United States
Department of
Agriculture

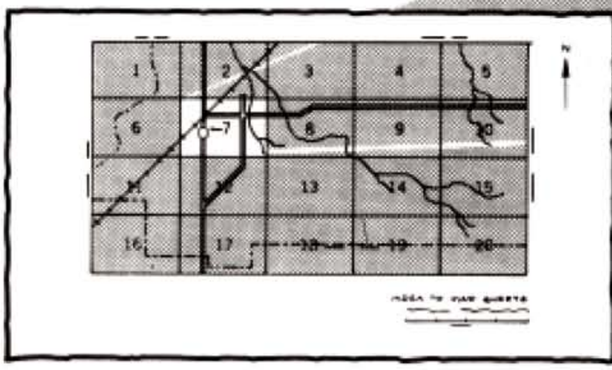
Soil
Conservation
Service

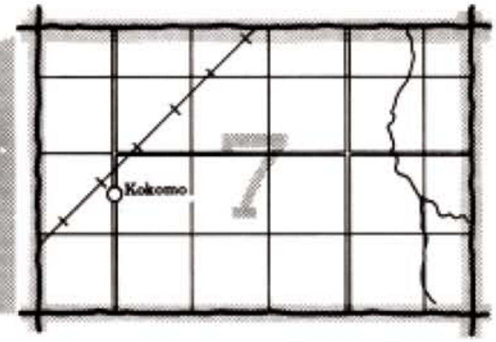
In Cooperation with
United States Department
of Agriculture, Forest
Service; United
States Department of the
Interior, Office of the
High Commissioner, Trust
Territory of the Pacific
Islands; and University of
Hawaii at Manoa, College
of Tropical Agriculture
and Human Resources

Soil Survey of Islands of Palau Republic of Palau

HOW TO USE

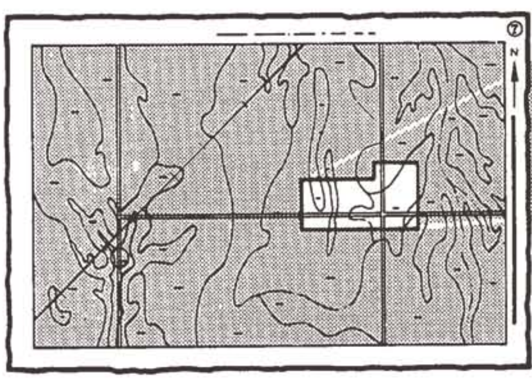
1. Locate your area of interest on the "Index to Map Sheets"

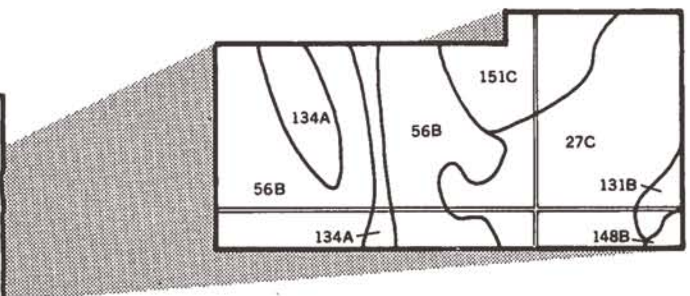




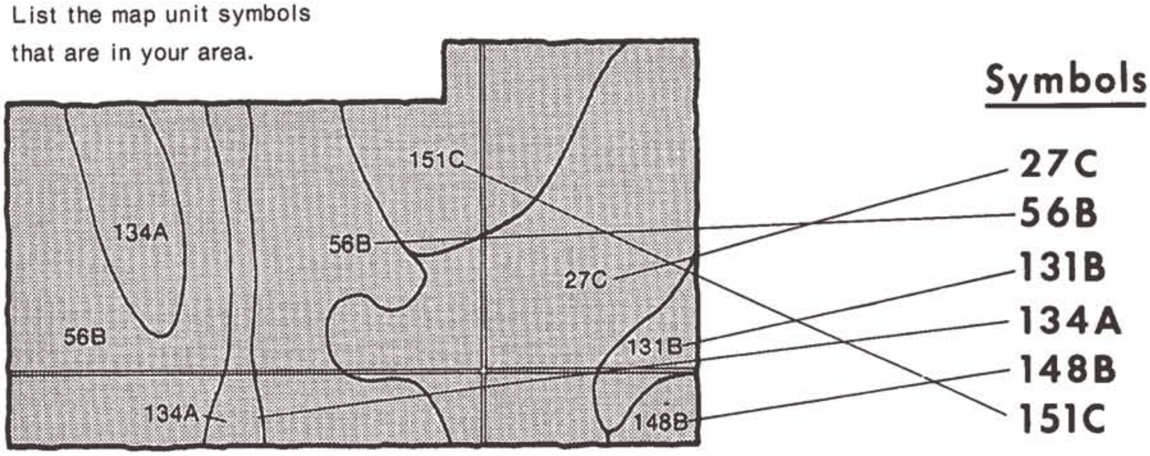
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



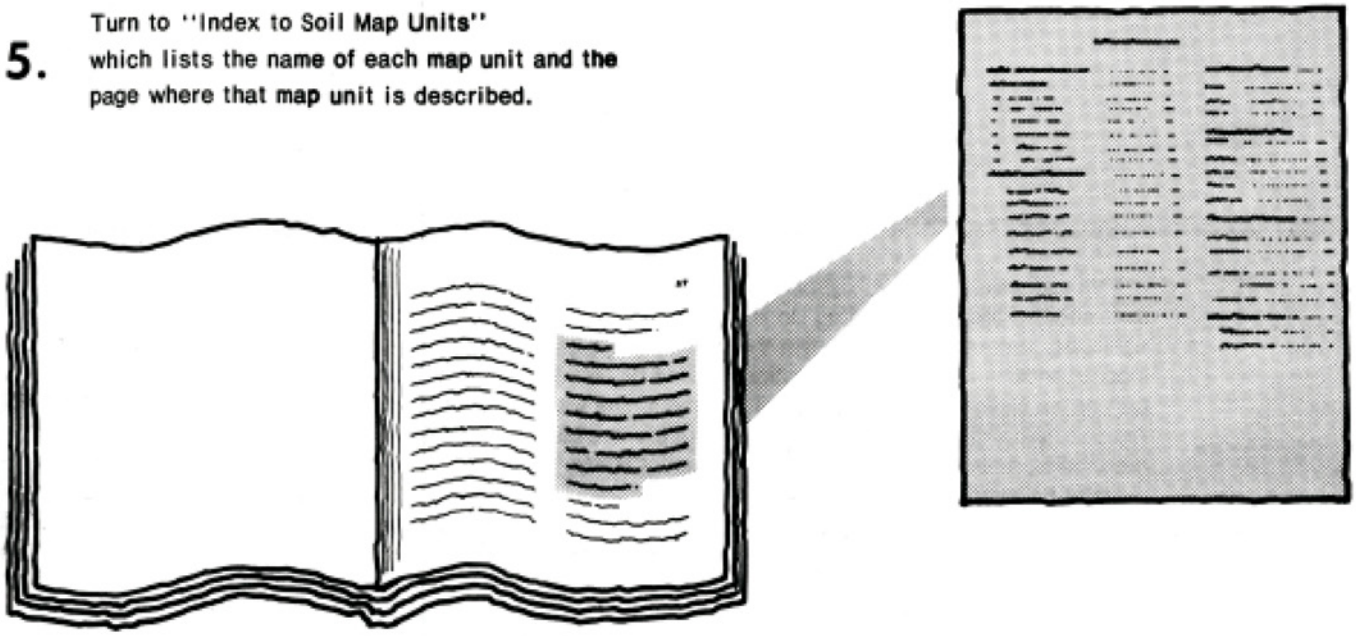


4. List the map unit symbols that are in your area.

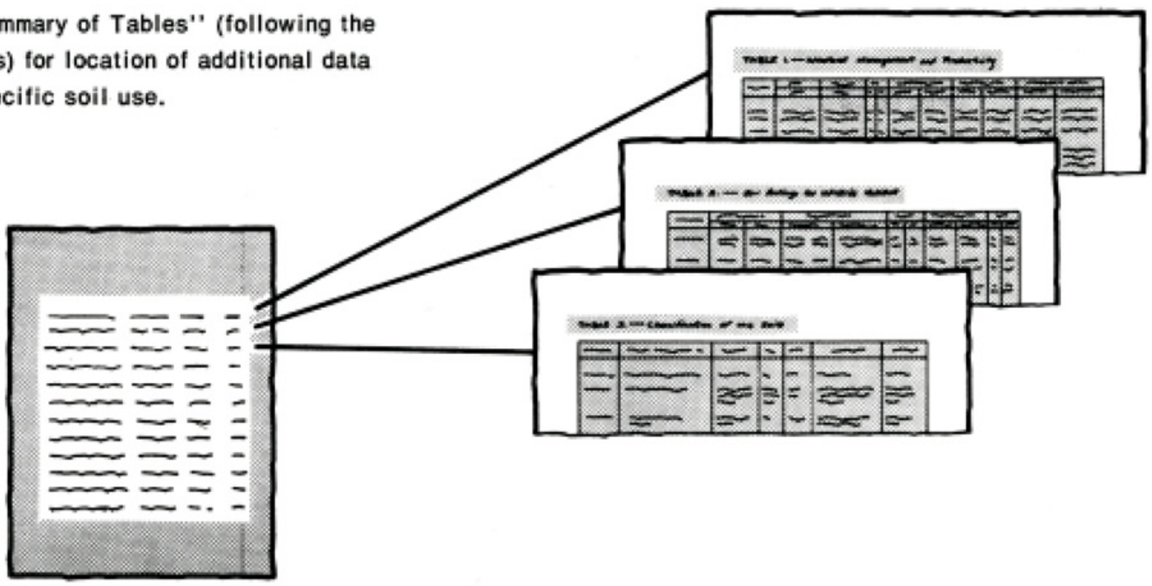


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

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, the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1979-80. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980. This survey was made cooperatively by the Soil Conservation Service and Forest Service; United States Department of the Interior, Office of the High Commissioner, Trust Territory of the Pacific Islands; and the University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources.

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.

Cover: Typical area of the Islands of Palau, in the northeastern part of Babelthuap Island. Coconut trees and savannah vegetation on Aimeliik and Palau soils in foreground; mangrove forest on Ilachetomel soils adjacent to shoreline.

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Issued March 1983

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foreword

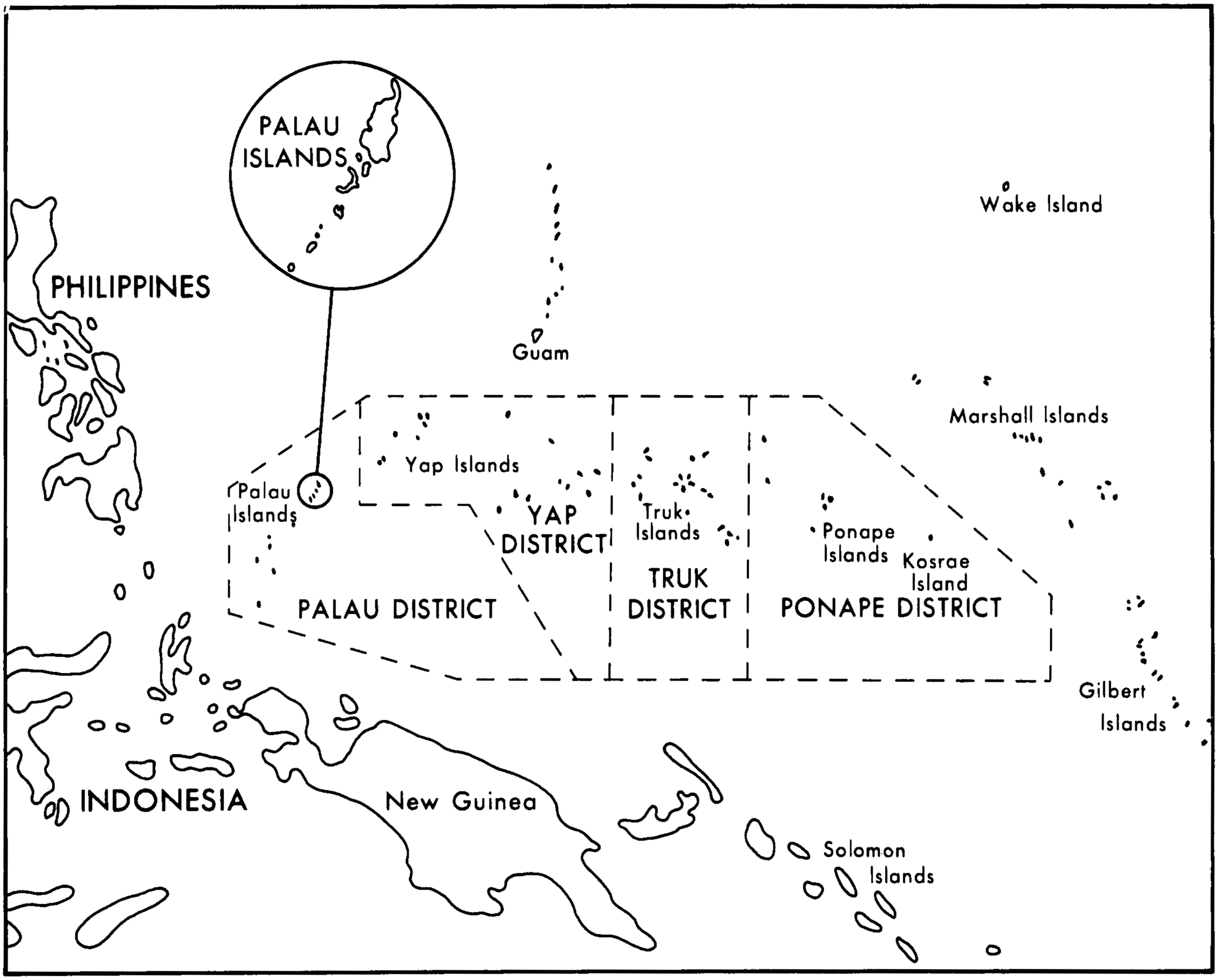
This soil survey contains information that can be used in land-planning programs in the Islands of Palau. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the 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, and builders can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

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

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil 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 Honolulu, Hawaii, office of the Soil Conservation Service or the Palau Department of Agriculture.

Jack P. Kanalz
State Conservationist, Hawaii
Soil Conservation Service



Location of the Islands of Palau, Republic of Palau.

soil survey of
Islands of Palau
Republic of Palau

By Christopher W. Smith, Soil Conservation Service

Fieldwork by Christopher W. Smith and Neil R. Babik,
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United States Department of Agriculture, Soil Conservation Service
In cooperation with
United States Department of Agriculture, Forest Service;
United States Department of the Interior, Office of the
High Commissioner, Trust Territory of the Pacific Islands;
and University of Hawaii at Manoa, College of Tropical
Agriculture and Human Resources

The ISLANDS OF PALAU, part of the Western Caroline Islands, are in the western part of the Pacific Ocean. The survey area is about 250 kilometers north of the equator and about 340 kilometers east of the Philippine Islands. It lies within a reef system that is about 80 kilometers long and about 27 kilometers wide at its widest point. Most of the reefs are barrier reefs, but some are fringing. All of the islands in the area are inside of the reef system except the island of Angaur, which lies across a deep channel off the southern tip of the system. The survey area is about 65 square kilometers, or 43,830 hectares. The town of Koror, on the island of Koror, is the capital. It is in the center of the barrier and fringing reefs. In 1980 the population of the survey area was about 11,800.

The southern part of the survey area consists of the level to extremely steep, raised and low coral limestone islands of Angaur, Ngedebus, and Peleliu. The south-central part consists of the high, raised, extremely steep coral limestone islands known locally as the "rock islands." Beginning in the central part and continuing north are the nearly level to very steep, high volcanic islands of Malakal, Koror, Arakabesan, and Babelthuap. These islands are characterized by deep dendritic drainageways and generally rounded hills.

Subsistence crop production is the main agricultural enterprise in the survey area. The major crops include cassava, taro, sweet potato, banana, and coconut. Copra is produced intermittently, mainly on the island of Ngedebus but to some extent on most of the other islands.

Soil scientists determined that there are about 18 different kinds of soil in the survey area. The soils range widely in texture, natural drainage, depth, fertility, and other characteristics. Those soils on the coral limestone islands are nearly level, somewhat excessively drained, very deep, and sandy or are steep, well drained, shallow, and loamy and are associated with areas of Rock outcrop. On the volcanic islands, the upland soils are mostly nearly level to very steep, well drained, and fine textured. Most of these soils are well suited to the production of agricultural forest crops and to use as woodland. If careful management is practiced, the soils also support a sustained yield of clean-tilled crops. In some areas are degraded or eroded soils that can be reclaimed by reforestation.

The soils on bottom lands are level to nearly level, very poorly drained, and fine textured or mucky. They are mostly in small areas adjacent to the coast. They are well suited to the production of wetland taro.

Mangrove forest is along most of the coastline of the volcanic islands and along the northern end of the island of Peleliu.

A report entitled "Military Geology of Palau Islands, Caroline Islands," published in 1956, includes information on the soils in this survey area (*12*). The present survey updates this earlier report and provides additional information including crop suitability, management techniques, and larger maps that show the soils in greater detail. Some of the soil names used in this older report are also used in the present survey; therefore, the reader can refer to the older report for some of the chemical and engineering properties for these soils.

general nature of the survey area

This section gives general information concerning the history and climate of the survey area.

history

The first settlement in the survey area probably occurred more than 1,000 years ago (*12*). The presence of stone pillars, embankments, stone platforms, stone pathways, and manmade terraces indicates that the population was once far greater than it is today. During the early days, portions of the native forest were burned and cleared to construct terraces, view game animals from greater distances, increase ease of access, and perhaps other reasons. Many of these cleared areas still support savannah vegetation.

In 1543, the first European contact in the survey area was made by the Spanish explorer Ruiz Lopez de Villabobos. The British claimed the area in 1790, but by 1800 they had lost interest in it. From 1800 to 1880, although under Spain's influence, the survey area was not subject to extensive outside control and administration. During this period, British traders such as Andrew Cheyne and David Dean O'Keefe frequented the islands.

In 1899, the survey area became a German protectorate following the purchase of the Caroline and Mariana Islands, excluding Guam, from Spain. Scientists and officials were sent to study the conditions and resources of the islands and to improve maps and charts. Fisheries and coconut plantations were established, and cassava was introduced. In 1909, the mining of phosphate was begun on the island of Angaur.

The Japanese took military control of the Caroline Islands in 1914. They built a town at Koror and a deepwater port at Malakal. The Japanese population in the survey area reached about 18,000, or about three times that of the Palauan population. Agricultural settlements were established on the island of Babelthuap. The Japanese purchased the phosphate mining operation from Germany and in 1938 began mining bauxite in the Ngardmau area of Babelthuap.

Following World War II, the United Nations made the United States the administering authority for the Caroline Islands. At the time of this writing, this trusteeship is drawing to a close and the self-governing Republic of Palau is emerging.

climate

Throughout the year, the climate of the survey area is hot and humid (*11*). Because the islands are relatively small and the maximum elevation, which is on the island of Babelthuap, is about 230 meters, the differences in temperature and rainfall between the windward and leeward sides of the islands and at the highest and lowest elevations generally are slight.

Rainfall averages about 370 centimeters per year, but it ranges from about 315 to 440 centimeters per year. Rainfall is heavy during December and January, averaging about 30 centimeters per month, but it falls off sharply when the intertropical convergence zone moves south of the islands. February, March, and April are the driest months of the year; rainfall averages about 19 to 23 centimeters per month.

In June the intertropical convergence zone generally moves northward across the survey area bringing with it heavy rainfall and thunderstorms. As much as 2 or 3 centimeters of rain may fall in 15 to 30 minutes. Heavy rainfall continues from July through November. The center of the convergence zone generally is near the survey area by December as reflected by the frequency of periods of calm and light winds from all directions and the continued heavy showers.

The prevailing wind from December through March is from the northeast. During April the frequency of northeasterly winds decreases with an increase in the frequency of easterly winds. In May the winds are dominantly from the southeast and northeast. The wind velocity generally is slow to moderate, averaging about 13 kilometers per hour. During the 10-year period from 1963-1973, wind velocity of 95 kilometers per hour was recorded in 1964, 117 kilometers per hour in 1967, and 80 kilometers per hour in 1972. Two windstorms in the last 20 years have had enough force to cause significant damage.

The mean daily temperature throughout the year is quite constant. It averages about 27 degrees C with a mean diurnal range of about 7 degrees. Relative humidity averages about 90 percent at night and 75 to 80 percent during the day.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, areas of savannah, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and local specialists.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, pastureland and woodland managers, engineers, planners, developers and builders, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The 11 map units in this survey have been grouped into five general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

map unit descriptions

soils on bottom lands

This group consists of three map units. It makes up about 18 percent of this survey area. The soils in this group are level and nearly level. The vegetation is mainly freshwater marsh, swamp forest, tropical forest, and mangrove forest.

The soils in this group are very deep and very poorly drained to somewhat poorly drained. They formed in alluvium washed from upland soils derived dominantly from volcanic rock and in deposits of organic matter derived dominantly from wetland grasses and sedges or mangrove forest vegetation.

This group is used for wetland taro production, subsistence agricultural forest crops, row crops, and mangrove wood production.

1. Dechel-Mesei-Ngersuul

Very deep, very poorly drained and somewhat poorly drained, level and nearly level soils; on valley and coastal bottom lands

This map unit is uniformly distributed throughout the volcanic islands of the survey area. Slope is 0 to 2 percent. The vegetation on the Dechel and Mesei soils is mainly freshwater marsh and swamp forest. The vegetation on the Ngersuul soils is mainly tropical forest.

This unit makes up about 7 percent of the survey area. It is about 30 percent Dechel soils, 30 percent Mesei soils, and 30 percent Ngersuul soils. The remaining 10 percent is components of minor extent.

Dechel soils are on valley bottoms and in depressional areas. These soils are very deep and very poorly drained. They formed in alluvium washed from upland soils derived dominantly from volcanic rock. The surface is covered with a mat of undecomposed and partially decomposed grasses and sedges. The surface layer is mucky and loamy. The underlying material to a depth of 168 centimeters is loamy.

Mesei soils are on valley bottoms and in depressional areas. These soils are very deep and very poorly drained. They formed in deposits of organic material overlying alluvium that washed from upland soils derived dominantly from volcanic rock. The soils are muck to a depth of 99 centimeters and are loamy below this depth.

Ngersuul soils are on flood plains adjacent to rivers and to the coast. These soils are very deep and somewhat poorly drained. They formed in alluvium washed from upland soils derived dominantly from volcanic rock. The upper 99 centimeters of the soils is loamy, and the lower part to a depth of 167 centimeters is mucky peat.

Of minor extent in this unit are somewhat poorly drained Tabecheding soils on marine terraces and well drained Palau and Aimeliik soils on uplands.

This unit is used for production of wetland taro, agricultural forest crops, and some clean-tilled crops.

This unit is well suited to wetland taro and agricultural forest crop production. It is poorly suited to clean-tilled crop production and to most engineering uses.

2. Ngerungor Variant-Ngerungor

Very deep, very poorly drained, level and nearly level soils; on bottom lands and in depressional areas

This map unit is on the islands of Peleliu and Angaur. Slope is 0 to 1 percent. The vegetation on this unit is mainly freshwater marsh.

This unit makes up about 1 percent of the survey area. It is about 70 percent Ngerungor Variant soils and 25 percent Ngerungor soils. The remaining 5 percent is components of minor extent.

Ngerungor Variant soils generally are on the edges of wet bottom lands, in depressional areas, and adjacent to beach deposits. These soils are very deep and very poorly drained. They formed in organic material derived dominantly from freshwater marsh vegetation overlying coral sand. The surface layer is muck about 53 centimeters thick. Below this to a depth of more than 150 centimeters is coral sand.

Ngerungor soils generally are near the center of wet bottom lands and in depressional areas. These soils are very deep and very poorly drained. They formed in organic material derived dominantly from freshwater marsh vegetation overlying coral sand. The soils are mucky throughout.

Of minor extent in this unit are areas of organic material underlain by coral sand at a depth of less than 40 centimeters and areas of organic material underlain by fragments of coral limestone.

This unit is used for wetland taro production.

This unit is well suited to wetland taro production and is poorly suited to most engineering uses.

3. Ilachetomel

Very deep, very poorly drained, level soils; in the intertidal zone adjacent to the shoreline

This map unit is along most of the shoreline of the volcanic islands. Slope is 0 to 1 percent. The vegetation on this unit is mainly mangrove forest.

This unit makes up about 10 percent of the survey area. It is about 80 percent Ilachetomel soils and 20 percent components of minor extent.

The Ilachetomel soils are very deep and very poorly drained. They formed in decomposing roots and litter derived dominantly from mangrove forest vegetation. The soils are peat throughout. They are flooded by seawater at high tide.

Of minor extent in this unit are Chia soils near the lagoon and mucky silt loam soils.

This unit is well suited to the production of mangrove timber; however, clearcutting should not be used. The unit is poorly suited to onsite waste disposal systems because of the hazard of seawater contamination.

soils on marine terraces

This group consists of one map unit. It makes up about 6 percent of this survey area. The soils in this group are nearly level to steep. The vegetation is mainly savannah, some of which is deteriorated, and tropical forest.

The soils in this group are very deep and are somewhat poorly drained and moderately well drained. They formed in marine clay deposits derived dominantly from volcanic rock.

This group is used for watershed, prawn ponds, subsistence agricultural forest crops, and livestock grazing.

4. Tabecheding-Ngatpang

Very deep, somewhat poorly drained and moderately well drained, nearly level to steep soils; on dissected terraces

This map unit is mainly in the southern and west-central, coastal parts of the survey area. Slope is 2 to 50 percent. The vegetation on the Tabecheding and Ngatpang soils is mainly savannah. The vegetation on the Ngatpang and Tabecheding soils, severely eroded, is mainly deteriorated savannah.

This unit makes up about 6 percent of the survey area. It is about 35 percent Tabecheding soils; 25 percent Ngatpang soils; 15 percent Tabecheding soils, severely eroded; and 10 percent Ngatpang soils, severely eroded. The remaining 15 percent is components of minor extent.

The Tabecheding soils generally are on the lower terraces. These soils are very deep and somewhat poorly drained. They formed in residuum derived dominantly from bedded marine clay deposits. The surface layer is loamy, and the subsoil and substratum are clayey.

The Ngatpang soils generally are on dissected terraces. These soils are very deep and moderately well drained. They formed in residuum derived dominantly from bedded marine clay deposits. The surface layer is loamy, and the subsoil and substratum are clayey.

The Tabecheding soils, severely eroded, are on dissected terraces. These soils are very deep and somewhat poorly drained. They formed in residuum derived dominantly from bedded marine clay deposits. The surface layer has been lost through erosion. The soils are clayey throughout.

The Ngatpang soils, severely eroded, are on dissected terraces. These soils are very deep and moderately well drained. They formed in residuum derived dominantly from bedded marine clay deposits. The surface layer has been lost through erosion. The soils are clayey throughout.

Of minor extent in this unit are well drained Aimeliik, Palau, and Babelthuap soils on uplands and very poorly drained Dechel and Mesei soils on bottom lands.

This unit is used mainly as watershed and for farming. Some areas are used as woodland.

The Ngatpang soils are well suited to agricultural forest crops and to use as woodland. The Tabecheding soils and the Tabecheding and Ngatpang soils, severely eroded, are limited for most types of farming by wetness and very low soil fertility.

The main limitations of this unit for engineering uses are low soil strength, wetness, and slope.

Soils on volcanic uplands

This group consists of four map units. It makes up about 70 percent of this survey area. The soils in this group are nearly level to very steep. The vegetation is mainly tropical forest and savannah.

The soils in this group are shallow to very deep and are well drained. They formed in residuum derived dominantly from highly weathered and unweathered volcanic rock.

Most areas of this group are used as watershed. A few areas are used for subsistence crop production and as woodland for village use.

5. Aimeliik-Palau

Very deep, well drained, nearly level to very steep soils; on hills

This map unit is on the volcanic islands. The unit is characterized by hills that have mostly rounded ridges, convex slopes, and numerous drainageways. Slope is 2 to 75 percent. The vegetation on this unit is mainly tropical forest and some areas of savannah.

This unit makes up about 43 percent of the survey area. It is about 60 percent Aimeliik soils and 25 percent Palau soils. The remaining 15 percent is components of minor extent.

Aimeliik soils are on hills. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. The surface layer and the upper part of the subsoil are loamy. The lower part of the subsoil and the substratum to a depth of 150 centimeters are clayey.

Palau soils are on hills. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. The surface layer is loamy, and the subsoil and substratum to a depth of 150 centimeters are clayey.

Of minor extent in this unit are Babelthuap and Ngardmau soils that are under deteriorated savannah and are in areas that are subject to erosion and Ngardok soils that are under forest vegetation and are in the northern part of the survey area.

This unit is poorly suited to subsistence clean-tilled crop production. The unit is suited to subsistence and mechanized agricultural forest crop production. The main limitations of the unit for engineering uses are low soil strength, slope, and the hazard of erosion.

6. Babelthuap-Aimeliik-Ngardmau

Very deep, well drained, nearly level to very steep soils; on hills and ridges

This map unit is on the volcanic islands. It is mainly in areas that are subject to erosion. Slope is 2 to 75 percent. The vegetation on the Babelthuap and Ngardmau soils is mainly deteriorated savannah. The vegetation on the Aimeliik soils is mainly tropical forest and savannah.

This unit makes up about 12 percent of the survey area. It is about 50 percent Babelthuap soils, 25 percent Aimeliik soils, and 10 percent Ngardmau soils. The remaining 15 percent is components of minor extent.

The Babelthuap soils generally are on ridgetops and on side slopes that are subject to erosion. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. From 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is very gravelly and loamy. The subsoil and substratum to a depth of 150 centimeters are clayey.

The Aimeliik soils are on hills. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. The surface layer and the upper part of the subsoil are loamy. The lower part of the subsoil and the substratum to a depth of 150 centimeters are clayey.

The Ngardmau soils are mostly on very steep side slopes and ridgetops. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. From 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is gravelly and loamy. The subsoil and substratum to a depth of 150 centimeters are clayey.

Of minor extent in this unit are Palau and Ngardok soils.

This unit is used mainly as watershed. Some areas of the Aimeliik soils are used as woodland for village use.

This unit is poorly suited to most agricultural uses. The unit is well suited to reforestation. The main limitations of the unit for engineering uses are low soil strength, slope, and the hazard of erosion.

7. Ngardok-Babelthuap

Very deep, well drained, nearly level to very steep soils; on ridgetops and side slopes

This map unit is on the volcanic islands. Slope is 2 to 75 percent. The vegetation on the Ngardok soils is mainly tropical forest. The vegetation on the Babelthuap soils is mainly deteriorated savannah.

This unit makes up about 10 percent of the survey area. It is about 60 percent Ngardok soils and 25 percent Babelthuap soils. The remaining 15 percent is components of minor extent.

Ngardok soils generally are on side slopes and ridgetops. These soils are very deep and well drained. They formed in residuum derived dominantly from highly weathered volcanic tuff. The soils are loamy throughout.

Babelthuap soils generally are on ridgetops and on side slopes that are subject to erosion. These soils are very deep and well drained. They formed in residuum derived dominantly from volcanic breccia and tuff. From 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is gravelly and loamy, the subsoil is clayey, and the substratum is loamy.

Of minor extent in this unit are Aimeliik, Palau, and very gravelly Ngardmau soils. The Ngardmau soils are on ridgetops and in areas that are subject to erosion and are under deteriorated savannah vegetation.

This unit is used mainly for watershed. Some areas are used as woodland for village use.

The Babelthuap soils are poorly suited to most agricultural uses. The Ngardok soils are suited to agricultural forest crop production. The main limitations of the unit for engineering uses are low soil strength, slope, and the hazard of erosion.

8. Ollei-Nekken-Rock outcrop

Shallow and moderately deep, well drained, strongly sloping to very steep soils, and Rock outcrop; on hills and ridgetops

This map unit is in the west-central, coastal part of the island of Babelthuap. Slope is 12 to 75 percent. The vegetation on this unit is mainly tropical forest, savannah, and brush.

This unit makes up about 5 percent of the survey area. It is about 40 percent Ollei soils, 40 percent Nekken soils, and 10 percent Rock outcrop. The remaining 10 percent is components of minor extent.

Ollei soils are on very steep side slopes and ridgetops. These soils are shallow and well drained. They formed in residuum derived dominantly from hard andesitic and basaltic breccia and tuff. The surface layer is loamy, the subsoil is very gravelly and loamy, and the substratum is extremely flaggy and loamy. Unweathered bedded tuff is at a depth of 43 centimeters.

Nekken soils are on forested side slopes and rolling ridgetops. These soils are moderately deep and well drained. They formed in residuum derived dominantly from hard andesitic and basaltic breccia and tuff. The surface is covered with a mat of forest litter. The soils are very gravelly and loamy. Bedded tuff is at a depth of 56 centimeters.

Rock outcrop is on coastal fringes and very steep side slopes. It consists primarily of exposures of hard basalt, breccia, and tuff.

Of minor extent in this unit are Aimeliik, Ngardok, and Palau soils in shallow depressional areas.

This unit is used mainly as watershed. Some areas are used as woodland for village use.

This unit is well suited to use as woodland and as a source of rock. The main limitations of the unit for engineering uses are depth to hard bedrock and slope.

soils on limestone

This group consists of two map units. It makes up about 5 percent of this survey area. The soils in this group are nearly level to extremely steep. The vegetation is mainly forest and brush.

The soils in this group are shallow and well drained. They formed in residuum derived dominantly from coral limestone.

This group is used mainly as watershed. Some areas are used for subsistence crop production.

9. Rock outcrop-Peleliu

Rock outcrop, and shallow, well drained, very steep soils; on uplands

This map unit is on the rock islands and on parts of the islands of Peleliu and Angaur. The unit is characterized by forested, high-lying limestone islands that are undercut at the base. Slope is 80 to 150 percent. The vegetation on this unit is mainly forest.

This unit makes up about 3 percent of the survey area. It is about 55 percent Rock outcrop and 30 percent Peleliu soils. The remaining 15 percent is components of minor extent.

Rock outcrop consists of massive vertical exposures and small, sharp, jagged pinnacles of hard limestone.

Peleliu soils are mostly in very small, nearly level areas and in depressional areas between areas of Rock outcrop. These soils are shallow and well drained. They formed in residuum derived dominantly from coral limestone. From 80 to 100 percent of the surface is covered with cobbles and stones. The surface layer is extremely cobbly and loamy, and the subsoil is very gravelly and loamy. Unweathered coral limestone is at a depth of 30 centimeters.

Of minor extent in this unit are Ngedebus and Ngedebus Variant soils. These very deep, sandy soils are in nearly level areas adjacent to beaches.

This unit is used mainly as watershed and for recreation. Some areas are used as woodland for village use.

This unit is poorly suited to most agricultural and engineering uses. Some areas of the Ngedebus soils are moderately suited to recreational development.

10. Peleliu-Rock outcrop

Shallow, well drained, nearly level to moderately steep soils, and Rock outcrop; on low-lying coral islands

This map unit is on the islands of Peleliu and Angaur. Slope is 0 to 20 percent. The vegetation on this unit is mainly forest.

This unit makes up about 2 percent of the survey area. It is about 60 percent Peleliu soils and 25 percent Rock outcrop. The remaining 15 percent is components of minor extent.

Rock outcrop consists of small, sharp, jagged pinnacles and level benches of limestone.

Peleliu soils are mostly on low benches. These soils are shallow and well drained. They formed in residuum derived dominantly from coral limestone. From 80 to 100 percent of the surface is covered with cobbles and stones. The surface layer is extremely cobbly and loamy, and the subsoil is very gravelly and loamy. Unweathered coral limestone is at a depth of 30 centimeters.

Of minor extent in this unit are Ngedebus and Ngedebus Variant soils. These very deep, sandy soils are in nearly level areas adjacent to beaches.

This unit is used mainly as watershed and for phosphate mining. Some areas are used as woodland for village use.

If this unit is used for agricultural and timber production, the main limitations are restricted rooting depth, coarse fragments on the surface and in the soil, and outcroppings of limestone. The main limitation of the unit for engineering uses is the depth to bedrock.

soils that formed in coral sand

This group consists of one map unit. It makes up about 1 percent of this survey area. The soils in this group are nearly level to gently sloping. The vegetation is mainly coconut trees, atoll forest, and casuarina forest.

The soils in this group are very deep and somewhat excessively drained. They formed in water- and wind-deposited coral sand.

This group is used for coconut plantations, recreation sites, homesites, and subsistence crop production.

11. Ngedebus

Very deep, somewhat excessively drained, nearly level to gently sloping soils; on raised beach deposits

This map unit is adjacent to beaches on the east coast of the island of Babelthuap and on the coral islands in the southern part of the survey area. Slope is 0 to 3 percent. The vegetation on this unit is mainly coconut trees, atoll forest, and casuarina forest.

This unit makes up about 1 percent of the survey area. It is about 85 percent Ngedebus soils and 15 percent components of minor extent.

Ngedebus soils are adjacent to coastal beaches and to the interior of atoll islands. These soils are very deep and somewhat excessively drained. They formed in alluvium derived dominantly from water- and wind-deposited coral sand. The soils are sandy throughout.

Of minor extent in this unit are very gravelly Ngedebus Variant soils adjacent to beaches and shallow Peleliu soils on raised coral platforms.

This unit is used for subsistence farming and commercial copra production.

This unit is well suited to growing coconut. If the unit is used for homesite development, the main limitation is the hazard of flooding during high-intensity storms. If the unit is used for sanitary facilities, the main limitation is poor filtration resulting in a hazard of ground water contamination.

detailed soil map units

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

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil 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 or of the underlying material, 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 or of the underlying material. They also can differ in slope, 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, Tabecheding silty clay loam, 2 to 6 percent slopes, is one of several phases in the Tabecheding series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Aimeliik-Palau complex, 6 to 12 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 1 gives the hectarage and proportionate extent of each map unit. Other tables (see "Summary of 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.

map unit descriptions

400—Aimeliik-Palau complex, 6 to 12 percent slopes. This map unit is on low-lying foothills. Slopes are slightly convex. Areas are irregular in shape and are 3 to 115 hectares in size. The native vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 60 percent Aimeliik silt loam and 30 percent Palau silty clay loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained and are in drainageways and other concave areas. Also included are small areas of soils that have slopes of less than 6 percent or more than 12 percent.

Most areas of this unit on the islands of Koror and Arakabesan that are under urban development have had the surface layer removed. Some areas have been cut deeply, and the underlying material is exposed. A few large boulders are on the surface of the soil or are buried in the soil profile.

The Aimeliik soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silt loam 10 centimeters thick. The upper 10 centimeters of the subsoil is brown silty clay loam, the next 56 centimeters is yellowish red and strong brown silty clay, and the lower 10 centimeters is yellowish red and strong brown silty clay loam. The substratum to a depth of 150 centimeters or more is dominantly yellowish red and dusky red silty clay loam. In some areas the surface layer is silty clay loam.

Permeability of the Aimeliik soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

The Palau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silty clay loam 10 centimeters thick. The upper 19 centimeters of the subsoil is strong brown silty clay, and the lower 77 centimeters is yellowish red and strong brown silty clay. The substratum to a depth of more than 150 centimeters or more is dominantly red and brownish yellow silt loam.

Permeability of the Palau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for urban and homesite development and for garden crops, mainly dryland taro, cassava, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, cucumbers, and sugarcane. Other crops grown are banana, coconut, and pineapple. This unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture. It has few limitations. Grasses and legumes grow well if adequate fertilizer is used. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is well suited to subsistence agricultural forest crop production. It is poorly suited to subsistence clean-tilled crop production. The main limitations are low soil fertility and the hazard of soil degradation. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome these limitations. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland.

This unit is well suited to homesite development. The main limitations are slope, which increases the construction costs, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on the unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of the unit.

Septic tank absorption fields should be placed in the less sloping areas of this unit. Place leach lines on the contour, and avoid using pit leaching wherever possible.

401—Aimeliik-Palau complex, 12 to 30 percent slopes. This map unit is on low-lying foothills. Slopes are convex. Areas are irregular in shape and are 5 to 200 hectares in size. The native vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 60 percent Aimeliik silt loam and 30 percent Palau silty clay loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained and are in drainageways and other concave areas. Also included are small areas of soils that have slopes of less than 12 percent or more than 30 percent and soils that are less than 3.5 meters deep to hard basalt.

Most areas on the islands of Koror and Arakabesan that are used for urban development have had the surface layer removed. Some areas have been cut deeply and the underlying material is exposed. A few large boulders are on the surface of the soil or are buried in the soil profile.

The Aimeliik soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silt loam 10 centimeters thick. The upper 10 centimeters of the subsoil is brown silty clay loam, the next 56 centimeters is yellowish red and strong brown silty clay, and the lower 10 centimeters is yellowish red and strong brown silty clay loam. The substratum to a depth of 150 centimeters or more is dominantly yellowish red and dusky red silty clay loam.

Permeability of the Aimeliik soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

The Palau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silty clay loam 10 centimeters thick. The upper 19 centimeters of the subsoil is strong brown silty clay, and the lower 77 centimeters is yellowish red and strong brown silty clay. The substratum to a depth of more than 150 centimeters is dominantly red and brownish yellow silt loam.

Permeability of the Palau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

Most areas of this unit are used as watershed, food gathering, and some woodland for village use. A few areas are used for homesite and urban development and for garden crops, mainly dryland taro, cassava, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, cucumbers, and sugarcane. Other crops grown are bananas, coconuts, and pineapples. The unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture.

This unit is well suited to subsistence agricultural forest crop production. It is poorly suited to subsistence clean-tilled crop production. The main limitations are low soil fertility and the hazards of erosion and soil degradation. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome these limitations. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland.

This unit is poorly suited to homesite development. The main limitations are slope, which increases the construction costs, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on the unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of the unit.

This unit is poorly suited to onsite waste disposal. The main limitations are slope and the hazard of lateral seepage.

402—Aimeliik-Palau complex, 30 to 50 percent slopes. This map unit is on high hills and ridges. Slopes are convex. Areas are irregular in shape and are 5 hectares to more than 1,000 hectares in size. The native vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 50 percent Aimeliik silt loam and 40 percent Palau silty clay loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland, Ngardok soils, and somewhat poorly drained to moderately well drained soils in drainageways and other concave areas. Also included are small areas of soils that have slopes of less than 30 percent or more than 50 percent.

Most areas of this unit on the islands of Koror and Arakabesan that are under urban development have had the surface layer removed. Some areas have been cut deeply, and the underlying material is exposed. A few large boulders are on the surface of the soil or are buried in the soil profile.

The Aimeliik soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silt loam 10 centimeters thick. The upper 10 centimeters of the subsoil is brown silty clay loam, the next 56 centimeters is yellowish red and strong brown silty clay, and the lower 10 centimeters is silty clay loam. The substratum to a depth of 150 centimeters or more is dominantly yellowish red and dusky red silty clay loam.

Permeability of the Aimeliik soil is moderately rapid. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is high. In general, areas under forest vegetation are more fertile than those under savannah vegetation.

The Palau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silty clay loam 10 centimeters thick. The upper 19 centimeters of the subsoil is strong brown silty clay, and the lower 77 centimeters is yellowish red and strong brown silty clay. The substratum to a depth of 150 centimeters or more is red and brownish yellow silt loam.

Permeability of the Palau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. Runoff is rapid, and the hazard of water erosion is high. In general, areas under forest vegetation are more fertile than those under savannah vegetation.

Most areas of this unit are used as watershed and woodland for village use. A few areas are used for garden crops, mainly dryland taro, cassava, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, cucumbers, and sugarcane. Other crops grown are bananas, coconuts, and pineapples. A few areas are used for homesite development. Where savannah vegetation is present, this unit can be used for pasture.

This unit is moderately suited to use as pasture. The main limitations are slope and the hazard of erosion. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and is moderately suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility, slope, and the hazards of erosion and soil degradation. Avoiding burning, contour stripcropping, sod cropping, adding compost, fertilizer, and lime, rotating crops, and mulching are needed to maintain fertility and reduce the risk of erosion. If the unit is used for subsistence agricultural forest crops, the main limitations are slope and the hazard of erosion. To minimize the risk of erosion and loss of fertility, only small areas of forest land should be cleared for planting.

This unit is moderately suited to use as woodland. The main concerns in producing and harvesting timber are slope and the hazard of erosion.

This unit is poorly suited to homesite development. The main limitations are slope and the hazard of erosion. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Material cast to the side during road construction in critical areas should be planted with a suitable ground cover to reduce the hazard of sedimentation of streams.

This unit is poorly suited to onsite waste disposal systems. The main limitations are slope and the hazard of lateral seepage. Deep, well-type leaching pits can be used where the depth to bedrock is greater than 6 meters.

403—Aimeliik-Palau complex, 50 to 75 percent slopes. This map unit is on high hills and ridges. Slopes are convex. Areas are irregular in shape and are 5 hectares to more than 1,000 hectares in size. The native vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 45 percent Aimeliik silt loam and 35 percent Palau silty clay loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained and are in drainageways and other concave areas. Also included are small areas of soils that have slopes of less than 50 or more than 75 percent.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Aimeliik soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silt loam 10 centimeters thick. The upper 10 centimeters of the subsoil is brown silty clay loam, the next 56 centimeters is yellowish red and strong brown silty clay, and the lower 10 centimeters is yellowish red and strong brown silty clay loam. The substratum to a depth of 150 centimeters or more is dominantly yellowish red and dusky red silty clay loam.

Permeability of the Aimeliik soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

The Palau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silty clay loam 10 centimeters thick. The upper 19 centimeters of the subsoil is strong brown silty clay, and the lower 77 centimeters is yellowish red and strong brown silty clay. The substratum to a depth of more than 150 centimeters is dominantly red and brownish yellow silt loam.

Permeability of the Palau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

This unit is used as watershed, for food gathering, and as some woodland for village use. The unit can be used for pasture where savannah vegetation is present.

This unit is poorly suited to use as pasture. The main limitations are slope and the hazard of erosion. Proper grazing management, weed control, and fertilization are needed for maximum quality forage.

This unit is very poorly suited to subsistence clean-tilled crop production. It is moderately suited to subsistence agricultural forest crop production. If the unit is used for these crops, the main limitations are slope, the hazards of erosion and soil degradation, and low soil fertility. Only small areas of forest land should be cleared for planting subsistence agricultural forest crops.

This unit is moderately suited to use as woodland. The main concerns in producing and harvesting timber are slope and the hazard of erosion. Clearcutting should be avoided.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. Structures to divert runoff are needed if buildings and roads are constructed. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

This unit is poorly suited to use as a source of roadfill because of the low soil strength when wet. This can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow soil material to dry sufficiently before filling. Material cast to the side in critical areas during road construction should be stabilized with permanent plant cover so that sedimentation of streams is minimized.

This unit is poorly suited to onsite waste disposal. The very steep slopes and the hazard of lateral seepage are the main limitations.

404—Babelthuap-Ngardmau complex, 2 to 6 percent slopes. This map unit is on ridges. Slopes are slightly convex. Areas are irregular or elongated in shape and are 3 to 50 hectares in size. The vegetation is deteriorated savannah (fig. 1).

This unit is 70 percent Babelthuap very gravelly loam and 25 percent Ngardmau very gravelly silty clay loam.

Included in this unit are small areas of Aimeliik and Palau soils in concave areas primarily under forest vegetation, and soils that have slopes of less than 2 percent or more than 6 percent. Also included are small areas of soils in gullied areas that are similar to the Babelthuap and Ngardmau soils but are more highly erodible.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Babelthuap soil is very deep and well drained. It formed in residuum derived dominantly from very soft

Figure 1.—Area of Babelthuap and Ngardmau soils under deteriorated savannah vegetation in foreground. Tabecheding soils on a marine terrace in center, and Aimeliik and Palau soils under tropical forest in background.

volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is dark reddish brown very gravelly loam 10 centimeters thick. The upper 18 centimeters of the subsoil is strong brown silty clay, and the lower 36 centimeters is dark red and yellowish red silty clay. The substratum to a depth of more than 150 centimeters is dark yellowish brown silty clay loam.

Permeability of the Babelthuap soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight.

The Ngardmau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is strong brown very gravelly silty clay loam 12 centimeters thick. The subsoil is yellowish red and red silty clay 28 centimeters thick. The substratum to a depth of more than 150 centimeters is weak red and yellowish red silty clay loam.

Permeability of the Ngardmau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight.

This unit is used mainly as watershed. It can be used for crops and as woodland if proper management practices are used. A few areas have been mined for bauxite.

This unit is poorly suited to use as pasture. The main limitations are low soil fertility and a high amount of gravel on and in the surface layer. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

Small livestock watering ponds can be installed on this unit if the pond area is properly compacted.

This unit is poorly suited to subsistence clean-tilled crops and very poorly suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are very low soil fertility, droughtiness of the surface layer, and a high amount of gravel on and in the surface layer. Fertility can be increased by adding lime and large amounts of compost and other organic fertilizer. The high content of gravel in the surface layer results in droughtiness, which may cause seedlings to wilt. Clearing gravel from the surface, adding organic matter, and cultivating the surface layer with the upper part of the nongravelly subsoil help to overcome this problem. All tillage should be on the contour or across the slope. Crop rotation should be used on this unit.

This unit is well suited to woodland species tolerant of very low soil fertility. Reforestation is needed.

This unit is well suited to homesite development. The main limitation is the low strength of the soil. If buildings and roads are constructed on the unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. If the unit is used for onsite waste disposal, place leach lines on the contour and avoid using pit leaching wherever possible.

405—Babelthuap-Ngardmau complex, 6 to 12 percent slopes. This map unit is on ridges and upper side slopes. Slopes are slightly convex. Areas are irregular or long and narrow in shape and are 5 to 180 hectares in size. The vegetation is deteriorated savannah.

This unit is 65 percent Babelthuap very gravelly loam and 30 percent Ngardmau very gravelly silty clay loam.

Included in this unit are small areas of Aimeliik and Palau soils in concave areas primarily under forest vegetation and soils that have slopes of less than 6 percent or more than 12 percent. Also included are small areas of gullied soils that are similar to the Babelthuap and Ngardmau soils but are more highly erodible.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Babelthuap soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is dark reddish brown very gravelly loam 10 centimeters thick. The upper 18 centimeters of the subsoil is strong brown silty clay, and the lower 36 centimeters is dark red and yellowish red silty clay. The substratum to a depth of more than 150 centimeters is dark yellowish brown silty clay loam.

Permeability of the Babelthuap soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight.

The Ngardmau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is strong brown very gravelly silty clay loam 12 centimeters thick. The subsoil is yellowish red and red silty clay 28 centimeters thick. The substratum to a depth of more than 150 centimeters is weak red and yellowish red silty clay loam.

Permeability of the Ngardmau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight.

This unit is used mainly as watershed. It can be used for pasture, crops, and woodland if proper management practices are used. A few areas have been mined for bauxite.

This unit is poorly suited to use as pasture. The main limitations are very low soil fertility and a large amount of gravel on and in the surface layer. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production, and very poorly suited to subsistence agricultural forest crops. If the unit is used for subsistence clean-tilled crops, the main limitations are very low soil fertility, the large amount of gravel on and in the surface layer, and droughtiness. Fertility can be increased by adding lime and large amounts of compost and other organic fertilizer. Crop rotation should be used. The high content of gravel in the surface layer results in droughtiness, which may cause seedlings to wilt. Clearing gravel from the surface, mulching, adding organic matter, and cultivating the surface layer with the upper part of the nongravelly subsoil help to overcome this problem. All tillage should be on the contour or across the slope.

This unit is well suited to woodland species tolerant of low soil fertility. Reforestation is needed.

This unit is well suited to homesite development. The main limitations are slope, which increases construction costs, and low soil strength. If roads and buildings are constructed on the unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of the unit.

Septic tank absorption fields should be placed in the less sloping areas of this unit. Place leach lines on the contour, and avoid using pit leaching wherever possible.

406—Babelthuap-Ngardmau complex, 12 to 30 percent slopes. This map unit is on ridges and upper side slopes. Slopes are convex. Areas are irregular in shape and are 3 to 50 hectares in size. The vegetation is deteriorated savannah.

This unit is 60 percent Babelthuap very gravelly loam and 35 percent Ngardmau very gravelly silty clay loam.

Included in this unit are small areas of Aimeliik and Palau soils in concave areas primarily under forest vegetation and soils that have slopes of less than 12 percent or more than 30 percent. Also included are small areas of gullied soils that are similar to the Babelthuap and Ngardmau soils but are more highly erodible.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Babelthuap soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is dark reddish brown very gravelly loam 10 centimeters thick. The upper 18 centimeters of the subsoil is strong brown silty clay, and the lower 36 centimeters is dark red and yellowish red silty clay. The substratum to a depth of 150 centimeters or more is dark yellowish brown silty clay loam.

Permeability of the Babelthuap soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

The Ngardmau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is strong brown very gravelly silty clay loam 12 centimeters thick. The subsoil is yellowish red and red silty clay 28 centimeters thick. The substratum to a depth of more than 150 centimeters is weak red and yellowish red silty clay loam.

Permeability of the Ngardmau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

This unit is used mainly as watershed. It can be used for pasture, crops, and woodland if proper management practices are used. A few areas have been mined for bauxite.

This unit is poorly suited to use as pasture. The main limitations are very low soil fertility and a large amount of gravel on and in the surface layer. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and very poorly suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are very low soil fertility, slope, the hazard of erosion, droughtiness of the surface layer, and a large amount of gravel on and in the surface layer. Fertility can be increased by adding lime and large amounts of compost and other organic fertilizer. The high content of gravel in the surface layer results in droughtiness, which may cause seedlings to wilt. Clearing gravel from the surface, adding organic matter, mulching, and cultivating the surface layer with the upper part of the nongravelly subsoil help to overcome this problem.

This unit is well suited to woodland species tolerant of very low soil fertility. Reforestation is needed.

This unit is moderately suited to homesite development. The main limitations are slope and low soil strength. If buildings and roads are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

This unit is poorly suited to onsite waste disposal. The main limitations are slope and the hazard of lateral seepage. Place leach lines on the contour, and avoid using pit leaching wherever possible.

407—Chia-Insak complex, 0 to 1 percent slopes. This map unit is in the intertidal area adjacent to the shoreline. Areas are irregular in shape and are 2 to 50 hectares in size. The vegetation is mangrove forest.

This unit is 45 percent Chia mucky peat and 35 percent Insak peaty loamy sand. Also in this unit is about 15 percent Ilachetomel soils. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to the Chia soil but are shallow to a hard coral reef platform.

The Chia soil is very deep and very poorly drained. It formed in decomposing mangrove roots and litter over coral sand and gravel. The surface layer is black, dark reddish brown, and very dark grayish brown mucky peat 73 centimeters thick. The upper 22 centimeters of the underlying material is dark reddish brown gravelly loamy sand, and the lower part to a depth of 150 centimeters or more is dark grayish brown very gravelly loamy sand.

Permeability of the Chia soil is rapid. Effective rooting depth for saltwater-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow and the hazard of water erosion is high because of wave action. A water table is 30 centimeters above the surface to 30 centimeters below the surface year-round. If this soil is drained, it decomposes and subsides.

The Insak soil is moderately deep and very poorly drained. It formed in decomposing mangrove roots and litter and in coral sand. The surface layer is very dark grayish brown peaty loamy sand about 8 centimeters thick. The next layer is dark brown mucky loamy sand about 9 centimeters thick. The upper part of the underlying material is dark yellowish brown mucky loamy sand about 28 centimeters thick, and the lower part to a depth of 75 centimeters is dark yellowish brown gravelly loamy sand. A hard coral reef platform is at a depth of 75 centimeters.

Permeability of the Insak soil is rapid. Effective rooting depth for saltwater-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow and the hazard of water erosion is high because of wave action. A water table is 30 centimeters above the surface to 30 centimeters below the surface year-round. If this soil is drained, it decomposes and subsides.

From the lagoon to the island are significant differences in the frequency, depth, and duration of tidal water flooding as well as differences in the salinity of the water because of the freshwater runoff and rainfall. As a result, the soils in this unit vary in wetness from areas nearer the lagoon that are submerged all the time to areas nearer the island that are submerged only at the highest tide. Because of these differences, the habitat on this unit is diverse and includes a wide variety of plants and animals.

This unit is used mainly for collecting firewood and harvesting mangrove crabs. It can be used as a source of compost. The Chia soils are well suited and the Insak soils are moderately suited to mangrove species such as *Rhizophora apiculata* and *Bruguieria gymnorhiza*. The Chia soils are moderately suited and the Insak soils are poorly suited to the planting of most other mangrove species.

The Chia soil has potential as a source of compost. It is limited by the high content of salts and sulfur. If the soil material is collected for use as compost, it should be stockpiled for about 1 month so that the rain can leach out the salts. Finely crushed coral sand or other sources of lime should be thoroughly mixed into the material at the time of stockpiling. This prevents the conversion of the sulfur to sulfuric acid, which would lower the reaction of the material to levels that are toxic to plants. The addition of lime results in the formation of gypsum, a desirable soil amendment. Enough lime should be added so that the reaction of the compost is about 6.0 after the 1-month stockpiling period.

This unit is poorly suited to onsite waste disposal systems because of wetness and the hazard of flooding. The effluent may be washed into the lagoon with the daily outflow of tidal waters and thus contaminate the adjacent lagoon and create a hazard to the health of swimmers and consumers of the sea life taken from these areas.

This unit is poorly suited to roads because of low soil strength, wetness, and the hazard of flooding. These limitations can be overcome by placing crushed coral down to the bedrock and by elevating the road surface to about 1 meter above the mean high tide level.

408—Dechel-Mesei complex, 0 to 2 percent slopes. This map unit is on valley bottoms near sea level, in areas where water cannot drain freely into streams or the ocean. Areas are long and narrow or irregular in shape and are 2 to 150 hectares in size. The vegetation in areas not cultivated is mainly freshwater marsh. Some areas of the Dechel soil are under swamp forest.

This unit is 50 percent Dechel mucky silt loam and 30 percent Mesei muck. The Mesei soil is randomly distributed throughout the unit, but typically it is not adjacent to streams. The Dechel soil is adjacent to uplands, near streams or the shoreline. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils on dikes and levees that are better drained than the Dechel and Mesei soils and that support banana plants and coconut trees. Also included are small areas of soils that are similar to this Dechel soil but have a layer of muck or peaty muck; soils that are similar to the Mesei soil but have muck that extends to a depth of 150 centimeters or have silt loam or silty clay loam at a depth of less than 63 centimeters; and, in the area of Ngersuul, soils that are similar to the Dechel soil but are underlain by marine clay at a depth of about 122 centimeters.

The Dechel soil is very deep and very poorly drained. It formed in alluvium washed from upland soils derived dominantly from volcanic rock. Typically, the surface is covered with a mat of undecomposed and partially decomposed grasses and sedges 10 centimeters thick. The surface layer is dark gray mucky silt loam 10 centimeters thick. The upper 92 centimeters of the underlying material is olive gray, greenish gray, and dark greenish gray silty clay loam, and the lower part to a depth of 168 centimeters or more is dark greenish gray very gravelly silty clay loam and dark grayish brown silty clay loam.

Permeability of the Dechel soil is moderately slow. The effective rooting depth for water-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. This soil is subject to frequent, very long periods of flooding and deposition throughout the year. A high water table is 10 centimeters above the surface to 15 centimeters below the surface year-round.

The Mesei soil is very deep and very poorly drained. It formed in organic material derived from decomposed and partially decomposed freshwater marsh vegetation overlying alluvium washed from upland soils derived dominantly from volcanic rock. The surface layer is dark brown and very dark grayish brown muck about 86 centimeters thick. The underlying material to a depth of 150 centimeters is dark gray silt loam. Below this to a depth of 188 centimeters or more is black mucky peat.

Permeability of the Mesei soil is rapid to a depth of 86 centimeters and moderately slow below this depth. The effective rooting depth for water-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. This soil is subject to frequent, very long periods of flooding throughout the year. A high water table is 30 centimeters above the surface to 15 centimeters below the surface year-round. If the soil is drained, the organic layer decomposes and subsides.

This unit is used for the production of wetland taro.

The Dechel soil is moderately suited to the production of wetland taro, and the Mesei soil is well suited to this use (fig. 2). Developing a thick layer of organic material improves the suitability of the Dechel soil for the production of taro. The yield of these soils can be increased by proper fertilization.

This unit is poorly suited to most engineering uses. Roads constructed across the unit need large volumes of base material to compensate for the low strength of the soils.

This unit is well suited to pond reservoir areas; however, because of the low strength of the soils, the edge of the pond should be adjacent to an area of an upland soil that is accessible to livestock. Keying in dam cores to suitable material may be difficult because of the great depth of saturated alluvium in many areas.

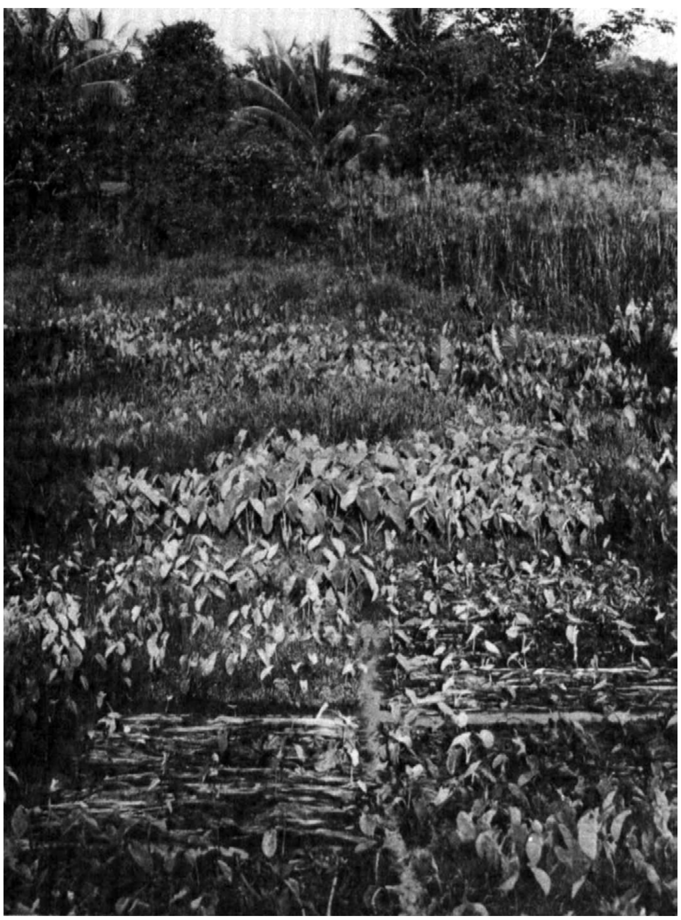

Figure 2.—Taro patch on Dechel and Mesei soils. Banana leaf mulch reduces weed growth. Water level is controlled by ditches and levees.

409—Ilachetomel peat, 0 to 1 percent slopes. This very deep, very poorly drained soil is in the intertidal area adjacent to the shoreline. It formed in decomposing roots and litter derived dominantly from mangrove vegetation. Areas are irregular in shape and are 3 to 690 hectares in size. The vegetation is mangrove forest.

Typically, the surface layer is black peat 20 centimeters thick. The next layer is very dark grayish brown peat 21 centimeters thick. Below this to a depth of 150 centimeters or more is very dark grayish brown peat.

Included in this unit are small areas of Chia soils on the lagoon side of the unit and mucky silt loam soils on the landward side. Included areas make up about 25 percent of the total hectarage. The percentage varies from one area to another.

Permeability of this Ilachetomel soil is rapid. Effective rooting depth for saltwater-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow and the hazard of water erosion is high because of wave action.

In areas of this unit from the lagoon to the island there are significant differences in the frequency, depth, and duration of tidal water flooding as well as differences in the salinity of the water because of the freshwater runoff and rainfall. As a result, the unit varies in wetness from areas nearer the lagoon that are submerged all the time to areas nearer the island that are submerged only at the highest tide. Because of these differences, the habitat on the unit is diverse and supports a wide variety of plants and animals.

This unit is used for woodland and the harvesting of mangrove crabs. It can be used as a source of compost.

This unit is well suited to the production of woodland species such as *Rhizophora mucronata*, *Sonneratia alba*, *Lumnitzera littorea*, *Bruguiera gymnorhiza*, and *Xylocarpus granatum*. *Rhizophora mucronata* is used as firewood and as a source of good quality charcoal. *Sonneratia alba* is used for posts. *Lumnitzera littorea* is used for timber and posts. *Xylocarpus granatum* is used as storyboard material and for decorating. *Bruguiera gymnorhiza* occasionally is used for posts. The main concerns in producing and harvesting timber are the hazards of erosion and soil degradation, and low soil fertility. Clearcutting trees to the edge of the lagoon exposes the soil in this unit to wave action, resulting in erosion, and allows nutrients to be leached from the soil, reducing the suitability of the soil for reforestation.

This unit has potential as a source of compost. It is limited by the high content of salts and sulfur. If the soil material is collected, it should be stockpiled for about 1 month so that the rain can leach out the salts. Finely crushed coral sand or other sources of lime should be thoroughly mixed into the material at the time of stockpiling. This prevents the conversion of the sulfur to sulfuric acid, which would lower the reaction of the material to levels that are toxic to plants. The addition of lime results in the formation of gypsum, a desirable soil amendment. Enough lime should be added so that the reaction of the compost is about 6.0 after the 1-month stockpiling period.

This unit is poorly suited to onsite waste disposal systems because of wetness and the hazard of flooding. Effluent may be washed into the lagoon with the daily outflow of tidal waters and thus contaminate the adjacent lagoon and create a hazard to the health of swimmers and consumers of the sea life taken from these areas.

This unit is poorly suited to roads because of low soil strength, wetness, and the hazard of flooding. These limitations may be overcome by placing crushed coral or basalt ballast down to the bedrock and by elevating the road surface to about 1 meter above the mean high tide level.

410—Nekken-Ollei complex, 12 to 30 percent slopes. This map unit is on low-lying foothills and ridgetops. Slopes are convex. Areas are irregular in shape and are 5 to 100 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 65 percent Nekken very gravelly silt loam and 25 percent Ollei very gravelly loam.

Included in this unit are small areas of Babelthuap soils on ridges, Aimeliik and Ngardok soils, and Rock outcrop on small convex knolls and side slopes. Also included are small areas of soils that have slopes of less than 12 percent or more than 30 percent.

The Nekken soil is moderately deep and well drained. It formed in residuum derived dominantly from andesitic and basaltic breccia and tuff. Typically, the surface is covered with a mat of undecomposed and partially decomposed forest litter 3 centimeters thick. The surface layer is very dark brown very gravelly silt loam 20 centimeters thick. The upper 56 centimeters of the subsoil is dark yellowish brown very gravelly silty clay loam, and the lower 10 centimeters is very dark brown very gravelly silt loam. Very hard, bedded tuff is at a depth of 56 centimeters. Bedrock is at a depth of 50 to 76 centimeters.

Permeability of the Nekken soil is moderate. Effective rooting depth is 50 to 76 centimeters. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

The Ollei soil is shallow and well drained. It formed in residuum derived dominantly from hard andesitic and basaltic breccia and tuff. The surface layer is very dark brown silt loam 18 centimeters thick. The subsoil is brown very gravelly loam 10 centimeters thick. The substratum to a depth of 43 centimeters is dark yellowish brown extremely flaggy loam. Hard, bedded tuff is at a depth of 43 centimeters. Bedrock is at a depth of 25 to 51 centimeters.

Permeability of the Ollei soil is moderate. Effective rooting depth is 25 to 51 centimeters. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. The areas that support savannah vegetation can be used for pasture.

This unit is well suited to use as pasture. Grasses and legumes grow well if adequate fertilizer is used. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are shallow rooting depth and droughtiness of the Ollei soil, low soil fertility, the content of coarse fragments, and the hazards of erosion and soil degradation. If the unit is used for subsistence agricultural forest crops, the main limitations are shallow rooting depth and droughtiness of the Ollei soil, slope, and the hazard of erosion. Avoiding burning, adding compost and other organic fertilizer, rotating crops, and mulching are needed to maintain fertility and reduce the hazards of erosion and soil degradation. Yields of agricultural forest crops from the Ollei soil may be less than those from the Nekken soil. This may be partially overcome by applying a larger amount of fertilizer to the Ollei soil.

This unit is moderately suited to use as woodland. The main concerns in producing and harvesting timber are shallow rooting depth and droughtiness of the Ollei soil.

This unit is poorly suited to homesite development. The main limitations are slope and depth to rock. The deep cuts needed to provide essentially level building sites expose bedrock. Erosion is a hazard on the steeper slopes. Only the part of the site that is used for construction should be disturbed. Structures to divert runoff are needed if buildings and roads are constructed. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling.

This unit is poorly suited to use as roadfill because of the low strength of the subsoil. The bedrock underlying the soils is well suited to use as a source of rock for road construction.

This unit is poorly suited to onsite waste disposal systems because of the shallow and moderate depth to bedrock and the steepness of slope.

411—Ngardmau-Babelthuap complex, 30 to 50 percent slopes. This map unit is on ridges and upper side slopes. Slopes are convex. Areas are irregular in shape and are 3 to 50 hectares in size. The vegetation is deteriorated savannah.

This unit is 55 percent Ngardmau very gravelly silty clay loam and 40 percent Babelthuap very gravelly loam.

Included in this unit are small areas of Aimeliik and Palau soils in concave areas primarily under forest vegetation and soils that have slopes of less than 30 percent or more than 50 percent. Also included are small areas of gullied soils that are similar to the Babelthuap and Ngardmau soils but are more highly erodible.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Ngardmau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is strong brown very gravelly silty clay loam 12 centimeters thick. The subsoil is dominantly yellowish red and red silty clay 28 centimeters thick. The substratum to a depth of 150 centimeters or more is weak red and yellowish red silty clay loam.

Permeability of the Ngardmau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

The Babelthuap soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is dark reddish brown very gravelly loam 10 centimeters thick. The upper 18 centimeters of the subsoil is strong brown silty clay, and the lower 36 centimeters is dark red and yellowish red silty clay. The substratum to a depth of more than 150 centimeters is dark yellowish brown silty clay loam.

Permeability of the Babelthuap soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

This unit is used mainly as watershed. It can be used for pasture, crops, and woodland if proper management practices are used. A few areas have been mined for bauxite.

This unit is poorly suited to use as pasture. The main limitations are slope, the hazard of erosion, very low soil fertility, and a large amount of gravel on and in the surface layer. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and very poorly suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are very low soil fertility, slope, the hazard of erosion, droughtiness of the surface layer, and a large amount of gravel on and in the surface layer. Fertility of the soil can be increased by adding lime and large amounts of compost and other organic fertilizer. The high content of gravel in the surface layer results in droughtiness, which may cause seedlings to wilt. Clearing gravel from the surface, mulching, adding organic matter, and cultivating the surface layer with the upper part of the nongravelly subsoil help to overcome this problem. Contour stripcropping and using crop rotation are needed.

This unit is moderately suited to woodland species tolerant of low soil fertility such as *Casuarina spp.* and some *Eucalyptus spp.*. The main limitations are slope and the hazard of erosion. Reforestation is needed.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. If roads and buildings are constructed on this unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Material cast to the side from road construction in critical areas should be planted with a suitable ground cover to reduce the hazard of sedimentation of streams.

This unit is poorly suited to onsite waste disposal systems. The main limitations are slope and the hazard of lateral seepage. Deep-well leaching pits can be used where the depth to hard bedrock is more than 6 meters.

412—Ngardmau-Babelthuap complex, 50 to 75 percent slopes. This map unit is on upper side slopes. Slopes are convex. Areas are irregular in shape and are 3 to 50 hectares in size. The vegetation is deteriorated savannah.

This unit is 60 percent Ngardmau very gravelly silty clay loam and 35 percent Babelthuap very gravelly loam.

Included in this unit are small areas of Aimeliik and Palau soils in concave areas primarily under forest vegetation and soils that have slopes of less than 50 percent or more than 75 percent. Also included are small areas of gullied soils that are similar to the Babelthuap and Ngardmau soils but are more highly erodible.

A few large boulders are on the surface of the soil in this unit or are buried in the soil profile.

The Ngardmau soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer is strong brown very gravelly silty clay loam 12 centimeters thick. The subsoil is dominantly yellowish red and red silty clay 28 centimeters thick. The substratum to a depth of 150 centimeters or more is weak red and yellowish red silty clay loam.

Permeability of the Ngardmau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high.

The Babelthuap soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. Typically, 25 to 90 percent of the surface is ironstone and gibbsite concretions. The surface layer is dark reddish brown very gravelly loam 10 centimeters thick. The upper 18 centimeters of the subsoil is strong brown silty clay, and the lower 36 centimeters is dark red and yellowish red silty clay. The substratum to a depth of 150 centimeters or more is dark yellowish brown silty clay loam.

Permeability of the Babelthuap soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high.

This unit is used mainly for watershed. It can be used for crops and woodland if proper management practices are used. A few areas have been mined for bauxite.

This unit is very poorly suited to subsistence clean-tilled crop production and subsistence agricultural forest crop production.

This unit is moderately suited to woodland species tolerant of low soil fertility. The main limitations are slope and the hazard of erosion. Reforestation of this unit is needed.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. If roads and buildings are constructed on this unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow soil material to dry sufficiently before filling and compacting areas of this unit. Material cast to the side from road construction in critical areas should be planted with a suitable ground cover to reduce the hazard of sedimentation of streams.

This unit is poorly suited to onsite waste disposal systems. The main limitations are the very steep slopes and the hazard of lateral seepage.

413—Ngardok silt loam, 2 to 6 percent slopes. This very deep, well drained soil is on low-lying foothills. It formed in residuum derived dominantly from very soft volcanic tuff. Slopes are slightly convex. Areas are irregular in shape and are 2 to 50 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark yellowish brown silt loam 5 centimeters thick. The upper 13 centimeters of the subsoil is brown silty clay loam, the next 51 centimeters is strong brown silty clay loam, and the lower 12 centimeters is mixed brown silty clay loam and dusky red saprolite. The substratum to a depth of 150 centimeters or more is dusky red very soft silt loam. In some areas the surface layer is silty clay loam. In some areas are a few boulders or outcroppings of hard rock.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland. Also included are small areas of Aimeliik and Palau soils, soils that have slopes of less than 2 percent or more than 6 percent, and badland consisting of grassland that has been severely gullied to expose the substratum. Included areas make up about 25 percent of the total hectarage.

Permeability of the Ngardok soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for subsistence crop production and homesites. The unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture. The main limitation is the hazard of gully erosion from livestock trails. This can be reduced by deferring grazing and avoiding overgrazing.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are the hazards of erosion and soil degradation and low soil fertility. Using crop rotation, avoiding burning, applying compost and other organic fertilizer, adding lime, and mulching help to overcome these limitations. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland. Practices that expose the highly erodible substratum should be avoided.

This unit is well suited to homesite development. Sites where the substratum is exposed by cutting are subject to a high hazard of erosion. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

If this unit is used for onsite waste disposal, place septic tank leach lines on the contour and avoid using pit leaching.

414—Ngardok silt loam, 6 to 12 percent slopes. This very deep, well drained soil is on low-lying foothills. It formed in residuum derived dominantly from very soft volcanic tuff. Slopes are slightly convex. Areas are irregular in shape and are 2 to 50 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark yellowish brown silt loam 5 centimeters thick. The upper 13 centimeters of the subsoil is brown silty clay loam, the next 51 centimeters is strong brown silty clay loam, and the lower 12 centimeters is mixed brown silty clay loam and dusky red saprolite. The substratum to a depth of 150 centimeters or more is dusky red silt loam. In some areas are a few boulders or outcroppings of hard rock.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland. Also included are small areas of Aimeliik and Palau soils, soils that have slopes of less than 6 percent or more than 12 percent, and badland that consists of grassland that has been severely gullied to expose the substratum. Included areas make up about 25 percent of the total hectarage.

Permeability of the Ngardok soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for subsistence crop production and homesites. The unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture. The main limitation is the hazard of gully erosion of livestock trails. This can be reduced by deferring grazing and avoiding overgrazing.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility, the hazard of soil degradation, and the high hazard of erosion if the substratum is exposed. Rotating crops, avoiding burning, applying compost and other organic fertilizer, adding lime, and mulching help to overcome these limitations. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland. Practices that expose the highly erodible substratum should be avoided.

This unit is well suited to homesite development. The main limitations are slope, which increases the construction costs, and low soil strength. Sites where the substratum is exposed by cutting are subject to a high hazard of erosion. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow soil material to dry sufficiently before filling and compacting areas of this unit.

Septic tank absorption fields should be placed in the less sloping areas of this unit. Place all leach lines on the contour, and avoid using pit leaching wherever possible.

415—Ngardok silt loam, 12 to 30 percent slopes. This very deep, well drained soil is on low-lying foothills. It formed in residuum derived dominantly from very soft volcanic tuff. Slopes are convex. Areas are irregular in shape and are 2 hectares to several hundred hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark yellowish brown silt loam 5 centimeters thick. The upper 13 centimeters of the subsoil is brown silty clay loam, the next 51 centimeters is strong brown silty clay loam, and the lower 12 centimeters is mixed brown silty clay loam and dusky red saprolite. The substratum to a depth of 150 centimeters or more is dusky red very soft silt loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland. Also included are small areas of Aimeliik and Palau soils, soils that have slopes of less than 12 percent or more than 30 percent, and badland consisting of grassland that has been severely gullied to expose the substratum. Included areas make up about 25 percent of the total hectarage. In some areas of this unit are a few boulders or outcropings of hard rock.

Permeability of the Ngardok soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for subsistence crop production and homesites. The unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture. The main limitation is the hazard of gully erosion of livestock trails. This can be reduced by deferring grazing and avoiding overgrazing.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility, the hazard of soil degradation, and the high hazard of erosion if the substratum is exposed. Rotating crops, avoiding burning, applying compost and other organic fertilizer, adding lime, and mulching help to overcome these limitations. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland. Practices that expose the highly erodible substratum should be avoided.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. Sites where the substratum is exposed by cutting are subject to a high hazard of erosion. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow soil material to dry sufficiently before filling and compacting areas of this unit.

This unit is poorly suited to onsite waste disposal. The main limitations are slope and the hazard of lateral seepage. All leach lines should be placed on the contour, and pit leaching should be avoided.

416—Ngardok silt loam, 30 to 50 percent slopes. This very deep, well drained soil is on low-lying foothills. It formed in residuum derived dominantly from very soft volcanic tuff. Slopes are convex. Areas are irregular in shape and are 2 to more than 1,000 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark yellowish brown silt loam 5 centimeters thick. The upper 13 centimeters of the subsoil is brown silty clay loam, the next 51 centimeters is strong brown silty clay loam, and the lower 12 centimeters is mixed brown silty clay loam and dusky red saprolite. The substratum to a depth of 150 centimeters or more is dusky red very soft silt loam. In some areas are a few boulders or outcroppings of hard rock.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland. Also included are small areas of Aimeliik and Palau soils, soils that have slopes of less than 30 percent or more than 50 percent, and badland consisting of grassland that has been severely gullied to expose the substratum. Included areas make up about 25 percent of the total hectarage.

Permeability of the Ngardok soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for subsistence crop production and homesites. The unit can be used for pasture where savannah vegetation is present.

This unit is moderately suited to use as pasture. The main limitations are slope and the hazard of gully erosion of livestock trails. Gully erosion can be reduced by deferring grazing and avoiding overgrazing.

This unit is very poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. Care should be taken to avoid burning. All crop residue should be returned to the soil.

This unit is moderately suited to use as woodland. The main limitations are slope and the hazard of erosion. Practices that expose the highly erodible substratum and clearcutting should be avoided.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. Sites where the substratum is exposed by cutting are subject to a high hazard of erosion. The hazard of erosion is increased if the soil is left exposed during site development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficently before filling and compacting areas of this unit.

This unit is poorly suited to septic tank absorption fields. The main limitations are slope and the hazard of lateral seepage. Deep-well leaching pits can be used where the depth to bedrock is more than 6 meters.

417—Ngardok silt loam, 50 to 75 percent slopes. This very deep, well drained soil is on low-lying foothills. It formed in residuum derived dominantly from very soft volcanic tuff. Slopes are convex. Areas are irregular in shape and are 3 to more than 400 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark yellowish brown silt loam 5 centimeters thick. The upper 13 centimeters of the subsoil is brown silty clay loam, the next 51 centimeters is strong brown silty clay loam, and the lower 12 centimeters is mixed brown silty clay loam and dusky red saprolite. The substratum to a depth of 150 centimeters or more is dusky red, very soft silt loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland. Also included are small areas of Aimeliik and Palau soils, soils that have slopes of less than 50 percent or more than 75 percent, and badland consisting of grassland that has been severely gullied to expose the substratum. Included areas make up about 25 percent of the total hectarage. In some areas of this unit are a few boulders or outcroppings of hard rock.

Permeability of the Ngardok soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high.

Most areas of this unit are used for watershed, food gathering, and some woodland for village use. A few areas are used for subsistence crop production and homesites. The unit can be used for pasture where savannah vegetation is present.

This unit is poorly suited to use as pasture. The main limitations are slope and the hazard of gully erosion of livestock trails. The hazard of gully erosion can be reduced by deferring grazing and avoiding overgrazing.

This unit is very poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. Because of the hazard of erosion, only very small areas should be cleared at any one time for planting subsistence agricultural forest crops.

This unit is poorly suited to use as woodland. The main limitations are slope and the hazard of erosion. Practices that expose the highly erodible substratum and clearcutting should be avoided.

This unit is poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and low soil strength. The hazard of erosion is increased if the soil is left exposed during site development. Sites where the substratum is exposed by cutting are subject to a very high hazard of erosion. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

This unit is poorly suited to onsite waste disposal systems. The main limitations are slope and the hazard of lateral seepage.

418—Ngatpang gravelly clay loam, 2 to 12 percent slopes, severely eroded. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Slopes are slightly convex. Areas are irregular in shape and are 3 to 40 hectares in size. The vegetation is deteriorated savannah.

Typically, 50 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer has been lost through erosion. The upper 20 centimeters of the subsoil is dark brown gravelly clay loam, the next 18 centimeters is yellowish red clay, and the lower 28 centimeters is mottled, brownish yellow and yellowish brown clay. The substratum to a depth of 150 centimeters or more is mottled, light gray and yellowish brown clay.

Included in this unit are small areas of Ngatpang soils that are not eroded, Tabecheding silty clay loam, and Tabecheding silty clay loam, severely eroded, in depressional areas and low-lying areas. Also included are small areas of soils that have slopes of less than 2 percent or more than 12 percent. Included areas make up about 10 percent of the total hectarage.

Permeability of the Ngatpang, severely eroded, soil is very slow. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight.

This unit is used as watershed. It can be used for reservoirs, as a source of clay for pottery, tile, and bricks, and as woodland.

This unit is poorly suited to subsistence clean-tilled crop production and very poorly suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitation is very low soil fertility. Avoiding burning, rotating crops, adding compost, fertilizer, and lime, and mulching help to overcome this limitation. All tillage should be on the contour or across the slope.

This unit is well suited to woodland species adapted to very low soil fertility and high acidity. Reforestation is needed.

This unit is moderately suited to homesite development. The main limitations are low strength of the soil and very slow permeability. If roads and buildings are constructed on this unit, the low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Allow the soil material to dry sufficiently before filling and compacting areas of the unit.

Septic tank absorption fields do not function properly on this unit because of the very slow permeability. Construction of filter fields on a raised bed helps to overcome this limitation. Absorption fields should be placed in the less sloping areas.

This unit is well suited to prawn ponds, reservoirs, and livestock watering ponds because of the very slow permeability.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

419—Ngatpang gravelly clay loam, 12 to 50 percent slopes, severely eroded. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Slopes are convex. Areas are irregular in shape and are 5 to 20 hectares in size. The vegetation is deteriorated savannah.

Typically, 50 to 90 percent of the surface is covered with ironstone and gibbsite concretions. The surface layer has been lost through erosion. The upper 20 centimeters of the subsoil is dark brown gravelly clay loam, the next 18 centimeters is yellowish red clay, and the lower 28 centimeters is mottled, brownish yellow and yellowish brown clay. The substratum to a depth of 150 centimeters or more is mottled, light gray and yellowish brown clay.

Included in this unit are small areas of Ngatpang soils that are not eroded, Tabecheding silty clay loam, and Tabecheding silty clay loam, severely eroded, in depressional areas and low-lying areas. Also included are small areas of soils that have slopes of less than 12 percent or more than 50 percent. Included areas make up about 10 percent of the total hectarage.

Permeability of the Ngatpang, severely eroded, soil is very slow. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium to rapid and the hazard of water erosion is moderate to high.

This unit is used as watershed. It can be used for reservoirs, as a source of clay for pottery, tile, and bricks, for dryland crops, and as woodland.

This unit is very poorly suited to crop production.

This unit is moderately suited to woodland species adapted to very low soil fertility and high acidity. The main limitations are slope and the hazard of erosion. Reforestation is needed.

This unit is poorly suited to homesite development. Foundations should be designed to offset the shrink-swell potential of the substratum. Slope increases the cost of construction. Structures to divert runoff are needed if buildings and roads are constructed.

Septic tank absorption fields do not function properly on this unit because of the very slow permeability and slope.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

420—Ngatpang silty clay loam, 2 to 6 percent slopes. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 3 to 80 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark brown and dark yellowish brown silty clay loam 15 centimeters thick. The upper 13 centimeters of the subsoil is strong brown gravelly silty clay, and the lower 86 centimeters is strong brown, yellowish red, and yellowish brown, mottled clay. The substratum to a depth of 150 centimeters or more is yellowish brown and light gray clay that has yellowish red, strong brown, and light yellowish brown mottles.

Included in this unit are small areas of Aimeliik and Palau soils, Tabecheding soils in depressional areas, and Ngatpang soils, severely eroded, in random areas and adjacent to gullies. Also included are small areas of soils that have slopes of less than 2 percent or more than 6 percent. In some areas are soils that are similar to this Ngatpang soil but have lignite in the substratum. Included areas make up about 10 percent of the total hectarage.

Permeability of the Ngatpang soil is moderately slow to a depth of 136 centimeters and very slow below this depth. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight.

Most areas of this unit are used as watershed. A few areas are used for small garden crops, mainly dryland taro cassava, cucumbers, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, and sugarcane. Other crops grown are bananas, coconuts, and pineapples. The unit can be used as pasture and woodland.

This unit is well suited to use as pasture.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility and the hazard of soil degradation. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome these limitations. In a few localized areas, drainage trenches installed on the contour about every 15 meters may be needed if a few crops such as black pepper and pineapple are grown.

This unit is well suited to use as woodland.

This unit is well suited to homesite development. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

This unit is poorly suited to septic tank absorption fields because of the moderately slow permeability. This limitation can be reduced by increasing the size of the absorption field. Absorption fields may not function properly after heavy rains because of wetness. All leach lines should be placed on the contour or across the slope. Disturbed areas where the very slowly permeable substratum is at a shallower depth should be avoided.

Development of reservoirs, prawn ponds, and livestock watering ponds is well suited to this unit because of the very slowly permeable substratum. Compaction of embankments may be difficult because of the high rainfall.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

421—Ngatpang silty clay loam, 6 to 12 percent slopes. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 4 to 40 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark brown and dark yellowish brown silty clay loam 15 centimeters thick. The upper 13 centimeters of the subsoil is strong brown gravelly silty clay, and the lower 86 centimeters is strong brown, yellowish red, and yellowish brown, mottled clay. The substratum to a depth of 150 centimeters or more is yellowish brown and light gray clay that has yellowish red, strong brown, and light yellowish brown mottles.

Included in this unit are small areas of Aimeliik and Palau soils, Tabecheding soils in depressional areas, and Ngatpang soils, severely eroded, in random areas and adjacent to gullies. Also included are small areas of soils that have slopes of less than 6 or more than 12 percent. In some areas are soils that are similar to this Ngatpang soil but have lignite in the substratum. Included areas make up about 15 percent of the total hectarage.

Permeability of the Ngatpang soil is moderately slow to a depth of 136 centimeters and very slow below this depth. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight.

Most areas of this unit are used as watershed. A few areas are used for small garden crops, mainly dryland taro cassava, cucumbers, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, and sugarcane. Other crops grown are bananas, coconuts, and pineapples. The unit can be used as pasture and woodland.

This unit is well suited to use as pasture. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility and the hazard of soil degradation. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome these limitations.

This unit is well suited to use as woodland.

This unit is well suited to homesite development. The main limitations are slope, which increases construction costs, and low soil strength. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

This unit is poorly suited to septic tank absorption fields because of the moderately slow permeability. This limitation can be reduced by increasing the size of the absorption field. Absorption fields may not function properly after heavy rains because of wetness. Effluent from absorption fields can surface in downslope areas and create a hazard to health. All leach lines should be placed on the contour, and disturbed areas where the very slowly permeable substratum is at a shallower depth should be avoided.

The development of reservoirs, prawn ponds, and livestock watering ponds is well suited to this unit because of the very slowly permeable substratum. The main limitation is slope.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

422—Ngatpang silty clay loam, 12 to 30 percent slopes. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Slopes are convex. Areas are irregular in shape and are 3 to 150 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark brown and dark yellowish brown silty clay loam 15 centimeters thick. The upper 13 centimeters of the subsoil is strong brown gravelly silty clay, and the lower 86 centimeters is strong brown, yellowish red, and yellowish brown, mottled clay. The substratum to a depth of 150 centimeters or more is yellowish brown and light gray clay that has yellowish red, strong brown, and light yellowish brown mottles.

Included in this unit are small areas of Aimeliik and Palau soils, Tabecheding soils in depressional areas, and Ngatpang soils, severely eroded, in random areas and adjacent to gullies. Also included are small areas of soils that have slopes of less than 12 percent or more than 30 percent. In some areas are soils that are similar to this Ngatpang soil but have lignite in the substratum. Included areas make up about 15 percent of the total hectarage.

Permeability of the Ngatpang soil is moderately slow to a depth of 136 centimeters and very slow below this depth. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate.

This unit is used for watershed, food gathering, and some woodland for village use. The unit can be used as pasture.

This unit is well suited to use as pasture. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility and the hazards of soil degradation and erosion. Avoiding burning, rotating crops, adding compost, fertilizer, and lime, and mulching help to overcome these limitations. The hazard of erosion can be reduced by planting a cover crop. All tillage should be on the contour or across the slope.

This unit is well suited to use as woodland.

This unit is poorly suited to homesite development. The main limitations are slope, low soil strength, moderately slow permeability, and the hazard of erosion. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of the unit. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

This unit is poorly suited to onsite waste disposal because of slope and the hazard of lateral seepage.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

423—Ngatpang silty clay loam, 30 to 50 percent slopes. This very deep, moderately well drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Slopes are convex. Areas are irregular in shape and are 5 to 100 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

Typically, the surface layer is dark brown and dark yellowish brown silty clay loam 15 centimeters thick. The upper 13 centimeters of the subsoil is strong brown gravelly silty clay, and the lower 86 centimeters is strong brown, yellowish red, and yellowish brown, mottled clay. The substratum to a depth of 150 centimeters or more is yellowish brown and light gray clay that has yellowish red, strong brown, and light yellowish brown mottles.

Included in this unit are small areas of Aimeliik and Palau soils, Tabecheding soils in depressional areas, and Ngatpang soils, severely eroded, in random areas and adjacent to gullies. Also included are small areas of soils that have slopes of less than 30 percent or more than 50 percent. In some areas are soils that are similar to this Ngatpang soil but have lignite in the substratum. Included areas make up about 25 percent of the total hectarage.

Permeability of the Ngatpang soil is moderately slow to a depth of 136 centimeters and very slow below this depth. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

This unit is used for watershed, food gathering, and some woodland for village use. The unit can be used as pasture.

This unit is moderately suited to use as pasture. The main limitations are slope and the hazard of erosion. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility and the hazards of erosion and soil degradation. Preventing burning, sod cropping, contour stripcropping, rotating crops, adding compost, fertilizer, and lime, and mulching help to overcome these limitations. If the unit is used for subsistence agricultural forest crops, the main limitations are slope and the hazard of erosion. Clearing only small areas at a time reduces the hazard of erosion.

This unit is moderately suited to use as woodland. The main limitations are slope and the hazard of erosion.

This unit is very poorly suited to homesite development. The main limitations are slope, the hazard of erosion, and the low soil strength. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction.

This unit is very poorly suited to onsite waste disposal because of slope and the hazard of lateral seepage.

This unit is moderately suited to use as a source of clay for pottery, tile, and bricks. The main limitation is the depth to the material suitable for this use.

424—Ngedebus sand, 0 to 3 percent slopes. This very deep, somewhat excessively drained soil is adjacent to coastal beaches and in the interior of the atoll islands. It formed in water- and wind-deposited coral sand. Slopes are slightly convex or hummocky. Areas are long and narrow in shape and are 3 to 600 hectares in size. The vegetation is coconut trees, atoll forest, and casaurina forest.

Typically, the surface layer is mixed grayish brown and very pale brown sand 46 centimeters thick. The upper 35 centimeters of the underlying material is pale yellow sand, and the lower part to a depth of 150 centimeters or more is very pale brown coarse sand.

Included in this unit are small areas of Ngedebus Variant soils on raised beach deposits and Peleliu soils on coral islands. Also included are small areas of poorly drained soils in depressional areas and soils that have slopes of more than 3 percent. Included areas make up about 10 percent of the total hectarage.

Permeability of the Ngedebus soil is rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very slow and the hazard of water erosion is slight. A water table is at a depth of 105 centimeters to more than 150 centimeters. The soil is subject to occasional, very brief periods of flooding. Areas of the soil closest to the shore may be affected by sodium and salt from seawater.

This unit is used mainly for growing coconut and subsistence farming. It is also used as some woodland for village use. A few areas are used for homesite development. Some areas adjacent to beaches and on secluded islands are used as campsites and picnic areas.

If this unit is used for the production of coconut, nitrogen and potassium should be added to the soil. A sufficient amount of potassium increases the number of coconuts per tree and increases the copra content. A good source of potassium is ashes from firewood and coconut husks. Broadcast application of potassium fertilizer is the most efficient method. Growing a cover crop of legumes between the trees provides an adequate amount of nitrogen. The soil in this unit commonly is also low in iron, manganese, and zinc; therefore, additions of ferrous sulfate, manganese, and zinc sulfate annually by trunk injection or spot placement in the root zone are needed. All crop residue should be returned to the soil.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. The main limitations are low soil fertility and droughtiness. Adding large quantities of compost or other organic fertilizer helps to overcome these limitations. All crop residue should be returned to the soil.

This unit is moderately suited to the production of grasses and legumes for livestock grazing. The main limitations are low soil fertility and low available water capacity. Proper grazing management, weed control, and fertilization are needed for maximum quality of forage.

This unit is moderately suited to use as woodland. Trees are subject to windthrow during typhoons, especially in areas adjacent to beaches.

Most areas of this unit are well suited to homesite development; however, some areas are severely limited because of the hazard of flooding during typhoons. This can be reduced by building structures on a raised foundation.

This unit is well suited to use as a source of roadfill and sand, but is poorly suited to use as a source of gravel.

This unit is poorly suited to septic tank absorption fields. The main limitation is seepage resulting in the hazard of ground water contamination.

425—Ngedebus Variant extremely cobbly loamy sand, 2 to 6 percent slopes. This very deep, somewhat excessively drained soil is on beaches, some of which are raised. It formed in water- and wind-deposited coral sand, gravel, and cobbles. Areas are long and narrow in shape and are 3 to 100 hectares in size. The vegetation is atoll forest.

Typically, the surface is covered with a layer of organic material 6 centimeters thick. The surface layer is mixed very dark brown and pale brown extremely cobbly loamy sand 12 centimeters thick. The subsurface layer is mixed dark brown and brown extremely cobbly loamy sand 24 centimeters thick. The underlying material to a depth of 150 centimeters or more is mixed pinkish gray and brown very cobbly loamy sand.

Included in this unit are small areas of Ngedebus soils. Also included are small areas of soils that have coral bedrock at a depth of 150 centimeters or less and a few outcroppings of coral. Included areas make up about 10 percent of the total hectarage.

Permeability of the Ngedebus Variant soil is rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is very slow and the hazard of water erosion is slight. Areas of this unit closest to the shore may be affected by sodium and salt from seawater.

This unit is used as watershed, for food gathering, and as some woodland for village use.

This unit is very poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. The main limitations are the high content of coarse fragments, low soil fertility, and droughtiness. Excavating for the planting of coconut trees is difficult and time-consuming because of the high content of coarse fragments. If this unit is used for production of coconut, nitrogen and potassium should be added to the soil. A sufficient amount of potassium increases the number of coconuts per tree and increases the copra content. A good source of potassium is ashes from wood and coconut husks. Broadcast application of potassium fertilizer is the most efficient method. A legume cover crop, seeded between the trees, provides an adequate amount of nitrogen. The soil in this unit commonly is also low in iron, manganese, and zinc; therefore, additions of ferrous sulfate, manganese, and zinc sulfate annually by trunk injection or spot placement in the root zone are needed. All crop residue should be returned to the soil.

This unit is moderately suited to use as woodland. Trees are subject to windthrow during typhoons.

This unit is poorly suited to homesite development because of the high content of coarse fragments and the hazard of flooding during typhoons. The hazard of flooding can be reduced by building structures on a raised foundation. Cobbles on the surface and in the soil make excavation difficult.

This unit is poorly suited to use as a source of roadfill and sand because of the high content of large cobbles.

This unit is poorly suited to septic tank absorption fields. The main limitations are the high content of coarse fragments, which makes excavation difficult, and poor filtration, which results in a hazard of ground water contamination.

426—Ngersuul silt loam, 0 to 2 percent slopes. This very deep, somewhat poorly drained soil is on flood plains adjacent to rivers and to the coast. It formed in alluvium washed from upland soils derived dominantly from volcanic rock. Slopes are nearly level or gently sloping. Areas are long and narrow or irregular in shape and are 10 to 65 hectares in size. The vegetation is mainly tropical forest. Some areas have been cleared and are under tall grasses.

Typically, the surface layer is dominantly reddish brown silt loam 15 centimeters thick. The upper 8 centimeters of the subsoil is yellowish brown silty clay loam, and the lower 53 centimeters is mottled, brownish yellow silty clay loam. The upper 23 centimeters of the substratum is very dark gray silty clay loam, and the lower part to a depth of 167 centimeters or more is dark gray mucky peat.

Included in this unit are small areas of Dechel soils at the lowest elevations and soils that are similar to this Ngersuul soil but are poorly drained or moderately well drained. Also included are small areas of soils that have a silty clay loam substratum that extends to a depth of more than 150 centimeters. Included areas make up about 25 percent of the total hectarage.

Permeability of the Ngersuul soil is moderately slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 60 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is very slow and the hazard of water erosion is slight. A water table is at a depth of 60 to 90 centimeters throughout the year. This soil is subject to very brief periods of flooding throughout the year.

This unit is used mainly as watershed. A few areas are used for vegetable crops.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. The unit is well suited to production of deep-rooted, water-tolerant crops. If the unit is used for subsistence clean-tilled crops, the main limitations are the hazard of flooding, the high water table, low soil fertility, and poor tilth. If the unit is used for subsistence agricultural forest crops, the main limitation is the high water table. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome the limitations of low soil fertility and poor tilth. The high water table can be lowered by the use of drainage ditches. The hazard of flooding can be reduced by the use of levees adjacent to the river. Unless crops are protected, losses because of flooding can be expected about once every 2 years.

This unit is well suited to certain woodland species adapted to wetness.

This unit is poorly suited to most engineering uses because of wetness, low soil strength, and the hazard of flooding. Upland soils that are adjacent to this unit should be selected as building sites. Thick layers of crushed coral or basalt ballast are needed to offset the limitation of low strength of the soil.

427—Ngerungor Variant-Ngerungor complex, 0 to 1 percent slopes. This map unit is on coastal bottom lands adjacent to beach deposits and in depressional areas on low coral islands. Areas are long and narrow in shape and are 3 to 400 hectares in size. The vegetation in areas not cultivated is mainly freshwater marsh.

This unit is 70 percent Ngerungor Variant peaty muck and 25 percent Ngerungor peaty muck. The Ngerungor Variant soil typically is on the fringes of the unit, and the Ngerungor soil is near the middle of the unit.

Included in this unit are small areas of soils that consist of less than 41 centimeters of organic material overlying coralline sand. Also included are areas of soils that consist of organic material overlying coral fragments or coral limestone and soils in dikes and levees that are better drained than the Ngerungor Variant and Ngerungor soils.

The Ngerungor Variant soil is very deep and very poorly drained. It formed in deposits of organic material derived dominantly from decomposed and partially decomposed freshwater marsh vegetation and overlying coral sand. The surface layer is dark brown peaty muck 53 centimeters thick. The underlying material to a depth of 150 centimeters or more is pale brown coarse sand.

Permeability of the Ngerungor Variant soil is rapid. The effective rooting depth for water-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. A high water table fluctuates from the surface to a depth of 25 centimeters year-round. The soil is subject to frequent, very brief periods of flooding year-round. If the soil is drained, the organic layer decomposes and subsides.

The Ngerungor soil is very deep and very poorly drained. It formed in organic material derived dominantly from decomposed and partially decomposed freshwater marsh vegetation. The surface layer is dark reddish brown peaty muck 39 centimeters thick. The upper 63 centimeters of the underlying material is black peaty muck, and the lower part to a depth of 150 centimeters or more is dark brown peaty muck.

Permeability of the Ngerungor soil is rapid. The effective rooting depth for water-tolerant plants is more than 150 centimeters. If the vegetation is removed, runoff is very slow or ponded and the hazard of water erosion is slight. A high water is at the surface or within a depth of 15 centimeters year-round. The soil is subject to frequent, very long periods of flooding year-round. If the soil is drained, it decomposes and subsides.

Most areas of this unit are used for the production of wetland taro. A few areas on the island of Angaur are used for phosphate mining.

This unit is well suited to the production of wetland taro. Yield can be increased by the use of green manure.

This unit is poorly suited to most engineering uses. Roads constructed across the unit need a large volume of base material to compensate for the low strength of the soil.

If this unit is used for phosphate mining, the organic layer should be stockpiled and used to reclaim abandoned strip mines immediately after mining operations have ceased. Coral sand should be used as backfill before replacing the organic material.

428—Ollei-Nekken complex, 30 to 50 percent slopes. This map unit is on high foothills and ridgetops. Slopes are convex. Areas are irregular in shape and are 5 to 200 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 50 percent Ollei very gravelly loam and 40 percent Nekken very gravelly silt loam.

Included in this unit are small areas of Babelthuap soils on ridges, Aimeliik and Ngardok soils, and Rock outcrop on small convex knolls and side slopes. Also included are small areas of soils that have slopes of less than 30 percent or more than 50 percent.

The Ollei soil is shallow and well drained. It formed in residuum derived dominantly from andesitic and basaltic breccia and tuff. The surface layer is very dark brown silt loam 18 centimeters thick. The subsoil is brown very gravelly loam 10 centimeters thick. The substratum to a depth of 43 centimeters is dark yellowish brown extremely flaggy loam. Hard, bedded tuff is at a depth of 43 centimeters. In some areas the surface layer is gravelly silt loam.

Permeability of the Ollei soil is moderate. Effective rooting depth is 25 to 50 centimeters. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

The Nekken soil is moderately deep and well drained. It formed in residuum derived dominantly from andesitic and basaltic breccia and tuff. Typically, the surface is covered with a mat of undecomposed and partially decomposed forest litter 3 centimeters thick. The surface layer is very dark brown very gravelly silt loam 20 centimeters thick. The subsoil is dark yellowish brown very gravelly silty clay loam 26 centimeters thick. The substraum is very dark brown very gravelly silt loam 10 centimeters thick. Very hard, bedded tuff is at a depth of 56 centimeters.

Permeability of the Nekken soil is moderate. Effective rooting depth is 50 to 75 centimeters. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high.

Most areas of this unit are used as watershed, for food gathering, and as some woodland for village use. Some areas have been cleared and now support savannah vegetation that can be used for pasture.

This unit is moderately suited to use as pasture. The main limitations are shallow rooting depth and droughtiness of the Ollei soil, slope, and coarse fragments on the surface.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are the shallow rooting depth and droughtiness of the Ollei soil, the content of coarse fragments, slope, the hazards of erosion and soil degradation, and low soil fertility. Areas of the Ollei soil should be avoided. Avoiding burning, adding compost and other organic fertilizer, rotating crops, contour stripcropping, and mulching are needed to increase fertility and reduce the hazard of erosion.

If the unit is used for subsistence agricultural forest crops, the main limitations are the shallow rooting depth and droughtiness of the Ollei soil and slope. Crop yields from the Ollei soil may be less than those from the Nekken soil. This may be partially overcome by applying a larger amount of fertilizer to the Ollei soil. Only small areas should be cleared at one time for planting subsistence agricultural forest crops.

This unit is moderately suited to use as woodland. The main concerns in producing and harvesting timber are the shallow rooting depth and droughtiness of the Ollei soil, slope, and the hazard of erosion. Clearcutting should be avoided.

This unit is poorly suited to homesite development. The main limitations are depth to bedrock and steepness of slope. The deep cuts needed to provide essentially level building sites will expose bedrock. Erosion is a hazard; therefore, only the part of the site that is used for construction should be disturbed. Structures to divert runoff are needed if buildings and roads are constructed. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling.

This unit is poorly suited to use as a source of roadfill because of the low strength of the subsoil. The bedrock underlying the soil in the unit is well suited as a source of rock for road construction.

This unit is very poorly suited to onsite waste disposal systems because of the shallow to moderate depth to bedrock and the steepness of slope.

429—Ollei-Nekken complex, 50 to 75 percent slopes. This map unit is on high hills and ridgetops. Slopes are convex. Areas are irregular in shape and are 5 to 350 hectares in size. The vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 55 percent Ollei very gravelly loam and 25 percent Nekken very gravelly silt loam.

Included in this unit are small areas of Babelthuap soils on ridges, Aimeliik and Ngardok soils, and Rock outcrop on small convex knolls and side slopes. Also included are small areas of soils that have slopes of less than 50 percent or more than 75 percent.

The Ollei soil is shallow and well drained. It formed in residuum derived dominantly from hard andesitic and basaltic breccia and tuff. The surface layer is very dark brown silt loam 18 centimeters thick. The subsoil is brown very gravelly loam 10 centimeters thick. The substratum to a depth of 43 centimeters is dark yellowish brown extremely flaggy loam. Hard, bedded tuff is at a depth of 43 centimeters.

Permeability of the Ollei soil is moderate. Effective rooting depth is 25 to 50 centimeters. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high.

The Nekken soil is moderately deep and well drained. It formed in residuum derived dominantly from andesitic and basaltic breccia and tuff. Typically, the surface is covered with a mat of undecomposed and partially decomposed forest litter 3 centimeters thick. The surface layer is very dark brown very gravelly silt loam 20 centimeters thick. The subsoil is dark yellowish brown very gravelly silty clay loam 26 centimeters thick. The substratum is very dark brown very gravelly silt loam 10 centimeters thick. Very hard, bedded tuff is at a depth of 56 centimeters.

Permeability of the Nekken soil is moderate. Effective rooting depth is 50 to 75 centimeters. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is very high.

Most areas of this unit are used as watershed, for food gathering, and as some woodland for village use. Some areas have been cleared and now support savannah vegetation that can be used for pasture.

This unit is poorly suited to use as pasture. The main limitations are the shallow rooting depth and droughtiness of the Ollei soil and coarse fragments on the surface.

This unit is poorly suited to subsistence clean-tilled crop production and moderately suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are the shallow rooting depth and droughtiness of the Ollei soil, low soil fertility, the content of coarse fragments, slope, and the hazards of erosion and soil degradation. Areas of the Ollei soil should be avoided. Avoiding burning, sod cropping, adding compost and other organic fertilizer, rotating crops, and mulching are needed to increase fertility and reduce the hazard of erosion.

If this unit is used for subsistence agricultural forest crops, the main limitations are the shallow rooting depth and droughtiness of the Ollei soil, slope, and the hazard of erosion. Crop yields from the Ollei soil may be less than those from the Nekken soil. This may be partially overcome by applying greater amounts of fertilizer to the Ollei soil. Only small areas should be cleared at one time when planting subsistence agricultural forest crops.

This unit is poorly suited to use as woodland. The main concerns in producing and harvesting timber are slope and the hazard of erosion. Clearcutting should be avoided.

This unit is poorly suited to homesite development. The main limitations are depth to bedrock and steepness of slope. The deep cuts needed to provide essentially level building sites expose bedrock. Because the hazard of erosion is very high, only the part of the site that is used for construction should be disturbed. Structures to divert runoff are needed if buildings and roads are constructed. Topsoil can be stockpiled and used to reclaim areas disturbed by cutting and filling.

This unit is poorly suited to use as a source of roadfill because of the low strength of the subsoil. The bedrock underlying the soil in the unit is well suited as a source of rock for road construction.

This unit is poorly suited to onsite waste disposal systems because of the shallow and moderate depth to bedrock and the steepness of slope.

430—Ollei-Rock outcrop complex, 12 to 75 percent slopes. This map unit is on uplands. Areas are long and narrow or nearly oval in shape and are 3 to 150 hectares in size.

This unit is 50 percent Ollei silt loam and 35 percent Rock outcrop.

Included in this unit are small areas of Nekken soils and Aimeliik soils in depressional areas and at the base of slopes. Also included are small areas of soils that have slopes of less than 12 percent, mainly along the western coast of the island of Babelthuap, and soils that have slopes of more than 75 percent.

The Ollei soil is shallow and well drained. It formed in residuum derived dominantly from hard volcanic breccia and tuff. The surface layer is very dark brown silt loam 18 centimeters thick. The subsoil is brown very gravelly loam 10 centimeters thick. The substratum to a depth of 43 centimeters is dark yellowish brown extremely flaggy loam. Hard, bedded tuff is at a depth of 43 centimeters.

Permeability of the Ollei soil is moderate. Effective rooting depth is 25 to 50 centimeters. If the vegetation is removed, runoff is medium to very rapid and the hazard of water erosion is moderate to very high.

The Rock outcrop in this unit consists primarily of areas of exposed basaltic and andesitic breccia and some tuffaceous breccia and layers of interbedded tuff. The breccia is well suited as a source of rock for road construction.

This unit is used as watershed.

This unit is poorly suited to livestock grazing, woodland, dryland crops, and homesite development. The main limitations for these uses are depth to rock and steepness of slope.

431—Palau-Aimeliik complex, 2 to 6 percent slopes. This map unit is on low-lying foothills. Slopes are slightly convex or plane. Areas are irregular in shape and are 5 to 200 hectares in size. The native vegetation is mainly tropical forest. Cleared areas support savannah vegetation.

This unit is 50 percent Palau silty clay loam and 40 percent Aimeliik silt loam.

Included in this unit are small areas of Babelthuap soils on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained and are in drainageways and other concave areas. Also included are small areas of soils that have slopes of less than 2 percent or more than 6 percent.

Most areas on the islands of Koror and Arakabesan that are used for urban development have had the surface layer removed. Some areas have been cut deeply, and the underlying material is exposed. A few large boulders are on the surface of the soil or are buried in the soil profile.

The Palau soil is very deep and well drained. It formed in residuum derived dominantly from highly weathered, very soft volcanic breccia and tuff. The surface layer is dark brown silty clay loam 10 centimeters thick. The upper 19 centimeters of the subsoil is strong brown silty clay, and the lower 77 centimeters is yellowish red and strong brown silty clay. The substratum to a depth of more than 150 centimeters is dominantly red and brownish yellow silt loam. In some areas the surface layer is silt loam.

Permeability of the Palau soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

The Aimeliik soil is very deep and well drained. It formed in residuum derived dominantly from very soft volcanic breccia and tuff. The surface layer is dark brown silt loam 10 centimeters thick. The upper 10 centimeters of the subsoil is brown silty clay loam, the next 56 centimeters is yellowish red and strong brown silty clay, and the lower 10 centimeters is dominantly yellowish red and strong brown silty clay loam. The substratum to a depth of 150 centimeters or more is dominantly yellowish red and dusky red silty clay loam.

Permeability of the Aimeliik soil is moderately rapid. Effective rooting depth is 150 centimeters or more. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight. In general, areas under forest vegetation are more fertile than areas under savannah vegetation.

Most areas of this unit are used as watershed and for food gathering. A few areas are used as woodland for village use and for urban and homesite development. Other areas are used for garden crops, mainly dryland taro, cassava, sweet potatoes, green onions, corn, pole beans, Chinese cabbage, cucumbers, and sugarcane. Other crops grown are bananas, coconuts, and pineapples. This unit can be used for pasture where savannah vegetation is present.

This unit is well suited to use as pasture.

This unit is poorly suited to subsistence clean-tilled crop production and well suited to subsistence agricultural forest crop production. If the unit is used for subsistence clean-tilled crops, the main limitations are low soil fertility and the hazard of soil degradation. Rotating crops, avoiding burning, adding compost, fertilizer, and lime, and mulching help to overcome these limitations.

This unit is well suited to use as woodland.

This unit is well suited to homesite development. The main limitation is low soil strength. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. If roads and buildings are constructed on this unit, the limitation of low soil strength can be overcome by using an adequate amount of crushed coral or basalt ballast. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting areas of this unit.

If this unit is used for onsite waste disposal, place leach lines on the contour and avoid using pit leaching wherever possible.

432—Peleliu-Rock outcrop complex, 0 to 4 percent slopes. This map unit is on raised coral limestone islands. Slopes are plane to slightly convex. Areas are broad to long and narrow in shape and are 15 to 550 hectares in size. The vegetation is mainly forest. Cleared areas are overgrown with various legumes and woody shrubs.

This unit is 60 percent Peleliu extremely cobbly silt loam and 25 percent Rock outcrop.

Included in this unit are small areas of soils that are similar to this Peleliu soil but are less than 20 centimeters or more than 50 centimeters deep to bedrock and are less than 35 percent coarse fragments and small areas of Ngedebus and Ngedebus Variant soils on beach deposits, some of which are raised. Also included are small areas of soils that have slopes of more than 4 percent.

The Peleliu soil is shallow and well drained. It formed in residuum derived dominantly from coral limestone. Typically, 75 to 100 percent of the surface is covered with cobbles and stones. The surface layer is very dark grayish brown extremely cobbly silt loam 12 centimeters thick. The subsoil is dark brown very gravelly loam 18 centimeters thick. Coral limestone is at a depth of 30 centimeters.

Permeability of the Peleliu soil is rapid. Effective rooting depth is 25 to 50 centimeters. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight.

The Rock outcrop consists of exposed areas of coral limestone and small amounts of silt and clay that have been cemented by secondary carbonates. In most areas the limestone is porous and fractured, allowing roots to penetrate into the rock. The Rock outcrop is mostly level, but it is jagged, irregularly shaped, and raised in some areas.

This unit is used as watershed, for phosphate mining, and as some woodland for village use.

This unit is poorly suited to most types of crop production. The main limitations are the restricted rooting depth, coarse fragments on the surface and in the soil, and the areas of Rock outcrop. The restricted rooting depth reduces the yield of deep-rooted crops. Cobbles and gravel on the surface and the areas of Rock outcrop impede cultivation of the soil. Garden plots can be improved by removing the cobbles, adding topsoil from areas of the included Ngedebus soils, and adding compost and commercial fertilizer. Commercial fertilizer, if used, should be added frequently in small quantities so that losses from leaching are minimized.

This unit is poorly suited to use as woodland. Restricted rooting depth and droughtiness are the main limitations. Reforestation is needed.

This unit is poorly suited to homesite development. The main limitation is the shallow depth to bedrock. Excavation is difficult because of the depth to hard bedrock. Seepage from onsite sewage disposal systems may contaminate the ground water through fractures in the bedrock.

433—Peleliu-Rock outcrop complex, 6 to 20 percent slopes. This map unit is on raised coral limestone islands. Slopes are convex. Areas are irregular in shape and are 40 to 75 hectares in size. The vegetation is forest. Cleared areas have been overgrown with various legumes and woody shrubs.

This unit is 45 percent Peleliu extremely cobbly silt loam and 40 percent Rock outcrop. The Peleliu soil is in nearly level pockets between areas of Rock outcrop.

Included in this unit are small areas of soils that are similar to this Peleliu soil but are less than 20 or more than 50 centimeters deep to bedrock and are less than 35 percent coarse fragments. Also included are small areas of soils that have slopes of less than 6 or more than 20 percent.

The Peleliu soil is shallow and well drained. It formed in residuum derived dominantly from coral limestone. Typically, the surface is covered with cobbles and stones. The surface layer is very dark grayish brown extremely cobbly silt loam 12 centimeters thick. The subsoil is dark brown very gravelly loam 18 centimeters thick. Coral limestone is at a depth of 30 centimeters.

Permeability of the Peleliu soil is rapid. Effective rooting depth is 25 to 50 centimeters. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight to moderate.

The Rock outcrop consists of exposed areas of coral limestone and small amounts of other mineral silt and clay that have been cemented by secondary carbonates. In most areas the limestone is porous and fractured, allowing roots to penetrate into the rock. The Rock outcrop is mostly sloping to moderately steep and is commonly jagged, and irregularly shaped.

Most areas of this unit are used as watershed and for wildlife habitat and phosphate mining. Some areas are used as woodland for village use.

This unit is poorly suited to subsistence agricultural forest crop production. The main limitations are restricted rooting depth, coarse fragments on the surface and in the soil, and the areas of Rock outcrop.

This unit is poorly suited to use as woodland. The main limitations are depth to bedrock and slope.

If this unit is used for homesite development, excavation is difficult because of the shallow depth to hard bedrock. Excavations needed to provide level building sites expose hard bedrock. Seepage from onsite sewage disposal systems may contaminate the ground water through fractures in the bedrock.

434—Rock outcrop-Peleliu complex, 80 to 150 percent slopes. This map unit is on uplands of high coral limestone islands. It is characterized of vertical cliffs rising 3.5 to 30.5 meters above the lagoon. The vegetation is mainly forest.

This unit is 55 percent Rock outcrop, and 30 percent Peleliu extremely cobbly silt loam. The Rock outcrop is in convex areas, and the Peleliu soil is in nearly level pockets and on ledges. The areas of soil are only a few centimeters to a few meters wide. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of soils that are similar to this Peleliu soil but are less than 20 or more than 50 centimeters deep to bedrock and are less than 35 percent coarse fragments. Also included are small areas of soils that have slopes of less than 80 or more than 150 percent and small, nearly level areas of Ngedebus soils adjacent to small beaches on the rock islands. Small deposits of rock and earthy phosphate are in some closed depressional areas and large deposits are on the island of Angaur. Included in this unit adjacent to small beaches are nearly level areas of Ngedebus soils.

The Rock outcrop consists of jagged, sharp areas of exposed coral limestone composed mainly of calcareous sediment and a small amount of silt and clay that have been cemented by secondary carbonates. In addition to calcium and minor content of magnesium, a low to high content of phosphate is in the limestone. In most areas the limestone is porous and fractured, allowing roots to penetrate into the rock. Small pockets of organic matter and mineral soil material are in the fractures. Unique marine lakes that are fed by subtidal pores or larger tunnels also are in some areas of the Rock outcrop.

The Peleliu soil is shallow and somewhat excessively drained. It formed in residuum derived dominantly from coral limestone. Typically, 80 to 100 percent of the surface is covered with cobbles and stones. The surface layer is very dark grayish brown extremely cobbly silt loam 12 centimeters thick. The subsoil is dark brown very gravelly loam 18 centimeters thick. Coral limestone is at a depth of 30 centimeters.

Permeability of this Peleliu soil is moderately rapid. Effective rooting depth is 25 to 50 centimeters or more. If the vegetation is removed, runoff is very rapid and the hazard of water erosion is high.

This unit is used mainly as watershed and for wildlife habitat and recreation. Some areas are used as woodland for village use. Guano has been collected in the few caves scattered throughout the islands and in small areas on the island of Eil Malk. Large areas on the island of Angaur have been used for phosphate mining. The rock islands should be preserved for their esthetic value.

This unit mainly is poorly suited to recreational development.

435—Tabecheding silty clay loam, 2 to 6 percent slopes. This very deep, somewhat poorly drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 4 to 50 hectares in size. The vegetation is savannah and scattered pandanus.

Typically, the surface layer is mottled, olive brown silty clay loam 18 centimeters thick. The subsoil is mottled, brownish yellow clay 33 centimeters thick. The upper 35 centimeters of the substratum is mottled, light gray clay, the next 28 centimeters is mottled, reddish gray clay, and the lower part to a depth of 158 centimeters or more is stratified, dark gray clay and very dark gray lignite.

Included in this unit are small areas of Ngatpang soils in the higher and better drained areas on terraces and severely eroded Tabecheding soils in the steeper areas adjacent to gullies. Also included are small areas of soils that have slopes of less than 2 and more than 6 percent, soils that have a water table at a depth of less than 38 centimeters or more than 91 centimeters, soils that are underlain by lignite at a depth of more than 158 centimeters, and soils that have small shell fragments and marl in pockets and as layers in the substratum. Included areas make up about 15 percent of the total hectarage.

Permeability of the Tabecheding soil is very slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 45 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is slow and the hazard of water erosion is slight. A perched water table typically is at a depth of 45 to 90 centimeters. This soil is ponded during storms and for a few days after storms.

This unit is used as watershed. It can be used for reservoirs if they are placed downstream from an adequate watershed area. The unit can also be used as a source of clay for pottery, tile, and other products, as woodland, and for clean-tilled crop production.

This unit is very poorly suited to use as pasture because of wetness. It is well suited to livestock watering ponds because of the perched water table and very slow permeability.

This unit is poorly suited to subsistence clean-tilled crop production. It is limited mainly by wetness, high acidity, the content of aluminum, and low soil fertility. The perched water table generally limits the suitability of the soil for deep-rooted crops. Drainage can be provided by using ditch systems to intercept water from higher lying areas and to lower the water table if a suitable outlet is available. Most crops respond to lime. Fertility of the soil can be increased and maintained by adding compost and other organic fertilizer, rotating crops, returning crop residue to the soil, avoiding burning, and mulching.

This unit is moderately suited to the production of wetland taro. It is limited mainly by high acidity, wetness, and low soil fertility. The high acidity can be overcome by the addition of lime. A system of terraces for ponding water decreases the potential for low water supply during brief periods of drought. Low soil fertility can be overcome by the use of large quantities of green manure.

This unit is moderately suited to certain woodland species adapted to wetness, high acidity, and low soil fertility. Wetness and low soil strength limit the use of heavy equipment.

This unit is poorly suited to homesite and urban development. The main limitations are wetness and the clayey subsoil and substratum. Drainage is needed if roads and building foundations are constructed on this unit. Wetness can be reduced by installing drain tiles around footings. Excess water can be removed by using shallow ditches and diversions and by providing the proper grade. Buildings and paved roads should be designed to offset the effects of shrinking and swelling. Properly designing foundations and footings and backfilling excavations with material that has low shrink-swell potential help to prevent structural damage.

The very slow permeability and wetness may cause failure of septic tank absorption fields on this unit. Constructing the absorption field in a raised bed of suitable filtering material helps to compensate for these limitations.

This unit is well suited to use as a source of clay for pottery, tile, and bricks.

436—Tabecheding silty clay loam, 6 to 12 percent slopes. This very deep, somewhat poorly drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 5 to 40 hectares in size. The vegetation is savannah and scattered pandanus.

Typically, the surface layer is mottled, olive brown silty clay loam 18 centimeters thick. The subsoil is mottled, brownish yellow clay 33 centimeters thick. The upper 35 centimeters of the substratum is mottled, light gray clay, the next 28 centimeters is mottled, reddish gray clay, and the lower part to a depth of 158 centimeters or more is stratified, dark gray clay and very dark gray lignite.

Included in this unit are small areas of Ngatpang soils in the higher and better drained areas of terraces and severely eroded Tabecheding soils in the steeper areas adjacent to gullies. Also included are small areas of soils that have slopes of less than 6 percent and more than 12 percent, soils that have a water table at a depth of less than 38 centimeters or more than 91 centimeters, soils that are underlain by lignite at a depth of more than 150 centimeters, and soils that have small shell fragments and marl in pockets and as strata in the substratum. Included areas make up about 20 percent of the total hectarage.

Permeability of the Tabecheding soil is very slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 45 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is medium and the hazard of water erosion is moderate. A perched water table typically is at a depth of 45 to 90 centimeters. A water table is near the surface for a few days following storms.

This unit is used as watershed. It can be used for reservoirs if they are placed downstream from an adequate watershed area. The unit can also be used as a source of clay for pottery, tile, and other products, as woodland, and for clean-tilled crop production.

This unit is very poorly suited to use as pasture because of wetness; however, it is well suited to livestock watering ponds because of the perched water table and very slow permeability.

This unit is poorly suited to subsistence clean-tilled crop production. It is limited mainly by wetness, the hazard of erosion, high acidity, the content of aluminum, and low soil fertility. The perched water table generally limits the suitability of the soil in this unit for deep-rooted crops. Drainage can be provided by using ditch systems to intercept water from higher lying areas and to lower the water table if a suitable outlet is available. Furrows should be on the contour or across the slope. Most crops respond to lime. Fertility of the soil can be increased and maintained by adding compost and other organic fertilizer, rotating crops, returning crop residue to the soil, avoiding burning, and mulching.

This unit is moderately suited to certain woodland species adapted to wetness, high acidity, and low soil fertility. Wetness and low soil strength limit the use of heavy equipment.

This unit is poorly suited to homesite and urban development. The main limitations are wetness and the clayey subsoil and substratum. Drainage is needed if roads and building foundations are constructed on this unit. Wetness can be reduced by installing drain tiles around footings. Excess water can be removed by using shallow ditches and diversions and by providing the proper grade. Buildings and paved roads should be designed to offset the effects of shrinking and swelling. Properly designing foundations and footings and backfilling excavations with material that has low shrink-swell potential help to prevent structural damage. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. The hazard of erosion is increased if the soil is left exposed during site development.

The very slow permeability and wetness may cause failure of septic tank filter fields on this unit.

This unit is well suited as a source of clay for pottery, tile, and bricks.

437—Tabecheding silty clay loam, 2 to 12 percent slopes, severely eroded. This very deep, somewhat poorly drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 2 to 45 hectares in size. The vegetation is deteriorated savannah and scattered pandanus.

Typically, 10 to 50 percent of the surface is covered with ironstone and gibbsite concretions. Most of the original surface layer has been lost through erosion. The present surface layer is reddish brown silty clay loam 8 centimeters thick. The subsoil is mottled, light gray silty clay 10 centimeters thick. The upper 82 centimeters of the substratum is mottled, pale olive silty clay, and the lower part to a depth of 178 centimeters or more is black silty clay and lignite.

Included in this unit are small areas of Ngatpang soils, severely eroded, in the higher and better drained areas on terraces and Tabecheding silty clay loam. Also included are small areas of soils that have slopes of less than 2 percent or more than 12 percent, soils that have a water table at a depth of less than 45 centimeters or more than 90 centimeters, soils that are underlain by lignite at a depth of less than 102 centimeters, and soils that have small shell fragments and marl in pockets and as layers in the substratum. Included areas make up about 10 percent of the total hectarage.

Permeability of the Tabecheding soil is very slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 45 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is slow to medium and the hazard of water erosion is slight to moderate. A perched water table typically is at a depth of 45 to 90 centimeters. This soil is ponded during storms and for a few days following storms.

This unit is used for watershed. It can be used for reservoirs if they are placed downstream from an adequate watershed area. The unit can also be used as a source of clay for pottery, tile, and other products, as woodland, and for subsistence clean-tilled crop production.

This unit is very poorly suited to use as pasture because of the very low soil fertility and wetness. It is well suited to livestock watering ponds because of the perched water table and very slow permeability.

This unit is poorly suited to crop production. It is limited mainly by the very low soil fertility. If lime and large amounts of compost and other organic fertilizer are added to the soil and drainage is provided, moderate yields of many subsistence crops can be obtained.

This unit is moderately suited to certain woodland species adapted to wetness, high acidity, and very low soil fertility. Wetness and low soil strength limit the use of heavy equipment.

This unit is poorly suited to homesite and urban development. The main limitations are wetness and the clayey subsoil and substratum. Drainage is needed if roads and building foundations are constructed on the unit. Wetness can be reduced by installing drain tiles around footings. Excess water can be removed by using shallow ditches and diversions and by providing the proper grade. Buildings and paved roads should be designed to offset the effects of shrinking and swelling. Properly designing foundations and footings and backfilling excavations with material that has low shrink-swell potential help to prevent structural damage.

The very slow permeability and wetness may cause failure of septic tank filter fields on this unit. Constructing the absorption field in a raised bed of suitable filtering material helps to compensate for these limitations.

This unit is well suited to use as a source of clay for pottery, tile, and bricks.

438—Tabecheding silty clay loam, 12 to 30 percent slopes. This very deep, somewhat poorly drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 4 to 60 hectares in size. The vegetation is savannah and scattered pandanus.

Typically, the surface layer is mottled, olive brown silty clay loam 18 centimeters thick. The subsoil is mottled brownish yellow clay 33 centimeters thick. The upper 36 centimeters of the substratum is mottled, light gray clay, the next 28 centimeters is mottled, reddish gray clay, and the lower part to a depth of 152 centimeters or more is stratified, dark gray clay and very dark gray lignite.

Included in this unit are small areas of Ngatpang soils in the higher and better drained areas on terraces and severely eroded Tabecheding soils in the steeper areas adjacent to gullies. Also included are small areas of soils that have slopes of less than 12 percent and more than 30 percent, soils that have a water table at a depth of less than 45 centimeters or more than 90 centimeters, soils that are underlain by lignite at a depth of more than 150 centimeters, and soils that have small shell fragments and marl in pockets and as layers in the substratum. Included areas make up about 20 percent of the total hectarage.

Permeability of the Tabecheding soil is very slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 45 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high. A perched water table typically is at a depth of 45 to 90 centimeters.

This unit is used for watershed. It can be used as a source of clay for pottery, tile, and other products. The unit can also be used as woodland and for clean-tilled crop production.

This unit is very poorly suited to use as pasture because of wetness.

This unit is poorly suited to subsistence clean-tilled crop production. It is limited mainly by wetness, the hazard of erosion, high acidity, the content of aluminum, and low soil fertility. Wetness generally limits the suitability of the soil in this unit for deep-rooted crops. Drainage can be provided by using ditch systems to intercept water from higher lying areas and to lower the water table if a suitable outlet is available. Most crops respond to lime. Fertility of the soil can be increased and maintained by adding compost and other organic fertilizer, rotating crops, returning crop residue to the soil, avoiding burning, and mulching. All tillage should be on the contour or across the slope.

This unit is moderately suited to certain woodland species adapted to wetness, high acidity, and low soil fertility. Wetness, slope, and low soil strength limit the use of heavy equipment.

This unit is poorly suited to homesite and urban development. The main limitations are wetness, slope, the hazard of erosion, and the clayey subsoil and substratum. Drainage is needed if roads and building foundations are constructed on this unit. Wetness can be reduced by installing drain tiles around footings. Excess water can be removed by using shallow ditches and diversions and by providing the proper grade. Buildings and paved roads should be designed to offset the effects of shrinking and swelling. Properly designing foundations and footings and backfilling excavations with material that has low shrink-swell potential help to prevent structural damage. Preserving the existing plant cover during construction helps to control erosion. Topsoil can be stockpiled and used to reclaim areas disturbed during construction. The hazard of erosion is increased if the soil is left exposed during site development.

The slope, very slow permeability, and wetness may cause failure of septic tank absorption fields on this unit.

The substratum of the soil in this unit is well suited to use as a source of clay for pottery, tile, and bricks.

439—Tabecheding silty clay loam, 12 to 30 percent slopes, severely eroded. This very deep, somewhat poorly drained soil is on dissected marine terraces. It formed in bedded marine clay derived dominantly from volcanic rock. Areas are irregular in shape and are 3 to 20 hectares in size. The vegetation is deteriorated savannah and scattered pandanus.

Typically, 10 to 50 percent of the surface is covered with ironstone and gibbsite concretions. Most of the original surface layer has been lost through erosion. The present surface layer is reddish brown silty clay loam 8 centimeters thick. The subsoil is mottled, light gray silty clay 10 centimeters thick. The upper 84 centimeters of the substratum is mottled, pale olive silty clay, and the lower part to a depth of 178 centimeters or more is black silty clay and lignite.

Included in this unit are small areas of Ngatpang soils, severely eroded, in the higher and better drained areas on terraces and Tabecheding silty clay loam. Also included are small areas of soils that have slopes of less than 12 percent or more than 30 percent, soils that have a water table at a depth of less than 45 centimeters or more than 90 centimeters, soils that are underlain by lignite at a depth of less than 102 centimeters, and soils that have small shell fragments and marl in pockets and as layers in the substratum. Included areas make up about 25 percent of the total hectarage.

Permeability of the Tabecheding soil is very slow. Effective rooting depth is 150 centimeters or more for water-tolerant plants but is limited to depths between 45 and 90 centimeters for non-water-tolerant plants. If the vegetation is removed, runoff is rapid and the hazard of water erosion is high. A perched water table typically is at a depth of 45 to 90 centimeters.

This unit is used as watershed. It can be used as a source of clay for pottery, tile, and other products. The unit can also be used as woodland and for subsistence clean-tilled crop production.

This unit is very poorly suited to use as pasture.

This unit is poorly suited to crop production. It is limited mainly by very low soil fertility, slope, and the hazard of erosion. If lime and large amounts of compost and other organic fertilizer are added to the soil and drainage is provided, moderate yields of many subsistence crops can be obtained.

This unit is moderately suited to certain woodland species adapted to wetness, high acidity, and very low soil fertility. Wetness and low soil strength limit the use of heavy equipment.

This unit is poorly suited to homesite and urban development. The main limitations are slope, the hazard of erosion, wetness, and the clayey subsoil and substratum. Drainage is needed if roads and building foundations are constructed on this unit. Wetness can be reduced by installing drain tiles around footings. Excess water can be removed by using shallow ditches and diversions and by providing the proper grade. Buildings and paved roads should be designed to offset the effects of shrinking and swelling. Properly designing foundations and footings and backfilling excavations with material that has low shrink-swell potential help to prevent structural damage.

The slope, very slow permeability, and wetness may cause failure of septic tank absorption fields on this unit.

This unit is well suited to use as a source of clay for pottery, tile, and bricks.

440—Typic Troporthents, 30 to 75 percent slopes. These very deep, well drained soils are on side slopes of uplands near Ngardmau, on the island of Babelthuap. They formed in soft residuum derived from andesitic volcanic breccia. The soils have been strip mined for bauxite so that only the substratum remains. Slopes are concave and are characterized by steplike benches, or terraces (fig. 3). Each bench is about 3.5 to 4.5 meters wide and about 2 meters high. The horizontal dimension may vary considerably from one area to another. The slope between the benches is about 90 percent to more than 100 percent. Little if any vegetation has been reestablished on this unit since it was mined.

Typically, 40 to 90 percent of the surface is covered with ferritic and gibbsitic concretions and cobbles. The exposed substratum to a depth of more than 150 centimeters is dark yellowish brown, red, and dusky red, highly weathered andesitic volcanic breccia that crushes easily to silty clay loam or silt loam. The upper 8 to 15 centimeters is 10 to 40 percent gravel, decreasing to less than 10 percent with increased depth. These soils are very strongly acid and strongly acid.

This unit can be reforested by planting woodland species adapted to very low soil fertility and high acidity. The unit can also be revegetated by planting adapted grasses. Suitable practices are disking and adding lime and a complete fertilizer with trace elements. Fertilizer containing phosphorus should be banded in at the time of seeding.

441—Typic Troporthents-Urban land complex, 0 to 1 percent slopes. This unit consists of areas adjacent to the ocean that have been disturbed and are partially covered by urban structures. Areas are long and narrow in shape and are 2 to 10 hectares in size.

This unit is 50 percent Typic Troporthents and 45 percent Urban land.

Included in this unit are small areas of Palau soils.

Typic Troporthents consist of areas filled with crushed coral, clayey soil material, and basalt rock fragments. In a few areas on the islands of Malakal and Arakabesan, the soil material has been removed exposing very soft, weathered rock.

Urban land consists of areas covered by structures such as roads and buildings.

This unit is used mainly for urban and homesite development and for roads.

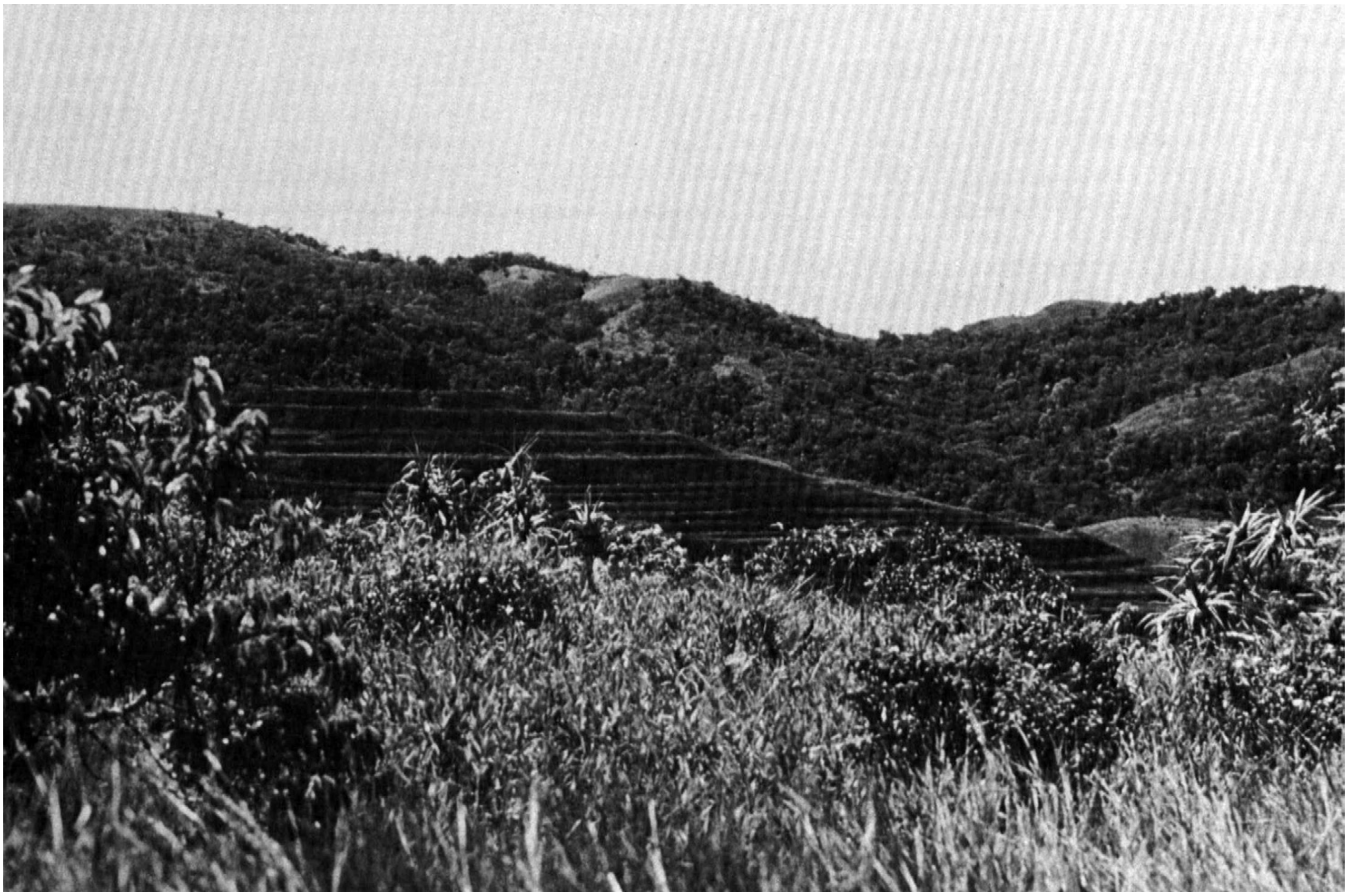

Figure 3.—Abandoned bauxite strip mine area near Ngardmau. Little vegetation has reestablished in more than 40 years. These areas can be reclaimed by reforestation.

Areas of this unit where clayey material is the dominant fill material are poorly suited to use as a source of roadfill, to septic tank absorption fields, and to the placement of roads. The main limitations for these uses are the low strength and slow permeability of the soil material. Use of an adequate amount of crushed coral or basalt ballast for the construction of roads helps to overcome the limitation of low soil strength. Increasing the size of the absorption fields helps to overcome the slow permeability.

Areas of this unit where coral and basalt gravel and cobbles are the dominant fill material are well suited to homesite and urban development. The main limitations are the rapid permeability of the soil material in these areas and the hazard of lagoon contamination because of seepage from onsite waste disposal systems.

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 avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, engineers, and others collect extensive field data about the nature and behavior 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 woodland; and as sites for buildings, sanitary facilities, roads and other transportation systems, and parks and other recreation facilities. 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 or wetness can cause difficulty in excavation.

Health officials, public works 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.

In addition, this survey can be used to transfer crop data on a particular soil in one area to any other area where that soil occurs.

crops and pasture

Miles Grabau, assistant professor of biology, Northwest Missouri State University, provided the discussion on composting.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units."

Crops. The soils in this survey area, as in other tropical environments, have special limitations that must be considered in order to obtain good yields over an extended period of time. Poor management practices can lead to severe damage to the soils, and reclamation may not be economically feasible. A large percentage of the soils in the area are well suited to the production of adapted crops for local use and export; however, only a very small percentage is presently being used for crops. Table 2 gives the suitability of many crops for specified map units in the area (*2, 4, 5, 6, 8, 13*).

The soils in the survey area that are under forest are the most fertile. The main reason for this is the presence of large amounts of organic matter, which provides nutrients for plants. As fallen leaves and branches rot, organic matter and nutrients are returned to the soil. Before these nutrients can be leached through the soil and lost, roots absorb them and the process begins again. In this way, the forest land soils become more fertile with each cycle (*7*). In addition, the forest canopy and layer of litter provide protection from erosion. The canopy also provides shade, which keeps the temperature lower and reduces droughtiness of the surface layer. If the forest cover is removed, the organic matter content of the soil is reduced, nutrients are lost through oxidation and leaching, and the soil becomes less productive.

These factors should be considered when determining the type of crops to be grown and the management systems to be used. In the following paragraphs suitable management practices for crop production are discussed.

Subsistence agricultural forest crop production generally is the least damaging to the soil and requires the least human and monetary resources. Agricultural forest crops include food and wood crops. Soils under mature forest are best suited to agricultural forest crops.

If agricultural forest crops are grown on forested soils such as the Aimeliik, Nekken, Ngardok, Ngatpang, and Palau soils, undesirable woodland species should be removed. Burning, however, should be avoided. Seeds, seedlings, cuttings, and suckers should then be planted. A desirable mixture of vegetation in an established planting might include wetland taro in the more moist areas near drainageways and breadfruit, coconut, mango, and adapted timber species in the other areas. Desirable understory vegetation might include banana, plantain, pineapple, yams, and certain dryland taro species tolerant of shade, such as *Alocasia*. After planting, little care is required. Volunteer undesirable understory vegetation should be slashed, and the cuttings should be concentrated around the root zones of desirable vegetation. Applying commercial fertilizer normally is not necessary. All crop residue should be returned to the soil.

If subsistence agricultural forest crops are grown in an area of savannah, heavy additions of green manure, compost, and other organic fertilizer are necessary to insure a good survival rate of the plantings. Continued applications of fertilizer may be necessary until the canopy is established. Grasses should only be cleared from areas around plantings. Grasses growing between the plantings should be trimmed, and the cuttings should be concentrated around the trees. The application of lime may be beneficial to some crops such as coconut.

Subsistence clean-tilled crop production is common in this survey area. Crops commonly grown are cassava, sweet potato, sugarcane, dryland taro, and vegetable crops such as Chinese cabbage, onions, eggplant, and tomatoes. Wetland taro is grown mainly on the Dechel, Mesei, Ngerungor, and Ngerungor Variant soils. The main limitations for clean-tilled crop production are loss of the surface layer by erosion, loss of organic matter by exposure of the surface layer to sunlight, and loss of fertility through leaching and erosion.

Using adequate amounts of compost and other organic fertilizer, returning all crop residue to the soil, rotating crops, and applying lime help to overcome fertility problems. In general, fresh organic fertilizers should be used on the Dechel, Mesei, Ngerungor, and Ngerungor Variant soils. Use of compost, which contains nitrate, is not desirable on these soils because the nitrate may be converted to a gas and be lost to the atmosphere. Tilling on the contour, contour stripcropping, and mulching reduce the hazard of erosion. An adequate amount of mulch helps to shade and cool the soil, which reduces the loss of organic matter and reduces growth of weeds. If garden plots are abandoned, they should be seeded with a suitable ground cover.

Pasture. On the volcanic islands of Arakabesan and Babelthuap, a large percentage of the savannah vegetation is well suited or moderately suited to cattle grazing. The soils associated with these areas are mainly those in the Aimeliik, Palau, and Ngardok series and to a lesser extent those in the Nekken, Ollei, and Ngatpang series. The sustained production of forage is limited by low soil fertility. Ollei soils are also limited by shallow rooting depth. The average carrying capacity of the soils ranges from about 3 hectares per animal unit if the soils are not fertilized to as much as 1 hectare per animal unit if fertilized.

Good management practices help to maintain a desirable quality and yield of grasses and legumes and reduce erosion. Proper grazing use that maintains the height of forage at about 10 to 13 centimeters is needed. Also, cattle should be rotated from pasture to pasture to reduce overgrazing. Mineral blocks are needed to fulfill animal nutritional requirements because of minor deficiencies in elements such as zinc in many areas. These mineral blocks may be moved periodically to improve grazing distribution and to lessen the hazard of the formation of cattle trails.

If areas of grassland are improved for use as pasture, the method used depends on the quality of the grassland. Improvement of a stand of tall, thick grasses should begin by allowing the cattle to heavily graze the grasses and thereby trample and turn under much of the dry material near the base of the plant. This reduces the competition from the grasses so that legumes can be established. Secondly, grazing should be deferred to other areas. Thirdly, seeding with legumes and fertilizing are needed. For maximum plant production, about 36 to 45 kilograms per acre of nitrogen, phosphorus, and micro-nutrients is desirable. Phosphorus encourages the growth of legumes that in turn provide additional nitrogen to the soil. Areas under a stand of short, sparse grasses should be disked, seeded, and fertilized. If equipment is available, phosphorus should be applied when the legumes are seeded.

The pasture needs to be rested until a satisfactory stand of grasses and legumes is established. Overgrazing results in soil compaction, which restricts root development, and in depletion of organic matter and nutrients, which reduces fertility, yield, and the rate of recovery. Overgrazing also increases the hazard of erosion. Livestock watering ponds generally can be located in depressional areas or near drainageways if a concrete diversion is installed from the drainageway to the pond.

The Babelthuap, Ngardmau, and Ngatpang, severely eroded, soils are poorly suited to livestock grazing. They are limited mainly by very low soil fertility. Fertilization and seeding tests have been conducted on these soils at the Nekken Forestry station. The results show that it is feasible to reclaim some areas of these soils for livestock grazing. More information can be obtained from the Palau Department of Agriculture.

Land-clearing methods. If forested areas are cleared for subsistence clean-tilled crop production, use of the following method conserves the nutrients stored in the vegetation and conserves the organic material. Slash all understory vegetation. Girdle trees and allow time for the leaves to drop. The forest litter on the soil surface should either be allowed to remain in place or should be raked and composted and returned to the garden later. If clean-tilled crops are grown in the steeper areas, it is preferable to leave a litter mulch on the soil surface and to use sod crops where feasible. Woody material should be cut for use as firewood.

If areas of savannah are cleared for subsistence clean-tilled crops, two basic methods are suitable. These methods maintain the content of organic matter and the fertility of the soil. The first method requires cutting the grass by hand down to the soil surface, composting the cuttings, and then returning the compost to the garden. The second method requires tethering goats or cattle in the proposed garden area until the vegetation has been eaten down far enough so that the soil can be turned. This method eliminates the need for labor to clear the land and adds manure to the soil. Because the animals trample the manure and the dry grass at the base of the plant into the soil, the organic material is highly decomposed by the time of planting.

Burning vegetation to clear land should be avoided wherever possible. If vegetation is burned, some nutrients remain in the ashes but many that are essential to plant growth are lost. Among those that are lost are nitrogen, sulfur, and phosphorus. The organic matter that could have been added to the soil is also lost.

Soil fertility. In most of the soils on uplands and terraces of the volcanic islands, the upper 10 centimeters contains the most nutrients for plant growth. These soils include the Aimeliik, Babelthaup, Palau, Ngardmau, Ngatpang, and Tabecheding soils. Of these, the Aimeliik soils are the most fertile and the Babelthaup and Ngardmau soils are the least fertile. Because the most fertile layer is so thin, it is very important to control erosion.

The Aimeliik, Palau, Ngatpang, and Tabecheding soils are very high in content of aluminum that is available to plants. This aluminum can be toxic to certain plants, such as Chinese cabbage and tomatoes, and generally results in stunted growth and poor root development. Most of the plants that are native to tropical areas, however, are adapted to soils high in content of aluminum. Examples of these are cassava, yams, pineapple, sweet potatoes, sugarcane, and black pepper.

Soils that are low in content of calcium and high in content of aluminum can be improved by the addition of calcium silicate and lime. The best source of lime is dolomite, which contains a large amount of magnesium and calcium. Agricultural lime, quicklime, and slaked lime are also excellent sources of calcium. Because of the low cost and availability, coral sand and limestone are good sources of lime in the survey area. The coral sand should be very fine, and the limestone should be crushed. The smaller the particle size, the more quickly the calcium carbonate and other compounds will dissolve in the soil, become available to the plants, and raise the soil reaction to a more suitable level.

For most of the upland soils, the reaction should not be raised to levels higher than about 6.2. Apply about 2 to 3 tons of lime per hectare. The lime should be incorporated into the surface layer and upper part of the subsoil before planting if feasible. Reaction should be tested after harvesting to determine if further applications of lime are needed. After the reaction has been raised to the desired level, additional applications need not be made for as long as 5 years or more. The content of calcium and magnesium is adequate in the Ngedebus and Ngedebus Variant soils. These soils have the least ability to hold nutrients of any of the soils in the survey area; therefore, maintaining a high content of organic matter is very important.

Applications of commercial fertilizers generally should be small and frequent because of the high rainfall, which causes loss by leaching. Phosphorus, however, should be applied in a band or pocket a few inches below the seed or seedling at the time of planting. This prevents the phosphorus from combining with iron or calcium and becoming unavailable to plants.

Substantial deposits of nodular and rock phosphate have been mined on the island of Angaur and smaller deposits on the islands of Peleliu and Eil Malk are potentially important for agricultural use (*12*). If the phosphate has a high enough citrate solubility or is calcined phosphate, it can be used as fertilizer. Use of this phosphate saves the increasing expense of importing commercially processed phosphate fertilizer. There are also small deposits of bat guano on some of the caves on the rock islands that can be used as fertilizer.

Composting. Fresh, green plant material and dry plants should not be added directly to the soil at or near planting time. Rather plant material should be piled up and left to rot for as long as 6 months. The compost pile should be located near a source of fresh material and in an area free of standing water and not subject to flooding if possible. A shady spot is desirable; however, if it is placed under trees, the roots of the tree should be kept out of the pile. It may be necessary to partially cover the pile to keep it from becoming too wet because of the high rainfall. Banana and coconut leaves are a good cover because they allow air to penetrate the pile and also provide shade. Generally, piles about 2 to 3 meters wide and 1.2 to 1.5 meters high are best. The size and shape should be maintained by a fence. Tree logs 1 to 3 centimeters in diameter and 3 to 4 meters long make good fencing. A fence 60 centimeters high is adequate.

Almost any kind of plant material can be used for composting. Legumes are the most desirable because of their high content of nitrogen. Plants growing on fertile soils contain more nutrients in their leaves, stems, and roots than do plants growing on less fertile soils. Adding a liberal amount of high-quality commercial fertilizer to the pile is beneficial. If commercial fertilizer is not available or is too expensive, manure and sea animals or African snail can be substituted. If a sufficient quantity of commercial fertilizer or animal waste is used in the composting process, the total time required to produce a usable compost will be decreased and the compost will be richer in nutrients.

In this survey area, the compost can be applied to the soil after about 6 months or less if the following method is used. Place enough plant material on the pile to make a layer about 0.3 meter thick after packing by trampling. Next apply commercial fertilizer, manure, or sea animals and some coral sand and old compost or rich topsoil. The old compost or topsoil acts as a source of bacteria and fungi to start the rotting process. Repeat the steps until the pile is as high as desired. Finally, top with banana or coconut leaves or other suitable cover. Green, freshly cut plant material is higher in content of nutrients and rots faster than brown, dry plant material. If dry plant material must be used, it should not be covered until it has been wetted.

If the compost pile has been made properly it will heat up in a few days. The internal temperature will likely rise to about 49 degrees C. This can be checked by inserting a metal rod into the pile. If it is too hot to comfortably hold, the temperature is correct. As the composting process slows down, the temperature will drop.

After about 3 months the pile cools and thus needs to be turned for rotting to continue. The unrotted portions of the pile, the top and sides, should then be placed on the bottom. The rest of the pile should be loosened to add air. Once the entire pile has been turned over, it should be covered again. The temperature will rise as before, and the rotting process will start again. By the end of the next 3 months, the temperature will again be down and the rotting process will have gone far enough so that the compost can be added to the garden. At the time the pile is turned, a new pile should be started so that an almost continuous supply of compost can be maintained.

Because of the amount of time and energy used in its production, compost should be used wisely. Since compost spread on the surface of the garden might be mostly wasted, it is best to place the compost in narrow deep rows or mix it into the upper 15 centimeters of the soil. A well organized garden should have permanent beds or rows, and compost should be added to them at the time of each planting. Soil rich in compost is loose and needs little if any preparation before planting.

woodland management and productivity

Virgin forest once covered most of the survey area. Some areas have been cleared, but the majority of the land is still covered with dense heterogeneous tropical forest. The soils under tropical forest are capable of producing a relatively high, sustained yield of timber if properly managed. The potential for supplying the timber needs of the survey area is good.

About 22,663 hectares, or about 52 percent of the survey area, is woodland on the uplands of the island of Babelthuap. Mangrove forest, which makes up about 4,080 hectares, or 9 percent of the survey area, surrounds most of this island and part of the island of Koror. All of the woodland is private land except a small area of government land at the Nekken Forestry Station. The largest areas of woodland are in general map units 3, 5, 7, and 8. The areas of forest on uplands are mainly in units 5, 7, and 8, and the areas of mangrove forest are mainly in unit 3.

The most common trees in areas of Aimeliik, Palau, and Ngardok soils on uplands are *Alphitonia carolinensis*, *Calophyllum inophyllum*, *Calophyllum wakamachi*, *Parinarium palavensis*, and *Pterocarpus indicus*. The most common trees in areas of Nekken soils on uplands are *Calophyllum inophyllum*, *Calophyllum wakamachi*, *Horsfieldia palavensis*, and *Pterocarpus indicus*. Introduced species that are suitable for planting and that have potential for timber production are *Araucaria heterophylla*, *Campnosperma brevipetiolata*, *Cedrela odorata*, *Elaeocarpus carolinensis*, *Eucalyptus diglupta*, *Eucalyptus saligna*, *Swietenia macrophylla*, and *Toona ciliata australis*.

Because the forests on uplands generally are a mixture of several species, thinning undesirable vegetation and handplanting nursery stock commonly are needed to improve a stand. Clearing of undesirable competing vegetation is necessary periodically. Fertilization improves the production of most species. Trees in exposed areas such as on ridgetops are subject to windthrow during typhoons.

To minimize harvesting costs, trees that have fallen should be cut for timber. The main equipment needed is a portable mill and chainsaw. The lumber then can be taken to the shore on foot and transported to market by boat, which eliminates the need for heavy equipment and roads. Production can be sufficient to provide a good source of income.

Land reclamation by reforestation is needed on the Babelthuap and Ngardmau soils, the Ngatpang and Tabecheding soils, severely eroded, and the Typic Troporthents, 30 to 75 percent slopes. All of these soils, except the Tabecheding soils, severely eroded, can be reforested with *Eucalyptus grandis* or *Casuarina* Tabecheding soils, severely eroded, are not suited to the planting of *Casuarina* because of wetness. Because of the droughtiness of the surface layer, trees planted on the Babelthuap and Ngardmau soils should be positioned so that the roots are in the lower part of the surface layer and the upper part of the subsoil.

Further information on management of woodland can be obtained from the Palau Department of Forestry and the offices of the Forest Service and Soil Conservation Service in Honolulu, Hawaii.

Table 3 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The species listed in the table are given by scientific name because the English common name is not available for all the species. The English common names that are known are:

Scientific name	Common name
Alphitonia carolinensis	none
Araucaria heterophylla	Norfolk-Island pine
Bruguiera gymnorhiza	oriental mangrove
Calophyllum inophyllum	alexandrian laurel
Calophyllum wakamachi	none
Campnosperma brevipetiolata	campnosperma
Cedrela odorata	Spanish cedar
Elaeocarpus carolinensis	blue marble
Eucalyptus	eucalyptus
Horsfieldia palavensis	none
Lumnitzera littorea	lumnitzera
Parinarium palavensis	none
Pterocarpus indicus	nara
Phizophora apiculata	mangrove
Rhizophora mucronata	rhizophora
Sonneratia alba	sonneratia
Swietenia macrophylla	Honduras mahogany
Toona ciliata australis	Australian toon
Xylocarpus granatum	xylocarpus

In table 3, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *common trees* are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

recreation

Recreation sites in the survey area are mainly in areas of Ngedebus soils on several of the rock islands and on the island of Peleliu, at Honeymoon Beach, and in areas of Peleliu soils on the island of Peleliu. They are used primarily for picnicking, but a few are sites for lodges and camp areas. All of these areas are subject to flooding during typhoons, especially those areas on the island of Peleliu that face the ocean.

Because of their esthetic value, these areas make desirable sites for vacation homes. The hazard of flooding, however, should be taken into consideration when designing structures. Structures should be built on raised post foundations.

Septic tank filter fields are poorly suited to the Ngedebus soils because of the hazard of contamination of adjacent saltwater, especially in areas inside the lagoon.

The soils of the survey area are rated in table 4 according to limitations that affect their suitability for recreation. The ratings 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 areas suitable for waste disposal. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 4, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 4 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 6 and interpretations for dwellings without basements and for local roads and streets in table 5.

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. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones, boulders, or rock outcroppings can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones, boulders, or rock outcroppings that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

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 within a depth of 150 to 180 centimeters. 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 need to 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 grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 150 to 180 centimeters of the surface, soil wetness, depth to a high water table, 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 kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 5 shows the degree and kind of soil limitations that affect shallow excavations, dwellings without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 150 to 180 centimeters for graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, stone content, soil texture, and slope. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings and dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 150 to 180 centimeters are not considered.

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 stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 180 centimeters. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 100 centimeters, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 6 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 6 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 61 and 183 centimeters is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 120 centimeters below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 60 to 120 centimeters. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 6 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 30 to 60 centimeters of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 6 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 180 centimeters. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 7 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 150 to 180 centimeters.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 180 centimeters high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 150 to 180 centimeters. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 150 centimeters of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 90 centimeters. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 30 to 90 centimeters. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 30 centimeters. They may have layers of suitable material, but the material is less than 90 centimeters thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 7, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 90 centimeters thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 100 centimeters of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 100 centimeters. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 50 to 100 centimeters of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 50 centimeters of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 8 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 150 centimeters. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 6 meters high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 150 centimeters. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 150 centimeters of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement, permeability, depth to a high water table or depth of standing water if the soil is subject to ponding, slope, susceptibility to flooding, and subsidence of organic layers. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory testing. 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. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

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 Hawaii. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 9 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 150 to 180 centimeters.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

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. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 76 millimeters 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. A letter K indicates soils dominated by the clay mineral tubular halloysite and an O indicates soils that are oxidic. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

Rock fragments larger than 76 millimeters 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 76 millimeters 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 grain-size distribution, liquid limit, and plasticity index are 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 omitted in the table.

physical and chemical properties

Table 10 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major 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. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

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 centimeters of water per centimeter of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major 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.

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.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 10, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil and by adding green manure and compost. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 11 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall and water in swamps and marshes are not considered flooding.

Table 11 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone in the soil in most years. The depth to a high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 11 are the depth to the high water table and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 11.

Only saturated zones within a depth of about 180 centimeters are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 150 centimeters. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either dessication and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 11 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves 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 creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel 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 is also 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 (*10*). 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. In table 12, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten 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 Entisol.

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 Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

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; 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 Hydraquents (*Hydr*, meaning presence of water, plus *aquent*, the suborder of the Entisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic 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 known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Tropic* identifies the subgroup that has a warm climate that varies little in mean summer and winter temperatures. An example is Tropic Hydraquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly 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, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is very fine, mixed, nonacid, isohyperthermic Tropic Hydraquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other 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 (*9*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*10*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

Soil reaction (pH) was determined by use of a portable pH meter and hydrogen ion electrode. Dilution was 1:1. In addition, the pH was determined after diluting the soil sample 1:1 with 1 Normal potassium chloride solution. The difference between the pH values is negative, zero, or positive and corresponds to the net charge on the colloid (*3*). While none of the soils in this survey area have a net positive charge, the information is presented in the series for comparison with other soils in tropical areas.

The map units of each soil series are described in the section "Detailed soil map units."

Aimeliik series

The Aimeliik series consists of very deep, well drained soils on uplands. These soils formed in highly weathered volcanic breccia and tuff. Slope is 2 to 75 percent. The mean annual rainfall is 370 centimeters, and the mean annual temperature is 27 degrees C.

Taxonomic class: Very fine, halloysitic, isohyperthermic Oxic Humitropepts.

Typical pedon: Aimeliik silt loam; on a 19-percent, convex, east-by-northeast-facing slope in a tropical forest. When described (10/19/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 10 centimeters; dark brown (10YR 3/3) silt loam; strong fine and medium granular structure; friable, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; common very fine and fine tubular and interstitial pores; very strongly acid (pH 4.9 in 1:1 water); clear smooth boundary. (8 to 25 centimeters thick)

B1—10 to 20 centimeters; brown (7.5YR 4/4) silty clay loam; strong very fine and fine subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; common very fine, fine, and medium tubular and interstitial pores; common dark brown (10YR 3/3) wormcasts filling many fine and medium tubular pores; common thin coatings on faces of peds and lining pores; very strongly acid (pH 4.6 in 1:1 water); gradual smooth boundary. (8 to 20 centimeters thick)

B21—20 to 38 centimeters; strong brown (7.5YR 4/6) silty clay; strong medium subangular blocky structure parting to moderate very fine and fine subangular blocky; firm, sticky and plastic; few very fine, fine, medium, and coarse roots; common very fine, fine, and medium tubular and interstitial pores; common dark brown (10YR 3/3) wormcasts filling many fine and medium tubular pores; continuous thin coatings on faces of peds and lining pores; very strongly acid (pH 4.6 in 1:1 water); clear wavy boundary. (10 to 25 centimeters thick)

B22—38 to 61 centimeters; 70 percent strong brown (7.5YR 4/6) and 30 percent yellowish red (5YR 4/6) silty clay; strong medium subangular blocky structure parting to moderate very fine and fine angular blocky; firm, sticky and plastic; few very fine, fine, and medium roots; common very fine, fine, and medium tubular and interstitial pores; common dark brown (10YR 3/3) wormcasts filling many fine and medium tubular pores; continuous thin coatings on faces of peds and lining pores; few thin black (7.5YR 2/1) manganese coatings on faces of peds; very strongly acid (pH 4.7 in 1:1 water); gradual wavy boundary. (10 to 72 centimeters thick)

B23—61 to 76 centimeters; 60 percent yellowish red (5YR 4/6) and 40 percent strong brown (7.5YR 4/6) silty clay; strong medium subangular blocky structure parting to moderate very fine and fine angular blocky; firm, sticky and plastic; few very fine, fine, and medium roots; common very fine and fine tubular and interstitial pores; common dark brown (10YR 3/3) wormcasts filling many fine and medium tubular pores; continuous thin coatings on faces of peds and lining pores; very few thin black (7.5YR 2/1) manganese coatings on faces of peds; very strongly acid (pH 4.8 in 1:1 water); gradual wavy boundary. (10 to 20 centimeters thick)

B3—76 to 86 centimeters; 60 percent yellowish red (5YR 4/6) and 25 percent strong brown (7.5YR 4/6) silty clay loam; about 15 percent mixed yellowish red (5YR 4/6) and dusky red (10R 3/3) saprolite that crushes to silty clay loam; also contains brown (7.5YR 4/4), weak red (10R 5/2), and white (5Y 8/2) saprolite material as specks, streaks, and blotches; moderate very fine and fine subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; many very fine and fine and common medium tubular and interstitial pores; common thin coatings on faces of peds and lining pores; few thin black (7.5YR 2/2) manganese coatings on faces of peds; very strongly acid (pH 4.9 in 1:1 water); gradual wavy boundary. (0 to 20 centimeters thick)

C—86 to 152 centimeters; mixed 40 percent yellowish red (5YR 4/6), 30 percent dusky red (10R 3/3), and 30 percent specks of white (5Y 8/2) and streaks and blotches of brown (7.5YR 4/4) and weak red (10R 5/2) silty clay loam; moderate medium and coarse subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine, fine, medium, and coarse roots within interior of peds and following ped faces; many very fine and fine and common medium tubular and interstitial pores; very strongly acid (pH 4.8 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 3.2 kilometers north of the road to the Ngerimel Reservoir, on the road to Nekken, then 91 meters north of the road; lat. 7°23'38" N. and long. 132°32'20" E.

Range in characteristics: Thickness of the solum ranges from 50 to 100 centimeters.

The A horizon has moist color of 7.5YR 3/4 or of 10YR 3/3, 3/4, 4/3, or 4/4. The apparent field texture is silt loam or silty clay loam. The horizon is 0 to 10 percent iron-rich concretions 6 to 30 millimeters in size. Reaction in 1:1 water is extremely acid or very strongly acid.

The B1 horizon matrix has moist color of 7.5YR 4/4 or 4/6. The B2 horizon matrix has moist color of 2.5YR 4/4 or 4/6, of 5YR 4/6, or of 7.5YR 4/6. The apparent field texture is silty clay loam, silty clay, or clay. The amount of clay, as measured by the product of 2.5 times the 15-bar water percentage, is more than 75 percent. The horizon is 0 to 6 percent iron-rich concretions 5 to 30 millimeters in size. Reaction in 1:1 water is very strongly acid or strongly acid.

The C horizon has moist color of 10R 3/3, 3/6, or 4/8, of 2.5YR 3/6 or 4/6, or of 5YR 4/6 with stringers and coatings of 7.5YR 4/4 or 4/6, of 10YR 4/6 or 6/8, or of 10R 5/2 and pseudomorphs of feldspar specks of 2.5Y 7/0, 5GY 6/1, or 5Y 8/2. The apparent field texture is silty loam or silty clay loam. Reaction in 1:1 water is very strongly acid or strongly acid.

Babelthuap series

The Babelthuap series consists of very deep, well drained soils on uplands. These soils formed in material weathered from volcanic breccia and tuff. Slope is 2 to 75 percent. The mean annual rainfall is 370 centimeters, and the mean annual temperature is 27 degrees C.

Taxonomic class: Clayey, oxidic, isohyperthermic Haplic Acrorthox.

Typical pedon: Babelthuap very gravelly loam; on a 10-percent, slightly convex, north-by-northeast-facing slope in an area of deteriorated savannah. Colors are for moist soil unless otherwise noted. All textures are apparent field textures. Approximately 70 percent of the surface is covered with irregular, platy ferritic concretions and irregular, vesicular gibbsitic pendants and concretions 3 to 3.5 centimeters in diameter, and 15 percent of the surface is covered with irregular, blocky ferritic and gibbsitic fragments 10 to 15 centimeters in size.

A1—0 to 10 centimeters; dark reddish brown (5YR 3/4) very gravelly loam, dark brown (7.5YR 4/4) dry; strong very fine and fine granular structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine interstitial pores and common very fine and fine tubular pores; approximately 50 percent ferritic and gibbsitic fragments 3 to 3.5 centimeters in size; very strongly acid (pH 4.8 in 1:1 water); clear smooth boundary. (10 to 20 centimeters thick)

B1—10 to 28 centimeters; strong brown (7.5YR 4/6) silty clay; moderate medium and coarse subangular blocky structure parting to moderate very fine and fine subangular blocky; firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular and interstitial pores; common pressure faces; approximately 15 percent irregular, blocky ferritic pebbles 2 to 3 centimeters in diameter; very strongly acid (pH 4.9 in 1:1 water); clear wavy boundary. (15 to 30 centimeters thick)

B2—28 to 64 centimeters; dark red (2.5YR 3/6) and yellowish red (5YR 4/6) silty clay; moderate medium and coarse angular blocky structure parting to moderate very fine and fine angular blocky; firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine tubular and interstitial pores; common thin strong brown (7.5YR 4/6) coatings on faces of peds and lining pores; approximately 6 percent irregular, blocky ferritic pebbles 2 millimeters to 3 centimeters in diameter; very strongly acid (pH 4.9 in 1:1 water); gradual irregular boundary. (25 to 50 centimeters thick)

C—64 to 150 centimeters; dark yellowish brown (10YR 3/6) silty clay loam; numerous gray (7.5YR 6/2) specks, some areas dominated by specks, others by matrix color; weak medium and thick platy structure parting to moderate fine angular blocky; firm, slightly sticky and slightly plastic; few very fine roots following ped faces; few very fine tubular pores in peds; common very fine and fine tubular pore coatings on peds; many thin and moderately thick strong brown (7.5YR 5/6) coatings on faces of peds and lining pores; approximately 14 percent gibbsitic pendants 2 millimeters to 1.5 centimeters in diameter and ferritic concretions 1.0 to 1.5 centimeters in diameter; very strongly acid (pH 4.6 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 920 meters east and 360 meters south of the southeast corner of Ngerimel Reservoir dam; lat. 7°22'05" N. and long. 134°32'45" E.

Range in characteristics: From 25 to 90 percent of the surface is covered with pebbles and 0 to 15 percent with irregular, vesicular ferritic and gibbsitic concretions 8 to 16 centimeters in size. Thickness of the solum ranges from 50 to 100 centimeters.

The A horizon has moist color of 5YR 3/3 or 3/4, of 7.5YR 3/4 or 4/4, or of 10YR 3/2. It has an apparent field texture of loam or silt loam and is gravelly, very gravelly, or extremely gravelly. It is 30 to 75 percent pebble-sized ferritic and gibbsitic concretions. In many areas the horizon is as much as 10 percent cobble-sized concretions. Reaction in 1:1 water ranges from extremely acid to strongly acid.

The B1 horizon has moist color of 7.5YR 4/4 or 4/6. The B2 horizon has moist color of 10R 4/6, of 2.5YR 3/6, of 5YR 4/6, or of 7.5YR 4/6. The apparent field texture of the B horizon is silty clay loam or silty clay. The amount of clay, as measured by the product of 2.5 times the 15-bar water percentage, is more than 75 percent. The horizon is 5 to 15 percent pebble-sized ferritic and gibbsitic concretions. Reaction in 1:1 water ranges from extremely acid to strongly acid.

The C horizon has moist color of 10R 3/3, 3/6, 4/4, 4/6, or 4/8, of 2.5YR 4/6, of 5YR 4/6, of 7.5YR 4/6, 5/6, or 6/0, or of 10YR 3/6, 4/4, or 4/6. The apparent field texture is silt loam or silty clay loam. The horizon is 5 to 15 percent pebble-sized ferritic and gibbsitic concretions. Reaction in 1:1 water is very strongly acid or strongly acid.

Chia series

The Chia series consists of very deep, very poorly drained soils in coastal mangrove swamps. These soils formed in organic deposits over coral sand and gravel. Slope is 0 to 2 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy or sandy-skeletal, carbonatic, euic, isohyperthermic Terric Tropohemists.

Typical pedon: Chia mucky peat; in mangrove swamp forest. When described (9/15/80), the soil was wet throughout and the water table, because of the fluctuating tide, was at a depth of 20 centimeters. Colors are for moist soil.

Oi1—0 to 22 centimeters; black (5YR 2.5/1) mucky peat; about 65 percent fiber, 45 percent rubbed; massive; firm; common medium and few coarse roots; color in pyrophosphate solution is 10YR 8/2; slight odor of sulfur; slightly acid (pH 6.5 in 1:1 water); clear smooth boundary.

Oi2—22 to 50 centimeters; dark reddish brown (5YR 2.5/2) mucky peat; about 70 percent fiber, 60 percent rubbed; massive; firm; common medium and few coarse roots; color in pyrophosphate solution is 10YR 8/2; moderate odor of sulfur; neutral (pH 7.0 in 1:1 water); clear smooth boundary.

Oi3—50 to 73 centimeters; very dark grayish brown (10YR 3/2) mucky peat with about 20 percent very pale brown (10YR 9/3) uncoated sand grains; about 80 percent fiber, 70 percent rubbed; massive; friable; few medium roots; color in pyrophosphate solution is 10YR 8/2; strong odor of sulfur; about 20 percent mineral material; neutral (pH 7.1 in 1:1 water); abrupt smooth boundary.

IIC1—73 to 95 centimeters; dark grayish brown (10YR 4/2) gravelly loamy sand with very pale brown (10YR 8/3) uncoated sand grains; massive; friable; many very fine interstitial pores; moderate odor of sulfur; about 20 percent coral pebbles; neutral (pH 7.2 in 1:1 water); clear smooth boundary.

IIC2—95 to 150 centimeters; dark grayish brown (10YR 4/2) very gravelly loamy sand with very pale brown (10YR 8/3) uncoated sand grains; massive; friable; many very fine interstitial pores; moderate odor of sulfur; about 35 percent coral pebbles; strongly effervescent; mildly alkaline (pH 7.4 in 1:1 water).

Type location: Island of Moen, Truk State, Federated States of Micronesia; about 200 meters south of Epinup Village; lat. 7°25'55" N. and long. 151°51'50.5" E.

Range in characteristics: The O horizon ranges from medium acid to neutral. The depth to the IIC horizon ranges from 50 to 130 centimeters. It is loamy sand to sand and is gravelly or very gravelly.

Dechel series

The Dechel series consists of very deep, very poorly drained soils on valley floors. These soils formed in alluvium derived from volcanic rock and schist. Slope is 0 to 2 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Very fine, mixed, nonacid, isohyperthermic Tropic Hydraquents.

Typical pedon: Dechel mucky silt loam; in a level area of hydrophytic grasses and sedges. When described (11/29/79), the water table was at the soil surface. Colors are for moist soil. All textures are apparent field textures.

O1—10 centimeters to 0; undecomposed and partially decomposed mat of grass and sedge litter.

A1—0 to 10 centimeters; dark gray (5Y 4/1) mucky silt loam; massive; slightly sticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; strongly acid (pH 5.1 in 1:1 water); abrupt smooth boundary. (10 to 30 centimeters thick)

C1—10 to 28 centimeters; olive gray (5Y 4/2) silty clay loam; areas of yellowish red (5YR 5/6) oxidized material surrounding pores and a few small specks of bluish gray (5B 5/1); weak fine and medium subangular blocky structure; slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; many very fine and fine tubular and interstitial pores and few medium tubular pores; strongly acid (pH 5.5 in 1:1 water); abrupt smooth boundary. (5 to 25 centimeters thick)

C2g—28 to 61 centimeters; greenish gray (5GY 5/1) silty clay loam; common olive (5Y 4/3) organic coatings on ped faces and lining pores and areas of yellowish red (5YR 5/6) oxidized material surrounding pores; weak medium subangular blocky structure; sticky and slightly plastic; many very fine and fine tubular and interstitial pores and common medium tubular pores; approximately 2 percent rounded and subrounded ferritic concretions 2 to 7 millimeters in diameter; medium acid (pH 5.9 in 1:1 water); clear wavy boundary. (30 to 100 centimeters thick)

C3g—61 to 102 centimeters; dark greenish gray (5GY 4/1) silty clay loam; few small specks of dark bluish gray (5B 4/1); massive; sticky and slightly plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular and interstitial pores and few medium tubular pores; approximately 12 percent irregular, solid ferritic concretions 2 to 15 millimeters in diameter and one 6-by-9-centimeter, irregular, solid ferritic concretion; medium acid (pH 5.9 in 1:1 water); abrupt smooth boundary. (40 to 80 centimeters thick)

IIC4g—102 to 109 centimeters; dark greenish gray (5GY 4/1) very gravelly silty clay loam; massive; sticky and slightly plastic; few very fine roots; few very fine and fine tubular pores; approximately 40 percent irregular ferritic concretions 2 to 15 millimeters in diameter and 5 percent rounded and subrounded basalt cobbles 7.5 to 24 centimeters in diameter; medium acid (pH 5.6 in 1:1 water); clear smooth boundary. (0 to 15 centimeters thick)

IIIC5—109 to 168 centimeters; dark grayish brown (2.5Y 4/2) silty clay loam; massive; sticky and slightly plastic; few very fine roots; few very fine and fine tubular pores; approximately 2 percent rounded and subrounded ferritic concretions 2 to 7 millimeters in diameter; strongly acid (pH 5.1 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 595 meters along main road southeast of *T* intersection of main road and road leading to Nekken. Turn northeast and head 37 miles along trail and up small escarpment to first small, nearly level area of ancient manmade terrace and then northwest 73 meters; lat. 7°22'3" N. and long. 134°32'28.1" E.

Range in characteristics: Depth to the water table ranges from 10 centimeters above the mineral soil surface to about 25 centimeters below. The O1 horizon ranges from 0 to 10 centimeters in thickness. In areas of forest vegetation, the O1 horizon typically is absent and the water table is rarely above the surface. Soil depth is more than 150 centimeters. The *n* value throughout the pedon is assumed to be more than 1.0 except in very gravelly strata.

The A horizon has moist color in hue of 10YR, 2.5Y, 5Y, 5G, or 5GY, value of 3, 4, or 5, and chroma of 1 or 2. The apparent field texture is silt loam, silty clay loam, or mucky silt loam. Organic-carbon content ranges from 8 to 13 percent. Reaction in 1:1 water is strongly acid to neutral.

The C horizon has moist color in hue of 10YR, 2.5Y, 5Y, or 5GY, value of 3, 4, or 5, and chroma of 1 or 2. The apparent field texture is silt loam or silty clay loam. The amount of clay, as measured by the product of 2.5 times the 15-bar water percentage, is more than 80 percent. Some pedons have thin strata containing 20 to 50 percent pebble-sized schist or ferritic and gibbsitic concretions and 2 to 10 percent ironstone or basalt cobbles. A few pedons contain strata of hemic or sapric material in the lower part of the substratum. Reaction in 1:1 water is strongly acid to neutral.

Ilachetomel series

The Ilachetomel series consists of very deep, very poorly drained organic soils in the intertidal zone adjacent to the shoreline. These soils formed in decomposing mangrove roots and litter. Slope is 0 to 2 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Euic, isohyperthermic Typic Sulfihemists.

Typical pedon: Ilachetomel peat; in a level area of mangrove forest. When described (12/6/79), the soil was wet throughout. Because of the fluctuating tide, the water table was 10 centimeters above the soil surface. Colors are for moist soil.

Oi1—0 to 20 centimeters; black (10YR 2/1) fibric material, about 70 percent fiber rubbed; weak fine and medium subangular blocky structure; many very fine and fine roots and few medium roots; common very fine interstitial pores; moderate odor of sulfur; slightly acid (pH 6.0 in calcium chloride); clear smooth boundary. (10 to 25 centimeters thick)

Oi2—20 to 41 centimeters; very dark grayish brown (10YR 3/2) fibric material, about 70 percent fiber rubbed; weak fine and medium subangular blocky structure; many very fine and fine roots and few medium roots; common very fine interstitial pores; slight odor of sulfur; common medium and coarse decomposing roots; slightly acid (pH 6.0 in calcium chloride); gradual smooth boundary. (10 to 100 centimeters thick)

Oi3—41 to 81 centimeters; very dark grayish brown (10YR 3/2) fibric material, about 55 percent fiber rubbed; weak fine and medium subangular blocky structure; many very fine and fine roots, few medium roots, and common coarse roots; common very fine interstitial pores; slight odor of sulfur; common medium and coarse decomposing roots; medium acid (pH 5.6 in calcium chloride); gradual smooth boundary. (0 to 100 centimeters thick)

Oi4—81 to 150 centimeters; very dark grayish brown (10YR 3/2) hemic material, about 42 percent fiber rubbed; weak medium and coarse subangular blocky structure; many very fine and fine roots, few medium roots, and common coarse roots; common very fine interstitial pores; slightly acid (pH 5.8 in calcium chloride).

Type location: Aimeliik Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 27 meters west of first landing up channel through mangroves leading to the Dabador area in Aimeliik, then about 5 meters north into mangroves; lat. 7°24'11" N. and long. 134°129'8.2" E.

Range in characteristics: The sea level fluctuates between about 30 centimeters above the surface and 30 centimeters below the surface. Areas closer to the lagoon are submerged longer than areas closer to land. The organic material ranges from fibric to sapric throughout the profile. Typically, the surface tier has the highest content of fiber when rubbed. Depth to sulfidic material ranges from 100 centimeters to more than 150 centimeters. Nonaerated samples of the soil are medium acid or slightly acid in calcium chloride.

The upper 10 to 25 centimeters of the profile has moist color of 7.5YR 2/1, 3/1, or 3/2, of 10YR 2/1, 3/1, or 3/2, or of 2.5Y 2/1, 3/1, or 3/2.

Insak series

The Insak series consists of moderately deep, very poorly drained soils in coastal marshes. These soils formed in water-deposited coral sand and organic matter. Slope is 0 to 2 percent. The mean annual rainfall is about 450 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy, carbonatic, isohyperthermic Typic Tropaquents.

Typical pedon: Insak peaty loamy sand; in mangrove swamp forest. When described (3/3/80), the soil was wet throughout and the water table, because of the fluctuating tide, was at a depth of 12 centimeters. Colors are for moist soil.

A1—0 to 8 centimeters; very dark grayish brown (10YR 3/2) peaty loamy sand; massive; friable, nonsticky and nonplastic; many fine and very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.0 in 1:1 water); abrupt smooth boundary. (5 to 10 centimeters thick)

AC—8 to 17 centimeters; dark brown (10YR 3/3) mucky loamy sand; massive; friable, nonsticky and nonplastic; many fine and very fine roots; many very fine tubular pores; moderately alkaline (pH 8.0 in 1:1 water); gradual smooth boundary. (5 to 12 centimeters thick)

C1—17 to 45 centimeters; dark yellowish brown (10YR 3/4) mucky loamy sand; single grain; loose; many fine and very fine roots and few coarse roots; common very fine tubular pores; moderately alkaline (pH 8.0 in 1:1 water); gradual smooth boundary. (20 to 40 centimeters thick)

C2—45 to 75 centimeters; dark yellowish brown (10YR 3/4) gravelly loamy sand; single grain; loose; common fine and very fine roots; common very fine tubular pores; about 25 percent coral pebbles; moderately alkaline (pH 8.0 in 1:1 water); abrupt smooth boundary. (20 to 40 centimeters thick)

R—75 centimeters; coral bedrock.

Type location: Island of Kosrae, Federated States of Micronesia; about 3 kilometers north of Malem and 30 meters east of the main road; lat. 5°18'28" N. and long. 163°1'58" E.

Range in characteristics: The depth to coral bedrock ranges from 50 to 100 centimeters. The soil is mildly alkaline or moderately alkaline.

The A horizon has moist color of 10YR 3/2, 4/2, or 5/2. It is peaty loamy sand, mucky loamy sand, or loamy sand.

The C horizon has color of 10YR 3/4, 4/4, or 5/4. It is mucky loamy sand or loamy sand and is 0 to 35 percent pebbles.

Mesei series

The Mesei series consists of very deep, very poorly drained soils on bottom lands. These soils formed in deposits of organic material overlying alluvial sediment. Slope is 0 to 1 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Very fine, mixed, euic, isohyperthermic Terric Troposaprists.

Typical pedon: Mesei muck; in a level area supporting wetland taro and hydrophytic grasses and sedges. When described (3/6/80), the soil was saturated throughout. The water table was 25 centimeters above the soil surface. Colors are for moist soil. Texture for the C horizon is apparent field texture.

Oa1—0 to 12 centimeters; dark brown (7.5YR 3/2) muck; about 30 percent fiber; massive; nonsticky and slightly plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores; color is 10YR 7/2 in pyrophosphate solution; very strongly acid (pH 4.5 in calcium chloride); clear smooth boundary. (10 to 30 centimeters thick)

Oa2—12 to 40 centimeters; very dark grayish brown (10YR 3/2) muck; about 24 percent fiber, 4 percent rubbed; weak coarse subangular blocky structure; nonsticky and slightly plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores; color is 10YR 6/3 in pyrophosphate solution; strongly acid (pH 5.3 in calcium chloride); gradual wavy boundary. (20 to 50 centimeters thick)

Oa3—40 to 86 centimeters; very dark grayish brown (10YR 3/2) muck; about 29 percent fiber, 1 percent rubbed; weak medium and coarse subangular blocky structure; nonsticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores and common fine interstitial pores; color is 10YR 6/3 in pyrophosphate solution; strongly acid (pH 5.4 in calcium chloride); abrupt smooth boundary. (30 to 50 centimeters thick)

IICg—86 to 150 centimeters; dark gray (10YR 4/1) silt loam; massive; slightly sticky and slightly plastic; common very fine roots; many very fine and fine tubular pores; about 5 percent plant fibers 1 to 15 millimeters in diameter; slightly acid (pH 6.2 in 1:1 water); abrupt smooth boundary. (50 to 85 centimeters thick)

IIIOe1—150 to 188 centimeters; black (10YR 2/1) hemic material; about 76 percent fiber, 48 percent rubbed; weak medium subangular blocky structure; friable, nonsticky and nonplastic; many very fine tubular pores; color is 10YR 8/1 in pyrophosphate solution; strongly acid (pH 5.4 in calcium chloride).

Type location: Airia Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 585 meters along the main road southeast of *T* intersection of main road and road leading to Nekken; turn northeast and proceed 20 meters along trail; site is 10 meters northwest of trail; lat. 7°22'2.5" N. and long. 134°32'28" E.

Range in characteristics: Thickness of the organic tiers above a mineral layer ranges from 65 to 100 centimeters. The water table ranges from 30 centimeters above the surface to 15 centimeters below the surface. Rubbed fiber content throughout the surface and subsurface tiers ranges from 0 to 20 percent. Some pedons have strata that are as much as 15 percent mineral silt and clay. The surface tier is hemic or sapric material.

The Oa horizon has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 1 to 3. Reaction in calcium chloride is very strongly acid or strongly acid.

The IIC horizon is silt loam or silty clay loam. It has hue of 10YR, 2.5YR, or 5Y, value of 4 to 6, and chroma of 0 to 2. It is 0 to 10 percent coarse fragments. Reaction in 1:1 water is medium acid or slightly acid. The *n* value is more than 0.7.

Nekken series

The Nekken series consists of moderately deep, well drained soils on hills and ridgetops. These soils formed in residuum derived from andesitic and basaltic breccia and tuff. Slope is 12 to 75 percent. The mean annual rainfall is about 370 centimeters,'and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Typic Tropohumults.

Typical pedon: Nekken very gravelly silt loam; on a 27-percent slope in a tropical forest. When described (1/10/80), the soil was moist throughout. Colors are for moist soil.

O1—3 centimeters to 0; undecomposed and partially decomposed forest litter.

A1—0 to 20 centimeters; very dark brown (10YR 2/2) very gravelly silt loam; strong fine granular structure; friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and common coarse roots; many very fine interstitial pores; approximately 50 percent platy fragments of hard tuff 20 to 100 millimeters by 10 to 50 millimeters in size; slightly acid (pH 6.1 in 1:1 water); clear wavy boundary. (10 to 20 centimeters thick)

B2t—20 to 46 centimeters; dark yellowish brown (10YR 4/4) very gravelly silty clay loam; moderate very fine and fine subangular blocky structure; firm, sticky and plastic; many very fine, fine, and medium roots and common coarse roots; many very fine interstitial pores; common thin dark brown (10YR 3/3) coatings on faces of peds and lining pores; approximately 45 percent platy fragments of hard tuff 20 to 100 millimeters by 10 to 50 millimeters in size; medium acid (pH 6.0 in 1:1 water); clear wavy boundary. (20 to 54 centimeters thick)

C—46 to 56 centimeters; lithochromic very dark brown (10YR 2/2) very gravelly silt loam; massive; firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; many very fine tubular and interstitial pores; approximately 85 percent platy, moderately hard, bedded tuff that can be dug with difficulty with a spade; soil material fills cracks and joints between tuff fragments; strongly acid (pH 5.4 in 1:1 water); abrupt wavy boundary. (0 to 33 centimeters thick)

R—56 centimeters; black and olive (10YR 2/1 and 5Y 4/3) bedded tuff that has very fine phenocrysts of hornblende; very hard.

Type location: Ngatpang Municipality, Babelthuap Island, Palau, Western Caroline Islands; from falling at back of channel and through the mangroves, head south up slope along trail about 185 meters past stand of betelnut trees; site is on a north-by-northwest aspect; lat. 7°28'31.5" N. and long. 134°29'30.5" E.

Range in characteristics: From 20 to 60 percent of the surface is covered with very hard cobbles and pebbles. Depth to bedrock ranges from 50 to 76 centimeters. Thickness of the solum ranges from 43 to 64 centimeters.

The A horizon has moist color of 10YR 2/2 or 3/3. It is 20 to 35 percent pebbles and cobbles. Reaction in 1:1 water is medium acid or slightly acid.

The B horizon has moist color of 7.5YR 3/4, 4/4, or 4/6 or of 10YR 3/4, 4/4, or 4/6. It has an apparent field texture of very gravelly clay loam or very gravelly silty clay loam. The B horizon is 15 to 25 percent pebbles and 20 to 25 percent cobbles. Reaction in 1:1 water is strongly acid or medium acid. Clay content, as measured by the product of 2.5 times the 15-bar water percentage, is more than 60 percent.

The C horizon has lithochromic moist color of 10YR 2/2, 3/2, 3/3, 3/4, 3/6, or 4/4. Pebble content ranges from 40 to 85 percent. Reaction in 1:1 water is strongly acid or medium acid.

Ngardmau series

The Ngardmau series consists of very deep, well drained soils on uplands. These soils formed in material derived from volcanic breccia and tuff. Slope is 2 to 75 percent. The mean annual rainfall is 370 centimeters, and the mean annual temperature is 27 degrees C.

Taxonomic class: Very fine, oxidic, acid, isohyperthermic Typic Troporthents.

Typical pedon: Ngardmau very gravelly silty clay loam; on an 18-percent, convex, east-facing slope in an area of deteriorated savannah. When described (10/5/79), the soil was moist throughout. Colors are for moist soil unless otherwise noted. All textures are apparent field textures. Approximately 80 percent of the surface is covered with pebble-sized irregular platy ironstone fragments and ferritic and gibbsitic concretions.

A1—0 to 12 centimeters; strong brown (7.5YR 4/6) very gravelly silty clay loam, brown (7.5YR 5/4) dry; moderate very fine and fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; approximately 50 percent pebble-sized vesicular irregular gibbsite pendants and irregular blocky solid ironstone fragments; extremely acid (pH 4.3 in 1:1 water); clear wavy boundary. (10 to 20 centimeters thick)

B2—12 to 27 centimeters; 60 percent yellowish red (5YR 4/6) and 40 percent red (2.5YR 4/6) silty clay; moderate medium subangular blocky structure parting to strong very fine and fine angular blocky; firm, sticky and plastic; few very fine and fine roots; common very fine, fine, and medium tubular pores; continuous thin coatings on faces of peds and lining pores; approximately 2 percent ironstone pebbles; extremely acid (pH 4.5 in 1:1 water); gradual wavy boundary. (10 to 25 centimeters thick)

B3—27 to 40 centimeters; 40 percent red (2.5YR 4/6) and 30 percent yellowish red (5YR 4/6) silty clay, with 30 percent variegated dark red (10R 3/6) and red (10R 4/8) saprolite that contains common fine greenish gray (5GY 6/1) and light greenish gray (5GY 7/1) specks of pseudomorphs of feldspar; moderate medium and coarse subangular blocky structure parting to moderate very fine and fine angular blocky; saprolite shows rock structure; firm, sticky and plastic; few very fine and fine roots; common very fine and fine tubular and interstitial pores; many thin coatings on faces of peds and lining pores; approximately 2 percent ironstone pebbles; extremely acid (pH 4.5 in 1:1 water); gradual irregular boundary. (0 to 20 centimeters thick)

C—40 to 150 centimeters; 50 percent weak red (10R 4/4) and 50 percent yellowish red (5YR 4/6) silty clay loam; many fine greenish gray (5GY 6/1, 5BG 6/1) specks of pseudomorphs of feldspar; moderate medium and coarse subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine and fine roots within interior of peds; common very fine tubular pores; common thin coatings on the faces of peds and lining pores; approximately 4 percent ironstone pebbles and a few vesicular irregular gibbsite fragments; extremely acid (pH 4.5 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 1,435 meters north and 975 meters east of the southeast corner of the dam at Ngerimel Reservoir; proceed north on the road to Nekken, approximately 2.1 kilometers north past the intersection with the road to Ngerimel Reservoir, then 45 meters east of road; lat. 7°22'45" N. and long. 134°32'36" E.

Range in characteristics: From 25 to 90 percent of the surface is covered with pebble-sized coarse fragments and 0 to 15 percent is covered with irregular vesicular ferritic and gibbsitic concretions 8 to 16 centimeters in size. Thickness of the solum ranges from 25 to 50 centimeters.

The A horizon has moist color of 10YR 3/2, of 7.5YR 4/6, of 5YR 3/4 or 3/3, or of 2.5YR 3/4, 4/4, or 4/6. It has an apparent field texture of loam, silt loam, or silty clay loam and is gravelly, very gravelly, or extremely gravelly. It is 30 to 75 percent pebble-sized ferritic and gibbsitic concretions. It is as much as 10 percent cobble-sized concretions in some pedons. Reaction in 1:1 water ranges from extremely acid to strongly acid.

The B1 horizon, where present, has moist color of 7.5YR 4/4 or 4/6. The B2 horizon has moist color of 10R 4/6, of 2.5YR 3/6 or 4/6, of 5YR 4/6, or of 7.5YR 4/6 or 5/6. The apparent field texture is silty clay loam or silty clay. The amount of clay, as measured by the product of 2.5 times the 15-bar water percentage, is more than 75 percent. The horizon is 2 to 15 percent pebble-sized ferritic and gibbsitic concretions. Reaction in 1:1 water ranges from extremely acid to strongly acid.

The C horizon has moist color of 10R 3/3, 3/6, 4/4, 4/6, or 4/8, of 2.5YR 4/6, of 5YR 4/6, of 7.5YR 4/6, 5/6, or 6/0, or of 10YR 3/6, 4/4, or 4/6. The apparent field texture is silt loam or silty clay loam. Pebble-sized ferritic and gibbsitic concretions make up 2 to 15 percent of the horizon. Reaction in 1:1 water is very strongly acid or strongly acid.

Ngardok series

The Ngardok series consists of very deep, well drained soils on hills. These soils formed in highly weathered volcanic tuff. Slope is 2 to 75 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, mixed, isohyperthermic Tropeptic Haplorthox.

Typical pedon: Ngardok silt loam; on an 18-percent slope in an area of savannah. When described (11/29/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 5 centimeters; dark yellowish brown (10YR 3/4) silt loam; moderate medium subangular blocky structure; friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; common very fine and few fine interstitial pores; common thin coatings on faces of peds and lining pores; approximately 2 percent irregular blocky ferritic concretions 10 to 25 millimeters in size; very strongly acid (pH 4.6 in 1:1 water); gradual smooth boundary. (5 to 15 centimeters thick)

B1—5 to 18 centimeters; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable, sticky and slightly plastic; many very fine roots and common fine roots; common very fine and few fine interstitial pores; continuous thin coatings on faces of peds and lining pores; approximately 3 percent irregular blocky ferritic concretions and 2 percent gibbsitic concretions 5 to 25 millimeters in size; very strongly acid (pH 4.8 in 1:1 water); gradual wavy boundary. (10 to 20 centimeters thick)

B2—18 to 69 centimeters; strong brown (7.5YR 4/6) silty clay loam; moderate medium subangular blocky structure parting to moderate very fine and fine subangular blocky; friable, sticky and slightly plastic; few very fine and fine roots; many very fine and few fine interstitial pores and common very fine vesicular pores; continuous thin coatings on faces of peds and lining pores; approximately 3 percent irregular blocky ferritic concretions and 3 percent gibbsitic concretions 5 to 30 millimeters in size; strongly acid (pH 5.3 in 1:1 water); clear wavy boundary. (25 to 60 centimeters thick)

B3—69 to 81 centimeters; 60 percent brown (7.5YR 4/4) silty clay loam and 40 percent dusky red (10R 3/4) saprolite that crushes easily to silt loam; moderate medium subangular blocky structure; friable, sticky and slightly plastic; many very fine and few fine interstitial pores and common very fine vesicular pores; common thin coatings on faces of peds and lining pores; strong brown (7.5YR 5/6) coatings; approximately 8 percent indurated saprolite fragments 10 to 50 millimeters in size; black (7.5YR 2/1) manganese veins and light brown (7.5YR 6/4) material along horizontal bedding planes in the saprolite fragments; strongly acid (pH 5.2 in 1:1 water); gradual wavy boundary. (10 to 30 centimeters thick)

C—81 to 150 centimeters; dusky red (10R 3/4) silt loam; massive; friable, sticky and slightly plastic; many very fine and common fine vesicular pores; approximately 8 percent indurated saprolite fragments 10 to 50 millimeters in size; common thin strong brown (7.5YR 5/6) coatings along fracture faces of saprolite; black (7.5YR 2/1) manganese veins and light brown (7.5YR 6/4) material along horizontal bedding planes in the saprolite; strongly acid (pH 5.4 in 1:1 water).

Type location: Ngaremlengui Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 0.4 kilometer up the channel at Algongui, take the right fork another 0.8 kilometer to the first clearing on the mainland, then about 45 meters south of the channel; lat. 7°31'36" N. and long. 134°31'43.5" E.

Range in characteristics: Thickness of the solum ranges from 50 to 100 centimeters.

The A horizon has moist color of 7.5YR 3/4 or of 10YR 3/3, 3/4, 4/3, or 4/4. The apparent field texture is silt loam or silty clay loam. The horizon is 0 to 15 percent ferritic and gibbsitic concretions 5 millimeters to 3 centimeters in size.

The B2 horizon has moist color of 5YR 4/4 or 4/6 or of 7.5YR 4/4 or 4/6. The apparent field texture is silt loam or silty clay loam. The amount of clay, as calculated by the product of 2.5 times the 15-bar water percentage, is more than 75 percent. The horizon is 0 to 10 percent ferritic and gibbsitic concretions 5 millimeters to 5 centimeters in size. Reaction in 1:1 water is strongly acid or very strongly acid.

The C horizon has moist color of 10R 3/3, 3/4, 3/6, 4/3, or 4/4 and has layers of interbedded tuffaceous material that has moist color of 7.5YR 6/4, 5/4, 5/8, 4/2, 4/4, 3/4, or 2/1. The apparent field texture is silt loam or silty clay loam. The horizon is 5 to 15 percent indurated saprolite fragments 5 to 75 millimeters in size. Reaction is very strongly acid or strongly acid.

Ngatpang series

The Ngatpang series consists of very deep, moderately well drained soils on dissected marine terraces. These soils formed in bedded marine clay.

Slope is 2 to 50 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, halloysitic, isohyperthermic Tropeptic Haplorthox.

Typical pedon: Ngatpang silty clay loam; on a 3-percent slope in an area of savannah. When described (11/2/79), the soil was moist throughout. Colors are for moist soil. All textures, except those in the C horizon, are apparent field textures.

A11—0 to 5 centimeters; dark brown (10YR 3/3) silty clay loam; moderate fine granular structure; friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; common very fine and fine and few medium tubular pores; approximately 10 percent spherical iron concretions 2 to 5 millimeters in diameter; very strongly acid (pH 4.9 in 1:1 water); clear smooth boundary. (3 to 20 centimeters thick)

A12—5 to 15 centimeters; 85 percent dark yellowish brown (10YR 4/4) silty clay loam and 15 percent fine blotches of dark brown (10YR 3/3) silty clay loam; moderate fine subangular blocky structure; firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine and few medium tubular pores; common fine specks of light yellowish brown (10YR 6/4) gibbsite; common thin and moderately thick dark brown (10YR 3/3) coatings in root and worm channels; approximately 10 percent spherical iron concretions 2 to 5 millimeters in diameter; very strongly acid (pH 4.6 in 1:1 water); gradual smooth boundary. (4 to 15 centimeters thick)

B1—15 to 28 centimeters; strong brown (7.5YR 4/6) gravelly silty clay; moderate fine subangular blocky structure; firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine and few medium tubular pores; common thin and moderately thick coatings on faces of peds and lining pores; approximately 20 percent spherical iron concretions 2 to 5 millimeters in diameter; very strongly acid (pH 4.9 in 1:1 water); clear smooth boundary. (5 to 20 centimeters thick)

B21—28 to 48 centimeters; 70 percent strong brown (7.5YR 4/6) and 30 percent yellowish red (5YR 5/8) clay; weak medium prismatic structure parting to strong very fine and fine angular blocky; firm, sticky and plastic; few very fine and fine roots along vertical faces of peds; common very fine and fine tubular pores; continuous thin coatings on faces of peds and lining pores; approximately 2 percent spherical iron concretions 2 to 4 millimeters in diameter; very strongly acid (pH 4.6 in 1:1 water); gradual wavy boundary. (15 to 50 centimeters thick)

B22—48 to 94 centimeters; strong brown (7.5YR 5/8) clay; common medium distinct yellowish red (5YR 5/8) mottles; weak medium prismatic structure parting to strong very fine and fine angular blocky; firm, sticky and plastic; few very fine and fine roots along vertical faces of peds; common very fine, fine, and medium tubular pores and few fine vesicular pores; continuous thin coatings on faces of peds and lining pores; approximately 2 percent spherical iron concretions 2 to 4 millimeters in diameter; very strongly acid (pH 4.7 in 1:1 water); clear wavy boundary. (40 to 70 centimeters thick)

B3—94 to 114 centimeters; yellowish brown (10YR 5/6) clay; common distinct yellowish red (5YR 4/6), strong brown (7.5YR 5/8), and light yellowish brown (10YR 6/4) mottles; moderate medium and coarse subangular blocky structure parting to strong very fine and fine angular blocky; firm, sticky and plastic; few fine roots; common very fine and fine tubular pores; continuous pressure faces; few thin black (7.5YR 2/0) manganese coatings on faces of peds; very strongly acid (pH 4.9 in 1:1 water); gradual wavy boundary. (10 to 30 centimeters thick)

C—114 to 152 centimeters; 50 percent light gray (10YR 7/2) and 50 percent yellowish brown (10YR 5/6) clay; common fine distinct yellowish red (5YR 4/6), strong brown (7.5YR 5/8), and light yellowish brown (10YR 6/4) mottles; moderate medium and coarse subangular blocky structure parting to strong fine angular blocky; firm, sticky and plastic; common very fine and fine tubular pores; continuous pressure faces; few thin black (7.5YR 2/0) manganese coatings on faces of peds; few fine and medium black (7.5YR 2/0) manganese concretions; very strongly acid (pH 4.9 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 91 meters southwest of the prawn ponds in the eastern part of Airai Municipality; lat. 7°22'8" N. and long. 134°35'17" E.

Range in characteristics: Thickness of the solum ranges from 100 to 150 centimeters.

The A horizon has moist color of 10YR 3/3, 3/4, or 4/4 or of 7.5YR 3/4, 4/4, or 4/6. The apparent field texture is silt loam or silty clay loam. Eroded areas have an apparent field texture of silty clay loam, clay loam, or clay and are gravelly or very gravelly. Content of small, pebble-sized ferritic and gibbsitic concretions ranges from 0 to 15 percent. Reaction in 1:1 water is very strongly acid or strongly acid.

The B1 horizon has moist color of 7.5YR 4/4 or 4/6. It has an apparent field texture of clay loam, silty clay loam, or silty clay and is gravelly or very gravelly in some pedons. Content of small, spherical, pebble-sized ferritic concretions ranges from 5 to 50 percent. The B2 horizon has moist color of 7.5YR 4/6 or 5/8, of 5YR 4/6, 5/6, or

5/8, or of 2.5YR 4/6, 5/6, or 5/8. It has an apparent field texture of silty clay or clay. Content of small, spherical, pebble-sized ferritic concretions ranges from 0 to 6 percent. Reaction in 1:1 water is extremely acid or very strongly acid.

The C horizon has moist color of 10YR 8/2, 7/2, 8/3, 7/3, 7/4, 6/6, 5/4, or 5/6 or of 2.5Y 8/2, 8/4, 7/4, or 7/2. It is silty clay or clay. Reaction in 1:1 water is extremely acid or very strongly acid.

Ngedebus series

The Ngedebus series consists of very deep, somewhat excessively drained soils adjacent to coastal beaches and within interiors of atoll islands. These soils formed in water- and wind-deposited coral sand. Slope is 0 to 4 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Carbonatic, isohyperthermic Typic Tropopsamments.

Typical pedon: Ngedebus sand; on a 2-percent, east-by-southeast-facing, convex slope in an area of casuarina forest. When described (10/30/79), the soil was moist throughout. Colors are for moist soil.

A1—0 to 46 centimeters; 50 percent grayish brown (10YR 5/2) sand mixed with 50 percent very pale brown (10YR 7/3) uncoated sand; single grain; loose; common very fine, fine, medium, and coarse roots; many very fine interstitial pores; mixed by land crabs to include lenses of pale yellow (2.5Y 8/4) sand; strongly effervescent; mildly alkaline (pH 7.7 in 1:1 water); clear wavy boundary. (10 to 50 centimeters thick)

C1—46 to 81 centimeters; pale yellow (2.5Y 8/4) sand; single grain; loose; many very fine interstitial pores; strongly effervescent; moderately alkaline (pH 7.9 in 1:1 water); clear smooth boundary. (35 to 100 centimeters thick)

C2—81 to 150 centimeters; very pale brown (10YR 8/4) coarse sand; single grain; loose; many very fine interstitial pores; about 4 percent coarse coral fragments 5 to 20 millimeters by 20 to 40 millimeters in size; freshwater table at a depth of 122 centimeters; strongly effervescent; moderately alkaline (pH 8.0 in 1:1 water).

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 1.25 kilometers north-northeast of Peleliu Village on main road and 1 kilometer south from the first road junction, then about 5 meters east of roadway; lat. 7°2'36" N. and long. 134°16'35" E.

Range in characteristics: Depth to the freshwater table ranges from 100 centimeters to more than 150 centimeters.

The A horizon has moist color of 10YR 2/1, 2/2, 3/1, 3/2, 3/3, 4/2, 4/3, 5/2, 5/3, or 7/3 or of 2.5Y 3/2. An AC horizon, present in some pedons, has moist color of 10YR 6/1, 6/2, or 7/2. It is sand, fine sand, or loamy sand and is gravelly in some pedons. The A horizon is 0 to 20 percent pebbles and 0 to 10 percent cobbles. Reaction in 1:1 water ranges from neutral to moderately alkaline.

The C horizon has moist color of 10YR, 7.5YR, or 2.5Y, value of 6 to 8, and chroma of 2 to 4. It is stratified fine sand, sand, or coarse sand and is gravelly in some pedons. Pebble content ranges from 0 to 25 percent. Cobble content ranges from 0 to 15 percent. Coarse fragment content averages less than 35 percent within the particle-size control section. Reaction in 1:1 water ranges from mildly alkaline to strongly alkaline.

Ngedebus Variant

Ngedebus Variant consists of very deep, somewhat excessively drained soils adjacent to rubbly coastal beaches and within interiors of atoll islands. These soils formed in water- and wind-deposited coral rubble and sand. Slope is 2 to 6 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy-skeletal, carbonatic, isohyperthermic Typic Troporthents.

Typical pedon: Ngedebus Variant extremely cobbly loamy sand; on a 5-percent, convex, southeast-facing slope in an area of casuarina forest. When described (2/26/80), the soil was moist throughout. Colors are for moist soil unless otherwise noted.

O1—6 centimeters to 0; dark reddish brown (5YR 2/2) partially decomposed leaves and other organic material, dark reddish gray (5YR 4/2) dry; neutral (pH 6.7 in 1:1 water); abrupt wavy boundary. (9 to 10 centimeters thick)

A1—0 to 12 centimeters; mixed 85 percent very dark brown (10YR 2/2) and 15 percent pale brown (10YR 6/3) extremely cobbly loamy sand, dark grayish brown (10YR 4/2) and very pale brown (10YR 7/3) dry, respectively; weak very fine granular structure and single grain; very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and few coarse roots; many very fine interstitial pores; slightly effervescent; approximately 30 percent cobbles and 50 percent gravel; neutral (pH 7.3 in 1:1 water); clear wavy boundary. (5 to 30 centimeters thick)

A12—12 to 36 centimeters; mixed 60 percent dark brown (7.5YR 4/2) and 40 percent brown (7.5YR

5/2) extremely cobbly loamy sand; single grain; loose; common very fine, fine, and medium roots; many very fine interstitial pores; strongly effervescent; approximately 30 percent cobbles and 50 percent gravel; mildly alkaline (pH 7.0 in 1:1 water); gradual wavy boundary. (10 to 30 centimeters thick)

C—36 to 150 centimeters; mixed 70 percent pinkish gray (7.5YR 6/2) and 30 percent brown (7.5YR 5/2) extremely cobbly loamy sand; single grain; loose; few very fine, fine, and medium roots; many very fine interstitial pores; strongly effervescent; approximately 30 percent cobbles and 50 percent gravel; mildly alkaline (pH 7.5 in 1:1 water).

Type location: Angaur Municipality, Anguar Island, Palau, Western Caroline Islands; 1.2 kilometers southwest of the south end of Angaur airstrip, along the coast road, and 30 meters southeast of the roadway; lat. 6°52'35.5" N. and long. 134°8'24.5" E.

Range in characteristics: The profile is more than 150 centimeters thick. It is 35 to 50 percent pebbles and 0 to 50 percent throughout. Total coarse fragment content ranges from 35 to 90 percent cobbles throughout. Reaction in 1:1 water is neutral to moderately alkaline throughout the profile.

The A horizon is 25 to 50 centimeters thick. It has moist color of 10YR 2/2, 3/2, 4/2, or 4/3 or of 7.5YR 3/2 or 4/2 and includes partially coated sand grains in colors of 10YR 6/2, 6/3, 7/2, or 7/3 or of 7.5YR 5/2 or 6/2. The A horizon is sand or loamy sand and is very gravelly, extremely gravelly, very cobbly, or extremely cobbly.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 8, and chroma of 2 to 4. It is loamy sand or sand and is very gravelly, extremely gravelly, very cobbly, or extremely cobbly.

Ngersuul series

The Ngersuul series consists of very deep, somewhat poorly drained soils on flood plains. These soils formed in alluvium derived from volcanic rock. Slope is 0 to 2 percent. The mean-annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Very fine, mixed, isohyperthermic Aquic Dystropepts.

Typical pedon: Ngersuul silt loam; in a level area of tropical forest with scattered betelnut. When described (3/10/80), the soil was moist throughout and had a water table at a depth of 66 centimeters. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 15 centimeters; reddish brown (5YR 4/3) silt loam that grades to strong brown (7.5YR 4/6) in the lower 5 centimeters of the horizon; weak and moderate fine and medium subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine, medium, and coarse roots; common very fine and fine tubular pores; very strongly acid (pH 5.0 in 1:1 water); clear wavy boundary. (10 to 30 centimeters thick)

B21—15 to 23 centimeters; yellowish brown (10YR 5/8) silty clay loam; weak medium subangular blocky structure; firm, sticky and slightly plastic; few very fine, fine, and medium roots; common very fine and few fine tubular pores; strongly acid (pH 5.2 in 1:1 water); gradual wavy boundary. (6 to 30 centimeters thick)

B22—23 to 76 centimeters; brownish yellow (10YR 6/8) silty clay loam; common medium distinct red (2.5YR 5/8) mottles and few fine distinct light olive gray (5YR 6/2) mottles; moderate medium subangular blocky structure; firm, sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; permanganate test indicates reducing regime; standing water at a depth of 66 centimeters; strongly acid (pH 5.2 in 1:1 water); abrupt smooth boundary. (25 to 70 centimeters thick)

Cg—76 to 99 centimeters; very dark gray (5Y 3/1) silty clay loam; weak medium subangular blocky structure; firm, sticky and slightly plastic; common very fine roots; common very fine and fine tubular pores; permanganate test indicates reducing regime; strongly acid (pH 5.5 in 1:1 water); abrupt wavy boundary. (50 to 100 centimeters thick)

IIOe—99 to 167 centimeters; very dark gray (2.5Y 3/0) mucky peat; massive; friable, nonsticky and slightly plastic; many very fine and fine tubular pores; medium acid (pH 5.6 in 1:1 calcium chloride).

Type location: Ngaremlengui Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 7.5 kilometers up the Ngatpang River from the bay, about 10 meters downstream from remnant of a stone wall in the riverbank, and then 18 meters south of the river; lat. 7°31'3.3" N. and long. 134°33'7.5" E.

Range in characteristics: The solum ranges from 50 to 100 centimeters in thickness. The profile has mottles that have chroma of 2 or less at a depth of 30 to 50 centimeters. Depth to the water table ranges from 57 to 91 centimeters.

The A horizon has moist color in hue of 5YR, 7.5YR, or 10YR, value of 2 to 4, and chroma of 2 to 4. It is very strongly acid or strongly acid.

The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 0 to 2. It is silt loam or silty clay loam. This horizon ranges from very strongly acid to medium acid. Some pedons do not have a mucky peat or muck layer in the lower part.

Ngerungor series

The Ngerungor series consists of very deep, very poorly drained soils in depressional areas and on wet coastal bottom lands. These soils formed in deposits of organic material overlying coral sand. Slope is 0 to 1 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Euic, isohyperthermic Typic Sulfihemists.

Typical pedon: Ngerungor peaty muck; in a level area supporting wetland taro and hydrophytic grasses and sedges. When described (2/6/80), the soil was saturated throughout. The water table was at the surface. Colors are for moist soil.

Oe1—0 to 39 centimeters; dark reddish brown (5YR 2.5/2) peaty muck; 55 percent fiber, 25 percent rubbed; massive; nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; very strongly acid (pH 4.5 in 1:1 calcium chloride); gradual wavy boundary. (30 to 80 centimeters thick)

Oe2—39 to 102 centimeters; black (10YR 2/1) peaty muck; about 58 percent fiber, 33 percent rubbed; massive; nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; medium acid (pH 5.9 in 1:1 calcium chloride); gradual smooth boundary. (90 to 130 centimeters thick)

Oe3—102 to 150 centimeters; dark brown (7.5YR 3/2) mucky peat; about 68 percent fiber, 30 percent rubbed; massive; nonsticky and nonplastic; common very fine and fine roots and few medium and coarse roots; color is 7.5YR 7/4 in pyrophosphate; medium acid (pH 5.6 in 1:1 calcium chloride).

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 0.3 kilometer north-northeast of Peleliu airstrip, turn left at road junction and proceed 190 meters north-northwest; site is 30 meters southwest of roadway; lat. 7°00'15" N. and long. 134°15'02.5" E.

Range in characteristics: Depth to the water table ranges from 0 to 15 centimeters.

Thickness of the O horizon ranges from 128 centimeters to more than 150 centimeters. This horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 or 3, and chroma of 1 or 2. Rubbed fiber content throughout the profile ranges from 20 to 55 percent. Reaction in calcium chloride ranges from very strongly acid to medium acid, but in some pedons it is neutral.

A IIC horizon, present in some pedons, has hue of 10YR or 2.5Y, value of 6 to 8, and chroma of 1 to 4. It is sand or loamy sand and is gravelly in some pedons. It is 0 to 15 percent pebbles 2 to 70 millimeters in size. A thin mucky transitional layer is present in some pedons. Reaction in 1:1 water is neutral to moderately alkaline.

Ngerungor Variant

Ngerungor Variant consists of very deep, very poorly drained, level soils in depressional areas. These soils formed in deposits of organic material overlying coral sand. The mean annual rainfall ranges from about 317 to 365 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Sandy or sandy-skeletal, carbonatic, euic, isohyperthermic Terric Tropohemists.

Typical pedon: Ngerungor Variant peaty muck; in a level area supporting wetland taro. When described (2/6/80), the soil was wet throughout. The water table was 20 centimeters below the surface. Colors are for moist soil.

Oe1—0 to 8 centimeters; dark brown (7.5YR 3/2) peaty muck (hemic material); 80 percent fiber, 20 percent rubbed; massive; nonsticky and nonplastic; many very fine, fine, and medium roots and few coarse roots; color is 7.5YR 7/4 in pyrophosphate solution; neutral (pH 6.8 in calcium chloride); clear wavy boundary. (15 to 70 centimeters thick)

Oe2—8 to 53 centimeters; dark brown (7.5YR 3/2) hemic material; 70 percent fiber, 22 percent rubbed; massive; nonsticky and nonplastic; common very fine, fine, and medium roots; color is 7.5YR 7/4 in pyrophosphate solution; neutral (pH 6.8 calcium chloride); clear smooth boundary. (15 to 70 centimeters thick)

IIC—53 to 150 centimeters; pale brown (10YR 6/3) coarse sand; single grain; loose; few very fine and fine roots; many very fine interstitial pores; strongly effervescent; moderately alkaline (pH 8.0 in 1:1 water).

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 1.9 kilometers south-southwest of the school yard at Peleliu Village on the main road and then about 94 meters northwest of the roadway at the edge of a taro patch; lat. 7°1'37" N. and long. 134°15'35" E.

Range in characteristics: Depth to the water table ranges from 9 to 25 centimeters. The profile is more than 150 centimeters thick.

The O horizon ranges from 40 to 130 centimeters in thickness. It has moist color in hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Rubbed fiber content ranges from 20 to 35 percent.

The IIC horizon has moist color in hue of 10YR or 2.5Y, value of 6 to 8, and chroma of 1 to 4.

Ollei series

The Ollei series consists of shallow, well drained soils on coastal benches, hills, and ridgetops. These soils formed in residuum derived from andesitic and basaltic breccia and tuff. Slope is 12 to 75 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, mixed, isohyperthermic Lithic Dystropepts.

Typical pedon: Ollei silt loam; on a 14-percent, southwest-facing, convex slope in an area of savannah. When described (1/2/80), the soil was moist throughout. Colors are for moist soil.

A1—0 to 18 centimeters; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; friable, slightly sticky and slightly plastic; many very fine and fine roots and common medium roots; common very fine and fine tubular and interstitial pores; common fine and medium very dark brown (10YR 2/2) and black (10YR 2/1) wormcasts; 5 percent hard basalt fragments 5 to 10 millimeters by 10 to 25 millimeters in size; strongly acid (pH 5.4 in 1:1 water); clear wavy boundary. (10 to 20 centimeters thick)

B2—18 to 28 centimeters; brown (10YR 4/3) very gravelly loam; moderate fine subangular blocky structure; friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine and few fine and medium tubular and interstitial pores; 40 percent angular platy horizontally oriented rock fragments 4 to 7 millimeters by 20 to 59 millimeters in size; strongly acid (pH 5.1 in 1:1 water); clear wavy boundary. (10 to 35 centimeters thick)

C—28 to 43 centimeters; dark yellowish brown (10YR 4/4) extremely flaggy loam; massive; friable, slightly sticky and slightly plastic; few fine and medium roots within soil material and following fracture faces; 90 percent thick platy rock with soil material in horizontal beds between rock; strongly acid (pH 5.1 in 1:1 water); clear wavy boundary. (0 to 15 centimeters thick)

R—43 centimeters; hard, slightly weathered tuff with fractures primarily in the horizontal plane.

Type location: Aimeliik Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 5 meters inland from the midway point of the southwest shore of Bkurengel or about 53 meters east and 38 meters south of the westernmost tip of Bkurengel; lat. 7°26'37.5" N. and long. 134°28'13" E.

Range in characteristics: Depth to lithic contact ranges from 25 to 51 centimeters. The solum is 20 to 40 centimeters thick.

The A horizon has moist color of 10YR 2/2, 3/2, or 3/3. It has an apparent field texture of silt loam or gravelly silt loam. The A horizon is 5 to 25 percent hard basalt and indurated tuff fragments 5 millimeters to 4 centimeters in size and is 0 to 10 percent cobbles. Reaction in 1:1 water is strongly acid or medium acid.

The B horizon has moist color of 7.5YR 3/4, 4/4, or 4/6 or of 10YR 3/4, 4/3, 4/4, or 4/6. It has an apparent field texture of loam, clay loam, or silty clay loam and is very gravelly. Clay content, as calculated by the product of 2.5 times the 15-bar water percentage, is more than about 70 percent. The B horizon is 35 to 60 percent pebbles and 0 to 10 percent cobbles.

The C horizon has moist color of 10YR 4/3, 4/4, or 5/2 or of 5Y 5/1. The apparent field texture is extremely flaggy loam or extremely flaggy silt loam. Exfoliated and partially weathered, hard, tuffaceous flagstones are 1 to 3 centimeters in thickness and 8 to 20 centimeters across. Pedons overlying breccia contain pebbles and cobbles 3 to 15 centimeters in size. Coarse fragment content ranges from 70 to 90 percent.

Palau series

The Palau series consists of very deep, well drained soils on uplands. These soils formed in volcanic breccia and tuff. Slope is 2 to 75 percent. The mean annual rainfall is 370 centimeters, and the mean annual temperature is 27 degrees C.

Taxonomic class: Clayey, halloysitic, isohyperthermic Tropeptic Haplorthox.

Typical pedon: Palau silty clay loam; on a 15-percent, slightly convex, south-by-southwest-facing slope in an area of savannah. When described (10/3/79), the soil was moist throughout. Colors are for moist soil. All textures are apparent field textures.

A1—0 to 10 centimeters; dark brown (10YR 3/3) silty clay loam; moderate fine and medium subangular blocky structure parting to moderate very fine and fine granular; friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine tubular and interstitial pores; 5 percent smooth nonporous irregular ferritic concretions 1 to 2 centimeters in size; extremely acid (pH 4.0 in 1:1 water); clear smooth boundary. (8 to 25 centimeters thick)

B1—10 to 29 centimeters; strong brown (7.5YR 4/6) silty clay; moderate fine and medium subangular blocky structure parting to moderate very fine subangular blocky; firm, sticky and plastic; common very fine and fine roots; many very fine tubular and interstitial pores; 5 percent smooth nonporous irregular ferritic concretions 1 to 2 centimeters in size; one subangular basalt cobble 10 by 15 centimeters in size; two fragments of prehistoric pottery at upper boundary of horizon; few fragments of charcoal; very strongly acid (pH 4.6 in 1:1 water); clear wavy boundary. (10 to 20 centimeters thick)

B21—29 to 55 centimeters; 70 percent yellowish red (5YR 4/6) and 30 percent strong brown (7.5YR 4/6) silty clay; moderate medium subangular blocky structure parting to moderate very fine subangular blocky; firm, sticky and plastic; few very fine and fine roots; many very fine and fine tubular and interstitial pores; common pressure faces and many thin waxy coatings on faces of peds and lining pores; 5 percent smooth nonporous irregular ferritic concretions 1 to 2 centimeters in size; one vesicular irregular ferritic concretion 8 by 13 centimeters in size; 2 percent saprolite fragments 1 to 2 centimeters in size; few fragments of charcoal; very strongly acid (pH 4.7 in 1:1 water); diffuse wavy boundary. (10 to 30 centimeters thick)

B22—55 to 80 centimeters; 80 percent yellowish red (5YR 4/6) and 20 percent strong brown (7.5YR 4/6) silty clay; moderate medium subangular blocky structure parting to moderate very fine subangular blocky; firm, sticky and plastic; few very fine and fine roots; many very fine and fine tubular and interstitial pores; common pressure faces and many thin waxy coatings on faces of peds and lining pores; 5 percent ferritic gibbsite pendants 5 millimeters in diameter and 5 centimeters long; few fragments of charcoal; very strongly acid (pH 4.9 in 1:1 water); clear wavy boundary. (10 to 72 centimeters thick)

B23—80 to 106 centimeters; 80 percent strong brown (7.5YR 4/6) and 20 percent yellowish red (5YR 4/6) silty clay; moderate medium subangular blocky structure parting to moderate very fine subangular blocky; firm, sticky and plastic; few very fine and fine roots; many very fine and fine tubular, interstitial, and vesicular pores; common pressure faces and many thin waxy coatings on faces of peds and lining pores; 5 percent smooth nonporus irregular ferritic concretions 1 to 2 centimeters in size; strongly acid (pH 5.2 in 1:1 water); gradual wavy boundary. (0 to 30 centimeters thick)

C—106 to 150 centimeters; 50 percent red (10YR 4/8) blotches of silt loam with parallel stringers that are 25 percent brownish yellow (10YR 6/8) and 10 percent strong brown (7.5YR 4/6); many light gray (2.5Y 7/1) specks and strong brown (7.5YR 4/6) waxy coatings; moderate medium and coarse subangular blocky structure; friable, slightly sticky and slightly plastic; few very fine roots in peds and on faces of peds; common very fine and fine vesicular pores in peds and common very fine and fine tubular pores with waxy coatings between peds; continuous moderately thick and thick waxy coatings on faces of peds; strongly acid (pH 5.3 in 1:1 water).

Type location: Airai Municipality, Babelthaup Island, Palau, Western Caroline Islands; about 0.48 kilometer north from the T intersection of main road to airport and road to Nekken, stop at water tank, and then head 143 meters east and 920 meters south; lat. 7°21'22" N. and long. 134°32'32.9" E.

Range in characteristics: Thickness of the solum ranges from 100 to 127 centimeters.

The A horizon has moist color of 7.5YR 3/4 or of 10YR 3/3, 4/3, or 4/4. The apparent field texture is silt loam or silty clay loam. The horizon is 0 to 10 percent ferritic concretions 5 to 30 millimeters in size. Reaction in 1:1 water is extremely acid or very strongly acid.

The B1 horizon has moist color of 7.5YR 4/4 or 4/6. The B2 horizon has moist color of 2.5YR 4/4 or 4/6, of 5YR 4/4 or 4/6 or of 7.5YR 4/6. The apparent field texture is silty clay loam or silty clay. The amount of clay, as calculated by the product of 2.5 times the 15-bar water percentage, is more than 75 percent. The B horizon is 0 to 6 percent ferritic concretions 5 to 30 millimeters in size. Reaction in 1:1 water is very strongly acid or strongly acid.

The C horizon has moist color of 10R 3/3, 3/6, or 4/8, of 2.5YR 3/6 or 4/6, or of 5YR 4/6. It has stringers and coatings of 7.5YR 4/6 or of 10YR 4/6, 5/4, or 6/8, and it has pseudomorphs of feldspar specks of 2.5Y 7/3, 5GY 6/I, and 5Y 8/2. The apparent field texture is silt loam or silty clay loam. Reaction in 1:1 water is very strongly acid or strongly acid.

Peleliu series

The Peleliu series consists of shallow, well drained soils on raised coral limestone islands. These soils formed in residuum derived from coral limestone. Slope is 0 to 150 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey-skeletal, oxidic, isohyperthermic Lithic Eutropepts.

Typical pedon: Peleliu extremely cobbly silt loam; in a level area of "limestone" forest. When described (10/31/79), the soil was moist throughout. Colors are for moist soil unless otherwise noted. All textures are apparent field textures.

O1—1 centimeter to 0; undecomposed leaf litter and twigs. (0 to 4 centimeters thick)

A1—0 to 12 centimeters; very dark grayish brown (10YR 3/2) extremely cobbly silt loam, grayish brown (10YR 5/2) dry; moderate very fine and fine granular structure; friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine and fine interstitial pores; approximately 35 percent pebble-sized and 30 percent cobble-sized coral limestone fragments; common thin organic stains coating pebbles and cobbles; neutral (pH 7.1 in 1:1 water); clear wavy boundary. (8 to 15 centimeters thick)

B2—12 to 30 centimeters; dark brown (7.5YR 3/4) very gravelly loam; moderate very fine and fine subangular blocky structure; friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and few coarse roots; approximately 35 percent pebble-sized and 25 percent cobble-sized coral limestone fragments; common thin and moderately thick clay films and organic stains coating pebbles and cobbles; neutral (pH 7.2 in 1:1 water); abrupt irregular boundary. (15 to 40 centimeters thick)

R—30 centimeters; white (10YR 8/1) hard coral limestone; massive; crystal structure apparent in freshly exposed face.

Type location: Peleliu Municipality, Peleliu Island, Palau, Western Caroline Islands; about 643 meters west of the southwestern end of Honeymoon Beach, then 30 meters south of the main road; lat. 6°59'50" N. and long. 134°15'36" E.

Range in characteristics: Depth to a lithic contact and thickness of the solum range from 25 to 50 centimeters.

The A horizon has moist color of 10YR 3/1, 3/2, or 3/3 and dry color of 10YR 5/1, 5/2, or 5/3. It is 25 to 50 percent limestone pebbles 2 to 76 millimeters in size and 25 to 35 percent limestone cobbles 7.6 to 25 centimeters in size. Reaction in 1:1 water is neutral or mildly alkaline. This horizon is slightly effervescent or noneffervescent.

The B2 horizon has moist color of 7.5YR 3/4, 4/6 or 5/6 or of 10YR 4/4 or 4/6. It has an apparent field texture of very gravelly or extremely gravelly loam or very cobbly or extremely cobbly loam. Clay content, as measured by the product of 2.5 times the 15-bar water percentage, is more than 45 percent. It is 25 to 50 percent limestone pebbles 2 to 76 millimeters in size and 15 to 35 percent limestone cobbles 7.6 to 25 centimeters in size. Reaction in 1:1 water is neutral or mildly alkaline. This horizon is slightly effervescent or noneffervescent.

Tabecheding series

The Tabecheding series consists of very deep, somewhat poorly drained soils on dissected marine terraces. These soils formed in bedded marine clay deposits. Slope is 2 to 30 percent. The mean annual rainfall is about 370 centimeters, and the mean annual temperature is about 27 degrees C.

Taxonomic class: Clayey, halloysitic, isohyperthermic Aquic Tropudults.

Typical pedon: Tabecheding silty clay loam; on a 5-percent, east-facing, slightly convex slope in an area of wetland savannah. Colors are for moist soil. Texture of the surface layer is an apparent field texture.

A1—0 to 18 centimeters; 70 percent olive brown (2.5Y 4/4) silty clay loam; many fine and medium faint light olive brown (2.5Y 5/4) mottles; moderate fine granular structure in the upper 2.5 centimeters over moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; many very fine and common fine tubular and interstitial pores; 2 to 4 percent angular uncoated quartz sand grains 1 millimeter in diameter; extremely acid (pH 4.2 in 1:1 water); clear smooth boundary. (12 to 18 centimeters thick)

B2t—18 to 35 centimeters; brownish yellow (10YR 6/6) clay; few fine distinct light brownish gray (10YR 6/2) mottles and few fine faint yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate fine subangular and angular blocky; friable, sticky and plastic; common very fine and fine roots; many very fine and common fine tubular and vesicular pores; common thin coatings on faces of peds and lining tubular pores; many pressure faces; extremely acid (pH 4.0 in 1:1 water); clear irregular boundary. (15 to 25 centimeters thick)

B3t—35 to 51 centimeters; brownish yellow (10YR 6/6) clay; many fine distinct light gray (10YR 7/2) mottles, common fine distinct yellowish brown (10YR 5/8) mottles, and few fine distinct yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to moderate very fine and fine angular blocky; firm, sticky and plastic; few very fine, fine, and medium roots; many very fine and fine tubular and vesicular pores; few thin coatings on faces of peds; common pressure faces; extremely acid (pH 4.0 in 1:1 water); gradual irregular boundary. (5 to 20 centimeters thick)

C1—51 to 86 centimeters; light gray (10YR 7/2) clay; common medium distinct yellowish brown (10YR 5/8) mottles and few medium prominent red (2.5YR 4/6) mottles; weak medium and coarse prismatic structure; firm, sticky and plastic; few very fine, fine, and medium roots; many very fine and fine tubular pores; common pressure faces; extremely acid (pH 4.0 in 1:1 water); clear smooth boundary. (20 to 50 centimeters thick)

C2—86 to 104 centimeters; reddish gray (5YR 5/2) clay; common medium distinct strong brown (7.5YR 5/8) mottles; weak medium and coarse prismatic structure; firm, sticky and plastic; few very fine and fine roots; common very fine tubular pores; common pressure faces; common medium distinct black (7.5YR 2/1) masses of lignite; extremely acid (pH 4.0 in 1:1 water); abrupt smooth boundary. (0 to 25 centimeters thick)

IIC3g—104 to 158 centimeters; about 60 percent dark gray (10YR 4/1) clay finely interbedded with about 40 percent very dark gray (10YR 3/1) lignite;

moderate medium platy structure parting to strong thin platy; firm, sticky and plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular and interstitial pores; few thin oxidized iron stains lining some tubular pores; lignite bed is tilted at a 6-degree dip to the south and a 14-degree dip to the east by northeast; extremely acid (pH 3.2 in 1:1 water).

Type location: Airai Municipality, Babelthuap Island, Palau, Western Caroline Islands; about 930 meters east and 180 meters south of the southeast end of the dam at Ngerimel Reservoir; north on the road to Nekken about 1.6 kilometers past water tank, continue on road about one-half the distance to the bottom of the hill beyond first 90-degree left turn, then turn right 90 degrees and proceed 182 meters; lat. 7°22'3.6" N. and long. 134°32'45" E.

Range in characteristics: The solum is 38 to 56 centimeters thick. A perched water table is at a depth of 38 to 90 centimeters throughout the year.

The A horizon has moist color of 2.5Y 3/2 or 4/4, of 5Y 4/3, or of 10YR 3/2 and has mottles of 2.5Y 5/4 or of 10YR 5/4 or 5/6.

The Bt horizon has moist color of 10YR 5/6 or 6/6 or of 5Y 7/2. It has few to many mottles of 10R 4/6, of 5YR 4/6, of 7.5YR 5/8, or of 10YR 5/6, 6/2, 6/4, 6/6, 7/1, or 7/2. It has an apparent field texture of silty clay loam, silty clay, or clay. Some pedons are as much as 15 percent spherical iron concretions 2 to 10 millimeters in diameter. Base saturation is less than 5 percent. Aluminum saturation is more than 85 percent.

The C horizon has moist color of 2.5YR 7/4, of 5YR 5/2, of 10YR 3/1, 4/1, or 7/2, or of 5Y 6/1 or 6/3. It has few to many mottles in colors of 10R 3/6, 4/6, or 4/8, of 2.5YR 4/6 or 5/8, of 5YR 5/8, of 7.5YR 5/8 or 2/0, of 10YR 5/8, or of 5Y 7/6. The apparent field texture is clay or silty clay.

formation of the soils

Soil is the collection of natural bodies on the earth's surface, containing living matter that supports or is capable of supporting plants (*10*). It is a mixture of varying amounts of rocks and minerals, elements combined as salts or ions, organic matter, water, and air.

The processes involved in soil formation are complex, and the soil is constantly changing. There are five factors that interact with one another to form soil. They are 1) the physical and mineralogical composition of the parent material; 2) the climate under which the material has accumulated and has existed since accumulation; 3) the plant and animal life on and in the soil; 4) the relief, or lay of the land; and 5) the length of time the forces of soil formation have acted on the soil material.

Climate and plants and animals are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into soil. The effects of the climate and plants and animals are influenced by relief. The parent material also affects the kind of soil that is formed. Finally, time is needed for the changing of the parent material into a mature soil.

The five factors of soil formation are so closely interrelated in their effect on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four.

This section describes the five major factors of soil formation and how these factors affect the soils in this survey area.

parent material

Parent material is the unconsolidated mass from which soil forms. It largely determines the chemical and mineralogical composition of the soil. The minerals in the parent material generally determine the kinds and amount of clay in the soil. Some of the upland soils in the area, such as those in the Aimeliik, Palau, and Ngardok series, formed in place from saprolitic material derived from extrusive volcanic rock such as tuff and tuffaceous breccia. These soils have a high content of tubular halloysite clay. Other soils, such as those in the Dechel series, formed in alluvial deposits washed from the upland soils. Still others, such as those in the Ngedebus series, formed in material weathered from coral limestone and coral sand.

climate

Soil forms rapidly in this survey area because of the warm tropical climate. This warm climate is favorable throughout the year for rapid chemical and physical reactions and for the decomposition of organic material from plants and animals. Temperature and rainfall, which vary only slightly within the area, partially govern the rate of weathering of the rocks and the decomposition of minerals. They also influence leaching, eluviation, illuviation, and soil degradation.

More specific information on the climate of the survey area is given in the section "General nature of the survey area."

plants and animals

Plants, animals, fungi, and bacteria are important to soil formation. The changes they bring about depend mainly on the kinds of life processes peculiar to each.

Originally, most of the soils in the survey area were covered by dense tropical forest. Some areas were burned and cleared for cultivation and other uses. When these areas were left idle, savannah vegetation became dominant. Repeated burning and removal of the savannah vegetation further depleted the soils, so that now some areas support only deteriorated savannah vegetation. The Babelthuap and Ngardmau soils are examples. Burning clearly has altered the physical and chemical properties of these soils.

The vegetation generally determines the amount of organic matter in the soil, the color of the surface layer, and the amount of nutrients. Growing plants provides a cover that helps to reduce erosion and stabilize the surface so that soil-forming processes can continue. Plants recycle nutrients, and plant roots intercept many nutrients being released into the soil before they can be leached through the soil and lost. Leaves, twigs, and entire plants accumulate on the surface of the soil and then decompose as a result of micro-organisms, earthworms, and other forms of animal life acting on the soil. The plant roots leave pores and widen cracks in the rocks and thus permit more water to enter the soil. Also, the uprooting of trees influences soil formation by mixing the soil layers and loosening the underlying material.

Earthworms, ants, and many other burrowing animals are active in the survey area. They help to keep the soil open and porous, mix the layers of the soil, mix organic matter into the soil, and help to break down the remains of plants. Earthworms and other small invertebrates feed on organic matter in the upper few centimeters of the soil. They slowly but continually mix the soil material and, in places, alter it chemically. Bacteria, fungi, and other micro-organisms hasten the weathering of rock minerals and the decay of organic matter.

relief

The shape of the land surface, the slope, and the depth of the water table have had a great influence on the formation of the soils in the survey area. Strongly sloping to steep soils, where runoff is moderate to rapid, generally are well drained and have a bright colored subsoil. Soils in bottom land areas, such as the Dechel soils, have a water table at or near the surface for long periods of time. These soils exhibit marked evidence of wetness in the form of mottles or solid gleyed colors.

time

A long period of time generally is needed for changes to take place in the parent material. The soils in the survey area range from those that exhibit little or no development to older soils that exhibit very pronounced development. The Ngedebus and Dechel soils are examples of young soils. The Palau and Babelthuap soils, which are on uplands of volcanic islands where the parent material has weathered in place for a long time, are examples of older soils.

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glossary

Agricultural forest. A forest consisting of planted trees for producing food, such as bananas and breadfruit, mixed with other native non-food-producing trees.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Animal unit. One cow, one horse, one mule, five sheep, or five goats.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as centimeters of water per centimeter of soil. The capacity, in centimeters, in a 150-centimeter profile or to a limiting layer is expressed as—

	Centi-meters
Very low	0 to 7.5
Low	7.5 to 15
Moderate	15 to 22.5
High	22.5 to 30
Very high	More than 30

Barrier reef. A coral reef that is separated from the coast by a lagoon that is too deep for coral growth.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 60 centimeters in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

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 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.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 7.5 to 25 centimeters in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil 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 are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

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 25 centimeters and 100 or 200 centimeters.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

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.

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 the activities of man or other animals or of a

catastrophe in nature; for example, fire that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Excess sulfur (in tables). Excessive amount of sulfur in the soil. The sulfur causes extreme acidity if the soil is drained, and the growth of most plants is restricted.

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.

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 15 to 37.5 centimeters long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Fringing reef. A coral reef that is attached directly to the shore.

Gathering. The collecting or gleaning of food and other raw material from the wild.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 2 millimeters to 7.5 centimeters in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric 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 upper case letter represents the major horizons. Numbers or lower case 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 at the surface of a mineral soil.

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.

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. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

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 A or B horizon. 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, the Roman numeral II precedes the letter C.

Cr layer.—Weathered bedrock or saprolite, such as weathered igneous rock, that roots cannot enter except along fracture planes. The material can be dug with a spade.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

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-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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.

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.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intertropical convergence zone. The boundary area between the trade wind systems of the Northern Hemisphere and the Southern Hemisphere. It is an elongated band of disturbed weather that usually is broken rather than continuous. In the Pacific Ocean area, it generally is north of the equator in all seasons.

Large stones (in tables). Rock fragments 7.5 centimeters or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

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.

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. Mottling generally indicates poor aeration and impeded drainage. 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; *medium*, from 5 to 15 millimeters; and *coarse*, more than 15 millimeters.

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mulch. A protective covering of organic materials on the surface of the soil.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

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.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

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 1 square meter to 10 square meters, depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.02 centimeter
Slow	0.02 to 0.5 centimeter
Moderately slow	0.5 to 1.5 centimeters
Moderate	1.5 to 5.0 centimeters
Moderately rapid	5.0 to 15.0 centimeters
Rapid	15.0 to 50 centimeters
Very rapid	more than 50 centimeters

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pit leaching. A method of disposal of effluent from septic tanks whereby a deep pit is dug (about 2 meters in diameter and 5 meters deep) into the soft parent material and then backfilled with gravel. This method may be used where slopes are too steep for other absorption fields to function without the hazard of lateral seepage.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

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.

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.

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 degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly 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

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.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

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.

Salty water (in tables.) Water that is too salty for consumption by livestock.

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.

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 (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell (in tables). The shrinking of soil when dry and swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damange plant roots.

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.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

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 6.1 meters in 30.5 meters of horizontal distance. In this survey the following slope classes are recognized:

	Percent
Nearly level	0 to 2
Gently sloping	2 to 6
Strongly sloping	6 to 12
Moderately steep	12 to 20
Steep	20 to 50
Very steep	50 to 75
Extremely steep	60 and higher

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 7.5 centimeters in diameter. Small stones adversely affect the specified use of the soil.

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 degradation. The process whereby fertile soils under natural conditions are rendered less productive by the removal of the forest, frequent burning, and clean-till cultivation. This interrupts the recycling of nutrients and allows sunlight to heat and dry the surface layer and volitalize organic matter. Leaching of nutrients and erosion increases. Available water capacity of the soil is reduced.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millime-ters
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 and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 25 to 60 centimeters in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind and water erosion.

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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsidence. The settlement of organic soils, which results either from dessication and shrinkage or oxidation of organic material, or both, following drainage.

Subsistence farming. Farm operations that provide barely the living requirements of the operator and his family rather than an excess for sale on the market.

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. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Suitability ratings. Ratings for the degree of suitability of soils for pasture, crops, woodland, and engineering uses. The ratings and the general criteria used for their selection are as follows:

Well suited.—The intended use may be initiated and maintained by using only the standard materials and methods typically required for that use. Good results can be expected.

Moderately suited.—The intended use has limitations that make special planning, design, or maintenance necessary.

Poorly suited.—The intended use is difficult or costly to initiate and maintain because of soil properties such as steep slopes, a high hazard of erosion, a high water table, low fertility, or a hazard of flooding. Major soil reclamation, special design, or intensive management practices are needed.

Very poorly suited.—The intended use is very difficult or costly to initiate and maintain, and thus it generally should not be undertaken.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 10 to 25 centimeters. Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

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."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The upper limit of the soil or underlying rock that is wholly saturated with water.

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.

tables

TABLE 1.--HECTARAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Hectares	Percent
400	Aimeliik-Palau complex, 6 to 12 percent slopes	1,222	2.8
401	Aimeliik-Palau complex, 12 to 30 percent slopes	4,701	10.7
402	Aimeliik-Palau complex, 30 to 50 percent slopes	8,129	18.5
403	Aimeliik-Palau complex, 50 to 75 percent slopes	5,521	12.6
404	Babelthuap-Ngardmau complex, 2 to 6 percent slopes	170	0.4
405	Babelthuap-Ngardmau complex, 6 to 12 percent slopes	1,046	2.4
406	Babelthuap-Ngardmau complex, 12 to 30 percent slopes	1,744	4.0
407	Chia-Insak complex, 0 to 1 percent slopes	318	0.7
408	Dechel-Mesei complex, 0 to 2 percent slopes	2,161	4.9
409	Ilachetomel peat, 0 to 1 percent slopes	4,130	9.4
410	Nekken-Ollei complex, 12 to 30 percent slopes	299	0.7
411	Ngardmau-Babelthuap complex, 30 to 50 percent slopes	1,489	3.4
412	Ngardmau-Babelthuap complex, 50 to 75 percent slopes	560	1.3
413	Ngardok silt loam, 2 to 6 percent slopes	103	0.2
414	Ngardok silt loam, 6 to 12 percent slopes	469	1.1
415	Ngardok silt loam, 12 to 30 percent slopes	959	2.2
416	Ngardok silt loam, 30 to 50 percent slopes	1,269	2.9
417	Ngardok silt loam, 50 to 75 percent slopes	575	1.3
418	Ngatpang gravelly clay loam, 2 to 12 percent slopes, severely eroded	229	0.5
419	Ngatpang gravelly clay loam, 12 to 50 percent slopes, severely eroded	89	0.2
420	Ngatpang silty clay loam, 2 to 6 percent slopes	152	0.3
421	Ngatpang silty clay loam, 6 to 12 percent slopes	233	0.5
422	Ngatpang silty clay loam, 12 to 30 percent slopes	202	0.5
423	Ngatpang silty clay loam, 30 to 50 percent slopes	107	0.2
424	Ngedebus sand, 0 to 3 percent slopes	577	1.3
425	Ngedebus Variant extremely cobbly loamy sand, 2 to 6 percent slopes	89	0.2
426	Ngersuul silt loam, 0 to 2 percent slopes	991	2.3
427	Ngerungor Variant-Ngerungor complex, 0 to 1 percent slopes	214	0.5
428	Ollei-Nekken complex, 30 to 50 percent slopes	455	1.0
429	Ollei-Nekken complex, 50 to 75 percent slopes	1,078	2.5
430	Ollei-Rock outcrop complex, 12 to 75 percent slopes	391	0.9
431	Palau-Aimeliik complex, 2 to 6 percent slopes	332	0.8
432	Peleliu-Rock outcrop complex, 0 to 4 percent slopes	811	1.9
433	Peleliu-Rock outcrop complex, 6 to 20 percent slopes	176	0.4
434	Rock outcrop-Peleliu complex, 80 to 150 percent slopes	1,392	3.2
435	Tabecheding silty clay loam, 2 to 6 percent slopes	312	0.7
436	Tabecheding silty clay loam, 6 to 12 percent slopes	198	0.5
437	Tabecheding silty clay loam, 2 to 12 percent slopes, severely eroded	322	0.7
438	Tabecheding silty clay loam, 12 to 30 percent slopes	217	0.5
439	Tabecheding silty clay loam, 12 to 30 percent slopes, severely eroded	93	0.2
440	Typic Troporthents, 30 to 75 percent slopes	107	0.2
441	Typic Troporthents-Urban land complex, 0 to 1 percent slopes	198	0.5
	Total	43,830	100.0

TABLE 2.--SUITABILITY OF CROPS FOR SPECIFIED MAP UNITS

[A rating of 1 indicates that the crop is suited to the unit; 2, that the crop is suited if special management is used; and 3, that the crop is not suited. Slope and the hazard of erosion are not considered in ratings. Map units not rated are not suited to any of the crops specified]

Crop	Map units											
	400 401 402 403 431	404 405 406 411 412	408	410 428[1] 429[1] 430[2]	413 414 415 416 417	420 421 422 423	424	425	426	427	430[2]	432 433	435 436 438
Avocados	1	2	3	1	1	2	2	2	2	3	2	2	3
Bananas	1	2	3	1	1	1	2	2	1	3	2	2	2
Breadfruit	1	2	3	1	1	1	2	2	2	3	2	2	3
Cacao	1	3	3	1	1	2	3	3	2	3	3	3	2
Cassava	1	2	3	1	1	1	2	3	1	3	2	2	2
Chinese cabbage	1	2	3	1	1	1	2	3	2	3	2	2	2
Cinnamon	1	2	3	1	1	1	3	3	2	3	2	2	3
Citrus fruit	1	2	3	1	1	1	3	3	2	3	2	2	3
Clove	1	2	3	1	1	1	3	3	2	3	2	2	3
Coconuts	1	2	3	1	1	1	1	1	1	3	2	2	3
Corn	1	2	3	1	1	1	2	3	2	3	2	2	2
Cucumbers	1	2	3	1	1	1	2	3	2	3	2	2	2
Eggplant	1	2	3	1	1	1	2	3	2	3	2	2	2
Green onions	1	2	3	1	1	1	2	3	2	3	2	2	2
Guava	1	2	3	1	1	1	3	3	1	3	2	2	2
Mangoes	1	2	3	1	1	1	3	3	2	3	2	2	3
Mangosteens	1	2	3	1	1	1	3	3	1	3	2	2	3
Nutmeg	1	2	3	1	1	1	3	3	2	3	2	2	3
Papayas	1	2	3	1	1	1	2	2	2	3	2	2	3
Pineapples	1	2	3	1	1	1	2	2	2	3	1	2	3
Rice, lowland	3	3	1	3	3	3	3	3	2	1	3	3	2
Sugarcane	1	2	3	2	1	1	2	3	2	3	2	2	2
Sweet potatoes	1	2	3	1	1	1	2	3	1	3	2	2	2
Taro, dryland	1	2	3	1	1	1	2	2	1	3	2	2	2
Taro, wetland	3	3	1	3	3	3	3	3	2	1	3	3	2
Tea	1	2	3	1	1	1	3	3	2	3	2	3	3
Tomatoes	1	2	3	1	1	2	2	3	2	3	2	2	3
Yams	1	2	3	1	1	3	2	3	2	3	2	2	2

[1]Only the Nekken soil in these map units is used for crops.

[2]Only the Ollei soil in these map units is used for crops.

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of trees are listed. Absence of an entry indicates information was not available. Only scientific names of trees are listed in this table. Common names are given in the section "Woodland management and productivity"]

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
400*:						
Aimeliik	Slight	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla Toona ciliata australis.
Palau	Slight	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
401*:						
Aimeliik	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
Palau	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
402*:						
Aimeliik	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
Palau	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.

See footnotes at end of table.

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
403*:						
Aimeliik----------	Severe	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus cardinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
Palau-------------	Severe	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
407*:						
Chia--------------	Severe	Moderate	Slight	Slight	Bruguiera gymnorhiza, Rhizophora mucronata, Rhizophora apiculata.	**
Insak-------------	Severe	Moderate	Slight	Slight	Rhizophora apiculata, Rhizophora mucronata.	**
409---------------- Ilachetomel	Severe	Moderate	Slight	Slight	Bruguiera gymnorhiza, Lumnitzera littorea, Sonneratia alba, Xylocarpus granatum, Rhizophora mucronata, Rhizophora apiculata.	**
410*:						
Nekken------------	Moderate	Slight	Moderate	Severe	Calophyllum inophyllum, Calophyllum wakamachi, Horsfieldia palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
Ollei.						
413, 414----------- Ngardok	Slight	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
415---------------- Ngardok	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.

See footnotes at end of table.

TABLE 3.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Management concerns				Common trees	Trees to plant
	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition		
416----------------- Ngardok	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
417----------------- Ngardok	Severe	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
420, 421------------ Ngatpang	Slight	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
422----------------- Ngatpang	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
423----------------- Ngatpang	Moderate	Slight	Moderate	Severe	Alphitonia carolinensis, Calophyllum inophyllum, Calophyllum wakamachi, Parinarium palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Ealeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
428*: Ollei.						
Nekken-------------	Moderate	Slight	Moderate	Severe	Calophyllum inophyllum, Calophyllum wakamachi, Horsfieldia palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australis.
429*: Ollei.						
Nekken-------------	Severe	Slight	Moderate	Severe	Calophyllum inophyllum, Calophyllum wakamachi, Horsfieldia palavensis, Pterocarpus indicus.	Araucaria heterophylla, Campnosperma brevipetiolata, Cedrela odorata, Elaeocarpus carolinensis, Eucalyptus, Swietenia macrophylla, Toona ciliata australia.

* See description of the map unit for composition and behavior characteristics of the map unit.
**This soil is not suited to planting of trees. Only natural regeneration is practiced.

TABLE 4.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
400*:					
Aimeliik	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Palau	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
401*:					
Aimeliik	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Palau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
402*, 403*:					
Aimeliik	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Palau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
404*:					
Babelthuap	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones, droughty.
Ngardmau	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.	Severe: small stones.
405*:					
Babelthuap	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Severe: small stones.	Severe: small stones, droughty.
Ngardmau	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Severe: small stones.	Severe: small stones.
406*:					
Babelthuap	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones, slope.	Severe: small stones, droughty, slope.
Ngardmau	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones, slope.	Severe: small stones, slope.
407*:					
Chia	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus, excess salt.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: excess salt, ponding, flooding.
Insak	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus, excess salt.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: excess salt, ponding, flooding.

See footnote at end of table.

TABLE 4.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
408*:					
Dechel	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding.
Mesei	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
409 Ilachetomel	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus, excess salt.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: excess salt, excess sulfur, ponding.
410*:					
Nekken	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones.	Severe: small stones, slope.
Ollei	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
411*, 412*:					
Ngardmau	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones, slope.
Babelthuap	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones, droughty, slope.
413 Ngardok	Slight	Slight	Moderate: slope.	Slight	Slight.
414 Ngardok	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
415 Ngardok	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
416, 417 Ngardok	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
418 Ngatpang	Severe: percs slowly.	Severe: percs slowly.	Severe: small stones, percs slowly.	Slight	Moderate: small stones.
419 Ngatpang	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, small stones, percs slowly.	Severe: slope.	Severe: slope.
420 Ngatpang	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, percs slowly.	Slight	Slight.
421 Ngatpang	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 4.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
422: Ngatpang	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
423: Ngatpang	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
424: Ngedebus	Severe: flooding, too sandy.	Severe: too sandy.	Moderate: small stones, flooding.	Severe: too sandy.	Moderate: droughty, flooding.
425: Ngedebus Variant	Severe: flooding, large stones, small stones.	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones.	Severe: small stones, large stones, droughty.
426: Ngersuul	Severe: flooding.	Moderate: flooding, wetness, percs slowly.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
427*:					
Ngerungor Variant	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
Ngerungor	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
428*, 429*:					
Ollei	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
Nekken	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: small stones, slope.
430*:					
Ollei	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope, thin layer.
Rock outcrop.					
431*:					
Palau	Slight	Slight	Moderate: slope.	Slight	Slight.
Aimeliik	Slight	Slight	Moderate: slope.	Slight	Slight.
432*:					
Peleliu	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: small stones.	Severe: small stones, large stones.
Rock outcrop.					

See footnote at end of table.

TABLE 4.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
433*:					
Peleliu	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones, slope, small stones.	Severe: small stones.	Severe: small stones, large stones.
Rock outcrop.					
434*:					
Rock outcrop.					
Peleliu	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: large stones, small stones.	Severe: small stones.	Severe: small stones, large stones.
435 Tabecheding	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Moderate: wetness.	Moderate: wetness.
436, 437 Tabecheding	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Moderate: wetness.	Moderate: wetness, slope.
438, 439 Tabecheding	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Moderate: wetness, slope.	Severe: slope.
440. Typic Troporthents					
441*:					
Typic Troporthents.					
Urban land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 5.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
400*:					
Aimeliik	Moderate: too clayey, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
Palau	Moderate: too clayey, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Severe: droughty.
401*, 402*, 403*:					
Aimeliik	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
Palau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
404*:					
Babelthuap	Moderate: too clayey.	Slight	Moderate: slope.	Severe: low strength.	Severe: small stones, droughty.
Ngardmau	Slight	Slight	Moderate: slope.	Severe: low strength.	Severe: small stones.
405*:					
Babelthuap	Moderate: too clayey, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Severe: small stones, droughty.
Ngardmau	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Severe: small stones.
406*:					
Babelthuap	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, droughty, slope.
Ngardmau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, slope.
407*:					
Chia	Severe: cutbanks cave, excess humus, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: excess salt, ponding, flooding.
Insak	Severe: depth to rock, ponding.	Severe: flooding, ponding, depth to rock.	Severe: flooding, ponding, depth to rock.	Severe: depth to rock, ponding, flooding.	Severe: excess salt, ponding, flooding.
408*:					
Dechel	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, wetness.	Severe: ponding, flooding.

See footnote at end of table.

TABLE 5.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
408*:					
Mesei	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: low strength, ponding, wetness.	Severe: ponding, flooding, excess humus.
409 Ilachetomel	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: low strength, wetness, flooding.	Severe: excess salt, excess sulfur, ponding.
410*:					
Nekken	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, slope.
Ollei	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
411*, 412*:					
Ngardmau	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, slope.
Babelthuap	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, droughty, slope.
413 Ngardok	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
414 Ngardok	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
415, 416, 417 Ngardok	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
418 Ngatpang	Moderate: too clayey, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: small stones, droughty.
419 Ngatpang	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
420 Ngatpang	Moderate: too clayey.	Slight	Moderate: slope.	Severe: low strength.	Slight.
421 Ngatpang	Moderate: too clayey, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
422, 423 Ngatpang	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
424 Ngedebus	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty, flooding.
425 Ngedebus Variant	Severe: cutbanks cave, large stones.	Severe: flooding, large stones.	Severe: flooding, large stones.	Severe: large stones.	Severe: small stones, large stones, droughty.

See footnote at end of table.

TABLE 5.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
426---------------- Ngersuul	Severe: excess humus, wetness.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
427*:					
Ngerungor Variant	Severe: cutbanks cave, excess humus, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, wetness.	Severe: ponding, flooding, excess humus.
Ngerungor---------	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding, low strength.	Severe: low strength, wetness.	Severe: ponding, flooding, excess humus.
428*, 429*:					
Ollei-------------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
Nekken------------	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: small stones, slope.
430*:					
Ollei-------------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
Rock outcrop.					
431*:					
Palau-------------	Moderate: too clayey.	Slight-----------	Slight------------	Severe: low strength.	Slight.
Aimeliik----------	Moderate: too clayey.	Slight-----------	Slight------------	Severe: low strength.	Slight.
432*:					
Peleliu-----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, low strength.	Severe: small stones, large stones.
Rock outcrop.					
433*:					
Peleliu-----------	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, low strength.	Severe: small stones, large stones.
Rock outcrop.					
434*:					
Rock outcrop.					
Peleliu-----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, low strength.	Severe: small stones, large stones.
435---------------- Tabecheding	Severe: wetness.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell, slope.	Severe: low strength.	Moderate: wetness.

See footnote at end of table.

TABLE 5.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
436, 437---------- Tabecheding	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: slope.	Severe: low strength.	Moderate: wetness, slope.
438, 439---------- Tabecheding	Severe: wetness, slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
440. Typic Troporthents					
441*: Typic Troporthents.					
Urban land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
400*:					
Aimeliik	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too clayey, slope.
Palau	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too clayey.	Severe: seepage.	Poor: too clayey.
401*, 402*, 403*:					
Aimeliik	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Palau	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too clayey.	Severe: seepage, slope.	Poor: too clayey, slope.
404*:					
Babelthuap	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too clayey.
Ngardmau	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too clayey.
405*:					
Babelthuap	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too clayey, slope.
Ngardmau	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too clayey, slope.
406*:					
Babelthuap	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Ngardmau	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
407*:					
Chia	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: seepage, too sandy, small stones.
Insak	Severe: flooding, depth to rock, ponding.	Severe: seepage, depth to rock, flooding.	Severe: flooding, depth to rock, seepage.	Severe: flooding, depth to rock, seepage.	Poor: area reclaim, seepage, too sandy.
408*:					
Dechel	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Poor: hard to pack, ponding.

See footnote at end of table.

TABLE 6.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
408*:					
Mesei	Severe: flooding, ponding, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, ponding.	Severe: flooding, seepage, ponding.	Poor: hard to pack, ponding.
409 Ilachetomel	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus, excess salt.
410*:					
Nekken	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Ollei	Severe: depth to rock, slope.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
411*, 412*:					
Ngardmau	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Babelthuap	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
413 Ngardok	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: hard to pack.
414 Ngardok	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: hard to pack.
415, 416, 417 Ngardok	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: hard to pack, slope.
418 Ngatpang	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
419 Ngatpang	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.
420 Ngatpang	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
421 Ngatpang	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
422, 423 Ngatpang	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, slope.
424 Ngedebus	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 6.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
425------ Ngedebus Variant	Severe: flooding, poor filter, large stones.	Severe: seepage, flooding, large stones.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy, small stones.
426------ Ngersuul	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: hard to pack.
427*:					
Ngerungor Variant--	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: seepage, too sandy, ponding.
Ngerungor------	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
428*, 429*:					
Ollei------	Severe: depth to rock, slope.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Nekken------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
430*:					
Ollei------	Severe: depth to rock, slope.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Rock outcrop.					
431*:					
Palau------	Slight------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: too clayey.
Aimeliik------	Slight------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too clayey.
432*:					
Peleliu------	Severe: depth to rock.	Severe: depth to rock, large stones.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones.
Rock outcrop.					
433*:					
Peleliu------	Severe: depth to rock.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones.
Rock outcrop.					
434*:					
Rock outcrop.					
Peleliu------	Severe: depth to rock.	Severe: depth to rock, large stones.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones.

See footnote at end of table.

TABLE 6.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
435----------------- Tabecheding	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey.
436, 437------------ Tabecheding	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: wetness, too clayey.	Moderate: wetness, slope.	Poor: too clayey.
438, 439------------ Tabecheding	Severe: wetness, percs slowly, slope.	Severe: slope, wetness.	Severe: wetness, slope, too clayey.	Severe: slope.	Poor: too clayey, slope.
440. Typic Troporthents					
441*: Typic Troporthents.					
Urban land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
400*:				
Aimeliik	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Palau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
401*:				
Aimeliik	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Palau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
402*, 403*:				
Aimeliik	Poor: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Palau	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
404*, 405*:				
Babelthuap	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Ngardmau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
406*:				
Babelthuap	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Ngardmau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
407*:				
Chia	Poor: low strength, wetness.	Probable	Probable	Poor: excess humus, area reclaim, excess salt.
Insak	Poor: area reclaim, thin layer, wetness.	Improbable: thin layer.	Improbable: thin layer.	Poor: area reclaim, excess humus, small stones.
408*:				
Dechel	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Mesei	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.

See footnote at end of table.

TABLE 7.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
409 Ilachetomel	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, excess salt, wetness.
410*:				
Nekken	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Ollei	Poor: area reclaim, thin layer.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: area reclaim, small stones, slope.
411*, 412*:				
Ngardmau	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Babelthuap	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
413 Ngardok	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
414 Ngardok	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
415 Ngardok	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
416, 417 Ngardok	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
418 Ngatpang	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
419 Ngatpang	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
420, 421 Ngatpang	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
422 Ngatpang	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
423 Ngatpang	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
424 Ngedebus	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
425 Ngedebus Variant	Poor: large stones.	Improbable: large stones.	Improbable: large stones.	Poor: small stones, area reclaim.
426 Ngersuul	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.

See footnote at end of table.

TABLE 7.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
427*:				
Ngerungor Variant	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
Ngerungor	Poor: low strength, wetness.	Probable	Probable	Poor: excess humus, wetness.
428*, 429*:				
Ollei	Poor: area reclaim, thin layer, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: area reclaim, small stones, slope.
Nekken	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
430*:				
Ollei	Poor: area reclaim, thin layer, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: area reclaim, small stones, slope.
Rock outcrop.				
431*:				
Palau	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Aimeliik	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
432*, 433*:				
Peleliu	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Rock outcrop.				
434*:				
Rock outcrop.				
Peleliu	Poor: area reclaim, low strength, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
435, 436, 437 Tabecheding	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
438, 439 Tabecheding	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
440. Typic Troporthents				
441*:				
Typic Troporthents.				
Urban land.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
400*, 401*, 402*, 403*:					
Aimeliik	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope.
Palau	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope.
404*:					
Babelthuap	Severe: seepage.	Slight	Deep to water	Favorable	Droughty.
Ngardmau	Severe: seepage.	Slight	Deep to water	Favorable	Droughty.
405*, 406*:					
Babelthuap	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope, droughty.
Ngardmau	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope, droughty.
407*:					
Chia	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, flooding, cutbanks cave.	Ponding, too sandy.	Wetness, excess salt.
Insak	Severe: depth to rock.	Severe: seepage, ponding, excess salt.	Ponding, depth to rock, flooding.	Depth to rock, ponding, too sandy.	Wetness, excess salt, depth to rock.
408*:					
Dechel	Moderate: seepage.	Severe: hard to pack, ponding.	Ponding, flooding, subsides.	Ponding	Wetness.
Mesei	Severe: seepage.	Severe: hard to pack, ponding.	Ponding, flooding, subsides.	Ponding	Wetness.
409 Ilachetomel	Severe: seepage.	Severe: excess humus, ponding, excess salt.	Ponding, flooding, subsides.	Ponding	Wetness, excess salt.
410*:					
Nekken	Severe: slope.	Severe: thin layer.	Deep to water	Slope, depth to rock.	Slope, droughty, depth to rock.
Ollei	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water	Slope, large stones, depth to rock.	Large stones, slope, droughty.
411*, 412*:					
Ngardmau	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope, droughty.

See footnote at end of table.

TABLE 8.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
411*, 412*:					
Babelthuap	Severe: seepage, slope.	Slight	Deep to water	Slope	Slope, droughty.
413 Ngardok	Severe: seepage.	Severe: hard to pack.	Deep to water	Favorable	Favorable.
414, 415, 416, 417 Ngardok	Severe: seepage, slope.	Severe: hard to pack.	Deep to water	Slope	Slope.
418 Ngatpang	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly	Droughty, percs slowly.
419 Ngatpang	Severe: slope.	Severe: hard to pack.	Deep to water	Slope, percs slowly.	Slope, percs slowly.
420 Ngatpang	Moderate: slope.	Moderate: thin layer.	Deep to water	Favorable	Favorable.
421, 422, 423 Ngatpang	Severe: slope.	Moderate: thin layer.	Deep to water	Slope	Slope.
424 Ngedebus	Severe: seepage.	Severe: seepage, piping.	Deep to water	Large stones, too sandy, soil blowing.	Large stones, droughty.
425 Ngedebus Variant	Severe: seepage.	Severe: seepage, large stones.	Deep to water	Large stones, too sandy.	Large stones, droughty.
426 Ngersuul	Severe: seepage.	Severe: hard to pack.	Flooding	Wetness	Favorable.
427*:					
Ngerungor Variant	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, flooding, subsides.	Ponding, too sandy.	Wetness.
Ngerungor	Severe: seepage.	Severe: excess humus, ponding.	Ponding, flooding, subsides.	Ponding	Wetness.
428*, 429*:					
Ollei	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water	Slope, large stones, depth to rock.	Large stones, slope, droughty.
Nekken	Severe: slope.	Severe: thin layer.	Deep to water	Slope, depth to rock.	Slope, droughty, depth to rock.
430*:					
Ollei	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water	Slope, large stones, depth to rock.	Large stones, slope.
Rock outcrop.					
431*:					
Palau	Severe: seepage.	Slight	Deep to water	Favorable	Favorable.
Aimeliik	Severe: seepage.	Slight	Deep to water	Favorable	Favorable.

See footnote at end of table.

TABLE 8.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
432*:					
Peleliu----------	Severe: depth to rock.	Severe: seepage, large stones.	Deep to water----	Large stones, depth to rock.	Large stones, droughty.
Rock outcrop.					
433*:					
Peleliu----------	Severe: depth to rock, slope.	Severe: seepage, large stones.	Deep to water----	Slope, large stones, depth to rock.	Large stones, slope, droughty.
Rock outcrop.					
434*:					
Rock outcrop.					
Peleliu----------	Severe: depth to rock.	Severe: seepage, large stones.	Deep to water----	Large stones, depth to rock.	Large stones, droughty.
435--------------- Tabecheding	Moderate: slope.	Moderate: wetness.	Percs slowly, slope.	Wetness, percs slowly.	Percs slowly.
436, 437, 438, 439-------------- Tabecheding	Severe: slope.	Moderate: wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Slope, percs slowly.
440. Typic Troporthents					
441*:					
Typic Troporthents.					
Urban land.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Unified classification	Fragments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	Cm			Pct					Pct	
400*, 401*, 402*, 403*:										
Aimeliik-------	0-10	Silt loam--------	MH-K	0	85-100	85-100	75-100	60-90	80-90	10-20
	10-86	Silty clay loam, silty clay, clay.	MH-K	0	95-100	90-100	85-100	75-95	75-85	15-25
	86-150	Silt loam, silty clay loam.	MH-K	0	100	100	90-100	80-95	75-85	10-30
Palau----------	0-10	Silty clay loam	MH-K	0	90-100	85-100	80-100	75-95	80-90	10-20
	10-106	Silty clay, silty clay loam.	MH-K	0	95-100	90-100	85-100	75-95	75-85	15-25
	106-150	Silt loam, silty clay loam.	MH-K	0	100	100	95-100	85-95	75-85	15-30
404*, 405*, 406*:										
Babelthuap------	0-10	Very gravelly loam.	SM	0-15	80-90	20-50	20-50	15-40	35-60	10-20
	10-64	Silty clay loam, silty clay.	MH-O	0	95-100	75-90	70-90	65-85	65-85	20-30
	64-150	Silt loam, silty clay loam.	MH-O	0	95-100	75-90	70-85	65-85	80-95	25-50
Ngardmau--------	0-12	Very gravelly silty clay loam.	GM	0-15	35-60	30-50	30-50	25-50	35-60	10-20
	12-40	Silty clay, silty clay loam.	MH-O	0	80-95	75-90	70-90	70-85	65-85	20-30
	40-150	Silty clay loam, silt loam.	MH-O	0	80-95	75-90	70-85	65-85	80-95	25-50
407*:										
Chia------------	0-50	Mucky peat-------	PT	0	---	---	---	---	---	NP
	50-73	Mucky peat-------	PT	0	---	---	---	---	---	NP
	73-150	Stratified very gravelly loamy sand to sand.	SP-SM, SM	0-5	60-100	50-100	25-75	5-25	---	NP
Insak-----------	0-8	Peaty loamy sand	PT	0	---	---	---	---	---	NP
	8-18	Mucky loamy sand	PT	0	65-100	60-100	---	---	---	NP
	18-75	Gravelly loamy sand, very gravelly sand, sand.	SP, SP-SM, GP, GP-GM	0-5	30-85	25-85	15-55	0-10	---	NP
	75	Unweathered bedrock.	---	---	---	---	---	---	---	---
408*:										
Dechel----------	0-10	Mucky silt loam	OH, MH	0	100	100	90-100	70-100	75-100	10-20
	10-102	Silty clay loam	MH	0	100	100	90-100	85-100	65-75	15-20
	102-109	Very gravelly silty clay loam.	MH, GM	10-15	35-60	30-55	30-55	25-55	65-75	15-20
	109-168	Silty clay loam, silt loam.	MH	0	100	100	90-100	85-100	65-75	15-20
Mesei-----------	0-86	Muck-------------	PT	0	---	---	---	---	---	NP
	86-150	Silt loam, silty clay loam.	MH	0	90-100	85-100	80-100	70-95	65-75	15-20
409-------------- Ilachetomel	0-150	Peat-------------	PT	0	---	---	---	---	---	NP

See footnote at end of table.

TABLE 9.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Frag- ments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	Cm			Pct					Pct	
410*:										
Nekken	0-20	Very gravelly silt loam.	GM, GM-GC	10-20	30-55	25-50	25-45	20-35	25-35	5-10
	20-46	Very gravelly silty clay loam, very gravelly clay loam.	GM	10-20	30-55	25-50	25-50	20-45	35-45	10-20
	46-56	Very gravelly silt loam.	GM, GM-GC	10-20	40-60	35-55	30-50	25-40	25-35	5-10
	56-150	Unweathered bedrock.	---	---	---	---	---	---	---	---
Ollei	0-18	Silt loam	CL-ML, CL	0-15	80-95	75-95	70-95	60-85	25-35	5-10
	18-28	Very gravelly loam, very gravelly silty clay loam, very gravelly clay loam.	GM-GC, GM, GC	10-25	30-50	25-50	15-50	15-45	25-35	5-10
	28-43	Extremely flaggy loam, extremely flaggy silt loam.	GM, GM-GC	55-75	20-40	15-35	15-35	10-30	25-35	5-10
	43-46	Unweathered bedrock.	---	---	---	---	---	---	---	---
411*, 412*:										
Ngardmau	0-12	Very gravelly silty clay loam.	GM	0-15	35-60	30-50	30-50	25-50	35-60	10-20
	12-40	Silty clay, silty clay loam.	MH-O	0	80-95	75-90	70-90	70-85	65-85	20-30
	40-150	Silty clay loam, silt loam.	MH-O	0	80-95	75-90	70-85	65-85	80-95	25-50
Babelthuap	0-10	Very gravelly loam.	SM	0-15	80-90	20-50	20-50	15-40	35-60	10-20
	10-64	Silty clay loam, silty clay.	MH-O	0	95-100	75-90	70-90	65-85	65-85	20-30
	64-150	Silt loam, silty clay loam.	MH-O	0	95-100	75-90	70-85	65-85	80-95	25-50
413, 414, 415, 416, 417 Ngardok	0-5	Silt loam	MH	0	75-100	75-100	70-100	60-90	75-85	5-15
	5-81	Silt loam, silty clay loam.	MH	0	85-100	85-100	75-100	65-95	80-90	25-35
	81-150	Silt loam, silty clay loam.	MH	0	75-95	75-95	70-95	55-90	60-80	10-20
418, 419 Ngatpang	0-20	Gravelly clay loam.	MH-K, GM	5-10	55-80	50-75	45-75	35-70	75-85	20-30
	20-66	Clay, silty clay	MH-K	0	95-100	90-100	80-100	70-95	75-85	25-35
	66-150	Clay, silty clay	MH	0	100	100	90-100	75-95	80-100	30-45
420, 421, 422, 423 Ngatpang	0-15	Silty clay loam	MH-K	0	80-100	75-100	70-100	65-95	80-90	5-15
	15-28	Gravelly silty clay, gravelly clay loam, very gravelly clay loam.	MH-K, GM	0	45-80	35-75	30-75	25-70	75-85	20-30
	28-114	Clay, silty clay	MH-K	0	95-100	90-100	80-100	70-95	75-85	25-35
	114-150	Clay, silty clay	MH	0	100	100	90-100	75-95	80-100	30-45
424 Ngedebus	0-46	Sand	SP-SM, SM	0-5	85-100	80-100	45-60	5-15	---	NP
	46-150	Stratified sand to gravelly sand.	SP-SM, SM	0-25	70-100	65-100	30-80	5-35	---	NP

See footnote at end of table.

TABLE 9.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Fragments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	Cm			Pct					Pct	
425---------------- Ngedebus Variant	0-36	Extremely cobbly loamy sand.	GP-GM, GM	50-65	35-50	25-45	15-45	5-15	---	NP
	36-150	Stratified very gravelly loamy sand to extremely cobbly sand.	GP-GM, GM, SP-SM, SM	35-65	25-70	20-65	15-50	5-15	---	NP
426---------------- Ngersuul	0-15	Silt loam--------	ML, MH	0	100	100	90-100	70-90	45-55	5-10
	15-99	Silty clay loam, silt loam.	MH	0	100	100	95-100	85-100	65-75	25-35
	99-167	Mucky peat-------	PT	0	---	---	---	---	---	NP
427*: Ngerungor Variant---------	0-53	Mucky peat-------	PT	0	---	---	---	---	---	NP
	53-150	Coarse sand------	SP-SM, SM	0	100	100	40-60	5-15	---	NP
Ngerungor--------	0-39	Mucky peat-------	PT	0	---	---	---	---	---	NP
	39-150	Hemic material, mucky peat.	PT	0	---	---	---	---	---	NP
	150-200	Sand, gravelly sand.	SP, SP-SM	0	60-90	60-85	30-50	0-10	---	NP
428*, 429*: Ollei------------	0-18	Silt loam--------	CL-ML, ML, CL	0-15	80-95	75-95	70-95	60-85	25-35	5-10
	18-28	Very gravelly loam, very gravelly silty clay loam, very gravelly clay loam.	GM-GC, GM, GC	10-25	30-50	25-50	15-50	15-45	25-35	5-10
	28-43	Extremely flaggy loam, extremely flaggy silt loam.	GM, GM-GC, GC, GP-GM	55-75	20-40	15-35	15-35	10-30	25-35	5-10
	43-46	Unweathered bedrock.	---	---	---	---	---	---	---	---
Nekken-----------	0-20	Very gravelly silt loam.	GM, GM-GC	0	30-55	25-50	25-45	20-35	25-35	5-10
	20-46	Very gravelly silty clay loam, very gravelly clay loam.	GM	0	30-55	25-50	25-50	20-45	35-45	10-20
	46-56	Very gravelly silt loam.	GM, GM-GC	0	40-60	35-55	30-50	25-40	25-35	5-10
	56-150	Unweathered bedrock.	---	---	---	---	---	---	---	---
430*: Ollei------------	0-18	Silt loam--------	CL-ML, ML, CL	0-15	80-95	75-95	70-95	60-85	25-35	5-10
	18-28	Very gravelly loam, very gravelly silty clay loam, very gravelly clay loam.	GM-GC, GM, GC	10-25	30-50	25-50	15-50	15-45	25-35	5-10
	28-43	Extremely flaggy loam, extremely flaggy silt loam.	GM, GM-GC, GC, GP-GM	55-75	20-40	15-35	15-35	10-30	25-35	5-10
	43-46	Unweathered bedrock.	---	---	---	---	---	---	---	---
Rock outcrop.										

See footnote at end of table.

TABLE 9.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Unified classification	Fragments > 76 mm	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	Cm			Pct					Pct	
431*:										
Palau-----------	0-10	Silty clay loam	MH-K	0	90-100	85-100	80-100	75-95	80-90	10-20
	10-106	Silty clay, silty clay loam.	MH-K	0	95-100	90-100	85-100	75-95	75-85	15-25
	106-150	Silt loam, silty clay loam.	MH-K	0	100	100	95-100	85-95	75-85	15-30
Aimeliik---------	0-10	Silt loam--------	MH-K	0	85-100	85-100	75-100	60-90	80-90	10-20
	10-86	Silty clay loam, silty clay, clay.	MH-K	0	95-100	90-100	85-100	75-95	75-85	15-25
	86-150	Silt loam, silty clay loam.	MH-K	0	100	100	90-100	80-95	75-85	10-30
432*, 433*:										
Peleliu---------	0-12	Extremely cobbly silt loam.	GM, GC	40-50	30-50	20-40	20-40	15-35	30-50	10-20
	12-30	Extremely gravelly loam, very cobbly loam, extremely cobbly loam.	GM	25-50	25-65	15-60	15-55	10-50	60-80	20-30
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---
Rock outcrop.										
434*:										
Rock outcrop.										
Peleliu---------	0-12	Extremely cobbly silt loam.	GM, GC	40-50	30-50	20-40	20-40	15-35	30-50	10-20
	12-30	Extremely gravelly loam, very cobbly loam, extremely cobbly loam.	GM	25-50	25-65	15-60	15-55	10-50	60-80	20-30
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---
435, 436--------- Tabecheding	0-18	Silty clay loam	MH-K	0	100	100	95-100	90-95	50-60	5-15
	18-51	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	80-100	20-40
	51-158	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	90-115	25-45
437-------------- Tabecheding	0-8	Silty clay loam	MH-K	0	100	100	95-100	90-95	50-60	5-15
	8-100	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	80-100	20-40
	100-178	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	90-115	25-45
438-------------- Tabecheding	0-18	Silty clay loam	MH-K	0	100	100	95-100	90-95	50-60	5-15
	18-51	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	80-100	20-40
	51-152	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	90-115	25-45
439-------------- Tabecheding	0-8	Silty clay loam	MH-K	0	100	100	95-100	90-95	50-60	5-15
	8-100	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	80-100	20-40
	100-178	Clay, silty clay	MH-K	0	80-100	75-100	70-100	60-95	90-115	25-45
440. Typic Troporthents										
441*:										
Typic Troporthents.										
Urban land.										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	Cm	G/cm3	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
400*, 401*, 402*, 403*:										
Aimeliik	0-10	0.80-1.00	5.0-15	0.10-0.13	3.6-5.0	<2	Low	0.10	5	6-12
	10-86	1.00-1.20	5.0-15	0.13-0.15	4.5-5.5	<2	Low	0.10		
	86-150	0.90-1.10	5.0-15	0.13-0.15	4.5-5.5	<2	Low	0.10		
Palau	0-10	0.80-1.00	5.0-15	0.10-0.12	3.6-5.0	<2	Low	0.10	5	5-9
	10-106	1.00-1.20	5.0-15	0.13-0.15	4.5-5.5	<2	Low	0.10		
	106-150	0.90-1.10	5.0-15	0.13-0.15	4.5-5.5	<2	Low	0.10		
404*, 405*, 406*:										
Babelthuap	0-10	0.80-1.00	15-50	0.05-0.10	3.6-5.5	<2	Low	0.05	5	1-4
	10-64	1.00-1.20	5.0-15	0.15-0.18	3.6-5.5	<2	Low	0.15		
	64-150	0.90-1.10	5.0-15	0.14-0.16	4.5-5.5	<2	Low	0.17		
Ngardmau	0-12	0.80-1.00	15-50	0.10-0.14	3.6-5.5	<2	Low	0.05	5	1-4
	12-40	1.00-1.20	5.0-15	0.15-0.18	3.6-5.5	<2	Low	0.10		
	40-150	0.90-1.10	5.0-15	0.15-0.18	4.5-5.5	<2	Low	0.10		
407*:										
Chia	0-50	0.10-0.15	15-50	0.20-0.30	5.6-7.3	>16	Low	0.02	5	>80
	50-73	0.10-0.15	15-50	0.20-0.30	5.6-7.3	<2	Low	0.02		
	73-150	1.20-1.40	15-50	0.05-0.06	6.6-7.8	<2	Low	----		
Insak	0-8	0.10-0.20	15-50	0.20-0.30	6.6-7.3	>16	Low	0.02	1	30-50
	8-28	0.10-0.20	15-50	0.15-0.20	6.6-7.3	>16	Low	0.02		
	28-75	1.30-1.50	15-50	0.10-0.15	6.6-7.3	>16	Low	0.02		
	75	---	---	---	---	---	------------	----		
408*:										
Dechel	0-10	0.50-0.90	5.0-15	0.15-0.25	5.1-7.3	<2	Low	0.15	5	12-18
	10-102	0.90-1.10	0.5-1.5	0.15-0.18	5.1-7.3	<2	Low	0.15		
	102-109	0.90-1.10	1.5-5.0	0.10-0.13	5.1-7.3	<2	Low	0.15		
	109-168	0.90-1.10	0.2-0.6	0.15-0.18	5.1-7.3	<2	Low	0.15		
Mesei	0-86	0.07-0.20	15-50	0.20-0.30	4.5-5.5	<2	Low	0.00	1	>99
	86-150	1.00-1.30	0.5-0.6	0.07-0.11	5.6-6.5	<2	Low	0.10		
409 Ilachetomel	0-150	0.05-0.09	15-50	0.20-0.30	5.6-6.0	>16	Low	0.02	1	70-90
410*:										
Nekken	0-20	0.70-1.00	5.0-15	0.10-0.14	5.6-6.5	<2	Low	0.10	2	5-8
	20-46	0.90-1.10	1.5-5.0	0.10-0.14	5.1-6.0	<2	Low	0.10		
	46-56	0.70-1.00	1.5-5.0	0.10-0.14	5.1-6.0	<2	Low	0.10		
	56-150	---	---	---	---	---	------------	----		
Ollei	0-18	0.70-1.00	5.0-15	0.14-0.18	5.1-6.0	<2	Low	0.10	2	5-8
	18-28	0.90-1.10	5.0-15	0.10-0.13	5.1-5.5	<2	Low	0.05		
	28-43	0.70-1.00	1.5-5.0	0.05-0.08	5.1-5.5	<2	Low	0.05		
	43-46	---	---	---	---	---	------------	----		
411*, 412*:										
Ngardmau	0-12	0.80-1.00	15-50	0.10-0.14	3.6-5.5	<2	Low	0.05	5	1-4
	12-40	1.00-1.20	5.0-15	0.15-0.18	3.6-5.5	<2	Low	0.10		
	40-150	0.90-1.10	5.0-15	0.15-0.18	4.5-5.5	<2	Low	0.10		
Babelthuap	0-10	0.80-1.00	15-50	0.05-0.10	3.6-5.5	<2	Low	0.05	5	1-4
	10-64	1.00-1.20	5.0-15	0.15-0.18	3.6-5.5	<2	Low	0.15		
	64-150	0.90-1.10	5.0-15	0.14-0.16	4.5-5.5	<2	Low	0.17		

See footnote at end of table.

TABLE 10.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	Cm	G/cm3	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
413, 414, 415, 416, 417-------- Ngardok	0-5	0.75-0.85	15-50	0.14-0.16	4.5-5.0	<2	Low----------	0.15	2	5-8
	5-81	0.90-1.10	5.0-15	0.15-0.18	4.5-5.5	<2	Low----------	0.10		
	81-150	0.75-0.85	5.0-15	0.15-0.18	4.5-5.5	<2	Low----------	0.10		
418, 419--------- Ngatpang	0-20	1.00-1.20	1.5-6.0	0.15-0.18	3.6-5.0	<2	Low----------	0.10	5	1-3
	20-66	0.90-1.10	0.5-1.5	0.15-0.18	3.6-5.0	<2	Low----------	0.15		
	66-150	0.70-0.80	<0.2	0.15-0.18	3.6-5.0	<2	Moderate-----	0.15		
420, 421, 422, 423------------- Ngatpang	0-15	0.80-1.00	1.5-5.0	0.14-0.16	4.5-5.5	<2	Low----------	0.10	5	1-6
	15-28	1.00-1.20	1.5-5.0	0.15-0.18	3.6-5.0	<2	Low----------	0.10		
	28-114	0.90-1.10	0.5-1.5	0.15-0.18	3.6-5.0	<2	Low----------	0.15		
	114-150	0.70-0.80	<0.2	0.15-0.18	3.6-5.0	<2	Moderate-----	0.15		
424-------------- Ngedebus	0-46	1.20-1.40	15-50	0.05-0.07	6.6-8.4	<2	Low----------	0.10	5	1-3
	46-150	1.50-1.70	15-50	0.04-0.07	7.4-9.0	<2	Low----------	0.10		
425-------------- Ngedebus Variant	0-36	1.20-1.40	15-50	0.02-0.04	6.6-8.4	<2	Low----------	0.02	5	1-3
	36-150	1.50-1.70	15-50	0.01-0.07	6.6-8.4	<2	Low----------	0.02		
426-------------- Ngersuul	0-15	0.70-0.90	5.0-15	0.14-0.16	4.5-5.5	<2	Low----------	0.15	5	5-8
	15-99	0.90-1.10	0.5-1.5	0.14-0.16	4.5-6.0	<2	Low----------	0.15		
	99-167	0.10-0.20	15-50	0.20-0.30	4.5-6.0	<2	Low----------	0.05		
427*:										
Ngerungor Variant--------	0-53	0.10-0.15	15-50	0.20-0.30	6.6-7.3	<2	Low----------	0.02	1	>80
	53-150	1.20-1.40	15-50	0.05-0.08	7.9-8.4	<2	Low----------	0.05		
Ngerungor--------	0-39	0.10-0.15	15-50	0.20-0.30	4.5-6.0	<2	Low----------	0.02	1	90-99
	39-150	0.10-0.15	15-50	0.20-0.30	4.5-6.0	<2	Low----------	0.02		
	150-200	1.20-1.40	15-50	0.04-0.05	6.6-7.3	<2	Low----------	0.10		
428*, 429*:										
Ollei-----------	0-18	0.70-1.00	5.0-15	0.14-0.18	5.1-6.0	<2	Low----------	0.10	2	5-8
	18-28	0.90-1.10	5.0-15	0.10-0.13	5.1-5.5	<2	Low----------	0.05		
	28-43	0.70-1.00	1.5-5.0	0.05-0.08	5.1-5.5	<2	Low----------	0.05		
	43-46	---	---	---	---	---	-------------	----		
Nekken----------	0-20	0.70-1.00	5.0-15	0.10-0.18	5.6-6.5	<2	Low----------	0.10	2	5-8
	20-46	0.90-1.10	1.5-5.0	0.10-0.13	5.1-6.0	<2	Low----------	0.10		
	46-56	0.70-1.00	1.5-5.0	0.03-0.09	5.1-6.0	<2	Low----------	0.10		
	56-150	---	---	---	---	---	-------------	----		
430*:										
Ollei-----------	0-18	0.70-1.00	5.0-15	0.14-0.18	5.1-6.0	<2	Low----------	0.10	2	5-8
	18-28	0.90-1.10	5.0-15	0.10-0.13	5.1-5.5	<2	Low----------	0.05		
	28-43	0.70-1.00	1.5-5.0	0.05-0.08	5.1-5.5	<2	Low----------	0.05		
	43-46	---	---	---	---	---	-------------	----		
Rock outcrop.										
431*:										
Palau-----------	0-10	0.80-1.00	5.0-15	0.10-0.12	3.6-5.0	<2	Low----------	0.10	5	5-9
	10-106	1.00-1.20	5.0-15	0.13-0.15	4.5-5.5	<2	Low----------	0.10		
	106-150	0.90-1.10	5.0-15	0.13-0.15	4.5-5.5	<2	Low----------	0.10		
Aimeliik---------	0-10	0.80-1.00	5.0-15	0.10-0.13	3.6-5.0	<2	Low----------	0.10	5	6-12
	10-86	1.00-1.20	5.0-15	0.04-0.07	4.5-5.5	<2	Low----------	0.17		
	86-150	0.90-1.10	5.0-15	0.04-0.07	4.5-5.5	<2	Low----------	0.17		
432*, 433*:										
Peleliu----------	0-12	0.70-0.90	15-50	0.10-0.13	6.6-7.8	<2	Low----------	0.05	1	5-8
	12-30	0.90-1.10	5.0-15	0.05-0.08	6.6-7.8	<2	Low----------	0.05		
	30	---	---	---	---	---	-------------	----		
Rock outcrop.										

See footnote at end of table.

TABLE 10.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Organic matter
								K	T	
	Cm	G/cm3	Cm/hr	Cm/cm	pH	Mmhos/cm				Pct
434*:										
Rock outcrop.										
Peleliu----------	0-12	0.70-0.90	15-50	0.10-0.13	6.6-7.8	<2	Low----------	0.05	1	5-8
	12-30	0.90-1.10	5.0-15	0.05-0.08	6.6-7.8	<2	Low----------	0.05		
	30	---	---	---	---	---	------------	----		
435, 436---------- Tabecheding	0-18	0.50-0.70	1.5-5.0	0.15-0.18	3.6-5.0	<2	Low----------	0.17	5	2-5
	18-51	0.80-1.00	0.2-0.5	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
	51-158	0.70-0.90	<0.2	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
437--------------- Tabecheding	0-8	0.50-0.70	1.5-5.0	0.15-0.18	3.6-5.0	<2	Low----------	0.17	5	2-5
	8-100	0.80-1.00	0.2-0.5	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
	100-178	0.70-0.90	<0.2	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
438--------------- Tabecheding	0-18	0.50-0.70	1.5-5.0	0.15-0.18	3.6-5.0	<2	Low----------	0.17	5	2-5
	18-51	0.80-1.00	0.2-0.5	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
	51-152	0.70-0.90	<0.2	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
439--------------- Tabecheding	0-8	0.50-0.70	1.5-5.0	0.15-0.18	3.6-5.0	<2	Low----------	0.17	5	2-5
	8-100	0.80-1.00	0.2-0.5	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
	100-178	0.70-0.90	<0.2	0.12-0.15	3.6-4.4	<2	Moderate-----	0.15		
440. Typic Troporthents										
441*: Typic Troporthents.										
Urban land.										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "frequent" and "occasional" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table		Bedrock		Subsidence		Risk of corrosion	
		Frequency	Duration	Months	Depth	Months	Depth	Hardness	Initial	Total	Uncoated steel	Concrete
					Cm		Cm		Cm	Cm		
400*, 401*, 402*, 403*:												
Aimeliik	B	None	---	---	>180	---	>150	---	---	---	High	High.
Palau	B	None	---	---	>180	---	>150	---	---	---	High	High.
404*, 405*, 406*:												
Babelthuap	B	None	---	---	>180	---	>150	---	---	---	High	High.
Ngardmau	B	None	---	---	>180	---	>150	---	---	---	High	High.
407*:												
Chia	D	Frequent	Long	Jan-Dec	+30-30	Jan-Dec	>150	---	---	---	High	High.
Insak	D	Frequent	Long	Jan-Dec	+30-30	Jan-Dec	25-50	Hard	---	---	High	High.
408*:												
Dechel	D	Frequent	Long	Jan-Dec	+10-25	Jan-Dec	>150	---	5-10	15-20	Moderate	Moderate.
Mesei	D	Frequent	Long	Jan-Dec	+30-15	Jan-Dec	>150	---	10-20	63-100	High	High.
409 Ilachetomel	D	Frequent	Long	Jan-Dec	+30-30	Jan-Dec	>150	---	10-20	>150	High	High.
410*:												
Nekken	B	None	---	---	>180	---	50-76	Hard	---	---	Moderate	Moderate.
Ollei	D	None	---	---	>180	---	25-51	Hard	---	---	Moderate	Moderate.
411*, 412*:												
Ngardmau	B	None	---	---	>180	---	>150	---	---	---	High	High.
Babelthuap	B	None	---	---	>180	---	>150	---	---	---	High	High.
413, 414, 415, 416, 417 Ngardok	B	None	---	---	>180	---	>150	---	---	---	High	High.
418, 419, 420, 421, 422, 423 Ngatpang	C	None	---	---	>180	---	>150	---	---	---	High	High.
424 Ngedebus	A	Occasional	Very brief	Jan-Dec	>105	Jan-Dec	>150	---	---	---	High	Low.
425 Ngedebus Variant	A	Occasional	Very brief	Jan-Dec	>180	---	>150	---	---	---	High	Low.
426 Ngersuul	C	Frequent	Very brief	Jan-Dec	60-90	Jan-Dec	>150	---	---	---	High	High.

See footnote at end of table.

TABLE 11.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Subsidence: Initial	Subsidence: Total	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Cm		Cm		Cm	Cm		
427*:												
Ngerungor Variant	D	Frequent----	Long------	Jan-Dec	+0-25	Jan-Dec	>150	---	5-10	40-130	High-----	Moderate.
Ngerungor---------	D	Frequent----	Long------	Jan-Dec	0-15	Jan-Dec	>150	---	10-20	>150	High-----	High.
428*, 429*:												
Ollei------------	D	None--------	---	---	>180	---	25-50	Hard	---	---	Moderate	Moderate.
Nekken-----------	B	None--------	---	---	>180	---	50-75	Hard	---	---	Moderate	Moderate.
430*:												
Ollei------------	D	None--------	---	---	>180	---	25-50	Hard	---	---	Moderate	Moderate.
Rock outcrop.												
431*:												
Palau------------	B	None--------	---	---	>180	---	>150	---	---	---	High-----	High.
Aimeliik---------	B	None--------	---	---	>180	---	>150	---	---	---	High-----	High.
432*, 433*:												
Peleliu----------	D	None--------	---	---	>180	---	25-50	Hard	---	---	Moderate	Low.
Rock outcrop.												
434*:												
Rock outcrop.												
Peleliu----------	D	None--------	---	---	>180	---	25-50	Hard	---	---	Moderate	Low.
435, 436, 437, 438, 439--------- Tabecheding	---	None--------	---	---	45-90	Jan-Dec	>150	---	---	---	High-----	High.
440. Typic Troporthents												
441*:												
Typic Troporthents.												
Urban land.												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aimeliik	Very fine, halloysitic, isohyperthermic Oxic Humitropepts
Babelthuap	Clayey, oxidic, isohyperthermic Haplic Acrorthox
Chia	Sandy or sandy-skeletal, carbonatic, euic, isohyperthermic Terric Tropohemists
Dechel	Very fine, mixed, nonacid, isohyperthermic Tropic Hydraquents
Ilachetomel	Euic, isohyperthermic Typic Sulfihemists
Insak	Sandy, carbonatic, isohyperthermic Typic Tropaquents
Mesei	Very fine, mixed, euic, isohyperthermic Terric Troposaprists
Nekken	Clayey-skeletal, mixed, isohyperthermic Typic Tropohumults
Ngardmau	Very fine, oxidic, acid, isohyperthermic Typic Troporthents
Ngardok	Clayey, mixed, isohyperthermic Tropeptic Haplorthox
Ngatpang	Clayey, halloysitic, isohyperthermic Tropeptic Haplorthox
Ngedebus	Carbonatic, isohyperthermic Typic Tropopsamments
Ngedebus Variant	Sandy-skeletal, carbonatic, isohyperthermic Typic Troporthents
Ngersuul	Very fine, mixed, isohyperthermic Aquic Dystropepts
Ngerungor	Euic, isohyperthermic Typic Sulfihemists
Ngerungor Variant	Sandy or sandy-skeletal, carbonatic, euic, isohyperthermic Terric Tropohemists
Ollei	Clayey-skeletal, mixed, isohyperthermic Lithic Dystropepts
Palau	Clayey, halloysitic, isohyperthermic Tropeptic Haplorthox
Peleliu	Clayey-skeletal, oxidic, isohyperthermic Lithic Eutropepts
Tabecheding	Clayey, halloysitic, isohyperthermic Aquic Tropudults

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