describe soil material that has andic soil properties and has a water content at 1500 kPa tension (wilting point) between 30 and 100 percent on undried samples.
- Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.
- Metavolcanic.** A volcanic rock that shows evidence of metamorphism but has not been fully metamorphosed into metamorphic rock.
- Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.
- Miscellaneous area.** An area that has little or no natural soil and supports little or no vegetation.
- Moderately coarse textured soil.** Coarse sandy loam, sandy loam, or fine sandy loam.
- Moderately deep soil.** See Depth, soil.
- Moderately fine textured soil.** Clay loam, sandy clay loam, or silty clay loam.
- Mollic epipedon.** A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.
- Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

- Mottling, soil.** Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common, and many*; size—*fine, medium, and coarse*; and contrast—*faint, distinct, and prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).
- Mountain.** A natural elevation of the land surface that rises more than 1,000 feet (300 meters) above surrounding lowlands, commonly has limited summit area relative to surrounding surfaces, and generally has steep sides (slopes of more than 25 percent) with or without considerable bare-rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic and/or volcanic activity and by differential erosion.
- Muck.** Unconsolidated soil material consisting primarily of highly decomposed organic material in which the original plants are not recognizable. It generally contains more mineral material and is darker in color than peat. (See Sapric soil material.)
- Mulch.** A natural or artificial layer of plant residue or other material, such as paper or sand, on the soil surface.
- Munsell notation.** A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.
- Natric horizon.** A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.
- Neutral soil.** A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)
- Nodules.** Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.
- Noncrystalline clay.** An aluminosilicate mineral having no crystalline structure or having no characteristic external form because the internal arrangement is so irregular.
- Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.
- OM.** See Organic matter.
- Organic material.** Material made up primarily of hydrocarbon compounds. Contrasted with mineral material, which has no hydrocarbon constituents.
- Organic matter (OM).** Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:
- | | |
|----------------------|-----------------------|
| Very low | less than 0.5 percent |
| Low | 0.5 to 1.0 percent |
| Moderately low | 1.0 to 2.0 percent |
| Moderate | 2.0 to 4.0 percent |
| High | 4.0 to 8.0 percent |
| Very high | more than 8.0 percent |
- Organic soils.** Specifically defined in “Soil Taxonomy.” Generally defined as soils containing very large amounts of organic material.
- Paleosol.** A soil that formed in a particular area with distinctive morphological features resulting from a soil-forming environment that no longer exists in the area. The pedogenic process was either altered as a result of external environmental changes or interrupted by burial. A paleosol (or component horizon) is classified as relict if it has persisted without major alteration of

morphology by the prevailing pedogenic environment. An exhumed paleosol is one that was buried and has been re-exposed by erosion of the mantle. Most paleosols have been affected by some subsequent modification of the morphology of diagnostic horizons and truncation of the profile.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan*, *fragipan*, *claypan*, *plowpan*, and *traffic pan*.

Parent material. The unconsolidated and chemically weathered mineral and organic material in which the solum of a soil is formed as a result of pedogenic processes.

Peat. Unconsolidated soil material consisting largely of undecomposed or slightly decomposed organic matter that has accumulated under excessive moisture conditions. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Pele's hair. A spun volcanic glass formed naturally by blowing out during quiet fountaining of fluid lava, cascading lava, or turbulent lava flows.

Perched water table. The upper surface of unconfined ground water separated from an underlying main body of ground water by an unsaturated zone.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity," which is defined in the "Soil Survey Manual." In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as "permeability." Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

PI. See Plasticity index.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index (PI). The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Pleistocene. The epoch of the Quaternary period of geologic time following the Pliocene and preceding the Holocene (approximately 2 million to 10 thousand years ago). Also refers to the corresponding (time-stratigraphic) "series" of earth material.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

- Poorly graded.** Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.
- Potential native plant community.** See Climax plant community.
- Potential rooting depth (effective rooting depth).** Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.
- Prescribed burning.** Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.
- Productivity, soil.** The capability of a soil for producing a specified plant or sequence of plants under specific management.
- Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.
- Pyroclastic.** Pertaining to fragmental material produced by commonly explosive aerial ejection of clastic particles from a volcanic vent. Such material may accumulate on land or under water.
- Range condition.** The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community differs from the potential.
- Range site.** An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind, proportion, and total production.
- Rangeland.** Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.
- Reaction, soil.** A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

- Redoximorphic concentrations.** Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.
- Redoximorphic depletions.** Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.
- Redoximorphic features.** Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features

indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

- Reduced matrix.** A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.
- Regolith.** All unconsolidated earth material above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits. Soil scientists regard as soil only that part of the regolith that has been modified by organisms and soil-forming processes. Most engineers describe the entire regolith, even to a great depth, as "soil."
- Relief.** The elevations or inequalities of a land surface, considered collectively.
- Residuum (residual soil material).** Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.
- Reticulite.** Basaltic pumice in which all cell walls of gas bubbles have burst, leaving a honeycomb structure.
- Rill.** A small steep-sided channel resulting from erosion. It is cut by a concentrated, but intermittent, flow of water, usually during and immediately following moderate rains or following icemelt or snowmelt. Generally, a rill is not an obstacle to wheeled vehicles and is shallow enough to be obliterated by ordinary tillage.
- Riverwash.** Barren alluvial areas of unstabilized sand, silt, clay, or gravel reworked frequently by stream activity.
- Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.
- Rock outcrop.** Exposures of bedrock, excluding lava and rock-lined pits.
- Root zone.** The part of the soil that can be penetrated by plant roots.
- Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.
- Saline soil.** A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium. Salinity is expressed as the electrical conductivity of a saturation extract at 25 degrees C. Salinity classes, expressed in millimhos per centimeter, are as follows:
- | | |
|----------------------------|--------------|
| Nonsaline | 0 to 2 |
| Very slightly saline | 2 to 4 |
| Slightly saline | 4 to 8 |
| Moderately saline | 8 to 16 |
| Strongly saline | more than 16 |
- Saline-sodic soil.** A soil that contains sufficient exchangeable sodium to interfere with the growth of most crops and appreciable quantities of soluble salts. The exchangeable sodium ratio is greater than 0.15; the conductivity of the soil solution, when saturated, is greater than 4 decisiemens per meter (at 25 degrees C); and the pH is commonly 8.5 or less when the soil is saturated.
- Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.
- Sandy.** Sand and loamy sand.
- Sapric soil material (muck).** The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.
- Saprolite.** Soft, friable, isovolumetrically weathered bedrock that retains the fabric and structure of the parent rock and exhibits extensive intercrystal and

intracrystal weathering. In pedology, saprolite has been used to refer to any unconsolidated residual material that underlies the soil and grades to hard bedrock below.

SAR. See Sodium adsorption ratio.

Saturated hydraulic conductivity (Ksat). Refers to the ease with which pores in a saturated soil transmit water. Estimates of saturated hydraulic conductivity are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shallow soil. See Depth, soil.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shoulder. The position that forms the uppermost inclined surface near the top of a hillslope. It is a transition from backslope to summit. The surface is dominantly convex in profile and erosional in origin.

Shrink-swell potential. See Linear extensibility.

Side slope. A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $\text{Ca}^{++} + \text{Mg}^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil erodibility factors. The Kw and Kf factors quantify the susceptibility of soil to detachment by water. These erodibility factors predict the long-term average soil loss that results from sheet and rill erosion when various cropping systems and conservation techniques are used. The whole soil is considered in the Kw factor, but only the fine-earth fraction, which is the material less than 2 millimeters in diameter, is considered in the Kf factor.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Referring to geologic deposits that were formed, arranged, or laid down in layers. Layers in soils that are a result of the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsidence. The decrease in surface elevation as a result of the drainage of wet soils that have organic layers or semifluid mineral layers.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summit. The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

T factor. The soil loss tolerance, which is defined as the maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained. Maintaining the quality of the soil includes maintaining the surface soil as a seedbed for plants, maintaining the atmosphere-soil interface to allow the entry of air and water into the soil and still protect the underlying soil from wind and water erosion, and maintaining the total soil volume as a reservoir for water and plant nutrients, which is preserved by minimizing soil loss.

Temperature regime, soil. A system that categorizes for taxonomic purposes general, long-term soil temperature conditions at the standard depth of 20 inches or at the surface of the bedrock, whichever is at a shallower depth. The various regimes are defined according to the freezing point of water or to the high and low extremes for significant biological activity. The prefix “iso” in the name of a regime indicates that the difference between the mean summer and mean winter temperature is more than 9 degrees F. The regimes, which are defined in “Keys to Soil Taxonomy,” are as follows:

Pergellic.—Soils that have a mean annual temperature of less than 32 degrees F and have permafrost.

Cryic.—Soils that have a mean annual temperature of 32 to 47 degrees F and remain cold in summer.

Frigid.—Soils that have a mean annual temperature similar to that of the cryic regime but have a mean summer temperature at least 9 degrees warmer.

Mesic.—Soils that have a mean annual temperature of 47 to 59 degrees F, and the difference between the mean summer and mean winter temperature is more than 9 degrees.

Thermic.—Soils that have a mean annual temperature of 59 to 72 degrees F, and the difference between the mean summer and mean winter temperature is more than 9 degrees.

Hyperthermic.—Soils that have a mean annual temperature of more than 72 degrees F, and the difference between the mean summer and mean winter temperature is more than 9 degrees.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.” The abbreviations for texture terms (or in-lieu-of texture terms) are explained in table 11.

Thermic temperature regime. See Temperature regime, soil.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope. The outermost inclined surface at the base of a hill; part of a footslope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tuff. A generic term for any consolidated or cemented deposit that is 50 percent volcanic ash (less than 2 millimeters in size). Various types of tuff can be recognized by their composition; acidic tuff is dominantly acidic particles, and basic tuff is dominantly basic particles.

Unified soil classification. A system for classifying mineral and organic soils for engineering purposes based on particle-size characteristics, liquid limit, and plasticity index.

Upland (geomorphologic). A general term for the higher land of a region in contrast to the low-lying, adjacent land, such as a valley or plain; land at a higher elevation than the flood plain or low stream terrace; or land above the footslope zone of the hillslope continuum.

Variation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Vegetative cover. The crown cover of all live plants in relation to the ground surface.

Very deep soil. See Depth, soil.

Very shallow soil. See Depth, soil.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Water table. The upper surface of ground water or the level below which the soil is saturated by water. Also, the top of an aquifer.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

WEG. See Wind erodibility group.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Wind erodibility group (WEG). A grouping of soils that have similar properties affecting their resistance to wind erosion in cultivated areas.

Windward. A term commonly used in Hawaii to refer to landscape locations as they relate to the direction of the trade winds that generally blow from the northeast. Windward areas are generally on the northern and eastern sides of the mountains on all the main Hawaiian islands. See Leeward.

Xerophytic. Pertaining to vegetation that is adapted to dry areas.

Tables

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 1.--Temperature and Precipitation

(Recorded in the period 1971-2000 at Hawaii Volcanoes National Park)

Month	Temperature						Precipitation			
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have--		Average number of growing degree days*	Average	2 years in 10 will have--		Average number of days with 0.10 inch or more
				Maximum temperature higher than--	Minimum temperature lower than--			Less than--	More than--	
°F	°F	°F	°F	°F	Units	In	In	In		
January----	67.5	49.4	58.5	76	40	254	10.37	2.61	16.08	11
February---	67.6	49.2	58.4	77	40	228	9.14	1.78	12.79	10
March-----	67.0	50.2	58.6	76	42	260	14.10	4.28	21.10	16
April-----	67.3	51.4	59.3	75	45	268	10.45	5.72	14.37	18
May-----	69.0	52.4	60.7	77	46	320	6.29	3.95	8.34	15
June-----	70.3	53.9	62.1	79	48	353	5.23	2.62	7.38	12
July-----	71.5	55.1	63.3	80	48	400	7.21	3.06	10.39	14
August-----	72.9	55.3	64.1	80	48	427	6.31	3.14	8.95	11
September--	72.9	55.1	64.0	79	48	410	6.01	2.98	8.11	11
October----	71.9	54.7	63.3	79	48	405	6.83	4.86	8.51	14
November---	69.6	53.4	61.5	77	45	331	13.19	5.21	19.20	15
December---	67.6	51.0	59.3	77	41	283	11.01	3.98	16.84	14
Yearly:										
Average---	69.6	52.6	61.1	---	---	---	---	---	---	---
Extreme---	93	31	---	83	38	---	---	---	---	---
Total-----	---	---	---	---	---	3,939	106.14	81.69	124.39	161

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 2.--Acreage and Proportionate Extent of the Soils

Map symbol	Soil name	Acres	Percent
10	Lava flows, aa, 2 to 20 percent slopes-----	111,072	30.2
12	Lava flows, pahoehoe, 2 to 20 percent slopes-----	76,936	20.9
14	Lava flows complex, 2 to 20 percent slopes-----	31,806	8.6
15	Cinder land, 2 to 20 percent slopes-----	2,171	0.6
16	Cinder land, 20 to 40 percent slopes-----	329	*
19	Riverwash, 2 to 10 percent slopes-----	888	0.2
24	Badland, geothermal, 2 to 40 percent slopes-----	124	*
26	Lava flows association, 40 to 99 percent slopes-----	2,587	0.7
117	Kapua-Lava flows complex, 2 to 10 percent slopes-----	2	*
130	Mawae very cobbly highly decomposed plant material, 2 to 10 percent slopes-----	439	0.1
131	Mawae very cobbly highly decomposed plant material, 10 to 20 percent slopes-----	351	*
132	Mawae-Lava flows complex, 2 to 10 percent slopes-----	633	0.2
133	Mawae-Lava flows complex, 10 to 20 percent slopes-----	772	0.2
137	Kekake-Lava flows complex, 2 to 10 percent slopes-----	44	*
138	Kekake-Lava flows complex, 10 to 25 percent slopes-----	40	*
161	Kekake-Mawae complex, 10 to 20 percent slopes-----	53	*
163	Lava flows-Kekake complex, 10 to 20 percent slopes-----	134	*
164	Lava flows-Kekake complex, 2 to 20 percent slopes-----	1,833	0.5
169	Iwalani-Lava flows complex, moist, 2 to 10 percent slopes-----	930	0.3
179	Iwalani-Lava flows complex, moist, 10 to 20 percent slopes-----	472	0.1
205	Ihuanu very cobbly medial silt loam, moist, 10 to 20 percent slopes-----	1,498	0.4
206	Ihuanu very cobbly medial silt loam, moist, 2 to 10 percent slopes-----	283	*
211	Kapulehu very cobbly medial silt loam, moist, 2 to 10 percent slopes-----	549	0.1
212	Kapulehu very cobbly medial silt loam, moist, 10 to 20 percent slopes-----	510	0.1
213	Nanaia-Lava flows complex, moist, 2 to 10 percent slopes-----	376	0.1
214	Lava flows-Nanaia complex, moist, 2 to 20 percent slopes-----	58	*
215	Keaa cobbly medial loam, moist, 2 to 10 percent slopes-----	495	0.1
216	Keaa cobbly medial loam, moist, 10 to 20 percent slopes-----	105	*
217	Kapulehu-Keaa complex, moist, 20 to 40 percent slopes-----	117	*
218	Kiolakaa medial loam, moist, 2 to 10 percent slopes-----	208	*
219	Kiolakaa-Keaa complex, moist, 10 to 20 percent slopes-----	318	*
275	Kapulehu-Lava flows complex, 2 to 10 percent slopes-----	193	*
276	Kapulehu very cobbly medial silt loam, 2 to 10 percent slopes-----	404	0.1
277	Kapulehu very cobbly medial silt loam, 10 to 20 percent slopes-----	1,042	0.3
280	Nanaia-Lava flows complex, 2 to 10 percent slopes-----	1,275	0.3
281	Lava flows-Nanaia complex, 2 to 20 percent slopes-----	1,029	0.3
290	Keaa cobbly medial loam, 2 to 10 percent slopes-----	53	*
292	Keaa-Kiolakaa complex, 2 to 10 percent slopes-----	206	*
300	Kamaoa medial loam, 2 to 10 percent slopes-----	1	*
305	Kiolakaa medial loam, 2 to 10 percent slopes-----	404	0.1
395	Hokukano-Lava flows complex, 10 to 20 percent slopes-----	131	*
401	Ihuanu-Lava flows complex, 10 to 20 percent slopes-----	3,192	0.9
402	Ihuanu very cobbly medial silt loam, 10 to 20 percent slopes-----	1,557	0.4
403	Ihuanu very cobbly medial silt loam, 2 to 10 percent slopes-----	780	0.2
406	Lava flows-Iwalani complex, 10 to 20 percent slopes-----	2,280	0.6
407	Iwalani-Lava flows complex, 2 to 10 percent slopes-----	839	0.2
408	Iwalani-Lava flows complex, 10 to 20 percent slopes-----	3,110	0.8
461	Hapuu very gravelly medial silt loam, 10 to 20 percent slopes-----	61	*
463	Hapuu extremely gravelly medial silt loam, 10 to 20 percent slopes-----	422	0.1
511	Akihi very cobbly hydrous silt loam, 10 to 20 percent slopes-----	380	0.1
512	Akihi very cobbly hydrous silt loam, 2 to 10 percent slopes-----	132	*
513	Hilea hydrous silty clay loam, 10 to 20 percent slopes-----	381	0.1
514	Hilea hydrous silty clay loam, 3 to 10 percent slopes-----	163	*
515	Pahipa-Puali association, 2 to 20 percent slopes-----	621	0.2
516	Alapai hydrous silty clay loam, 3 to 10 percent slopes-----	73	*
517	Alapai hydrous silty clay loam, 10 to 20 percent slopes-----	1	*
518	Alapai hydrous silty clay loam, 20 to 35 percent slopes-----	26	*
519	Lalau very cobbly highly decomposed plant material, 2 to 10 percent slopes-----	376	0.1
525	Alapai hydrous silty clay loam, low precipitation, 10 to 20 percent slopes-----	1	*

See footnote at end of table.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 2.--Acreage and Proportionate Extent of the Soils--Continued

Map symbol	Soil name	Acres	Percent
534	Kahaluu-Lava flows complex, 2 to 10 percent slopes-----	185	*
555	Kuanene-Lava flows complex, 20 to 35 percent slopes-----	1	*
574	Ihuanu-Lava flows complex, 10 to 20 percent slopes-----	1,437	0.4
575	Durustands medial loam, 2 to 10 percent slopes-----	744	0.2
576	Puali-Puu Oo-Pahipa association, 2 to 20 percent slopes-----	711	0.2
577	Pahipa-Puu Oo association, 2 to 20 percent slopes-----	31	*
605	Kaholimo-Ki complex, 3 to 10 percent slopes-----	1	*
607	Kaholimo-Ki complex, 10 to 20 percent slopes-----	1	*
610	Piihonua hydrous silty clay loam, 0 to 3 percent slopes-----	59	*
613	Kilooa extremely cobbly highly decomposed plant material, 3 to 10 percent slopes-----	603	0.2
621	Eheuiki-Pekailio complex, 3 to 10 percent slopes-----	20	*
625	Hao medial loam, 3 to 10 percent slopes-----	917	0.2
631	Kapapala medial loam, 2 to 10 percent slopes-----	25	*
657	Malama-Lava flows complex, dry, 2 to 40 percent slopes-----	29	*
709	Lava flows-Lithic Ustipsamments complex, 2 to 10 percent slopes-----	19,489	5.3
711	Lava flows-Apuki complex, 2 to 20 percent slopes-----	6,638	1.8
713	Lithic Haplustands-Lava flows complex, 2 to 10 percent slopes-----	8,270	2.2
715	Alahapa-Heake complex, 2 to 10 percent slopes-----	829	0.2
716	Alahapa extremely stony ashy sandy loam, 2 to 10 percent slopes-----	1,254	0.3
717	Alahapa-Lava flows complex, 2 to 10 percent slopes-----	3,273	0.9
718	Halemaumau extremely gravelly ashy coarse sand, 2 to 10 percent slopes---	304	*
719	Heake ashy loam, 2 to 10 percent slopes-----	1,274	0.3
720	Heake-Lava flows complex, 2 to 10 percent slopes-----	1,825	0.5
722	Kilauea very gravelly ashy sand, 2 to 10 percent slopes-----	2,280	0.6
724	Lava flows-Kaholimo-Puiwa complex, 2 to 15 percent slopes-----	1,091	0.3
725	Lava flows-Kaholimo complex, 2 to 15 percent slopes-----	603	0.2
726	Kulalio medial silt loam, 2 to 10 percent slopes-----	360	*
727	Puauulu hydrous silt loam, 2 to 20 percent slopes-----	995	0.3
728	Puauulu-Hao complex, 2 to 20 percent slopes-----	4,997	1.4
729	Eheuiki-Puauulu complex, 2 to 20 percent slopes-----	2,112	0.6
731	Kahalii-Lava flows complex, 2 to 10 percent slopes-----	1,437	0.4
734	Kanohina-Lava flows complex, 2 to 10 percent slopes-----	11,412	3.1
735	Puhimau ashy silt loam, 2 to 10 percent slopes-----	4,199	1.1
736	Manu medial silt loam, 2 to 10 percent slopes-----	645	0.2
737	Nakanui-Lava flows complex, 2 to 10 percent slopes-----	8,933	2.4
738	Vitric Haplustands, 2 to 20 percent slopes-----	1,133	0.3
741	Ahiu-Lava flows complex, 2 to 10 percent slopes-----	3,975	1.1
743	Pakini medial very fine sandy loam, 2 to 10 percent slopes-----	136	*
744	Haa-Keamoku complex, 2 to 10 percent slopes-----	1,103	0.3
745	Maunaiu-Akelelu complex, 3 to 10 percent slopes-----	1,542	0.4
746	Kulalio-Maunaiu-Akelelu complex, 3 to 10 percent slopes-----	1,036	0.3
747	Oneula extremely stony medial loam, 2 to 10 percent slopes-----	804	0.2
748	Lava flows-Menehune complex, 2 to 20 percent slopes-----	160	*
749	Wahi extremely cobbly medial loam, 2 to 20 percent slopes-----	326	*
750	Ki medial loam, 3 to 10 percent slopes-----	331	*
751	Oneula extremely stony medial loam, low elevation, 2 to 10 percent slopes	559	0.2
752	Oneula-Keamoku-Maunaiu complex, 2 to 10 percent slopes-----	422	0.1
753	Kalapana medial coarse sandy loam, 2 to 10 percent slopes-----	3,109	0.8
754	Kalapana-Lava flows complex, dry, 2 to 10 percent slopes-----	4,635	1.3
755	Makaopuhi very paragravelly highly decomposed plant material, 2 to 10 percent slopes-----	6,083	1.7
756	Ahiu-Vitric Haplustands complex, 2 to 10 percent slopes-----	771	0.2
	Total-----	368,375	100.0

* Less than 0.1 percent.

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage

(The abbreviation "Rv" stands for representative value)

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
10: Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
12: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
14: Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
15: Cinder land-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
16: Cinder land-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
19: Riverwash-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
24: Badland, geothermal-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
26: Lava flows, aa, sparsely vegetated-----	Low Elevation Makai Range- R161AY008HI	500-700-1000	_ _ _	ilima, ohia lehua, aalii

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
26: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
117: Kapua-----	Kona Weather Pattern Dry Forest- F161BY501HI	_ _ _	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, lama
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
130: Mawae-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	_ _ _	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
131: Mawae-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	_ _ _	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
132: Mawae-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	_ _ _	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
133: Mawae-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	_ _ _	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---
137: Kekake-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	_ _ _	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	_ _ _	_ _ _	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity	Standing live wood	Native trees or shrubs to manage
		(lb/acre/year)**	of native trees (cu. ft/acre)***	
		Low-Rv-High	Low-Rv-High	
138: Kekake-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
161: Kekake-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
Mawae-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
163: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Kekake-----	Pahoehoe Shrubland- R161AY011HI	500-1000-1500	___-___-___	ohia lehua, aalii, pukiawe
164: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Kekake-----	Pahoehoe Shrubland- R161AY011HI	500-1000-1500	___-___-___	ohia lehua, aalii, pukiawe
169: Iwalani, moist-----	Transition Zone Ohia-Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
179: Iwalani, moist-----	Transition Zone Ohia-Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
205: Ihuanu, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
206: Ihuanu, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
211: Kapulehu, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
212: Kapulehu, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
213: Nanaia, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
214: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Nanaia, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
215: Keaa, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
216: Keaa, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
217: Kapulehu, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Keaa, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
218: Kiolakaa, moist-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
219: Kiolakaa-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Keaa-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
275: Kapulehu-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, lama
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
276: Kapulehu-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, lama
277: Kapulehu-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, lama
280: Nanaia-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, koa, lama, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
281: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Nanaia-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohe makai, ohia lehua, alahee, kauila, lama

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
290: Keaa-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohi makai, ohia lehua, alahee, kauila, lama
292: Keaa-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohi makai, ohia lehua, alahee, kauila, lama
Kiolakaa-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohi makai, ohia lehua, alahee, kauila, lama
300: Kamaoa-----	Kona Weather Pattern Dry Forest- F161BY501HI	1500-2500-3500	1000-1500-2300	Hawaii hala pepe, ohi makai, ohia lehua, alahee, kauila, lama
305: Kiolakaa-----	Kona Weather Pattern Dry Forest- F161BY501HI	___-___-___	1000-1500-2300	Hawaii hala pepe, ohi makai, ohia lehua, alahee, kauila, lama
395: Hokukano-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahii, ohia lehua, koa, kolea, mamane, naio
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
401: Ihuanu-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
402: Ihuanu-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
403: Ihuanu-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
406: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Iwalani-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
407: Iwalani-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
408: Iwalani-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
461: Hapuu, very gravelly----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
463: Hapuu, extremely gravelly-----	Koa-Sandalwood-Mamane Forest- F161BY503HI	___-___-___	1200-1600-2000	iliahi, ohia lehua, koa, kolea, mamane, naio
511: Akihi-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
512: Akihi-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
513: Hilea-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	300-3000-5700	ohia lehua, olapa, kawau, koa, kolea lau nui
514: Hilea-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	300-3000-5700	ohia lehua, olapa, kawau, koa, kolea lau nui

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
515: Pahipa-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
Puali-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
516: Alapai-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
517: Alapai-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
518: Alapai-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
519: Lalaau-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	1000-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
525: Alapai, low precipitation-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	800-2500-3000	ohia lehua, olapa, kawau, koa, kolea lau nui
534: Kahaluu-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
555: Kuanene-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
574: Ihuanu-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
574: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
575: Durustands-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
576: Puali-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
Puu Oo-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
Pahipa-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
577: Pahipa-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
Puu Oo-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
605: Kaholimo-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Ki-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
607: Kaholimo-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Ki-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
610: Piihonua-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
613: Kiloa-----	Shallow Wet Ohia-Olapa Forest- F162XY503HI	___-___-___	3000-4000-5000	ohia lehua, olapa, kolea lau nui

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
621: Eheuiki-----	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
Pekailio-----	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
625: Hao-----	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
631: Kapapala-----	Soapberry-Koa Kipuka Forest-F160XY500HI	___-___-___	3000-5000-6000	ohia lehua, ae, koa, olopu
657: Malama-----	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI	___-___-___	150-250-800	ohia lehua, alahee, lama
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI	___-___-___	___-___-___	---
709: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI	___-___-___	___-___-___	---
Lithic Ustipsamments----	Mid-Elevation Mauka Range-R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
711: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI	___-___-___	___-___-___	---
Apuki-----	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI	___-___-___	150-250-800	ohia lehua, alahee, lama
713: Lithic Haplustands, cindery substratum----	Mid-Elevation Mauka Range-R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Lithic Haplustands, loamy surface-----	Mid-Elevation Mauka Range-R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity	Standing live wood	Native trees or shrubs to manage
		(lb/acre/year)**	of native trees (cu. ft/acre)***	
		Low-Rv-High	Low-Rv-High	
713: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
715: Alahapa-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Heake-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
716: Alahapa-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
717: Alahapa-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Lava flows, aa-----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
718: Halemaumau-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
719: Heake-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
720: Heake-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
722: Kilauea-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
724: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Kaholimo, uneroded-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Kaholimo, eroded-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Puiwa, uneroded-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Puiwa, eroded-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
725: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Kaholimo, eroded-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Kaholimo, uneroded-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
726: Kulalio-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
727: Puauulu-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
728: Puauulu-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
Hao-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui
729: Eheuiki-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1500-5000-5900	ohia lehua, olapa, kawau, koa, kolea lau nui

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
729: Puauulu-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-3000-5000	ohia lehua, olapa, kawau, koa, kolea lau nui
731: Kahalii-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
734: Kanoehina-----	Low Elevation Makai Range- R161AY008HI	500-700-1000	___-___-___	ilima, ohia lehua, aalii
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
735: Puhimau-----	Shallow Wet Ohia-Olapa Forest- F162XY503HI	___-___-___	3000-4000-5000	ohia lehua, olapa, kolea lau nui
736: Manu-----	Shallow Wet Ohia-Olapa Forest- F162XY503HI	___-___-___	3000-4000-5000	ohia lehua, olapa, kolea lau nui
737: Nakanui-----	Low Elevation Makai Range- R161AY008HI	500-700-1000	___-___-___	ilima, ohia lehua, aalii
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
738: Vitric Haplustands-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
741: Ahiu-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
743: Pakini-----	Desert Grassland- R157XY001HI	800-2000-3500	___-___-___	ilima, aalii, maiapilo
744: Haa-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Keamoku-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
745: Maunaiu-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Akelelu-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
746: Kulalio-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Maunaiu-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
Akelelu-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
747: Oneula-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
748: Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
Menehune-----	Transition Zone Ohia- Koa-Mamane Forest- F161AY500HI	___-___-___	1000-1700-2500	ohia lehua, koa, mamane, naio
749: Wahi-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
750: Ki-----	Soapberry-Koa Kipuka Forest- F160XY500HI	___-___-___	3000-5000-6000	ohia lehua, ae, koa, olopua

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Table 3.--Ecological Sites, Range Productivity, Forest Tree Volume, and Native Trees to Manage--Continued

Map symbol and component name	Ecological site*	Range productivity (lb/acre/year)**	Standing live wood of native trees (cu. ft/acre)***	Native trees or shrubs to manage
		Low-Rv-High	Low-Rv-High	
751: Oneula, low elevation----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
752: Oneula-----	Mauna Loa Savannah- R161AY010HI	500-1000-2000	___-___-___	ohia lehua, olapa, kawau, koa, kolea lau nui
Keamoku-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
Maunaiu-----	Ohia-Koa/Hapuu-Kanawao Forest- F159BY500HI	___-___-___	1000-2500-4000	ohia lehua, olapa, kawau, koa, kolea lau nui
753: Kalapana-----	Lama-Alahee-Pandanus Coastal Forest- F162XY501HI	___-___-___	150-250-800	ohia lehua, alahee, lama
754: Kalapana, dry-----	Lama-Alahee-Pandanus Coastal Forest- F162XY501HI	___-___-___	150-250-800	ohia lehua, alahee, lama
Lava flows, pahoehoe----	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI	___-___-___	___-___-___	---
755: Makaopuhi-----	Shallow Wet Ohia-Olapa Forest- F162XY503HI	___-___-___	3000-4000-5000	ohia lehua, olapa, kolea lau nui
756: Ahiu-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe
Vitric Haplustands-----	Mid-Elevation Mauka Range- R161AY009HI	500-1000-2000	___-___-___	ohia lehua, aalii, pukiawe

* Ecological site descriptions are available in the USDA-NRCS Hawaii Field Office Technical Guide, Section II (<http://www.nrcs.usda.gov/technical/efotg>).

** Range productivity estimates are shown only for the interpretive plant community as described in the ecological site description. Refer to the ecological site description for an understanding of the plant community dynamics for the site. The productivity values shown here do not necessarily represent the productivity of the plant community that is presently on the site.

*** For standing live wood of native trees, only native tree species were measured. Measurements were conducted during the period from 2004 through 2007. Volume of live standing wood in tree boles only was measured in cubic feet per acre. Volume measurements do not include tree branches. Refer to the ecological site descriptions for more specific information regarding vegetation, soil, and site management.

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Table 4.--Index of Common and Scientific Plant Names and Plant Symbols

(This table aids in correct plant identification and serves as a cross-reference to plant species listed in table 3. The plant synonymy listed is in accordance with the USDA-NRCS National PLANTS Database at the time of publication)

Local common name	Scientific name	Plant symbol
iliahi	<i>Santalum paniculatum</i>	SAPA7
ilima	<i>Sida fallax</i>	SIFA
ohe makai	<i>Reynoldsia sandwicensis</i>	RESA
ohia lehua	<i>Metrosideros polymorpha</i>	MEPO5
olapa	<i>Cheirodendron trigynum</i>	CHTR2
aalii	<i>Dodonaea viscosa</i>	DOVI
ae	<i>Sapindus saponaria</i>	SASA4
alahee	<i>Psychdrax odorata</i>	PSOD
Hawaii hala pepe	<i>Pleomele hawaiiensis</i>	PLHA4
kauila	<i>Alphitonia ponderosa</i>	ALPO3
kawau	<i>Ilex anomala</i>	ILAN
koa	<i>Acacia koa</i>	ACKO
kolea	<i>Myrsine lanaiensis</i>	MYLA3
kolea lau nui	<i>Myrsine lessertiana</i>	MYLE2
lama	<i>Diospyros sandwicensis</i>	DISA10
maiapilo	<i>Capparis sandwichiana</i>	CASA4
mamane	<i>Sophora chrysophylla</i>	SOCH
naio	<i>Myoporum sandwicense</i>	MYSA
olopua	<i>Nestegis sandwicensis</i>	NESA2
pukiawe	<i>Styphelia tameiameia</i>	STTA

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Table 5.--List of Ecological Sites

Site ID	Ecological site name
F159BY500HI	Ohia-Koa/Hapuu-Kanawao Forest
F160XY500HI	Soapberry-Koa Kipuka Forest
F161AY500HI	Transition Zone Ohia-Koa-Mamane Forest
F161BY501HI	Kona Weather Pattern Dry Forest
F161BY503HI	Koa-Sandalwood-Mamane Forest
F162XY501HI	Lama-Alahee-Pandanus Coastal Forest
F162XY503HI	Shallow Wet Ohia-Olapa Forest
R157XY001HI	Desert Grassland
R161AY008HI	Low Elevation Makai Range
R161AY009HI	Mid-Elevation Mauka Range
R161AY010HI	Mauna Loa Savannah
R161AY011HI	Pahoehoe Shrubland
R161AY999HI	Miscellaneous Area With Minimal Vegetative Development

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Table 6.--Prime Farmland

Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the map unit name)

Map symbol	Map unit name
516	Alapai hydrous silty clay loam, 3 to 10 percent slopes
517	Alapai hydrous silty clay loam, 10 to 20 percent slopes
525	Alapai hydrous silty clay loam, low precipitation, 10 to 20 percent slopes
631	Kapapala medial loam, 2 to 10 percent slopes (where irrigated)
736	Manu medial silt loam, 2 to 10 percent slopes
744	Haa-Keamoku complex, 2 to 10 percent slopes
745	Maunaiu-Akelelu complex, 3 to 10 percent slopes
750	Ki medial loam, 3 to 10 percent slopes

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Table 7a.--Recreational Development

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. The rating is based on the limitation with the highest value. Only the three highest value limitations are listed. There may be more limitations. Fine-earth fractions and coarse fragments are reported on a weight basis. An explanation of the rating criteria and of the abbreviations used in describing the limitations is given at the end of the table)

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
10: Lava flows, aa-----	100	Not rated		Not rated	
12: Lava flows, pahoehoe----	100	Not rated		Not rated	
14: Lava flows, aa-----	50	Not rated		Not rated	
Lava flows, pahoehoe----	50	Not rated		Not rated	
15: Cinder land-----	100	Not rated		Not rated	
16: Cinder land-----	100	Not rated		Not rated	
19: Riverwash-----	90	Not rated		Not rated	
24: Badland, geothermal----	90	Not rated		Not rated	
26: Lava flows, aa, sparsely vegetated-----	50	Not rated		Not rated	
Lava flows, pahoehoe----	50	Not rated		Not rated	
117: Kapua-----	60	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Fragments > 3" > 30%	1.00
		Fragments >3" 25 to 75%	0.90	Organic surface layer >= 4" thick	1.00
				Slopes 2 to 6%	0.98
Lava flows, aa-----	35	Not rated		Not rated	
130: Mawae-----	90	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Fragments > 3" > 30%	1.00
		Fragments >3" >75%	1.00	Organic surface layer >= 4" thick	1.00
				Slopes 2 to 6%	0.98
131: Mawae-----	90	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Slopes > 6%	1.00
		Fragments >3" >75%	1.00	Fragments > 3" > 30%	1.00
		Slopes > 15%	1.00	Organic surface layer >= 4" thick	1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
132: Mawae-----	60	Limitations Organic surface layer \geq 4" thick Fragments $>$ 3" $>$ 75%	1.00 1.00	Limitations Fragments $>$ 3" $>$ 30% Organic surface layer \geq 4" thick Slopes 2 to 6%	1.00 1.00 0.98
Lava flows, aa-----	35	Not rated		Not rated	
133: Mawae-----	60	Limitations Organic surface layer \geq 4" thick Fragments $>$ 3" $>$ 75% Slopes $>$ 15%	1.00 1.00 1.00	Limitations Slopes $>$ 6% Fragments $>$ 3" $>$ 30% Organic surface layer \geq 4" thick	1.00 1.00 1.00
Lava flows, aa-----	35	Not rated		Not rated	
137: Kekake-----	60	Limitations Bedrock depth $<$ 20" Organic surface layer \geq 4" thick	1.00 1.00	Limitations Bedrock depth $<$ 20" Organic surface layer \geq 4" thick Slopes 2 to 6%	1.00 1.00 0.98
Lava flows, pahoehoe----	35	Not rated		Not rated	
138: Kekake-----	60	Limitations Bedrock depth $<$ 20" Organic surface layer \geq 4" thick Slopes $>$ 15%	1.00 1.00 1.00	Limitations Slopes $>$ 6% Bedrock depth $<$ 20" Organic surface layer \geq 4" thick	1.00 1.00 1.00
Lava flows, pahoehoe----	35	Not rated		Not rated	
161: Kekake-----	60	Limitations Bedrock depth $<$ 20" Organic surface layer \geq 4" thick Slopes $>$ 15%	1.00 1.00 1.00	Limitations Slopes $>$ 6% Bedrock depth $<$ 20" Organic surface layer \geq 4" thick	1.00 1.00 1.00
Mawae-----	35	Limitations Organic surface layer \geq 4" thick Fragments $>$ 3" $>$ 75% Slopes $>$ 15%	1.00 1.00 1.00	Limitations Slopes $>$ 6% Fragments $>$ 3" $>$ 30% Organic surface layer \geq 4" thick	1.00 1.00 1.00
163: Lava flows, pahoehoe----	70	Not rated		Not rated	
Kekake-----	25	Limitations Bedrock depth $<$ 20" Organic surface layer \geq 4" thick Slopes $>$ 15%	1.00 1.00 1.00	Limitations Slopes $>$ 6% Bedrock depth $<$ 20" Organic surface layer \geq 4" thick	1.00 1.00 1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
164: Lava flows, pahoehoe----	80	Not rated		Not rated	
Kekake-----	15	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Slopes 8 to 15%	0.37	Slopes > 6%	1.00
169: Iwalani, moist-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
		Dusty	0.50	Slopes 2 to 6%	0.98
				Dusty	0.50
Lava flows, pahoehoe----	40	Not rated		Not rated	
179: Iwalani, moist-----	70	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Slopes > 6%	1.00
		Slopes > 15%	1.00	Bedrock depth < 20"	1.00
		Dusty	0.50	Dusty	0.50
Lava flows, pahoehoe----	30	Not rated		Not rated	
205: Ihuanu, moist-----	95	Limitations		Limitations	
		Slopes > 15%	1.00	Slopes > 6%	1.00
		Dusty	0.50	Fragments > 3" > 30%	1.00
		Fragments >3" 25 to 75%	0.32	Surface fragments (<3") >25%	0.99
206: Ihuanu, moist-----	95	Limitations		Limitations	
		Dusty	0.50	Fragments > 3" > 30%	1.00
		Fragments >3" 25 to 75%	0.32	Surface fragments (<3") >25%	0.99
				Slopes 2 to 6%	0.98
211: Kapulehu, moist-----	95	Limitations		Limitations	
		Fragments >3" 25 to 75%	0.90	Fragments > 3" > 30%	1.00
		Dusty	0.50	Slopes 2 to 6%	0.98
				Bedrock 20-40" and slope >2%	0.50
212: Kapulehu, moist-----	95	Limitations		Limitations	
		Slopes > 15%	1.00	Slopes > 6%	1.00
		Fragments >3" 25 to 75%	0.90	Fragments > 3" > 30%	1.00
		Dusty	0.50	Bedrock 20-40" and slope >2%	0.50
213: Nanaia, moist-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
		Dusty	0.50	Surface fragments (<3") >25%	1.00
		Fragments (<3") 25-50%	0.08	Slopes 2 to 6%	0.98
Lava flows, pahoehoe----	35	Not rated		Not rated	

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
214: Lava flows, pahoehoe----	60	Not rated		Not rated	
Nanaia, moist-----	35	Limitations Bedrock depth < 20" Dusty Slopes 8 to 15%	1.00 0.50 0.37	Limitations Bedrock depth < 20" Surface fragments (<3") >25% Slopes > 6%	1.00 1.00 1.00
215: Keea, moist-----	90	Limitations Bedrock depth < 20" Dusty Fragments >3" 25 to 75%	1.00 0.50 0.01	Limitations Bedrock depth < 20" Fragments >3" 5 to 30% Slopes 2 to 6%	1.00 0.99 0.98
216: Keea, moist-----	90	Limitations Slopes > 15% Bedrock depth < 20" Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Bedrock depth < 20" Fragments >3" 5 to 30%	1.00 1.00 0.99
217: Kapulehu, moist-----	60	Limitations Slopes > 15% Fragments >3" 25 to 75% Dusty	1.00 0.90 0.50	Limitations Slopes > 6% Fragments > 3" > 30% Bedrock 20-40" and slope >2%	1.00 1.00 0.50
Keea, moist-----	40	Limitations Slopes > 15% Bedrock depth < 20" Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Bedrock depth < 20" Fragments >3" 5 to 30%	1.00 1.00 0.99
218: Kiolakaa, moist-----	90	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Bedrock 20-40" and slope >2% Dusty	0.98 0.50 0.50
219: Kiolakaa-----	60	Limitations Slopes > 15% Dusty	1.00 0.50	Limitations Slopes > 6% Bedrock 20-40" and slope >2% Dusty	1.00 0.50 0.50
Keea-----	40	Limitations Slopes > 15% Bedrock depth < 20" Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Bedrock depth < 20" Fragments >3" 5 to 30%	1.00 1.00 0.99
275: Kapulehu-----	60	Limitations Fragments >3" 25 to 75% Dusty	0.90 0.50	Limitations Fragments > 3" > 30% Slopes 2 to 6% Bedrock 20-40" and slope >2%	1.00 0.98 0.50
Lava flows, aa-----	40	Not rated		Not rated	

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
276: Kapulehu-----	95	Limitations Fragments >3" 25 to 75% Dusty	0.90 0.50	Limitations Fragments > 3" > 30% Slopes 2 to 6% Bedrock 20-40" and slope >2%	1.00 0.98 0.50
277: Kapulehu-----	95	Limitations Slopes > 15% Fragments >3" 25 to 75% Dusty	1.00 0.90 0.50	Limitations Slopes > 6% Fragments > 3" > 30% Bedrock 20-40" and slope >2%	1.00 1.00 0.50
280: Nanaia-----	60	Limitations Bedrock depth < 20" Dusty Fragments (<3") 25-50%	1.00 0.50 0.08	Limitations Bedrock depth < 20" Surface fragments (<3") >25% Slopes 2 to 6%	1.00 1.00 0.98
Lava flows, pahoehoe----	35	Not rated		Not rated	
281: Lava flows, pahoehoe----	60	Not rated		Not rated	
Nanaia-----	35	Limitations Bedrock depth < 20" Dusty Slopes 8 to 15%	1.00 0.50 0.37	Limitations Bedrock depth < 20" Surface fragments (<3") >25% Slopes > 6%	1.00 1.00 1.00
290: Keaa-----	90	Limitations Bedrock depth < 20" Dusty Fragments >3" 25 to 75%	1.00 0.50 0.01	Limitations Bedrock depth < 20" Fragments >3" 5 to 30% Slopes 2 to 6%	1.00 0.99 0.98
292: Keaa-----	60	Limitations Bedrock depth < 20" Dusty Fragments >3" 25 to 75%	1.00 0.50 0.01	Limitations Bedrock depth < 20" Fragments >3" 5 to 30% Slopes 2 to 6%	1.00 0.99 0.98
Kiolakaa-----	35	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Bedrock 20-40" and slope >2% Dusty	0.98 0.50 0.50
300: Kamoa-----	90	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Dusty	0.98 0.50
305: Kiolakaa-----	90	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Bedrock 20-40" and slope >2% Dusty	0.98 0.50 0.50

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
395: Hokukano-----	60	Limitations Slopes > 15% Bedrock depth < 20"	1.00 1.00	Limitations Slopes > 6% Bedrock depth < 20" Occasional flooding	1.00 1.00 0.50
Lava flows, pahoehoe----	35	Not rated		Not rated	
401: Ihuanu-----	60	Limitations Slopes > 15% Dusty Fragments >3" 25 to 75%	1.00 0.50 0.32	Limitations Slopes > 6% Fragments > 3" > 30% Surface fragments (<3") >25%	1.00 1.00 0.99
Lava flows, aa-----	40	Not rated		Not rated	
402: Ihuanu-----	95	Limitations Slopes > 15% Dusty Fragments >3" 25 to 75%	1.00 0.50 0.32	Limitations Slopes > 6% Fragments > 3" > 30% Surface fragments (<3") >25%	1.00 1.00 0.99
403: Ihuanu-----	95	Limitations Dusty Fragments >3" 25 to 75%	0.50 0.32	Limitations Fragments > 3" > 30% Surface fragments (<3") >25% Slopes 2 to 6%	1.00 0.99 0.98
406: Lava flows, pahoehoe----	70	Not rated		Not rated	
Iwalani-----	30	Limitations Bedrock depth < 20" Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Bedrock depth < 20" Dusty	1.00 1.00 0.50
407: Iwalani-----	60	Limitations Bedrock depth < 20" Dusty	1.00 0.50	Limitations Bedrock depth < 20" Slopes 2 to 6% Dusty	1.00 0.98 0.50
Lava flows, pahoehoe----	40	Not rated		Not rated	
408: Iwalani-----	70	Limitations Bedrock depth < 20" Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Bedrock depth < 20" Dusty	1.00 1.00 0.50
Lava flows, pahoehoe----	30	Not rated		Not rated	
461: Hapuu, very gravelly----	90	Limitations Slopes > 15% Fragments (<3") 25-50% Dusty	1.00 0.92 0.50	Limitations Slopes > 6% Surface fragments (<3") >25% Fragments >3" 5 to 30%	1.00 1.00 0.92

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
463: Hapuu, extremely gravelly-----	90	Limitations Fragments (<3") > 50% Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Slopes > 6% Surface fragments (<3") >25% Fragments >3" 5 to 30%	1.00 1.00 0.92
511: Akihi-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15% Fragments >3" 25 to 75%	1.00 1.00 0.88	Limitations Slopes > 6% Fragments > 3" > 30% Organic surface layer >= 4" thick	1.00 1.00 1.00
512: Akihi-----	100	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.88	Limitations Fragments > 3" > 30% Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 1.00 0.98
513: Hilea-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15% Bedrock depth < 20"	1.00 1.00 1.00	Limitations Slopes > 6% Bedrock depth < 20" Organic surface layer >= 4" thick	1.00 1.00 1.00
514: Hilea-----	100	Limitations Organic surface layer >= 4" thick Bedrock depth < 20"	1.00 1.00	Limitations Bedrock depth < 20" Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 1.00 0.98
515: Pahipa-----	45	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick Slopes > 6% Permeability .06-.6"/hr	1.00 1.00 0.60
Pualii-----	45	Limitations Organic surface layer >= 4" thick Bedrock depth < 20" Slopes 8 to 15%	1.00 1.00 0.63	Limitations Organic surface layer >= 4" thick Slopes > 6% Bedrock depth < 20"	1.00 1.00 1.00
516: Alapai-----	100	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 0.98
517: Alapai-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15%	1.00 1.00	Limitations Slopes > 6% Organic surface layer >= 4" thick	1.00 1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
518: Alapai-----	100	Limitations Slopes > 15% Organic surface layer >= 4" thick	1.00 1.00	Limitations Slopes > 6% Organic surface layer >= 4" thick	1.00 1.00
519: Lalaau-----	95	Limitations Fragments >3" 25 to 75%	0.71	Limitations Fragments > 3" > 30% Slopes 2 to 6%	1.00 0.98
525: Alapai, low precipitation-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15%	1.00 1.00	Limitations Slopes > 6% Organic surface layer >= 4" thick	1.00 1.00
534: Kahaluu-----	60	Limitations Bedrock depth < 20" Organic surface layer >= 4" thick	1.00 1.00	Limitations Bedrock depth < 20" Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 1.00 0.98
Lava flows, pahoehoe----	40	Not rated		Not rated	
555: Kuanene-----	55	Limitations Slopes > 15% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Slopes > 6% Bedrock depth < 20" Very dusty	1.00 1.00 1.00
Lava flows, pahoehoe----	45	Not rated		Not rated	
574: Ihuanu-----	55	Limitations Slopes > 15% Dusty Fragments >3" 25 to 75%	1.00 0.50 0.32	Limitations Slopes > 6% Fragments > 3" > 30% Surface fragments (<3") >25%	1.00 1.00 0.99
Lava flows, pahoehoe----	35	Not rated		Not rated	
575: Durustands-----	95	Limitations Dusty Permeability .06-.6"/hr Slopes 8 to 15%	0.50 0.10 0.01	Limitations Slopes > 6% Bedrock 20-40" and slope >2% Dusty	1.00 0.50 0.50
576: Puali-----	35	Limitations Organic surface layer >= 4" thick Bedrock depth < 20" Slopes 8 to 15%	1.00 1.00 0.63	Limitations Organic surface layer >= 4" thick Slopes > 6% Bedrock depth < 20"	1.00 1.00 1.00
Puu Oo-----	35	Limitations Slopes 8 to 15%	0.63	Limitations Slopes > 6%	1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
576: Pahipa-----	25	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick Slopes > 6% Permeability .06-.6"/hr	1.00 1.00 0.60
577: Pahipa-----	70	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick Slopes > 6% Permeability .06-.6"/hr	1.00 1.00 0.60
Puu Oo-----	25	Limitations Slopes 8 to 15%	0.63	Limitations Slopes > 6%	1.00
605: Kaholimo-----	60	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.26
Ki-----	35	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6%	1.00 0.74
607: Kaholimo-----	60	Limitations Bedrock depth < 20" Slopes 8 to 15%	1.00 0.16	Limitations Slopes > 6% Bedrock depth < 20"	1.00 1.00
Ki-----	35	Limitations Very dusty Slopes 8 to 15%	1.00 0.16	Limitations Slopes > 6% Very dusty	1.00 1.00
610: Piihonua-----	100	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 0.02
613: Kilauea-----	95	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.08	Limitations Organic surface layer >= 4" thick Fragments > 3" > 30% Slopes 2 to 6%	1.00 1.00 0.50
621: Eheuiki-----	60	No limitations		Limitations Slopes 2 to 6%	0.50
Pekailio-----	40	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty Fragments >3" 5 to 30%	1.00 1.00 0.68

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
625: Hao-----	90	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick Slopes 2 to 6%	1.00 0.50
631: Kapapala-----	90	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Dusty	0.50 0.50
657: Malama-----	60	Limitations Fragments >3" >75% Fragments >10" >3% Slopes 8 to 15%	1.00 1.00 0.16	Limitations Fragments > 3" > 30% Slopes > 6% Fragments >10" >3%	1.00 1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
709: Lava flows, pahoehoe----	60	Not rated		Not rated	
Lithic Ustipsamments----	40	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00
711: Lava flows, pahoehoe----	65	Not rated		Not rated	
Apuki-----	30	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00
713: Lithic Haplustands, cindery substratum----	50	Limitations Fragments (<3") > 50% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Surface fragments (<3") >25% Bedrock depth < 20" Very dusty	1.00 1.00 1.00
Lithic Haplustands, loamy surface-----	25	Limitations Fragments (<3") > 50% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Surface fragments (<3") >25% Bedrock depth < 20" Very dusty	1.00 1.00 1.00
Lava flows, pahoehoe----	25	Not rated		Not rated	
715: Alahapa-----	65	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Fragments >10" >3% Very dusty	1.00 1.00 1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
715: Heake-----	25	Limitations Bedrock depth < 20" Very dusty	1.00 1.00	Limitations Bedrock depth < 20" Very dusty Slopes 2 to 6%	1.00 1.00 0.50
716: Alahapa-----	90	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Fragments >10" >3% Very dusty	1.00 1.00 1.00
717: Alahapa-----	50	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Fragments >10" >3% Very dusty	1.00 1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
718: Halemaumau-----	90	Limitations Fragments (<3") > 50% Surface sand fractions >90% by wt. Very dusty	1.00 1.00 1.00	Limitations Surface fragments (<3") >25% Surface sand fractions >90% by wt. Slopes > 6%	1.00 1.00 1.00
719: Heake-----	85	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.50
720: Heake-----	45	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.50
Lava flows, pahoehoe----	40	Not rated		Not rated	
722: Kilauea-----	90	Limitations Surface pH < 3.5 Very dusty Permeability .06-.6"/hr	1.00 1.00 0.50	Limitations Surface pH < 3.5 Very dusty Slopes 2 to 6%	1.00 1.00 0.50
724: Lava flows, pahoehoe----	35	Not rated		Not rated	
Kaholimo, uneroded-----	20	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.26
Kaholimo, eroded-----	20	Limitations Permeability < .06"/hr Bedrock depth < 20"	1.00 1.00	Limitations Permeability < .06"/hr Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.26

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
724:					
Puiwa, uneroded-----	12	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick Bedrock 20-40" and slope >2% Slopes 2 to 6%	1.00 0.50 0.26
Puiwa, eroded-----	13	Limitations Permeability < .06"/hr	1.00	Limitations Permeability < .06"/hr Bedrock 20-40" and slope >2% Slopes 2 to 6%	1.00 0.50 0.26
725:					
Lava flows, pahoehoe----	55	Not rated		Not rated	
Kaholimo, eroded-----	20	Limitations Permeability < .06"/hr Bedrock depth < 20"	1.00 1.00	Limitations Permeability < .06"/hr Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.50
Kaholimo, uneroded-----	10	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.26
726:					
Kulalio-----	88	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty Fragments >3" 5 to 30%	1.00 1.00 0.92
727:					
Puauulu-----	90	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6% Surface fragments (<3") 10-25%	1.00 0.50 0.22
728:					
Puauulu-----	65	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6% Surface fragments (<3") 10-25%	1.00 0.50 0.22
Hao-----	25	No limitations		Limitations Slopes 2 to 6%	0.50
729:					
Eheuiki-----	60	No limitations		Limitations Slopes 2 to 6%	0.50
Puauulu-----	40	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6% Surface fragments (<3") 10-25%	1.00 0.50 0.22

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
731: Kahalii-----	55	Limitations Fragments (<3") > 50% Surface sand fractions >90% by wt. Bedrock depth < 20"	1.00 1.00 1.00	Limitations Surface fragments (<3") >25% Surface sand fractions >90% by wt. Bedrock depth < 20"	1.00 1.00 1.00
Lava flows, pahoehoe----	40	Not rated		Not rated	
734: Kanoehina-----	60	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.98
Lava flows, pahoehoe----	40	Not rated		Not rated	
735: Puhimau-----	90	Limitations Bedrock depth < 20" Very dusty	1.00 1.00	Limitations Bedrock depth < 20" Very dusty Slopes 2 to 6%	1.00 1.00 0.26
736: Manu-----	92	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6% Bedrock 20-40" and slope >2%	1.00 0.50 0.50
737: Nakanui-----	55	Limitations Bedrock depth < 20" Dusty	1.00 0.50	Limitations Bedrock depth < 20" Slopes 2 to 6% Dusty	1.00 0.50 0.50
Lava flows, pahoehoe----	35	Not rated		Not rated	
738: Vitric Haplustands-----	90	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Fragments >10" >3% Slopes > 6%	1.00 1.00 1.00
741: Ahiu-----	60	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty Bedrock depth < 20" Slopes 2 to 6%	1.00 1.00 0.26
Lava flows, pahoehoe----	30	Not rated		Not rated	
743: Pakini-----	95	Limitations Dusty	0.50	Limitations Slopes 2 to 6% Dusty	0.50 0.50
744: Haa-----	45	No limitations		Limitations Slopes 2 to 6%	0.50

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
744: Keamoku-----	40	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6%	1.00 0.50
745: Maunaiu-----	60	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.50
Akelelu-----	25	No limitations		Limitations Slopes 2 to 6% Bedrock 20-40" and slope >2%	0.50 0.50
746: Kulalio-----	40	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty Fragments >3" 5 to 30%	1.00 1.00 0.68
Maunaiu-----	35	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.50
Akelelu-----	15	No limitations		Limitations Slopes 2 to 6% Bedrock 20-40" and slope >2%	0.50 0.50
747: Oneula-----	90	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Very dusty Fragments >10" >3%	1.00 1.00 1.00
748: Lava flows, pahoehoe----	65	Not rated		Not rated	
Menehune-----	25	Limitations Bedrock depth < 20"	1.00	Limitations Bedrock depth < 20" Slopes 2 to 6%	1.00 0.50
749: Wahi-----	76	Limitations Fragments >10" >3% Fragments >3" >75%	1.00 1.00	Limitations Fragments > 3" > 30% Fragments >10" >3% Slopes 2 to 6%	1.00 1.00 0.50
750: Ki-----	85	Limitations Very dusty	1.00	Limitations Very dusty Slopes 2 to 6%	1.00 0.50
751: Oneula, low elevation---	95	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00	Limitations Fragments > 3" > 30% Very dusty Fragments >10" >3%	1.00 1.00 1.00

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Table 7a.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Picnic areas		Playgrounds	
		Limitations	Value	Limitations	Value
752:					
Oneula-----	40	Limitations		Limitations	
		Very dusty	1.00	Fragments > 3" > 30%	1.00
		Fragments >10" >3%	1.00	Very dusty	1.00
		Fragments >3" >75%	1.00	Fragments >10" >3%	1.00
Keamoku-----	30	Limitations		Limitations	
		Very dusty	1.00	Very dusty	1.00
				Slopes 2 to 6%	0.50
Maunaiu-----	15	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
				Slopes 2 to 6%	0.50
753:					
Kalapana-----	85	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
		Surface sand fractions 70-90% by wt.	0.12	Slopes 2 to 6%	0.50
				Surface sand fractions 70-90% by wt.	0.12
754:					
Kalapana, dry-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
		Surface sand fractions 70-90% by wt.	0.12	Slopes 2 to 6%	0.50
				Surface sand fractions 70-90% by wt.	0.12
Lava flows, pahoehoe----	40	Not rated		Not rated	
755:					
Makaopuhi-----	88	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
				Slopes 2 to 6%	0.26
756:					
Ahiu-----	45	Limitations		Limitations	
		Very dusty	1.00	Very dusty	1.00
		Bedrock depth < 20"	1.00	Bedrock depth < 20"	1.00
				Slopes 2 to 6%	0.26
Vitric Haplustands-----	40	Limitations		Limitations	
		Fragments >10" >3%	1.00	Fragments > 3" > 30%	1.00
		Fragments >3" >75%	1.00	Fragments >10" >3%	1.00
		Very dusty	1.00	Very dusty	1.00

The interpretation for picnic areas evaluates the following soil properties at variable depths in the soil: flooding, ponding, wetness, slope, depth to bedrock, depth to a cemented pan, salinity (EC), pH, soil dustiness, fragments more than 3 inches in size, surface fragments more than 10 inches in size, the amount of sand or clay in the surface layer, Unified classes for a high content of organic matter (PT, OL, and OH), and permeability (Ksat) that is too rapid, allowing seepage in some climates.

The interpretation for playgrounds evaluates the following soil properties at variable depths in the soil: flooding, ponding, wetness, slope, depth to bedrock, depth to a cemented pan, surface fragments more than 10 inches in size, fragments equal to or less than 3 inches in size, Unified classes for a high content of organic matter (PT, OL, and OH), soil dustiness, content of sand or clay in the surface layer, pH, salinity (EC), and permeability that is too rapid, allowing seepage in some climates.

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Table 7b.--Recreational Development

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. The rating is based on the limitation with the highest value. Only the three highest value limitations are listed. There may be more limitations. Fine-earth fractions and coarse fragments are reported on a weight basis. An explanation of the rating criteria and of the abbreviations used in describing the limitations is given at the end of the table)

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
10: Lava flows, aa-----	100	Not rated		Not rated	
12: Lava flows, pahoehoe----	100	Not rated		Not rated	
14: Lava flows, aa-----	50	Not rated		Not rated	
Lava flows, pahoehoe----	50	Not rated		Not rated	
15: Cinder land-----	100	Not rated		Not rated	
16: Cinder land-----	100	Not rated		Not rated	
19: Riverwash-----	90	Not rated		Not rated	
24: Badland, geothermal----	90	Not rated		Not rated	
26: Lava flows, aa, sparsely vegetated-----	50	Not rated		Not rated	
Lava flows, pahoehoe----	50	Not rated		Not rated	
117: Kapua-----	60	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" 25 to 75%	0.90	Fragments >3" 25 to 75%	0.90
Lava flows, aa-----	35	Not rated		Not rated	
130: Mawae-----	90	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
131: Mawae-----	90	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
		Slopes > 15%	1.00		

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
132:					
Mawae-----	60	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
Lava flows, aa-----	35	Not rated		Not rated	
133:					
Mawae-----	60	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
		Slopes > 15%	1.00		
Lava flows, aa-----	35	Not rated		Not rated	
137:					
Kekake-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Organic surface layer >= 4" thick	1.00
		Organic surface layer >= 4" thick	1.00		
Lava flows, pahoehoe----	35	Not rated		Not rated	
138:					
Kekake-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Organic surface layer >= 4" thick	1.00
		Organic surface layer >= 4" thick	1.00		
		Slopes > 15%	1.00		
Lava flows, pahoehoe----	35	Not rated		Not rated	
161:					
Kekake-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Organic surface layer >= 4" thick	1.00
		Organic surface layer >= 4" thick	1.00		
		Slopes > 15%	1.00		
Mawae-----	35	Limitations		Limitations	
		Organic surface layer >= 4" thick	1.00	Organic surface layer >= 4" thick	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
		Slopes > 15%	1.00		
163:					
Lava flows, pahoehoe----	70	Not rated		Not rated	
Kekake-----	25	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Organic surface layer >= 4" thick	1.00
		Organic surface layer >= 4" thick	1.00		
		Slopes > 15%	1.00		

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
164: Lava flows, pahoehoe----	80	Not rated		Not rated	
Kekake-----	15	Limitations Bedrock depth < 20" Organic surface layer >= 4" thick Slopes 8 to 15%	1.00 1.00 0.37	Limitations Organic surface layer >= 4" thick	1.00
169: Iwalani, moist-----	60	Limitations Bedrock depth < 20" Dusty	1.00 0.50	Limitations Dusty	0.50
Lava flows, pahoehoe----	40	Not rated		Not rated	
179: Iwalani, moist-----	70	Limitations Bedrock depth < 20" Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Dusty	0.50
Lava flows, pahoehoe----	30	Not rated		Not rated	
205: Ihuanu, moist-----	95	Limitations Slopes > 15% Dusty Fragments >3" 25 to 75%	1.00 0.50 0.32	Limitations Dusty Fragments >3" 25 to 75%	0.50 0.32
206: Ihuanu, moist-----	95	Limitations Dusty Fragments >3" 25 to 75%	0.50 0.32	Limitations Dusty Fragments >3" 25 to 75%	0.50 0.32
211: Kapulehu, moist-----	95	Limitations Fragments >3" 25 to 75% Dusty	0.90 0.50	Limitations Fragments >3" 25 to 75% Dusty	0.90 0.50
212: Kapulehu, moist-----	95	Limitations Slopes > 15% Fragments >3" 25 to 75% Dusty	1.00 0.90 0.50	Limitations Fragments >3" 25 to 75% Dusty	0.90 0.50
213: Nanaia, moist-----	60	Limitations Bedrock depth < 20" Dusty Fragments (<3") 25-50%	1.00 0.50 0.08	Limitations Dusty	0.50
Lava flows, pahoehoe----	35	Not rated		Not rated	
214: Lava flows, pahoehoe----	60	Not rated		Not rated	
Nanaia, moist-----	35	Limitations Bedrock depth < 20" Dusty Slopes 8 to 15%	1.00 0.50 0.37	Limitations Dusty	0.50

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
215: Keea, moist-----	90	Limitations Bedrock depth < 20" Dusty Fragments >3" 25 to 75%	 1.00 0.50 0.01	Limitations Dusty Fragments >3" 25 to 75%	 0.50 0.01
216: Keea, moist-----	90	Limitations Slopes > 15% Bedrock depth < 20" Dusty	 1.00 1.00 0.50	Limitations Dusty Fragments >3" 25 to 75%	 0.50 0.01
217: Kapulehu, moist-----	60	Limitations Slopes > 15% Fragments >3" 25 to 75% Dusty	 1.00 0.90 0.50	Limitations Slopes > 25% Fragments >3" 25 to 75% Dusty	 1.00 0.90 0.50
Keea, moist-----	40	Limitations Slopes > 15% Bedrock depth < 20" Dusty	 1.00 1.00 0.50	Limitations Slopes > 25% Dusty Fragments >3" 25 to 75%	 1.00 0.50 0.01
218: Kiolakaa, moist-----	90	Limitations Dusty	 0.50	Limitations Dusty	 0.50
219: Kiolakaa-----	60	Limitations Slopes > 15% Dusty	 1.00 0.50	Limitations Dusty	 0.50
Keea-----	40	Limitations Slopes > 15% Bedrock depth < 20" Dusty	 1.00 1.00 0.50	Limitations Dusty Fragments >3" 25 to 75%	 0.50 0.01
275: Kapulehu-----	60	Limitations Fragments >3" 25 to 75% Dusty	 0.90 0.50	Limitations Fragments >3" 25 to 75% Dusty	 0.90 0.50
Lava flows, aa-----	40	Not rated		Not rated	
276: Kapulehu-----	95	Limitations Fragments >3" 25 to 75% Dusty	 0.90 0.50	Limitations Fragments >3" 25 to 75% Dusty	 0.90 0.50
277: Kapulehu-----	95	Limitations Slopes > 15% Fragments >3" 25 to 75% Dusty	 1.00 0.90 0.50	Limitations Fragments >3" 25 to 75% Dusty	 0.90 0.50
280: Nanaia-----	60	Limitations Bedrock depth < 20" Dusty Fragments (<3") 25-50%	 1.00 0.50 0.08	Limitations Dusty	 0.50
Lava flows, pahoehoe----	35	Not rated		Not rated	

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
281: Lava flows, pahoehoe----	60	Not rated		Not rated	
Nanaia-----	35	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Dusty	0.50
		Dusty	0.50		
		Slopes 8 to 15%	0.37		
290: Keea-----	90	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Dusty	0.50
		Dusty	0.50	Fragments >3" 25 to 75%	0.01
		Fragments >3" 25 to 75%	0.01		
292: Keea-----	60	Limitations		Limitations	
		Bedrock depth < 20"	1.00	Dusty	0.50
		Dusty	0.50	Fragments >3" 25 to 75%	0.01
		Fragments >3" 25 to 75%	0.01		
Kiolakaa-----	35	Limitations		Limitations	
		Dusty	0.50	Dusty	0.50
300: Kamaoa-----	90	Limitations		Limitations	
		Dusty	0.50	Dusty	0.50
305: Kiolakaa-----	90	Limitations		Limitations	
		Dusty	0.50	Dusty	0.50
395: Hokukano-----	60	Limitations		No limitations	
		Flooding >= rare	1.00		
		Slopes > 15%	1.00		
		Bedrock depth < 20"	1.00		
Lava flows, pahoehoe----	35	Not rated		Not rated	
401: Ihuanu-----	60	Limitations		Limitations	
		Slopes > 15%	1.00	Dusty	0.50
		Dusty	0.50	Fragments >3" 25 to 75%	0.32
		Fragments >3" 25 to 75%	0.32		
Lava flows, aa-----	40	Not rated		Not rated	
402: Ihuanu-----	95	Limitations		Limitations	
		Slopes > 15%	1.00	Dusty	0.50
		Dusty	0.50	Fragments >3" 25 to 75%	0.32
		Fragments >3" 25 to 75%	0.32		
403: Ihuanu-----	95	Limitations		Limitations	
		Dusty	0.50	Dusty	0.50
		Fragments >3" 25 to 75%	0.32	Fragments >3" 25 to 75%	0.32

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
406: Lava flows, pahoehoe----	70	Not rated		Not rated	
Iwalani-----	30	Limitations Bedrock depth < 20" Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Dusty	0.50
407: Iwalani-----	60	Limitations Bedrock depth < 20" Dusty	1.00 0.50	Limitations Dusty	0.50
Lava flows, pahoehoe----	40	Not rated		Not rated	
408: Iwalani-----	70	Limitations Bedrock depth < 20" Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Dusty	0.50
Lava flows, pahoehoe----	30	Not rated		Not rated	
461: Hapuu, very gravelly----	90	Limitations Slopes > 15% Fragments (<3") 25-50% Dusty	1.00 0.92 0.50	Limitations Dusty	0.50
463: Hapuu, extremely gravelly-----	90	Limitations Fragments (<3") > 50% Slopes > 15% Dusty	1.00 1.00 0.50	Limitations Dusty	0.50
511: Akihi-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15% Fragments >3" 25 to 75%	1.00 1.00 0.88	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.88
512: Akihi-----	100	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.88	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.88
513: Hilea-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15% Bedrock depth < 20"	1.00 1.00 1.00	Limitations Organic surface layer >= 4" thick	1.00
514: Hilea-----	100	Limitations Organic surface layer >= 4" thick Bedrock depth < 20"	1.00 1.00	Limitations Organic surface layer >= 4" thick	1.00

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
515: Pahipa-----	45	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick	1.00
Puali-----	45	Limitations Organic surface layer >= 4" thick Bedrock depth < 20" Slopes 8 to 15%	1.00 1.00 0.63	Limitations Organic surface layer >= 4" thick	1.00
516: Alapai-----	100	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick	1.00
517: Alapai-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15%	1.00 1.00	Limitations Organic surface layer >= 4" thick	1.00
518: Alapai-----	100	Limitations Slopes > 15% Organic surface layer >= 4" thick	1.00 1.00	Limitations Organic surface layer >= 4" thick Slopes > 25%	1.00 1.00
519: Lalaau-----	95	Limitations Fragments >3" 25 to 75%	0.71	Limitations Fragments >3" 25 to 75%	0.71
525: Alapai, low precipitation-----	100	Limitations Organic surface layer >= 4" thick Slopes > 15%	1.00 1.00	Limitations Organic surface layer >= 4" thick	1.00
534: Kahaluu-----	60	Limitations Bedrock depth < 20" Organic surface layer >= 4" thick	1.00 1.00	Limitations Organic surface layer >= 4" thick	1.00
Lava flows, pahoehoe----	40	Not rated		Not rated	
555: Kuanene-----	55	Limitations Slopes > 15% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Slopes > 25% Very dusty	1.00 1.00
Lava flows, pahoehoe----	45	Not rated		Not rated	

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
574: Ihuanu-----	55	Limitations Slopes > 15% Dusty Fragments >3" 25 to 75%	1.00 0.50 0.32	Limitations Dusty Fragments >3" 25 to 75%	0.50 0.32
Lava flows, pahoehoe----	35	Not rated		Not rated	
575: Durustands-----	95	Limitations Dusty Permeability .06-.6"/hr Slopes 8 to 15%	0.50 0.10 0.01	Limitations Dusty	0.50
576: Puali-----	35	Limitations Organic surface layer >= 4" thick Bedrock depth < 20" Slopes 8 to 15%	1.00 1.00 0.63	Limitations Organic surface layer >= 4" thick	1.00
Puu Oo-----	35	Limitations Slopes 8 to 15%	0.63	No limitations	
Pahipa-----	25	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick	1.00
577: Pahipa-----	70	Limitations Organic surface layer >= 4" thick Slopes 8 to 15% Permeability .06-.6"/hr	1.00 0.63 0.60	Limitations Organic surface layer >= 4" thick	1.00
Puu Oo-----	25	Limitations Slopes 8 to 15%	0.63	No limitations	
605: Kaholimo-----	60	Limitations Bedrock depth < 20"	1.00	No limitations	
Ki-----	35	Limitations Very dusty	1.00	Limitations Very dusty	1.00
607: Kaholimo-----	60	Limitations Bedrock depth < 20" Slopes 8 to 15%	1.00 0.16	No limitations	
Ki-----	35	Limitations Very dusty Slopes 8 to 15%	1.00 0.16	Limitations Very dusty	1.00
610: Piihonua-----	100	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick	1.00

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
613: Kilua-----	95	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.08	Limitations Organic surface layer >= 4" thick Fragments >3" 25 to 75%	1.00 0.08
621: Eheuiki-----	60	No limitations		No limitations	
Pekailio-----	40	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty	1.00 1.00
625: Hao-----	90	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick	1.00
631: Kapapala-----	90	Limitations Dusty	0.50	Limitations Dusty	0.50
657: Malama-----	60	Limitations Fragments >3" >75% Fragments >10" >3% Slopes 8 to 15%	1.00 1.00 0.16	Limitations Fragments >3" >75% Fragments >10" >3%	1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
709: Lava flows, pahoehoe----	60	Not rated		Not rated	
Lithic Ustipsammits-----	40	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00	Limitations Very dusty Surface sand fractions >90% by wt.	1.00 1.00
711: Lava flows, pahoehoe----	65	Not rated		Not rated	
Apuki-----	30	Limitations Surface sand fractions >90% by wt. Very dusty Bedrock depth < 20"	1.00 1.00 1.00	Limitations Very dusty Surface sand fractions >90% by wt.	1.00 1.00
713: Lithic Haplustands, cindery substratum-----	50	Limitations Fragments (<3") > 50% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Surface fragments <3" >65% Very dusty Surface sand fractions 70-90% by wt.	1.00 1.00 0.50
Lithic Haplustands, loamy surface-----	25	Limitations Fragments (<3") > 50% Bedrock depth < 20" Very dusty	1.00 1.00 1.00	Limitations Surface fragments <3" >65% Very dusty	1.00 1.00

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
713: Lava flows, pahoehoe----	25	Not rated		Not rated	
715: Alahapa-----	65	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00
Heake-----	25	Limitations Bedrock depth < 20" Very dusty	1.00 1.00	Limitations Very dusty	1.00
716: Alahapa-----	90	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00
717: Alahapa-----	50	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
718: Halemaumau-----	90	Limitations Fragments (<3") > 50% Surface sand fractions >90% by wt. Very dusty	1.00 1.00 1.00	Limitations Surface fragments <3" >65% Surface sand fractions >90% by wt. Very dusty	1.00 1.00 1.00
719: Heake-----	85	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty	1.00
720: Heake-----	45	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty	1.00
Lava flows, pahoehoe----	40	Not rated		Not rated	
722: Kilauea-----	90	Limitations Surface pH < 3.5 Very dusty Permeability .06-.6"/hr	1.00 1.00 0.50	Limitations Very dusty	1.00
724: Lava flows, pahoehoe----	35	Not rated		Not rated	
Kaholimo, uneroded-----	20	Limitations Bedrock depth < 20"	1.00	No limitations	

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
724:					
Kaholimo, eroded-----	20	Limitations Permeability < .06"/hr Bedrock depth < 20"	1.00 1.00	No limitations	
Puiwa, uneroded-----	12	Limitations Organic surface layer >= 4" thick	1.00	Limitations Organic surface layer >= 4" thick	1.00
Puiwa, eroded-----	13	Limitations Permeability < .06"/hr	1.00	No limitations	
725:					
Lava flows, pahoehoe----	55	Not rated		Not rated	
Kaholimo, eroded-----	20	Limitations Permeability < .06"/hr Bedrock depth < 20"	1.00 1.00	No limitations	
Kaholimo, uneroded-----	10	Limitations Bedrock depth < 20"	1.00	No limitations	
726:					
Kulalio-----	88	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty	1.00 1.00
727:					
Puaulu-----	90	Limitations Very dusty	1.00	Limitations Very dusty	1.00
728:					
Puaulu-----	65	Limitations Very dusty	1.00	Limitations Very dusty	1.00
Hao-----	25	No limitations		No limitations	
729:					
Eheuiki-----	60	No limitations		No limitations	
Puaulu-----	40	Limitations Very dusty	1.00	Limitations Very dusty	1.00
731:					
Kahalii-----	55	Limitations Fragments (<3") > 50% Surface sand fractions >90% by wt. Bedrock depth < 20"	1.00 1.00 1.00	Limitations Surface fragments <3" >65% Surface sand fractions >90% by wt. Very dusty	1.00 1.00 1.00
Lava flows, pahoehoe----	40	Not rated		Not rated	
734:					
Kanohina-----	60	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty	1.00
Lava flows, pahoehoe----	40	Not rated		Not rated	

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
735: Puhimau-----	90	Limitations Bedrock depth < 20" Very dusty	1.00 1.00	Limitations Very dusty	1.00
736: Manu-----	92	Limitations Very dusty	1.00	Limitations Very dusty	1.00
737: Nakanui-----	55	Limitations Bedrock depth < 20" Dusty	1.00 0.50	Limitations Dusty	0.50
Lava flows, pahoehoe----	35	Not rated		Not rated	
738: Vitric Haplustands-----	90	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00	Limitations Fragments >10" >3% Fragments >3" >75% Very dusty	1.00 1.00 1.00
741: Ahiu-----	60	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty	1.00
Lava flows, pahoehoe----	30	Not rated		Not rated	
743: Pakini-----	95	Limitations Dusty	0.50	Limitations Dusty	0.50
744: Haa-----	45	No limitations		No limitations	
Keamoku-----	40	Limitations Very dusty	1.00	Limitations Very dusty	1.00
745: Maunaiu-----	60	Limitations Bedrock depth < 20"	1.00	No limitations	
Akelelu-----	25	No limitations		No limitations	
746: Kulalio-----	40	Limitations Fragments >10" >3% Very dusty	1.00 1.00	Limitations Fragments >10" >3% Very dusty	1.00 1.00
Maunaiu-----	35	Limitations Bedrock depth < 20"	1.00	No limitations	
Akelelu-----	15	No limitations		No limitations	
747: Oneula-----	90	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00

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Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
748: Lava flows, pahoehoe----	65	Not rated		Not rated	
Menehune-----	25	Limitations Bedrock depth < 20"	1.00	No limitations	
749: Wahi-----	76	Limitations Fragments >10" >3% Fragments >3" >75%	1.00 1.00	Limitations Fragments >10" >3% Fragments >3" >75%	1.00 1.00
750: Ki-----	85	Limitations Very dusty	1.00	Limitations Very dusty	1.00
751: Oneula, low elevation---	95	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00
752: Oneula-----	40	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00	Limitations Very dusty Fragments >10" >3% Fragments >3" >75%	1.00 1.00 1.00
Keamoku-----	30	Limitations Very dusty	1.00	Limitations Very dusty	1.00
Maunaiu-----	15	Limitations Bedrock depth < 20"	1.00	No limitations	
753: Kalapana-----	85	Limitations Bedrock depth < 20" Surface sand fractions 70-90% by wt.	1.00 0.12	Limitations Surface sand fractions 70-90% by wt.	0.12
754: Kalapana, dry-----	60	Limitations Bedrock depth < 20" Surface sand fractions 70-90% by wt.	1.00 0.12	Limitations Surface sand fractions 70-90% by wt.	0.12
Lava flows, pahoehoe----	40	Not rated		Not rated	
755: Makaopuhi-----	88	Limitations Bedrock depth < 20"	1.00	No limitations	
756: Ahiu-----	45	Limitations Very dusty Bedrock depth < 20"	1.00 1.00	Limitations Very dusty	1.00

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 7b.--Recreational Development--Continued

Map symbol and component name	Pct. of map unit	Camp areas		Paths and trails	
		Limitations	Value	Limitations	Value
756: Vitric Haplustands-----	40	Limitations		Limitations	
		Fragments >10" >3%	1.00	Fragments >10" >3%	1.00
		Fragments >3" >75%	1.00	Fragments >3" >75%	1.00
		Very dusty	1.00	Very dusty	1.00

The interpretation for camp areas evaluates the following soil properties at variable depths in the soil: flooding; ponding; wetness; slope; depth to bedrock; depth to a cemented pan; fragments less than, equal to, or more than 3 inches in size; sodium content (SAR); salinity (EC); a clayey surface layer; Unified classes for a high content of organic matter (PT, OL, and OH); soil dustiness; and permeability (Ksat) that is too rapid, allowing seepage in some climates.

The interpretation for paths and trails evaluates the following soil properties at variable depths in the soil: flooding; ponding; wetness; slope; fragments less than, equal to, or more than 3 inches in size; content of clay and sand in the surface layer; surface fragments more than or equal to 10 inches in size; Unified classes for a high content of organic matter (PT, OL, and OH); soil dustiness; and the hazard of water erosion.

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Table 8a.--Building Site Development

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. The rating is based on the limitation with the highest value. Only the three highest value limitations are listed. There may be more limitations. Fine-earth fractions and coarse fragments are reported on a weight basis. An explanation of the rating criteria and of the abbreviations used in describing the limitations is given at the end of the table)

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10: Lava flows, aa-----	100	Not rated		Not rated	
12: Lava flows, pahoehoe-----	100	Not rated		Not rated	
14: Lava flows, aa-----	50	Not rated		Not rated	
Lava flows, pahoehoe-----	50	Not rated		Not rated	
15: Cinder land-----	100	Not rated		Not rated	
16: Cinder land-----	100	Not rated		Not rated	
19: Riverwash-----	90	Not rated		Not rated	
24: Badland, geothermal-----	90	Not rated		Not rated	
26: Lava flows, aa, sparsely vegetated	50	Not rated		Not rated	
Lava flows, pahoehoe-----	50	Not rated		Not rated	
117: Kapua-----	60	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.50
Lava flows, aa-----	35	Not rated		Not rated	
130: Mawae-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.50
131: Mawae-----	90	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.99	Severe Slopes > 8% Fragments (>3") >50%	1.00 1.00
132: Mawae-----	60	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.50
Lava flows, aa-----	35	Not rated		Not rated	

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
133:					
Mawae-----	60	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.99	Severe Slopes > 8% Fragments (>3") >50%	1.00 1.00
Lava flows, aa-----	35	Not rated		Not rated	
137:					
Kekake-----	60	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth	1.00 1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	35	Not rated		Not rated	
138:					
Kekake-----	60	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 1.00 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Lava flows, pahoehoe-----	35	Not rated		Not rated	
161:					
Kekake-----	60	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 1.00 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Mawae-----	35	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.99	Severe Slopes > 8% Fragments (>3") >50%	1.00 1.00
163:					
Lava flows, pahoehoe-----	70	Not rated		Not rated	
Kekake-----	25	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 1.00 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
164:					
Lava flows, pahoehoe-----	80	Not rated		Not rated	
Kekake-----	15	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 1.00 0.43	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
169:					
Iwalani, moist-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	40	Not rated		Not rated	
179:					
Iwalani, moist-----	70	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Lava flows, pahoehoe-----	30	Not rated		Not rated	

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
205: Ihuanu, moist-----	95	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.97	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97
206: Ihuanu, moist-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.97	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40" Slopes 4 to 8%	1.00 0.97 0.50
211: Kapulehu, moist-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40" Slopes 4 to 8%	1.00 0.79 0.50
212: Kapulehu, moist-----	95	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.79	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79
213: Nanaia, moist-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	35	Not rated		Not rated	
214: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Nanaia, moist-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.43	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
215: Keaa, moist-----	90	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 20" depth Fragments (>3") >50% Slopes 4 to 8%	1.00 0.99 0.50
216: Keaa, moist-----	90	Severe Bedrock (hard) < 20" depth Fragments (>3") >50% Slopes 8 to 15%	1.00 0.99 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 1.00 0.99
217: Kapulehu, moist-----	60	Severe Slopes > 15% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
217: Keea, moist-----	40	Severe Slopes > 15% Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 1.00 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 1.00 0.99
218: Kiolakaa, moist-----	90	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50% Slopes 4 to 8%	0.84 0.83 0.50
219: Kiolakaa-----	60	Moderate Slopes 8 to 15% Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.99 0.84 0.83	Severe Slopes > 8% Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	1.00 0.84 0.83
Keea-----	40	Severe Bedrock (hard) < 20" depth Fragments (>3") >50% Slopes 8 to 15%	1.00 0.99 0.99	Severe Slopes > 8% Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 1.00 0.99
275: Kapulehu-----	60	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40" Slopes 4 to 8%	1.00 0.79 0.50
Lava flows, aa-----	40	Not rated		Not rated	
276: Kapulehu-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40" Slopes 4 to 8%	1.00 0.79 0.50
277: Kapulehu-----	95	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.79	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79
280: Nanaia-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	35	Not rated		Not rated	
281: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Nanaia-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.43	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
290: Keaa-----	90	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 20" depth Fragments (>3") >50% Slopes 4 to 8%	1.00 0.99 0.50
292: Keaa-----	60	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 20" depth Fragments (>3") >50% Slopes 4 to 8%	1.00 0.99 0.50
Kiolakaa-----	35	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50% Slopes 4 to 8%	0.84 0.83 0.50
300: Kamooa-----	90	Slight		Moderate Slopes 4 to 8%	0.50
305: Kiolakaa-----	90	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50% Slopes 4 to 8%	0.84 0.83 0.50
395: Hokukano-----	60	Severe Flash flooding > rare Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 1.00 0.99	Severe Slopes > 8% Flash flooding > rare Bedrock (hard) < 20" depth	1.00 1.00 1.00
Lava flows, pahoehoe-----	35	Not rated		Not rated	
401: Ihuanu-----	60	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.97	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97
Lava flows, aa-----	40	Not rated		Not rated	
402: Ihuanu-----	95	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.97	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97
403: Ihuanu-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.97	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40" Slopes 4 to 8%	1.00 0.97 0.50

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
406:					
Lava flows, pahoehoe-----	70	Not rated		Not rated	
Iwalani-----	30	Severe		Severe	
		Bedrock (hard) < 20" depth	1.00	Slopes > 8%	1.00
		Slopes 8 to 15%	0.99	Bedrock (hard) < 20" depth	1.00
407:					
Iwalani-----	60	Severe		Severe	
		Bedrock (hard) < 20" depth	1.00	Bedrock (hard) < 20" depth	1.00
				Slopes 4 to 8%	0.50
Lava flows, pahoehoe-----	40	Not rated		Not rated	
408:					
Iwalani-----	70	Severe		Severe	
		Bedrock (hard) < 20" depth	1.00	Slopes > 8%	1.00
		Slopes 8 to 15%	0.99	Bedrock (hard) < 20" depth	1.00
Lava flows, pahoehoe-----	30	Not rated		Not rated	
461:					
Hapuu, very gravelly-----	90	Moderate		Severe	
		Slopes 8 to 15%	0.99	Slopes > 8%	1.00
463:					
Hapuu, extremely gravelly-----	90	Moderate		Severe	
		Slopes 8 to 15%	0.99	Slopes > 8%	1.00
511:					
Akihi-----	100	Severe		Severe	
		Fragments (>3") >50%	1.00	Slopes > 8%	1.00
		Slopes 8 to 15%	0.99	Fragments (>3") >50%	1.00
		Liquefaction - low strength (OH-T) below 25 cm	0.50	Bedrock (hard) from 20 to 40"	0.10
512:					
Akihi-----	100	Severe		Severe	
		Fragments (>3") >50%	1.00	Fragments (>3") >50%	1.00
		Liquefaction - low strength (OH-T) below 25 cm	0.50	Slopes 4 to 8%	0.50
		Bedrock (hard) from 20 to 40"	0.10	Bedrock (hard) from 20 to 40"	0.10
513:					
Hilea-----	100	Severe		Severe	
		Bedrock (hard) < 20" depth	1.00	Slopes > 8%	1.00
		Slopes 8 to 15%	0.99	Bedrock (hard) < 20" depth	1.00
		Liquefaction - low strength (OH-T) below 25 cm	0.50		
514:					
Hilea-----	100	Severe		Severe	
		Bedrock (hard) < 20" depth	1.00	Bedrock (hard) < 20" depth	1.00
		Liquefaction - low strength (OH-T) below 25 cm	0.50	Slopes 4 to 8%	0.50

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
515: Pahipa-----	45	Moderate Fragments (>3") >50% Slopes 8 to 15% Liquefaction - low strength (OH-T) below 25 cm	0.99 0.57 0.50	Severe Slopes > 8% Fragments (>3") >50%	1.00 0.99
Puali-----	45	Severe Bedrock (hard) < 20" depth Slopes 8 to 15% Liquefaction - low strength (OH-T) below 25 cm	1.00 0.57 0.50	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
516: Alapai-----	100	Slight		Moderate Slopes 4 to 8%	0.50
517: Alapai-----	100	Moderate Slopes 8 to 15%	0.99	Severe Slopes > 8%	1.00
518: Alapai-----	100	Severe Slopes > 15%	1.00	Severe Slopes > 8%	1.00
519: Lalaa-----	95	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.50
525: Alapai, low precipitation-----	100	Moderate Slopes 8 to 15%	0.99	Severe Slopes > 8%	1.00
534: Kahaluu-----	60	Severe OL, OH, PT in 10-40" Bedrock (hard) < 20" depth	1.00 1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	40	Not rated		Not rated	
555: Kuanene-----	55	Severe Slopes > 15% Bedrock (hard) < 20" depth	1.00 1.00	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Lava flows, pahoehoe-----	45	Not rated		Not rated	
574: Ihuanu-----	55	Severe Fragments (>3") >50% Slopes 8 to 15% Bedrock (hard) from 20 to 40"	1.00 0.99 0.97	Severe Slopes > 8% Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97
Lava flows, pahoehoe-----	35	Not rated		Not rated	
575: Durustands-----	95	Moderate Bedrock (hard) from 20 to 40" Slopes 8 to 15%	0.79 0.01	Moderate Slopes > 8% Bedrock (hard) from 20 to 40"	0.98 0.79

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
576:					
Puali-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15% Liquefaction - low strength (OH-T) below 25 cm	1.00 0.57 0.50	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Puu Oo-----	35	Moderate Slopes 8 to 15%	0.57	Severe Slopes > 8%	1.00
Pahipa-----	25	Moderate Fragments (>3") >50% Slopes 8 to 15% Liquefaction - low strength (OH-T) below 25 cm	0.99 0.57 0.50	Severe Slopes > 8% Fragments (>3") >50%	1.00 0.99
577:					
Pahipa-----	70	Moderate Fragments (>3") >50% Slopes 8 to 15% Liquefaction - low strength (OH-T) below 25 cm	0.99 0.57 0.50	Severe Slopes > 8% Fragments (>3") >50%	1.00 0.99
Puu Oo-----	25	Moderate Slopes 8 to 15%	0.57	Severe Slopes > 8%	1.00
605:					
Kaholimo-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Ki-----	35	Slight		Moderate Slopes 4 to 8%	0.26
607:					
Kaholimo-----	60	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.29	Severe Slopes > 8% Bedrock (hard) < 20" depth	1.00 1.00
Ki-----	35	Moderate Slopes 8 to 15%	0.29	Severe Slopes > 8%	1.00
610:					
Piihonua-----	100	Slight		Slight	
613:					
Kilooa-----	95	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
621:					
Eheuiki-----	60	Slight		Moderate Slopes 4 to 8%	0.02
Pekailio-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
625:					
Hao-----	90	Slight		Moderate Slopes 4 to 8%	0.02

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
631: Kapapala-----	90	Slight		Moderate Slopes 4 to 8%	0.02
657: Malama-----	60	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.29	Severe Slopes > 8% Fragments (>3") >50%	1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
709: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Lithic Ustipsamments-----	40	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
711: Lava flows, pahoehoe-----	65	Not rated		Not rated	
Apuki-----	30	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
713: Lithic Haplustands, cindery substratum-----	50	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Lithic Haplustands, loamy surface	25	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Lava flows, pahoehoe-----	25	Not rated		Not rated	
715: Alahapa-----	65	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
Heake-----	25	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
716: Alahapa-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
717: Alahapa-----	50	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
Lava flows, aa-----	40	Not rated		Not rated	
718: Halemaumau-----	90	Moderate Bedrock (hard) from 20 to 40" Slopes 8 to 15%	0.50 0.01	Moderate Slopes > 8% Bedrock (hard) from 20 to 40"	0.98 0.50

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
719: Heake-----	85	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
720: Heake-----	45	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Lava flows, pahoehoe-----	40	Not rated		Not rated	
722: Kilauea-----	90	Slight		Moderate Slopes 4 to 8%	0.02
724: Lava flows, pahoehoe-----	35	Not rated		Not rated	
Kaholimo, uneroded-----	20	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Kaholimo, eroded-----	20	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Puiwa, uneroded-----	12	Moderate Bedrock (hard) from 20 to 40"	0.01	Moderate Bedrock (hard) from 20 to 40"	0.01
Puiwa, eroded-----	13	Moderate Bedrock (hard) from 20 to 40"	0.01	Moderate Bedrock (hard) from 20 to 40"	0.01
725: Lava flows, pahoehoe-----	55	Not rated		Not rated	
Kaholimo, eroded-----	20	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Kaholimo, uneroded-----	10	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
726: Kulalio-----	88	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
727: Puauulu-----	90	Slight		Moderate Slopes 4 to 8%	0.02
728: Puauulu-----	65	Slight		Moderate Slopes 4 to 8%	0.02
Hao-----	25	Slight		Moderate Slopes 4 to 8%	0.02

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
729: Eheuiki-----	60	Slight		Moderate Slopes 4 to 8%	0.02
Puaulu-----	40	Slight		Moderate Slopes 4 to 8%	0.02
731: Kahalii-----	55	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	40	Not rated		Not rated	
734: Kaochina-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.50
Lava flows, pahoehoe-----	40	Not rated		Not rated	
735: Puhimau-----	90	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
736: Manu-----	92	Moderate Bedrock (hard) from 20 to 40"	0.16	Moderate Bedrock (hard) from 20 to 40" Slopes 4 to 8%	0.16 0.02
737: Nakanui-----	55	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Lava flows, pahoehoe-----	35	Not rated		Not rated	
738: Vitric Haplustands-----	90	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.01	Severe Fragments (>3") >50% Slopes > 8%	1.00 0.98
741: Ahiu-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Lava flows, pahoehoe-----	30	Not rated		Not rated	
743: Pakini-----	95	Slight		Moderate Slopes 4 to 8%	0.02
744: Haa-----	45	Slight		Moderate Slopes 4 to 8%	0.02
Keamoku-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
745: Maunaiu-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Akelelu-----	25	Moderate Bedrock (hard) from 20 to 40"	0.16	Moderate Bedrock (hard) from 20 to 40" Slopes 4 to 8%	0.16 0.02
746: Kulalio-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
Maunaiu-----	35	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Akelelu-----	15	Moderate Bedrock (hard) from 20 to 40"	0.16	Moderate Bedrock (hard) from 20 to 40" Slopes 4 to 8%	0.16 0.02
747: Oneula-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
748: Lava flows, pahoehoe-----	65	Not rated		Not rated	
Menehune-----	25	Severe Bedrock (hard) < 20" depth OL, OH, PT in 10-40"	1.00 1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
749: Wahi-----	76	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
750: Ki-----	85	Slight		Moderate Slopes 4 to 8%	0.02
751: Oneula, low elevation-----	95	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
752: Oneula-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
Keamoku-----	30	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02
Maunaiu-----	15	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02

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Table 8a.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Dwellings without basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value
753: Kalapana-----	85	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
754: Kalapana, dry-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth Slopes 4 to 8%	1.00 0.02
Lava flows, pahoehoe-----	40	Not rated		Not rated	
755: Makaopuhi-----	88	Severe Bedrock (hard) < 20" depth OL, OH, PT in 10-40"	1.00 1.00	Severe Bedrock (hard) < 20" depth	1.00
756: Ahiu-----	45	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 20" depth	1.00
Vitric Haplustands-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Slopes 4 to 8%	1.00 0.02

The interpretation for dwellings without basements evaluates the following soil properties, some at variable depths in the soil: flash flooding, ponding, wetness, slope, shrink-swell potential expressed as linear extensibility percent (LEP), organic Unified classes for low soil strength (PT, OL, OH, and OH-T), liquefaction, depth to hard or soft bedrock, depth to a thick or thin cemented pan, and fragments more than 3 inches in size.

The interpretation for small commercial buildings evaluates the following soil properties, some at variable depths in the soil: flash flooding, ponding, wetness, slope, subsidence of organic soils, shrink-swell potential expressed as linear extensibility percent (LEP), depth to hard or soft bedrock, depth to a thick or thin cemented pan, and fragments more than 3 inches in size.

Table 8b.--Building Site Development

(The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. The rating is based on the limitation with the highest value. Only the three highest value limitations are listed. There may be more limitations. Fine-earth fractions and coarse fragments are reported on a weight basis. An explanation of the rating criteria and of the abbreviations used in describing the limitations is given at the end of the table)

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10: Lava flows, aa-----	100	Not rated		Not rated	
12: Lava flows, pahoehoe-----	100	Not rated		Not rated	
14: Lava flows, aa-----	50	Not rated		Not rated	
Lava flows, pahoehoe-----	50	Not rated		Not rated	
15: Cinder land-----	100	Not rated		Not rated	
16: Cinder land-----	100	Not rated		Not rated	
19: Riverwash-----	90	Not rated		Not rated	
24: Badland, geothermal-----	90	Not rated		Not rated	
26: Lava flows, aa, sparsely vegetated	50	Not rated		Not rated	
Lava flows, pahoehoe-----	50	Not rated		Not rated	
117: Kapua-----	60	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential	1.00 0.10
Lava flows, aa-----	35	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
130: Mawae-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Bedrock (hard) < 40" depth Caving potential	1.00 0.99 0.10
131: Mawae-----	90	Severe Fragments (>3") >50% Slopes > 15%	1.00 1.00	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) < 40" depth	1.00 1.00 0.99
132: Mawae-----	60	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Bedrock (hard) < 40" depth Caving potential	1.00 0.99 0.10
Lava flows, aa-----	35	Not rated		Not rated	
133: Mawae-----	60	Severe Fragments (>3") >50% Slopes > 15%	1.00 1.00	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) < 40" depth	1.00 1.00 0.99
Lava flows, aa-----	35	Not rated		Not rated	
137: Kekake-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	35	Not rated		Not rated	
138: Kekake-----	60	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
Lava flows, pahoehoe-----	35	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
161: Kekake-----	60	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
Mawae-----	35	Severe Fragments (>3") >50% Slopes > 15%	1.00 1.00	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) < 40" depth	1.00 1.00 0.99
163: Lava flows, pahoehoe-----	70	Not rated		Not rated	
Kekake-----	25	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
164: Lava flows, pahoehoe-----	80	Not rated		Not rated	
Kekake-----	15	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.37	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.37 0.10
169: Iwalani, moist-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
179: Iwalani, moist-----	70	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
Lava flows, pahoehoe-----	30	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
205: Ihuanu, moist-----	95	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
206: Ihuanu, moist-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
211: Kapulehu, moist-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 0.10
212: Kapulehu, moist-----	95	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Slopes > 15%	1.00 1.00 1.00
213: Nanaia, moist-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	35	Not rated		Not rated	
214: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Nanaia, moist-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.37	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.37 0.10
215: Keaa, moist-----	90	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 0.99 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
216: Keaa, moist-----	90	Severe Bedrock (hard) < 20" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99	Severe Bedrock (hard) < 40" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99
217: Kapulehu, moist-----	60	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Slopes > 15%	1.00 1.00 1.00
Keaa, moist-----	40	Severe Bedrock (hard) < 20" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99	Severe Bedrock (hard) < 40" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99
218: Kiolakaa, moist-----	90	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Severe Bedrock (hard) < 40" depth Fragments (>3") 25 to 50% Caving potential	1.00 0.83 0.10
219: Kiolakaa-----	60	Severe Slopes > 15% Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	1.00 0.84 0.83	Severe Bedrock (hard) < 40" depth Slopes > 15% Fragments (>3") 25 to 50%	1.00 1.00 0.83
Keaa-----	40	Severe Bedrock (hard) < 20" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99	Severe Bedrock (hard) < 40" depth Slopes > 15% Fragments (>3") >50%	1.00 1.00 0.99
275: Kapulehu-----	60	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 0.10
Lava flows, aa-----	40	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
276: Kapulehu-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 0.10
277: Kapulehu-----	95	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.79	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Slopes > 15%	1.00 1.00 1.00
280: Nanaia-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	35	Not rated		Not rated	
281: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Nanaia-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.37	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.37 0.10
290: Kaaa-----	90	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 0.99 0.10
292: Kaaa-----	60	Severe Bedrock (hard) < 20" depth Fragments (>3") >50%	1.00 0.99	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 0.99 0.10
Kiolakaa-----	35	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Severe Bedrock (hard) < 40" depth Fragments (>3") 25 to 50% Caving potential	1.00 0.83 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
300: Kamaoa-----	90	Slight		Moderate Caving potential	0.10
305: Kiolakaa-----	90	Moderate Bedrock (hard) from 20 to 40" Fragments (>3") 25 to 50%	0.84 0.83	Severe Bedrock (hard) < 40" depth Fragments (>3") 25 to 50% Caving potential	1.00 0.83 0.10
395: Hokukano-----	60	Severe Bedrock (hard) < 20" depth Flooding >= occasional Slopes > 15%	1.00 1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Flash flooding >= occasional	1.00 1.00 0.50
Lava flows, pahoehoe-----	35	Not rated		Not rated	
401: Ihuanu-----	60	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
402: Ihuanu-----	95	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
403: Ihuanu-----	95	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
406: Lava flows, pahoehoe-----	70	Not rated		Not rated	
Iwalani-----	30	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
407: Iwalani-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
408: Iwalani-----	70	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
Lava flows, pahoehoe-----	30	Not rated		Not rated	
461: Hapuu, very gravelly-----	90	Severe Slopes > 15%	1.00	Severe Caving potential Slopes > 15% Bedrock (hard) from 40 to 60"	1.00 1.00 0.93
463: Hapuu, extremely gravelly-----	90	Severe Slopes > 15%	1.00	Severe Caving potential Slopes > 15% Bedrock (hard) from 40 to 60"	1.00 1.00 0.93
511: Akihi-----	100	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.10	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Liquefaction below 20" (OH-T)	1.00 1.00 1.00
512: Akihi-----	100	Severe Fragments (>3") >50% Bedrock (hard) from 20 to 40"	1.00 0.10	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Liquefaction below 20" (OH-T)	1.00 1.00 1.00
513: Hilea-----	100	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
514: Hilea-----	100	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
515: Pahipa-----	45	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.63	Severe Bedrock (hard) < 40" depth Liquefaction below 20" (OH-T) Fragments (>3") >50%	1.00 1.00 0.99
Puali-----	45	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.63	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.63 0.10
516: Alapai-----	100	Slight		Moderate Caving potential	0.10
517: Alapai-----	100	Severe Slopes > 15%	1.00	Severe Slopes > 15% Caving potential	1.00 0.10
518: Alapai-----	100	Severe Slopes > 15%	1.00	Severe Slopes > 15% Caving potential	1.00 0.10
519: Lalaa-----	95	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Bedrock (hard) from 40 to 60" Caving potential	1.00 0.42 0.10
525: Alapai, low precipitation-----	100	Severe Slopes > 15%	1.00	Severe Slopes > 15% Caving potential	1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
534:					
Kahaluu-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
555:					
Kuanene-----	55	Severe Bedrock (hard) < 20" depth Slopes > 15%	1.00 1.00	Severe Bedrock (hard) < 40" depth Slopes > 15% Caving potential	1.00 1.00 0.10
Lava flows, pahoehoe-----	45	Not rated		Not rated	
574:					
Ihuanu-----	55	Severe Fragments (>3") >50% Slopes > 15% Bedrock (hard) from 20 to 40"	1.00 1.00 0.97	Severe Bedrock (hard) < 40" depth Fragments (>3") >50% Caving potential	1.00 1.00 1.00
Lava flows, pahoehoe-----	35	Not rated		Not rated	
575:					
Durustands-----	95	Severe AASHTO GI >8 (low soil strength) Bedrock (hard) from 20 to 40"	1.00 0.79	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
576:					
Puali-----	35	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.63	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.63 0.10
Puu Oo-----	35	Moderate Slopes 8 to 15%	0.63	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.63 0.10
Pahipa-----	25	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.63	Severe Bedrock (hard) < 40" depth Liquefaction below 20" (OH-T) Fragments (>3") >50%	1.00 1.00 0.99

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
577: Pahipa-----	70	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.63	Severe Bedrock (hard) < 40" depth Liquefaction below 20" (OH-T) Fragments (>3") >50%	1.00 1.00 0.99
Puu Oo-----	25	Moderate Slopes 8 to 15%	0.63	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.63 0.10
605: Kaholimo-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Ki-----	35	Moderate AASHTO GI 5-8 (soil strength)	0.78	Severe Caving potential	1.00
607: Kaholimo-----	60	Severe Bedrock (hard) < 20" depth Slopes 8 to 15%	1.00 0.16	Severe Bedrock (hard) < 40" depth Slopes 8 to 15% Caving potential	1.00 0.16 0.10
Ki-----	35	Moderate AASHTO GI 5-8 (soil strength) Slopes 8 to 15%	0.78 0.16	Severe Caving potential Slopes 8 to 15%	1.00 0.16
610: Piihonua-----	100	Slight		Moderate Bedrock (hard) from 40 to 60" Caving potential	0.68 0.10
613: Kila-----	95	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Bedrock (hard) from 40 to 60" Caving potential	1.00 0.42 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
621: Eheuiki-----	60	Severe AASHTO GI >8 (low soil strength)	1.00	Moderate Caving potential	0.10
Pekailio-----	40	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
625: Hao-----	90	Slight		Moderate Caving potential	0.10
631: Kapapala-----	90	Slight		Moderate Bedrock (hard) from 40 to 60" Caving potential	0.92 0.10
657: Malama-----	60	Severe Fragments (>3") >50% Slopes 8 to 15%	1.00 0.16	Severe Fragments (>3") >50% Slopes 8 to 15% Caving potential	1.00 0.16 0.10
Lava flows, aa-----	40	Not rated		Not rated	
709: Lava flows, pahoehoe-----	60	Not rated		Not rated	
Lithic Ustipsamments-----	40	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
711: Lava flows, pahoehoe-----	65	Not rated		Not rated	
Apuki-----	30	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
713: Lithic Haplustands, cindery substratum-----	50	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
713: Lithic Haplustands, loamy surface	25	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	25	Not rated		Not rated	
715: Alahapa-----	65	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential	1.00 1.00
Heake-----	25	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
716: Alahapa-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential	1.00 1.00
717: Alahapa-----	50	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential	1.00 1.00
Lava flows, aa-----	40	Not rated		Not rated	
718: Halemaumau-----	90	Severe AASHTO GI >8 (low soil strength) Bedrock (hard) from 20 to 40"	1.00 0.50	Severe Bedrock (hard) < 40" depth Caving potential	1.00 1.00
719: Heake-----	85	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
720: Heake-----	45	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
722: Kilauea-----	90	Slight		Severe Caving potential	1.00
724: Lava flows, pahoehoe-----	35	Not rated		Not rated	
Kaholimo, uneroded-----	20	Severe		Severe	
		Bedrock (hard) < 20" depth AASHTO GI >8 (low soil strength)	1.00 1.00	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Kaholimo, eroded-----	20	Severe		Severe	
		Bedrock (hard) < 20" depth AASHTO GI >8 (low soil strength)	1.00 1.00	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Puiwa, uneroded-----	12	Moderate		Severe	
		Bedrock (hard) from 20 to 40"	0.01	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Puiwa, eroded-----	13	Moderate		Severe	
		Bedrock (hard) from 20 to 40"	0.01	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
725: Lava flows, pahoehoe-----	55	Not rated		Not rated	
Kaholimo, eroded-----	20	Severe		Severe	
		Bedrock (hard) < 20" depth AASHTO GI >8 (low soil strength)	1.00 1.00	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Kaholimo, uneroded-----	10	Severe		Severe	
		Bedrock (hard) < 20" depth AASHTO GI >8 (low soil strength)	1.00 1.00	Bedrock (hard) < 40" depth Caving potential	1.00 0.10
726: Kulalio-----	88	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
727: Puauulu-----	90	Slight		Severe Caving potential	1.00

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
728: Puauulu-----	65	Slight		Severe Caving potential	1.00
Hao-----	25	Slight		Moderate Caving potential	0.10
729: Eheuiki-----	60	Severe AASHTO GI >8 (low soil strength)	1.00	Moderate Caving potential	0.10
Puauulu-----	40	Slight		Severe Caving potential	1.00
731: Kahalii-----	55	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
734: Kanochina-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
735: Puhimau-----	90	Severe Bedrock (hard) < 20" depth AASHTO GI >8 (low soil strength)	1.00 1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
736: Manu-----	92	Moderate Bedrock (hard) from 20 to 40"	0.16	Severe Bedrock (hard) < 40" depth Caving potential	1.00 1.00
737: Nakanui-----	55	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	35	Not rated		Not rated	

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
738: Vitric Haplustands-----	90	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential Bedrock (hard) < 40" depth	1.00 1.00 1.00
741: Ahiu-----	60	Severe Bedrock (hard) < 20" depth AASHTO GI 5-8 (soil strength)	1.00 0.78	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	30	Not rated		Not rated	
743: Pakini-----	95	Slight		Moderate Caving potential	0.10
744: Haa-----	45	Severe AASHTO GI >8 (low soil strength)	1.00	Moderate Bedrock (hard) from 40 to 60" Caving potential	0.93 0.10
Keamoku-----	40	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 0.99
745: Maunaiu-----	60	Severe AASHTO GI >8 (low soil strength) Bedrock (hard) < 20" depth	1.00 1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Akelelu-----	25	Moderate Bedrock (hard) from 20 to 40"	0.16	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
746: Kulalio-----	40	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
Maunaiu-----	35	Severe AASHTO GI >8 (low soil strength) Bedrock (hard) < 20" depth	1.00 1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
746: Akelelu-----	15	Moderate Bedrock (hard) from 20 to 40"	0.16	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
747: Oneula-----	90	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
748: Lava flows, pahoehoe-----	65	Not rated		Not rated	
Menehune-----	25	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
749: Wahi-----	76	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential	1.00 0.10
750: Ki-----	85	Moderate AASHTO GI 5-8 (soil strength)	0.78	Severe Caving potential	1.00
751: Oneula, low elevation-----	95	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
752: Oneula-----	40	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 1.00
Keamoku-----	30	Severe Fragments (>3") >50%	1.00	Severe Caving potential Fragments (>3") >50%	1.00 0.99
Maunaiu-----	15	Severe AASHTO GI >8 (low soil strength) Bedrock (hard) < 20" depth	1.00 1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10

Table 8b.--Building Site Development--Continued

Map symbol and component name	Pct. of map unit	Local roads and streets		Shallow excavations	
		Rating class and limiting features	Value	Rating class and limiting features	Value
753: Kalapana-----	85	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
754: Kalapana, dry-----	60	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Lava flows, pahoehoe-----	40	Not rated		Not rated	
755: Makaopuhi-----	88	Severe Bedrock (hard) < 20" depth	1.00	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
756: Ahiu-----	45	Severe Bedrock (hard) < 20" depth AASHTO GI 5-8 (soil strength)	1.00 0.78	Severe Bedrock (hard) < 40" depth Caving potential	1.00 0.10
Vitric Haplustands-----	40	Severe Fragments (>3") >50%	1.00	Severe Fragments (>3") >50% Caving potential Bedrock (hard) < 40" depth	1.00 1.00 1.00

The interpretation for local roads and streets evaluates the following soil properties at variable depths in the soil: flooding, ponding, wetness, slope, organic Unified classes for low soil strength (PT, OL, and OH), amount of clay, depth to hard or soft bedrock, depth to a thick or thin cemented pan, fragments more than 3 inches in size, bulk density, and the caving potential of the soil.

The interpretation for shallow excavation evaluates the following soil properties at variable depths in the soil: flooding, ponding, wetness, slope, liquefaction, shrink-swell potential expressed as linear extensibility percent (LEP), potential for frost action, depth to hard or soft bedrock, depth to a thick or thin cemented pan, fragments more than 3 inches in size, and soil strength expressed as the AASHTO group index number (AASHTO GI) or Unified class (OH-T).

Table 9.--Selected Soil and Site Features

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
10: Lava flows, aa-----	100	2-20	0-13681	7-80	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
12: Lava flows, pahoehoe-----	100	2-20	0-13681	7-80	mountains	Pahoehoe lava flow on shield volcano	Pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
14: Lava flows, aa-----	50	2-20	0-13681	7-80	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
Lava flows, pahoehoe-----	50	2-20	0-13681	7-80	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
15: Cinder land-----	100	2-20	0-13681	7-80	mountains	cinder cone on shield volcano	cinders	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
16: Cinder land-----	100	20-40	0-13681	7-80	mountains	cinder cone	cinders	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI
19: Riverwash-----	90	2-10	0-1001	20-30	mountains	flood plain	sandy and gravelly alluvium over pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development - R161AY999HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
24: Badland, geothermal	90	2-40	3501-4003	60-90	mountains	volcanic field	volcanic rock	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI
26: Lava flows, aa, sparsely vegetated	50	40-99	400-2500	30-60	mountains	aa lava flow on escarpment on shield volcano	aa lava	Low Elevation Makai Range- R161AY008HI
Lava flows, pahoehoe-----	50	40-99	400-2500	30-60	mountains	pahoehoe lava flow on escarpment on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI
117: Kapua-----	60	2-10	1001-3501	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Kona Weather Pattern Dry Forest- F161BY501HI
Lava flows, aa-----	35	2-10	1001-3501	20-50	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI
130: Mawae-----	90	2-10	3501-6998	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Koa-Sandalwood-Mamane Forest- F161BY503HI
131: Mawae-----	90	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Koa-Sandalwood-Mamane Forest- F161BY503HI
132: Mawae-----	60	2-10	3501-6998	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Mauna Loa Savannah- R161AY010HI
Lava flows, aa-----	35	2-10	3501-6998	20-50	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
133: Mawae-----	60	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Mauna Loa Savannah-R161AY010HI
Lava flows, aa-----	35	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
137: Kekake-----	60	2-10	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
Lava flows, pahoehoe-----	35	2-10	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
138: Kekake-----	60	10-25	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
Lava flows, pahoehoe-----	35	10-25	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
161: Kekake-----	60	10-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
Mawae-----	35	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	organic matter mixed in aa lava	Koa-Sandalwood-Mamane Forest-F161BY503HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
163: Lava flows, pahoehoe-----	70	10-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Kekake-----	25	10-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Pahoehoe Shrubland-R161AY011HI
164: Lava flows, pahoehoe-----	80	2-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Kekake-----	15	2-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Pahoehoe Shrubland-R161AY011HI
169: Iwalani, moist-----	60	2-10	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash and cinders over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Lava flows, pahoehoe-----	40	2-10	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
179: Iwalani, moist-----	70	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash and cinders over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Lava flows, pahoehoe-----	30	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
205: Ihuanu, moist-----	95	10-20	3501-5400	40-50	mountains	aa lava flow on shield volcano	basic volcanic ash and cinders over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
206: Ihuanu, moist-----	95	2-10	3501-5400	40-50	mountains	aa lava flow on shield volcano	basic volcanic ash and cinders over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
211: Kapulehu, moist----	95	2-10	2402-4593	53-59	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
212: Kapulehu, moist----	95	10-20	2402-4593	53-59	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
213: Nanaia, moist-----	60	2-10	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Lava flows, pahoehoe-----	35	2-10	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
214: Lava flows, pahoehoe-----	60	2-20	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Nanaia, moist-----	35	2-20	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
215: Keaa, moist-----	90	2-10	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
216: Keaa, moist-----	90	10-20	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
217: Kapulehu, moist----	60	20-40	2402-4593	53-59	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Keaa, moist-----	40	20-40	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
218: Kiolakaa, moist----	90	2-10	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
219: Kiolakaa-----	60	10-20	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Keaa-----	40	10-20	2402-4593	53-59	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
275: Kapulehu-----	60	2-10	1001-3501	30-60	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Kona Weather Pattern Dry Forest-F161BY501HI
Lava flows, aa-----	40	2-10	1001-3501	30-60	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
276: Kapulehu-----	95	2-10	1001-3501	30-60	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Kona Weather Pattern Dry Forest-F161BY501HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
277: Kapulehu-----	95	10-20	1001-3501	30-60	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Kona Weather Pattern Dry Forest-F161BY501HI
280: Nanaia-----	60	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
Lava flows, pahoehoe-----	35	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
281: Lava flows, pahoehoe-----	60	2-20	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Nanaia-----	35	2-20	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
290: Keaa-----	90	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
292: Keaa-----	60	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
Kiolakaa-----	35	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
300: Kamaoa-----	90	2-10	1001-2500	30-60	mountains	lava flow on shield volcano	basic volcanic ash	Kona Weather Pattern Dry Forest-F161BY501HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
305: Kiolakaa-----	90	2-10	1001-3501	30-60	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Kona Weather Pattern Dry Forest-F161BY501HI
395: Hokukano-----	60	10-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
Lava flows, pahoehoe-----	35	10-20	3501-6998	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
401: Ihuanu-----	60	10-20	3501-5400	40-50	mountains	aa lava flow on shield volcano	basic volcanic ash and cinders over aa lava	Mauna Loa Savannah-R161AY010HI
Lava flows, aa-----	40	10-20	3501-5400	40-50	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
402: Ihuanu-----	95	10-20	3501-5400	40-50	mountains	aa lava flow on shield volcano	basic volcanic ash and cinders over aa lava	Mauna Loa Savannah-R161AY010HI
403: Ihuanu-----	95	2-10	3501-5400	40-50	mountains	aa lava flow on shield volcano	basic volcanic ash and cinders over aa lava	Mauna Loa Savannah-R161AY010HI
406: Lava flows, pahoehoe-----	70	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Iwalani-----	30	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash and cinders over pahoehoe lava	Mauna Loa Savannah-R161AY010HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
407: Iwalani-----	60	2-10	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash and cinders over pahoehoe lava	Mauna Loa Savannah-R161AY010HI
Lava flows, pahoehoe-----	40	2-10	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
408: Iwalani-----	70	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash and cinders over pahoehoe lava	Mauna Loa Savannah-R161AY010HI
Lava flows, pahoehoe-----	30	10-20	3501-5400	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
461: Hapuu, very gravelly-----	90	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
463: Hapuu, extremely gravelly-----	90	10-20	3501-6998	20-50	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Koa-Sandalwood-Mamane Forest-F161BY503HI
511: Akihi-----	100	10-20	1201-4003	60-150	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
512: Akihi-----	100	2-10	1201-4003	60-150	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
513: Hilea-----	100	10-20	1001-4003	60-150	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
514: Hilea-----	100	3-10	1001-4003	60-150	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
515: Pahipa-----	45	2-20	4003-5000	60-100	mountains	aa lava flow on shield volcano	basic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Puali-----	45	2-20	4003-5000	60-100	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
516: Alapai-----	100	3-10	1598-3999	90-150	mountains	lava flow on shield volcano	basic volcanic ash over basalt	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
517: Alapai-----	100	3-20	1598-4003	90-150	mountains	lava flow on shield volcano	basic volcanic ash over basalt	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
518: Alapai-----	100	20-35	1598-4003	90-150	mountains	lava flow on shield volcano	basic volcanic ash over basalt	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
519: Lalaa-----	95	2-10	3501-7001	60-150	mountains	aa lava flow on shield volcano	organic matter mixed with minor amounts of basic volcanic ash in aa lava	Mauna Loa Savannah-R161AY010HI
525: Alapai, low precipitation-----	100	10-20	1001-1903	60-90	mountains	ash-covered lava flow	pahala basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
534: Kahaluu-----	60	2-10	3501-7001	60-150	mountains	pahoehoe lava flow on shield volcano	organic matter over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Lava flows, pahoehoe-----	40	2-10	3501-7001	60-150	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
555: Kuanene-----	55	20-35	1499-4501	61-118	mountains	pahoehoe lava flow	basaltic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Lava flows, pahoehoe-----	45	20-35	1499-4501	61-118	mountains	pahoehoe lava flow	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
574: Ihuanu-----	55	10-20	6499-7999	40-50	mountains	aa lava flow	basic volcanic ash and cinders over aa lava	Mauna Loa Savannah-R161AY010HI
Lava flows, pahoehoe-----	35	10-20	6499-7999	40-50	mountains	pahoehoe lava flow	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
575: Durustands-----	95	2-10	6398-7054	40-50	mountains	kipuka on pahoehoe lava flow	volcanic ash over pahoehoe lava	Mauna Loa Savannah-R161AY010HI
576: Puali-----	35	2-20	4501-6499	60-100	mountains	pahoehoe lava flow	basic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
576: Puu Oo-----	35	2-20	4501-6499	60-100	mountains	kipuka	basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Pahipa-----	25	2-20	4501-6499	60-100	mountains	aa lava flow	basic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
577: Pahipa-----	70	2-20	4501-6499	60-100	mountains	aa lava flow	basic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Puu Oo-----	25	2-20	4501-6499	60-100	mountains	kipuka	basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
605: Kaholimo-----	60	3-10	4265-4593	50-60	mountains	pahoehoe lava flow	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Ki-----	35	3-10	4265-4593	50-60	mountains	kipuka	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
607: Kaholimo-----	60	10-20	4265-4593	50-60	mountains	pahoehoe lava flow	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Ki-----	35	10-20	4265-4593	50-60	mountains	kipuka	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
610: Piionua-----	100	0-3	3999-5600	1-118	mountains	lava flow on shield volcano	basaltic volcanic ash over aa lava and/or pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
613: Kiloa-----	95	3-10	1001-4501	90-150	mountains	aa lava flow	organic material over aa lava	Shallow Wet Ohia-Olapa Forest-F162XY503HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
621: Eheuiki-----	60	3-10	2999-4501	115-165	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Pekailio-----	40	3-10	2999-4501	115-165	mountains	aa lava flow	basaltic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
625: Hao-----	90	3-10	2799-3281	105-300	mountains	lava flow on shield volcano	basaltic volcanic ash over aa lava and/or pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
631: Kapapala-----	90	2-10	3281-4501	59-70	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Soapberry-Koa Kipuka Forest-F160XY500HI
657: Malama-----	60	2-40	0-1201	60-120	mountains	aa lava flow	organic material over aa lava	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI
Lava flows, aa-----	40	2-40	0-1201	60-120	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
709: Lava flows, pahoehoe-----	60	2-10	2001-4003	30-60	mountains	pahoehoe lava flow	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Lithic Ustipsamments-----	40	2-10	2001-4003	30-60	mountains	pahoehoe lava flow	eolian sands over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
711: Lava flows, pahoehoe-----	65	2-20	0-1001	40-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Apuki-----	30	2-20	0-1001	40-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI
713: Lithic Haplustands, cindery substratum	50	2-10	2500-3501	40-80	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over cinders over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI
Lithic Haplustands, loamy surface-----	25	2-10	2500-3002	40-80	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI
Lava flows, pahoehoe-----	25	2-10	2500-3501	40-80	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
715: Alahapa-----	65	2-10	3399-4003	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mid-Elevation Mauka Range-R161AY009HI
Heake-----	25	2-10	3399-4003	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI
716: Alahapa-----	90	2-10	3609-4003	40-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mid-Elevation Mauka Range-R161AY009HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
717: Alahapa-----	50	2-10	2805-3602	40-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mid-Elevation Mauka Range- R161AY009HI
Lava flows, aa-----	40	2-10	2805-3602	40-60	mountains	aa lava flow on shield volcano	aa lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI
718: Halemaumau-----	90	2-10	3497-3799	60-80	mountains	pahoehoe lava flow on shield volcano	cinders over basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range- R161AY009HI
719: Heake-----	85	2-10	3396-3806	50-80	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range- R161AY009HI
720: Heake-----	45	2-10	3396-3806	50-80	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range- R161AY009HI
Lava flows, pahoehoe-----	40	2-10	3396-3806	50-80	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI
722: Kilauea-----	90	2-10	3494-3691	40-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range- R161AY009HI
724: Lava flows, pahoehoe-----	35	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development- R161AY999HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
724: Kaholimo, uneroded	20	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Kaholimo, eroded---	20	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mauna Loa Savannah-R161AY010HI
Puiwa, uneroded----	12	2-15	5502-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Puiwa, eroded-----	13	2-15	5502-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
725: Lava flows, pahoehoe-----	55	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Kaholimo, eroded---	20	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mauna Loa Savannah-R161AY010HI
Kaholimo, uneroded	10	2-15	5495-7497	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
726: Kulalio-----	88	2-10	4501-7001	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
727: Puaulu-----	90	2-20	3199-4498	110-150	mountains	lava flow on shield volcano	basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
728: Puauulu-----	65	2-20	3199-4498	110-160	mountains	lava flow on shield volcano	basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Hao-----	25	2-20	3199-4501	115-160	mountains	lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava and/or aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
729: Eheuiki-----	60	2-20	3199-4501	115-165	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Puauulu-----	40	2-20	3199-4498	110-160	mountains	lava flow on shield volcano	basaltic volcanic ash	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
731: Kahalii-----	55	2-10	2001-3199	70-90	mountains	pahoehoe lava flow on shield volcano	cinders over basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI
Lava flows, pahoehoe-----	40	2-10	2001-3199	70-90	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
734: Kanoehina-----	60	2-10	0-1001	20-50	mountains	pahoehoe lava flow on shield volcano	basic volcanic ash over pahoehoe lava	Low Elevation Makai Range-R161AY008HI
Lava flows, pahoehoe-----	40	2-10	0-1001	20-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
735: Puhimau-----	90	2-10	2999-3999	80-120	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Shallow Wet Ohia-Olapa Forest-F162XY503HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
736: Manu-----	92	2-10	3806-4003	80-120	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Shallow Wet Ohia-Olapa Forest-F162XY503HI
737: Nakanui-----	55	2-10	1001-2799	40-50	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Low Elevation Makai Range-R161AY008HI
Lava flows, pahoehoe-----	35	2-10	1001-2799	40-50	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
738: Vitric Haplustands	90	2-20	0-1001	20-40	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mid-Elevation Mauka Range-R161AY009HI
741: Ahiu-----	60	2-10	1690-3002	25-35	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range-R161AY009HI
Lava flows, pahoehoe-----	30	2-10	1690-3002	25-35	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
743: Pakini-----	95	2-10	0-1001	15-30	mountains	kipuka on lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Desert Grassland-R157XY001HI
744: Haa-----	45	2-10	4101-5003	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Keamoku-----	40	2-10	4101-5003	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
745: Maunaiu-----	60	3-10	4400-5610	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Akelelu-----	25	3-10	4396-5610	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
746: Kulalio-----	40	3-10	4501-5610	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Maunaiu-----	35	3-10	4400-5610	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
Akelelu-----	15	3-10	4396-5610	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
747: Oneula-----	90	2-10	4498-6004	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mauna Loa Savannah-R161AY010HI
748: Lava flows, pahoehoe-----	65	2-20	5003-7005	50-60	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
Menehune-----	25	2-20	5003-7005	50-60	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Transition Zone Ohia-Koa-Mamane Forest-F161AY500HI
749: Wahi-----	76	2-20	6699-7611	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mauna Loa Savannah-R161AY010HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
750: Ki-----	85	3-10	3904-4593	59-79	mountains	kipuka on lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Soapberry-Koa Kipuka Forest-F160XY500HI
751: Oneula, low elevation-----	95	2-10	4003-4593	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mauna Loa Savannah-R161AY010HI
752: Oneula-----	40	2-10	4003-4593	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mauna Loa Savannah-R161AY010HI
Keamoku-----	30	2-10	4003-4298	50-60	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
Maunaiu-----	15	2-10	4003-4298	50-80	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Ohia-Koa/Hapuu-Kanawao Forest-F159BY500HI
753: Kalapana-----	85	2-10	1499-2402	75-100	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI
754: Kalapana, dry-----	60	2-10	1001-2543	50-75	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Lama-Alahee-Pandanus Coastal Forest-F162XY501HI
Lava flows, pahoehoe-----	40	2-10	1214-2543	50-75	mountains	pahoehoe lava flow on shield volcano	pahoehoe lava	Miscellaneous Area With Minimal Vegetative Development-R161AY999HI
755: Makaopuhi-----	88	2-10	2198-2904	100-120	mountains	pahoehoe lava flow on shield volcano	organic material over basaltic volcanic ash over pahoehoe lava	Shallow Wet Ohia-Olapa Forest-F162XY503HI

Table 9.--Selected Soil and Site Features--Continued

Map symbol and component name	Pct. of map unit	Slope	Elevation	Average annual rainfall	Landscape	Landform	Parent material	Ecological site
	Pct	Pct	Ft	In				
756: Ahiu-----	45	2-10	1696-2992	25-35	mountains	pahoehoe lava flow on shield volcano	basaltic volcanic ash over pahoehoe lava	Mid-Elevation Mauka Range- R161AY009HI
Vitric Haplustands	40	2-10	1696-2992	25-35	mountains	aa lava flow on shield volcano	basaltic volcanic ash over aa lava	Mid-Elevation Mauka Range- R161AY009HI

Table 10.--Engineering Index Properties

(See table 11 for definitions of abbreviations in the "apparent field texture" column. Absence of an entry indicates that data were not estimated)

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
10. Lava flows, aa												
12. Lava flows, pahoehoe												
14: Lava flows, aa. Lava flows, pahoehoe.												
15: Cinder land-----	0-60	CIND	GW	A-1-a	0-5	0-10	10-25	5-25	0-10	0-5	0-5	NP
16: Cinder land-----	0-60	CIND	GW	A-1-a	0-5	0-10	10-25	5-25	0-10	0-5	0-5	NP
19. Riverwash												
24. Badland, geothermal												
26: Lava flows, aa, sparsely vegetated. Lava flows, pahoehoe.												
117: Kapua-----	0-6	CBV-HPM	PT	A-1-b	0-20	56-71	---	---	---	---	---	---
	6-18	CBX-HPM	GW	A-1-a	0-20	56-71	---	---	---	---	---	---
	18-60	FRAG	GW	A-1-a	0-20	60-80	---	---	---	---	---	NP
Lava flows, aa.												
130: Mawae-----	0-5	CBV-HPM	PT	A-7-5	0-10	80-90	---	---	---	---	---	---
	5-40	FRAG	GW	A-1-a	0-10	90-100	---	---	---	---	---	NP
	40-44	BR		---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
131:												
Mawae-----	0-5	CBV-HPM	PT	A-7-5	0-10	80-90	---	---	---	---	---	---
	5-40	FRAG	GW	A-1-a	0-10	90-100	---	---	---	---	---	NP
	40-44	BR		---	---	---	---	---	---	---	---	---
132:												
Mawae-----	0-5	CBV-HPM	PT	A-7-5	0-10	80-90	---	---	---	---	---	---
	5-40	FRAG	GW	A-1-a	0-10	90-100	---	---	---	---	---	NP
	40-44	BR		---	---	---	---	---	---	---	---	---
Lava flows, aa.												
133:												
Mawae-----	0-5	CBV-HPM	PT	A-7-5	0-10	80-90	---	---	---	---	---	---
	5-40	FRAG	GW	A-1-a	0-10	90-100	---	---	---	---	---	NP
	40-44	BR		---	---	---	---	---	---	---	---	---
Lava flows, aa.												
137:												
Kekake-----	0-5	GR-HPM	PT	A-7-5	0	0-15	---	---	---	---	---	---
	5-9	BR		---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
138:												
Kekake-----	0-5	GR-HPM	PT	A-7-5	0	0-15	---	---	---	---	---	---
	5-9	BR		---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
161:												
Kekake-----	0-5	GR-HPM	PT	A-7-5	0	0-15	---	---	---	---	---	---
	5-9	BR		---	---	---	---	---	---	---	---	---
Mawae-----	0-5	CBV-HPM	PT	A-7-5	0-10	80-90	---	---	---	---	---	---
	5-40	FRAG	GW	A-1-a	0-10	90-100	---	---	---	---	---	NP
	40-44	BR		---	---	---	---	---	---	---	---	---
163:												
Lava flows, pahoehoe.												

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index	
			Unified	AASHTO	>10	3-10	4	10	40	200			
					inches	inches							
	In				Pct	Pct					Pct		
163: Kekake-----	0-5	GR-HPM	PT		A-7-5	0	0-15	---	---	---	---	---	---
	5-9	BR		---	---	---	---	---	---	---	---	---	---
164: Lava flows, pahoehoe.													
Kekake-----	0-5	GR-HPM	PT		A-7-5	0	0-15	---	---	---	---	---	---
	5-9	BR		---	---	---	---	---	---	---	---	---	---
169: Iwalani, moist--	0-2	MEDL-L	ML-A		A-7-5	0	0	90-100	90-100	81-90	57-71	40-45	10-15
	2-3	MEDL-VFSL	ML-A		A-7-5	0	0	90-100	90-100	81-90	48-62	40-45	10-15
	3-5	MEDL-LS	SM		A-2-7	0	0	70-80	70-80	40-60	12-24	40-45	10-15
	5-10	MEDL-VFSL	ML-A		A-7-5	0	0-10	90-100	90-100	81-90	48-62	40-45	10-15
	10-14	BR		---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.													
179: Iwalani, moist--	0-2	MEDL-L	ML-A		A-7-5	0	0	90-100	90-100	81-90	57-71	40-45	10-15
	2-3	MEDL-VFSL	ML-A		A-7-5	0	0	90-100	90-100	81-90	48-62	40-45	10-15
	3-5	MEDL-LS	SM		A-2-7	0	0	70-80	70-80	40-60	12-24	40-45	10-15
	5-10	MEDL-VFSL	ML-A		A-7-5	0	0-10	90-100	90-100	81-90	48-62	40-45	10-15
	10-14	BR		---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.													
205: Ihuanu, moist---	0-2	CBV-MEDL-SIL	GM		A-7-5	0-10	38-56	50-60	50-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM		A-2-7	0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW		A-1-a	0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR		---	---	---	---	---	---	---	---	---	---
206: Ihuanu, moist---	0-2	CBV-MEDL-SIL	GM		A-7-5	0-10	38-56	50-60	50-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM		A-2-7	0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW		A-1-a	0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR		---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
In					Pct	Pct					Pct	
211:												
Kapulehu, moist	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---
212:												
Kapulehu, moist	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---
213:												
Nanaia, moist---	0-2	GR-MEDL-SIL	ML-A	A-7-6	0	0-20	62-76	62-76	62-70	49-63	40-45	15-20
	2-6	MEDL-SIL	ML-A	A-7-6	0	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	6-10	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoe-hoe.												
214:												
Lava flows, pahoe-hoe.												
Nanaia, moist---	0-2	GR-MEDL-SIL	ML-A	A-7-6	0	0-20	62-76	62-76	62-70	49-63	40-45	15-20
	2-6	MEDL-SIL	ML-A	A-7-6	0	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	6-10	BR	---	---	---	---	---	---	---	---	---	---
215:												
Keaa, moist-----	0-4	CB-MEDL-L	ML-A, GM	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
216:												
Keaa, moist-----	0-4	CB-MEDL-L	GM, ML-A	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
217:												
Kapulehu, moist	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
217:												
Keaa, moist-----	0-4	CB-MEDL-L	ML-A, GM	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
218:												
Kiolakaa, moist	0-6	MEDL-L	ML-A	A-7-6	0	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	6-10	CB-MEDL-FSL	SC	A-7-6	0	30-45	75-85	75-85	56-68	32-44	40-45	15-20
	10-15	CBV-MEDL-L	ML-A	A-7-6	0	49-60	85-95	85-95	76-86	54-68	40-45	15-20
	15-25	CBV-MEDL-L	ML-A	A-7-6	0	55-70	85-95	85-95	76-86	54-68	40-45	15-20
	25-29	BR	---	---	---	---	---	---	---	---	---	---
219:												
Kiolakaa-----	0-6	MEDL-L	ML-A	A-7-6	0	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	6-10	CB-MEDL-FSL	SC	A-7-6	0	30-45	75-85	75-85	56-68	32-44	40-45	15-20
	10-15	CBV-MEDL-L	ML-A	A-7-6	0	49-60	85-95	85-95	76-86	54-68	40-45	15-20
	15-25	CBV-MEDL-L	ML-A	A-7-6	0	55-70	85-95	85-95	76-86	54-68	40-45	15-20
	25-29	BR	---	---	---	---	---	---	---	---	---	---
Keaa-----	0-4	CB-MEDL-L	GM, ML-A	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
275:												
Kapulehu-----	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, aa.												
276:												
Kapulehu-----	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---
277:												
Kapulehu-----	0-10	CBV-MEDL-SIL	GC	A-7-6	0-20	57-73	44-62	44-62	42-55	38-50	40-45	15-20
	10-26	CBX-MEDL-L	GC	A-7-6	0-20	79-88	53-69	50-66	50-57	36-45	40-45	15-20
	26-30	BR	---	---	---	---	---	---	---	---	---	---
280:												
Nanaia-----	0-2	GR-MEDL-SIL	ML-A	A-7-6	0	0-20	62-76	62-76	62-70	49-63	40-45	15-20
	2-6	MEDL-SIL	ML-A	A-7-6	0	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	6-10	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
280: Lava flows, pahoehoe.												
281: Lava flows, pahoehoe.												
Nanaia-----	0-2	GR-MEDL-SIL	ML-A	A-7-6	0	0-20	62-76	62-76	62-70	49-63	40-45	15-20
	2-6	MEDL-SIL	ML-A	A-7-6	0	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	6-10	BR	---	---	---	---	---	---	---	---	---	---
290: Kaaa-----	0-4	CB-MEDL-L	ML-A, GM	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
292: Kaaa-----	0-4	CB-MEDL-L	GM, ML-A	A-7-6	0-20	24-38	72-84	69-81	64-71	45-56	40-50	15-20
	4-10	CBV-MEDL-VFSL	GM	A-2-7, A-7-6	0-20	37-54	53-70	51-68	51-57	30-39	40-50	15-20
	10-18	CBV-MEDL-VFSL	GM	A-7-6	0-20	54-70	72-84	69-81	64-71	38-49	40-50	15-20
	18-22	BR	---	---	---	---	---	---	---	---	---	---
Kiolakaa-----	0-6	MEDL-L	ML-A	A-7-6	0	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	6-10	CB-MEDL-FSL	SM	A-7-6	0	30-45	75-85	75-85	56-68	32-44	40-45	15-20
	10-15	CBV-MEDL-L	ML-A	A-7-6	0	49-60	85-95	85-95	76-86	54-68	40-45	15-20
	15-25	CBV-MEDL-L	ML-A	A-7-6	0	55-70	85-95	85-95	76-86	54-68	40-45	15-20
	25-29	BR	---	---	---	---	---	---	---	---	---	---
300: Kamaoa-----	0-7	MEDL-L	ML-A	A-7-6	0-5	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	7-21	MEDL-L	ML-A	A-7-6	0-5	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	21-47	MEDL-SICL	ML-A	A-7-6	0-5	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	47-68	MEDL-SIL	ML-A	A-7-6	0-5	0-20	90-100	90-100	86-95	66-86	40-45	15-20
	68-72	BR	---	---	---	---	---	---	---	---	---	---
305: Kiolakaa-----	0-6	MEDL-L	ML-A	A-7-6	0	0-20	90-100	90-100	81-90	57-71	40-45	15-20
	6-10	CB-MEDL-FSL	SC	A-7-6	0	30-45	75-85	75-85	56-68	32-44	40-45	15-20
	10-15	CBV-MEDL-L	ML-A	A-7-6	0	49-60	85-95	85-95	76-86	54-68	40-45	15-20
	15-25	CBV-MEDL-L	ML-A	A-7-6	0	55-70	85-95	85-95	76-86	54-68	40-45	15-20
	25-29	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
395:												
Hokukano-----	0-6	MEDL-SIL	ML-A	A-7-6	0	10-20	90-100	90-100	86-95	66-86	40-50	15-20
	6-10	CB-MEDL-SIL	ML-A	A-7-6	0	20-30	80-90	80-90	76-85	60-76	40-50	15-20
	10-20	CB-MEDL-SIL	ML-A	A-7-6	0	5-15	80-90	80-90	76-85	60-76	40-50	15-20
	20-24	BR		---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
401:												
Ihuanu-----	0-2	CBV-MEDL-SIL	GM	A-7-5	0-10	38-56	50-60	50-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM	A-2-7	0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW	A-1-a	0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR		---	---	---	---	---	---	---	---	---
Lava flows, aa.												
402:												
Ihuanu-----	0-2	CBV-MEDL-SIL	GM	A-7-5	0-10	38-56	50-60	50-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM	A-2-7	0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW	A-1-a	0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR		---	---	---	---	---	---	---	---	---
403:												
Ihuanu-----	0-2	CBV-MEDL-SIL	GM	A-7-5	0-10	38-56	50-60	50-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM	A-2-7	0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW	A-1-a	0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR		---	---	---	---	---	---	---	---	---
406:												
Lava flows, pahoehoe.												
Iwalani-----	0-2	MEDL-L	ML-A	A-7-5	0	0	90-100	90-100	81-90	57-71	40-45	10-15
	2-3	MEDL-VFSL	ML-A	A-7-5	0	0	90-100	90-100	81-90	48-62	40-45	10-15
	3-5	MEDL-LS	SM	A-2-7	0	0	70-80	70-80	40-60	12-24	40-45	10-15
	5-10	MEDL-VFSL	ML-A	A-7-5	0	0-10	90-100	90-100	81-90	48-62	40-45	10-15
	10-14	BR		---	---	---	---	---	---	---	---	---
407:												
Iwalani-----	0-2	MEDL-L	ML-A	A-7-5	0	0	90-100	90-100	81-90	57-71	40-45	10-15
	2-3	MEDL-VFSL	ML-A	A-7-5	0	0	90-100	90-100	81-90	48-62	40-45	10-15
	3-5	MEDL-LS	SM	A-2-7	0	0	70-80	70-80	40-60	12-24	40-45	10-15
	5-10	MEDL-VFSL	ML-A	A-7-5	0	0-10	90-100	90-100	81-90	48-62	40-45	10-15
	10-14	BR		---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
407: Lava flows, pahoehoe.												
408: Iwalani-----	0-2	MEDL-L	ML-A	A-7-5	0	0	90-100	90-100	81-90	57-71	40-45	10-15
	2-3	MEDL-VFSL	ML-A	A-7-5	0	0	90-100	90-100	81-90	48-62	40-45	10-15
	3-5	MEDL-LS	SM	A-2-7	0	0	70-80	70-80	40-60	12-24	40-45	10-15
	5-10	MEDL-VFSL	ML-A	A-7-5	0	0-10	90-100	90-100	81-90	48-62	40-45	10-15
	10-14	BR		---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
461: Hapuu, very gravelly-----	0-4	GRV-MEDL-SIL	GC	A-2-7	0-20	22-27	36-43	36-43	36-40	28-36	40-45	15-20
	4-6	GRX-LS	GW	A-2-7	0-20	22-27	14-18	10-15	6-10	2-4	40-45	10-15
	6-14	GRX-S	GW	A-1-a	0-20	22-27	21-27	21-27	12-18	1-4	5-15	NP-5
	14-43	GRX-S	GW	A-1-a	0-20	22-27	21-27	21-27	12-18	1-4	5-15	NP-5
	43-47	BR		---	---	---	---	---	---	---	---	---
463: Hapuu, extremely gravelly-----	0-4	GRX-MEDL-SIL	GC	A-2-7	0-20	22-27	17-21	15-20	15-18	12-16	40-45	15-20
	4-6	GRX-LS	GW	A-2-7	0-20	22-27	14-18	10-15	6-10	2-4	40-45	10-15
	6-14	GRX-S	GW	A-1-a	0-20	22-27	21-27	21-27	12-18	1-4	5-15	NP-5
	14-43	GRX-S	GW	A-1-a	0-20	22-27	21-27	21-27	12-18	1-4	5-15	NP-5
	43-47	BR		---	---	---	---	---	---	---	---	---
511: Akihi-----	0-10	CBV-HYDR-SIL	OH-T	A-7-5	0-36	60-70	60-70	60-70	58-65	46-58	150-250	30-60
	10-35	CBV-HYDR-SICL	OH-T	A-7-5	0-36	70-80	60-70	60-70	60-65	55-62	150-250	30-60
	35-39	BR		---	---	---	---	---	---	---	---	---
512: Akihi-----	0-10	CBV-HYDR-SIL	OH-T	A-7-5	0-36	60-70	60-70	60-70	58-65	46-58	150-250	30-60
	10-35	CBV-HYDR-SICL	OH-T	A-7-5	0-36	70-80	60-70	60-70	60-65	55-62	150-250	30-60
	35-39	BR		---	---	---	---	---	---	---	---	---
513: Hilea-----	0	HPM	PT	A-7-5	---	---	---	---	---	---	---	---
	0-8	HYDR-SICL	OH-T	A-7-5	0	0-25	100	95-100	95-100	85-95	150-250	30-60
	8-19	HYDR-SICL	OH-T	A-7-5	0	0-25	100	95-100	95-100	85-95	150-250	30-60
	19-23	BR		---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
514: Hilea-----	0	HPM	PT	A-7-5	---	---	---	---	---	---	---	---
	0-8	HYDR-SICL	OH-T	A-7-5	0	0-25	100	95-100	95-100	85-95	150-250	30-60
	8-19	HYDR-SICL	OH-T	A-7-5	0	0-25	100	95-100	95-100	85-95	150-250	30-60
	19-23	BR		---	---	---	---	---	---	---	---	---
515: Pahipa-----	0-2	MPM	PT	A-7-5	---	---	---	---	---	---	---	---
	2-8	HYDR-SICL	OH-T	A-7-5	0-15	15-25	90-100	80-90	76-85	60-76	150-250	30-60
	8-16	GR-HO-HYDR-SIL	OH-T	A-7-5	0-15	15-25	90-100	80-90	55-60	51-57	150-250	30-60
	16-30	CBV-HYDR-SICL	OH-T	A-7-5	0-15	65-75	50-60	50-60	50-55	45-50	150-250	30-60
	30-39	CBX-HYDR-SICL	GM	A-2-7	0-15	70-80	30-40	30-40	30-35	30-35	150-250	30-60
	39-43	BR		---	---	---	---	---	---	---	---	---
Puali-----	0-4	MPM	PT	A-7-5	0	0	---	---	---	---	---	---
	4-10	HO-HYDR-SIL	OH-T	A-7-5	0	0-25	100	95-100	90-95	70-85	150-250	30-60
	10-18	CB-HYDR-SICL	OH-T	A-7-5	0	0-25	100	95-100	95-100	85-95	150-250	30-60
	18-22	BR		---	---	---	---	---	---	---	---	---
516: Alapai-----	0-7	HYDR-SICL	OH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	7-15	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	15-27	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	27-36	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	36-43	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	43-50	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	50-57	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	57-66	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	66-70	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	70-74	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
517: Alapai-----	0-7	HYDR-SICL	OH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	7-15	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	15-27	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	27-36	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	36-43	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	43-50	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	50-57	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	57-66	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	66-70	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	70-74	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
518:												
Alapai-----	0-7	HYDR-SICL	OH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	7-15	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	15-27	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	27-36	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	36-43	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	43-50	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	50-57	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	57-66	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	66-70	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
	70-74	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-95	85-90	150-250	30-60
519:												
Lalaa-----	0-3	CBV-HPM	PT	A-1-b	20-35	15-40	---	---	---	---	---	---
	3-53	FRAG	GW	A-1-a	25-65	30-55	---	---	---	---	---	NP
	53-57	BR		---	---	---	---	---	---	---	---	---
525:												
Alapai, low precipitation--	0-9	HYDR-SICL	OH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	9-17	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	17-23	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	23-31	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	31-40	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	40-48	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	48-54	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	54-65	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
	65-74	HYDR-SICL	MH-T	A-7-5	0	0	100	95-100	90-100	80-95	100-200	30-50
534:												
Kahaluu-----	0-5	HPM	PT	A-7-5	0	0-65	---	---	---	---	---	---
	>5	BR		---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index	
			Unified	AASHTO	>10	3-10	4	10	40	200			
					inches	inches							
	In				Pct	Pct					Pct		
555:													
Kuanene-----	0-1	SPM	PT			0	0	---	---	---	---	---	
	1-6	MEDL-FSL, MEDL-VFSL, MEDL-L	SM, ML-A	A-4, A-5		0	0	100	100	80-95	40-70	20-50	NP-5
	6-7	MEDL-LVFS, MEDL-FSL	SM	A-5, A-4		0	0	100	100	90-95	40-55	15-30	NP-5
	7-12	ASHY-LVFS, ASHY-LS, ASHY-LFS	SM	A-4, A-2-4		0	0	100	100	50-95	15-50	10-25	NP-5
	12-17	CB-MEDL-L, CB-MEDL-VFSL, CB-MEDL-FSL	ML-A, SM	A-4, A-5		0	15-50	95-100	70-85	50-80	30-65	20-50	NP-5
	>17	BR				---	---	---	---	---	---	---	---
Lava flows, pahoehoe.													
574:													
Ihuanu-----	0-2	CBV-MEDL-SIL	GM	A-7-5		0-10	38-56	50-60	55-60	50-55	38-50	40-45	10-15
	2-20	CBX-MEDL-SL	GM	A-2-7		0-10	63-77	40-50	40-50	30-35	15-20	40-45	10-15
	20-22	GRX-COS	GW	A-1-a		0-10	63-77	10-20	5-15	5-7	0-2	10-20	NP-5
	22-26	BR				---	---	---	---	---	---	---	---
Lava flows, pahoehoe.													
575:													
Durustands-----	0-4	MEDL-L	MH-T	A-7		0	0	100	90-100	85-95	60-75	150-250	5-30
	4-6	MEDL-VFSL	ML-A	A-5		0	0	100	95-100	70-85	40-55	50-150	NP-20
	6-7	MEDL-SIL	MH-T	A-7-5		0	0	100	95-100	90-100	70-90	150-250	5-30
	7-11	MEDL-SIL	MH-T	A-7		0	0	100	95-100	90-100	70-90	150-250	5-30
	11-13	CEM-SIL				0	0	---	---	---	---	---	---
	13-26	HYDR-SICL	MH-T	A-7		0	0-10	90-100	85-100	95-100	85-95	150-250	5-30
	26-36	BR				---	---	---	---	---	---	---	---
576:													
Puali-----	0-4	MPM	PT	A-7-5		0	0	---	---	---	---	---	---
	4-10	HO-HYDR-SIL	OH-T	A-7-5		0	0-25	100	95-100	90-95	70-85	150-250	30-60
	10-18	CB-HYDR-SICL	OH-T	A-7-5		0	0-25	100	95-100	95-100	85-95	150-250	30-60
	18-22	BR				---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
576: Puu Oo-----	0-3	MEDL-SIL, MEDL- L	OH-T	A-7	0	0	95-100	90-100	90-100	70-90	100-250	15-50
	3-6	MEDL-SIL, MEDL- L	OH-T	A-7	0	0	95-100	90-100	90-100	70-90	100-250	15-50
	6-9	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	9-16	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	16-22	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	22-27	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	27-50	MEDL-SCL, MEDL- L, MEDL-S	MH-T	A-7	0	0	95-100	90-100	10-80	5-60	50-150	15-50
Pahipa-----	0-2	MPM	PT	A-7-5	0	0	---	---	---	---	---	---
	2-8	HYDR-SICL	OH-T	A-7-5	0-15	15-25	90-100	80-90	76-85	60-76	150-250	30-60
	8-16	GR-HO-HYDR-SIL	OH-T	A-7-5	0-15	15-25	90-100	80-90	55-60	51-57	150-250	30-60
	16-30	CBV-HYDR-SICL	OH-T	A-7-5	0-15	65-75	50-60	50-60	50-55	45-50	150-250	30-60
	30-39	CBX-HYDR-SICL	GM	A-2-7	0-15	70-80	30-40	30-40	30-35	30-35	150-250	30-60
	39-43	BR		---	---	---	---	---	---	---	---	---
577: Pahipa-----	0-2	MPM	PT	A-7-5	0	0	---	---	---	---	---	---
	2-8	HYDR-SICL	OH-T	A-7-5	0-15	15-25	90-100	80-90	76-85	60-76	150-250	30-60
	8-16	GR-HO-HYDR-SIL	OH-T	A-7-5	0-15	15-25	90-100	80-90	55-60	51-57	150-250	30-60
	16-30	CBV-HYDR-SICL	OH-T	A-7-5	0-15	65-75	50-60	50-60	50-55	45-50	150-250	30-60
	30-39	CBX-HYDR-SICL	GM	A-2-7	0-15	70-80	30-40	30-40	30-35	30-35	150-250	30-60
	39-43	BR		---	---	---	---	---	---	---	---	---
Puu Oo-----	0-3	MEDL-SIL, MEDL- L	OH-T	A-7	0	0	95-100	90-100	90-100	70-90	100-250	15-50
	3-6	MEDL-SIL, MEDL- L	OH-T	A-7	0	0	95-100	90-100	90-100	70-90	100-250	15-50
	6-9	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	9-16	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	16-22	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	22-27	HYDR-SIL, HYDR- SICL	MH-T	A-7	0	0	95-100	90-100	90-100	85-95	100-250	15-50
	27-50	MEDL-SCL, MEDL- L, MEDL-S	MH-T	A-7	0	0	95-100	90-100	10-80	5-60	50-150	15-50

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
605:												
Kaholimo-----	0-2	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	30-50	10-15
	2-4	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	30-50	10-15
	4-7	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	7-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	10-12	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	12-13	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	>13	BR										
Ki-----	0-2	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	2-4	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	4-5	ASHY-VFSL	ML-A	A-4	0	0	100	100	85-100	50-65	0-5	NP-5
	5-6	GR-ASHY-COS	SM	A-1-b	0	0	75-85	70-80	35-50	5-15	0-5	NP-5
	6-9	GRV-ASHY-VFSL	GM	A-2-4	0	0	45-55	40-50	35-50	20-35	0-5	NP-5
	9-13	GR-ASHY-FSL	GM	A-4	0	0	55-65	50-60	45-60	25-40	0-5	NP-5
	13-15	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	15-19	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	19-23	MEDL-L	ML-A	A-7, A-6	0	0	85-95	80-90	65-85	55-70	30-50	10-15
	23-26	MEDL-L	ML-A	A-6, A-7	0	0	85-100	85-95	75-90	55-75	30-50	10-15
	26-30	GR-MEDL-L	SC	A-7, A-6	0	0	50-60	45-55	35-50	30-45	30-50	10-15
	30-32	MEDL-SIL	ML-A, MH-A	A-7, A-6	0	0	95-100	95-100	85-100	75-90	40-60	10-15
	32-36	GRV-MEDL-L	GC	A-7, A-6	0	0	40-50	35-45	25-40	25-40	30-50	10-15
	36-38	MEDL-L	ML-A, GM	A-2-4, A-4	0	0	75-85	70-80	40-60	30-50	0-5	NP-5
	38-41	GRV-MEDL-LS	GM	A-1-b	0	0	50-60	45-55	25-40	10-25	0-5	NP-5
	41-43	SR- GRV-MEDL-FS	GM	A-2-4	0	0	40-50	35-45	25-40	10-25	0-5	NP-5
		GRV-MEDL-S										
	43-48	GR-MEDL-L	GM, SM	A-6, A-7	0	0	60-70	55-65	40-55	35-50	30-50	10-15
	48-52	GRV-MEDL-VFSL	GM	A-2-4	0	0	45-55	40-50	25-40	10-25	0-5	NP-5
	52-60	MEDL-SIL	ML-A, MH-A	A-7	0	0	90-100	85-95	75-90	65-80	40-60	10-15
607:												
Kaholimo-----	0-2	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	30-50	10-15
	2-4	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	30-50	10-15
	4-7	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	7-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	10-12	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	12-13	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-80	10-15
	>13	BR										

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
607:												
Ki-----	0-2	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	2-4	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	4-5	ASHY-VFSL	ML-A	A-4	0	0	100	100	85-100	50-65	0-5	NP-5
	5-6	GR-ASHY-COS	SM	A-1-b	0	0	75-85	70-80	35-50	5-15	0-5	NP-5
	6-9	GRV-ASHY-VFSL	GM	A-2-4	0	0	45-55	40-50	35-50	20-35	0-5	NP-5
	9-13	GR-ASHY-FSL	GM	A-4	0	0	55-65	50-60	45-60	25-40	0-5	NP-5
	13-15	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	15-19	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	19-23	MEDL-L	ML-A	A-7, A-6	0	0	85-95	80-90	65-85	55-70	30-50	10-15
	23-26	MEDL-L	ML-A	A-6, A-7	0	0	85-100	85-95	75-90	55-75	30-50	10-15
	26-30	GR-MEDL-L	ML-A	A-7, A-6	0	0	50-60	45-55	35-50	40-60	30-50	10-15
	30-32	MEDL-SIL	ML-A, MH-A	A-7, A-6	0	0	95-100	95-100	85-100	75-90	40-60	10-15
	32-36	GRV-MEDL-L	ML-A	A-7, A-6	0	0	40-50	35-45	25-40	25-40	30-50	10-15
	36-38	MEDL-L	ML-A, GM	A-2-4, A-4	0	0	75-85	70-80	40-60	30-50	0-5	NP-5
	38-41	GRV-MEDL-LS	GM	A-1-b	0	0	50-60	45-55	25-40	10-25	0-5	NP-5
	41-43	SR- GRV-MEDL-FS	GM	A-2-4	0	0	40-50	35-45	25-40	10-25	0-5	NP-5
		GRV-MEDL-S										
	43-48	GR-MEDL-L	GM, SM	A-6, A-7	0	0	60-70	55-65	40-55	35-50	30-50	10-15
	48-52	GRV-MEDL-VFSL	GM	A-2-4	0	0	45-55	40-50	25-40	10-25	0-5	NP-5
	52-60	MEDL-SIL	ML-A, MH-A	A-7	0	0	90-100	85-95	75-90	65-80	40-60	10-15
610:												
Piihonua-----	0-2	HPM	PT		0	0	---	---	---	---	---	---
	2-7	HYDR-SICL	OH-T	A-7-5	0	0	90-100	90-100	90-100	70-90	150-250	30-60
	7-16	HYDR-SICL, HYDR-L	MH-A	A-7	0	0	90-100	90-100	90-100	70-90	150-250	30-60
	16-22	HYDR-SICL, HYDR-L, HYDR- SIL	MH-A	A-7	0	0	90-100	90-100	90-100	70-90	150-250	30-60
	22-28	HYDR-SICL, HYDR-L, HYDR- SIL	MH-A	A-7	0	0-57	80-100	90-100	90-100	60-90	150-250	30-60
	28-47	HYDR-SICL, HYDR-L, HYDR- SIL	MH-A	A-7	0	0-57	80-100	90-100	90-100	60-90	150-250	30-60
	47-59	BR	---	A-1	---	---	---	---	---	---	---	---
613:												
Kiloe-----	0-10	CBX-HPM	PT	A-8	5-35	25-77	---	---	---	---	---	---
	10-60	FRAG	GP, GP-GM	A-1	15-47	40-77	0-20	0-5	0-5	0-5	0-10	NP
	>60	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
621:												
Eheuiki-----	0-4	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-95	70-85	40-60	10-15
	4-9	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-95	70-85	40-60	10-15
	9-13	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	13-15	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	15-19	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	19-23	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	23-26	MEDL-SICL	MH-A	A-7	0	0	100	100	80-95	75-90	50-70	15-20
	26-28	MEDL-SICL	MH-A	A-7	0	0	90-100	85-95	70-85	65-80	50-70	15-20
	28-60	CBX-MEDL-SICL	MH-A	A-7	15-25	55-65	60-70	55-65	50-60	50-60	50-70	15-20
Pekailio-----	0-5	ST-MEDL-L, MEDL-L, CB- MEDL-L	MH-A	A-4, A-6	0-25	0-20	85-95	80-90	65-85	45-70	50-80	10-15
	5-12	ST-MEDL-L	CH, OL, MH-A	A-7-5, A-5	25-40	10-30	80-95	70-85	60-75	40-60	30-80	10-15
	12-22	CBX-MEDL-L	GM	A-4	5-55	10-70	70-85	55-70	50-55	35-45	30-80	10-15
	22-34	CBX-MEDL-L	GM	A-1-b	5-50	10-55	35-55	20-30	20-30	15-25	30-80	10-15
	34-60	STX-ASHY-COS	GP	A-1	25-60	25-60	40-75	5-20	1-10	1-5	30-80	10-15
625:												
Hao-----	0-2	HPM	PT		0	0	---	---	---	---	---	---
	2-8	MEDL-L	OH-T	A-7-5	0	0	95-100	100	85-100	75-90	100-250	10-15
	8-15	MEDL-L	MH-A	A-7-5	0-10	0	95-100	100	80-95	60-75	100-250	10-15
	15-21	MEDL-SL	MH-A	A-7-5	0	0	100	100	85-100	80-95	100-250	10-15
	21-41	MEDL-SICL	MH-A	A-7-5	0	0	100	95-100	85-100	80-95	100-250	10-15
631:												
Kapapala-----	0-3	MEDL-L	ML-A	A-7-6	0	0-5	90-100	90-100	80-90	60-70	30-50	15-20
	3-9	MEDL-SL	SM	A-2-7	0	0-5	90-100	90-100	60-70	30-40	30-50	15-20
	9-13	MEDL-SL	SC	A-2-7	0	0-5	95-100	95-100	50-70	5-15	20-40	10-18
	13-21	MEDL-L	ML-A	A-7-6	0	0-5	90-100	90-100	80-90	60-70	30-50	15-20
	21-29	MEDL-SL	SM	A-2-7	0	0-5	90-100	90-100	60-70	30-40	30-50	15-20
	29-43	MEDL-L	ML-A	A-7-6	0	0-5	90-100	90-100	80-90	60-70	30-50	15-20
	>43	BR	---	---	---	---	---	---	---	---	---	---
657:												
Malama-----	0-3	CBX-HPM	GP, PT	A-8	29-32	59-66	---	---	---	---	---	---
	3-60	FRAG	GP, GP-GM	A-1	15-50	25-75	0-15	0-5	0-5	0-5	0-10	NP
Lava flows, aa.												
709:												
Lava flows, pahoehoe.												

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index	
			Unified	AASHTO	>10	3-10	4	10	40	200			
					inches	inches							
		In			Pct	Pct					Pct		
709:													
Lithic													
Ustipsamments--	0	DUR	SM		A-3, A-2-4	0	0	100	100	50-70	5-20	0-5	NP-5
	0-2	ASHY-S	SM		A-3, A-2-4	0	0	100	100	50-70	5-20	0-5	NP-5
	2-10	ASHY-S	SM		A-3, A-2-4	0	0	100	100	50-70	5-20	0-5	NP-5
	>10	BR		---	---	---	---	---	---	---	---	---	---
711:													
Lava flows, pahoehoe.													
Apuki-----	0	ASHY-S	SM		A-2-4, A-3	0	0	100	100	55-70	5-20	0-5	NP-5
	0-6	ASHY-S	SM		A-3, A-2-4	0	0	100	100	55-70	5-20	0-5	NP-5
	6-7	ASHY-LS	SM		A-2-4	0	0	100	100	60-75	15-30	0-5	NP-5
	>7	BR		---	---	---	---	---	---	---	---	---	---
713:													
Lithic													
Haplustands, cindery													
substratum----	0-2	GRX-ASHY-LS	GP-GM		A-1-a	0	0	20-30	15-25	5-20	0-10	0-5	NP-5
	2-2	ASHY-LS	SM		A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	2-3	GRV-ASHY-S	GP-GM		A-1-a	0	0	45-55	40-50	20-35	0-5	0-5	NP-5
	3-4	ASHY-FS	SM		A-2-4	0	0	100	100	65-80	20-35	0-5	NP-5
	4-5	SR- ASHY-FS	SM		A-2-4	0	0	100	100	65-80	20-35	0-5	NP-5
	5-6	ASHY-LS	SM		A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	6-8	GRV-ASHY-COS	GP		A-1-a	0	0	10-20	5-15	0-10	0-5	0-5	NP-5
	>8	BR		---	---	---	---	---	---	---	---	---	---
Lithic													
Haplustands, loamy surface--													
	0-4	GRV-ASHY-L	GM		A-1-b	0	0	25-35	20-30	15-30	15-25	0-5	NP-5
	4-5	ASHY-SL	SM		A-2-4, A-4	0	0	90-100	85-95	55-70	25-40	0-5	NP-5
	5-6	GRV-ASHY-LCOS	GM		A-1-a	0	0	25-35	20-30	5-20	5-15	0-5	NP-5
	6-7	SR- ASHY-S	SM		A-2-4	0	0	100	100	45-60	15-30	0-5	NP-5
		ASHY-FS ASHY- LS											
	7-8	GRV-ASHY-COSL	GM		A-1-a	0	0	35-45	30-40	10-25	0-15	0-5	NP-5
	8-10	ASHY-GR-LS	SM		A-2-4	0	0	70-80	65-75	35-50	10-25	0-5	NP-5
	10-13	GRX-ASHY-LCOS	GP		A-1-a	0	0	10-20	5-15	0-10	0-5	0-5	NP-5
	>13	BR		---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.													

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
715:												
Alahapa-----	0-3	STX-ASHY-SL	GM	A-1-a, A-1-b	50-60	25-35	40-50	30-45	25-35	10-20	0-15	NP-5
	3-17	ASHY-CBX-L	GM	A-1-b	0-10	65-75	40-50	30-45	20-30	15-25	20-30	NP-5
	17-36	CBX-ASHY-S	GW	A-1-a	0-10	45-55	10-25	5-20	0-10	0-5	0-5	NP
	36-60	STX-ASHY-COS	GW	A-1-a	35-45	15-25	10-25	5-20	0-5	0	0-5	NP
Heake-----	0-1	ASHY-L	ML-A	A-6, A-7, A-5	0	0	85-95	80-90	65-80	50-65	30-50	10-15
	1-4	ASHY-LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	4-7	SR- ASHY-LFS	SM	A-2-4	0	0	85-95	80-90	45-60	15-30	0-5	NP-5
	7-8	ASHY-L	ML-A	A-7, A-6, A-5	0	0	100	100	75-90	55-70	30-50	10-15
	8-10	SR- ASHY-SL	ML-A	A-4	0	0	100	90-100	80-95	55-70	0-5	NP-5
	10-12	SR- ASHY-COS S FS LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	12-14	PG	---	---	0	0	---	---	---	---	---	---
	>14	BR	---	---	---	---	---	---	---	---	---	---
716:												
Alahapa-----	0-3	STX-ASHY-SL	GM	A-1-b, A-1-a	50-60	25-35	40-50	30-45	25-35	10-20	0-15	NP-5
	3-17	ASHY-CBX-L	GM	A-1-b	0-10	65-75	40-50	30-45	20-30	15-25	20-30	NP-5
	17-36	CBX-ASHY-S	GW	A-1-a	0-10	45-55	10-25	5-20	0-10	0-5	0-5	NP
	36-60	STX-ASHY-COS	GW	A-1-a	35-45	15-25	10-25	5-20	0-5	0	0-5	NP
717:												
Alahapa-----	0-3	STX-ASHY-SL	GM	A-1-a, A-1-b	50-60	25-35	40-50	30-45	25-35	10-20	0-15	NP-5
	3-17	ASHY-CBX-L	GM	A-1-b	0-10	65-75	40-50	30-45	20-30	15-25	20-30	NP-5
	17-36	CBX-ASHY-S	GW	A-1-a	0-10	45-55	10-25	5-20	0-10	0-5	0-5	NP
	36-60	STX-ASHY-COS	GW	A-1-a	35-45	15-25	10-25	5-20	0-5	0	0-5	NP
Lava flows, aa.												
718:												
Halemaumau-----	0-6	GRX-ASHY-COS	GP	A-1-a	0	0	10-20	5-15	0-10	0	---	NP
	6-7	GR-ASHY-SL	SM	A-2-6	0	0	75-85	70-80	40-55	20-30	30-50	10-15
	7-10	GRX-ASHY-COS	GP	A-1-a	0	0	5-15	0-10	0-5	0	---	NP
	10-13	ASHY-L	ML-A	A-6, A-7, A-5	0	0	100	100	80-95	60-75	30-50	10-15
	13-20	GRV-ASHY-FS GRV-ASHY-S	GM	A-2-4	0	0	35-45	30-40	15-40	15-30	0-5	NP-5
	20-23	ASHY-FS	ML-A	A-2-7, A-2-6	0	0	100	100	65-80	20-35	30-50	10-15
	23-27	ASHY-SL	ML-A	A-7, A-6, A-5	0	0	100	100	60-75	30-45	30-50	10-15
	27-35	GRX-ASHY-COS	GP	A-1-a	0	0	5-15	0-10	0-5	0	---	NP
	>35	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
					Pct	Pct					Pct	
719: Heake-----	In											
	0-1	ASHY-L	ML-A	A-6, A-7, A-5	0	0	85-95	80-90	65-80	50-65	30-50	10-15
	1-4	ASHY-LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	4-7	SR- ASHY-LFS	SM	A-2-4	0	0	85-95	80-90	45-60	15-30	0-5	NP-5
	7-8	ASHY-L	ML-A	A-7, A-6, A-5	0	0	100	100	75-90	55-70	30-50	10-15
	8-10	SR- ASHY-SL	ML-A	A-4	0	0	100	90-100	80-95	55-70	0-5	NP-5
	10-12	SR- ASHY-COS S FS LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	12-14	PG	---	---	0	0	---	---	---	---	---	---
	>14	BR	---	---	---	---	---	---	---	---	---	---
720: Heake-----	0-1	ASHY-L	ML-A	A-6, A-7, A-5	0	0	85-95	80-90	65-80	50-65	30-50	10-15
	1-4	ASHY-LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	4-7	SR- ASHY-LFS	SM	A-2-4	0	0	85-95	80-90	45-60	15-30	0-5	NP-5
	7-8	ASHY-L	ML-A	A-7, A-6, A-5	0	0	100	100	75-90	55-70	30-50	10-15
	8-10	SR- ASHY-SL	ML-A	A-4	0	0	100	90-100	80-95	55-70	0-5	NP-5
	10-12	SR- ASHY-COS S FS LFS	SM	A-2-4	0	0	100	100	55-70	15-30	0-5	NP-5
	12-14	PG	---	---	0	0	---	---	---	---	---	---
	>14	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
722: Kilauea-----	0	DUR	GW, GP		0	0	---	---	---	---	---	NP
	0-3	SR- GRV-ASHY-S	GP-GM, GP	A-1-a	0	0	25-35	20-30	5-15	0-10	0-5	NP-5
	3-5	ASHY-SL	SM	A-2-4	0	0	90-100	85-95	55-65	25-40	0-5	NP-5
	5-7	SR- GRV-ASHY-S	GP, GP-GM	A-1-b	0	0	45-55	40-50	25-40	0-10	0-5	NP-5
	7-10	GRV-ASHY-LS	SM	A-1-b	0	0	45-55	40-50	15-30	5-20	0-5	NP-5
	10-20	SR- GRV-ASHY- COS ASHY-GRV- LS	GP-GM, GM	A-1-a	0	0	25-35	20-30	10-25	5-20	0-5	NP-5
	20-23	GR-ASHY-S	SM	A-1-b	0	0	70-80	65-75	30-45	5-20	0-5	NP-5
	23-38	SR- ASHY-VFS ASHY-S	SM	A-2-4	0	0	100	100	55-70	10-25	0-5	NP-5
	38-40	GR-ASHY-S	SP-SM	A-2-4	0	0	70-80	65-75	35-50	5-10	0-5	NP-5
	40-56	ASHY-VFS	SM	A-2-4	0	0	100	100	65-80	20-35	0-5	NP-5
	56-75	ASHY-COS	SM	A-1-b	0	0	85-95	80-90	30-45	5-15	0-5	NP-5

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
724: Lava flows, pahoehoe.												
Kaholimo, uneroded-----	0-2	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	2-4	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	4-7	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	7-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	10-12	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	12-13	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	>13	BR	---	---	---	---	---	---	---	---	---	---
Kaholimo, eroded	0-2	CB-MEDL-L	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	2-5	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	5-8	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	8-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	10-11	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	>11	BR	---	---	---	---	---	---	---	---	---	---
Puiwa, uneroded	0-4	MEDL-L	OL	A-6, A-7	0	0	100	100	80-95	60-75	30-60	10-15
	4-7	MEDL-L	ML-A	A-7, A-6	0	0	100	100	80-95	60-75	30-60	10-15
	7-9	SR- MEDL-SIL	ML-A	A-7, A-6	0	0	100	100	85-100	65-80	30-60	10-15
		MEDL-L										
	9-11	MEDL-FS	SM	A-6, A-7	0	0	100	100	65-80	20-35	30-60	10-15
	11-17	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	65-80	40-60	10-15
	17-25	MEDL-SIL	ML-A	A-7	0	0	90-100	85-95	75-90	55-70	40-60	10-15
	25-38	CB-MEDL-SIL	ML-A	A-7	0	25-35	90-100	85-95	75-90	70-85	30-60	10-15
	>38	BR	---	---	---	---	---	---	---	---	---	---
Puiwa, eroded---	0-3	CB-MEDL-L	ML-A	A-6, A-7	0	0	100	100	80-95	60-75	30-60	10-15
	3-6	SR- MEDL-SIL	ML-A	A-6, A-7	0	0	100	100	85-100	65-80	30-60	10-15
		MEDL-L										
	6-7	MEDL-FS	SM	A-6, A-7	0	0	100	100	65-80	20-35	30-60	10-15
	7-13	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	65-80	40-60	10-15
	13-21	MEDL-SIL	ML-A	A-7	0	0	90-100	85-95	75-90	55-70	40-60	10-15
	21-34	CB-MEDL-SIL	ML-A	A-7	0	25-35	90-100	85-95	75-90	70-85	30-60	10-15
	>34	BR	---	---	---	---	---	---	---	---	---	---
725: Lava flows, pahoehoe.												

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
725:												
Kaholimo, eroded	0-2	CB-MEDL-L	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	2-5	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	5-8	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	8-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	10-11	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	>11	BR	---	---	---	---	---	---	---	---	---	---
Kaholimo, uneroded-----	0-2	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	2-4	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	4-7	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	7-10	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	10-12	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
	12-13	MEDL-L	ML-A	A-4, A-7	0	0	100	100	80-95	60-75	30-50	10-15
		>13	BR	---	---	---	---	---	---	---	---	---
726:												
Kulalio-----	0-3	MEDL-SIL	MH-A, ML-A	A-7	20-30	0	95-100	95-100	85-95	70-90	40-70	10-15
	3-7	CB-MEDL-SIL	ML-A, ML-A	A-7	0	40-50	80-95	75-85	70-80	55-70	40-70	10-15
	7-11	GRV-MEDL-L	CL, ML-A	A-6, A-7	20-30	20-30	50-60	45-55	35-50	30-40	20-50	10-15
	11-16	GRV-MEDL-LS	GP-GM	A-1-a	20-30	20-30	35-45	30-40	15-25	5-15	0-10	NP-5
	16-25	GRX-ASHY-LS	GP-GM	A-1-a	15-25	35-45	15-30	10-25	5-15	0-10	0-10	NP-5
	25-60	GRX-ASHY-LS	GP-GM	A-1-a	10-20	55-65	30-40	25-35	10-20	5-15	0-10	NP-5
727:												
Puauulu-----	0-3	HYDR-SIL	MH-T	A-7	0	0	85-95	80-90	75-90	65-80	150-250	30-60
	3-9	MEDL-SIL	MH-T, ML-A	A-7	0	0	90-100	85-95	75-90	70-85	40-70	10-15
	9-12	ASHY-SL	ML-A	A-4	0	0	100	100	60-75	40-55	0-15	NP-5
	12-15	ASHY-S	SP-SM, SM	A-3, A-2-4	0	0	100	100	50-65	5-20	0-5	NP
	15-19	ASHY-S	SP	A-1-b	0	0	90-100	85-95	25-35	0-15	0-5	NP
	19-20	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	20-22	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	22-24	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	24-28	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-95	65-80	55-70	45-75	15-20
	28-30	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	30-31	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
	31-32	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	70-85	60-75	40-70	10-15
	32-34	MEDL-SIL	MH-A, ML-A	A-7	0	0	90-100	85-95	80-95	80-90	40-70	10-15
	34-35	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	35-37	GRV-MEDL-SCL	GC-GM	A-2-6, A-2-7	0	0	35-45	30-40	20-35	5-15	30-60	10-15
	37-38	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	38-41	GRX-MEDL-SCL	GC-GM	A-1-a	0	0	20-30	15-25	5-20	0-15	25-55	5-10
	41-43	HYDR-SICL	MH-T	A-7	0	0	100	100	85-95	85-95	150-250	30-60
	43-48	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
	48-51	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-100	75-90	55-70	45-75	15-20
51-53	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20	
53-55	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20	

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
728: Puauulu-----	0-3	HYDR-SIL	MH-T	A-7	0	0	85-95	80-90	75-90	65-80	150-250	30-60
	3-9	MEDL-SIL	MH-T, ML-A	A-7	0	0	90-100	85-95	75-90	70-85	40-70	10-15
	9-12	ASHY-SL	ML-A	A-4	0	0	100	100	60-75	40-55	0-15	NP-5
	12-15	ASHY-S	SP-SM, SM	A-3, A-2-4	0	0	100	100	50-65	5-20	0-5	NP
	15-19	ASHY-S	SP	A-1-b	0	0	90-100	85-95	25-35	0-15	0-5	NP
	19-20	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	20-22	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	22-24	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	24-28	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-95	65-80	55-70	45-75	15-20
	28-30	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	30-31	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
	31-32	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	70-85	60-75	40-70	10-15
	32-34	MEDL-SIL	MH-A, ML-A	A-7	0	0	90-100	85-95	80-95	80-90	40-70	10-15
	34-35	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	35-37	GRV-MEDL-SCL	GC-GM	A-2-6, A-2-7	0	0	35-45	30-40	20-35	5-15	30-60	10-15
	37-38	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	38-41	GRX-MEDL-SCL	GC-GM	A-1-a	0	0	20-30	15-25	5-20	0-15	25-55	5-10
	41-43	HYDR-SICL	MH-T	A-7	0	0	100	100	85-95	85-95	150-250	30-60
	43-48	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
	48-51	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-100	75-90	55-70	45-75	15-20
	51-53	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20
	53-55	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20
Hao-----	0-2	MEDL-SIL	ML-A	A-7	0	0	95-100	95-100	85-100	75-90	40-60	10-15
	2-3	MEDL-SIL	ML-A	A-7	0	0	100	100	85-100	75-90	40-60	10-15
	3-6	SR- MEDL-SCL	ML-A	A-7	0	0	100	100	80-95	60-75	40-60	10-15
		MEDL-SIL										
	6-8	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	8-9	MEDL-SICL	ML-A	A-7	0	0	95-100	95-100	85-100	80-95	40-60	10-15
	9-10	MEDL-SCL	ML-A	A-7	0	0	100	100	80-90	40-55	40-60	10-15
	10-12	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	12-13	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	13-15	MEDL-SCL	ML-A	A-7	0	0	100	100	80-90	40-55	40-60	10-15
	15-18	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	18-21	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	21-23	MEDL-SCL	ML-A	A-7	0	0	100	100	80-90	40-55	40-60	10-15
	23-24	MEDL-FSL	ML-A	A-7	0	0	100	100	70-85	40-55	40-60	10-15
	24-25	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	25-30	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	30-41	MEDL-SICL	ML-A	A-7	0	0	100	100	85-100	80-95	40-60	10-15
	41-60	MEDL-SICL		---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
729:												
Eheuiki-----	0-4	MEDL-SIL	MH-A	A-7	0	0	100	100	85-95	70-85	40-60	10-15
	4-9	MEDL-SIL	MH-A	A-7	0	0	100	100	85-95	70-85	40-60	10-15
	9-13	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	13-15	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	15-19	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	19-23	MEDL-SICL	MH-A	A-7	0	0	100	100	85-100	80-95	50-70	15-20
	23-26	MEDL-SICL	MH-A	A-7	0	0	100	100	80-95	75-90	50-70	15-20
	26-28	MEDL-SICL	MH-A	A-7	0	0	90-100	85-95	70-85	65-80	50-70	15-20
	28-60	CBX-MEDL-SICL	MH-A	A-7	15-25	55-65	60-70	55-65	50-60	50-60	50-70	15-20
Puauulu-----												
	0-3	HYDR-SIL	MH-T	A-7	0	0	85-95	80-90	75-90	65-80	150-250	30-60
	3-9	MEDL-SIL	MH-T, ML-A	A-7	0	0	90-100	85-95	75-90	70-85	40-70	10-15
	9-12	ASHY-SL	ML-A	A-4	0	0	100	100	60-75	40-55	0-15	NP-5
	12-15	ASHY-S	SP-SM, SM	A-3, A-2-4	0	0	100	100	50-65	5-20	0-5	NP
	15-19	ASHY-S	SP	A-1-b	0	0	90-100	85-95	25-35	0-15	0-5	NP
	19-20	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	20-22	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	22-24	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	24-28	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-95	65-80	55-70	45-75	15-20
	28-30	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	30-31	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
	31-32	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	70-85	60-75	40-70	10-15
	32-34	MEDL-SIL	MH-A, ML-A	A-7	0	0	90-100	85-95	80-95	80-90	40-70	10-15
	34-35	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	65-80	40-70	10-15
	35-37	GRV-MEDL-SCL	GC-GM	A-2-6, A-2-7	0	0	35-45	30-40	20-35	5-15	30-60	10-15
	37-38	HYDR-SIL	MH-T	A-7	0	0	100	100	80-95	65-80	150-250	30-60
	38-41	GRX-MEDL-SCL	GC-GM	A-1-a	0	0	20-30	15-25	5-20	0-15	25-55	5-10
	41-43	HYDR-SICL	MH-T	A-7	0	0	100	100	85-95	85-95	150-250	30-60
	43-48	MEDL-SICL	MH-A, ML-A	A-7	0	0	100	100	85-100	85-95	40-70	10-15
48-51	MEDL-SCL	MH-A, ML-A	A-7	0	0	90-100	85-100	75-90	55-70	45-75	15-20	
51-53	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20	
53-55	MEDL-SCL	MH-A, ML-A	A-7	0	0	100	100	75-90	55-70	45-75	15-20	
731:												
Kahalii-----	0-4	ASHY-GRX-COS	GP	A-1-a	0	0	10-20	5-15	0-10	0-5	---	NP
	4-5	GR-ASHY-LS	SM	A-1-b	0	0	70-80	65-75	35-50	10-20	0-5	NP-5
	5-7	GRV-ASHY-COS	GM	A-1-a	0	0	35-45	30-40	20-35	0-15	0-5	NP-5
	7-9	GRV-ASHY-SL	GM	A-1-a	0	0	45-55	40-50	25-40	10-25	0-5	NP-5
	9-9	ASHY-FS	SM	A-2-4	0	0	100	100	65-80	20-35	0-5	NP-5
	9-11	GRV-ASHY-COS	GP	A-1-a	0	0	10-20	5-15	0-10	0-5	0-5	NP-5
	11-12	VFSL	---	---	---	---	---	---	---	---	---	---
	>12	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
731: Lava flows, pahoehoe.												
734: Kanhina-----	0-1	ASHY-VFSL	ML-A	A-4	0	0-3	90-100	85-95	76-86	45-58	0-10	NP-5
	1-3	ASHY-SL	SM	A-2-4	0	0-3	90-100	75-85	48-56	24-32	0-10	NP-5
	3-6	ASHY-LS	SM	A-2-4	0	0-3	90-100	75-85	40-60	12-24	0-10	NP-5
	6-10	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
735: Puhimau-----	0-3	ASHY-SIL	MH-A, ML-A	A-7	0	0	100	100	80-95	75-90	40-60	10-15
	3-6	GRV-ASHY-LCOS	GW-GM, GW, GM	A-1-a	0	0	25-35	20-30	5-20	5-15	0-5	NP-5
	6-8	ASHY-L	MH-A, MH-L	A-6, A-7	0	0	85-95	80-90	70-85	50-65	30-50	10-15
	8-11	ASHY-SIL	MH-A, ML-A	A-7	0	0	100	100	85-95	65-90	40-60	10-15
	11-13	ASHY-L	ML-A, MH-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	>13	BR	---	---	---	---	---	---	---	---	---	---
736: Manu-----	0-3	MEDL-SIL	OL, OH-T	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	3-4	GRX-ASHY-SL	GW, GP	A-1-a	0	0	0-10	0-5	0-5	0-5	0-5	NP-5
	4-6	ASHY-L	OL	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	6-9	GRV-ASHY-S	SP-SM	A-1-a	0	0	35-45	30-40	15-30	0-15	0-5	NP-5
	9-11	ASHY-SL	SM, SC-SM	A-2-4, A-4	0	0	100	100	60-75	30-45	0-5	NP-5
	11-13	ASHY-LS	SM, SC-SM	A-2-4	0	0	100	100	60-75	15-30	0-5	NP-5
	13-15	ASHY-LFS	SM, SC-SM	A-2-4	0	0	100	100	65-80	20-35	0-5	NP-5
	15-17	ASHY-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	17-18	ASHY-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	18-20	ASHY-LS	SM	A-2-4	0	0	90-100	85-95	55-70	15-25	0-5	NP-5
	20-21	GRV-ASHY-SL	SM, SP-SM	A-1-a, A-1-b	0	0	35-45	30-40	20-35	5-20	0-5	NP-5
	21-26	GRV-ASHY-LS	SP-SM, SM	A-1-a	0	0	35-45	30-40	15-30	5-15	0-5	NP-5
	26-32	ASHY-LS	SM	A-2-4	0	0	90-100	85-95	55-70	15-25	0-5	NP-5
	32-34	ASHY-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	70-85	40-60	10-15
	>34	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
737:												
Nakanui-----	0-4	MEDL-L	ML-A	A-4	0	0	90-100	85-95	80-90	55-70	0-5	NP-5
	4-6	GRV-MEDL-SL	GP-GM, GM	A-1-b	0	0	45-55	40-50	25-40	10-25	0-5	NP-5
	6-7	GRV-MEDL-SL	GM, GP-GM	A-1-b	0	0	35-45	30-40	15-30	5-20	0-5	NP-5
	7-9	GRV-MEDL-LCOS	GM, GP-GM	A-1-b	0	0	30-40	25-35	10-25	5-20	0-5	NP-5
	9-11	GRV-MEDL-LCOS	GM, GP-GM	A-1-a	0	0	25-35	20-30	15-25	5-15	0-5	NP-5
	11-12	GR-MEDL-L	SM	A-4	0	0	75-85	70-80	60-75	45-60	0-5	NP-5
	12-16	GRV-MEDL-SL	GM, GP-GM	A-1-b	0	0	40-50	35-45	25-35	10-25	0-5	NP-5
	16-18	MEDL-L	ML-A	A-4	0	0	85-95	80-90	70-85	55-70	0-5	NP-5
	>18	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
738:												
Vitric												
Haplustands----	0-3	CBX-ASHY-VFSL	SM	A-4	40-50	60-70	75-85	70-80	65-75	40-50	0-5	NP-5
	3-16	CBX-ASHY-VFSL	GM	A-4, A-2-4	20-30	60-70	60-70	55-65	55-65	30-45	0-5	NP-5
	16-33	CBX-ASHY-LFS	SM	A-2-4	20-30	65-75	70-80	65-75	55-70	15-30	0-5	NP-5
	33-35	STX-ASHY-LFS	SM, GM	A-1-b	40-50	50-60	55-65	50-60	40-55	10-25	0-5	NP-5
	35-59	CBX-COS	SP, SW-SM	A-1-b	40-50	50-60	55-65	50-60	35-45	0-10	0-5	NP-5
741:												
Ahiu-----	0-3	ASHY-SIL	ML-A	A-7	0	0	100	100	80-95	60-75	40-50	10-15
	3-6	ASHY-SIL	ML-A	A-7	0	0	100	100	80-95	60-75	40-50	10-15
	6-11	SR- ASHY-FS ASHY-LFS	SM	A-4, A-2-4	0	0	100	100	65-90	30-45	0-5	NP-5
	11-12	ASHY-L	ML-A	A-7, A-5	0	0	100	100	80-95	55-70	30-50	10-15
	12-13	ASHY-L	ML-A	A-5, A-7	0	0	100	100	80-95	55-70	30-50	10-15
	13-17	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
743:												
Pakini-----	0-3	MEDL-VFSL	SM	A-6, A-7	0	0	90-100	90-100	80-90	50-60	30-50	10-15
	3-8	MEDL-VFSL	ML-A	A-7, A-6	0	0	90-100	90-100	80-90	50-60	30-50	10-15
	8-16	MEDL-VFSL	ML-A	A-7, A-6	0	0	90-100	90-100	80-90	50-60	30-50	10-15
	16-29	MEDL-L	ML-A	A-7, A-6	0	0	100	100	85-95	60-75	30-50	10-15
	29-45	MEDL-L	ML-A	A-7, A-6	0	0	100	100	85-95	60-75	30-50	10-15
	45-59	MEDL-VFSL	ML-A	A-7, A-6	0	0	100	100	85-95	50-65	30-50	10-15

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
		In			Pct	Pct					Pct	
744:												
Haa-----	0-3	MEDL-SIL	MH-A, ML-A	A-7	0	0	90-95	85-95	75-90	65-80	40-70	10-15
	3-7	MEDL-SIL	ML-A, MH-A	A-7	0	0	90-95	85-95	75-90	65-80	40-70	10-15
	7-10	MEDL-L	ML-A, MH-A	A-4	0	0	90-95	85-95	70-85	55-70	30-60	5-10
	10-14	MEDL-L	ML-A, MH-A	A-4	0	0	90-95	85-95	70-85	55-70	30-60	5-10
	14-20	MEDL-SIL	ML-A, MH-A	A-7	0	5-15	100	100	85-100	70-85	40-70	10-15
	20-25	MEDL-SIL	ML-A, MH-A	A-7	0	5-15	90-95	85-95	75-90	65-80	40-70	10-15
	25-30	MEDL-SIL	ML-A, MH-A	A-7	0	5-15	90-95	85-95	75-90	65-80	40-70	10-15
	30-36	CB-MEDL-L	ML-A, MH-A	A-4	0	15-25	90-95	85-95	70-85	55-70	30-60	5-10
	36-43	CB-MEDL-L	ML-A, MH-A	A-4	0	30-40	90-95	85-95	70-85	55-70	30-60	5-10
	>43	BR	---	---	---	---	---	---	---	---	---	---
Keamoku-----												
	0-3	MEDL-SIL	ML-A, MH-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	3-10	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	10-14	MEDL-L	MH-A, ML-A	A-6, A-7	0	0	85-95	80-90	70-85	55-70	30-60	10-15
	14-21	GRV-MEDL-L	GM	A-2-6, A-2-5	0	10-25	40-50	35-45	25-40	20-30	30-60	10-15
	21-35	CBX-ASHY-L	GM	A-2-5, A-2-6	25-35	65-75	30-40	25-35	15-30	15-30	30-60	10-15
	35-50	SR- CBX-MEDL-L	GM	A-2-5, A-2-6	25-35	65-75	30-40	25-35	15-30	15-30	30-60	10-15
	50-60	CBX-MEDL-L	GM	A-2-5, A-2-6	5-15	80-90	30-40	25-35	15-30	15-30	30-60	10-15
745:												
Maunaiu-----												
	0-2	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	2-6	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	6-9	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	9-14	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	14-19	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	>19	BR	---	---	---	---	---	---	---	---	---	---
Akelelu-----												
	0-4	MEDL-SIL	MH-A	A-7	0	0	100	100	85-100	75-90	50-70	10-15
	4-7	MEDL-SIL	MH-A	A-7	0	0	100	100	85-100	75-90	50-70	10-15
	7-15	MEDL-L	MH-A	A-7	0	0	100	100	85-100	65-80	50-70	10-15
	15-18	MEDL-L	MH-A	A-7	0	0	90-100	85-95	75-90	60-75	50-70	10-15
	18-21	MEDL-FSL	ML-A	A-4	0	0	90-100	85-95	65-80	40-55	0-10	NP-5
	21-27	MEDL-FSL	ML-A	A-4	0	0	100	100	75-90	45-60	0-10	NP-5
	27-30	MEDL-L	ML-A	A-5, A-6	0	0	100	100	85-100	65-80	25-55	10-15
	30-34	MEDL-L	ML-A	A-6, A-5	0	0	90-100	85-95	75-90	60-75	25-55	10-15
	34-38	BR	---	---	---	---	---	---	---	---	---	---
746:												
Kulalio-----												
	0-3	MEDL-SIL	MH-A, ML-A	A-7	0-25	0-25	95-100	95-100	85-95	70-90	40-70	10-15
	3-7	CB-MEDL-SIL	ML-A, MH-A	A-7	0-25	20-40	80-95	75-85	70-80	55-70	40-70	10-15
	7-11	GRV-MEDL-L	CL, ML-A	A-6, A-7	0-25	0-30	50-60	45-55	35-50	30-40	20-50	10-15
	11-16	GRV-MEDL-LS	GP-GM	A-1-a	0-25	0-30	35-45	30-40	15-25	5-15	0-10	NP-5
	16-25	GRX-ASHY-LS	GP-GM	A-1-a	0-25	0-40	15-30	10-25	5-15	0-10	0-10	NP-5
	25-60	GRX-ASHY-LS	GP-GM	A-1-a	0-25	0-80	30-40	25-35	10-20	5-15	0-10	NP-5

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
In					Pct	Pct					Pct	
746:												
Maunaiu-----	0-2	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	2-6	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	6-9	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	9-14	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	14-19	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	>19	BR	---	---	---	---	---	---	---	---	---	---
Akelelu-----	0-4	MEDL-SIL	MH-A	A-7	0	0	100	100	85-100	75-90	50-70	10-15
	4-7	MEDL-SIL	MH-A	A-7	0	0	100	100	85-100	75-90	50-70	10-15
	7-15	MEDL-L	MH-A	A-7	0	0	100	100	85-100	65-80	50-70	10-15
	15-18	MEDL-L	MH-A	A-7	0	0	90-100	85-95	75-90	60-75	50-70	10-15
	18-21	MEDL-FSL	ML-A	A-4	0	0	90-100	85-95	65-80	40-55	0-10	NP-5
	21-27	MEDL-FSL	ML-A	A-4	0	0	100	100	75-90	45-60	0-10	NP-5
	27-30	MEDL-L	ML-A	A-5, A-6	0	0	100	100	85-100	65-80	25-55	10-15
	30-34	MEDL-L	ML-A	A-6, A-5	0	0	90-100	85-95	75-90	60-75	25-55	10-15
	34-38	BR	---	---	---	---	---	---	---	---	---	---
	747:											
Oneula-----	0-2	STX-MEDL-L	ML-A	A-4	40-50	45-55	90-100	85-95	60-75	55-70	0-5	NP-5
	2-60	CBX-S	GM	A-1-a, A-1-b	0-10	45-55	40-55	35-50	20-35	0-15	0-5	NP-5
748:												
Lava flows, pahoehoe.												
Menehune-----	0-2	HPM	PT	A-8	0	0	---	---	---	---	---	NP-5
	2-2	MEDL-SL	SM	A-2-4	0	0	100	100	60-75	30-45	0-5	NP-5
	2-3	MEDL-L	ML-A	A-7, A-6	0	0	100	100	80-95	60-75	30-50	10-15
	3-5	SR- MEDL-LVFS	SM, ML-A	A-4	0	0	100	100	75-90	40-55	0-5	NP-5
	5-7	SR- MEDL-L	ML-A	A-7, A-6	0	0	100	100	80-95	60-75	30-50	10-15
	7-7	SR- MEDL-LS	SM	A-2-4	0	0	100	100	60-75	15-30	0-5	NP-5
	7-8	SR- MEDL-LVFS	SM, ML-A	A-4	0	0	100	100	75-90	40-55	0-5	NP-5
	8-14	SR- MEDL-FS	SM, ML-A	A-2-4	0	0	100	100	80-95	20-35	0-5	NP-5
			MEDL-LFS									
	>14	BR	---	---	---	---	---	---	---	---	---	---
749:												
Wahi-----	0-2	CBX-MEDL-L	ML-A	A-4, A-5	15-25	55-65	70-80	65-75	55-70	40-55	30-50	5-10
	2-5	CBX-MEDL-L	ML-A	A-4, A-5	10-20	70-80	85-95	80-90	70-85	55-70	30-50	5-10
	5-10	CBX-MEDL-L	ML-A	A-4, A-5	10-20	70-80	85-95	80-90	70-85	55-70	30-50	5-10
	10-12	CBX-MEDL-L	ML-A	A-4, A-5	0	65-75	75-85	70-80	60-75	50-65	30-50	5-10
	12-14	CBX-MEDL-L	ML-A	A-4, A-5	0	65-75	85-95	80-90	70-85	55-70	30-50	5-10
	14-60	STX-MEDL-L	ML-A	A-4, A-5	35-45	40-50	90-100	85-95	75-90	60-75	30-50	5-10

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
	In				Pct	Pct					Pct	
750:												
Ki-----	0-2	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	2-4	MEDL-L	ML-A	A-7	0	0	100	100	80-95	60-75	30-50	10-15
	4-5	ASHY-VFSL	ML-A	A-4	0	0	100	100	85-100	50-65	0-5	NP-5
	5-6	GR-ASHY-COS	SM	A-1-b	0	0	75-85	70-80	35-50	5-15	0-5	NP-5
	6-9	GRV-ASHY-VFSL	GM	A-2-4	0	0	45-55	40-50	35-50	20-35	0-5	NP-5
	9-13	GR-ASHY-FSL	GM	A-4	0	0	55-65	50-60	45-60	25-40	0-5	NP-5
	13-15	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	15-19	GRV-MEDL-SL	GM	A-2-4	0	0	40-50	35-45	25-35	15-30	0-5	NP-5
	19-23	MEDL-L	ML-A	A-7, A-6	0	0	85-95	80-90	65-85	55-70	30-50	10-15
	23-26	MEDL-L	ML-A	A-6, A-7	0	0	85-100	85-95	75-90	55-75	30-50	10-15
	26-30	GR-MEDL-L	ML-A	A-7, A-6	0	0	50-60	45-55	35-50	30-45	30-50	10-15
	30-32	MEDL-SIL	ML-A, MH-A	A-7, A-6	0	0	95-100	95-100	85-100	75-90	40-60	10-15
	32-36	GRV-MEDL-L	ML-A	A-7, A-6	0	0	40-50	35-45	25-40	25-40	30-50	10-15
	36-38	MEDL-L	ML-A, GM	A-2-4, A-4	0	0	75-85	70-80	40-60	30-50	0-5	NP-5
	38-41	GRV-MEDL-LS	GM	A-1-b	0	0	50-60	45-55	25-40	10-25	0-5	NP-5
	41-43	SR- GRV-MEDL-FS	GM	A-2-4	0	0	40-50	35-45	25-40	10-25	0-5	NP-5
		GRV-MEDL-S										
	43-48	GR-MEDL-L	GM, SM	A-6, A-7	0	0	60-70	55-65	40-55	35-50	30-50	10-15
	48-52	GRV-MEDL-VFSL	GM	A-2-4	0	0	45-55	40-50	25-40	10-25	0-5	NP-5
	52-60	MEDL-SIL	ML-A, MH-A	A-7	0	0	90-100	85-95	75-90	65-80	40-60	10-15
751:												
Oneula, low elevation-----	0-2	STX-MEDL-L	ML-A	A-4	40-50	45-55	90-100	85-95	60-75	55-70	0-5	NP-5
	2-60	CBX-S	GM	A-1-a, A-1-b	0-10	45-55	40-55	35-50	20-35	0-15	0-5	NP-5
752:												
Oneula-----	0-2	STX-MEDL-L	ML-A	A-4	40-50	45-55	90-100	85-95	60-75	55-70	0-5	NP-5
	2-60	CBX-S	GM	A-1-a, A-1-b	0-10	45-55	40-55	35-50	20-35	0-15	0-5	NP-5
Keamoku-----	0-3	MEDL-SIL	ML-A, MH-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	3-10	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	10-14	MEDL-L	MH-A, ML-A	A-6, A-7	0	0	85-95	80-90	70-85	55-70	30-60	10-15
	14-21	GRV-MEDL-L	GM	A-2-6, A-2-5	0	10-25	40-50	35-45	25-40	20-30	30-60	10-15
	21-35	CBX-ASHY-L	GM	A-2-5, A-2-6	25-35	65-75	30-40	25-35	15-30	15-30	30-60	10-15
	35-50	SR- CBX-MEDL-L	GM	A-2-5, A-2-6	25-35	65-75	30-40	25-35	15-30	15-30	30-60	10-15
	50-60	CBX-MEDL-L	GM	A-2-5, A-2-6	5-15	80-90	30-40	25-35	15-30	15-30	30-60	10-15
Maunaiu-----	0-2	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	2-6	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	6-9	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	9-14	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	14-19	MEDL-SIL	MH-A, ML-A	A-7	0	0	100	100	85-100	75-90	40-70	10-15
	>19	BR	---	---	---	---	---	---	---	---	---	---

Table 10.--Engineering Index Properties--Continued

Map symbol and soil name	Depth	Apparent field texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO	>10	3-10	4	10	40	200		
					inches	inches						
					Pct	Pct					Pct	
753:												
Kalapana-----	0-6	MEDL-COSL	ML-A	A-2-4, A-4	0	0	90-100	85-95	55-70	25-40	0-5	NP-5
	6-7	MEDL-S	SM, SW-SM	A-3, A-2-4	0	0	100	100	50-65	5-15	0-5	NP-5
	>7	BR	---	---	---	---	---	---	---	---	---	---
754:												
Kalapana, dry---	0-6	MEDL-COSL	ML-A	A-2-4, A-4	0	0	90-100	85-95	55-70	25-40	0-5	NP-5
	6-7	MEDL-S	SM, SW-SM	A-3, A-2-4	0	0	100	100	50-65	5-15	0-5	NP-5
	>7	BR	---	---	---	---	---	---	---	---	---	---
Lava flows, pahoehoe.												
755:												
Makaopuhi-----	0-2	PGRV-HPM	PT	A-8	0	0	---	---	---	---	---	---
	2-6	MEDL-SIL	ML-A	A-6, A-7	0	0	90-100	85-95	75-90	65-80	30-50	10-15
	>6	BR	---	---	---	---	---	---	---	---	---	---
756:												
Ahiu-----	0-3	ASHY-SIL	ML-A	A-7	0	0	100	100	80-95	60-75	40-50	10-15
	3-6	ASHY-SIL	ML-A	A-7	0	0	100	100	80-95	60-75	40-50	10-15
	6-11	SR- ASHY-FS ASHY-LFS	SM	A-4, A-2-4	0	0	100	100	65-90	30-45	0-5	NP-5
	11-12	ASHY-L	ML-A	A-7, A-5	0	0	100	100	80-95	55-70	30-50	10-15
	12-13	ASHY-L	ML-A	A-5, A-7	0	0	100	100	80-95	55-70	30-50	10-15
	13-17	BR	---	---	---	---	---	---	---	---	---	---
Vitric												
Haplustands----	0-3	CBX-ASHY-VFSL	SM	A-4	40-50	60-70	75-85	70-80	65-75	40-50	0-5	NP-5
	3-16	CBX-ASHY-VFSL	GM	A-4, A-2-4	20-30	60-70	60-70	55-65	55-65	30-45	0-5	NP-5
	16-33	CBX-ASHY-LFS	SM	A-2-4	20-30	65-75	70-80	65-75	55-70	15-30	0-5	NP-5
	33-35	STX-ASHY-LFS	SM, GM	A-1-b	40-50	50-60	55-65	50-60	40-55	10-25	0-5	NP-5
	35-59	CBX-COS	SP, SW-SM	A-1-b	40-50	50-60	55-65	50-60	35-45	0-10	0-5	NP-5

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 11.--Abbreviations Used in the Column "Apparent Field Texture" in Table 10

USDA texture class terms	Terms used in lieu of USDA texture class terms	Texture modifiers*
C--clay	AM--artifactual material	ART--artifactual
CL--clay loam	BR--bedrock	ARTV--very artifactual
COS--coarse sand	BY--boulders	ARTX--extremely artifactual
COSL--coarse sandy loam	CB--cobble	ASHY--ashy
FS--fine sand	CIND--cinders	BY--bouldery
FSL--fine sandy loam	CN--channers	BYV--very bouldery
L--loam	FL--flagstones	BYX--extremely bouldery
LCOS--loamy coarse sand	FRAG--fragmental material	CB--cobbly
LFS--loamy fine sand	G--gravel	CBV--very cobbly
LS--loamy sand	HFM--highly decomposed plant material	CBX--extremely cobbly
LVFS--loamy very fine sand	MAT--material	CEM--cemented
S--sand	MPM--moderately decomposed plant material	CN--channery
SC--sandy clay	MPT--mucky peat	CNV--very channery
SCL--sandy clay loam	MUCK--muck	CNX--extremely channery
SI--silt	PBY--paraboulders	COP--coprogenous
SIC--silty clay	PCB--paracobbles	DIA--diatomaceous
SICL--silty clay loam	PCN--parachanners	FL--flaggy
SIL--silt loam	PEAT--peat	FLV--very flaggy
SL--sandy loam	PFL--paraflagstones	FLX--extremely flaggy
VFS--very fine sand	PG--paragravel	GR--gravelly
VFSL--very fine sandy loam	PST--parastones	GRC--coarse gravelly
	SPM--slightly decomposed plant material	GRF--fine gravelly
	ST--stones	GRM--medium gravelly
	W--water	GRV--very gravelly
		GRX--extremely gravelly
		GS--grassy
		GYP--gypsiferous
		HB--herbaceous
		HYDR--hydrous
		MEDL--medial
		MK--mucky
		MR--marly
		MS--mossy
		ORH--highly organic
		PBY--parabouldery
		PBYV--very parabouldery
		PBYX--extremely parabouldery
		PCB--paracobbly
		PCBV--very paracobbly
		PCBX--extremely paracobbly
		PCN--parachannery
		PCNV--very parachannery
		PCNX--extremely parachannery
		PF--permanently frozen
		PFL--paraflaggy
		PFLV--very paraflaggy
		PFLX--extremely paraflaggy
		PGR--paragravelly
		PGRV--very paragravelly
		PGRX--extremely paragravelly
		PST--parastony
		PSTV--very parastony
		PSTX--extremely parastony
		PT--peaty
		ST--stony
		STV--very stony
		STX--extremely stony
		WD--woody

* Some of the texture modifiers apply only to the USDA texture class terms or to the terms used in lieu of those texture class terms, and some apply to both. For further explanation, see part 618.67 of the "National Soil Survey Handbook" (<http://soils.usda.gov/technical/handbook/contents/part618.html#67>).

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Table 12.--Physical Properties of the Soils

(See text for definitions of terms used in this table. Absence of an entry indicates that data were not estimated)

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
10: Lava flows, aa--	0-39 39-79	---	142.0-705.0 0.02-0.42	0.00-0.05 ---	---	---
12: Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
14: Lava flows, aa--	0-39 39-79	---	142.0-705.0 0.02-0.42	0.00-0.05 ---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
15: Cinder land-----	0-60	---	141.0-705.0	0.02-0.04	---	---
16: Cinder land-----	0-60	---	141.0-705.0	0.02-0.04	---	---
19: Riverwash-----	0-39 39-79	---	--- 0.43-1.40	--- ---	---	---
24. Badland, geothermal						
26: Lava flows, aa, sparsely vegetated-----	0-39 39-79	---	142.0-705.0 0.02-0.42	0.00-0.05 ---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
117: Kapua-----	0-6 6-18 18-60	0.10-0.20 0.10-0.20 1.90-2.10	42.00-141.0 141.0-705.0 141.0-705.0	0.15-0.20 0.10-0.15 0.01-0.03	0.00-10.00 0.00-5.00 ---	45-60 45-60 ---
Lava flows, aa--	0-39 39-79	---	142.0-705.0 0.02-0.42	0.00-0.05 ---	---	---
130: Mawae-----	0-5 5-40 40-44	0.10-0.20 1.90-2.10 ---	42.00-141.0 142.0-705.0 0.02-0.42	0.10-0.15 0.01-0.03 ---	0.00-10.00 ---	40-60 ---
131: Mawae-----	0-5 5-40 40-44	0.10-0.20 1.90-2.10 ---	42.00-141.0 142.0-705.0 0.02-0.42	0.10-0.15 0.01-0.03 ---	0.00-10.00 ---	40-60 ---

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Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
132:						
Mawae-----	0-5	0.10-0.20	42.00-141.0	0.10-0.15	0.00-10.00	40-60
	5-40	1.90-2.10	142.0-705.0	0.01-0.03	---	---
	40-44	---	0.02-0.42	---	---	---
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
133:						
Mawae-----	0-5	0.10-0.20	42.00-141.0	0.10-0.15	0.00-10.00	40-60
	5-40	1.90-2.10	142.0-705.0	0.01-0.03	---	---
	40-44	---	0.02-0.42	---	---	---
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
137:						
Kekake-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-15.00	40-60
	5-9	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
138:						
Kekake-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-15.00	40-60
	5-9	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
161:						
Kekake-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-15.00	40-60
	5-9	---	0.02-0.42	---	---	---
Mawae-----	0-5	0.10-0.20	42.00-141.0	0.10-0.15	0.00-10.00	40-60
	5-40	1.90-2.10	142.0-705.0	0.01-0.03	---	---
	40-44	---	0.02-0.42	---	---	---
163:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Kekake-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-15.00	40-60
	5-9	---	0.02-0.42	---	---	---
164:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Kekake-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-15.00	40-60
	5-9	---	0.01-0.42	---	---	---
169:						
Iwalani, moist--	0-2	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	15-20
	2-3	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	10-15
	3-5	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	10-15
	5-10	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	5.0-10
	10-14	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
179:						
Iwalani, moist--	0-2	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	15-20
	2-3	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	10-15
	3-5	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	10-15
	5-10	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	5.0-10
	10-14	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
205:						
Ihuanu, moist---	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---
206:						
Ihuanu, moist---	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---
211:						
Kapulehu, moist	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
212:						
Kapulehu, moist	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
213:						
Nanaia, moist---	0-2	0.45-0.85	14.00-42.00	0.10-0.12	5.00-20.00	5.0-10
	2-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	6-10	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
214:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Nanaia, moist---	0-2	0.45-0.85	14.00-42.00	0.10-0.12	5.00-20.00	5.0-10
	2-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	6-10	---	0.02-0.42	---	---	---
215:						
Keaa, moist-----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---
216:						
Keaa, moist-----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
217:						
Kapulehu, moist	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
Keaa, moist----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---
218:						
Kiolakaa, moist	0-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	10-20
	6-10	0.45-0.85	42.00-141.0	0.08-0.10	5.00-20.00	10-20
	10-15	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	15-25	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	25-29	---	0.02-0.42	---	---	---
219:						
Kiolakaa-----	0-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	10-20
	6-10	0.45-0.85	42.00-141.0	0.08-0.10	5.00-20.00	10-20
	10-15	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	15-25	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	25-29	---	0.02-0.42	---	---	---
Keaa-----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---
275:						
Kapulehu-----	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
276:						
Kapulehu-----	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
277:						
Kapulehu-----	0-10	0.45-0.85	42.00-141.0	0.06-0.08	5.00-15.00	5.0-10
	10-26	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	1.0-5.0
	26-30	---	0.02-0.42	---	---	---
280:						
Nanaia-----	0-2	0.45-0.85	14.00-42.00	0.10-0.12	5.00-20.00	5.0-10
	2-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	6-10	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
281:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Nanaia-----	0-2	0.45-0.85	14.00-42.00	0.10-0.12	5.00-20.00	5.0-10
	2-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	6-10	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen- bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
290:						
Keaa-----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---
292:						
Keaa-----	0-4	0.45-0.85	14.00-42.00	0.09-0.11	5.00-20.00	5.0-10
	4-10	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	10-18	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	1.0-5.0
	18-22	---	0.02-0.42	---	---	---
Kiolakaa-----	0-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	10-20
	6-10	0.45-0.85	42.00-141.0	0.08-0.10	5.00-20.00	10-20
	10-15	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	15-25	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	25-29	---	0.02-0.42	---	---	---
300:						
Kamaoa-----	0-7	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	5.0-15
	7-21	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	5.0-10
	21-47	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	47-68	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	1.0-5.0
	68-72	---	0.02-0.42	---	---	---
305:						
Kiolakaa-----	0-6	0.45-0.85	14.00-42.00	0.12-0.14	10.00-30.00	10-20
	6-10	0.45-0.85	42.00-141.0	0.08-0.10	5.00-20.00	10-20
	10-15	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	15-25	0.45-0.85	42.00-141.0	0.07-0.09	5.00-15.00	5.0-10
	25-29	---	0.02-0.42	---	---	---
395:						
Hokukano-----	0-6	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	25-35
	6-10	0.45-0.85	14.00-42.00	0.12-0.14	5.00-20.00	10-20
	10-20	0.45-0.85	14.00-42.00	0.11-0.13	5.00-20.00	10-20
	20-24	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
401:						
Ihuanu-----	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
402:						
Ihuanu-----	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---
403:						
Ihuanu-----	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
406:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Iwalani-----	0-2	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	15-20
	2-3	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	10-15
	3-5	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	10-15
	5-10	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	5.0-10
	10-14	---	0.02-0.42	---	---	---
407:						
Iwalani-----	0-2	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	15-20
	2-3	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	10-15
	3-5	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	10-15
	5-10	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	5.0-10
	10-14	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
408:						
Iwalani-----	0-2	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	15-20
	2-3	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	10-15
	3-5	0.45-0.85	14.00-42.00	0.14-0.16	10.00-30.00	10-15
	5-10	0.45-0.85	14.00-42.00	0.14-0.16	10.00-25.00	5.0-10
	10-14	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
461:						
Hapuu, very gravelly-----	0-4	0.65-0.85	42.00-141.0	0.10-0.12	5.00-15.00	30-40
	4-6	0.65-0.85	141.0-705.0	0.02-0.04	---	15-25
	6-14	1.10-1.30	141.0-705.0	0.02-0.04	0.00-15.00	5.0-10
	14-43	1.10-1.30	141.0-705.0	0.02-0.04	0.00-15.00	1.0-5.0
	43-47	---	0.02-0.42	---	---	---
463:						
Hapuu, extremely gravelly-----	0-4	0.65-0.85	42.00-141.0	0.04-0.08	0.00-10.00	30-40
	4-6	0.65-0.85	141.0-705.0	0.02-0.04	---	15-25
	6-14	1.10-1.30	141.0-705.0	0.02-0.04	0.00-15.00	5.0-10
	14-43	1.10-1.30	141.0-705.0	0.02-0.04	0.00-15.00	1.0-5.0
	43-47	---	0.02-0.42	---	---	---
511:						
Akihi-----	0-10	0.30-0.60	14.00-42.00	0.12-0.14	15.00-40.00	15-25
	10-35	0.30-0.60	14.00-42.00	0.09-0.11	10.00-20.00	5.0-15
	35-39	---	0.02-0.42	---	---	---
512:						
Akihi-----	0-10	0.30-0.60	14.00-42.00	0.12-0.14	15.00-40.00	15-25
	10-35	0.30-0.60	14.00-42.00	0.09-0.11	10.00-20.00	5.0-15
	35-39	---	0.02-0.42	---	---	---
513:						
Hilea-----	0	0.25-0.75	4.00-14.00	0.17-0.19	0.00-20.00	25-35
	0-8	0.25-0.75	4.00-14.00	0.17-0.19	30.00-50.00	15-25
	8-19	0.25-0.75	4.00-14.00	0.19-0.21	30.00-50.00	5.0-15
	19-23	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
514:						
Hilea-----	0	0.25-0.75	4.00-14.00	0.17-0.19	0.00-20.00	25-35
	0-8	0.25-0.75	4.00-14.00	0.17-0.19	30.00-50.00	15-25
	8-19	0.25-0.75	4.00-14.00	0.19-0.21	30.00-50.00	5.0-15
	19-23	---	0.02-0.42	---	---	---
515:						
Pahipa-----	0-2	0.25-0.75	14.00-42.00	0.15-0.17	0.00-20.00	40-70
	2-8	0.25-0.75	1.40-4.00	0.15-0.17	30.00-50.00	15-25
	8-16	0.25-0.75	4.00-14.00	0.13-0.15	30.00-50.00	10-20
	16-30	0.25-0.75	4.00-14.00	0.13-0.15	10.00-20.00	5.0-15
	30-39	0.25-0.75	4.00-14.00	0.08-0.09	5.00-15.00	5.0-10
	39-43	---	0.02-0.42	---	---	---
Puali-----	0-4	0.25-0.75	4.00-14.00	0.17-0.19	0.00-20.00	40-70
	4-10	0.25-0.75	4.00-14.00	0.17-0.19	30.00-50.00	15-25
	10-18	0.25-0.75	4.00-14.00	0.19-0.21	15.00-40.00	5.0-15
	18-22	---	0.02-0.42	---	---	---
516:						
Alapai-----	0-7	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	10-15
	7-15	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	15-27	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	27-36	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	36-43	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	43-50	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	50-57	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	57-66	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	66-70	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	70-74	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
517:						
Alapai-----	0-7	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	10-15
	7-15	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	15-27	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	27-36	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	36-43	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	43-50	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	50-57	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	57-66	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	66-70	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	70-74	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
518:						
Alapai-----	0-7	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	10-15
	7-15	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	15-27	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	5.0-10
	27-36	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	36-43	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	43-50	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	50-57	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	57-66	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	66-70	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	70-74	0.30-0.60	5.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
519:						
Lalaa-----	0-3	0.10-0.20	43.00-141.0	0.10-0.15	0.00-10.00	25-40
	3-53	1.90-2.10	142.0-705.0	0.01-0.03	0.00-3.00	---
	53-57	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
525:						
Alapai, low precipitation--	0-9	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	8.0-12
	9-17	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	4.0-8.0
	17-23	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	23-31	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	31-40	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	40-48	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	48-54	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	54-65	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
	65-74	0.25-0.60	4.00-14.00	0.19-0.21	30.00-50.00	1.0-5.0
534:						
Kahaluu-----	0-5	0.10-0.20	42.00-141.0	0.20-0.24	0.00-20.00	40-60
	>5	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
555:						
Kuanene-----	0-1	0.30-0.70	42.00-141.0	---	0.00-20.00	40-80
	1-6	0.50-0.90	14.00-42.00	0.22-0.26	10.00-25.00	5.0-10
	6-7	0.70-0.90	14.00-42.00	0.20-0.24	10.00-25.00	4.0-10
	7-12	1.00-1.50	42.00-141.0	0.19-0.22	5.00-15.00	0.0-2.0
	12-17	0.60-0.90	14.00-42.00	0.20-0.28	5.00-20.00	3.0-6.0
	>17	---	0.01-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
574:						
Ihuanu-----	0-2	0.45-0.85	42.00-141.0	0.08-0.10	5.00-15.00	20-30
	2-20	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	10-20
	20-22	0.45-0.85	141.0-705.0	0.05-0.07	0.00-10.00	5.0-10
	22-26	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
575:						
Durustands-----	0-4	0.40-0.90	4.00-14.00	0.12-0.25	10.00-30.00	5.0-15
	4-6	0.40-0.90	14.00-42.00	0.08-0.21	10.00-25.00	4.0-10
	6-7	0.40-0.90	4.00-14.00	0.12-0.25	10.00-30.00	5.0-10
	7-11	0.40-0.90	4.00-14.00	0.12-0.25	10.00-30.00	1.0-5.0
	11-13	0.60-1.20	1.40-4.00	0.05-0.12	10.00-30.00	1.0-5.0
	13-26	0.40-0.90	4.00-14.00	0.12-0.25	30.00-50.00	1.0-5.0
	26-36	---	0.02-0.42	0.00-0.01	---	---
576:						
Puali-----	0-4	0.40-0.60	14.00-42.00	---	5.00-40.00	40-70
	4-10	0.25-0.75	4.00-14.00	0.17-0.19	30.00-50.00	15-25
	10-18	0.25-0.75	4.00-14.00	0.19-0.21	15.00-40.00	5.0-15
	18-22	---	0.02-0.42	---	---	---
Puu Oo-----	0-3	0.50-0.70	4.00-14.00	0.20-0.40	10.00-30.00	5.0-15
	3-6	0.50-0.70	4.00-14.00	0.20-0.40	10.00-30.00	5.0-10
	6-9	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	9-16	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	16-22	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	22-27	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	27-50	0.50-0.90	4.00-14.00	0.10-0.30	10.00-30.00	0.0-3.0

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
576:						
Pahipa-----	0-2	0.40-0.60	14.00-42.00	---	5.00-40.00	40-70
	2-8	0.25-0.75	1.40-4.00	0.15-0.17	30.00-50.00	15-25
	8-16	0.25-0.75	4.00-14.00	0.13-0.15	30.00-50.00	10-20
	16-30	0.25-0.75	4.00-14.00	0.13-0.15	10.00-20.00	5.0-15
	30-39	0.25-0.75	4.00-14.00	0.08-0.09	5.00-15.00	5.0-10
	39-43	---	0.02-0.42	---	---	---
577:						
Pahipa-----	0-2	0.40-0.60	14.00-42.00	---	5.00-40.00	40-70
	2-8	0.25-0.75	1.40-4.00	0.15-0.17	30.00-50.00	15-25
	8-16	0.25-0.75	4.00-14.00	0.13-0.15	30.00-50.00	10-20
	16-30	0.25-0.75	4.00-14.00	0.13-0.15	10.00-20.00	5.0-15
	30-39	0.25-0.75	4.00-14.00	0.08-0.09	5.00-15.00	5.0-10
	39-43	---	0.02-0.42	---	---	---
Puu Oo-----	0-3	0.50-0.70	4.00-14.00	0.20-0.40	10.00-30.00	5.0-15
	3-6	0.50-0.70	4.00-14.00	0.20-0.40	10.00-30.00	5.0-10
	6-9	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	9-16	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	16-22	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	22-27	0.50-0.70	4.00-14.00	0.15-0.35	30.00-50.00	2.0-8.0
	27-50	0.50-0.90	4.00-14.00	0.10-0.30	10.00-30.00	0.0-3.0
605:						
Kaholimo-----	0-2	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	2-4	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	4-7	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	7-10	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	10-12	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	12-13	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	5.0-15
	>13	---	0.01-0.42	---	---	---
Ki-----	0-2	0.40-0.60	41.90-140.9	0.23-0.27	10.00-30.00	10-20
	2-4	0.40-0.80	41.90-140.9	0.23-0.27	10.00-30.00	10-20
	4-5	0.90-1.10	41.90-140.9	0.18-0.22	10.00-25.00	3.0-10
	5-6	0.90-1.10	41.90-140.9	0.08-0.12	0.00-15.00	3.0-10
	6-9	0.90-1.10	41.90-140.9	0.11-0.15	0.00-10.00	3.0-10
	9-13	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	13-15	0.90-1.10	41.90-140.9	0.10-0.14	5.00-15.00	3.0-10
	15-19	0.90-1.10	41.90-140.9	0.10-0.14	5.00-15.00	3.0-10
	19-23	0.40-0.60	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	23-26	0.40-0.60	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	26-30	0.40-0.60	41.90-140.9	0.11-0.15	5.00-20.00	3.0-10
	30-32	0.30-0.80	41.90-140.9	0.23-0.27	10.00-30.00	3.0-10
	32-36	0.70-0.90	41.90-140.9	0.09-0.11	5.00-15.00	3.0-10
	36-38	0.70-0.90	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	38-41	0.90-1.10	41.90-140.9	0.09-0.11	5.00-15.00	3.0-10
	41-43	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	41-43	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	43-48	0.70-0.90	41.90-140.9	0.04-0.10	5.00-20.00	3.0-10
	48-52	0.90-1.10	41.90-140.9	0.05-0.09	5.00-15.00	3.0-10
	52-60	0.40-0.80	41.90-140.9	0.24-0.30	10.00-30.00	3.0-10

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen- bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
607:						
Kaholimo-----	0-2	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	2-4	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	4-7	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	7-10	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	10-12	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	1.0-10
	12-13	0.40-0.90	14.00-42.00	0.26-0.28	10.00-30.00	5.0-15
	>13	---	0.01-0.42	---	---	---
Ki-----	0-2	0.40-0.60	41.90-140.9	0.23-0.27	10.00-30.00	10-20
	2-4	0.40-0.80	41.90-140.9	0.23-0.27	10.00-30.00	10-20
	4-5	0.90-1.10	41.90-140.9	0.18-0.22	10.00-25.00	3.0-10
	5-6	0.90-1.10	41.90-140.9	0.08-0.12	0.00-15.00	3.0-10
	6-9	0.90-1.10	41.90-140.9	0.11-0.15	0.00-10.00	3.0-10
	9-13	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	13-15	0.90-1.10	41.90-140.9	0.10-0.14	5.00-15.00	3.0-10
	15-19	0.90-1.10	41.90-140.9	0.10-0.14	5.00-15.00	3.0-10
	19-23	0.40-0.60	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	23-26	0.40-0.60	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	26-30	0.40-0.60	41.90-140.9	0.11-0.15	5.00-20.00	3.0-10
	30-32	0.30-0.80	41.90-140.9	0.23-0.27	10.00-30.00	3.0-10
	32-36	0.70-0.90	41.90-140.9	0.09-0.11	5.00-15.00	3.0-10
	36-38	0.70-0.90	41.90-140.9	0.18-0.22	10.00-30.00	3.0-10
	38-41	0.90-1.10	41.90-140.9	0.09-0.11	5.00-15.00	3.0-10
	41-43	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	41-43	0.90-1.10	41.90-140.9	0.13-0.17	0.00-15.00	3.0-10
	43-48	0.70-0.90	41.90-140.9	0.04-0.10	5.00-20.00	3.0-10
	48-52	0.90-1.10	41.90-140.9	0.05-0.09	5.00-15.00	3.0-10
	52-60	0.40-0.80	41.90-140.9	0.24-0.30	10.00-30.00	3.0-10
610:						
Piihonua-----	0-2	0.10-0.60	4.00-14.00	0.10-0.15	0.00-20.00	20-30
	2-7	0.50-0.80	4.00-14.00	0.16-0.20	30.00-50.00	10-18
	7-16	0.25-0.60	4.00-14.00	0.26-0.31	30.00-50.00	1.0-10
	16-22	0.25-0.60	4.00-14.00	0.26-0.31	30.00-50.00	1.0-10
	22-28	0.25-0.60	4.00-14.00	0.23-0.31	30.00-50.00	1.0-5.0
	28-47	0.25-0.60	4.00-14.00	0.23-0.31	30.00-50.00	1.0-5.0
	47-59	---	0.00-0.01	---	---	---
613:						
Kilooa-----	0-10	0.10-0.20	41.90-140.9	0.10-0.15	60.00-100.00	35-50
	10-60	1.10-1.30	141.0-141.0	0.01-0.03	0.00-5.00	0.0-15
	>60	---	0.02-0.42	---	---	---
621:						
Eheuiki-----	0-4	0.40-0.90	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	4-9	0.40-0.90	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	9-13	0.40-0.90	14.00-42.00	0.26-0.29	10.00-30.00	5.0-15
	13-15	0.40-0.90	14.00-42.00	0.25-0.28	10.00-30.00	5.0-15
	15-19	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	19-23	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	23-26	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	26-28	0.40-0.90	14.00-42.00	0.25-0.28	10.00-30.00	5.0-15
	28-60	0.40-0.90	42.00-141.0	0.04-0.06	0.00-10.00	0.0-5.0
Pekailio-----	0-5	0.50-0.80	14.10-41.90	0.20-0.28	5.00-20.00	5.0-15
	5-12	0.60-0.80	14.10-41.90	0.20-0.28	5.00-20.00	1.0-10
	12-22	0.60-0.80	14.10-41.90	0.10-0.20	0.00-10.00	1.0-5.0
	22-34	0.60-0.80	14.10-41.90	0.10-0.20	0.00-10.00	1.0-5.0
	34-60	0.60-0.80	141.1-704.9	0.05-0.15	0.00-15.00	0.0-2.0

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
625:						
Hao-----	0-2	0.10-0.60	4.00-14.00	0.10-0.15	0.00-20.00	25-40
	2-8	0.50-0.80	4.00-14.00	0.16-0.20	10.00-30.00	10-30
	8-15	0.50-0.80	4.00-14.00	0.20-0.25	10.00-30.00	10-20
	15-21	0.50-0.80	1.40-4.00	0.00-0.00	10.00-30.00	0.0-10
	21-41	0.50-0.80	4.00-14.00	0.00-0.00	10.00-30.00	5.0-15
631:						
Kapapala-----	0-3	0.45-0.85	14.00-42.00	0.22-0.30	10.00-30.00	5.0-10
	3-9	0.45-0.85	14.00-42.00	0.20-0.25	10.00-30.00	1.0-5.0
	9-13	0.65-0.85	141.0-705.0	0.18-0.25	10.00-30.00	1.0-5.0
	13-21	0.45-0.85	14.00-42.00	0.22-0.30	10.00-30.00	1.0-5.0
	21-29	0.60-0.85	14.00-42.00	0.20-0.25	10.00-30.00	1.0-5.0
	29-43	0.45-0.85	14.00-42.00	0.22-0.30	10.00-30.00	1.0-5.0
	>43	---	0.02-0.42	---	---	---
657:						
Malama-----	0-3	0.10-0.20	42.00-141.0	0.10-0.15	0.00-5.00	40-70
	3-60	1.10-1.30	141.0-141.0	0.01-0.03	0.00-5.00	0.0-15
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
709:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Lithic Ustipsamments--	0	1.10-1.70	0.42-1.40	0.01-0.03	0.00-15.00	---
	0-2	0.90-1.10	141.0-705.0	0.08-0.12	0.00-15.00	0.0-5.0
	2-10	0.90-1.10	141.0-705.0	0.08-0.12	0.00-15.00	0.0-5.0
	>10	---	0.02-0.42	---	---	---
711:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Apuki-----	0	0.90-1.70	42.00-141.0	0.11-0.17	0.00-15.00	5.0-10
	0-6	0.90-1.70	42.00-141.0	0.11-0.17	0.00-15.00	0.0-5.0
	6-7	0.90-1.70	42.00-141.0	0.13-0.17	5.00-20.00	0.0-5.0
	>7	---	0.02-0.42	---	---	---
713:						
Lithic Haplustands, cindery substratum----	0-2	0.90-1.10	42.00-141.0	0.04-0.08	0.00-5.00	0.0-5.0
	2-2	0.90-1.10	42.00-141.0	0.18-0.22	5.00-20.00	0.0-5.0
	2-3	0.90-1.10	42.00-141.0	0.04-0.08	0.00-15.00	0.0-5.0
	3-4	0.90-1.10	42.00-141.0	0.13-0.17	5.00-20.00	0.0-5.0
	4-5	0.90-1.10	42.00-141.0	0.13-0.17	5.00-20.00	0.0-5.0
	5-6	0.90-1.10	42.00-141.0	0.13-0.17	5.00-20.00	0.0-5.0
	6-8	0.90-1.10	141.0-705.0	0.04-0.08	0.00-15.00	0.0-5.0
	>8	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
713: Lithic Haplustands, loamy surface--	0-4	0.40-0.90	42.00-141.0	0.08-0.12	5.00-12.00	0.0-5.0
	4-5	0.60-0.90	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	5-6	0.90-1.10	42.00-141.0	0.05-0.09	5.00-10.00	0.0-5.0
	6-7	0.90-1.10	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	6-7	0.90-1.10	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	6-7	0.90-1.10	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	7-8	0.70-0.90	42.00-141.0	0.05-0.09	5.00-12.00	0.0-5.0
	8-10	0.90-1.10	42.00-141.0	0.13-0.17	5.00-10.00	0.0-5.0
	10-13	0.90-1.10	42.00-141.0	0.01-0.04	0.00-5.00	0.0-5.0
	>13	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
715: Alahapa-----	0-3	0.30-0.50	42.00-141.0	0.03-0.05	0.00-10.00	0.0-1.0
	3-17	0.40-0.60	42.00-141.0	0.02-0.05	0.00-10.00	0.0-1.0
	17-36	0.90-1.10	141.0-705.0	0.03-0.05	0.00-15.00	0.0-1.0
	36-60	0.90-1.10	141.0-705.0	0.02-0.05	0.00-15.00	0.0-1.0
Heake-----	0-1	0.40-0.60	42.00-141.0	0.21-0.25	12.50-22.50	0.0-5.0
	1-4	1.20-1.40	42.00-141.0	0.16-0.20	5.00-20.00	0.0-5.0
	4-7	1.50-1.80	42.00-141.0	0.10-0.14	2.50-5.00	0.0-5.0
	7-8	1.20-1.40	14.00-42.00	0.23-0.27	2.20-11.20	0.0-5.0
	8-10	1.30-1.70	14.00-42.00	0.19-0.23	2.20-11.20	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	12-14	0.05-0.20	141.0-705.0	0.24-0.28	2.70-6.70	---
	>14	---	0.02-0.42	---	---	---
716: Alahapa-----	0-3	0.30-0.50	42.00-141.0	0.03-0.05	0.00-10.00	0.0-1.0
	3-17	0.40-0.60	42.00-141.0	0.02-0.05	0.00-10.00	0.0-1.0
	17-36	0.90-1.10	141.0-705.0	0.03-0.05	0.00-15.00	0.0-1.0
	36-60	0.90-1.10	141.0-705.0	0.02-0.05	0.00-15.00	0.0-1.0
717: Alahapa-----	0-3	0.30-0.50	42.00-141.0	0.03-0.05	0.00-10.00	0.0-1.0
	3-17	0.40-0.60	42.00-141.0	0.02-0.05	0.00-10.00	0.0-1.0
	17-36	0.90-1.10	141.0-705.0	0.03-0.05	0.00-15.00	0.0-1.0
	36-60	0.90-1.10	141.0-705.0	0.02-0.05	0.00-15.00	0.0-1.0
Lava flows, aa--	0-39	---	142.0-705.0	0.00-0.05	---	---
	39-79	---	0.02-0.42	---	---	---
718: Halemaumau-----	0-6	0.30-0.50	141.0-705.0	0.04-0.08	0.00-15.00	0.0-5.0
	6-7	0.90-1.10	42.00-141.0	0.15-0.19	0.00-15.00	0.0-5.0
	7-10	1.10-1.70	141.0-705.0	0.01-0.05	0.00-15.00	0.0-5.0
	10-13	0.90-1.10	42.00-141.0	0.23-0.27	11.00-22.00	0.0-5.0
	13-20	0.90-1.10	141.0-705.0	0.08-0.12	0.00-15.00	0.0-5.0
	20-23	0.90-1.10	141.0-705.0	0.27-0.29	5.00-20.00	0.0-5.0
	23-27	0.90-1.10	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	27-35	0.05-0.20	141.0-705.0	0.18-0.22	0.00-15.00	0.0-5.0
	>35	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
719:						
Heake-----	0-1	0.40-0.60	42.00-141.0	0.21-0.25	12.50-22.50	0.0-5.0
	1-4	1.20-1.40	42.00-141.0	0.16-0.20	5.00-20.00	0.0-5.0
	4-7	1.50-1.80	42.00-141.0	0.10-0.14	2.50-5.00	0.0-5.0
	7-8	1.20-1.40	14.00-42.00	0.23-0.27	2.20-11.20	0.0-5.0
	8-10	1.30-1.70	14.00-42.00	0.19-0.23	2.20-11.20	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	12-14	0.05-0.20	141.0-705.0	0.24-0.28	2.70-6.70	---
	>14	---	0.02-0.42	---	---	---
720:						
Heake-----	0-1	0.40-0.60	42.00-141.0	0.21-0.25	12.50-22.50	0.0-5.0
	1-4	1.20-1.40	42.00-141.0	0.16-0.20	5.00-20.00	0.0-5.0
	4-7	1.50-1.80	42.00-141.0	0.10-0.14	2.50-5.00	0.0-5.0
	7-8	1.20-1.40	14.00-42.00	0.23-0.27	2.20-11.20	0.0-5.0
	8-10	1.30-1.70	14.00-42.00	0.19-0.23	2.20-11.20	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	10-12	1.30-1.70	42.00-141.0	0.13-0.17	2.00-8.00	0.0-5.0
	12-14	0.05-0.20	141.0-705.0	0.24-0.28	2.70-6.70	---
	>14	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
722:						
Kilauea-----	0	1.10-1.50	0.01-0.42	0.01-0.03	0.00-15.00	0.0-5.0
	0-3	0.90-1.10	141.0-705.0	0.03-0.07	0.00-15.00	0.0-5.0
	3-5	0.70-0.90	141.0-705.0	0.18-0.22	5.00-15.00	0.0-5.0
	5-7	0.90-1.10	141.0-705.0	0.04-0.08	0.00-15.00	0.0-5.0
	7-10	0.90-1.10	141.0-705.0	0.10-0.14	5.00-10.00	0.0-5.0
	10-20	0.90-1.10	141.0-705.0	0.04-0.08	0.00-15.00	0.0-5.0
	10-20	0.90-1.10	141.0-705.0	0.04-0.08	0.00-15.00	0.0-5.0
	20-23	0.90-1.10	141.0-705.0	0.06-0.10	0.00-15.00	0.0-5.0
	23-38	0.90-1.10	141.0-705.0	0.15-0.19	0.00-15.00	0.0-5.0
	23-38	0.90-1.10	141.0-705.0	0.15-0.19	0.00-15.00	0.0-5.0
	38-40	0.90-1.10	141.0-705.0	0.06-0.10	0.00-15.00	0.0-5.0
	40-56	0.90-1.10	141.0-705.0	0.28-0.32	5.00-20.00	0.0-5.0
	56-75	0.90-1.10	141.0-705.0	0.07-0.11	0.00-15.00	0.0-5.0
724:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Kaholimo, uneroded-----	0-2	0.40-0.90	42.00-141.0	0.33-0.37	10.00-30.00	15-20
	2-4	0.40-0.90	42.00-141.0	0.33-0.37	10.00-30.00	10-15
	4-7	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	7-10	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	10-12	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	12-13	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	>13	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
724:						
Kaholimo, eroded	0-2	0.40-0.90	42.00-141.0	0.33-0.37	5.00-20.00	10-15
	2-5	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	5-8	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	8-10	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	10-11	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	>11	---	0.02-0.42	---	---	---
	Puiwa, uneroded	0-4	0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00
4-7		0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	10-15
7-9		0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
7-9		0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
9-11		0.90-1.10	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
11-17		0.50-0.90	42.00-141.0	0.25-0.29	10.00-30.00	10-15
17-25		0.50-0.90	42.00-141.0	0.25-0.29	10.00-30.00	5.0-10
25-38		0.50-0.90	42.00-141.0	0.20-0.26	5.00-20.00	5.0-10
>38		---	0.02-0.42	---	---	---
Puiwa, eroded---		0-3	0.40-0.80	42.00-141.0	0.20-0.26	5.00-20.00
	3-6	0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	3-6	0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	6-7	0.90-1.10	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	7-13	0.50-0.90	42.00-141.0	0.25-0.29	10.00-30.00	10-15
	13-21	0.50-0.90	42.00-141.0	0.25-0.29	10.00-30.00	5.0-10
	21-34	0.50-0.90	42.00-141.0	0.20-0.26	5.00-20.00	5.0-10
	>34	---	0.02-0.42	---	---	---
725:						
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
Kaholimo, eroded	0-2	0.40-0.90	42.00-141.0	0.33-0.37	5.00-20.00	10-15
	2-5	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	5-8	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	8-10	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	10-11	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	>11	---	0.02-0.42	---	---	---
Kaholimo, uneroded-----	0-2	0.40-0.90	42.00-141.0	0.33-0.37	10.00-30.00	15-20
	2-4	0.40-0.90	42.00-141.0	0.33-0.37	10.00-30.00	10-15
	4-7	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	7-10	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	10-12	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	12-13	0.40-0.90	42.00-141.0	0.18-0.22	10.00-30.00	5.0-15
	>13	---	0.02-0.42	---	---	---
726:						
Kulalio-----	0-3	0.40-0.90	14.00-42.00	0.46-0.50	10.00-30.00	25-35
	3-7	0.40-0.90	14.00-42.00	0.08-0.12	5.00-20.00	15-25
	7-11	0.70-0.90	42.00-141.0	0.15-0.19	5.00-15.00	15-25
	11-16	0.90-1.10	141.0-705.0	0.06-0.10	5.00-15.00	10-15
	16-25	0.90-1.10	141.0-705.0	0.02-0.06	0.00-5.00	5.0-10
	25-60	0.90-1.10	141.0-705.0	0.02-0.06	0.00-5.00	0.0-5.0

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen- bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
727:						
Puaulu-----	0-3	0.40-0.90	42.00-141.0	0.30-0.34	30.00-50.00	10-20
	3-9	0.40-0.90	42.00-141.0	0.30-0.34	10.00-30.00	10-20
	9-12	0.50-0.90	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	12-15	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	15-19	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	19-20	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	20-22	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	20-30
	22-24	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	24-28	0.60-0.90	14.00-42.00	0.12-0.16	10.00-30.00	5.0-10
	28-30	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-15
	30-31	0.50-0.90	14.00-42.00	0.30-0.43	10.00-30.00	5.0-10
	31-32	0.50-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	32-34	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	34-35	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-15
	35-37	0.60-0.90	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	37-38	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-20
	38-41	0.60-0.90	42.00-141.0	0.03-0.07	0.00-10.00	5.0-10
	41-43	0.50-0.90	4.00-14.00	0.23-0.27	30.00-50.00	5.0-10
	43-48	0.50-0.90	4.00-14.00	0.28-0.32	10.00-30.00	5.0-10
	48-51	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-10
	51-53	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-5.0
	53-55	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	5.0-10
728:						
Puaulu-----	0-3	0.40-0.90	42.00-141.0	0.30-0.34	30.00-50.00	10-20
	3-9	0.40-0.90	42.00-141.0	0.30-0.34	10.00-30.00	10-20
	9-12	0.50-0.90	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	12-15	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	15-19	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	19-20	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	20-22	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	20-30
	22-24	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	24-28	0.60-0.90	14.00-42.00	0.12-0.16	10.00-30.00	5.0-10
	28-30	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-15
	30-31	0.50-0.90	14.00-42.00	0.30-0.43	10.00-30.00	5.0-10
	31-32	0.50-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	32-34	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	34-35	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-15
	35-37	0.60-0.90	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	37-38	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-20
	38-41	0.60-0.90	42.00-141.0	0.03-0.07	0.00-10.00	5.0-10
	41-43	0.50-0.90	4.00-14.00	0.23-0.27	30.00-50.00	5.0-10
	43-48	0.50-0.90	4.00-14.00	0.28-0.32	10.00-30.00	5.0-10
	48-51	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-10
	51-53	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-5.0
	53-55	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	5.0-10

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
728:						
Hao-----	0-2	0.40-0.90	4.00-14.00	0.33-0.37	10.00-30.00	10-20
	2-3	0.40-0.90	4.00-14.00	0.34-0.38	10.00-30.00	10-20
	3-6	0.40-0.90	1.40-4.00	0.13-0.17	10.00-30.00	5.0-15
	3-6	0.40-0.90	1.40-4.00	0.13-0.17	10.00-30.00	5.0-15
	6-8	0.40-0.90	14.00-42.00	0.26-0.30	10.00-30.00	5.0-15
	8-9	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	9-10	0.40-0.90	1.40-4.00	0.15-0.19	10.00-30.00	5.0-15
	10-12	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	12-13	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	13-15	0.40-0.90	1.40-4.00	0.15-0.19	10.00-30.00	5.0-15
	15-18	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	18-21	0.40-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	21-23	0.40-0.90	14.00-42.00	0.18-0.22	10.00-30.00	5.0-15
	23-24	0.40-0.90	42.00-141.0	0.18-0.22	10.00-25.00	5.0-15
	24-25	0.40-0.90	14.00-42.00	0.26-0.30	10.00-30.00	5.0-15
	25-30	0.40-0.90	14.00-42.00	0.26-0.30	10.00-30.00	5.0-15
	30-41	0.40-0.90	1.40-4.00	0.22-0.26	10.00-30.00	5.0-15
	41-60	1.10-1.70	0.42-1.40	0.00-0.00	10.00-30.00	0.0-5.0
729:						
Eheuiki-----	0-4	0.40-0.90	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	4-9	0.40-0.90	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	9-13	0.40-0.90	14.00-42.00	0.26-0.29	10.00-30.00	5.0-15
	13-15	0.40-0.90	14.00-42.00	0.25-0.28	10.00-30.00	5.0-15
	15-19	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	19-23	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	23-26	0.40-0.90	14.00-42.00	0.27-0.31	10.00-30.00	5.0-15
	26-28	0.40-0.90	14.00-42.00	0.25-0.28	10.00-30.00	5.0-15
	28-60	0.40-0.90	42.00-141.0	0.04-0.06	0.00-10.00	0.0-5.0
Puaulu-----	0-3	0.40-0.90	42.00-141.0	0.30-0.34	30.00-50.00	10-20
	3-9	0.40-0.90	42.00-141.0	0.30-0.34	10.00-30.00	10-20
	9-12	0.50-0.90	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	12-15	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	15-19	1.10-1.70	42.00-141.0	0.16-0.20	0.00-15.00	0.0-5.0
	19-20	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	20-22	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	20-30
	22-24	0.50-0.90	42.00-141.0	0.20-0.24	10.00-30.00	5.0-10
	24-28	0.60-0.90	14.00-42.00	0.12-0.16	10.00-30.00	5.0-10
	28-30	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-15
	30-31	0.50-0.90	14.00-42.00	0.30-0.43	10.00-30.00	5.0-10
	31-32	0.50-0.90	14.00-42.00	0.33-0.37	10.00-30.00	5.0-15
	32-34	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	34-35	0.50-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-15
	35-37	0.60-0.90	42.00-141.0	0.08-0.12	5.00-15.00	0.0-5.0
	37-38	0.50-0.90	42.00-141.0	0.20-0.24	30.00-50.00	10-20
	38-41	0.60-0.90	42.00-141.0	0.03-0.07	0.00-10.00	5.0-10
	41-43	0.50-0.90	4.00-14.00	0.23-0.27	30.00-50.00	5.0-10
	43-48	0.50-0.90	4.00-14.00	0.28-0.32	10.00-30.00	5.0-10
	48-51	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-10
	51-53	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	0.0-5.0
	53-55	0.60-0.90	14.00-42.00	0.28-0.32	10.00-30.00	5.0-10

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
731:						
Kahalii-----	0-4	0.40-0.60	141.0-705.0	0.03-0.07	0.00-15.00	0.0-5.0
	4-5	0.90-1.10	42.00-141.0	0.10-0.14	5.00-15.00	0.0-5.0
	5-7	0.90-1.10	42.00-141.0	0.05-0.09	0.00-15.00	0.0-1.0
	7-9	0.40-0.60	42.00-141.0	0.10-0.14	0.00-10.00	0.0-1.0
	9-9	0.90-1.10	42.00-141.0	0.18-0.22	5.00-20.00	0.0-1.0
	9-11	0.90-1.10	141.0-705.0	0.02-0.06	0.00-15.00	0.0-1.0
	11-12	1.40-1.60	14.00-42.00	---	---	---
	>12	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
734:						
Kanohina-----	0-1	0.45-0.85	42.00-141.0	0.15-0.17	10.00-25.00	5.0-10
	1-3	0.45-0.85	42.00-141.0	0.11-0.13	5.00-15.00	1.0-5.0
	3-6	0.45-0.85	42.00-141.0	0.06-0.08	5.00-20.00	1.0-5.0
	6-10	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
735:						
Puhimau-----	0-3	0.40-0.90	42.00-141.0	0.32-0.36	10.00-20.00	20-30
	3-6	0.90-1.10	141.0-705.0	0.10-0.14	5.00-10.00	5.0-10
	6-8	0.70-0.90	42.00-141.0	0.13-0.17	10.00-20.00	5.0-10
	8-11	0.40-0.90	42.00-141.0	0.32-0.36	10.00-20.00	5.0-10
	11-13	0.40-0.90	42.00-141.0	0.16-0.20	10.00-20.00	5.0-10
	>13	---	0.02-0.42	---	---	---
736:						
Manu-----	0-3	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	25-35
	3-4	0.40-0.70	42.00-141.0	0.03-0.05	0.00-5.00	0.0-5.0
	4-6	1.30-1.50	42.00-141.0	0.18-0.22	10.00-20.00	0.0-5.0
	6-9	1.30-1.50	42.00-141.0	0.01-0.05	0.00-15.00	0.0-5.0
	9-11	0.60-0.80	42.00-141.0	0.18-0.22	5.00-15.00	0.0-5.0
	11-13	0.90-1.20	42.00-141.0	0.16-0.22	5.00-20.00	0.0-5.0
	13-15	0.90-1.10	42.00-141.0	0.21-0.25	5.00-20.00	0.0-5.0
	15-17	0.40-0.70	42.00-141.0	0.20-0.24	10.00-20.00	0.0-5.0
	17-18	0.40-0.70	42.00-141.0	0.20-0.24	10.00-20.00	0.0-5.0
	18-20	0.90-1.10	42.00-141.0	0.11-0.15	5.00-20.00	0.0-5.0
	20-21	0.90-1.10	42.00-141.0	0.11-0.15	10.00-20.00	0.0-5.0
	21-26	0.90-1.10	42.00-141.0	0.11-0.15	5.00-10.00	0.0-5.0
	26-32	0.90-1.10	42.00-141.0	0.11-0.15	5.00-20.00	0.0-5.0
	32-34	0.90-1.10	42.00-141.0	0.31-0.35	10.00-20.00	0.0-5.0
	>34	---	0.02-0.42	---	---	---
737:						
Nakanui-----	0-4	0.40-0.60	42.00-141.0	0.22-0.26	10.00-30.00	15-25
	4-6	0.60-0.80	42.00-141.0	0.07-0.11	5.00-15.00	5.0-15
	6-7	0.60-0.80	42.00-141.0	0.07-0.11	5.00-15.00	5.0-15
	7-9	0.90-1.10	141.0-705.0	0.08-0.12	5.00-15.00	5.0-15
	9-11	0.90-1.10	141.0-705.0	0.08-0.12	5.00-15.00	5.0-15
	11-12	0.70-0.90	42.00-141.0	0.15-0.19	5.00-20.00	5.0-10
	12-16	0.70-0.90	42.00-141.0	0.06-0.10	5.00-15.00	5.0-10
	16-18	0.70-0.90	42.00-141.0	0.23-0.27	10.00-30.00	5.0-10
	>18	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
738:						
Vitric						
Haplustands----	0-3	0.70-0.90	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	3-16	0.70-0.90	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	16-33	0.90-1.10	42.00-141.0	0.03-0.06	0.00-5.00	0.0-5.0
	33-35	0.90-1.10	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	35-59	0.90-1.10	141.0-705.0	0.01-0.04	0.00-15.00	0.0-5.0
741:						
Ahiu-----	0-3	0.40-0.60	14.00-42.00	0.29-0.33	10.00-20.00	10-15
	3-6	0.40-0.70	14.00-42.00	0.35-0.39	10.00-20.00	5.0-10
	6-11	0.90-1.10	14.00-42.00	0.27-0.31	8.00-18.00	0.0-5.0
	6-11	0.90-1.10	14.00-42.00	0.27-0.31	8.00-18.00	0.0-5.0
	11-12	0.40-0.60	14.00-42.00	0.23-0.27	10.00-20.00	0.0-5.0
	12-13	0.70-0.90	14.00-42.00	0.23-0.27	10.00-20.00	0.0-5.0
	13-17	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---
743:						
Pakini-----	0-3	0.60-0.90	4.00-14.00	0.07-0.11	10.00-25.00	5.0-10
	3-8	0.60-0.90	4.00-14.00	0.07-0.11	10.00-25.00	5.0-10
	8-16	0.60-0.90	4.00-14.00	0.07-0.11	10.00-25.00	0.0-5.0
	16-29	0.40-0.90	4.00-14.00	0.13-0.17	10.00-30.00	0.0-5.0
	29-45	0.40-0.90	4.00-14.00	0.13-0.17	10.00-30.00	0.0-5.0
	45-59	0.60-0.90	4.00-14.00	0.13-0.17	10.00-25.00	0.0-5.0
744:						
Haa-----	0-3	0.40-0.70	4.00-14.00	0.34-0.38	10.00-30.00	25-35
	3-7	0.40-0.70	4.00-14.00	0.33-0.37	10.00-30.00	15-25
	7-10	0.70-0.90	4.00-14.00	0.20-0.24	10.00-30.00	15-25
	10-14	0.70-0.90	4.00-14.00	0.20-0.24	10.00-30.00	10-15
	14-20	0.40-0.80	4.00-14.00	0.24-0.28	10.00-30.00	5.0-10
	20-25	0.40-0.80	4.00-14.00	0.25-0.29	10.00-30.00	5.0-10
	25-30	0.40-0.80	4.00-14.00	0.25-0.29	10.00-30.00	5.0-10
	30-36	0.60-0.90	4.00-14.00	0.19-0.23	5.00-20.00	5.0-10
	36-43	0.60-0.90	4.00-14.00	0.17-0.21	5.00-20.00	5.0-10
	>43	---	0.02-0.42	---	---	---
Keamoku-----	0-3	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	25-35
	3-10	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	10-14	0.70-0.90	42.00-141.0	0.12-0.16	10.00-30.00	10-20
	14-21	0.70-0.90	141.0-705.0	0.09-0.13	5.00-15.00	5.0-10
	21-35	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
	35-50	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
	50-60	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
745:						
Maunaiu-----	0-2	0.40-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	2-6	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	6-9	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	9-14	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	14-19	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	>19	---	0.02-0.42	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
745:						
Akelelu-----	0-4	0.30-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	4-7	0.30-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	7-15	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	15-18	0.70-0.90	42.00-141.0	0.24-0.28	10.00-30.00	5.0-10
	18-21	0.70-0.90	42.00-141.0	0.24-0.28	10.00-25.00	5.0-10
	21-27	0.70-0.90	42.00-141.0	0.26-0.30	10.00-25.00	5.0-10
	27-30	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	30-34	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	34-38	---	0.02-0.42	---	---	---
746:						
Kulalio-----	0-3	0.40-0.70	42.00-141.0	0.46-0.50	10.00-30.00	25-35
	3-7	0.40-0.70	42.00-141.0	0.08-0.12	5.00-20.00	15-25
	7-11	0.70-0.90	42.00-141.0	0.15-0.19	5.00-15.00	15-25
	11-16	0.90-1.10	141.0-705.0	0.06-0.10	5.00-15.00	10-15
	16-25	0.90-1.10	141.0-705.0	0.02-0.06	0.00-5.00	5.0-10
	25-60	0.90-1.10	141.0-705.0	0.02-0.06	0.00-5.00	0.0-5.0
Maunaiu-----	0-2	0.40-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	2-6	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	6-9	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	9-14	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	14-19	0.40-0.80	42.00-141.0	0.25-0.35	10.00-30.00	5.0-10
	>19	---	0.02-0.42	---	---	---
Akelelu-----	0-4	0.30-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	4-7	0.30-0.70	42.00-141.0	0.25-0.35	10.00-30.00	10-15
	7-15	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	15-18	0.70-0.90	42.00-141.0	0.24-0.28	10.00-30.00	5.0-10
	18-21	0.70-0.90	42.00-141.0	0.24-0.28	10.00-25.00	5.0-10
	21-27	0.70-0.90	42.00-141.0	0.26-0.30	10.00-25.00	5.0-10
	27-30	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	30-34	0.70-0.90	42.00-141.0	0.26-0.30	10.00-30.00	5.0-10
	34-38	---	0.02-0.42	---	---	---
747:						
Oneula-----	0-2	0.70-0.90	42.00-141.0	0.01-0.04	0.00-10.00	0.0-5.0
	2-60	0.90-1.10	141.0-705.0	0.02-0.06	0.00-15.00	0.0-5.0
748:						
Lava flows, pahoe-hoe-----	0-79	---	0.43-1.40	---	---	---
Menehune-----	0-2	0.20-0.40	42.00-141.0	0.18-0.22	0.00-20.00	20-40
	2-2	1.10-1.40	42.00-141.0	0.18-0.22	10.00-30.00	0.0-5.0
	2-3	0.70-0.90	42.00-141.0	0.23-0.27	10.00-30.00	0.0-5.0
	3-5	0.90-1.10	42.00-141.0	0.23-0.27	5.00-15.00	0.0-5.0
	5-7	0.70-0.90	42.00-141.0	0.23-0.27	10.00-30.00	0.0-5.0
	7-7	0.90-1.10	42.00-141.0	0.18-0.22	5.00-25.00	0.0-5.0
	7-8	0.90-1.10	42.00-141.0	0.23-0.27	5.00-20.00	0.0-5.0
	8-14	0.90-1.10	42.00-141.0	0.18-0.22	5.00-20.00	0.0-5.0
	8-14	0.90-1.10	42.00-141.0	0.18-0.22	5.00-20.00	0.0-5.0
	>14	---	0.02-0.42	---	---	---
749:						
Wahi-----	0-2	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0
	2-5	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0
	5-10	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0
	10-12	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0
	12-14	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0
	14-60	0.40-0.80	42.00-141.0	0.05-0.09	0.00-10.00	0.0-5.0

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
750:						
Ki-----	0-2	0.40-0.60	42.00-141.0	0.23-0.27	10.00-30.00	10-20
	2-4	0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	10-20
	4-5	0.90-1.10	42.00-141.0	0.18-0.22	10.00-25.00	3.0-10
	5-6	0.90-1.10	42.00-141.0	0.08-0.12	0.00-15.00	3.0-10
	6-9	0.90-1.10	42.00-141.0	0.11-0.15	0.00-10.00	3.0-10
	9-13	0.90-1.10	42.00-141.0	0.13-0.17	0.00-15.00	3.0-10
	13-15	0.90-1.10	42.00-141.0	0.10-0.14	5.00-15.00	3.0-10
	15-19	0.90-1.10	42.00-141.0	0.10-0.14	5.00-15.00	3.0-10
	19-23	0.40-0.60	42.00-141.0	0.18-0.22	10.00-30.00	3.0-10
	23-26	0.40-0.60	42.00-141.0	0.18-0.22	10.00-30.00	3.0-10
	26-30	0.40-0.60	42.00-141.0	0.11-0.15	5.00-20.00	3.0-10
	30-32	0.30-0.80	42.00-141.0	0.23-0.27	10.00-30.00	3.0-10
	32-36	0.70-0.90	42.00-141.0	0.09-0.11	5.00-15.00	3.0-10
	36-38	0.70-0.90	42.00-141.0	0.18-0.22	10.00-30.00	3.0-10
	38-41	0.90-1.10	42.00-141.0	0.09-0.11	5.00-15.00	3.0-10
	41-43	0.90-1.10	42.00-141.0	0.13-0.17	0.00-15.00	3.0-10
	41-43	0.90-1.10	42.00-141.0	0.13-0.17	0.00-15.00	3.0-10
	43-48	0.70-0.90	42.00-141.0	0.04-0.10	5.00-20.00	3.0-10
	48-52	0.90-1.10	42.00-141.0	0.05-0.09	5.00-15.00	3.0-10
	52-60	0.40-0.80	42.00-141.0	0.24-0.30	10.00-30.00	3.0-10
751:						
Oneula, low elevation-----	0-2	0.70-0.90	42.00-141.0	0.01-0.04	0.00-10.00	0.0-5.0
	2-60	0.90-1.10	141.0-705.0	0.02-0.06	0.00-15.00	0.0-5.0
752:						
Oneula-----	0-2	0.70-0.90	42.00-141.0	0.01-0.04	0.00-10.00	0.0-5.0
	2-60	0.90-1.10	141.0-705.0	0.02-0.06	0.00-15.00	0.0-5.0
Keamoku-----	0-3	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	25-35
	3-10	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	10-20
	10-14	0.70-0.90	42.00-141.0	0.12-0.16	10.00-30.00	10-20
	14-21	0.70-0.90	141.0-705.0	0.09-0.13	5.00-15.00	5.0-10
	21-35	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
	35-50	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
	50-60	0.70-0.90	141.0-705.0	0.02-0.06	0.00-10.00	5.0-10
Maunaiu-----	0-2	0.40-0.70	42.00-141.0	0.35-0.39	10.00-30.00	10-15
	2-6	0.40-0.80	42.00-141.0	0.23-0.27	10.00-30.00	10-15
	6-9	0.40-0.80	42.00-141.0	0.18-0.22	10.00-30.00	5.0-10
	9-14	0.40-0.80	42.00-141.0	0.18-0.22	10.00-30.00	5.0-10
	14-19	0.40-0.80	42.00-141.0	0.18-0.22	10.00-30.00	5.0-10
	>19	---	0.02-0.42	---	---	---
753:						
Kalapana-----	0-6	0.90-1.10	42.00-142.0	0.07-0.11	10.00-30.00	10-20
	6-7	0.90-1.10	42.00-142.0	0.03-0.07	10.00-30.00	0.0-5.0
	>7	---	0.02-0.42	---	---	---
754:						
Kalapana, dry---	0-6	0.90-1.10	42.00-141.0	0.07-0.11	10.00-30.00	10-20
	6-7	0.90-1.10	42.00-141.0	0.03-0.07	10.00-30.00	0.0-5.0
	>7	---	0.02-0.42	---	---	---
Lava flows, pahoehoe-----	0-79	---	0.43-1.40	---	---	---

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 12.--Physical Properties of the Soils--Continued

Map symbol and component name	Depth	Moist bulk density (1/3-bar)	Saturated hydraulic conductivity (Ksat)	Available water capacity	Fifteen-bar water	Organic matter
	In	g/cc	um/sec	In/in	Pct	Pct
755:						
Makaopuhi-----	0-2	0.20-0.40	42.00-141.0	0.13-0.17	0.00-20.00	40-60
	2-6	0.40-0.70	42.00-141.0	0.18-0.22	10.00-30.00	0.0-10
	>6	---	0.02-0.42	---	---	---
756:						
Ahiu-----	0-3	0.40-0.60	14.00-42.00	0.29-0.33	10.00-20.00	10-15
	3-6	0.40-0.70	14.00-42.00	0.35-0.39	10.00-20.00	5.0-10
	6-11	0.90-1.10	14.00-42.00	0.27-0.31	8.00-18.00	0.0-5.0
	6-11	0.90-1.10	14.00-42.00	0.27-0.31	8.00-18.00	0.0-5.0
	11-12	0.40-0.60	14.00-42.00	0.23-0.27	10.00-20.00	0.0-5.0
	12-13	0.70-0.90	14.00-42.00	0.23-0.27	10.00-20.00	0.0-5.0
	13-17	---	0.02-0.42	---	---	---
Vitric						
Haplustands----	0-3	0.70-0.90	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	3-16	0.70-0.90	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	16-33	0.90-1.10	42.00-141.0	0.03-0.06	0.00-5.00	0.0-5.0
	33-35	0.90-1.10	42.00-141.0	0.02-0.05	0.00-5.00	0.0-5.0
	35-59	0.90-1.10	141.0-705.0	0.01-0.04	0.00-15.00	0.0-5.0

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Table 13.--Chemical Properties of the Soils

(Properties are based on the fraction of the soil less than 2 millimeters in size)

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
10. Lava flows, aa							
12. Lava flows, pahoehoe							
14: Lava flows, aa. Lava flows, pahoehoe.							
15: Cinder land-----	0-60	---	---	6.1-7.3	0	---	0-2
16: Cinder land-----	0-60	---	---	6.1-7.3	0	---	0-2
19. Riverwash							
24. Badland, geothermal							
26: Lava flows, aa, sparsely vegetated. Lava flows, pahoehoe.							
117: Kapua-----	0-6 6-18 18-60	100-140 100-140 ---	50-70 50-70 ---	6.1-7.3 6.1-7.3 6.6-7.3	0 0 0	--- --- ---	0-2 0-2 0-2
Lava flows, aa.							
130: Mawae-----	0-5 5-40 40-44	70-100 --- ---	50-70 --- ---	5.6-6.0 6.1-7.3 ---	0 0 0	--- --- ---	0-2 0-2 0
131: Mawae-----	0-5 5-40 40-44	70-100 --- ---	50-70 --- ---	5.6-6.0 6.1-7.3 ---	0 0 0	--- --- ---	0-2 0-2 0
132: Mawae-----	0-5 5-40 40-44	70-100 --- ---	50-70 --- ---	5.6-6.0 6.1-7.3 ---	0 0 0	--- --- ---	0-2 0-2 0
Lava flows, aa.							

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
133:							
Mawae-----	0-5	70-100	50-70	5.6-6.0	0	---	0-2
	5-40	---	---	6.1-7.3	0	---	0-2
	40-44	---	---	---	0	---	0
Lava flows, aa.							
137:							
Kekake-----	0-5	50-70	20-50	4.5-5.5	0	---	0-2
	5-9	---	---	---	0	---	0
Lava flows, pahoehoe.							
138:							
Kekake-----	0-5	50-70	20-50	4.5-5.5	0	---	0-2
	5-9	---	---	---	0	---	0
Lava flows, pahoehoe.							
161:							
Kekake-----	0-5	50-70	20-50	4.5-5.5	0	---	0-2
	5-9	---	---	---	0	---	0
Mawae-----	0-5	70-100	50-70	5.6-6.0	0	---	0-2
	5-40	---	---	6.1-7.3	0	---	0-2
	40-44	---	---	---	0	---	0
163:							
Lava flows, pahoehoe.							
Kekake-----	0-5	50-70	20-50	4.5-5.5	0	---	0-2
	5-9	---	---	---	0	---	0
164:							
Lava flows, pahoehoe.							
Kekake-----	0-5	50-70	20-50	4.5-5.5	0	---	0-2
	5-9	---	---	---	0	---	0
169:							
Iwalani, moist--	0-2	70-100	50-70	4.5-5.4	0	---	0-2
	2-3	50-70	20-50	6.1-7.3	0	---	0-2
	3-5	50-70	20-50	6.1-7.3	0	---	0-2
	5-10	50-70	20-50	6.1-7.3	0	---	0-2
	10-14	---	---	---	0	---	0
Lava flows, pahoehoe.							
179:							
Iwalani, moist--	0-2	70-100	50-70	4.5-5.4	0	---	0-2
	2-3	50-70	20-50	6.1-7.3	0	---	0-2
	3-5	50-70	20-50	6.1-7.3	0	---	0-2
	5-10	50-70	20-50	6.1-7.3	0	---	0-2
	10-14	---	---	---	0	---	0
Lava flows, pahoehoe.							

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
205:							
Ihuanu, moist---	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
206:							
Ihuanu, moist---	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
211:							
Kapulehu, moist	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
212:							
Kapulehu, moist	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
213:							
Nanaia, moist---	0-2	70-100	50-70	6.1-6.5	0	---	0-2
	2-6	50-70	20-50	6.6-7.3	0	---	0-2
	6-10	---	---	---	0	---	0
Lava flows, pahoehoe.							
214:							
Lava flows, pahoehoe.							
Nanaia, moist---	0-2	70-100	50-70	6.1-6.5	0	---	0-2
	2-6	50-70	20-50	6.6-7.3	0	---	0-2
	6-10	---	---	---	0	---	0
215:							
Keaa, moist-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0
216:							
Keaa, moist-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0
217:							
Kapulehu, moist	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
Keaa, moist-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
218:							
Kiolakaa, moist	0-6	70-100	50-70	5.1-6.0	0	---	0-2
	6-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-15	50-70	20-50	6.1-6.5	0	---	0-2
	15-25	50-70	20-50	6.1-6.5	0	---	0-2
	25-29	---	---	---	0	---	0
219:							
Kiolakaa-----	0-6	70-100	50-70	5.1-6.0	0	---	0-2
	6-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-15	50-70	20-50	6.1-6.5	0	---	0-2
	15-25	50-70	20-50	6.1-6.5	0	---	0-2
	25-29	---	---	---	0	---	0
Keaa-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0
275:							
Kapulehu-----	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
Lava flows, aa.							
276:							
Kapulehu-----	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
277:							
Kapulehu-----	0-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-26	50-70	20-50	6.6-7.3	0	---	0-2
	26-30	---	---	---	0	---	0
280:							
Nanaia-----	0-2	70-100	50-70	6.1-6.5	0	---	0-2
	2-6	50-70	20-50	6.6-7.3	0	---	0-2
	6-10	---	---	---	0	---	0
Lava flows, pahoehoe.							
281:							
Lava flows, pahoehoe.							
Nanaia-----	0-2	70-100	50-70	6.1-6.5	0	---	0-2
	2-6	50-70	20-50	6.6-7.3	0	---	0-2
	6-10	---	---	---	0	---	0
290:							
Keaa-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
292:							
Keaa-----	0-4	70-100	50-70	5.6-6.0	0	---	0-2
	4-10	50-70	20-50	5.6-6.0	0	---	0-2
	10-18	50-70	20-50	6.1-6.6	0	---	0-2
	18-22	---	---	---	0	---	0
Kiolakaa-----	0-6	70-100	50-70	5.1-6.0	0	---	0-2
	6-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-15	50-70	20-50	6.1-6.5	0	---	0-2
	15-25	50-70	20-50	6.1-6.5	0	---	0-2
	25-29	---	---	---	0	---	0
300:							
Kamaoa-----	0-7	70-100	50-70	5.6-7.3	0	---	0-2
	7-21	70-100	50-70	6.6-7.3	0	---	0-2
	21-47	50-70	20-50	6.6-7.3	0	---	0-2
	47-68	50-70	20-50	6.6-7.3	0	---	0-2
	68-72	---	---	---	0	---	0
305:							
Kiolakaa-----	0-6	70-100	50-70	5.1-6.0	0	---	0-2
	6-10	50-70	20-50	6.1-6.5	0	---	0-2
	10-15	50-70	20-50	6.1-6.5	0	---	0-2
	15-25	50-70	20-50	6.1-6.5	0	---	0-2
	25-29	---	---	---	0	---	0
395:							
Hokukano-----	0-6	50-70	20-50	5.1-6.5	0	---	0-2
	6-10	50-70	5.0-20	5.6-6.5	0	---	0-2
	10-20	50-70	5.0-20	5.6-6.5	0	---	0-2
	20-24	---	---	---	0	---	0
Lava flows, pahoehoe.							
401:							
Ihuanu-----	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
Lava flows, aa.							
402:							
Ihuanu-----	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
403:							
Ihuanu-----	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
406:							
Lava flows, pahoehoe.							

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
406:							
Iwalani-----	0-2	70-100	50-70	4.5-5.4	0	---	0-2
	2-3	50-70	20-50	6.1-7.3	0	---	0-2
	3-5	50-70	20-50	6.1-7.3	0	---	0-2
	5-10	50-70	20-50	6.1-7.3	0	---	0-2
	10-14	---	---	---	0	---	0
407:							
Iwalani-----	0-2	70-100	50-70	4.5-5.4	0	---	0-2
	2-3	50-70	20-50	6.1-7.3	0	---	0-2
	3-5	50-70	20-50	6.1-7.3	0	---	0-2
	5-10	50-70	20-50	6.1-7.3	0	---	0-2
	10-14	---	---	---	0	---	0
Lava flows, pahoehoe.							
408:							
Iwalani-----	0-2	70-100	50-70	4.5-5.4	0	---	0-2
	2-3	50-70	20-50	6.1-7.3	0	---	0-2
	3-5	50-70	20-50	6.1-7.3	0	---	0-2
	5-10	50-70	20-50	6.1-7.3	0	---	0-2
	10-14	---	---	---	0	---	0
Lava flows, pahoehoe.							
461:							
Hapuu, very gravelly-----	0-4	50-70	20-50	5.6-6.5	0	---	0-2
	4-6	20-50	5.0-20	5.6-6.5	0	---	0-2
	6-14	5.0-20	1.0-5.0	5.6-6.5	0	---	0-2
	14-43	5.0-20	1.0-5.0	5.6-6.5	0	---	0-2
	43-47	---	---	---	0	---	0
463:							
Hapuu, extremely gravelly-----	0-4	50-70	20-50	5.6-6.5	0	---	0-2
	4-6	20-50	5.0-20	5.6-6.5	0	---	0-2
	6-14	5.0-20	1.0-5.0	5.6-6.5	0	---	0-2
	14-43	5.0-20	1.0-5.0	5.6-6.5	0	---	0-2
	43-47	---	---	---	0	---	0
511:							
Akihi-----	0-10	50-70	20-50	5.1-6.0	0	---	0-2
	10-35	20-50	5.0-20	6.1-6.5	0	---	0-2
	35-39	---	---	---	0	---	0
512:							
Akihi-----	0-10	50-70	20-50	5.1-6.0	0	---	0-2
	10-35	20-50	5.0-20	6.1-6.5	0	---	0-2
	35-39	---	---	---	0	---	0
513:							
Hilea-----	0	50-70	5.0-20	4.5-5.5	0	---	0
	0-8	50-70	5.0-20	4.5-5.5	0	---	0-2
	8-19	20-50	5.0-20	5.1-5.5	0	---	0-2
	19-23	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
514:							
Hilea-----	0	50-70	5.0-20	4.5-5.5	0	---	0
	0-8	50-70	5.0-20	4.5-5.5	0	---	0-2
	8-19	20-50	5.0-20	5.1-5.5	0	---	0-2
	19-23	---	---	---	0	---	0
515:							
Pahipa-----	0-2	50-70	20-50	4.5-6.0	0	---	0
	2-8	50-70	20-50	6.1-6.5	0	---	0-2
	8-16	20-50	5.0-20	5.6-6.0	0	---	0-2
	16-30	20-50	5.0-20	6.1-6.5	0	---	0-2
	30-39	20-50	5.0-20	6.1-6.5	0	---	0-2
	39-43	---	---	---	0	---	0
Puali-----	0-4	50-70	30-70	4.5-6.0	0	---	0
	4-10	50-70	5.0-20	5.6-6.0	0	---	0-2
	10-18	20-50	5.0-20	6.1-6.5	0	---	0-2
	18-22	---	---	---	0	---	0
516:							
Alapai-----	0-7	20-50	5.0-20	4.5-6.0	0	---	0-2
	7-15	20-50	5.0-20	5.1-6.0	0	---	0-2
	15-27	20-50	5.0-20	6.1-6.8	0	---	0-2
	27-36	40-55	5.0-20	6.1-6.8	0	---	0-2
	36-43	20-50	5.0-20	6.1-6.8	0	---	0-2
	43-50	20-50	5.0-20	6.1-6.8	0	---	0-2
	50-57	20-50	5.0-20	6.1-6.8	0	---	0-2
	57-66	20-50	5.0-20	6.1-6.8	0	---	0-2
	66-70	20-50	5.0-20	6.1-6.8	0	---	0-2
	70-74	20-50	5.0-20	6.1-6.8	0	---	0-2
517:							
Alapai-----	0-7	20-50	5.0-20	4.5-6.0	0	---	0-2
	7-15	20-50	5.0-20	5.1-6.0	0	---	0-2
	15-27	20-50	5.0-20	6.1-6.8	0	---	0-2
	27-36	40-55	5.0-20	6.1-6.8	0	---	0-2
	36-43	20-50	5.0-20	6.1-6.8	0	---	0-2
	43-50	20-50	5.0-20	6.1-6.8	0	---	0-2
	50-57	20-50	5.0-20	6.1-6.8	0	---	0-2
	57-66	20-50	5.0-20	6.1-6.8	0	---	0-2
	66-70	20-50	5.0-20	6.1-6.8	0	---	0-2
	70-74	20-50	5.0-20	6.1-6.8	0	---	0-2
518:							
Alapai-----	0-7	20-50	5.0-20	4.5-6.0	0	---	0-2
	7-15	20-50	5.0-20	5.1-6.0	0	---	0-2
	15-27	20-50	5.0-20	6.1-6.8	0	---	0-2
	27-36	40-55	5.0-20	6.1-6.8	0	---	0-2
	36-43	20-50	5.0-20	6.1-6.8	0	---	0-2
	43-50	20-50	5.0-20	6.1-6.8	0	---	0-2
	50-57	20-50	5.0-20	6.1-6.8	0	---	0-2
	57-66	20-50	5.0-20	6.1-6.8	0	---	0-2
	66-70	20-50	5.0-20	6.1-6.8	0	---	0-2
	70-74	20-50	5.0-20	6.1-6.8	0	---	0-2
519:							
Lalaau-----	0-3	70-100	20-50	4.5-5.0	0	---	0-2
	3-53	5.0-15	0.0-10	5.0-7.0	0	---	0-2
	53-57	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
525:							
Alapai, low precipitation--	0-9	40-55	20-40	4.5-5.5	0	---	0-2
	9-17	40-55	20-40	6.1-6.8	0	---	0-2
	17-23	40-55	20-40	6.1-6.8	0	---	0-2
	23-31	40-55	20-40	6.1-6.8	0	---	0-2
	31-40	40-55	20-40	6.1-6.8	0	---	0-2
	40-48	40-55	20-40	6.1-6.8	0	---	0-2
	48-54	40-55	20-40	6.1-6.8	0	---	0-2
	54-65	40-55	20-40	6.1-6.8	0	---	0-2
	65-74	40-55	20-40	6.1-6.8	0	---	0-2
534:							
Kahaluu-----	0-5	70-100	20-50	4.5-5.0	0	---	0-2
	>5	---	---	---	0	---	0
Lava flows, pahoehoe.							
555:							
Kuanene-----	0-1	20-70	---	4.5-5.5	0	---	0
	1-6	10-20	0.0-15	4.5-5.0	0	---	0
	6-7	10-20	0.0-15	4.5-5.5	0	---	0
	7-12	5.0-20	0.0-15	5.0-6.0	0	---	0
	12-17	15-40	0.0-20	5.5-6.5	0	---	0
	>17	---	---	---	0	---	0
Lava flows, pahoehoe.							
574:							
Ihuanu-----	0-2	50-70	20-50	5.1-6.0	0	---	0-2
	2-20	20-50	5.0-20	5.6-6.5	0	---	0-2
	20-22	20-50	5.0-20	5.6-6.5	0	---	0-2
	22-26	---	---	---	0	---	0
Lava flows, pahoehoe.							
575:							
Durustands-----	0-4	20-40	15-25	5.0-5.8	0	---	0-2
	4-6	10-35	10-30	5.0-5.8	0	---	0-2
	6-7	20-40	10-35	5.0-5.6	0	---	0-2
	7-11	20-40	10-35	5.1-5.6	0	---	0-2
	11-13	10-40	5.0-35	4.4-5.8	0	---	0-2
	13-26	25-50	15-40	5.0-6.0	0	---	0
	26-36	---	---	---	0	---	0
576:							
Puali-----	0-4	25-70	20-60	4.5-6.0	0	---	0
	4-10	50-70	5.0-20	5.6-6.0	0	---	0-2
	10-18	20-50	5.0-20	6.1-6.5	0	---	0-2
	18-22	---	---	---	0	---	0
Puu Oo-----	0-3	20-60	10-55	5.0-6.0	0	0.0-5.0	0
	3-6	20-60	10-40	4.5-6.0	0	0.0-5.0	0
	6-9	15-50	5.0-40	4.2-6.0	0	0.0-5.0	0
	9-16	15-50	5.0-40	4.8-6.0	0	0.0-5.0	0
	16-22	15-50	5.0-40	5.0-6.0	0	0.0-5.0	0
	22-27	15-50	5.0-40	5.0-6.0	0	0.0-5.0	0
	27-50	10-50	5.0-40	5.0-6.0	0	0.0-5.0	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
576:							
Pahipa-----	0-2	25-70	15-30	4.5-6.0	0	---	0
	2-8	50-70	20-50	6.1-6.5	0	---	0-2
	8-16	20-50	5.0-20	5.6-6.0	0	---	0-2
	16-30	20-50	5.0-20	6.1-6.5	0	---	0-2
	30-39	20-50	5.0-20	6.1-6.5	0	---	0-2
	39-43	---	---	---	0	---	0
577:							
Pahipa-----	0-2	25-70	15-30	4.5-6.0	0	---	0
	2-8	50-70	20-50	6.1-6.5	0	---	0-2
	8-16	20-50	5.0-20	5.6-6.0	0	---	0-2
	16-30	20-50	5.0-20	6.1-6.5	0	---	0-2
	30-39	20-50	5.0-20	6.1-6.5	0	---	0-2
	39-43	---	---	---	0	---	0
Puu Oo-----							
	0-3	20-60	20-65	5.0-6.0	0	0.0-5.0	0
	3-6	20-60	20-65	4.5-6.0	0	0.0-5.0	0
	6-9	15-50	15-55	4.2-6.0	0	0.0-5.0	0
	9-16	15-50	15-55	4.8-6.0	0	0.0-5.0	0
	16-22	15-50	15-55	5.0-6.0	0	0.0-5.0	0
	22-27	15-50	15-55	5.0-6.0	0	0.0-5.0	0
	27-50	10-50	10-55	5.0-6.0	0	0.0-5.0	0
605:							
Kaholimo-----	0-2	30-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-4	30-50	15-25	5.5-6.0	0	0.0-0.0	0-2
	4-7	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	7-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-12	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	12-13	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>13	---	---	---	0	---	0
Ki-----							
	0-2	25-40	15-25	5.6-6.0	0	0.0-0.0	0-2
	2-4	10-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	4-5	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	5-6	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	6-9	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	9-13	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	13-15	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	15-19	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	19-23	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	23-26	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	26-30	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	30-32	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	32-36	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	36-38	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	38-41	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	43-48	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	48-52	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	52-60	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
607:							
Kaholimo-----	0-2	30-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-4	30-50	15-25	5.5-6.0	0	0.0-0.0	0-2
	4-7	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	7-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-12	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	12-13	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>13	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
607:							
Ki-----	0-2	25-40	15-25	5.6-6.0	0	0.0-0.0	0-2
	2-4	10-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	4-5	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	5-6	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	6-9	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	9-13	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	13-15	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	15-19	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	19-23	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	23-26	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	26-30	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	30-32	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	32-36	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	36-38	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	38-41	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	43-48	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	48-52	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	52-60	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
610:							
Piihonua-----	0-2	60-80	10-25	4.2-5.5	0	0.0-2.0	0-2
	2-7	60-80	1.5-3.0	4.2-5.0	0	0.0-2.0	0-2
	7-16	30-60	1.5-3.0	4.2-5.0	0	0.0-0.0	0
	16-22	30-60	1.5-3.0	4.2-5.0	0	0.0-0.0	0
	22-28	25-50	1.5-3.0	4.6-5.5	0	0.0-0.0	0
	28-47	25-50	1.5-3.0	4.6-5.6	0	0.0-0.0	0
	47-59	---	---	---	0	---	0
613:							
Kiloha-----	0-10	80-100	3.0-8.0	5.1-5.5	0	---	0
	10-60	20-35	2.0-7.0	6.0-7.5	0	---	0
	>60	---	---	---	0	---	0
621:							
Eheuiki-----	0-4	25-45	15-25	4.5-5.0	0	1.0-5.0	0-2
	4-9	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	9-13	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	13-15	20-40	10-25	4.5-5.0	0	1.0-5.0	0-2
	15-19	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	19-23	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	23-26	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	26-28	20-40	10-25	5.6-6.0	0	1.0-5.0	0-2
	28-60	20-40	15-30	5.6-6.0	0	1.0-5.0	0-2
Pekailio-----	0-5	20-40	21-41	4.5-5.5	0	0.0-2.0	0
	5-12	25-45	25-45	5.5-6.0	0	0.0-0.0	0
	12-22	25-45	25-45	5.5-6.0	0	0.0-0.0	0
	22-34	25-45	25-45	5.5-6.0	0	0.0-0.0	0
	34-60	10-35	10-30	5.5-6.0	0	0.0-0.0	0
625:							
Hao-----	0-2	60-80	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-8	60-80	15-25	5.6-6.0	0	0.0-2.0	0-2
	8-15	50-70	5.0-20	5.6-6.0	0	0.0-2.0	0-2
	15-21	25-35	5.0-25	5.6-6.5	0	0.0-1.0	0-2
	21-41	50-70	5.0-25	5.6-6.5	0	0.0-0.0	0-2

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
631:							
Kapapala-----	0-3	38-50	18-25	6.1-6.5	0	1.0-5.0	0-2
	3-9	35-45	18-25	6.1-6.5	0	1.0-5.0	0-2
	9-13	30-40	15-22	6.1-6.5	0	1.0-5.0	0-2
	13-21	38-50	18-25	6.1-6.5	0	1.0-5.0	0-2
	21-29	35-45	18-25	6.1-6.5	0	1.0-5.0	0-2
	29-43	38-50	18-25	6.1-6.5	0	1.0-5.0	0-2
	>43	---	---	---	0	---	0
657:							
Malama-----	0-3	60-130	30-40	5.1-5.5	0	0.0-0.0	0
	3-60	0.0-8.0	0.0-5.0	6.0-7.0	0	0.0-0.0	0
Lava flows, aa.							
709:							
Lava flows, pahoehoe.							
Lithic Ustipsamments--	0	5.0-15	2.0-10	3.5-5.5	0	1.0-3.0	0-2
	0-2	5.0-15	5.0-10	6.1-6.5	0	0.0-0.0	0-2
	2-10	5.0-15	5.0-10	6.6-7.3	0	0.0-0.0	0-2
	>10	---	---	---	0	---	0
711:							
Lava flows, pahoehoe.							
Apuki-----	0	3.0-10	2.0-8.0	3.5-4.4	0	1.0-5.0	0-2
	0-6	3.0-10	2.0-8.0	5.1-5.5	0	0.0-2.0	0-2
	6-7	3.0-10	2.0-8.0	6.1-7.3	0	0.0-0.0	0-2
	>7	---	---	---	0	---	0
713:							
Lithic Haplustands, cindery substratum-----	0-2	15-25	5.0-15	4.5-5.0	0	2.0-5.0	0-2
	2-2	5.0-10	2.0-8.0	5.1-5.5	0	1.0-3.0	0-2
	2-3	5.0-10	5.0-10	6.1-6.5	0	0.0-0.0	0-2
	3-4	5.0-10	5.0-10	6.1-6.5	0	0.0-0.0	0-2
	4-5	5.0-10	5.0-10	6.1-7.3	0	0.0-0.0	0-2
	5-6	5.0-10	5.0-10	6.1-7.3	0	0.0-0.0	0-2
	6-8	5.0-10	5.0-10	6.6-7.3	0	0.0-0.0	0-2
	>8	---	---	---	0	---	0
Lithic Haplustands, loamy surface--	0-4	20-30	5.0-10	5.1-5.5	0	1.0-3.0	0-2
	4-5	5.0-15	3.0-10	6.1-6.5	0	0.0-0.0	0-2
	5-6	5.0-15	3.0-10	6.1-6.5	0	0.0-0.0	0-2
	6-7	5.0-15	5.0-10	6.1-7.3	0	0.0-0.0	0-2
	6-7	5.0-15	5.0-10	6.1-7.3	0	0.0-0.0	0-2
	6-7	5.0-15	5.0-10	6.1-7.3	0	0.0-0.0	0-2
	7-8	10-20	5.0-15	6.1-7.3	0	0.0-0.0	0-2
	8-10	5.0-15	5.0-15	6.6-7.3	0	0.0-0.0	0-2
	10-13	5.0-15	5.0-15	6.6-7.3	0	0.0-0.0	0-2
	>13	---	---	---	0	---	0
Lava flows, pahoehoe.							

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
715:							
Alahapa-----	0-3	5.0-15	3.0-10	5.6-6.5	0	0.0-2.0	0-2
	3-17	5.0-15	3.0-15	6.6-7.3	0	0.0-0.0	0-2
	17-36	1.0-5.0	1.0-5.0	6.6-7.8	0	0.0-0.0	0-2
	36-60	1.0-5.0	1.0-3.0	6.6-7.8	0	0.0-0.0	0-2
Heake-----	0-1	20-30	3.0-8.0	5.1-5.5	0	1.0-5.0	0-2
	1-4	3.0-10	1.0-4.0	6.1-6.5	0	0.0-0.0	0-2
	4-7	1.0-6.0	1.0-4.0	6.6-7.3	0	0.0-0.0	0-2
	7-8	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	8-10	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	12-14	5.0-15	5.0-10	6.5-7.5	0	0.0-0.0	---
	>14	---	---	---	0	---	0
716:							
Alahapa-----	0-3	5.0-15	3.0-10	5.6-6.5	0	0.0-2.0	0-2
	3-17	5.0-15	3.0-15	6.6-7.3	0	0.0-0.0	0-2
	17-36	1.0-5.0	1.0-5.0	6.6-7.8	0	0.0-0.0	0-2
	36-60	1.0-5.0	1.0-3.0	6.6-7.8	0	0.0-0.0	0-2
717:							
Alahapa-----	0-3	5.0-15	3.0-10	5.6-6.5	0	0.0-2.0	0-2
	3-17	5.0-15	3.0-15	6.6-7.3	0	0.0-0.0	0-2
	17-36	1.0-5.0	1.0-5.0	6.6-7.8	0	0.0-0.0	0-2
	36-60	1.0-5.0	1.0-3.0	6.6-7.8	0	0.0-0.0	0-2
Lava flows, aa.							
718:							
Halemaumau-----	0-6	1.0-5.0	2.0-8.0	4.5-5.5	0	0.0-3.0	0-2
	6-7	5.0-15	5.0-15	5.1-5.5	0	0.0-3.0	0-2
	7-10	5.0-15	2.0-8.0	5.5-6.0	0	0.0-3.0	0-2
	10-13	20-40	2.0-8.0	5.5-6.0	0	0.0-3.0	0-2
	13-20	10-20	2.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	20-23	5.0-15	5.0-15	6.1-6.5	0	0.0-0.0	0-2
	23-27	5.0-15	2.0-8.0	6.1-7.3	0	0.0-0.0	0-2
	27-35	5.0-15	2.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	>35	---	---	---	0	---	0
719:							
Heake-----	0-1	20-30	3.0-8.0	5.1-5.5	0	1.0-5.0	0-2
	1-4	3.0-10	1.0-4.0	6.1-6.5	0	0.0-0.0	0-2
	4-7	1.0-6.0	1.0-4.0	6.6-7.3	0	0.0-0.0	0-2
	7-8	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	8-10	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	12-14	5.0-15	5.0-10	6.5-7.5	0	0.0-0.0	---
	>14	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
720:							
Heake-----	0-1	20-30	3.0-8.0	5.1-5.5	0	1.0-5.0	0-2
	1-4	3.0-10	1.0-4.0	6.1-6.5	0	0.0-0.0	0-2
	4-7	1.0-6.0	1.0-4.0	6.6-7.3	0	0.0-0.0	0-2
	7-8	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	8-10	10-20	8.0-12	6.6-7.3	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	10-12	5.0-15	5.0-10	6.6-7.8	0	0.0-0.0	0-2
	12-14	5.0-15	5.0-10	6.5-7.5	0	0.0-0.0	---
	>14	---	---	---	0	---	0
Lava flows, pahoehoe.							
722:							
Kilauea-----	0	5.0-15	1.0-5.0	2.9-3.5	0	4.0-8.0	0-2
	0-3	5.0-15	1.0-5.0	5.1-5.5	0	0.0-2.0	0-2
	3-5	5.0-15	2.0-10	6.6-7.3	0	0.0-0.0	0-2
	5-7	5.0-15	3.0-10	6.6-7.3	0	0.0-0.0	0-2
	7-10	10-20	3.0-10	6.6-7.3	0	0.0-0.0	0-2
	10-20	5.0-15	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	10-20	5.0-15	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	20-23	5.0-15	1.0-8.0	6.6-7.8	0	0.0-0.0	0-2
	23-38	5.0-15	3.0-10	7.4-7.8	0	0.0-0.0	0-2
	23-38	5.0-15	3.0-10	7.4-7.8	0	0.0-0.0	0-2
	38-40	5.0-15	3.0-10	7.4-7.8	0	0.0-0.0	0-2
	40-56	5.0-15	3.0-10	7.4-7.8	0	0.0-0.0	0-2
	56-75	5.0-15	3.0-10	7.4-7.8	0	0.0-0.0	0-2
724:							
Lava flows, pahoehoe.							
Kaholimo, uneroded-----	0-2	30-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-4	30-50	15-25	5.5-6.0	0	0.0-0.0	0-2
	4-7	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	7-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-12	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	12-13	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>13	---	---	---	0	---	0
Kaholimo, eroded	0-2	30-50	15-25	5.5-6.0	0	0.0-1.0	0-2
	2-5	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	5-8	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	8-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-11	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>11	---	---	---	0	---	0
Puiwa, uneroded	0-4	25-40	5.0-15	5.6-6.0	0	0.0-1.0	0-2
	4-7	25-35	5.0-15	5.6-6.0	0	0.0-1.0	0-2
	7-9	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	7-9	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	9-11	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	11-17	25-35	1.0-10	6.1-6.6	0	0.0-1.0	0-2
	17-25	15-25	1.0-10	6.6-7.3	0	0.0-1.0	0-2
	25-38	20-30	1.0-10	6.1-7.3	0	0.0-1.0	0-2
	>38	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
724:							
Puiwa, eroded---	0-3	25-35	5.0-15	5.6-6.0	0	0.0-1.0	0-2
	3-6	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	3-6	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	6-7	10-20	1.0-10	5.6-6.5	0	0.0-1.0	0-2
	7-13	25-35	1.0-10	6.1-6.5	0	0.0-1.0	0-2
	13-21	15-25	1.0-10	6.6-7.3	0	0.0-1.0	0-2
	21-34	20-30	1.0-10	6.1-7.3	0	0.0-1.0	0-2
	>34	---	---	---	0	---	0
725:							
Lava flows, pahoehoe.							
Kaholimo, eroded	0-2	30-50	15-25	5.5-6.0	0	0.0-1.0	0-2
	2-5	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	5-8	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	8-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-11	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>11	---	---	---	0	---	0
Kaholimo, uneroded-----	0-2	30-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-4	30-50	15-25	5.5-6.0	0	0.0-0.0	0-2
	4-7	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	7-10	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	10-12	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	12-13	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	>13	---	---	---	0	---	0
726:							
Kulalio-----	0-3	40-55	20-30	4.5-5.5	0	0.0-2.0	0-2
	3-7	35-50	20-30	5.1-5.5	0	0.0-1.0	0-2
	7-11	40-50	20-30	5.6-6.0	0	0.0-0.5	0-2
	11-16	25-40	10-20	5.6-6.5	0	0.0-0.0	0-2
	16-25	10-20	5.0-15	6.6-7.3	0	0.0-0.0	0-2
	25-60	5.0-20	5.0-10	6.6-7.3	0	0.0-0.0	0-2
727:							
Puauulu-----	0-3	30-40	20-30	4.5-5.5	0	0.0-0.0	0-2
	3-9	25-35	15-25	4.5-5.5	0	0.0-0.0	0-2
	9-12	5.0-15	3.0-12	5.6-7.3	0	0.0-0.0	0-2
	12-15	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	15-19	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	19-20	15-25	10-20	6.1-7.3	0	0.0-0.0	0-2
	20-22	55-65	45-55	6.1-6.5	0	0.0-0.0	0-2
	22-24	20-30	15-25	6.1-7.3	0	0.0-0.0	0-2
	24-28	35-45	30-40	6.1-7.3	0	0.0-0.0	0-2
	28-30	45-55	40-50	6.1-7.3	0	0.0-0.0	0-2
	30-31	25-35	20-30	6.1-7.3	0	0.0-0.0	0-2
	31-32	30-40	25-35	6.1-7.3	0	0.0-0.0	0-2
	32-34	20-30	15-25	5.6-6.5	0	0.0-0.0	0-2
	34-35	45-55	30-40	5.6-6.0	0	0.0-0.0	0-2
	35-37	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	37-38	45-55	35-45	5.1-6.0	0	0.0-0.0	0-2
	38-41	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	41-43	30-40	25-35	5.6-6.0	0	0.0-0.0	0-2
	43-48	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	48-51	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	51-53	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	53-55	30-40	20-30	5.1-5.5	0	0.0-0.0	0-2

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
728:							
Puauulu-----	0-3	30-40	20-30	4.5-5.5	0	0.0-0.0	0-2
	3-9	25-35	15-25	4.5-5.5	0	0.0-0.0	0-2
	9-12	5.0-15	3.0-12	5.6-7.3	0	0.0-0.0	0-2
	12-15	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	15-19	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	19-20	15-25	10-20	6.1-7.3	0	0.0-0.0	0-2
	20-22	55-65	45-55	6.1-6.5	0	0.0-0.0	0-2
	22-24	20-30	15-25	6.1-7.3	0	0.0-0.0	0-2
	24-28	35-45	30-40	6.1-7.3	0	0.0-0.0	0-2
	28-30	45-55	40-50	6.1-7.3	0	0.0-0.0	0-2
	30-31	25-35	20-30	6.1-7.3	0	0.0-0.0	0-2
	31-32	30-40	25-35	6.1-7.3	0	0.0-0.0	0-2
	32-34	20-30	15-25	5.6-6.5	0	0.0-0.0	0-2
	34-35	45-55	30-40	5.6-6.0	0	0.0-0.0	0-2
	35-37	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	37-38	45-55	35-45	5.1-6.0	0	0.0-0.0	0-2
	38-41	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	41-43	30-40	25-35	5.6-6.0	0	0.0-0.0	0-2
	43-48	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	48-51	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	51-53	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	53-55	30-40	20-30	5.1-5.5	0	0.0-0.0	0-2
Hao-----	0-2	30-40	15-25	5.1-5.5	0	0.0-1.0	0-2
	2-3	30-40	15-25	5.6-6.0	0	0.0-1.0	0-2
	3-6	20-30	10-20	5.6-6.0	0	0.0-0.0	0-2
	3-6	20-30	10-20	5.6-6.0	0	0.0-0.0	0-2
	6-8	25-35	15-25	5.6-6.5	0	0.0-0.0	0-2
	8-9	30-40	15-25	5.6-6.5	0	0.0-0.0	0-2
	9-10	30-40	15-25	6.1-6.5	0	0.0-0.0	0-2
	10-12	30-40	25-35	6.1-6.5	0	0.0-0.0	0-2
	12-13	30-40	25-35	6.1-6.5	0	0.0-0.0	0-2
	13-15	20-30	15-25	6.1-6.5	0	0.0-0.0	0-2
	15-18	25-35	15-25	6.1-6.5	0	0.0-0.0	0-2
	18-21	25-35	15-25	6.1-6.5	0	0.0-0.0	0-2
	21-23	25-35	15-25	6.1-6.5	0	0.0-0.0	0-2
	23-24	25-35	15-25	6.1-6.5	0	0.0-0.0	0-2
	24-25	40-50	30-40	6.1-7.3	0	0.0-0.0	0-2
	25-30	40-50	30-40	6.1-7.3	0	0.0-0.0	0-2
	30-41	30-40	30-40	6.1-7.3	0	0.0-0.0	0-2
	41-60	25-35	5.0-10	6.1-6.5	0	0.0-0.0	0-2
729:							
Eheuiki-----	0-4	25-45	15-25	4.5-5.0	0	1.0-5.0	0-2
	4-9	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	9-13	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	13-15	20-40	10-25	4.5-5.0	0	1.0-5.0	0-2
	15-19	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	19-23	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	23-26	20-40	10-25	5.1-5.5	0	1.0-5.0	0-2
	26-28	20-40	10-25	5.6-6.0	0	1.0-5.0	0-2
	28-60	20-40	15-30	5.6-6.0	0	1.0-5.0	0-2

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
729:							
Puauulu-----	0-3	30-40	20-30	4.5-5.5	0	0.0-0.0	0-2
	3-9	25-35	15-25	4.5-5.5	0	0.0-0.0	0-2
	9-12	5.0-15	3.0-12	5.6-7.3	0	0.0-0.0	0-2
	12-15	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	15-19	2.0-10	2.0-10	6.6-7.0	0	0.0-0.0	0-2
	19-20	15-25	10-20	6.1-7.3	0	0.0-0.0	0-2
	20-22	55-65	45-55	6.1-6.5	0	0.0-0.0	0-2
	22-24	20-30	15-25	6.1-7.3	0	0.0-0.0	0-2
	24-28	35-45	30-40	6.1-7.3	0	0.0-0.0	0-2
	28-30	45-55	40-50	6.1-7.3	0	0.0-0.0	0-2
	30-31	25-35	20-30	6.1-7.3	0	0.0-0.0	0-2
	31-32	30-40	25-35	6.1-7.3	0	0.0-0.0	0-2
	32-34	20-30	15-25	5.6-6.5	0	0.0-0.0	0-2
	34-35	45-55	30-40	5.6-6.0	0	0.0-0.0	0-2
	35-37	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	37-38	45-55	35-45	5.1-6.0	0	0.0-0.0	0-2
	38-41	25-35	20-30	5.6-6.0	0	0.0-0.0	0-2
	41-43	30-40	25-35	5.6-6.0	0	0.0-0.0	0-2
	43-48	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	48-51	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	51-53	30-40	20-30	5.1-6.0	0	0.0-0.0	0-2
	53-55	30-40	20-30	5.1-5.5	0	0.0-0.0	0-2
731:							
Kahalii-----	0-4	1.0-5.0	0.0-2.0	5.1-5.5	0	0.0-2.0	0-2
	4-5	7.0-17	3.0-7.0	5.1-5.5	0	0.0-2.0	0-2
	5-7	2.0-12	1.0-5.0	6.1-6.5	0	0.0-0.0	0-2
	7-9	5.0-15	4.0-10	5.6-6.5	0	0.0-0.0	0-2
	9-9	2.0-12	2.0-6.0	6.1-7.3	0	0.0-0.0	0-2
	9-11	2.0-12	1.0-5.0	6.1-7.3	0	0.0-0.0	0-2
	11-12	---	---	---	0	---	0
	>12	---	---	---	0	---	0
Lava flows, pahoehoe.							
734:							
Kanohina-----	0-1	70-100	50-70	6.1-6.5	0	---	0-2
	1-3	50-70	20-50	6.6-7.3	0	---	0-2
	3-6	50-70	20-50	6.6-7.3	0	---	0-2
	6-10	---	---	---	0	---	0
Lava flows, pahoehoe.							
735:							
Puhimau-----	0-3	35-55	10-20	3.5-4.4	0	3.0-5.0	0-2
	3-6	2.0-15	1.0-8.0	6.1-6.5	0	0.0-2.0	0-2
	6-8	30-40	20-30	6.1-7.3	0	0.0-2.0	0-2
	8-11	5.0-15	20-30	6.1-7.3	0	0.0-2.0	0-2
	11-13	10-20	5.0-15	6.1-7.3	0	0.0-2.0	0-2
	>13	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
736:							
Manu-----	0-3	50-60	20-30	4.5-5.5	0	0.0-4.0	0-2
	3-4	10-20	5.0-15	6.1-6.5	0	0.0-0.0	0-2
	4-6	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	6-9	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	9-11	5.0-15	2.0-10	6.6-7.3	0	0.0-0.0	0-2
	11-13	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	13-15	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	15-17	5.0-15	15-25	6.6-7.3	0	0.0-0.0	0-2
	17-18	5.0-15	15-25	6.6-7.3	0	0.0-0.0	0-2
	18-20	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	20-21	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	21-26	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	26-32	2.0-10	1.0-8.0	6.6-7.3	0	0.0-0.0	0-2
	32-34	5.0-15	10-20	6.6-7.3	0	0.0-0.0	0-2
	>34	---	---	---	0	---	0
737:							
Nakanui-----	0-4	35-45	20-30	5.6-6.0	0	0.0-2.0	0-2
	4-6	15-25	10-20	6.6-7.3	0	0.0-0.0	0-2
	6-7	15-25	10-20	6.6-7.3	0	0.0-0.0	0-2
	7-9	15-25	10-20	6.6-7.3	0	0.0-0.0	0-2
	9-11	15-25	10-20	6.6-7.3	0	0.0-0.0	0-2
	11-12	15-25	10-20	6.6-7.3	0	0.0-0.0	0-2
	12-16	10-20	5.0-15	6.6-7.3	0	0.0-0.0	0-2
	16-18	25-35	20-30	6.6-7.3	0	0.0-0.0	0-2
	>18	---	---	---	0	---	0
Lava flows, pahoehoe.							
738:							
Vitric							
Haplustands----	0-3	35-45	15-25	5.6-6.0	0	0.0-0.0	0-2
	3-16	35-45	15-25	6.1-6.5	0	0.0-0.0	0-2
	16-33	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	33-35	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	35-59	5.0-15	3.0-10	6.1-6.5	0	0.0-0.0	0-2
741:							
Ahiu-----	0-3	10-30	8.0-12	5.1-6.0	0	1.0-3.0	0-2
	3-6	10-30	0.0-0.0	5.6-6.5	0	0.0-0.0	0-2
	6-11	5.0-15	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	6-11	5.0-15	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	11-12	10-20	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	12-13	10-20	0.0-0.0	6.6-7.3	0	0.0-0.0	0-2
	13-17	---	---	---	0	---	0
Lava flows, pahoehoe.							
743:							
Pakini-----	0-3	45-55	---	6.6-7.3	0	---	0-2
	3-8	40-50	---	6.6-7.3	0	---	0-2
	8-16	55-65	---	6.6-7.3	0	---	0-2
	16-29	65-75	---	7.3-7.8	0	---	0-2
	29-45	55-65	---	7.8-8.4	0-5	---	0-2
	45-59	50-60	---	7.8-8.4	0-10	---	0-2

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
744:							
Haa -----	0-3	30-45	20-30	5.6-6.5	0	0.0-0.0	0-2
	3-7	25-45	15-35	6.1-7.3	0	0.0-0.0	0-2
	7-10	20-45	15-35	6.1-6.5	0	0.0-0.0	0-2
	10-14	20-45	15-35	6.1-6.5	0	0.0-0.0	0-2
	14-20	20-45	15-35	6.1-6.5	0	0.0-0.0	0-2
	20-25	20-40	15-35	6.1-6.5	0	0.0-0.0	0-2
	25-30	20-40	15-35	6.1-6.5	0	0.0-0.0	0-2
	30-36	20-40	15-35	6.1-7.3	0	0.0-0.0	0-2
	36-43	20-40	15-35	6.1-7.3	0	0.0-0.0	0-2
	>43	---	---	---	0	---	0
Keamoku -----	0-3	20-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	3-10	20-50	20-30	5.6-6.0	0	0.0-1.0	0-2
	10-14	25-45	10-20	5.6-6.5	0	0.0-0.0	0-2
	14-21	25-45	10-20	6.1-6.5	0	0.0-0.0	0-2
	21-35	25-45	10-20	6.1-6.5	0	0.0-0.0	0-2
	35-50	25-45	15-25	6.1-6.5	0	0.0-0.0	0-2
	50-60	25-45	15-25	6.1-6.5	0	0.0-1.0	0-2
745:							
Maunaiu -----	0-2	25-45	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-6	30-50	20-30	5.5-6.0	0	0.0-1.0	0-2
	6-9	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	9-14	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	14-19	30-50	20-30	5.6-6.5	0	0.0-0.0	0-2
	>19	---	---	---	0	---	0
Akelelu -----	0-4	30-55	15-30	5.1-5.5	0	1.0-3.0	0-2
	4-7	25-45	10-25	5.1-6.0	0	0.0-0.0	0-2
	7-15	20-45	10-20	6.1-6.6	0	0.0-0.0	0-2
	15-18	20-45	10-20	5.6-6.5	0	0.0-0.0	0-2
	18-21	15-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	21-27	15-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	27-30	20-45	15-30	6.1-6.5	0	0.0-0.0	0-2
	30-34	20-45	15-30	6.1-6.5	0	0.0-0.0	0-2
	34-38	---	---	---	0	---	0
746:							
Kulalio -----	0-3	40-55	20-30	4.5-5.5	0	0.0-2.0	0-2
	3-7	35-50	20-30	5.1-5.5	0	0.0-1.0	0-2
	7-11	40-50	20-30	5.6-6.0	0	0.0-0.5	0-2
	11-16	25-40	10-20	5.6-6.5	0	0.0-0.0	0-2
	16-25	10-20	5.0-15	6.6-7.3	0	0.0-0.0	0-2
	25-60	5.0-20	5.0-10	6.6-7.3	0	0.0-0.0	0-2
Maunaiu -----	0-2	25-45	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-6	30-50	20-30	5.1-6.0	0	0.0-1.0	0-2
	6-9	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	9-14	30-50	20-30	6.1-6.5	0	0.0-0.0	0-2
	14-19	30-50	20-30	5.6-6.5	0	0.0-0.0	0-2
	>19	---	---	---	0	---	0
Akelelu -----	0-4	30-55	15-30	5.1-5.5	0	1.0-3.0	0-2
	4-7	25-45	10-25	5.1-6.0	0	0.0-0.0	0-2
	7-15	20-45	10-20	6.1-6.6	0	0.0-0.0	0-2
	15-18	20-45	10-20	5.6-6.5	0	0.0-0.0	0-2
	18-21	15-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	21-27	15-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	27-30	20-45	15-30	6.1-6.5	0	0.0-0.0	0-2
	30-34	20-45	15-30	6.1-6.5	0	0.0-0.0	0-2
	34-38	---	---	---	0	---	0

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
747:							
Oneula-----	0-2	5.0-15	35-45	6.1-6.5	0	0.0-0.0	0-2
	2-60	5.0-15	2.0-8.0	6.1-6.5	0	0.0-0.0	0-2
748:							
Lava flows, pahoehoe.							
Menehune-----	0-2	100-200	70-100	4.5-5.0	0	2.0-5.0	0-2
	2-2	10-30	5.0-15	5.1-5.5	0	0.0-2.0	0-2
	2-3	25-45	15-25	5.1-5.5	0	0.0-2.0	0-2
	3-5	5.0-15	2.0-12	6.1-7.3	0	0.0-0.0	0-2
	5-7	25-35	20-30	6.1-7.3	0	0.0-0.0	0-2
	7-7	10-30	5.0-20	6.6-7.3	0	0.0-0.0	0-2
	7-8	5.0-15	3.0-13	6.6-7.3	0	0.0-0.0	0-2
	8-14	5.0-15	3.0-13	7.4-7.8	0	0.0-0.0	0-2
	8-14	5.0-15	3.0-13	7.4-7.8	0	0.0-0.0	0-2
	>14	---	---	---	0	---	0
749:							
Wahi-----	0-2	25-35	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-5	25-35	15-25	5.6-6.5	0	0.0-0.0	0-2
	5-10	20-30	10-20	5.6-6.5	0	0.0-0.0	0-2
	10-12	20-30	10-20	6.1-6.5	0	0.0-0.0	0-2
	12-14	20-30	10-20	6.1-7.3	0	0.0-0.0	0-2
	14-60	20-30	15-25	6.1-6.5	0	0.0-0.0	0-2
750:							
Ki-----	0-2	25-40	15-25	5.6-6.0	0	0.0-0.0	0-2
	2-4	10-35	10-20	6.1-6.5	0	0.0-0.0	0-2
	4-5	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	5-6	10-20	10-20	6.1-7.3	0	0.0-0.0	0-2
	6-9	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	9-13	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	13-15	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	15-19	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	19-23	30-40	30-40	6.6-7.3	0	0.0-0.0	0-2
	23-26	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	26-30	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	30-32	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	32-36	25-35	25-35	6.6-7.3	0	0.0-0.0	0-2
	36-38	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	38-41	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	41-43	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	43-48	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	48-52	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
	52-60	15-25	15-25	6.6-7.3	0	0.0-0.0	0-2
751:							
Oneula, low elevation-----	0-2	5.0-15	35-45	6.1-6.5	0	0.0-0.0	0-2
	2-60	5.0-15	2.0-8.0	6.1-6.5	0	0.0-0.0	0-2
752:							
Oneula-----	0-2	5.0-15	35-45	6.1-6.5	0	0.0-0.0	0-2
	2-60	5.0-15	2.0-8.0	6.1-6.5	0	0.0-0.0	0-2

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Table 13.--Chemical Properties of the Soils--Continued

Map symbol and component name	Depth	Cation-exchange capacity at pH 7.0	Effective cation-exchange capacity	Soil reaction (1:1 in water)	Calcium carbonate	Extractable Al by KCl	Salinity
	In	meq/100g	meq/100g		Pct	meq/100g	mmhos/cm
752:							
Keamoku-----	0-3	20-50	15-25	5.1-5.5	0	0.0-2.0	0-2
	3-10	20-50	20-30	5.6-6.0	0	0.0-1.0	0-2
	10-14	25-45	10-20	5.6-6.5	0	0.0-0.0	0-2
	14-21	25-45	10-20	6.1-6.5	0	0.0-0.0	0-2
	21-35	25-45	10-20	6.1-6.5	0	0.0-0.0	0-2
	35-50	25-45	15-25	6.1-6.5	0	0.0-0.0	0-2
	50-60	25-45	15-25	6.1-6.5	0	0.0-1.0	0-2
Maunaiu-----	0-2	25-45	15-25	5.1-5.5	0	0.0-2.0	0-2
	2-6	30-50	20-30	5.5-6.0	0	0.0-1.0	0-2
	6-9	30-50	20-30	6.1-6.6	0	0.0-0.0	0-2
	9-14	30-50	20-30	6.1-6.6	0	0.0-0.0	0-2
	14-19	30-50	20-30	5.6-6.6	0	0.0-0.0	0-2
	>19	---	---	---	0	---	0
753:							
Kalapana-----	0-6	10-20	2.0-10	5.1-6.0	0	0.0-2.0	0-2
	6-7	5.0-10	2.0-10	5.6-6.6	0	0.0-0.0	0-2
	>7	---	---	---	0	---	0
754:							
Kalapana, dry---	0-6	10-20	2.0-10	5.1-6.0	0	0.0-2.0	0-2
	6-7	5.0-10	2.0-10	5.6-6.5	0	0.0-0.0	0-2
	>7	---	---	---	0	---	0
Lava flows, pahoehoe.							
755:							
Makaopuhi-----	0-2	70-100	50-70	3.5-4.4	0	2.0-5.0	0-2
	2-6	30-40	10-20	5.1-5.5	0	0.0-1.0	0-2
	>6	---	---	---	0	---	0
756:							
Ahiu-----	0-3	10-30	8.0-12	5.1-6.0	0	1.0-3.0	0-2
	3-6	10-30	0.0-0.0	5.6-6.5	0	0.0-0.0	0-2
	6-11	5.0-15	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	6-11	5.0-15	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	11-12	10-20	0.0-0.0	6.1-7.3	0	0.0-0.0	0-2
	12-13	10-20	0.0-0.0	6.6-7.3	0	0.0-0.0	0-2
	13-17	---	---	---	0	---	0
Vitric Haplustands----	0-3	35-45	15-25	5.6-6.0	0	0.0-0.0	0-2
	3-16	35-45	15-25	6.1-6.5	0	0.0-0.0	0-2
	16-33	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	33-35	2.0-10	1.0-8.0	6.1-6.5	0	0.0-0.0	0-2
	35-59	5.0-15	3.0-10	6.1-6.5	0	0.0-0.0	0-2

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Table 14.--Soil Features

(See text for definitions of terms used in this table. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Map symbol and component name	Restrictive layer			Potential for frost action	Risk of corrosion		
	Kind	Depth to top	Thickness		Hardness	Uncoated steel	Concrete
10: Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
12: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
14: Lava flows, aa-----	Lithic bedrock	20-79	---	Very strongly cemented	None	---	---
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
15: Cinder land-----	Lithic bedrock	10-79	---	Very strongly cemented	Low	Low	Low
16: Cinder land-----	Lithic bedrock	40-354	---	Very strongly cemented	Low	Low	Low
19: Riverwash-----	Lithic bedrock	20-157	---	Very strongly cemented	None	High	High
24: Badland, geothermal----	---	---	---	---	None	High	High
26: Lava flows, aa, sparsely vegetated----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
117: Kapua-----	Lithic bedrock	40-60	---	Very strongly cemented	None	Low	Low
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
130: Mawae-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
131: Mawae-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
132: Mawae-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
133: Mawae-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
137: Kekake-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
138: Kekake-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
161: Kekake-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Mawae-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
163: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Kekake-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
164: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Kekake-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
169: Iwalani, moist-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	12-79	Very strongly cemented	None	---	---
179: Iwalani, moist-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	12-79	Very strongly cemented	None	---	---
205: Ihuanu, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
206: Ihuanu, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
211: Kapulehu, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low
212: Kapulehu, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low
213: Nanaia, moist-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Low
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
214: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Nanaia, moist-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Low
215: Keea, moist-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
216: Keea, moist-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
217: Kapulehu, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low
Keea, moist-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
218: Kiolakaa, moist-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
219: Kiolakaa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
Keea-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
275: Kapulehu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
276: Kapulehu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
277: Kapulehu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Low
280: Nanaia-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Low
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
281: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Nanaia-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Low
290: Keea-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
292: Keea-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Low
Kiolakaa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
300: Kamaoa-----	Lithic bedrock	60-79	---	Very strongly cemented	None	Moderate	Moderate
305: Kiolakaa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
395: Hokukano-----	Lithic bedrock	10-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
401: Ihuanu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
402: Ihuanu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate
403: Ihuanu-----	Lithic bedrock	20-40	---	Very strongly cemented	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
406: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Iwalani-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
407: Iwalani-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	12-79	Very strongly cemented	None	---	---
408: Iwalani-----	Lithic bedrock	2-10	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	12-79	Very strongly cemented	None	---	---
461: Hapuu, very gravelly---	Lithic bedrock	40-60	---	Very strongly cemented	None	Moderate	Moderate
463: Hapuu, extremely gravelly-----	Lithic bedrock	40-60	---	Very strongly cemented	None	Moderate	Moderate
511: Akihi-----	Lithic bedrock	20-40	---	Very strongly cemented	None	High	Moderate
512: Akihi-----	Lithic bedrock	20-40	---	Very strongly cemented	None	High	Moderate
513: Hilea-----	Lithic bedrock	8-20	---	Very strongly cemented	None	High	High
514: Hilea-----	Lithic bedrock	8-20	---	Very strongly cemented	None	High	High
515: Pahipa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	High	Moderate
Puali-----	Lithic bedrock	2-20	---	Very strongly cemented	None	High	Moderate
516: Alapai-----	---	---	---	---	None	High	Moderate
517: Alapai-----	---	---	---	---	None	High	Moderate
518: Alapai-----	---	---	---	---	None	High	Moderate

Soil Survey of Hawaii Volcanoes National Park, Hawaii

Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
519: Lalaau-----	Lithic bedrock	40-60	---	Very strongly cemented	None	High	High
525: Alapai, low precipitation-----	---	---	---	---	None	High	Low
534: Kahaluu-----	Lithic bedrock	1-10	---	Very strongly cemented	None	High	High
Lava flows, pahoehoe---	Lithic bedrock	0-2	12-79	Very strongly cemented	None	---	---
555: Kuanene-----	Lithic bedrock	10-20	---	Very strongly cemented	None	High	High
Lava flows, pahoehoe---	Lithic bedrock	0	---	Very strongly cemented	None	---	---
574: Ihuanu-----	Lithic bedrock	20-40	---	Very strongly cemented	Low	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0	---	Very strongly cemented	None	---	---
575: Durustands-----	Lithic bedrock	20-40	---	Very strongly cemented	Low	High	Moderate
576: Puali-----	Lithic bedrock	2-20	---	Very strongly cemented	None	High	Moderate
Puu Oo-----	Lithic bedrock	39-79	---	Very strongly cemented	None	High	High
Pahipa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	High	Moderate
577: Pahipa-----	Lithic bedrock	20-40	---	Very strongly cemented	None	High	Moderate
Puu Oo-----	Lithic bedrock	39-79	---	Very strongly cemented	None	High	High
605: Kaholimo-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Ki-----	---	---	---	---	None	Moderate	Moderate
607: Kaholimo-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Ki-----	---	---	---	---	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
610: Piihonua-----	Lithic bedrock	40-61	---	Very strongly cemented	None	High	High
613: Kilua-----	Lithic bedrock	40-60	---	Very strongly cemented	None	Moderate	Moderate
621: Eheuiki-----	---	---	---	---	None	Moderate	Moderate
Pekailio-----	Lithic bedrock	39-79	---	Very strongly cemented	None	Moderate	Moderate
625: Hao-----	Placic material	15-16	0-6	Weakly cemented	None	Moderate	Moderate
	Dense material	39-79	---	Strongly cemented			
631: Kapapala-----	Lithic bedrock	39-59	---	Very strongly cemented	None	Moderate	Low
657: Malama-----	Lithic bedrock	40-60	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
709: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Lithic Ustipsamments---	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
711: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Apuki-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
713: Lithic Haplustands, cindery substratum---	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Lithic Haplustands, loamy surface-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
715: Alahapa-----	---	---	---	---	None	Moderate	Moderate
Heake-----	Lithic bedrock	1-8	---	Very strongly cemented	None	Moderate	Moderate
	Dense material	2-5	0-5	Weakly cemented			

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
716: Alahapa-----	---	---	---	---	None	Moderate	Moderate
717: Alahapa-----	---	---	---	---	None	Moderate	Moderate
Lava flows, aa-----	Lithic bedrock	20-60	---	Very strongly cemented	None	---	---
718: Halemaumau-----	Dense material	6-14	0-4	Weakly cemented	None	Moderate	Moderate
	Lithic bedrock	20-39	---	Very strongly cemented			
719: Heake-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
	Dense material	6-12	0-12	Weakly cemented			
720: Heake-----	Dense material	6-12	0-12	Weakly cemented	None	Moderate	Moderate
	Lithic bedrock	2-20	---	Very strongly cemented			
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
722: Kilauea-----	---	---	---	---	None	Moderate	Moderate
724: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Kaholimo, uneroded-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Kaholimo, eroded-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Puiwa, uneroded-----	Lithic bedrock	20-39	---	Very strongly cemented	None	Moderate	Moderate
Puiwa, eroded-----	Lithic bedrock	20-39	---	Very strongly cemented	None	Moderate	Moderate
725: Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Kaholimo, eroded-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Kaholimo, uneroded-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
726: Kulalio-----	---	---	---	---	None	Moderate	Moderate
727: Puauulu-----	Dense material	8-16	0-10	Weakly cemented	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
728:		In	In				
Puauulu-----	Dense material	8-16	0-10	Weakly cemented*	None	Moderate	Moderate
Hao-----	Placic material	2-6	0-3	Weakly cemented	None	Moderate	Moderate
	Placic material	6-12	1-6	Weakly cemented			
	Dense material	39-79	---	Weakly cemented			
729:							
Eheuiki-----	---	---	---	---	None	Low	Low
Puauulu-----	Dense material	8-16	0-10	Weakly cemented*	None	Moderate	Moderate
731:							
Kahalii-----	Lithic bedrock	6-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
734:							
Kanohina-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Low	Low
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
735:							
Puhimau-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
736:							
Manu-----	Lithic bedrock	20-39	---	Very strongly cemented	None	Moderate	Moderate
737:							
Nakanui-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
738:							
Vitric Haplustands----	Lithic bedrock	39-79	---	Very strongly cemented	None	Moderate	Moderate
741:							
Ahiu-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
743:							
Pakini-----	---	---	---	---	None	Low	Moderate
744:							
Haa-----	Lithic bedrock	39-60	---	Very strongly cemented	None	Moderate	Moderate
Keamoku-----	---	---	---	---	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
745:		In	In				
Maunaiu-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Akelelu-----	Lithic bedrock	20-39	---	Very strongly cemented	None	Moderate	Moderate
746:							
Kulalio-----	---	---	---	---	None	Moderate	Moderate
Maunaiu-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Akelelu-----	Lithic bedrock	20-39	---	Very strongly cemented	None	Moderate	Moderate
747:							
Oneula-----	---	---	---	---	None	Moderate	Moderate
748:							
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
Menehune-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
749:							
Wahi-----	---	---	---	---	Low	Moderate	Moderate
750:							
Ki-----	---	---	---	---	None	Moderate	Moderate
751:							
Oneula, low elevation--	---	---	---	---	None	Moderate	Moderate
752:							
Oneula-----	---	---	---	---	None	Moderate	Moderate
Keamoku-----	---	---	---	---	None	Moderate	Moderate
Maunaiu-----	Lithic bedrock	1-20	---	Very strongly cemented	None	Moderate	Moderate
753:							
Kalapana-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
754:							
Kalapana, dry-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Lava flows, pahoehoe---	Lithic bedrock	0-2	---	Very strongly cemented	None	---	---
755:							
Makaopuhi-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate

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Table 14.--Soil Features--Continued

Map symbol and component name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
756:		In	In				
Ahiu-----	Lithic bedrock	2-20	---	Very strongly cemented	None	Moderate	Moderate
Vitric Haplustands-----	Lithic bedrock	39-79	---	Very strongly cemented	None	Moderate	Moderate

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Table 15.--Classification of the Soils

Soil name	Family or higher taxonomic class
Ahiu-----	Ashy, amorphic, isothermic Lithic Haplustands
Akelelu-----	Medial, amorphic, isomesic Eutric Pachic Fulvudands
Akihi-----	Hydrous-skeletal, ferrihydritic, isothermic Typic Hydrudands
Alahapa-----	Fragmental, mixed, isothermic Typic Ustivitrands
Alapai-----	Hydrous, ferrihydritic, isothermic Typic Hydrudands
Apuki-----	Ashy, glassy, isohyperthermic Lithic Ustivitrands
Aquands-----	Hydrous, ferrihydritic, nonacid, isomesic Lithic Endoaquands
Durustands-----	Medial, amorphic, isomesic Humic Durustands
Eheuiki-----	Medial, ferrihydritic, isothermic Typic Hapludands
Haa-----	Medial, amorphic, isomesic Typic Hapludands
Halemaumau-----	Ashy, glassy, isothermic Typic Ustivitrands
Hao-----	Medial, ferrihydritic, isothermic Typic Placaquands
Hapuu-----	Sandy-skeletal, isotic, isomesic Udic Ustorthents
Heake-----	Ashy, glassy, isothermic Lithic Ustivitrands
Hilea-----	Hydrous, ferrihydritic, isothermic Lithic Hydrudands
Hokukano-----	Medial, amorphic, isomesic Lithic Fulvudands
Ihuanu-----	Medial-skeletal, amorphic, isomesic Humic Haplustands
Iwalani-----	Medial, amorphic, isomesic Lithic Haplustands
Kaalualu-----	Medial-skeletal over fragmental or cindery, amorphic over mixed, isohyperthermic Typic Haplotorrands
Kahalii-----	Ashy, amorphic, isothermic Lithic Udivitrands
Kahaluu-----	Euc, isomesic Lithic Udifolists
Kaholimo-----	Medial, amorphic, isomesic Lithic Hapludands
Kalapana-----	Medial, ferrihydritic, isothermic Lithic Udivitrands
Kali-----	Euc, isothermic, micro Lithic Ustifolists
Kamaoa-----	Medial, amorphic, isothermic Humic Haplustands
Kanohina-----	Ashy, amorphic, isohyperthermic Lithic Ustivitrands
Kapapala-----	Medial, amorphic, isothermic Typic Hapludands
Kapua-----	Euc, isothermic Typic Ustifolists
Kapulehu-----	Medial-skeletal, amorphic, isothermic Humic Haplustands
Keaa-----	Medial-skeletal, amorphic, isothermic Lithic Hapludands
Kealoha-----	Medial-skeletal, amorphic, isomesic Pachic Hapludands
Keamoku-----	Medial-skeletal, amorphic, isomesic Typic Hapludands
Kekake-----	Euc, isomesic, micro Lithic Ustifolists
Ki-----	Medial, amorphic, isomesic Eutric Thaptic Hapludands
Kilauea-----	Ashy, ferrihydritic, nonacid, isothermic Udic Ustorthents
Kiloa-----	Euc, isothermic Typic Udifolists
Kiolakaa-----	Medial, amorphic, isothermic Humic Haplustands
Kuanene-----	Medial over ashy, aniso, amorphic, isothermic Lithic Hapludands
Kulalio-----	Medial-skeletal, amorphic, isomesic Eutric Pachic Fulvudands
Lalaa-----	Euc, isomesic Typic Udifolists
Lithic Haplustands-----	Lithic Haplustands
Lithic Ustipsamments-----	Lithic Ustipsamments
Makaopuhi-----	Medial, ferrihydritic, isothermic Lithic Hapludands
Malama-----	Euc, isohyperthermic Typic Udifolists
Manu-----	Ashy, amorphic, isothermic Aquic Hapludands
Maunai-----	Medial, amorphic, isomesic Eutric Lithic Fulvudands
Mawae-----	Euc, isomesic Typic Ustifolists
Menehune-----	Medial, amorphic, isomesic Lithic Hapludands
Nakanui-----	Medial, amorphic, isothermic Lithic Hapludands
Nanaia-----	Medial, amorphic, isothermic Lithic Hapludands
Ohaieka-----	Medial, amorphic, isothermic Typic Hapludands
Ohia-----	Hydrous, ferrihydritic, isothermic Acrudoxic Hydrudands
Oneula-----	Sandy-skeletal, mixed, isomesic Vitrandic Udorthents
Pahipa-----	Hydrous-skeletal, ferrihydritic, isomesic Thaptic Hydrudands
Pakini-----	Medial, amorphic, isohyperthermic Typic Haplotorrands
Pekalio-----	Medial-skeletal, amorphic, isothermic Typic Hapludands
Piihonua-----	Hydrous, ferrihydritic, isomesic Acrudoxic Hydrudands
Puali-----	Hydrous, ferrihydritic, isomesic Lithic Hydrudands
Puaulu-----	Medial over ashy, aniso, ferrihydritic over amorphic, isothermic Aquic Hapludands
Puhimau-----	Ashy, amorphic, isothermic Lithic Hapludands
Puiwa-----	Medial, amorphic, isomesic Typic Hapludands

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Table 15.--Classification of the Soils--Continued

Soil name	Family or higher taxonomic class
Puu Oo-----	Medial over hydrous, ferrihydritic, isomesic Acrudoxic Hydrudands
Puukala-----	Medial-skeletal, amorphic, isomesic Lithic Haplustands
Vitric Haplustands-----	Vitric Haplustands
Wahi-----	Medial-skeletal, amorphic, isomesic Typic Hapludands

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Table 16.--English and Hawaiian Spellings of Soil Names

English spelling	Hawaiian spelling
Ahiu	`Āhiu
Akelelu	`Akelelu
Akihi	`Akihi
Alahapa	Alahapa
Alapai	Alapa`i
Apuki	`Apuki
Aquands	Aquands
Durustands	Durustands
Eheuiki	Eheuiki
Haa	Ha`ā
Halemaumau	Halema`uma`u
Hao	Hao
Hapuu	Hāpu`u
Heake	Heake
Hilea	Hilea
Hokukano	Hōkūkano
Ihuanu	Ihuanu
Iwalani	`Iwalani
Kaalualu	Ka`alu`alu
Kahalii	Kahali`i
Kahaluu	Kahalu`u
Kaholimo	Kaholimo
Kalapana	Kalapana
Kali	Kali
Kamaoa	Kamā`oa
Kanohina	Kanohina
Kapapala	Kapāpala
Kapua	Kapu`a
Kapulehu	Kapūlehu
Keaa	Kea`ā
Kealoha	Kealoha
Keamoku	Ke`āmoku
Kekake	Kekake
Ki	Ki
Kilauea	Kilauea
Kiloa	Kiloa
Kiolakaa	Kiolaka`a
Kuanene	Kuanene
Kulalio	Kulalio
Lalaau	Lāla`au
Lithic Haplustands	Lithic Haplustands
Lithic Ustipsamments	Lithic Ustipsamments
Makaopuhi	Makaopuhi
Malama	Mālama
Manu	Manu
Maunaiu	Mauna`iu
Mawae	Māwae
Menehune	Menehune
Nakanui	Nakanui
Nanaia	Nanaia
Ohaikea	`Ōhaikea
Ohia	`Ōhi`a
Oneula	One`ula
Pahipa	Pahipa
Pakini	Pākini
Pekailio	Peka`ilio
Piihonua	Pi`ihonua
Puali	Pū`ali
Puaulu	Puaulu
Puhimau	Puhimau
Puiwa	Pū`iwa
Puu Oo	Pu`u `Ō`ō
Puukala	Pu`ukala
Vitric Haplustands	Vitric Haplustands
Wahi	Wahi

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