Ecological site QX191X01X502
Deep and Very Deep Soils on Limestone Plateaus

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

MLRA notes

Major Land Resource Area (MLRA): 191X–High Limestone Plateaus of the Mariana Islands

This MLRA consists of the northern half of Guam and the islands of Saipan, Tinian, Rota, and Aguijan. Topography consists mostly of limestone plateaus. The highest elevations are 1,700 feet (520 meters) on Rota, 1,485 feet (450 meters) on Saipan, 655 feet (200 meters) on Tinian, and 860 feet (260 meters) in the northern part of Guam. The limestone plateaus were uplifted by tectonic activity. Deeply weathered volcanic rock is exposed on some ridges and slopes. Average annual rainfall is about 100 inches (2,540 millimeters) on northern Guam and about 80 inches (2,030 millimeters) on Saipan, Tinian, Aguijan, and Rota. The rainy season occurs from July through November; the dry season occurs from December through June. Trade winds blow from the northeast. Average annual temperature is 79 degrees F (26 degrees C). Typhoons are frequent. Soils are Alfisols, Andisols, Entisols, Mollisols, or Oxisols. The dominant soil moisture regime is ustic. The soil temperature regime is isohyperthermic. Native vegetation consists of mixed tropical hardwoods; introduced white leadtree or tangantangan (Leucaena leucocephala) are abundant. Introduced deer, pigs, goats, and water buffalo are common (USDA-NRCS, 2006). The main human disturbance is clearing land for cultivation. Feral pigs, feral cattle, brown tree snakes, stray dogs (Boonie dogs), and introduced deer are destructive to the native forest (Amand, 2000; CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

Classification relationships

This ecological site occurs within Major Land Resource Area (MLRA) 191 – High Limestone Plateaus of the Mariana Islands.

Ecological site concept

This ecological site occurs on the islands of Guam, Saipan, Tinian, and Aguijan in the Mariana Islands. It occurs on nearly level to moderately sloping (0 to 15 percent slopes) limestone plateaus at elevations ranging from 10 to 1,300 feet (3 to 400 meters). (USDA-SCS, 1988; USDA-SCS, 1989). Soils are deep and very deep, well drained Oxisols (Eutrustox) that formed in sediment, residuum, or alluvium over coralline limestone or argillaceous limestone. Some phases consist of fill deposited over the natural soil surface. Soil temperature regimes are isohyperthermic; soil moisture regimes are ustic. Average annual precipitation is 85 inches (2,160 millimeters) and ranges from 76 to 95 inches (1,930 to 2,410 millimeters) (Prism, 2006). Water runoff is low to medium; permeability is slow to moderately slow. Effective rooting depth ranges from 40 to 60 inches (100 to 150 cm) or deeper, and available water-holding capacity is low (3.5 to 6 inches) in the upper 40 inches (100 cm) of soil (USDA-SCS, 1988; USDA-SCS, 1989). Most of this ecological site is used for farmland; areas not farmed are vegetated by mostly introduced grass, forb, and tree species. Tangantangan (Leucaena leucocephala) is abundant in places (Amidon et al., 2017; Falanruw et al., 1989; Fosberg, 1960; Liu and Fischer, 2008; Stone, 1970; Wagner and Grether, 1948; Willsey et al., 2019).

Associated sites

QX191X01X503	**Very Shallow to Moderately Deep Soils on Limestone Plateaus** Soils of QX191X01X503 (Very Shallow to Moderately Deep Soils on Limestone Plateaus Ecological Site) occur on plateaus. They are well drained, very shallow or shallow (2 to 20 inches) clays, clay loams and very gravelly sandy loams. Available water-holding capacity is very low (1 to 3 inches). Sub surface soils contain 0 to 9 percent rock fragments greater than 3 inches. Much of the area is farmed. Where not farmed, vegetation consists of mostly introduced grass, forb, and tree species. Soils of QX191X01X502 (Deep and Very Deep Soils on Limestone Plateaus Ecological Site) also occur on plateaus. They are deep (40 to 60 inches) and very deep (greater than 60 inches) and moderately well to well drained. Available water-holding capacity is low (3.5 to 6 inches). Most of this ecological site is also used for farmland; areas not farmed are vegetated by mostly introduced grass, forb, and tree species. Where not farmed, vegetation consists of mostly introduced grass, forb, and tree species. Tangantangan or white lead tree (Leucaena leucocephala) is abundant in places in both ecological sites.
QX191X01X505	**Very Low Available Water Capacity Soils on Limestone Plateaus and Escarpments** Soils of QX191X01X505 (Very Low Available Water Capacity Soils on Limestone Plateaus and Escarpments Ecological Site) occur on plateaus. They do not experience flooding. They are well drained, very-cobbly clays and cobbly clay loams with very low (1 inches) available water holding capacity. Sub surface soils contain 0 to 40 percent rock fragments greater than 3 inches. Most of the area is vegetated by native forest. Soils of QX191X01X502 (Deep and Very Deep Soils on Limestone Plateaus Ecological Site) also occur on plateaus. They are deep (40 to 60 inches) and very deep (greater than 60 inches) and moderately well to well drained. Available water-holding capacity is low (3.5 to 6 inches). Most of this ecological site is used for farmland. Where not farmed, vegetation consists of mostly introduced grass, forb, and tree species. Tangantangan or white lead tree (Leucaena leucocephala) is abundant in places in this ecological site
QX191X01X004	**Somewhat Poorly and Poorly Drained Limestone Basins** Soils of QX191X01X004 (The Somewhat Poorly and Poorly Drained Limestone Basins Ecological Site) occur on basin floors; they rarely flood or pond. They are deep, somewhat poorly and poorly drained, have low (6 inches) available water holding capacity, and somewhat moderately acidic to slightly basic soils (pH ranges from 5.1 to 7.8). Most of the area is vegetated by water- tolerant grasses and forest. Soils of QX191X01X502 (The Deep and Very Deep Soils on Limestone Plateaus Ecological Site) also occur on plateaus. They are deep (40 to 60 inches) and very deep (greater than 60 inches) and moderately well to well drained. Available water-holding capacity is low (3.5 to 6 inches). Most of this ecological site is used for farmland. Where not farmed, vegetation consists of mostly introduced grass, forb, and tree species. Tangantangan or white lead tree (Leucaena leucocephala) is abundant in places in this ecological site.
QX191X01X005	**Very Poorly Drained Muck** Soils of QX191X01X005 (Very Poorly Drained Muck Ecological Site) occurs in depressions on nearly level (0 to 2 percent) slopes at elevations ranging from 0 to 20 feet. The surface soil is 8 inches of muck over mucky clay loam. The soil moisture regimes are aquic; the soils are wet at the surface (about 0 inches). Groundwater varies from fresh to saline (EC 8 to 16 dS/m) depending on location. Flooding is frequent and ponding is rare. Most of the area is vegetated by marsh grasses and, in a few locations, small stands of hibiscus (Hibiscus tiliaceus) or mangrove forest. Soils of QX191X01X502 (Deep and Very Deep Soils on Limestone Plateaus Ecological Site) also occur on plateaus. They are deep (40 to 60 inches) and very deep (greater than 60 inches) and moderately well to well drained. Available water-holding capacity is low (3.5 to 6 inches). Most of this ecological site is used for farmland. Where not farmed, vegetation consists of mostly introduced grass, forb, and tree species. Tangantangan or white leadtree (Leucaena leucocephala) is abundant in places in this ecological site.

Table 1. Dominant plant species

Tree	(1) *Artocarpus mariannensis*
Shrub	(1) *Cycas circinalis*

Herbaceous	Not specified

Legacy ID

F191XY502MP

Physiographic features

This ecological site occurs on limestone plateaus. Some sites occur in concave depressions on the plateaus. However, these sites have moderately well to well drained soils as occur in the rest of the ecological site and probably receive only small to moderate amounts of runoff from surrounding areas due to the high porosity of the limestone. The depth to the water table is greater than 72 inches (183 centimeters) (USDA-SCS, 1988; USDA-SCS, 1989).

Table 2. Representative physiographic features

Landforms	(1) Island > Plateau
Runoff class	Low to medium
Flooding frequency	None
Ponding frequency	None
Elevation	0 – 400 m
Slope	0 – 20 %
Water table depth	180 cm
Aspect	Aspect is not a significant factor

Climatic features

Summary for this Ecological Site

Rainfall statistics were determined from PRISM rainfall raster data (PRISM, 2006). Representative (20th and 80th percentiles) values for mean annual precipitation range from 76 to 95 inches (1,930 to 2,410 millimeters) while actual (10th and 90th percentiles) values for mean annual precipitation range from 74 to 101 inches (1,880 to 2,560 millimeters). Extreme values range from 70 to 101 inches (1,780 to 2,560 millimeters). The average annual precipitation is 85 inches (2,150 millimeters) and the median annual average precipitation is also 85 inches (2,160 millimeters).

Temperature statistics were determined from PRISM temperature raster data (PRISM, 2006) Representative (20th and 80th percentiles) values for mean annual temperatures range from 79 to 81 degrees F (26 to 27 degrees C) while actual (10th and 90th percentiles) values for mean annual temperatures also range from 79 to 81 degrees F (26 to 27 degrees C). Extreme values range from 77 to 82 degrees F (25 to 28 degrees C). The average annual temperature is 81 degrees F (27 degrees C), and the median annual temperature is also 81 degrees F (27 degrees C).

The data presented in the climate normals tables below are from select climate stations in Guam. I used the data from these stations because they are representative of the spatial distribution of this ecological site and because the values for mean annual rainfall of 91 inches (2,310 millimeters) and mean annual temperature values of 80 degrees F (27 degrees C) are reasonably comparable to the PRISM data presented above.

General Principles

The climate is uniformly warm and humid throughout the year. Afternoon temperatures typically are about 86 degrees F (30 degrees C); nighttime temperatures are about 68 F (20 C). Relative humidity is 65 to 75 percent in the afternoon to 85 to 100 percent at night. Though temperature and humidity vary only slightly throughout the year, rainfall and wind conditions vary markedly. There are two main seasons, the dry season from December through June and the rainy season from mid-July to mid-November. Moisture deficit occurs between January and June. Mean annual rainfall ranges from about 98 inches (2,490 millimeters) on the windward (eastern) side of the higher mountains to about 79 inches (2,005 millimeters) along the coast of the western side of the islands. On average, about 15 percent of the annual rainfall occurs during the dry season and 55 percent during the rainy season (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

Throughout the year, the dominant winds are the trade winds that blow from the east or northeast. The trade winds are strongest and most constant during the dry season, when windspeeds of 15 to 25 mph (25 to 40 kph) are common. Coastal areas that have east, and northeast

exposures are subject to salt spray and buffeting winds (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

During the rainy season the trade winds may break down and be replaced by a weak, westerly monsoon influence that brings heavy showers or steady and sometimes torrential rains. The islands lie in the path of typhoons from the southeast and east. They bring heavy rains and violent winds that may result in a surge of water onto low-lying coastal areas. They occur most frequently during the latter half of the year. The chance of having one or more typhoons pass close to the islands in any particular year is about once in three years. The chance of having a typhoon move directly across an island is about once in eight years (Fosberg, 1960; USDA-SCS, 1988; USDA-SCS, 1989).

Table 3 Representative climatic features

Frost-free period (characteristic range)	370 days
Freeze-free period (characteristic range)	370 days
Precipitation total (characteristic range)	1,930-2,410 mm
Frost-free period (actual range)	370 days
Freeze-free period (actual range)	370 days
Precipitation total (actual range)	1,880-2,570 mm
Frost-free period (average)	370 days
Freeze-free period (average)	370 days
Precipitation total (average)	2,160 mm

- (1) ANDERSEN AFB GUAM [GQC00914025], GU
- (2) CAPITOL HILL 1 [CQC00914080], MP
- (3) GUAM INTL AP [GQW00041415], GU

Influencing water features

Number of National Wetland Inventory (NWI) features overlapping ecological site: Freshwater emergent wetland (65), riverine (49), freshwater pond (16), freshwater forested/shrub wetland (10), estuarine and marine wetland (7), and estuarine and marine deepwater (1) (USFWS, 2023).

Soil features

The soil components associated with this ecological site are Kagman, Saipan, and Yigo (USDA-SCS, 1988; USDA-SCS, 1989).

Kagman and Saipan are classified as Kandiustalfic Eutrustox; Yigo is classified as Tropeptic Eutrustox. Soil temperature regimes are isohyperthermic; soil moisture regimes are ustic. They are deep to very deep, well drained, and, except for Yigo soils, have an argillic (accumulated translocated clay) horizon. The underlying limestone is porous. Two phases of Saipan series and one phase of Kagman series consist of very gravelly sandy loam fill deposited over the natural soil surface (USDA-SCS, 1988; USDA-SCS, 1989).

Table 4. Representative soil features

Parent material	(1) Residuum – coral limestone (2) Alluvium – coral limestone
Surface texture	(1) Clay (2) Silty clay (3) Very gravelly sandy loam
Family particle size	(1) Very-fine (2) Fine (3) Clayey
Drainage class	Moderately well drained to well drained
Permeability class	Slow to moderately slow
Depth to restrictive layer	100 – 200 cm
Soil depth	100 – 200 cm
Surface fragment cover <=3"	0 – 10 %
Surface fragment cover >3"	Not specified
Available water capacity (0-101.6cm)	8.89 – 15.49 cm

Calcium carbonate equivalent (0-101.6cm)	Not specified
Electrical conductivity (0-101.6cm)	Not specified
Sodium adsorption ratio (0-101.6cm)	Not specified
Soil reaction (1:1 water) (0-25.4cm)	6.1 – 8.4
Subsurface fragment volume <=3" (0-101.6cm)	0 – 40 %
Subsurface fragment volume >3" (0-101.6cm)	0 – 10 %

Ecological dynamics

The main human disturbance is clearing land for cultivation. Most of the area is currently used for farmland. Feral pigs, feral cattle, and introduced deer are destructive to the forest (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

The main natural disturbance is strong storms that can damage or kill vegetation by high wind speeds. Natural fire is rare in forested areas due to the low amounts of fine fuels on the ground (CNMI SWARS Council, 2010; Donnegan et al., 2011; Liske-Clark, 2015; Willsey et al., 2019).

State and transition model

Additional community tables

Table 5. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 6. Community 1.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 7. Community 2.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 8. Community 2.2 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 9. Community 3.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 10. Community 4.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Table 11. Community 5.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production ()	Foliar Cover (%)

Other references

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	08/19/2025
Approved by	
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

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2. **Presence of water flow patterns:**

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3. **Number and height of erosional pedestals or terracettes:**

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

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5. **Number of gullies and erosion associated with gullies:**

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6. **Extent of wind scoured, blowouts and/or depositional areas:**

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7. **Amount of litter movement (describe size and distance expected to travel):**

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

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12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

Additional:

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13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
