ATTACHMENT J

Soil and Geology Descriptions

SOIL AND GEOLOGY DESCRIPTIONS

SOILS GREAT GROUPS WITHIN THE NAVAJO-GALLUP WATER SUPPLY PROJECT AREA

Cambothids

Cambothids are the Aridisols that:

(1) Have a cambic horizon that has its upper boundary within 100 centimeters of the soil surface

(2) Have a soil temperature regime warmer than cryic

(3) Do not have a duripan or an argillic, calcic, natric, petrocalcic, gypsic, petrogypsic, or salic horizon that has its upper boundary within 100 centimeters of the soil surface

These are the Aridisols with the least degree of soil development. These soils have a cambic horizon within 100 centimeters of the soil surface. They may have other diagnostic horizons, such as a petrocalcic, gypsic, or calcic horizon, but the upper boundary of these horizons must be below 100 centimeters of the soil surface. These soils are the most common Aridisols in the United States.

Haplargids

Haplargids are the Argids that:

(1) Do not have a duripan or a petrocalcic, petrogypsic, gypsic, or calcic horizon that has an upper boundary within 150 centimeters of the soil surface

(2) Do not have a natric horizon

(3) Have a densic, lithic, or paralithic contact within 50 centimeters of the soil surface, or

a. A clay increase of less than 15 percent (absolute) within a vertical distance of 2.5 centimeters either within the argillic horizon or at its upper b boundary, or

b. An argillic horizon that does not extend to 150 centimeters from the soil surface, has a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content, or has either (1) hue of 10YR or yellower or chroma of 4 or less in the matrix of all horizons between depths of 100 and 150 centimeters or (2) hue of 10YR or yellower and value, moist, of 4 or more or value, dry, of 4 or less in less than 50 percent of the matrix

These are the Argids that have an argillic horizon but do not have a duripan or a petrocalcic, petrogypsic, calcic, gypsic, or natric horizon. These soils commonly have calcium carbonate accumulations within or below the argillic horizon. Haplargids commonly occur on late-Pleistocene surfaces or sediments.

Torriorthents

Torriorthents are the Orthents that have an aridic (or torric) moisture regime and have a soil temperature regime warmer than cryic. These are the dry Orthents of cool to hot, arid regions. They have an aridic (or torric) moisture regime and a temperature regime warmer than cryic. Generally, they are neutral or calcareous and are on moderate to very steep slopes. A few are on gentle slopes. Many of the gently sloping soils are on rock pediments, are very shallow, have a sandy-skeletal particle-size class, or are salty. Others are on fans where sediments are recent but have little organic carbon. The vegetation on Torriorthents commonly is sparse and consists mostly of xerophytic shrubs and ephemeral grasses and forbs. The vegetation on a few of the soils is saltgrass. Torriorthents are used mainly for grazing. They are extensive in the Western United States.

Torrifluvents

Torrifluvents are the Fluvents that have an aridic (or torric) moisture regime and a soil temperature regime warmer than cyric. These are the Fluvents of arid climates. Most of them have a high pH value and are calcareous, and a few are somewhat salty. The soils are subject to flooding, but most are not flooded frequently or for long periods. The larger areas that have a favorable topography and are close to a source of water commonly are irrigated. The natural vegetation on the Torrifluvents in the United States consisted mostly of grasses, xerophytic shrubs, and cacti, but in some parts of the world, the only vegetation on the soils has been irrigated crops because the sediments accumulated while the soils were being cultivated.

Torripssaments

Torripsamments are the Psamments that have an aridic (or torric) moisture regime and a soil temperature regime warmer than cryic. These are the cool to hot Psamments of arid climates. They have an aridic (or torric) moisture regime and a temperature regime warmer than cryic. Many of these soils are on stable surfaces, some are on dunes, some are stabilized, and some are moving. Torripsamments consist of quartz, mixed sands, volcanic glass, or even gypsum, and may have any color. Generally, they are neutral or calcareous and are nearly level to steep. The vegetation consists mostly of xerophytic shrubs, grasses, and forbs. Many of these soils support more vegetation than other soils with an aridic moisture regime, presumably because they lose less water as runoff. Some of the soils on dunes support a few ephemeral plants or have a partial cover of xerophytic and ephemeral plants. The shifting dunes may be devoid of plants in normal years. Most of the deposits are of late-Pleistocene or younger age. These soils are used mainly for grazing. They are extensive in the Western United States.

Table J-1.—Soil map unit classifications within the project area

Map unit name	Slope (%)	Depth (inches)	Erosion[1] hazard	Land capability classification[2]	Project[3] features
Aquima-Hawaikuh silt loams	1–5	>60	1 to 2	3e & 6c	m
Badland			4	8	c
Badland-Genats complex[4]	35–60	20–40	3 to 4	7e	m
Badland-Rock complex			4	8	p
Benally fine sandy loam	1–5	>60	1 to 2	7s	a
Benally loamy sand	1–3	>60	1	6c	a
Breadsprings and Nahodish soils	0–2	>60	1	6c	m
Brimham-Benally-Genats association	0–45	20–60	1 to 3	7c & 7e	m
Buckle fine sandy loam	1–8	>60	1 to 2	6c	m
Buckle-Gapmesa-Barboncito complex	1–6	10–60	1 to 2	6c	m
Calladito-Elias association	1–6	>60	1 to 2	7e & 7s	c
Camac-Kimbeto-Badland association	0–50	20–40	1 to 4	7e & 7s	p
Chinde loam	0–5	>60	1 to 2	7s	a
Councelor-Eslendo-Calladito complex	2–25	5–60	1 to 3	6c & 7e	c
Doak-Shiprock complex	1–8	>60	1	7c	m
Doakum-Betonnie complex	1–8	>60	1 to 2	6c	c
Fajada-Huerfano-Benally Complex	1–5	10–60	1 to 2	7c & 7s	m
Farb-Chipeta-Rock outcrop complex	2–30	5–20	1 to 4	7e & 7s	m
Farb-Rock outcrop-Badland complex	2–25	5–10	1 to 4	7s	a, m, p
Gyptur very fine sandy loam	0–3	40–60	1	7s	a, m, p
Hamburg clay loam	0–1	>60	1	6s	m
Jeddito-Escavada association	0–3	>60	1	6e & 7c	m
Jeddito loamy fine sand	0–2	>60	1	7c	m
Kimbeto-Huerfano complex	1–4	10–60	1	7c & 7s	a, m
Kimbeto loamy fine sand	0–4	40–60	1	7c	M
Littlehat-Persayo-Badland complex	3–45	10–40	1 to 4	7s	a, p

Table J-1.—Soil map unit classifications within the project area (continued)

Map unit name	Slope (%)	Depth (inches)	Erosion[1] hazard	Land capability classification[2]	Project[3] features
Littlehat-Persayo-Nataani complex	1–15	10–40	1 to 2	7c & 7s	a, m, p
Mesa fine sandy loam	1–4	>60	1 to 2	7c	M
Nageezi loamy fine sand	1–6	>60	1 to 2	7c	P
Norkiki-Kimnoli complex	1–8	5–40	1 to 2	7c & 7s	M
Notal-Escavada-Riverwash association	0–1	>60	1 to 4	6e & 7c	a, p
Notal-Hamburn complex	0–2	>60	1	6c & 7c	M
Notal sandy clay loam	0–1	>60	1	7c	a, m, p
Persayo-Fordbutte association	1–10	10–40	1 to 2	7c & 7s	m
Ravola very fine sandy loam	1–3	>60	1	7c	a, m, p
Razito-Shiprock complex	3–8	>60	1 to 2	7c	m
Rehobeth silty clay loam	0–1	>60	1	6c	m
Riverwash-Escawetter association	0–1	>60	1 to 4	7c	m
Shiprock-Farb complex	1–5	5–60	1 to 2	7c & 7s	m
Sparank-San Mateo-Zia complex	0–3	>60	1	6c	m
Starlake clay	1–3	>60	1	7s	c
Suwanee loam	0–1	>60	1	6c	m
Tsosie-Councelor-Blancot fine sandy loams	1–3	>60	1	6c	c
Tsebitai very fine sandy loam	1–3	>60	1	7c	a, m
Wingrock – rock outcrop association	4–15	>60	1 to 4	7c	m
Werito loam	1–3	20–40	1	7s	m
Zia sandy loam	1–5	>60	1 to 2	6c	m

[1] Erosion hazards: 1 = slight, 2 = moderate, 3 = severe, 4 = very severe.
[2] Land capability classification: See table J-2 for definitions.
[3] Project features: a = Amarillo, c = Cutter, m = main, p = PNM laterals.
[4] A complex is a map unit where both soils are of roughly equal dominance.

Table J-2.—Land capability definitions[1]

Land capability classification	Class description
3	Soils in Class 3 have severe limitation that reduce the choice of plants or require special conservation practices, or both. When used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. They may be used for cultivated crops, pasture, woodland, range, or wildlife food and cover.
6	Soils in Class 6 have severe limitations that make them generally unsuited to cultivate and limit their use largely to pasture or range, woodland, or wildlife food and cover. Physical conditions of these soils are such that it is practical to apply range or pasture improvements, if needed, such as seeding, liming, fertilizing, and water control with contour furrows, drainage, diversions, or water spreaders.
7	Soils in Class 7 have severe limitations that make them unsuited and restrict their use largely to grazing, woodland, or wildlife. Physical conditions of these soils are such that it is impractical to apply pasture or range improvements.
8	Soils and landforms in Class 8 have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes. Badlands, rock outcrops, sandy beaches, river washes, mine tailings, and other nearly barren lands are include in Class 8.
Capability subclass	**Subclass description**
c	Climatic limitations – Made up of soils where the climate (temperature or lack of moisture) is the only major hazard or limitation in their use.
e	Erosion – Made up of soils where excess water is the dominant hazard or limitation in their use. Erosion susceptibility and past erosion damage are the major soil factors for placing soils in this subclass.
s	Soil limitation – Includes, as the name implies, soils that have such limitations as shallowness of rooting zones, stones, low moisture-holding capacity, low fertility difficult to correct, salinity, and sodium.

[1] Taken from the National Soils Survey Handbook, Part 622—Ecological and Interpretive Groups (Natural Resource Conservation Service, 2001).

GEOLOGIC MAP UNITS WITHIN THE PROJECT AREA

Alluvium (Holocene) – Stream-deposited clay, silt, sand, and gravel on valley floors and in lowest terraces. Includes some fan and sheetwash alluvium. As much as 10 meters thick.

San Jose Formation (Eocene) – Sandstone, shale, and minor conglomerate. Divided into three units in some areas (Baltz, 1967). Thickness as much as 600 meters.

Nacimiento Formation (Paleocene) – Gray to olive-gray shale; minor interbedded sandstone in southwest, but in northeast nearly one-half of formation is sandstone. Grades into the Animas Formation to the north. Thickness as much as 580 meters.

Ojo Alamo Formation (Paleocene) – Brown crossbedded sandstone containing spherical-pebble conglomerate composed of quartzite and chert clasts near base. Grades laterally into the lower part of the Animas Formation to the north. Contains abundant petrified wood. Thickness of 25–65 meters.

Undivided (Upper Cretaceous) – Undivided.

Kirkland and Fruitland Formations (Upper Cretaceous) – Undivided.

> *Kirkland Shale* – Upper most part is grayish mudstone, claystone, and sandstone; medial part is Farmington Sandstone Member; and lower part is greenish-gray mudstone and claystone (Mytton, 1979). Thickness of 25–30 meters.
>
> *Fruitland Formation* – Gray, brown, and black mudstone and shale; yellowish-brown, crossbedded sandstone; and coal. Thickness of 25–45 meters.

Pictured Cliff Sandstone (Upper Cretaceous) – Upper part is yellowish-gray to grayish-orange marine sandstone; lower part is interbedded, brown sandstone and gray shale. Thickness 0–78 meters.

Cliff House Sandstone – Tan, fine- to medium-grained marine sandstone and minor shale; mapped separately in southwestern part of area. Thickness of 12 meters near Tierra Amarilla to about 420 meters near Bloomfield (subsurface).

Meneffe Formation – Tan and brown sandstone, gray and brown claystone and shale, coal, and layers of large ironstone and limestone concretions; mapped separately in southwestern part of area, but not in central part. Thickness ranges from 4 meters near Chama to about 450 meters near Chaco Culture National Historic Park.

Point Lookout Sandstone – Tan and brown marine sandstone and lesser amount of gray shale; mapped with Mesaverde Group; not mapped separately. Thickness ranges from 12 meters near Tierra Amarilla to 46 meters near Chaco Culture National Historic Park.

Crevasse Canyon Formation – Coal-bearing units are Ditco and Gibson Coal Members; other members are Bortiett Barren, Dalton Sandstone, and Borrego Pass Sandstone (or Lentil).

Gallup Sandstone – Generally regressive marine sandstone, Turonian.

Mancos Shale (Upper Cretaceous) – Composed of three members. Undivided near Nacimiento Mountains. Total thickness ranges from 570–770 meters.

Morrison Formation (Upper Jurassic) – Grayish-orange, fine- to medium-grained sandstone, greenish-gray and red mudstone, red claystone, and some conglomerate in upper part. Thickness of about 270 meters.

San Rafael Group (Middle Jurassic) – Consists of Entrada Sandstone, Todilto, and Summerville Formations; Bluff Sandstone and locally Zuni Sandstone (or only Acoma Tongue of Zuni).

Chinle Group (Upper Triassic) – Consists of four members. Thickness of 210–430 meters.

Upper Shale Member – Interbedded, variegated red, green, and maroon shale and red siltstone and lenticular sandstone. Thickness 150–200 meters.

Poleo Sandstone Lentil – Greenish-gray, very fine- to coarse-grained, micaceous conglomeratic sandstone with subordinate green and reddish-maroon shale and minor pellet limestone. Thickness of 7–80 meters.

Salitral Shale Tongue – Maroon shale with subordinate green shale and, locally, some very coarse-grained, green calcareous sandstone. Thickness of 100–110 meters.

Agua Zarca Sandstone Member – White to light-buff, fine- to coarse-grained, very thick-bedded quartzose sandstone, conglomerate, and conglomeratic sandstone. Thickness of 1–40 meters.