Field Book for Describing and Sampling Soils

Version 2.0

National Soil Survey Center
Natural Resources Conservation Service
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ACKNOWLEDGMENTS

The science and knowledge in this document are distilled from the collective experience of thousands of dedicated Soil Scientists during the more than 100 years of the National Cooperative Soil Survey Program. A special thanks is due to these largely unknown stewards of the natural resources of this nation.

This book was written, compiled, and edited by Philip J. Schoeneberger, Douglas A. Wysocki, Ellis C. Benham, NRCS, Lincoln, NE; and William D. Broderson, NRCS, Salt Lake City, UT.

Special thanks and recognition are extended to those who contributed extensively to the preparation and production of this book: the 75 soil scientists from the NRCS along with NCSS cooperators who reviewed and improved it; Tammy Nepple for document preparation and graphics; Howard Camp for graphics; Jim Culver for sponsoring it; and the NRCS Soil Survey Division for funding it.

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Cover Photo: Soil profile of a Segno fine sandy loam (*Plinthic Paleudalf*) showing reticulate masses or blocks of plinthite at 30 inches (profile tape is in feet). *Courtesy of Frankie F. Wheeler (retired), NRCS, Temple TX; and Larry Ratliff (retired), National Soil Survey Center, Lincoln, NE.*

FOREWORD

Purpose: The following instructions, definitions, concepts, and codes are a field guide for making or reading soil descriptions and sampling soils as presently practiced in the USA.

Background: The methodology of soil descriptions was developed by soil scientists during the entire course of the Soil Survey Program. The USDA published small booklets of *Instructions to Field Parties*, including soil descriptions, in 1902-1904, 1906, and 1914. The first USDA guide for identification and description for soil horizons was released in 1937 (Bureau of Chemistry and Soils, 1937). Roy Simonson and others later summarized and revised this information (Soil Survey Staff, 1951; Soil Survey Staff, 1962). Very brief, color book inserts with shorthand notation were released by the Soil Conservation Service (e.g., Spartanburg, SC, 1961; Western Technical Center, Portland, OR, 1974). This document is an expanded, and updated version of earlier guides that summarizes the present knowledge base. This version (2.0) includes minor corrections and recent updates to the original 1998 release (ver. 1.1; Schoeneberger, et al., 1998) and updates in source documents.

Standards: This book summarizes and updates the current National Cooperative Soil Survey conventions for describing soils (SSM, 1993; NSSH, 2001; PDP 3.6, 1996; NASIS (5.0)). Much of the content is an abbreviation of the primary sources.

Regarding PEDON (PDP 3.5 / 3.6): This document is intended to be both current and usable by the entire soil science community. It is not a guide on "How to use PDP or NASIS." At this time, PDP is the most dated and therefore the least compatible NRCS document relative to the Soil Survey Manual, National Soil Survey Handbook, Soil Taxonomy, and NASIS. Differences and linkages between PDP 3.6 and NASIS are shown, where reasonable to do so, as an aid to interpreting and converting historical data.

Standard procedures and terms for describing soils have changed and increased in recent years (e.g., redoximorphic features). Coincident with these changes has been the development and use of computer databases to store soil descriptions and information. The nature of databases, for better or worse, requires consistent and "correct" use of terms.

Sources: This Field Book draws from several primary sources: The Soil Survey Manual (Soil Survey Staff, 1993); the PEDON Description Program (PDP) Version 4 Design Documents (Soil Survey Staff, 1996); and the

National Soil Survey Handbook (NSSH) — Parts 618 and 629 (Soil Survey Staff, 2001). Other less pervasive sources are footnoted throughout the Field Book to encourage access to original information.

Brevity: In a field book, brevity is efficiency. Despite this book's apparent length, the criteria, definitions, and concepts presented here are condensed. We urge users to review the more comprehensive information in the original sources to avoid errors due to our brevity.

Units: It is critical to specify and consistently use units for describing a soil. Metric units are preferred. NASIS requires metric units. (In PDP, you can choose Metric or English units.)

Format: The "Site Description Section" and "Profile Description Section" in this book generally follow conventional profile description format and sequence (e.g., SCS-Form 232, December 1984). Some data elements (descriptors) are rearranged in this document into a sequence that is more compatible with the description process in the field (e.g., **Horizon Boundary** is next to **Horizon Depth**, rather than at the very end). This sequence is somewhat different from and does <u>not</u> supersede the conventions followed in writing formal soil descriptions for Soil Survey Reports or Official Soil Series Descriptions (i.e., National Soil Survey Handbook, Part 614; Soil Survey Staff, 2001).

Codes: Short-hand notation is listed in the *Code* column for each descriptor. Long-standing, conventional codes are retained because of their widespread recognition. Some codes of recent origin have been changed to make them more logical. Some data elements have different codes in various systems [e.g., conventional (Conv.) vs. NASIS vs. PEDON Description Program codes (PDP)] and several columns may be shown to facilitate conversions. The preferred standard code column is shown **bold**. If only 1 untitled code column is shown, it can be assumed that the conventional, NASIS, and PDP codes are all the same.

Standard Terms vs. Creativity: <u>Describe and record what you observe</u>. Choice lists in this document are a minimal set of descriptors. Use additional descriptors, notes, and sketches to record pertinent information and/or features for which no data element exists. Record such information as free-hand notes under **Miscellaneous Field Notes** (or **User Defined Entries** in PDP).

Changes: Soil Science is an evolving field. Changes to this Field Book should and will occur. Please send comments or suggestions to the Director, National Soil Survey Center, USDA-NRCS; 100 Centennial Mall North, Rm. 152; Lincoln, NE 68508-3866.

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SITE DESCRIPTION

Compiled by: P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, NRCS, Lincoln, NE; W. D. Broderson, NRCS, Salt Lake City, UT.

DESCRIBER(S) NAME

NAME (or initials) - Record the observer(s) who makes the description; e.g., *Erling E. Gamble* or *EEG*.

DATE

MONTH / DAY / YEAR - Record the date of the observations. Use numeric notation (MM, DD, YYYY); e.g., *05/21/2002* (for May 21, 2002).

CLIMATE

Document the prevailing, general weather conditions at the time of observation. (Not a data element in PDP; a site-condition which affects some field methods; e.g., K_{sat}). Record the dominant **Weather Conditions** and **Air Temperature**; e.g., *Rain, 27 °C*.

Weather Conditions	Code
sunny / clear	SU
partly cloudy	PC
overcast	OV
rain	RA
sleet	SL
snow	SN

AIR TEMPERATURE - The ambient air temperature at approximately chest height (in degrees, Celsius or Fahrenheit); e.g., *27 °C*.

SOIL TEMPERATURE - Record the ambient **Soil Temperature** and the **Depth** at which it is determined; e.g., *22 °C, 50 cm.* (***NOTE***: Soil Taxonomy generally requires a depth of 50 cm.) Soil temperature should only be determined from a freshly excavated surface that reflects the ambient soil conditions. Avoid surfaces equilibrated with air temperatures.

Soil Temperature - Record the soil temperature (in °C or °F).

Soil Temperature Depth - Record the depth at which the ambient soil temperature is measured; e.g., *50 cm*.

LOCATION

Record the geographical location of the point / area of interest as precisely as possible. Latitude and longitude are preferred [record in degrees, minutes, seconds (decimal seconds), direction, and associated datum].

LATITUDE - e.g., *46° 10' 19.38" N. Lat.*

LONGITUDE - e.g., *95° 23' 47.16" W. Long.*

***NOTE*:** Latitude and Longitude are required in NASIS. For other location descriptors (e.g., *Public Land Survey*, *UTM*, *Metes and Bounds*, *State Plane Coordinates*, etc.), see the "Location Section."

DATUM NAME (called **Horizontal_datum_name** in NASIS)- ***Critical:*** Record the reference datum for latitude and longitude from either topographic map or GPS configuration used; e.g., NAD 1983 (North America Datum, 1983) for most of USA.

TOPOGRAPHIC QUADRANGLE

Record the appropriate topographic map name (i.e., Quadrangle Name) covering the observation site (commonly a USGS topographic map). Include the scale (or map "series") and the year printed; e.g., *Pollard Creek - NW; TX; 1:24,000; 1972*.

SOIL SURVEY SITE IDENTIFICATION NUMBER

An identification number must be assigned if samples are collected for analyses at the National Soil Survey Laboratory (Soil Survey Staff, 1995). This identifier consists of four required and one optional part. These are:

1) The letter *S* (for "soil characterization sample") and the four-digit (formerly 2-digit) calendar year; e.g., *S2001* (for 2001).
2) The two-character state abbreviation; e.g., *OK* (for Oklahoma). For non-USA samples, use the abbreviation *FN*.
3) The three-digit county FIPS code; e.g., *061* (for Haskell County, OK). For non-USA samples, use the appropriate three-digit GSA world-wide geographical location code (Public Building Service, 1996).
4) A three-digit, sequential code to identify the individual pedons sampled within the county or other survey area during any given calendar year; e.g., *005*. (***NOTE***: This sequential code starts over with *001* each January 1.)

5) (Optional) A one-character sub-sample code. This is generally used to indicate some relationship (such as satellite samples) between sampling sites; e.g., *A.*

A complete example is *S2001OK061005A.* [Translation: A pedon sampled for soil characterization during 2001 *(S2001)*, from Oklahoma *(OK)*, in Haskell County *(061)*, the fifth pedon *(005)* sampled in that county during 2001, and it is a satellite sample *(A)* related to the primary pedon.]

COUNTY FIPS CODE

This is the three-digit FIPS code for the county (National Institute of Standards and Technology, 1990) in a U.S. state in which the pedon or site is located. It is usually an odd number; e.g., *061* (for Haskell County, OK). For non-USA samples, enter *FN* followed by the appropriate three-digit GSA world-wide geographical location code (Public Building Service, 1996); e.g., *FN260* (for Canada).

MLRA

This is the one- to three-digit (and one-character sub-unit, if applicable) Major Land Resource Area identifier (SCS, 1981); e.g., *58C* (for Northern Rolling High Plains - Northeastern Part).

TRANSECTS

If the soil description is a point along a transect, record appropriate transect information: **Transect ID, Stop Number, Interval**. In NASIS, additional information can be recorded: **Transect Kind** [random point (–*R*), regular interval (–I)], **Transect Section Method** [biased (–*B*), random, (–*R*)], **Delineation Size** (acres), **Transect Direction** [compass heading; (°)].

TRANSECT ID - This is a four- to five-digit number that identifies the transect; e.g., *0029* (the 29th transect within the survey area).

STOP NUMBER - If the sample/pedon is part of a transect, enter the two-digit stop number along the transect; e.g., *07*. (***NOTE***: NASIS allows up to 13 characters.)

INTERVAL - Record distances between observation points, compass bearings, and GPS coordinates; or draw a route map in the **Field Notes** (“User Defined Section”). In PDP, if the observation is part of a transect, enter the distance (in feet or meters) between points; e.g., *30 m*.

SERIES NAME

This is the assumed Soil Series name at the time of the description; e.g., *Cecil*. If unknown, enter *SND* for "Series Not Designated". [In NASIS, "SND" is not used; use an appropriate Soil Taxonomic taxa; e.g. Udorthents.] ***NOTE***: The field-assigned series name may ultimately change after additional data collection and lab analyses.

GEOMORPHIC INFORMATION

See the "Geomorphology Section" for complete choice lists. Codes are shown following each example. Conventional "codes" traditionally consist of the entire name; e.g., *mountains*.

PART 1: PHYSIOGRAPHIC LOCATION

Physiographic Division - e.g., *Interior Plains* or *IN*
Physiographic Province - e.g., *Central Lowland* or *CL*
Physiographic Section - e.g., *Wisconsin Driftless Section* or *WDS*
State Physiographic Area (Opt.) - e.g., *Wisconsin Dells*
Local Physiographic / Geographic Name (Opt.) - e.g., *Bob's Ridge*

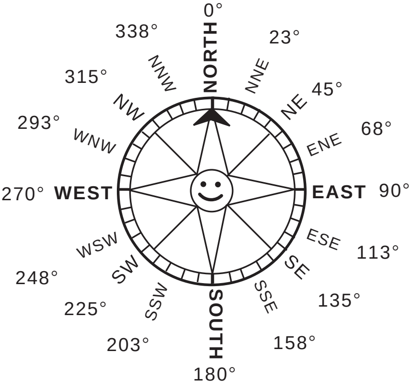
PART 2: GEOMORPHIC DESCRIPTION

Landscape - e.g., *Foothills* or *FH*
Landform - e.g., *Ridge* or *RI*
Microfeature - e.g., *Mound* or *M*
Anthropogenic Feature - e.g., *Midden* or *H*

PART 3: SURFACE MORPHOMETRY

Elevation - The height of a point on the earth's surface, relative to mean sea level (MSL). Use specific units; e.g., *106 m* or *348 ft*. Recommended methods: Interpolation from topographic map contours; altimeter reading tied to a known datum. ***NOTE***: At present, elevational determination by a sole Global Positioning System (GPS) unit is considered unacceptably inaccurate.

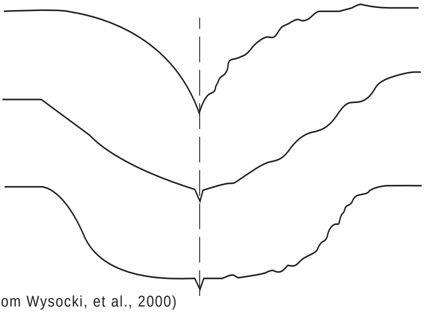
Slope Aspect - The compass direction (in degrees and accounting for declination) that a slope faces, looking downslope; e.g., *287°*.



Slope Gradient - The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. Commonly called "slope." Make observations facing downslope to avoid errors associated with some brands of clinometers; e.g., *18%*.

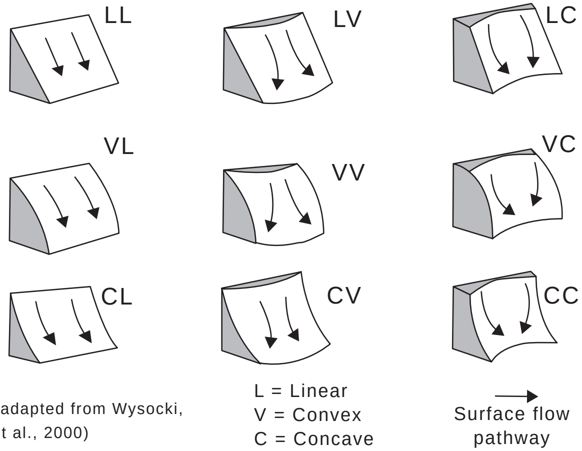
Slope Complexity - Describe the relative uniformity (smooth linear or curvilinear = *simple* or *S*) or irregularity (*complex* or *C*) of the ground surface leading downslope through the point of interest; e.g., s*imple* or *S*.

Simple vs. Complex



(adapted from Wysocki, et al., 2000)

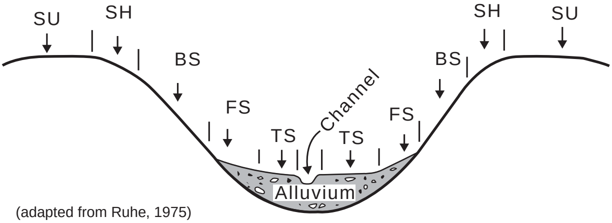
Slope Shape - Slope shape is described in two directions: up-and-down slope (perpendicular to the contour), and across slope (along the horizontal contour); e.g., *Linear, Convex* or *LV*.



(adapted from Wysocki, et al., 2000)

Hillslope - Profile Position (Hillslope Position in PDP) - Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This is best applied to transects or points, not areas.

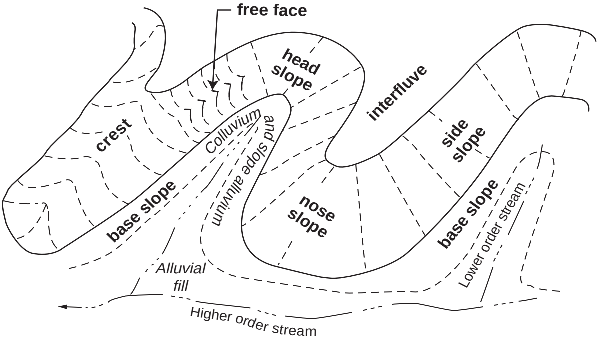
Position	**Code**
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS



(adapted from Ruhe, 1975)

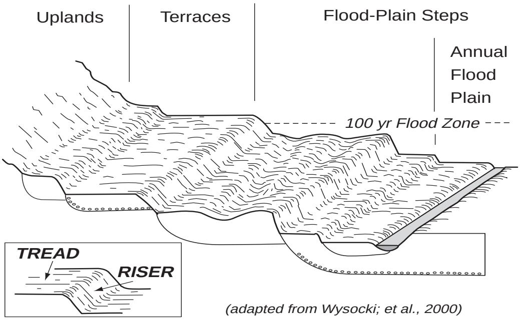
Geomorphic Component - Three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for Hills, Terraces, Mountains, and Flat Plains; e.g., (for Hills) *nose slope* or *NS.*

Hills	**Code**	
	PDP	**NASIS**
interfluve	IF	IF
crest	—	CT
head slope	HS	HS
nose slope	NS	NS
side slope	SS	SS
free face	—	FF
base slope	—	BS



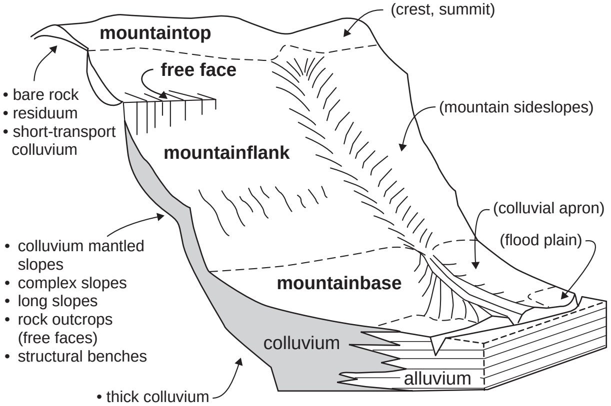
(adapted from Wysocki, et al., 2000)

Terraces, Stepped Landforms	**Code**
riser	RI
tread	TR



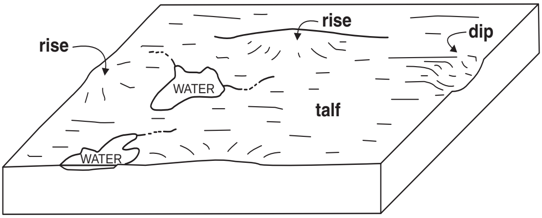
(adapted from Wysocki; et al., 2000)

Mountains	**Code**
mountaintop	MT
mountainflank	MF
upper third - mountainflank	UT
center third - mountainflank	CT
lower third - mountainflank	LT
free face	FF
mountainbase	MB



(adapted from Wysocki, et al., 2000)

Flat Plains	Code
dip	DP
rise	RI
talf	TF



(adapted from Wysocki, et al., 2000)

- very low gradients (e.g. slope 0–1%)
- deranged, non-integrated, or incipient drainage network
- “high areas” are broad and low (e.g. slope 1–3%)
- Sediments commonly lacustrine, alluvial, eolian, or till

Microrelief - Small, relative differences in elevation between adjacent areas on the earth’s surface; e.g., *micro-high* or *MH*; or *micro-low* or *ML*.

microhigh	MH
microlow	ML

Drainage Pattern – The arrangement of drainage channels on the land surface; also called drainage network. (See graphics p. 3–42).

Drainage Pattern	Code
annular	—
artificial	—
centripetal	—
dendritic	—
deranged	—
karst	—
parallel	—
pinnate	—
radial	—
rectangular	—
thermokarst	—
trellis	—

DRAINAGE - An estimate of the natural drainage class (i.e., the prevailing wetness conditions) of a soil; e.g., *somewhat poorly drained* or *SP*.

Drainage Class	**Code**	
	PDP	**CONV.**
Very Poorly Drained	VP	VP
Poorly Drained	P	PD
Somewhat Poorly Drained	SP	SP
Moderately Well Drained	MW	MW
Well Drained	W	WD
Somewhat Excessively Drained	SE	SE
Excessively Drained	E	ED

The following definitions are from the traditional, national criteria for Natural Soil Drainage Classes (Soil Survey Staff, 1993). More specific, regional definitions and criteria vary. (Contact an NRCS State Office for specific, local criteria.)

Very Poorly Drained - Water is at or near the soil surface during much of the growing season. Internal free-water is *very shallow* and *persistent* or *permanent.* Unless the soil is artificially drained, most mesophytic crops cannot be grown. Commonly, the soil occupies a depression or is level. If rainfall is persistent or high, the soil can be sloping.

Poorly Drained - The soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Internal free-water is *shallow* or *very shallow* and *common* or *persistent*. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soil, however, is not continuously wet directly below plow depth. The water table is commonly the result of *low* or *very low* saturated hydraulic conductivity class or persistent rainfall, or a combination of both factors.

Somewhat Poorly Drained - The soil is wet at a shallow depth for significant periods during the growing season. Internal free-water is commonly *shallow* to *moderately deep* and *transitory* to *permanent*. Unless the soil is artificially drained, the growth of most mesophytic plants is markedly restricted. The soil commonly has a *low* or *very low* saturated hydraulic conductivity class, or a high water table, or receives water from lateral flow, or persistent rainfall, or some combination of these factors.

Moderately Well Drained - Water is removed from the soil somewhat slowly during some periods of the year. Internal free water commonly is *moderately deep* and may be *transitory* or *permanent*. The soil is wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. The soil commonly has a *moderately low*, or lower, saturated hydraulic conductivity class within 1 meter of the surface, or periodically receives high rainfall, or both.

Well Drained - Water is removed from the soil readily, but <u>not</u> rapidly. Internal free-water commonly is *deep* or *very deep*; annual duration is not specified. Water is available to plants in humid regions during much of the growing season. Wetness does not inhibit growth of roots for significant periods during most growing seasons.

Somewhat Excessively Drained - Water is removed from the soil rapidly. Internal free water commonly is *very rare* or *very deep*. The soils are commonly coarse-textured, and have *high* saturated hydraulic conductivity, or are *very shallow.*

Excessively Drained - Water is removed from the soil very rapidly. Internal free water commonly is *very rare* or *very deep*. The soils are commonly coarse-textured, and have *very high* saturated hydraulic conductivity class or are *very shallow.*

FLOODING - Estimate the **Frequency, Duration**, and **Months** that flooding is expected; e.g., *rare, brief, Jan. - March*.

Frequency - Estimate how often, typically, that it floods.

Frequency Class	**Code**		**Criteria: estimated, average number of flood events per time span** [1]
	PDP	**NASIS**	
None	NO [2]	NO	No reasonable chance (e.g., < 1 time in 500 years)
Very Rare		VR	≥ 1 time in 500 years, but < 1 time in 100 years
Rare	RA	RA	1 to 5 times in 100 years
Occasional [3]	OC	OC	> 5 to 50 times in 100 years
Frequent [3, 4]	FR	FR	> 50 times in 100 years
Very Frequent [4,5]	—	VF	> 50% of all months in year

[1] Flooding Frequency is an estimate of the current condition, whether natural or human-influenced (such as by dams or levees).

[2] In PDP, *None* class (< 1 time in 100 years) spans both *None* and *Very Rare* NASIS classes.

[3] Historically, *Occasional* and *Frequent* classes could be combined and called *Common*; <u>not</u> recommended.

[4] *Very Frequent* class takes precedence over *Frequent*, if applicable.

[5] The *Very Frequent* class is intended for tidal flooding.

Duration - Estimate how long, typically, it stays flooded.

Duration Class	Code			Criteria: estimated average
	Conv.	PDP	**NASIS**	**duration per flood event**
Extremely Brief	EB	BE	EB	0.1 to < 4 hours
Very Brief	VB	BV	VB	4 to < 48 hours
Brief	BR	B	B	2 to < 7 days
Long	LO	L	L	7 to < 30 days
Very Long	VL	LV	VL	≥ 30 days

Months - Estimate the beginning and ending month(s) of the year that flooding generally occurs; e.g., *Dec. - Feb*.

PONDING - Estimate or monitor the **Frequency**, **Depth**, and **Duration** of standing water. In PDP, also note the months ponding generally occurs. A complete example is: *occasional, 50 cm, brief, Feb - Apr*.

Frequency - Estimate how often, typically, it ponds.

Frequency Class	Code	Criteria: estimated average # of ponding events per time span
None	NO	< 1 time in 100 years
Rare	RA	1 to 5 times in 100 years
Occasional	OC	> 5 to 50 times in 100 years
Frequent	FR	> 50 times in 100 years

Depth - Estimate the average, representative depth of ponded water at the observation site and specify units; e.g., *1 ft* or *30 cm.*

Duration - Estimate how long, typically, it stays ponded.

Duration Class	Code			Criteria: estimated average time per ponding event
	Conv.	PDP	**NASIS**	
Very Brief	VB	BV	VB	< 2 days
Brief	BR	B	B	2 to < 7 days
Long	LO	L	L	7 to < 30 days
Very Long	VL	LV	VL	≥ 30 days

(SOIL) WATER STATE - (Called **Observed Soil Moisture Status** in NASIS.) Estimate the water state of the soil at the time of observation; e.g., *wet, satiated*. Soil temperature must be above 0 °C. To record conditions with temperatures < 0 °C (frozen water); for permanently frozen conditions, see **Texture Modifiers** or **Terms Used in Lieu of Texture** in the "Profile Description Section." ***NOTE***: Criteria have changed.

Water State Class	Code		Criteria: tension	Traditional Criteria: tension and field
	Conv.	NASIS		
Dry [1]	D	D	> 1500 kPa	> 15 bars of tension [2] *(= 1500 kPa)*
Moist [1]	M	M [4]	≤ 1500 kPa to > 1.0 kPa (or > 0.5 kPa [3])	Former Usage: > 1/3 to 15 bars of tension (33 to 1500 kPa) (field capacity to wilting point)
Wet	W		≤ 1.0 kPa (or < 0.5 kPa [3])	0 - 1/3 bars tension (< 33 kPa) (field capacity or wetter)
Wet: Non-satiated [5]	WN		> 0.01 and ≤ 1.0 kPa (or < 0.5 kPa [3])	No Free Water: Water films are visible; sand grains and peds glisten, but no free water is present
Wet: Satiated [5]	WS	W	≤ 0.01 kPa	Free Water: Free water easily visible

[1] Additional subclasses of water state can be recognized for *Dry* and *Moist* classes, if desired (Soil Survey Staff, 1993; p. 91).

[2] Convention assumes 15 bars of tension as the wilting point for most annual, agricultural row-crops. Caution: Various perennials, shrubs, trees, and other native vegetation have wilting points up to 66 bars tension (= 6600 kPa) or more.

[3] Use the 1 kPa limit for all textures, except those coarser than loamy fine sand (which use 0.5 kPa limit; Soil Survey Staff, 1993; p. 90).

[4] NASIS uses the same 3 class names (Dry, Moist, Wet) but lumps the "wet-non-satiated" sub-class with the Moist class.

[5] **Satiation vs. Saturation:** Satiation implies minor amounts of entrapped air in the smallest pores. True saturation implies no entrapped air. Satiation, for practical purposes, is ≈ saturation. Temporal monitoring of a water table by piezometer or other accepted methods may be needed to verify saturation. Related terms used for classifying soils (i.e., Soil Taxonomy) include: *Endosaturation* is saturation in all layers to > 200 cm (80 inches). *Episaturation* requires saturated layers that overlie unsaturated layers within the upper 2 m (80 inches). *Anthric saturation*, a variant of episaturation, is saturation due to management-induced flooding (e.g., for rice or cranberry production).

DEPTH TO WATER TABLE - Measure or estimate the depth from the ground surface to the stabilized contact with free-standing water in an open bore-hole or well. Historically, record **Seasonal High Water Table - Kind**, and **Frequency** (duration, beginning month, and days); specify units (e.g., cm, ft). If seasonally variable water is absent at time of observation, it is common practice to estimate prevailing water table conditions based upon soil morphology (e.g., presence of Redoximorphic Features of chroma ≤ 2) in lieu of water table monitoring data.

> ***NOTE***: Within NRCS's PDP and NASIS databases the traditional designation of **Seasonal High Water Table - Kind** and **Frequency** are replaced. In PDP (PEDON), all water table information is recorded in a temporal table. Record **Depth to Stabilized Free Water** and **Date of Observation**. In NASIS, all water table information is replaced by **(Soil) Water State** (dry, moist or wet), for each layer, at time of observation; e.g., *layer A is moist, layer B is wet, layer C is dry.* For map unit component descriptions, soil water state is recorded, by layer, on a monthly basis in NASIS.

(Seasonal) High Water Table - Kind - Traditional types of intermittent (e.g., seasonal) high water tables (Soil Survey Staff, 1983); obsolete in NASIS.

Kind	Code	Criteria:
	PDP	
apparent	A	Level of stabilized water in a fresh, unlined borehole.
artesian	—	The final level within a cased borehole to which the water rises above an impermeable layer due to a positive hydrostatic head.
perched	P	A water table that lies above an unsaturated zone. The water table will fall if the borehole is extended.
ponding [1]	—	Standing water in a closed depression on top of the soil.

[1] A kind of intermittent water table, but not a seasonal high water table (Soil Survey Staff, 1983).

VEGETATION / LAND COVER

EARTH COVER - KIND - Record the dominant land cover at the site; e.g., *intermixed hardwoods and conifers*. (Similar to **Landuse** in PDP.)

Kind [1]	Code	Kind [1]	Code
ARTIFICIAL COVER (A) - Nonvegetative cover; due to human activity.			
rural transportation - roads, railroads	ARU	urban and built-up - cities, farmsteads, industry	AUR
BARREN LAND (B) - < 5% vegetative cover naturally or from construction.			
culturally induced - saline seeps, mines, quarries, and oil-waste areas	BCI	other barren - salt flats, mudflats, slickspots, badlands	BOB
permanent snow or ice	BPS	rock	BRK
		sand or gravel	BSG
CROP COVER (C) - includes entire cropping cycle (land prep, crop, or crop residue) for annual or perennial herbaceous plants.			
close-grown crop - wheat, rice, oats, and rye; small grains	CCG	row crop - corn, cotton, soybeans, tomatoes, and other truck crops, tulips	CRC
GRASS / HERBACEOUS COVER (G) - > 50% grass, grass-like (sedge/rushes), or forb cover, mosses, lichens, ferns; non-woody.			
hayland - alfalfa, fescue, bromegrass, timothy	GHL	rangeland, savanna - 10 to 20% tree cover	GRS
marshland - grasses and grass-like plants	GML	rangeland, shrubby - 20 to 50% shrub cover	GRH
pastureland, tame - fescues, bromegrass, timothy, and lespedeza	GPL	rangeland, tundra	GRT
rangeland, grassland; < 10% trees, < 20% shrubs; rangeland used for hayland	GRG	other grass and herbaceous cover	GOH
SHRUB COVER (S) - > 50% shrub or vine canopy cover.			
crop shrubs - filberts, blueberry, ornamental nursery stock	SCS	native shrubs - shrub live oak, mesquite, sage-brush, creosote bush; rangeland > 50% shrub cover	SNS
crop vines - grapes, blackberries, raspberries	SCV	other shrub cover	SOS

TREE COVER (T) - > 25% canopy cover by woody plants, natural or planted.			
conifers - spruce, pine, fir	TCO	swamp - trees, shrubs	TSW
crop, trees - nuts, fruit, nursery, Christmas trees	TCR	tropical - mangrove and royal palms	TTR
hardwoods - oak, hickory, elm, aspen	THW	other tree cover	TOC
intermixed hardwoods and conifers - oak-pine mix	TIM		
WATER (W) - water at the soil surface; includes seasonally frozen water.			

[1] Land Cover Kinds are presented at two levels of detail: Bolded table subheadings are the “NASIS - Level 1” choices (NSSH, Part 622.16; Soil Survey Staff, 2001b). Individual choices under the subheadings are the “NASIS - Level 2” choices.

PLANT SYMBOL - Record the codes (scientific plant name abbreviations) for the major plant species found at the site (NRCS, 2001b, 2001c); e.g., *ANGE* (Andropogon gerardii or big bluestem). ***NOTE***: This is the primary plant data element in NASIS.

PLANT COMMON NAME - Record the common names of the major plant species found at the site [NRCS, 2001c (electronic file)]; e.g., *cottonwood, big bluestem*. This item may be recorded as a secondary data element to augment the **Plant Symbol**. ***CAUTION***: Multiple common names exist for some plants; not all common names for a given plant are in the national PLANTS database.

PLANT SCIENTIFIC NAME - Record the scientific plant name along with or in lieu of common names; e.g., *Acer rubrum* (Red Maple). [***NOTE***: Although used in the past, scientific names of plants (Natural Resources Conservation Service, 1995) are not presently recorded by the NRCS; e.g., PDP has no data element for and does not recognize scientific plant names.] (***NOTE***: NASIS codes for common plant names are derived from the scientific names.)

PARENT MATERIAL

Record the **Kind(s)** and **Lithostratigraphic Unit(s)** of unconsolidated material (regolith) from which the soil is derived. [Note: Lithostratigraphic Units: e.g. Formation, Member, etc.; see p. 5-11; Proposed in NASIS – currently recorded under **Misc. Field Notes**.] If the soil is derived directly from the underlying bedrock (e.g., granite), identify the **Parent Material** as either grus, saprolite, or residuum and then record the appropriate **Bedrock - Kind** choice. Multiple parent materials, if present, should be denoted; e.g., *loess, over colluvium, over residuum*. Use numerical prefixes in the **Horizon** designations to denote different parent materials (lithologic discontinuities); e.g., *A*, *BE*, *2Bt*, *2BC*, *3C; Peoria Loess*, or *Calvert Formation*.

KIND - e.g., *saprolite*, *loess*, *colluvium*.

Kind *1*	**Code**		**Kind** *1*	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
EOLIAN DEPOSITS (non-volcanic)					
eolian deposit	E	EOD	loess, calcareous	—	CLO
eolian sands	S	EOS	loess, noncalcareous	—	NLO
loess	W	LOE	parna	—	PAR
GLACIAL DEPOSITS					
drift	D	GDR	till, basal	—	BTI
glaciofluvial deposit	—	GFD	till, flow	—	FTI
glaciolacustrine deposit	—	GLD	till, lodgement	—	LTI
glaciomarine deposit	—	GMD	till, melt-out	—	MTI
outwash	G	OTW	till, subglacial	—	GTI
supraglacial debris-flow	—	SGF	till, supraglacial	—	UTI
till	T	TIL	till, supraglacial meltout	—	PTI
till, ablation	—	ATI			
IN-PLACE DEPOSITS (non-transported)					
grus [2]	—	GRU	saprolite [2]	—	SAP
residuum [2]	X	RES			
MASS MOVEMENT DEPOSITS [3] *(See Mass Movement Types tables, p. 5-7)*					
MISCELLANEOUS MASS MOVEMENT DEPOSITS					
colluvium	V	COL	slump block	—	SLB
scree	—	SCR	talus	—	TAL
MASS MOVEMENT DEPOSIT (Unspecified Landslide)				—	MMD

MASS MOVEMENT DEPOSITS *(continued)*

COMPLEX LANDSLIDE DEPOSITS				—	CLD
FALL DEPOSITS				—	FAD
debris fall deposit	—	DLD	soil fall deposit (=*earth fall*)	—	SFD
rock fall deposit	—	RFD			
FLOW DEPOSITS				—	FLD
earthflow deposit	—	EFD	debris avalanche deposit	—	DAD
creep deposit	—	CRP	debris flow deposit	—	DFD
mudflow deposit	—	MFD	lahar	—	LAH
sand flow deposit	—	RWD	rockfall avalanche deposit	—	RAD
solifluction deposit	—	SOD			
SLIDE DEPOSITS				—	S
Rotational Slide deposit	—	RLD	Translational Slide dep.	—	TSD
rotational debris slide deposit	—	RDD	translational debris slide deposit	—	TDD
rotational earth slide deposit	—	RED	translational earth slide deposit	—	TED
rotational rock slide deposit	—	RRD	translational rock slide deposit	—	TRD
			block glide deposit	—	BGD
SPREAD DEPOSITS (=lateral spread)				—	LSD
debris spread deposit	—	DPD	rock spread deposit	—	RSD
earth spread deposit	—	ESD			
TOPPLE DEPOSITS				—	TOD
debris topple deposit	—	DTD	rock topple deposit	—	RTD
earth topple (=soil topple)	—	ETD			
MISCELLANEOUS DEPOSITS					
cryoturbate	—	CRY	mine spoil or earthy fill	F	MSE
diamicton	—	DIM			
ORGANIC DEPOSITS [4]					
coprogenic materials	—	COM	organic, grassy materials	—	OGM
diatomaceous earth	—	DIE	organic, herbaceous mat.	—	OHM
marl	—	MAR	organic, mossy materials	—	OMM
organic materials	O	ORM	organic, woody materials	—	OWM

VOLCANIC DEPOSITS (unconsolidated; eolian and mass movement)					
ash *(< 2 mm)*	H	ASH	cinders *(2-64 mm)*	—	CIN
ash, acidic	—	ASA	lahar *(volcaniclastic mudflow)*	—	LAH
ash, andesitic	—	ASN	lapilli *(2-64 mm, > 2.0 sg)*[5]	—	LAP
ash, basaltic	—	ASB	pyroclastic flow	—	PYF
ash, basic	—	ASC	pyroclastic surge	—	PYS
ash flow *(pyroclastic)*	—	ASF	pumice *(< 1.0 sg)*[5]	—	PUM
bombs *(> 64 mm)*	—	BOM	scoria *(> 2.0 sg)*[5]	—	SCO
			tephra *(all ejecta)*	—	TEP
WATER LAID or TRANSPORTED DEPOSITS					
alluvium	A	ALL	lacustrine deposit	L	LAD
backswamp deposit	—	BSD	marine deposit	M	MAD
beach sand	—	BES	overbank deposit	—	OBD
estuarine deposit	Z	ESD	pedisediment	—	PED
fluviomarine deposit	—	—	slope alluvium	—	SAL
greensands	—	—	valley side alluvium	—	VSA

[1] Parent material definitions are found in the “Glossary of Landforms and Geologic Terms”, NSSH - Part 629 (Soil Survey Staff, 2001), or the “Glossary of Geology” (Jackson, 1997).

[2] Use the most precise term for the in situ material. Residuum is the most generic term.

[3] Cruden and Varnes, 1996.

[4] These generic terms refer to the dominant origin of the organic materials or deposits from which the organic soil has formed (i.e. parent material) (Soil Survey Staff, 1993). These terms partially overlap with those recognized in Soil Taxonomy (terms which refer primarily to what the organic material presently is); see the “Diagnostic Horizons” or “Properties” table.

[5] sg = specific gravity = the ratio of a material’s density to that of water [weight in air / (weight in air - weight in water)].

BEDROCK

Describe the nature of the continuous hard rock underlying the soil. Specify the **Kind**, **Fracture Interval**, **Hardness**, and **Weathering Class**. Also record Lithostratigraphic unit(s) if possible (e.g. Formation, Member, etc.; — see p. 5–11); e.g. *Dakota Formation*. Proposed in NASIS; currently recorded under **Misc. Field Notes**.

KIND - e.g., *limestone*.

Kind [1]	**Code**		**Kind** [1]	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
IGNEOUS - INTRUSIVE					
anorthosite	—	ANO	pyroxenite	—	PYX
diabase	—	DIA	quartz-diorite	—	QZD
diorite	—	DIO	quartz-monzonite	—	QZM
gabbro	—	GAB	syenite	—	SYE
granite	I4	GRA	syenodiorite	—	SYD
granodiorite	—	GRD	tachylite	—	TAC
monzonite	—	MON	tonalite	—	TON
peridotite	—	PER	ultramafic rock [2]	—	UMU
IGNEOUS - EXTRUSIVE					
a'a lava	P8	AAL	pahoehoe lava	P9	PAH
andesite	I7	AND	pillow lava	—	PIL
basalt	I6	BAS	pumice *(flow, coherent)*	E6	PUM
block lava	—	BLL	rhyolite	—	RHY
dacite	—	DAC	scoria *(coherent mass)*	E7	SCO
latite	—	LAT	trachyte	—	TRA
obsidian	—	OBS			
IGNEOUS - PYROCLASTIC					
ignimbrite	—	IGN	tuff, welded	—	TFW
pyroclastics *(consolidated)*	P0	PYR	tuff breccia	P7	TBR
pyroclastc flow	—	PYF	volcanic breccia	P4	VBR
pyroclastic surge	—	PYS	volcanic breccia, acidic	P5	AVB
tuff	P1	TUF	volcanic breccia, basic	P6	BVB
tuff, acidic	P2	ATU	volcanic sandstone	—	VST
tuff, basic	P3	BTU			

METAMORPHIC

amphibolite	—	AMP	metavolcanics	—	MVO
gneiss	M1	GNE	mica schist	—	MSH
granofels	—	GRF	migmatite	—	MIG
granulite	—	GRL	mylonite	—	MYL
greenstone	—	GRE	phyllite	—	PHY
hornfels	—	HOR	schist	M5	SCH
marble	L2	MAR	serpentinite	M4	SER
metaconglomerate	—	MCN	slate	M8	SLA
metaquartzite	M9	MQT	soapstone *(talc)*	—	SPS
metasedimentary rocks [2]	—	MSR			

SEDIMENTARY - CLASTICS

arenite	—	ARE	mudstone	—	MUD
argillite	—	ARG	orthoquartzite	—	OQT
arkose	A2	ARK	porcellanite	—	POR
breccia, non-volcanic *(angular fragments)*	—	NBR	sandstone	A0	SST
breccia, non-volcanic, acidic	—	ANB	sandstone, calcareous	A4	CSS
breccia, non-volcanic, basic	—	BNB	shale	H0	SHA
claystone	—	CST	shale, acid	—	ASH
conglomerate *(rounded fragments)*	C0	CON	shale, calcareous	H2	CSH
conglomerate, calcareous	C2	CCN	shale, clayey	H3	YSH
fanglomerate	—	FCN	siltstone	T0	SIS
glauconitic sandstone	—	—	siltstone, calcareous	T2	CSI
graywacke	—	GRY			

EVAPORITES, ORGANICS, AND PRECIPITATES

chalk	L1	CHA	limestone, arenaceous	L5	ALS
chert	—	CHE	limestone, argillaceous	L6	RLS
coal	—	COA	limestone, cherty	L7	CLS
dolomite (*dolostone*)	L3	DOL	limestone, phosphatic	L4	PLS
gypsum	—	GYP	travertine	—	TRV
limestone	L0	LST	tufa	—	TUA

INTERBEDDED *(alternating layers of different sedimentary lithologies)*					
limestone-sandst.-shale	B1	LSS	sandstone-shale	B5	SSH
limestone-sandstone	B2	LSA	sandstone-siltstone	B6	SSI
limestone-shale	B3	LSH	shale-siltstone	B7	SHS
limestone-siltstone	B4	LSI			

[1] Definitions for kinds of bedrock are found in the "Glossary of Landforms and Geologic Terms", NSSH - Part 629 (Soil Survey Staff, 2001), or in the "Glossary of Geology" (Jackson, 1997).

[2] Generic term; use only with regional or reconnaissance surveys (Order 3, 4).

FRACTURE INTERVAL CLASS - Describe the dominant (average) horizontal spacing between vertical joints (geogenic cracks or seams) in the bedrock layer.

Average Distance Between Fractures	Code
< 10 cm	1
10 to < 45 cm	2
45 to < 100 cm	3
100 to < 200 cm	4
≥ 200 cm	5

BEDROCK HARDNESS (Obsolete — used in PDP. NASIS now uses **Rupture Resistence-Cementation** classes and criteria.)

Hardness Class	Code	Criteria [1]
Hard	H	Lithic contact criteria
Soft	S	Paralithic contact criteria

[1] See Soil Taxonomy (Soil Survey Staff, 1975).

WEATHERING CLASS - The relative extent to which a bedrock has weathered as compared to its presumed, non-weathered state.

Class	Code	Criteria
Slight	SL	[Not Available]
Moderate	MO	
Strong	ST	

DEPTH (**TO BEDROCK**) - Record the depth (cm) from the ground surface to the contact with coherent (continuous) bedrock.

EROSION

Estimate the dominant kind and magnitude of accelerated erosion at the site. Specify the **Kind** and **Degree**.

KIND -

Kind	**Code**		**Criteria** [1]
	PDP	**NASIS**	
wind	I	I	Deflation by wind
water :	W	---	Removal by running water
sheet	---	S	Even soil loss, no channels
rill	---	R	Small channels [2]
gully	---	G	Big channels [3]
tunnel	---	T	Subsurface voids within soil that enlarge by running water (i.e. piping)

[1] Soil Survey Staff, 1993, p. 82.

[2] Small, runoff channels that can be obliterated by conventional tillage.

[3] Large, runoff channels that cannot be obliterated by conventional tillage.

DEGREE CLASS -

Class	**Code**	**Criteria:** Estimated % loss of the original A & E horizons or, the estimated loss of the upper 20 cm (if original, combined A & E horizons were < 20 cm thick). [1]
None	0	0 %
1	1	> 0 up to 25%
2	2	25 up to 75%
3	3	75 up to 100%
4	4	> 75 % and total removal of A

[1] Soil Survey Staff; 1993, pp 86-89.

SURFACE RUNOFF - Surface runoff (Hortonian flow, overland flow) is the flow of water from an area that occurs over the surface of the soil. Surface runoff differs from internal flow or throughflow that results when infiltrated water moves laterally or vertically within a soil, above the water table. "The Index (of) Surface Runoff Classes" are relative estimates of surface runoff based on slope gradient and saturated hydraulic conductivity (K_{sat}). This index is specific to the following conditions (Soil Survey Staff, 1993).

- The soil surface is assumed to be bare.
- The soil is free of ice.
- Retention of water by ground surface irregularities is negligible or low.
- Infiltration is assumed to be at the steady ponded infiltration stage.
- Water is added to the soil by precipitation or snowmelt that yields 50 mm in 24 hours with no more than 25 mm in any 1-hour period.
- Antecedent soil water state is assumed to be very moist or wet to: a) the base of the solum; b) a depth of 1/2 m; or c) through the horizon that has the minimum K_{sat} within the top 1 meter; whichever is the least depth.

Use the following table and the above conditions to estimate "The Index (of) Surface Runoff Class" for the site. If seasonal or permanent, internal free-water occurs a depth of ≤ 50 cm (very shallow and shallow Internal Free-water classes), use a K_{sat} of *Very Low*. If seasonal or permanent, internal free-water is deeper than 50 cm, use the appropriate K_{sat} from the table. In PDP, if estimating runoff from vegetated areas, define and record under **User Defined Property**.

Index (of) Surface Runoff Classes						
	Saturated Hydraulic Conductivity (K_{sat}) Class [1]					
	Very High	High	Mod. High	Mod. Low	Low	Very Low
	cm / hour					
Slope Gradient Percent	≥ 36	3.6 to < 36	0.36 to < 3.6	0.036 to < 0.36	0.0036 to < 0.036	< 0.0036
Concave	N	N	N	N	N	N
< 1	N	N	N	L	M	H
1 to < 5	N	VL	L	M	H	VH
5 to < 10	VL	L	M	H	VH	VH
10 to < 20	VL	L	M	H	VH	VH
≥ 20	L	M	H	VH	VH	VH

[1] This table is based on the minimum K_{sat} occurring within 1/2 m of the soil surface. If the minimum K_{sat} for the soil occurs between 1/2 to 1 m,

the runoff estimate should be reduced by one class (e.g., *Medium* to *Low*). If the minimum K_{sat} for the soil occurs below 1 meter, use the lowest K_{sat} class that occurs within 1 m of the surface.

Index (of) Surface Runoff Class Names	**Code**
Negligible	N
Very Low	VL
Low	L
Medium	M
High	H
Very High	VH

SURFACE FRAGMENTS (formerly Surface Stoniness)

Record the amount of surface fragment [1] cover (either as a class or as a numerical percent), as determined by either a “point count” or “line-intercept” method. In NASIS, additional details can be recorded: **Surface Fragment Kind**, (use “Rock Fragment - Kind Table”), **Mean Distance Between Fragments** (edge to edge), **Shape** (FL-flat or NF-nonflat), **Size**, **Roundness** (use classes and criteria found in “Rock Fragment - Roundness Table”), and **Rock Fragment - Rupture Resistance**.

Surface Fragment Class [1]	**Code**		**Criteria:**
	Conv [2]	NASIS	Percentage of surface covered
Stony or Bouldery	1	%	0.01 to < 0.1
Very Stony or Very Bouldery	2	%	0.1 to < 3
Extremely Stony or Ext. Bouldery	3	%	3 to < 15
Rubbly	4	%	15 to < 50
Very Rubbly	5	%	≥ 50

[1] This data element is also used to record large wood fragments (e.g., tree trunks) on organic soils, if the fragments are a management concern and appear to be relatively permanent.

[2] Historically called *Surface Stoniness* classes (now *Surface Fragment* classes). Use as a map-unit phase modifier is restricted to stone-sized fragments, or larger (> 250 mm; Soil Survey Staff, 1951).

DIAGNOSTIC HORIZONS or PROPERTIES

Identify the **Kind** and **Upper** and **Lower Depths** of occurrence of Soil Taxonomic diagnostic horizons and properties; e.g., *mollic epipedon; 0 - 45 cm*. Multiple features per horizon can be recorded. (Called **Diagnostic Feature-Kind** in PDP.) In NASIS (**Diagnostic Horizon/Feature**) record **Kind**; **Thickness, Representative Value** (RV – high, low) can also be recorded.

KIND - (see definitions in current Keys to Soil Taxonomy)

Kind	**Code**		**Kind**	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
EPIPEDONS (Diagnostic Surface Horizons)					
anthropic	A	AN	mollic	M	MO
folistic	—	FO	ochric	O	OC
histic	H	HI	plaggen	P	PL
melanic	ME	ME	umbric	U	UM
DIAGNOSTIC SUBSURFACE HORIZONS					
agric	R	AG	natric	N	NA
albic	Q	AL	ortstein	—	OR
argillic	T	AR	oxic	X	OX
calcic	C	CA	petrocalcic	E	PE
cambic	B	CM	petrogypsic	J	PG
duripan	Z	DU	placic	K	PA
fragipan	F	FR	salic	Y	SA
glossic	TO	GL	sombric	I	SO
gypsic	G	GY	spodic	S	SP
kandic	KA	KA	sulfuric	V	SU

(continued)

DIAGNOSTIC PROPERTIES - MINERAL SOILS					
abrupt textural change	AC	AC	gelic materials [2]	—	GM
albic materials	—	AM	glacic layer [2]	—	GL
albic materials, interfingering	IF	AI	lamella / lamellae	—	LA
andic soil properties	AN	AP	lithic contact [2]	L	LC
anhydrous conditions	—	AH	paralithic contact [2]	W	PC
aquic conditions [2]	—	AQ	paralithic materials [2]	—	PM
carbonates, secondary [1]	LI	SC	permafrost [2]	PF	PF
cryoturbation [2]	—	CR	petroferric contact	PC	TC
densic contact [2]	—	DC	plinthite	PL	PI
densic materials [2]	—	DM	slickensides	SL	SS
durinodes	D	DN	sulfidic materials [2]	SU	SM
fragic soil properties	—	FP			
DIAGNOSTIC PROPERTIES - ORGANIC SOILS *(also see 2's above)*					
fibric soil materials	FI	FM	limnic materials :	LM	LM
hemic soil materials	HE	HM	coprogenous earth	CO	CO
humilluvic materials	HU	UM	diatomaceous earth	DI	DI
sapric soil materials	SA	RM	marl	MA	MA

[1] Secondary carbonates, replaces "soft, powdery lime". ***NOTE***: Gilgai (GI in PDP) is no longer a diagnostic feature in Soil Taxonomy.

[2] Diagnostic Properties, materials, or conditions that can occur in either mineral or organic soils.

DEPTH - Document the zone of occurrence for a diagnostic horizon or property, as observed, by recording the upper and lower depth and specify units; e.g., *22 - 39 cm*. Record **Top Depth** and **Bottom Depth**.

REFERENCES

References for this "Site Description Section" are combined with those at the end of the "Profile / Pedon Description Section" 2-79.

PROFILE

PROFILE / PEDON DESCRIPTION

Compiled by: D.A. Wysocki, P.J. Schoeneberger, E.C. Benham, NRCS,
Lincoln, NE; W. D. Broderson, NRCS, Salt Lake City, UT.

OBSERVATION METHOD

For each layer, indicate the type and relative extent of the exposure upon which the primary observations are made. (Examples of common sampling devices are included in the "Field Sampling Section.") Describe **Kind**, **Relative Size**.

KIND -

Kind	Code	Criteria: Types (common size or ranges)
"Disturbed" Samples		
bucket auger	BA	e.g., open, closed, sand, mud buckets (5-12 cm diam.)
screw auger	SA	e.g., external thread hand augers, power (flight) auger (2-30 cm diam.)
"Undisturbed" Samples		
push tube	PT	e.g., handheld, hydraulic, hollow stem (2-10 cm diam.)
shovel "slice" [1]	SS	e.g., undisturbed block extracted with a shovel (sharpshooter: 20 x 40 cm)
WALL / FLOOR - "Undisturbed" Area or Exposure		
small pit	SP	e.g., hand dug (< 1 m x 2 m)
trench	TR	e.g., backhoe, pipeline (> 1 m x 2 m)
beveled cut	BC	e.g., roadcuts graded to < 60% slope
cut	CU	e.g., roadcut, streambank, medium-sized borrow pit wall > 60% slope (e.g., > 4 m, < 33 m)
large open pit or quarry	LP	large borrow pit or quarry with large or irregular banks (e.g., > 33 m)

[1] Field method used for hydric soil investigations.

RELATIVE SIZE (of exposure) - Record the approximate size of the exposure observed. Use cm for "Drill Cores" and m for "Wall/Floor" observations; e.g., *bucket auger, 3 cm*; *trench wall, 3 m*. (***NOTE***: Common size range for each method is indicated in the "Criteria" column of the "Observation Method - Kind Table." These dimensions are approximate; not intended to be precise.)

TAXONOMIC CLASSIFICATION - After completely describing the soil, classify the pedon as thoroughly as possible (to the lowest level). See most current version of Soil Taxonomy, Keys to Soil Taxonomy or NASIS for complete choice list; e.g., *fine, mixed, active, mesic, Typic Haplohumult.*

HORIZON NOMENCLATURE

Use capital letters to identify master horizons; e.g., *A*, *B*. Use suffixes (lowercase letters) to denote additional horizon characteristics or features; e.g., *Ap*, *Btk*. [For more detailed criteria, see the "Soil Taxonomy Section;" for complete definitions see Soil Taxonomy (Soil Survey Staff, 1998, 1999)]. Label a horizon only <u>after</u> all morphology is recorded.

MASTER, TRANSITIONAL AND COMMON HORIZON COMBINATIONS [1] -

Horizon	**Criteria** *(expanded details listed in Soil Taxonomy Section)*
O	Organic soil materials (not limnic)
A	Mineral; organic matter (humus) accumulation, loss of Fe, Al, clay
AB (or **AE**)	Dominantly A horizon characteristics but also contains some characteristics of the B (or E) horizon
A/B (or **A/E**) (or **A/C**)	Discrete, intermingled bodies of A and B (or E, or C) material; majority of horizon is A material
AC	Dominantly A horizon characteristics but also contains some characteristics of C horizon
E	Mineral; loss of Fe, Al, clay, or organic matter
EA (or **EB)**	Dominantly E horizon characteristics but also contains some attributes of the A (or B) horizon
E/A (or **E/B**)	Discrete, intermingled bodies of E and A horizon (or E and B) material; majority of horizon is E material
E and Bt (or **B and E**)	Thin lamellae (Bt) within a dominantly E horizon (or thin E within dominantly B horizon)
BA (or **BE**)	Dominantly B characteristics but also contains some attributes of A (or E) horizon
B/A (or **B/E**)	Discrete, intermingled bodies of B and A (or E) material; majority of horizon is B material
B	Subsurface accumulation of clay, Fe, Al, Si, humus, $CaCO_3$, $CaSO_4$; or loss of $CaCO_3$; or accumulation of sesquioxides; or subsurface soil structure
BC	Dominantly B horizon characteristics but also contains some characteristics of the C horizon
B/C	Discrete, intermingled bodies of B and C material; majority of horizon is B material

CB (or **CA**)	Dominantly C horizon characteristics but also contains some characteristics of the B (or A) horizon
C/B (or **C/A**)	Discrete, intermingled bodies of C and B (or A) material; majority of horizon is C material
C	Little or no pedogenic alteration, unconsolidated earthy material, soft bedrock
L	Limnic soil materials [2]
R	Bedrock, *Strongly Cemented* to *Indurated*
W	A layer of liquid water (W) or permanently frozen water (Wf) within the soil (excludes water/ice above soil)

[1] Refer to the "Soil Taxonomy Section" for older horizon nomenclature.
[2] NRCS Soil Classification Staff, 1999; personal communication.

HORIZON SUFFIXES - Historically referred to as "Horizon Subscripts," and more recently as "Subordinate Distinctions."[1] (Historical nomenclature and conversions are shown in the "Soil Taxonomy Section.")

Horizon Suffix [1]	**Criteria** *(expanded details listed in Soil Taxonomy Section)*
a	Highly decomposed organic matter
b	Buried genetic horizon (not used with C horizons)
c	Concretions or nodules
co	Coprogenous earth (Used only with L) [2]
d	Densic layer (physically root restrictive)
di	Diatomaceous earth (Used only with L) [2]
e	Moderately decomposed organic matter
f	Permanently frozen soil or ice (permafrost); continuous, subsurface ice; not seasonal ice
ff	Permanently frozen soil ("Dry" permafrost); no continuous ice; not seasonal ice
g	Strong gley
h	Illuvial organic matter accumulation
i	Slightly decomposed organic matter
j	Jarosite accumulation
jj	Evidence of cryoturbation
k	Pedogenic carbonate accumulation
m	Strong cementation (pedogenic, massive)
ma	Marl (Used only with L) [2]
n	Pedogenic, exchangeable sodium accumulation

o	Residual sesquioxide accumulation (pedogenic)
p	Plow layer or other artificial disturbance
q	Secondary (pedogenic) silica accumulation
r	Weathered or soft bedrock
s	Illuvial sesquioxide accumulation
ss	Slickensides
t	Illuvial accumulation of silicate clay
v	Plinthite
w	Weak color or structure within B (used only with B)
x	Fragipan characteristics
y	Pedogenic accumulation of gypsum
z	Pedogenic accumulation of salt more soluble than gypsum

[1] Keys to Soil Taxonomy, 8th Ed., (Soil Survey Staff, 1998).
[2] NRCS Soil Classification Staff, 1999; personal communication.

OTHER HORIZON MODIFIERS -

Numerical Prefixes (2, 3, etc.) - Used to denote lithologic discontinuities. By convention, 1 is understood but is not shown; e.g., *A*, *E*, *Bt1*, ***2****Bt2*, ***2****BC*, ***3****C1*, ***3****C2*.

Numerical Suffixes - Used to denote subdivisions within a master horizon; e.g., *A****1***, *A****2***, *E*, *Bt****1***, *Bt****2***, *Bt****3***, *Bs****1***, *Bs****2***.

The Prime (´) - Used to indicate the second occurrence of an identical horizon descriptor(s) in a profile or pedon; e.g., *A*, ***E***, *Bt*, ***E´*** *Btx*, *C*. The prime does not indicate either buried horizons (which are denoted by a lower case "*b";* e.g., *Btb*), or lithologic discontinuities (denoted by numerical prefixes). Double and triple primes are used to denote subsequent occurrences of horizon descriptors in a pedon; e.g., *A*, *E*, *Bt*, ***E´***, *Btx*, ***E˝***, *Cd*.

DIAGNOSTIC HORIZONS - See the "Diagnostic Horizons Table" or "Properties Table", in the "Site Description Section".

HORIZON DEPTH - Record the depths of both the upper and lower boundary for each horizon; specify units (centimeters preferred); e.g., *15-24 cm.* Begin (zero datum) at the ground surface[1], which is not necessarily the mineral surface. (***NOTE***: Prior to 1993, the zero datum was at the top of the mineral surface, except for thick organic layers such as a peat or muck. Organic horizons were recorded as above and mineral horizons recorded as below, relative to the mineral surface.)

Example: Zero Datum for the same horizons
At Present: Oe 0 - 5 cm, A 5 - 15 cm, E 15 - 24 cm
Before 1993: Oe 5 - 0 cm, A 0 - 10 cm, E 10 - 19 cm

[1] Conventionally, the "soil surface" is considered to be the top boundary of the first layer that can support plant / root growth. This equates to:

a) (for bare mineral soil) the air/fine earth interface;
b) (for vegetated mineral soil) the upper boundary of the first layer that can support root growth;
c) (for organic mantles) the same as b) but excludes freshly fallen plant litter, and includes litter that has compacted and begun to decompose; e.g., Oi horizon;
d) (for submerged soil) the same as b) but refers to the water/soil contact and extends out from shore to the limit of emergent, rooted plants;
e) (for rock mulches; e.g., desert pavement, scree) the same as a) unless the areal percentage of surface rock coverage is greater than 80%, the top of the soil is the mean height of the top of the rocks.

HORIZON THICKNESS - Record the average thickness and range in thickness of horizon; e.g., *15 cm* (*12 - 21 cm*).

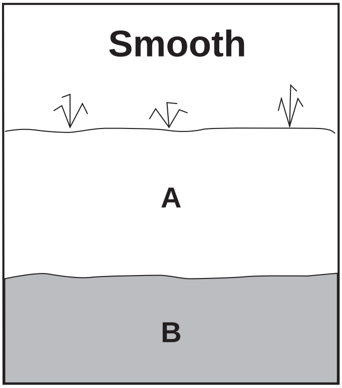
HORIZON BOUNDARY - Record **Distinctness** and **Topography** of horizon boundary. (In NASIS, Distinctness in called Boundary Distinctness). Distinctness is the distance through which one horizon grades into another. Topography is the lateral undulation and continuity of the boundary between horizons. A complete example is: *clear, wavy*, or *C,W*.

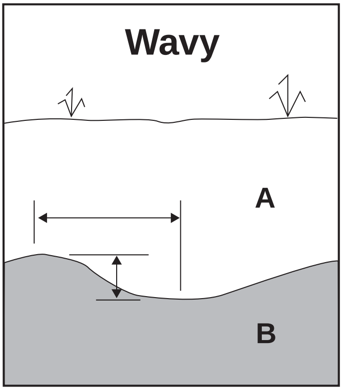
Distinctness

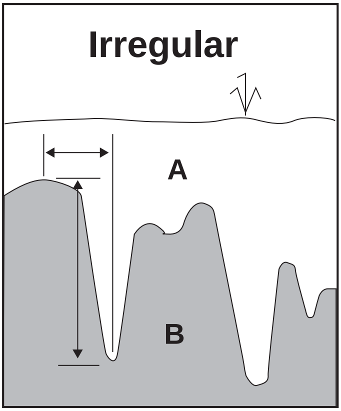
Distinctness Class	**Code**		**Criteria: thickness**
	PDP	**NASIS**	
Very Abrupt	—	V	< 0.5 cm
Abrupt	A	A	0.5 to < 2 cm
Clear	C	C	2 to < 5 cm
Gradual	G	G	5 to < 15 cm
Diffuse	D	D	≥ 15 cm

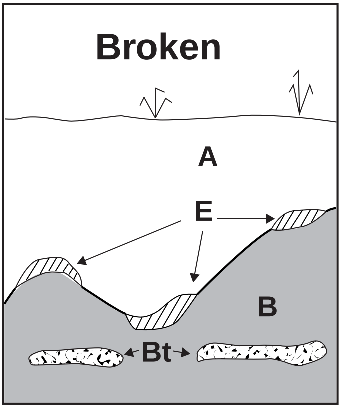
Topography - Cross-sectional shape of the contact between horizons.

Topography	**Code**	**Criteria**
Smooth	S	Planar with few or no irregularities
Wavy	W	Width of undulation is > than depth
Irregular	I	Depth of undulation is > than width
Broken	B	Discontinuous horizons; discrete but intermingled, or irregular pockets


Smooth
A
B

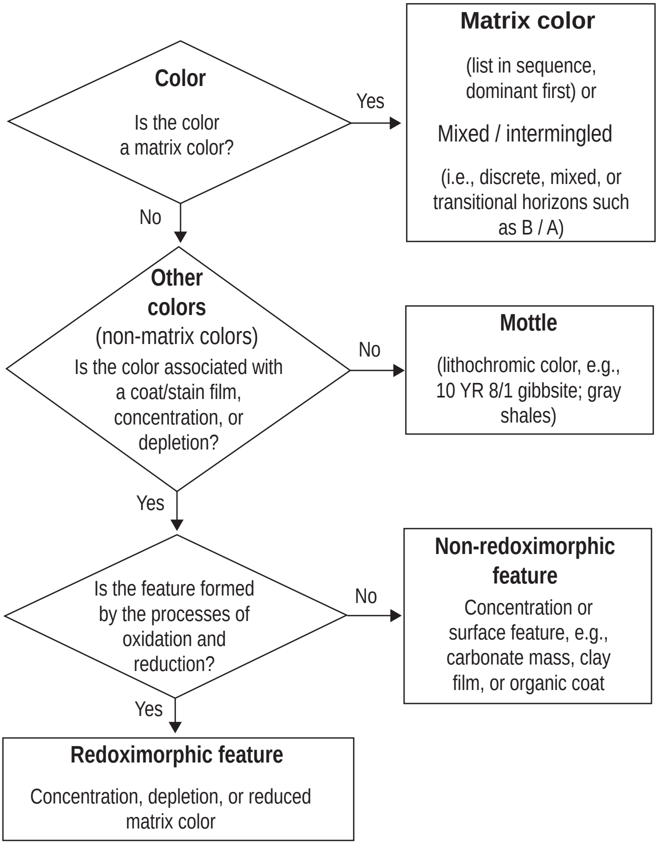

Wavy
A
B


Irregular
A
B


Broken
A
E
B
Bt

SOIL COLOR

DECISION FLOWCHART FOR DESCRIBING SOIL COLORS - Use the following chart to decide how and with which data elements the color patterns of a soil or soil feature should be described.



NOTE: *Reduced Matrix* color is described as a *Matrix Color* and in the associated “(Soil Color) - Location or Condition Described Table.”

(SOIL) MATRIX COLOR - Record **Color(s)**, **(Soil Color) Moisture State**, **Location or Condition**. (In PDP, also record **Percent of Horizon**, if more than one matrix color is described.)

(Soil) Matrix Color - (Soil) Color - Identify the color(s) of the soil matrix with Munsell ® notation (**Hue, Value, Chroma**); e.g., *10YR 3/2*. For Neutral colors, chroma is zero but not shown; e.g, *N 4/* . Other Gley colors use appropriate notation (see Munsell® Gley pages; e.g., *5GY 6/1*). For narrative descriptions (Soil Survey Reports, Official Series Descriptions) both the verbal name and the Munsell® notation are given; e.g., *dark brown, 10YR 3/3*.

(Soil) Matrix Color - Moisture State - Record the moisture condition of the soil described; e.g., *moist*. (Not to be confused with Soil Water State.)

Moisture State	Code
Dry	D
Moist	M

(Soil) Matrix Color - Location or Condition - Record pertinent circumstances of the color described (called **Color Physical State** in NASIS).

Color Location or Condition	Code	
	PDP	**NASIS**
COLOR LOCATION		
interior *(within ped)*	1	IN
exterior *(ped surface)*	2	EX
COLOR, MECHANICAL CONDITION		
broken Face	8	BF
crushed	3	CR
rubbed *(used only with Organic Matter)*	9	RU
COLOR, REDOXIMORPHIC CONDITION		
oxidized [1]	5	OX
reduced [2]	—	RE
COLOR, INTRICATE MULTICOLORED PATTERN		
variegated [3]	—	VA

[1] Soil that is reduced *in situ,* but oxidizes (changes color) after extraction and exposure to air. A mineral example is vivianite. ***NOTE***: Not used for soil that's normally oxidized in place. For indicators of reduction see **Redoximorphic Features**.

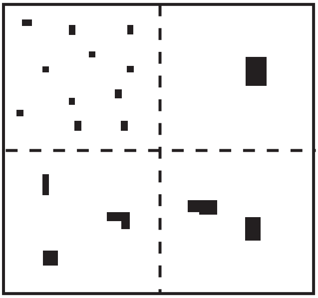
[2] Color immediately after extraction from a reduced environment, prior to oxidation; e.g., *FeS*. Also used to record **Reduced Matrix**.

[3] Color pattern is too intricate (banded or patchy) with numerous, diverse colors to credibly identify dominant matrix colors.

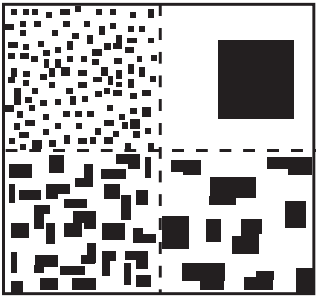
MOTTLES - Describe mottles (areas of color that differ from the matrix color). These colors are commonly lithochromic or lithomorphic (attributes retained from the geologic source rather than from pedogenesis; e.g., gray shale). Mottles exclude: Redoximorphic Features (RMF) and Ped and Void Surface Features (e.g., clay films). Record **Quantity Class** (in NASIS/PDP, estimate a numerical value "Percent of Horizon Area Covered"), **Size**, **Contrast**, **Color**, and **Moisture State** (D or M). **Shape** is an optional descriptor. A complete example is: *few, medium, distinct, reddish yellow, moist, irregular mottles* or *f, 2, d, 7.5 YR 7/8, m, z, mottles*.

Mottles - Quantity (Percent of Area Covered)

Quantity Class	Code		Criteria: range in percent
	Conv.	NASIS	
Few	f	%	< 2% of surface area
Common	c	%	2 to < 20% of surface area
Many	m	%	≥ 20% of surface area



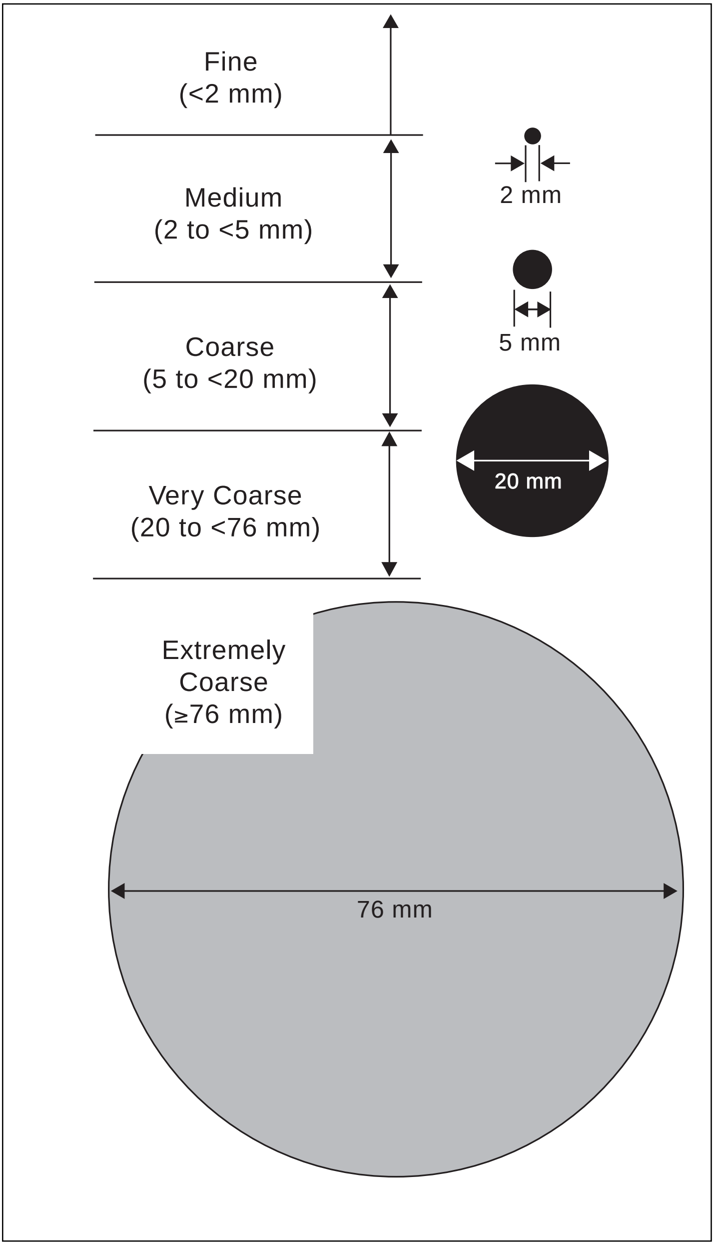
2%



20%

Mottles - Size - Record mottle size class. Use length if it's greater than 2 times the width; use width if the length is less than two times the width. Length is the greater of the two dimensions. (New size classes to be consistent with the new RMF size classes.)

Size Class	Code	Criteria
Fine	1	< 2 mm
Medium	2	2 to < 5 mm
Coarse	3	5 to < 20 mm
Very Coarse	4	20 to < 76 mm
Extremely Coarse	5	≥ 76 mm


Fine
(<2 mm)
Medium
(2 to <5 mm)
Coarse
(5 to <20 mm)
Very Coarse
(20 to <76 mm)
Extremely
Coarse
(≥76 mm)
2 mm
5 mm
20 mm
76 mm

Mottles - Contrast - Record the color difference between the mottle and the dominant matrix color. Use this table or the following chart to express the difference. [1st table: Obsolete —shown here for historical purposes]

Contrast Class	**Code**	***Difference in Color Between Matrix and Mottle***			
		Hue [1]	***Value***		***Chroma***
Faint [2]	F	same page	0 to ≤ 2	and	≤ 1
Distinct	D	same page	> 2 to < 4	and	< 4
				<u>or</u>	
			< 4	and	> 1 to < 4
		1 page	≤ 2	and	≤ 1
Prominent	P	same page	≥ 4	or	≥ 4
		1 page	> 2	or	> 1
		≥ 2 pages	≤ 0	or	≥ 0

[1] One Munsell® Color Book page = 2.5 hue units. Table contents compiled from material in or intended by the Soil Survey Manual (Soil Survey Staff, 1993).

Contrast Class	**Code**	***Difference in Color Between Matrix and Mottle*** (Δ means “difference between”)			
		Hue (h)	***Value (v)***		***Chroma (c)***
Faint [1]	F	Δh = 0;	Δv ≤ 2	and	Δc ≤ 1
		Δh = 1;	Δv ≤ 1	and	Δc ≤ 1
		Δh = 2;	Δv = 0	and	Δc = 0
Distinct [1]	D	Δh = 0;	Δv ≤ 2	and	Δc > 1 to < 4
		or	Δv > 2 to < 4	and	Δc < 4
		Δh = 1;	Δv ≤1	and	Δc > 1 to < 3
		or	Δv > 1 to < 3	and	Δc < 3
		Δh = 2;	Δv = 0	and	Δc > 0 to < 2
		or	Δv > 0 to < 2	and	Δc < 2
Prominent [1]	P	Δh = 0;	Δ ≥ 4	or	Δc ≥ 4
		Δh = 1;	Δ ≥ 3	or	Δc ≥ 3
		Δh = 2;	Δ ≥ 2	or	Δc ≥ 2
		Δh ≥ 3;			

[1] If compared colors have both a Value ≤ 3 and a Chroma of ≤ 2, the contrast is *Faint*, regardless of Hue differences.

Tabular List for Determination of Color Contrast

Hues are the same (Δ h = 0) [1]

Δ Value	Δ Chroma	Contrast
0	≤ 1	Faint
0	2	Distinct
0	3	Distinct
0	≥ 4	Prominent
1	≤ 1	Faint
1	2	Distinct
1	3	Distinct
1	≥ 4	Prominent
≤ 2	≤ 1	Faint
≤ 2	2	Distinct
≤ 2	3	Distinct
≤ 2	≥ 4	Prominent
3	≤ 1	Distinct
3	2	Distinct
3	3	Distinct
3	≥ 4	Prominent
≥ 4	—	Prominent

Hues differ by 1 (Δ h = 1) [1]

Δ Value	Δ Chroma	Contrast
0	≤ 1	Faint
0	2	Distinct
0	≥ 3	Prominent
1	≤ 1	Faint
1	2	Distinct
1	≥ 3	Prominent
2	≤ 1	Distinct
2	2	Distinct
2	≥ 3	Prominent
≥ 3	—	Prominent

Hues differ by 2 (Δ h = 2) [1]

Δ Value	Δ Chroma	Contrast
0	0	Faint
0	1	Distinct
0	≥ 2	Prominent
1	≤ 1	Distinct
1	≥ 2	Prominent
≥ 2	—	Prominent

Hues differ by 3 or more (Δ h ≥ 3) [1]

Δ Value	Δ Chroma	Contrast
Color contrast is Prominent, except for low Chroma and Value [1]		Prominent

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[1] Exception: If both colors have a Value ≤ 3 and a Chroma ≤ 2, the Color Contrast is *Faint*, regardless of Hue differences.

Mottles - Color - Use standard Munsell® notation of hue, value, chroma; e.g., *5 YR 4/4* (for reddish brown).

Mottles - Moisture State - Record the moisture condition of the mottle (not to be confused with soil water state); e.g., *moist*.

Moisture State	**Code**
Dry	D
Moist	M

Mottles - Shape (optional) - Use "Concentrations - Shape" table; e.g., *irregular*.

NOTE: In PDP, **Location** (use "Concentrations - Location" table), and **Hardness** (use "Rupture Resistance —Blocks, Peds, and Clods—Cementation" column) can be described **(optional)**.

REDOXIMORPHIC FEATURES - RMF (DISCUSSION)

Redoximorphic Features (RMF) are a color pattern in a soil due to loss (depletion) or gain (concentration) of pigment compared to the matrix color, formed by oxidation/ reduction of Fe and/or Mn coupled with their removal, translocation, or accrual; or a soil matrix color controlled by the presence of Fe^{+2}. The composition and process of formation for a soil color or color pattern must be known or inferred before describing it as a RMF. Because of this inference, RMF are described separately from other mottles, concentrations; e.g., *salts*; or compositional features; e.g., *clay films*. RMF generally occur in one or more of these settings:

a. In the soil matrix, unrelated to surfaces of peds or pores.
b. On or beneath the surfaces of peds.
c. As filled pores, linings of pores, or beneath the surfaces of pores.

RMFs include the following:

1. **Redox Concentrations** - Localized zones of enhanced pigmentation due to an accrual of, or a phase change in, the Fe-Mn minerals; or are physical accumulations of Fe-Mn minerals. ***NOTE***: Iron concentrations may be either Fe^{+3} or Fe^{+2}. Types of redox concentrations are:
    a. **Masses** - Noncemented bodies of enhanced pigmentation that have a redder or blacker color than the adjacent matrix.
    b. **Nodules** or **Concretions** - Cemented bodies of Fe-Mn oxides.

2. **Redox Depletions** - Localized zones of “decreased” pigmentation that are grayer, lighter, or less red than the adjacent matrix. Redox depletions include, but are not limited to, what were previously called “low chroma mottles” (chroma ≤ 2). Depletions with chroma ≤ 2 are used to define aquic conditions in Soil Taxonomy and are used extensively in the field to infer occurrence and depth of saturation in soils. Types of redox depletions are:
    a. **Iron Depletions** - Localized zones that have one or more of the following: a yellower, greener, or bluer hue; a higher value; or a lower chroma than the matrix color. Color value is normally ≥ 4. Loss of pigmentation results from the loss of Fe and/or Mn. Clay content equals that in the matrix.
    b. **Clay Depletions** - Localized zones that have either a yellower, greener, or bluer hue, a higher value, or a lower chroma than the matrix color. Color value is normally ≥ 4. Loss of pigmentation results from a loss of Fe and/or Mn and clay. Silt coats or skeletans commonly form as depletions but can be non-redox concentrations, if deposited as flow material in pores or along faces of peds.

3. **Reduced Matrix** - A soil horizon that has an in situ matrix chroma ≤ 2 due to the presence of Fe^{+2}. Color of a sample becomes redder or brighter (oxidizes) when exposed to air. The color change usually occurs within 30 minutes. A 0.2% solution of α, α'- dipyridyl dissolved in 1N ammonium acetate (NH_4OAc) pH 7 can verify the presence of Fe^{+2} in the field (Childs, 1981).

NOTE: Use of RMF alters the traditional sequence for describing soil color (see the "Decision Flowchart for Describing Colors for Soil Matrix and Soil Features"). RMF are described separately from other color variations or concentrations. Mottles (color variations not due to loss or accrual of Fe-Mn oxides; e.g., variegated weathered rock) are still described under **Soil Color**. A Reduced Matrix is recorded as a RMF and as "reduced" in **Soil Color - Location** or **Condition Described**.

REDOXIMORPHIC FEATURES

Record **Kind**, **Quantity** (percent of area covered), **Size**, **Contrast**, **Color**, **Moisture State**, **Shape**, **Location**, **Hardness**, and **Boundary**. A complete example is: *common, medium, prominent, black Iron-Manganese nodules, moist, spherical, In the matrix, weakly cemented, sharp* or *c, 2, p, 5 YR 2.5/1, FMM, M, S, MAT, w, s*. At present, relict RMF's, as supported by geomorphic setting, water table data, etc., are recorded as "relict RMF's" (include horizons and depths) under **Miscellaneous Field Notes**.

REDOXIMORPHIC FEATURES - KIND -

Kind	**Code**		**Kind**	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
REDUCED MATRIX (chroma $\leq$ 2 primarily from Fe^{+2})					
reduced matrix	—	RMX			
REDOX DEPLETIONS (loss of pigment or material)					
clay depletions	A3	CLD	iron depletions	F5	FED
REDOX CONCENTRATIONS (accumulated pigment, material)					
Masses [1] ***(noncemented)***					
iron *(Fe^{+3})* [3, 4, 5]	F2	F3M	iron-manganese [3, 4, 5]	M2	FMM
iron *(Fe^{+2})* [2]	—	F2M	manganese [4, 5]	M8	MNM
Nodules [1] ***(cemented; no layers, crystals not visible at 10X)***					
ironstone	F4	FSN	iron-manganese [4]	M5	FMN
plinthite	F1	PLN			
Concretions [1] ***(cemented; distinct layers, crystals not visible)***					
iron-manganese [4]				M3	FMC
Surface Coats / Films or Hypocoats					
manganese *(mangans: black, very thin, exterior films)*				M [6]	MNF
ferriargillans *(Fe^{+3} stained clay film)*				I [6]	FEF

[1] See discussion under **Concentrations** for definitions.

[2] A concentration of reduced iron Fe^{+2}; e.g., *FeS*.

[3] A concentration of oxidized iron Fe^{+3}; e.g., *hematite*, (formerly described as *reddish mottles*).

[4] Iron and Mn commonly occur in combination and field identification of distinct phases is difficult. Use *Mn masses* only for those that are at least *Slightly Effervescent* with H_2O_2. Describe nodules and concretions as *Iron-Manganese* unless colors are unambiguous.

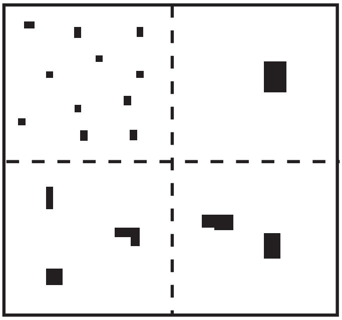
[5] Suggested, color guidelines for field description of Fe vs. Mn Masses:

Color of Concentration		Dominant Composition
Value	Chroma	
≤ 2	≤ 2	Mn
> 2 and ≤ 4	> 2 and ≤ 4	Fe and Mn
> 4	> 4	Fe

[6] In PDP, these features (codes) were recorded under **Coat - Kind**.

REDOXIMORPHIC FEATURES - QUANTITY (Percent of Area Covered) -

Class	**Code**		**Criteria: Percent of Surface Area Covered**
	Conv.	**NASIS**	
Few	f	#	< 2
Common	c	#	2 to < 20
Many	m	#	≥ 20



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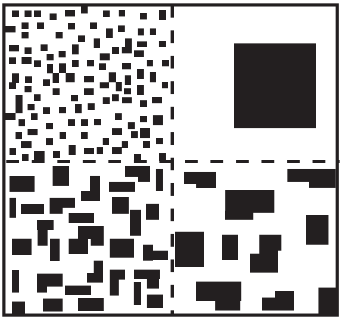


20%

REDOXIMORPHIC FEATURES - SIZE - See size class graphic under either **Mottles** or **Concentrations**.

Size Class	Code	Criteria
Fine	1	< 2 mm
Medium	2	2 to < 5 mm
Coarse	3	5 to < 20 mm
Very Coarse	4	20 to < 76 mm
Extremely Coarse	5	≥ 76 mm

REDOXIMORPHIC FEATURES - CONTRAST - Use "Mottle - Contrast Table" or "Mottle - Contrasts Chart;" e.g., *Prominent* or *p*.

REDOXIMORPHIC FEATURES - COLOR - Use standard Munsell® notation from the "Soil Color Section;" e.g., *light brownish gray* or *2.5Y 6/2*.

REDOXIMORPHIC FEATURES - MOISTURE STATE - Describe the moisture condition of the Redoximorphic Feature (use "Soil Color - Moisture State Table"); e.g., *Moist (M)* or *Dry (D)*.

REDOXIMORPHIC FEATURES - SHAPE - Describe the shape of the redoximorphic feature (use "Concentrations - Shape Table"); e.g., *Spherical (S)*.

REDOXIMORPHIC FEATURES - LOCATION - Describe the location(s) of the Redoximorphic Feature within the horizon (use "Concentrations - Location Table"); e.g., In the matrix around depletions *(MAD)*.

REDOXIMORPHIC FEATURES - HARDNESS - Describe the relative force required to crush the Redoximorphic Feature (use the same classes and criteria as the "Rupture Resistance for Blocks / Peds / Clods-Cementation" column); e.g., *Strongly Cemented (ST)*.

REDOXIMORPHIC FEATURES - BOUNDARY - The gradation between the Redoximorphic Feature and the adjacent matrix (use "Concentrations - Boundary Table"); e.g., *Sharp (S)*.

CONCENTRATIONS (DISCUSSION)

Concentrations are soil features that form by accumulation of material during pedogenesis. Dominant processes involved are chemical dissolution/ precipitation; oxidation and reduction; and physical and/or biological removal, transport, and accrual. Types of concentrations (modified from Soil Survey Staff, 1993) include the following:

1. **Finely Disseminated Materials** are physically small precipitates (e.g., salts, carbonates) dispersed throughout the matrix of a horizon. The materials cannot be readily seen (10X lens), but can be detected by a chemical reaction (e.g., effervescence of $CaCO_3$ by HCl) or other proxy indicators.

2. **Masses** are noncemented ("Rupture Resistance-Cementation Class" of *Extremely Weakly Cemented* or less) bodies of accumulation of various shapes that cannot be removed as discrete units, and do not have a crystal structure that is readily discernible in the field (10X hand lens). This includes finely crystalline salts and *Redox Concentrations* that do not qualify as nodules or concretions.

3. **Nodules** are cemented (*Very Weakly Cemented* or greater) bodies of various shapes (commonly spherical or tubular) that can be removed as discrete units from soil. Crystal structure is not discernible with a 10X hand lens.

4. **Concretions** are cemented bodies (*Very Weakly Cemented* or greater) similar to nodules, except for the presence of visible, concentric layers of material around a point, line, or plane. The terms "nodule" and "concretion" are not interchangeable.

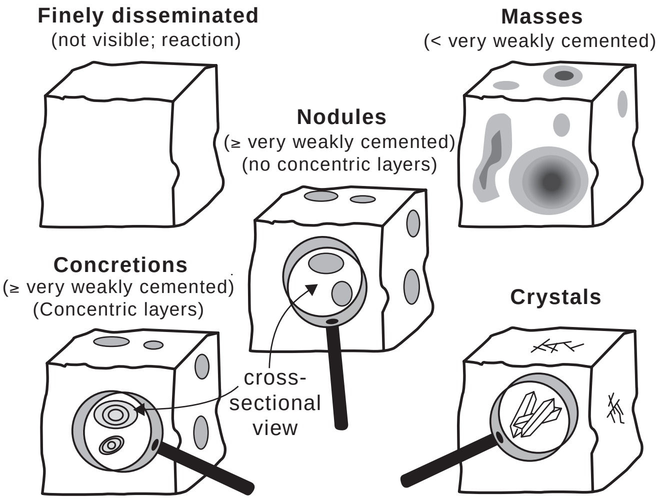
5. **Crystals** are macro-crystalline forms of relatively soluble salts (e.g., halite, gypsum, carbonates) that form *in situ* by precipitation from soil solution. The crystalline shape and structure is readily discernible in the field with a 10X hand lens.

6. **Biological Concentrations** are discrete bodies accumulated by a biological process (e.g., fecal pellets), or pseudomorphs of biota or biological processes (e.g., insect casts) formed or deposited in soil.

7. **Inherited Minerals** are field-observable particles (e.g. mica flakes) or aggregates (e.g. glauconite pellets) that impart distinctive soil characteristics and formed by geologic processes in the original Parent Material and subsequently inherited by the soil rather than formed or concentrated by pedogenic processes. Included here due to historical conventions; not all Concentrations descriptors may apply (e.g. shape, color).

General conventions for documenting various types of **Concentrations**:

Type of Distribution	Documentation	Examples
Finely Disseminated (discrete bodies not visible)	Horizon Suffix, Concentrations	Carbonates (*none*) Salts (Bz, Bn)
Masses, Nodules, Concretions, Crystals, Biological Features	Redoximorphic Features, or Concentrations	Mn nodules Fe concretions Insect casts
Continuous Cementation	Terms in Lieu of Texture	Duripan Petrocalcic



CONCENTRATIONS

Record **Kind**, **Quantity** (percent of area covered), **Size**, **Contrast**, **Color**, **Moisture State**, **Shape**, **Location**, **Hardness**, and **Boundary**. A complete example is: *many, fine, prominent, white, moist, cylindrical, carbonate nodules in the matrix, moderately cemented, clear* or *m, 1, p, 10YR 8/1, M, c, CAN, MAT, M, c*.

CONCENTRATIONS - KIND - Identify the composition and the physical state of the concentration in the soil. ***NOTE***: Table sub-headings (e.g., *Masses*) are a guide to various physical states of materials. Materials with similar or identical chemical compositions may occur in multiple physical states (under several sub-headings); e.g., *salt masses* and *salt crystals*.

CONCENTRATIONS (NON-REDOX) *(accumulations of material)*

Kind	Code		Kind	Code	
	PDP	**NASIS**		PDP	**NASIS**
FINELY DISSEMINATED (bodies not visible by unaided eye; proposed)					
Finely Dissem. carbonates	—	FDC	Finely Disseminated salts	—	FDS
MASSES (noncemented; crystals not visible with 10X hand lens)					
barite *($BaSO_4$)*	B2	BAM	gypsum *($CaSO_4 \cdot 2H_2O$)*	G2	GYM
carbonates *(Ca, Mg, $NaCO_3$)*	K2	CAM	salt *(NaCl, Na-Mg sulfates)*	H2	SAM
clay bodies	A2	CBM	silica	S2	SIM
gypsum *(nests)*	G3	GNM			
NODULES (cemented; non-crystalline at 10X, no layers)					
carbonates [1]	C4	CAN	gibbsite *(Al_2O_3)*	E4	GBN
durinodes *(SiO_2)*	S4	DNN	opal	S1	OPN
CONCRETIONS (cemented; non-crystalline at 10X, distinct layers)					
carbonates [1]	C3	CAC	silica	S3	SIC
gibbsite	E3	GBC	titanium oxide	—	TIC
CRYSTALS (crystals visible with 10X hand lens)					
barite *($BaSO_4$)*	B1	BAX	gypsum *($CaSO_4 \cdot 2H_20$)*	G1	GYX
calcite *($CaCO_3$)*	C1	CAX	salt *(NaCl, Na-Mg sulfates)*	H1	SAX
BIOLOGICAL CONCENTRATIONS (byproducts or pseudomorphs)					
diatoms [2]	—	DIB	root sheaths	—	RSB
fecal pellets	—	FPB	shell fragments *(terrestrial or aquatic)*	—	SFB
insect casts [3] (e.g. Cicada mold)	T 3	ICB	sponge spicules [2]	—	SSB
plant phytoliths [2] *(plant opal)*	—	PPB	worm casts [3]	T 2	WCB
INHERITED MINERALS (geogenic) [4]					
glauconite pellets	—	GLI	mica flakes	—	MIC

[1] For example: *loess doll* (*aka loess kindchen*, *loess puppies*, etc.).

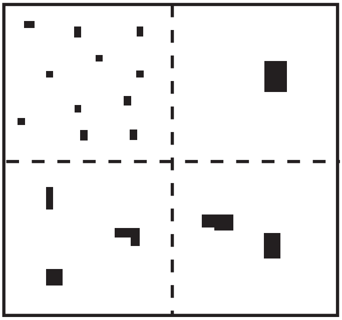
[2] Commonly requires magnification > 10X to be observed.

[3] Worm casts are ovoid, fecal pellets excreted by earthworms. Insect casts are cemented (e.g., $CaCO_3$) molds of insect bodies or burrows.

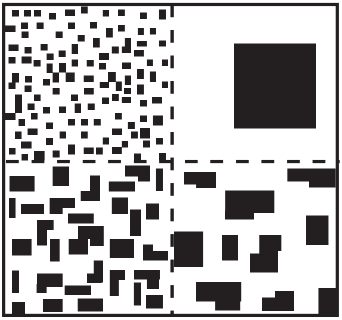
[4] Minerals inherited from parent material rather than formed in soil.

CONCENTRATIONS - QUANTITY (PERCENT OF AREA COVERED) -

Class	Code		Criteria: % of Surface Area Covered
	Conv.	NASIS	
Few	f	#	< 2
Common	c	#	2 to <20
Many	m	#	≥20



2%



20%

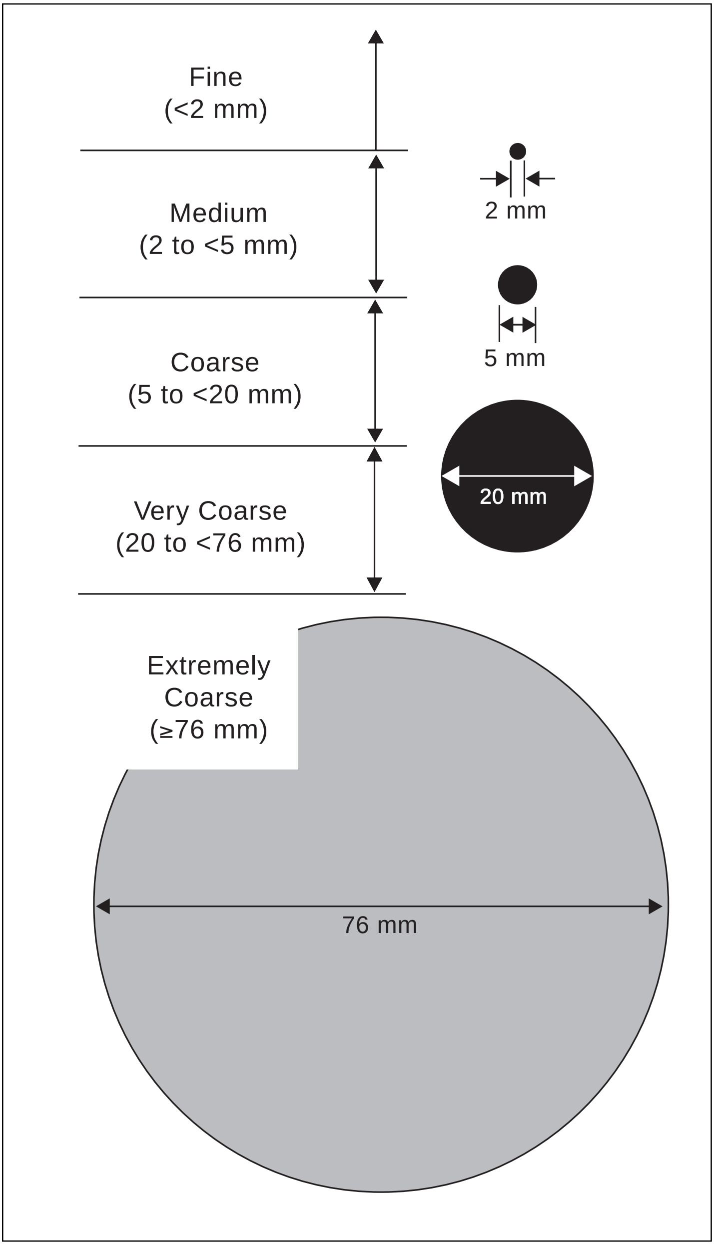
CONCENTRATIONS - SIZE - (Same as “RMF’s” and “Mottle Size Classes”. See graphic on next page.)

Size Class	Code	Criteria
Fine	1	< 2 mm
Medium	2	2 to < 5 mm
Coarse	3	5 to < 20 mm
Very Coarse	4	20 to < 76 mm
Extremely Coarse	5	≥ 76 mm

CONCENTRATIONS - CONTRAST - (Use “Mottle - Contrast Table” or “Mottle - Contrast Chart;” e.g., *distinct*.

CONCENTRATIONS - COLOR - Use standard Munsell® notation; e.g., *7.5 YR 8/1*.

CONCENTRATIONS - MOISTURE STATE - Use “Soil Color - Moisture State Table;” i.e., *Moist (M)* or *Dry (D)*.

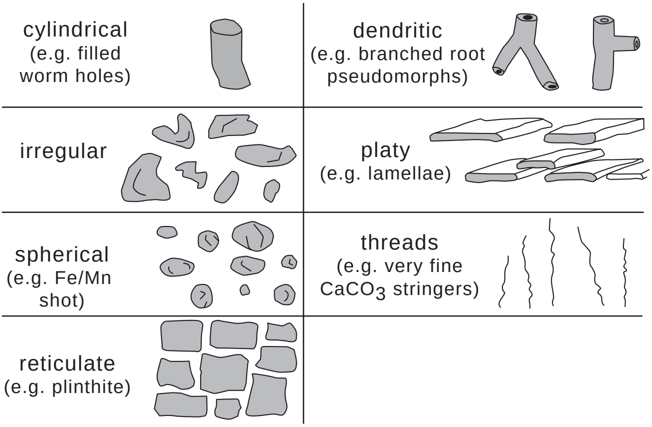

Fine
(<2 mm)
Medium
(2 to <5 mm)
Coarse
(5 to <20 mm)
Very Coarse
(20 to <76 mm)
Extremely
Coarse
(≥76 mm)
2 mm
5 mm
20 mm
76 mm

CONCENTRATIONS - SHAPE (also used for **Mottles, Redoximorphic Features**)

Shape	**Code**		**Criteria**
	PDP	**NASIS**	
cylindrical	C	C	tubular and elongated bodies; e.g., filled wormholes and insect burrows
dendritic	D	D	tubular, elongated, branched bodies; e.g., pipestems (root pseudomorphs)
irregular	Z	I	bodies of non-repeating spacing or shape
platy	P	P	relatively thin, tabular sheets, lenses; e.g., lamellae
reticulate	—	R	crudely interlocking bodies with similar spacing; e.g., plinthite
spherical [1]	O	S	well-rounded to crudely spherical bodies; e.g., Fe / Mn “shot”
threads	T	T	thin (e.g., < 1 mm diam.) elongated filaments; generally not dendritic; e.g., very fine $CaCO_3$ stringers

[1] Called *Rounded* in PDP.

Examples of Mottles, Concentrations, and RMF Shapes



CONCENTRATIONS - LOCATION - Describe the location(s) of the concentration (or depletion for RMF’s) within the horizon. Historically called **Concentrations - Distribution**.

Location	Code	
	PDP	**NASIS**
MATRIX (in soil matrix; not associated with ped faces or pores)		
In the matrix *(not associated with peds/pores)*	—	MAT
In matrix around depletions	—	MAD
In matrix around concentrations	—	MAC
Throughout *(e.g., finely disseminated carbonates)*	T	TOT
PEDS (on or associated with faces of peds)		
Between peds	P	BPF
Infused into the matrix along faces of peds *(hypocoats)* [1]	—	MPF
On faces of peds *(all orientations)*	—	APF
On horizontal faces of peds	—	HPF
On vertical faces of peds	—	VPF
PORES (in pores, or associated with surfaces along pores)		
On surfaces along pores	—	SPO
On surfaces along root channels *(proposed)*	—	RPO
Infused into the matrix adjacent to pores *(hypocoats)* [1]	—	MPO
Lining pores (see graphic p. 2-26)	—	LPO
OTHER		
In cracks	C	CRK
At top of horizon	M	TOH
Around rock fragments	S	ARF
On bottom of rock fragments *(e.g., pendants)*	—	BRF
On slickensides	—	SSS
Along lamina or strata surfaces *(proposed)*	—	ALS

CONCENTRATIONS - HARDNESS - Describe the relative force required to crush the concentration body (use the same criteria and classes as the "Rupture Resistance for Blocks, Peds, and Clods — Cementation" column***;*** e.g., *Moderately Cemented* (exclude the *Non-Cemented* class). ***NOTE***: PDP doesn't recognize the *Moderately Hard* class, dry nor moist (= *Very Weakly Cemented*).

CONCENTRATIONS - BOUNDARY - The gradation between feature and matrix.

Class	Code	Criteria
Sharp	S	Color changes in < 0.1 mm; change is abrupt even under a 10X hand lens.
Clear	C	Color changes within 0.1 to < 2 mm; gradation is visible without 10X lens.
Diffuse	D	Color changes in ≥ 2 mm; gradation is easily visible without 10X lens.

PED and VOID SURFACE FEATURES

These features are coats/films, hypocoats, or stress features formed by translocation and deposition, or shrink-swell processes on or along surfaces. Describe **Kind**, **Amount Class** (percent in NASIS and PDP), **Distinctness**, **Location**, and **Color** (dry or moist). An example is: *many, faint, brown 10YR 4/6 (Moist), clay films on all faces of peds* or *m, f, 10YR 4/6 (M), CLF, PF*.

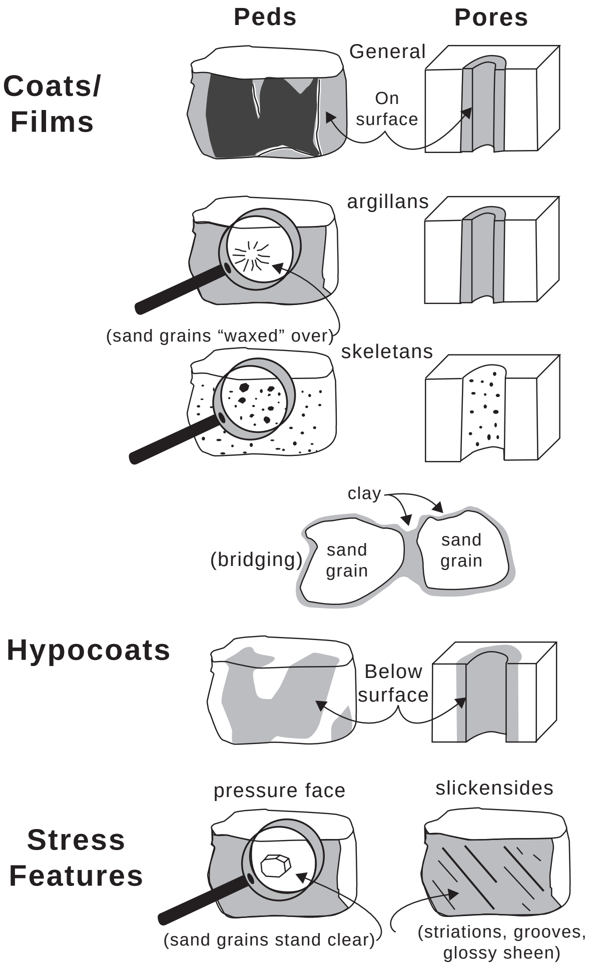
PED and VOID SURFACE FEATURES - KIND (non-redoximorphic)

Kind	**Code**		**Field Criteria**
	PDP	**NASIS**	
COATS, FILMS (exterior, adhered to surface)			
carbonate coats	K	CAF	off-white, effervescent with HCl
silica (silans, opal)	—	SIF	off-white, noneffervesent with HCl
clay films (argillans)	T	CLF	waxy, exterior coats
clay bridging	D	BRF	“wax” between sand grains
ferriargillans *described as **RMF - Kind***		see RMFs	Fe^{+3} stained clay film
gibbsite coats (sesquan)	G	GBF	$AlOH_3$, off-white, noneffervescent with HCl
manganese (mangans) *described as **RMF - Kind***		see RMFs	black, thin films effervescent with H_2O_2
organic stains	—	OSF	dark organic films
organoargillans	O	OAF	dark, organic stained clay films
sand coats	Z	SNF	separate grains visible with 10X
silt coats [1]	R	SLF	separate grains not visible at 10X
skeletans [2] (sand or silt)	S	SKF	clean sand or silt grains as coats
skeletans on argillans	A	SAF	clean sand or silt over clay coats
HYPOCOATS [3] (A stain infused beneath a surface)			
STRESS FEATURES (exterior face)			
pressure faces (i.e. stress cutans)	P	PRF	look like clay films; sand grains uncoated
slickensides *(pedogenic)*	K	SS	shrink-swell shear features (e.g. grooves, striations, glossy surface) on pedo-structure surfaces; (e.g. wedges, bowls);
slickensides *(geogenic)*	—	SSG	vertical / oblique, roughly planar shear face from external stress (e.g. faults; mass movement); striations, grooves

[1] Individual silt grains are not discernible with a 10X lens. Silt coats occur as a fine, off-white, noneffervescent, “grainy” coat on surfaces.

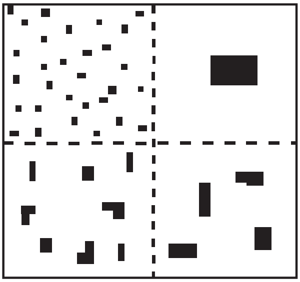
[2] Skeletans are (pigment) stripped grains > 2 μm and < 2 mm (Brewer, 1976). Preferably describe either *silt coats* (grains not discernible with 10X lens), or *sand coats* (grains discernible with 10X lens).

[3] Hypocoats, as used here, are field-scale features commonly expressed only as Redoximorphic Features. Micromorphological hypocoats include non-redox features (Bullock, et al., 1985).

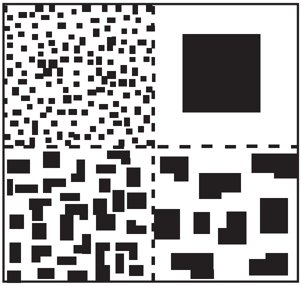


PED and VOID SURFACE FEATURES - AMOUNT - Estimate the relative percent of the visible surface area that a ped-surface feature occupies in a horizon. (See graphic below). In PDP & NASIS, record the estimate as a numeric percent; e.g., *20%.*

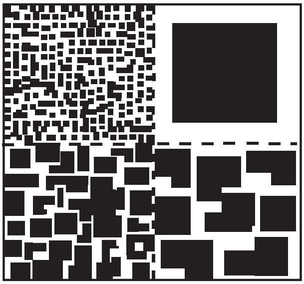
Amount Class	Code		Criteria: percent of surface area
	Conv.	NASIS	
Very Few	vf	%	< 5 percent
Few	f	%	5 to < 25 percent
Common	c	%	25 to < 50 percent
Many	m	%	50 to < 90 percent
Very Many	vm	%	≥ 90 percent



5%



25%



50%

90%

PED and VOID SURFACE FEATURES - CONTINUITY (Obsolete in NRCS) - Replaced by **Ped and Void Surface Feature - Amount** in PDP.

Continuity Class	Code (Conv.)	Criteria: Features Occur As
Continuous	C	Entire Surface Cover
Discontinuous	D	Partial Surface Cover
Patchy	P	Isolated Surface Cover

PED and VOID SURFACE FEATURES - DISTINCTNESS - The relative extent to which a ped surface feature visually stands out from adjacent material.

Distinctness Class	**Code**	**Criteria:**
Faint	F	Visible with magnification only (10X hand lens); little contrast between materials.
Distinct	D	Visible without magnification; significant contrast between materials.
Prominent	P	Markedly visible without magnification; sharp visual contrast between materials.

PED and VOID SURFACE FEATURES - LOCATION - Specify where ped-surface features occur within a horizon; e.g., *Between sand grains*.

Location	**Code**	
	PDP	**NASIS**
PEDS		
On bottom faces of peds	L[1]	BF
On top faces of peds	U[1]	TF
On vertical faces of peds	V	VF
On all faces of peds *(vertical & horizontal)*	P	PF
On tops of soil columns	C	TC
OTHER (NON-PED)		
Between sand grains *(bridging)*	B	BG
On surfaces along pores	I[1]	SP
On surfaces along root channels	I[1]	SC
On concretions	O	CC
On nodules	N	NO
On rock fragments	R	RF
On top surfaces of rock fragments	U[1]	TR
On bottom surfaces of rock fragments	L[1]	BR
On slickensides	—	SS

[1] Codes are repeated because these choices are combined in PDP.

PED and VOID SURFACE FEATURES - COLOR - Use standard Munsell® notation (hue, value, chroma) to record feature color. Indicate whether the color is Moist (M) or Dry (D).

(SOIL) TEXTURE

This is the numerical proportion (percent by weight) of sand, silt, and clay in a soil. Sand, silt, and clay content is estimated in the field by hand (or quantitatively measured in the office/lab by hydrometer or pipette) and then placed within the texture triangle to determine **Texture Class**. Estimate the **Texture Class**; e.g., *sandy loam*; or **Subclass**; e.g., *fine sandy loam* of the fine earth (≤ 2 mm) fraction, or choose a **Term in Lieu of Texture**; e.g., *gravel*. If appropriate, use a **Textural Class Modifier**; e.g., *gravelly silt loam*.

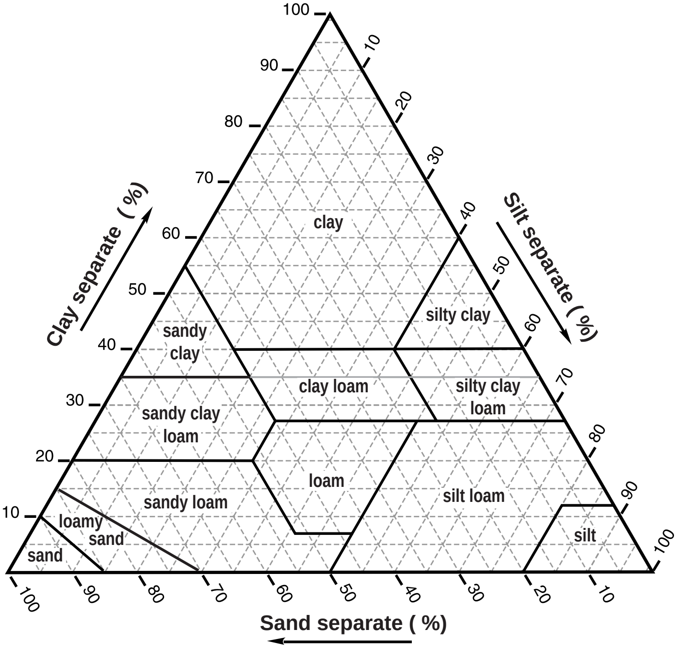
NOTE: **Soil Texture** encompasses only the fine earth fraction (≤ 2 mm). **Particle Size Distribution** (PSD) encompasses the whole soil, including both the fine earth fraction (≤ 2 mm; weight %) and rock fragments (> 2 mm; volume %).

TEXTURE CLASS

Texture Class or Subclass	Code	
	Conv.	NASIS
Coarse Sand	cos	COS
Sand	s	S
Fine Sand	fs	FS
Very Fine Sand	vfs	VFS
Loamy Coarse Sand	lcos	LCOS
Loamy Sand	ls	LS
Loamy Fine Sand	lfs	LFS
Loamy Very Fine Sand	lvfs	LVFS
Coarse Sandy Loam	cosl	COSL
Sandy Loam	sl	SL
Fine Sandy Loam	fsl	FSL
Very Fine Sandy Loam	vfsl	VFSL
Loam	l	L
Silt Loam	sil	SIL
Silt	si	SI
Sandy Clay Loam	scl	SCL
Clay Loam	cl	CL
Silty Clay Loam	sicl	SICL
Sandy Clay	sc	SC
Silty Clay	sic	SIC
Clay	c	C

Texture Triangle:

Fine Earth Texture Classes (▬▬▬)



TEXTURE MODIFIERS - Conventions for using “Rock Fragment Texture Modifiers” and for using textural adjectives that convey the “% volume” ranges for **Rock Fragments - Size and Quantity**.

Fragment Content % By Volume	Rock Fragment Modifier Usage
< 15	No texture adjective is used (noun only; e.g., *loam*).
15 to < 35	Use adjective for appropriate size; e.g., *gravelly*.
35 to < 60	Use “very” with the appropriate size adjective; e.g., *very gravelly*.
60 to < 90	Use “extremely” with the appropriate size adjective; e.g., *extremely gravelly*.
≥ 90	No adjective or modifier. If ≤ 10% fine earth, use the appropriate noun for the dominant size class; e.g., *gravel*. Use **Terms in Lieu of Texture**.

TEXTURE MODIFIERS - *(adjectives)*

ROCK FRAGMENTS: Size & Quantity [1]	**Code**		**Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (*name size*):** [1]
	Conv.	PDP/ **NASIS**	
ROCK FRAGMENTS (> 2 mm; ≥ Strongly Cemented)			
Gravelly	GR	GR	≥ 15% but < 35% gravel
Fine Gravelly	FGR	GRF	≥15% but < 35% fine gravel
Medium Gravelly	MGR	GRM	≥15% but < 35% med. gravel
Coarse Gravelly	CGR	GRC	≥ 15% but < 35% coarse gravel
Very Gravelly	VGR	GRV	≥ 35% but < 60% gravel
Extremely Gravelly	XGR	GRX	≥ 60% but < 90% gravel
Cobbly	CB	CB	≥ 15% but < 35% cobbles
Very Cobbly	VCB	CBV	≥ 35% but < 60% cobbles
Extremely Cobbly	XCB	CBX	≥ 60% but < 90% cobbles
Stony	ST	ST	≥ 15% but < 35% stones
Very Stony	VST	STV	≥ 35% but < 60% stones
Extremely Stony	XST	STX	≥ 60% but < 90% stones
Bouldery	BY	BY	≥ 15% but < 35% boulders
Very Bouldery	VBY	BYV	≥ 35% but < 60% boulders
Extremely Bouldery	XBY	BYX	≥ 60% but < 90% boulders
Channery	CN	CN	≥ 15% but < 35% channers
Very Channery	VCN	CNV	≥ 35% but < 60% channers
Extremely Channery	XCN	CNX	≥ 60% but < 90% channers
Flaggy	FL	FL	≥ 15% but < 35% flagstones
Very Flaggy	VFL	FLV	≥ 35% but < 60% flagstones
Extremely Flaggy	XFL	FLX	≥ 60% but < 90% flagstones
PARAROCK FRAGMENTS (> 2 mm; < Strongly Cemented) [2, 3]			
Parabouldery	PBY	PBY	(same criteria as bouldery)
Very Parabouldery	VPBY	PBYV	(same criteria as very bouldery)
Extr. Parabouldery	XPBY	PBYX	(same criteria as ext. bouldery)
etc.	etc.	etc.	(same criteria as non-para)

[1] The “Quantity” modifier (e.g., *very*) is based on the total rock fragment content. The “Size” modifier (e.g., *cobbly*) is independently based on the largest, dominant fragment size. For a mixture of sizes (e.g., *gravel and stones*), a smaller size–class is named only if its quantity (%) sufficiently exceeds that of a larger size–class. For field texture determination, a smaller size-class must exceed 2 times the quantity (vol. %) of a larger size class before it is named (e.g., 30% gravel and 14% stones = *very gravelly*, but 20% gravel and 14% stones = *stony*). For more explicit naming criteria see NSSH-Part 618, Exhibit 618.11(Soil Survey Staff, 2001b).

[2] Use “Para” prefix if the rock fragments are soft (i.e., meet criteria for “para”). [Rupture Resistance - Cementation Class is < *Strongly Cemented*, and do not slake (slake test: ≈3cm (1 inch) diam. block, air dried, then submerged in water for ≥ 1 hour; collapse / disaggregation = “slaking”).]

[3] For “Para” codes, add “P” to “Size” and “Quantity” code terms. Precedes noun codes and follows quantity adjectives, e.g., paragravelly = *PGR*; very paragravelly = *VPGR*.

COMPOSITIONAL TEXTURE MODIFIERS [1] - *(adjectives)*

Types	**Code**		**Criteria:**
	PDP	**NASIS**	
VOLCANIC			
Ashy	—	ASHY	Neither hydrous nor medial and ≥ 30% of the < 2 mm fraction is 0.02 to 2.00 mm in size of which ≥ 5% is volcanic glass
Hydrous	—	HYDR	Andic properties, and with field moist 15 bar water content ≥ 100% of the dry weight
Medial	—	MEDL	Andic properties, and with field moist 15 bar water content ≥ 30% to < 100% of the dry weight, or ≥12% water content for air-dried samples
ORGANIC SOILS (Histosols, Histels, and histic epipdons)			
Grassy	—	GS	OM > 15% (vol.) grassy fibers
Herbaceous	—	HB	OM > 15% (vol.) herbaceous fibers
Mossy	—	MS	OM > 15% (vol.) moss fibers
Mucky [2]	MK	MK	Used with peat (i.e. “mucky peat” for hemic materials — Soil Taxonomy). [2]
Woody	—	WD	OM ≥ 15% (vol.) wood pieces or fibers
ORGANIC MATERIALS IN MINERAL SOILS			
Mucky [2]	MK	MK	Mineral soil > 10% OM and < 17% fibers
Peaty	PT	PT	Mineral soil > 10% OM and > 17% fibers
LIMNIC MATERIALS			
Coprogenous	—	COP	
Diatomaceous	—	DIA	
Marly	—	MR	
OTHER			
Cemented	—	CEM	
Gypsiferous	—	GYP	≥ 15% (weight) gypsum
Permanently Frozen	PF	PF	e.g., Permafrost

[1] **Compositional Texture Modifiers** can be used with the **Soil Texture Name** (e.g., *gravelly ashy loam)* or with **Terms in Lieu of Texture** (e.g. *mossy peat)*. For definitions and usage of **Compositional Texture Modifiers**, see the National Soil Survey Handbook - Part 618.67 (Soil Survey Staff, 2001).

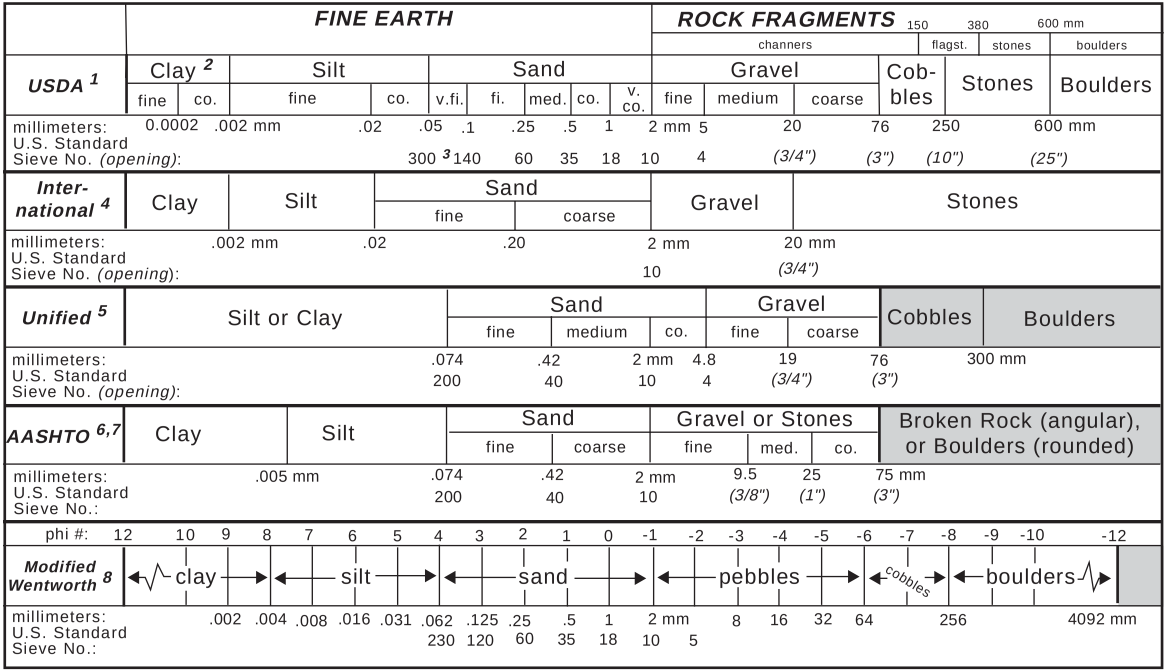
[2] Mucky can be used either with organic soils (e.g. mucky peat) or mineral soils (e.g., mucky sand) but its definition changes; Soil Taxonomy (Soil Survey Staff, 1999).

TERMS USED IN LIEU OF TEXTURE - *(nouns)*

Terms Used in Lieu of Texture	**Code**	
	PDP	**NASIS**
SIZE (ROCK FRAGMENTS) *≥ Strongly Cemented*		
Gravel	G	G
Cobbles	CB	CB
Stones	ST	ST
Boulders	B	BY
Channers	—	CN
Flagstones	—	FL
SIZE (PARAROCK FRAGMENTS) *< Strongly Cemented*		
Paragravel	—	PG
Paracobbles	—	PCB
Parastones	—	PST
Paraboulders	—	PBY
Parachanners	—	PCN
Paraflagstones	—	PFL
COMPOSITION		
Cemented / Consolidated:		
Bedrock	—	BR
Unweathered Bedrock *(unaltered)*	UWB	—
Weathered Bedrock *(altered; e.g., some Cr horizons)*	WB	—
Organics:		
Highly Decomposed Plant Material *(Oa)* [1]	—	HPM
Moderately Decomposed Plant Material *(Oe)* [1]	—	MPM
Slightly Decomposed Plant Material *(Oi)* [1]	—	SPM
Muck [2] *(≈Oa)*	—	MUCK
Mucky Peat [2] *(≈Oe)*	—	MPT
Peat [2] *(≈Oi)*	—	PEAT
Other:		
Ice *(permanently frozen)* [3, 4]	—	—
Material [5]	—	MAT
Water *(permanent)* [3, 4]	—	W

[1] Use only with organic soil layers of mineral soils.
[2] Use only with Histosols or histic epipedons.
[3] Use only for layers found below the soil surface.
[4] In NASIS, use "Permanently Frozen" Water to convey permanent, subsurface ice.
[5] "Material" is only used in combination with Compositional Texture Modifiers (p. 2-32); e.g. *woody material*; *medial material.* In NASIS, "Cemented Material" denotes any cemented soil material *(* i.e. *duripan, ortstein, petrocalcic, petroferric, petrogypsic).*

Comparison of Particle Size Classes in Different Systems



	FINE EARTH										ROCK FRAGMENTS					
											channers			flagst.	stones	boulders
USDA [1]	Clay [2]		Silt		Sand						Gravel			Cob-bles	Stones	Boulders
	fine	co.	fine	co.	v.fi.	fi.	med.	co.	v. co.		fine	medium	coarse			

ROCK FRAGMENTS: 150 380 600 mm

millimeters: 0.0002 .002 mm .02 .05 .1 .25 .5 1 2 mm 5 20 76 250 600 mm

U.S. Standard Sieve No. (opening): 300 [3] 140 60 35 18 10 4 (3/4") (3") (10") (25")

International [4]	Clay	Silt	Sand		Gravel	Stones
			fine	coarse		

millimeters: .002 mm .02 .20 2 mm 20 mm

U.S. Standard Sieve No. (opening): 10 (3/4")

Unified [5]	Silt or Clay	Sand			Gravel		Cobbles	Boulders
		fine	medium	co.	fine	coarse		

millimeters: .074 .42 2 mm 4.8 19 76 300 mm

U.S. Standard Sieve No. (opening): 200 40 10 4 (3/4") (3")

AASHTO [6,7]	Clay	Silt	Sand		Gravel or Stones			Broken Rock (angular), or Boulders (rounded)
			fine	coarse	fine	med.	co.	

millimeters: .005 mm .074 .42 2 mm 9.5 25 75 mm

U.S. Standard Sieve No.: 200 40 10 (3/8") (1") (3")

phi #: 12 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -12

Modified Wentworth [8]: clay silt sand pebbles cobbles boulders

millimeters: .002 .004 .008 .016 .031 .062 .125 .25 .5 1 2 mm 8 16 32 64 256 4092 mm

U.S. Standard Sieve No.: 230 120 60 35 18 10 5

References for Table Comparing Particle Size Systems

[1] Soil Survey Staff. 1995. Soil survey laboratory information manual. USDA, Natural Resources Conservation Service, Soil Survey Investigations Report No. 45, Version 1.0, National Soil Survey Center, Lincoln, NE. 305 p.

[2] Soil Survey Staff. 1995. Soil Survey Lab information manual. USDA-NRCS, Soil Survey Investigation Report #45, version 1.0, National Soil Survey Center, Lincoln, NE. Note: Mineralogy studies may subdivide clay into three size ranges: fine (< 0.08 μm), medium (0.08 – 0.2 μm), and coarse (0.2 – 2 μm); Jackson, 1969.

[3] The Soil Survey Lab (Lincoln, NE) uses a no. 300 sieve (0.047 mm opening) for the USDA – sand / silt measurement. A no. 270 sieve (0.053 mm opening) is more readily available and widely used.

[4] International Soil Science Society. 1951. *In*: Soil Survey Manual. Soil Survey Staff, USDA - Soil Conservation Service, Agricultural Handbook No. 18, U.S. Gov. Print. Office, Washington, D.C. 214 p.

[5] ASTM. 1993. Standard classification of soils for engineering purposes (Unified Soil Classification System). ASTM designation D2487-92. *In*: Soil and rock; dimension stone; geosynthetics. Annual book of ASTM standards - Vol. 04.08.

[6] AASHTO. 1986a. Recommended practice for the classification of soils and soil-aggregate mixtures for highway construction purposes. AASHTO designation M145-82. *In*: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.

[7] AASHTO. 1986b. Standard definitions of terms relating to subgrade, soil-aggregate, and fill materials. AASHTO designation M146-70 (1980). *In*: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.

[8] Ingram, R.L. 1982. Modified Wentworth scale. *In*: Grain-size scales. AGI Data Sheet 29.1. *In*: Dutro, J.T., Dietrich, R.V., and Foose, R.M. 1989. AGI data sheets for geology in the field, laboratory, and office, 3rd edition. American Geological Institute, Washington, D.C.

ROCK and OTHER FRAGMENTS

These are discrete, water-stable particles > 2 mm. Hard fragments (e.g., rock, wood) have a Rupture Resistance - Cementation Class ≥ *Strongly Cemented.* Softer fragments (e.g., para rock) are less strongly cemented. Describe **Kind**, **Volume Percent** (classes given below), **Roundness or Shape**, and **Size** (mm).

ROCK and OTHER FRAGMENTS - KIND - (Called **FRAGMENTS** in NASIS) Use the choice list given for **Bedrock - Kind** and the additional choices in the table below. ***NOTE***: Interbedded rocks from the "Bedrock - Kind Table" are not appropriate choices or terminology for rock fragments.

Kind	**Code**		**Kind**	**Code**	
	PDP	**NASIS**		PDP	**NASIS**
Includes all choices in **Bedrock - Kind** (except *Interbedded*), plus:					
calcrete *(caliche)* [1]	—	CA	metamorphic rocks [2]	—	MMR
carbonate concretions	—	CAC	mixed rocks [3]	—	MSR
carbonate nodules	—	CAN	ortstein fragments	—	ORF
carbonate rocks [2]	—	CAR	petrocalcic fragments	—	PEF
charcoal	—	CH	petroferric fragments	—	TCF
cinders	E5	CI	petrogypsic fragments	—	PGF
durinodes	—	DNN	plinthite nodules	—	PLN
duripan fragments	—	DUF	quartz	—	QUA
foliated metamorphic rocks [2]	—	FMR	quartzite	—	QZT
gibbsite concretions	—	GBC	scoria	—	SCO
gibbsite nodules	—	GBN	sedimentary rocks [2]	—	SED
igneous rocks [2]	—	IGR	shell fragments	—	SHF
iron-manganese concretions	—	FMC	silica concretions	—	SIC
iron-manganese nodules	—	FMN	volcanic bombs	—	VB
ironstone nodules	—	FSN	volcanic rocks [2]	—	VOL
lapilli	—	LA	wood	—	WO

[1] Fragments strongly cemented by carbonate; may include fragments derived from petrocalcic horizons.

[2] Generic rock names may be appropriate for identifying fragments (e.g. a cobble) but are too general and should not be used to name Bedrock-Kinds.

[3] Numerous, unspecified fragment lithologies are present, as in till or alluvium; not for use with residuum.

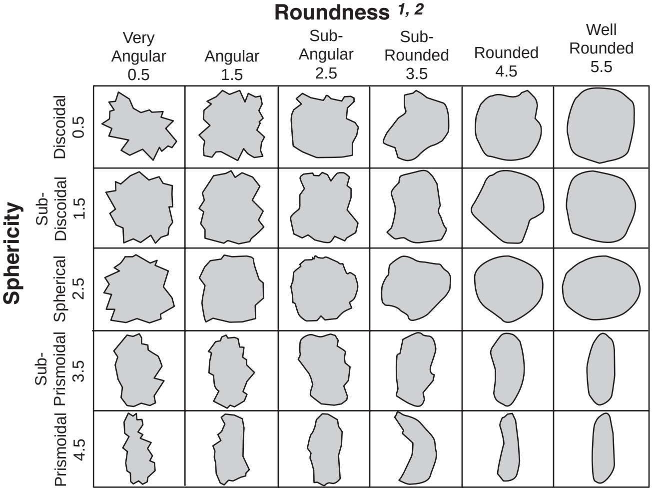
ROCK and OTHER FRAGMENTS - VOLUME PERCENT - Estimate the quantity on a volume percent basis. ***NOTE***: For proper use of **Texture Modifiers**, refer to the "Percent Volume Table" found under **Texture**.

ROCK and OTHER FRAGMENTS - ROUNDNESS - Estimate the relative roundness of rock fragments; use the following classes. (Called **Fragment Roundness** in PDP.)

Roundness Class	**Code**		**Criteria: visual estimate** [1]
	PDP	**NASIS**	
Very Angular	—	VA	*[Use **Roundness** graphic on next page]*
Angular	1	AN	
Subangular	2	SA	
Subrounded	3	SR	
Rounded	4	RO	
Well Rounded	5	WR	

[1] The criteria consist of a visual estimation; use the following graphic.

Estimate the relative rounding of rock fragments. (Ideally, use the average roundness based on 50 or more fragments.) The conventional geologic and engineering approach is presented in the following graphic. ***NOTE***: NRCS does <u>not</u> quantify **Sphericity**. It is included here for completeness and to show the range in **Fragment Roundness**.



[1] After Powers, 1953.

[2] Numerical values below *Roundness* and *Sphericity* headings are class midpoints (median rho values) (Folk, 1955) used in statistical analysis.

ROCK and OTHER FRAGMENTS - SIZE CLASSES AND DESCRIPTIVE TERMS -

Size [1]	**Noun**	**Adjective** [2]
SHAPE - SPHERICAL or CUBELIKE (discoidal, subdiscoidal, or spherical)		
> 2 - 75 mm diameter	gravel	gravelly
> 2 - 5 mm diameter	fine gravel	fine gravelly
> 5 - 20 mm diameter	medium gravel	medium gravelly
> 20 - 75 mm diameter	coarse gravel	coarse gravelly
> 75 - 250 mm diameter	cobbles	cobbly
> 250 - 600 mm diameter	stones	stony
> 600 mm diameter	boulders	bouldery
SHAPE - FLAT (prismoidal or subprismoidal)		
> 2 - 150 mm long	channers	channery
> 150 - 380 mm long	flagstones	flaggy
> 380 - 600 mm long	stones	stony
> 600 mm long	boulders	bouldery

[1] Fragment sizes measured by sieves; class limits have a > lower limit.

[2] For a mixture of sizes (e.g., gravels and stones present), the largest size-class (most mechanically restrictive) is named. A smaller size-class is named only if its quantity (%) sufficiently exceeds that of a larger size class. For field texture determination, a smaller size-class must exceed 2 times the quantity (vol.%) of a larger size-class in order to be named (e.g., 30% gravel and 14% stones = *very gravelly*; but 20% gravel and 14% stones = *stony*). For more explicit naming criteria see NSSH-Part 618, Exhibit 618.11

(SOIL) STRUCTURE

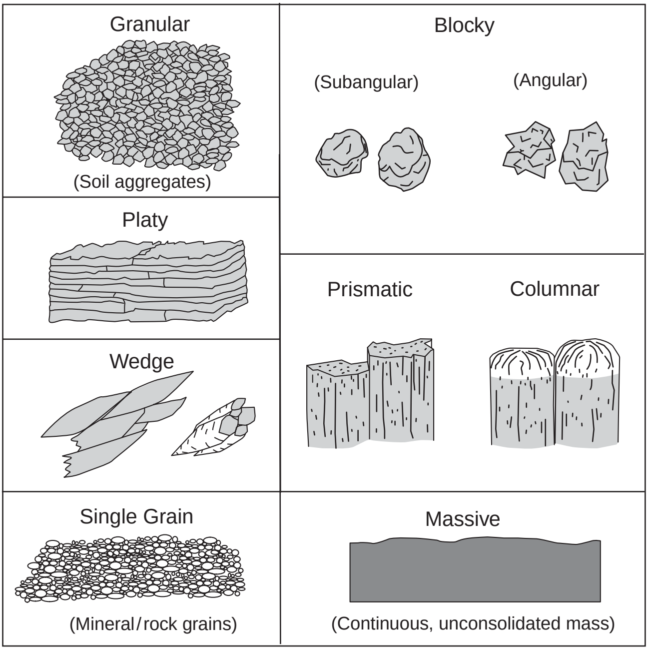
(Soil) Structure is the naturally occurring arrangement of soil particles into aggregates that results from pedogenic processes. Record **Grade**, **Size**, and **Type**. For compound structure, list each **Size** and **Type**; e.g., *medium and coarse SBK parting to fine GR*. Lack of structure (structureless) has two end members: *massive (MA)* or *single grain (SG)*. A complete example is: *weak, fine, subangular blocky* or *1, f, sbk*.

(SOIL) STRUCTURE - TYPE (formerly **Shape**) -

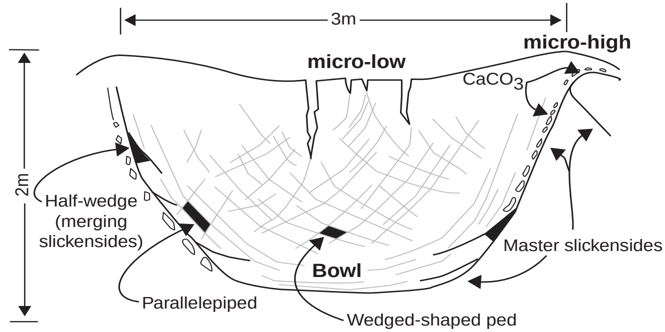
Type	**Code**		**Criteria:** (definition)
	Conv.	**NASIS**	
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)			
Granular	gr	GR	Small polyhedrals, with curved or very irregular faces.
Angular Blocky	abk	ABK	Polyhedrals with faces that intersect at sharp angles (planes).
Subangular Blocky	sbk	SBK	Polyhedrals with sub-rounded and planar faces, lack sharp angles.
Platy	pl	PL	Flat and tabular-like units.
Wedge	—	WEG	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials.
Prismatic	pr	PR	Vertically elongated units with flat tops.
Columnar	cpr	COL	Vertically elongated units with rounded tops which commonly are “bleached”.
STRUCTURELESS			
Single Grain	sg	SGR	No structural units; entirely noncoherent; e.g., loose sand.
Massive	m	MA	No structural units; material is a coherent mass (not necessarily cemented).
ARTIFICIAL EARTHY FRAGMENTS OR CLODS [1] ***(non-pedogenic structure)***			
Cloddy [1]	—	CDY	Irregular blocks created by artificial disturbance; e.g., tillage or compaction.

[1] Used only to describe oversized, “artificial” earthy units that are not pedogenically derived soil structural units; e.g., the direct result of mechanical alteration; use **Blocky Structure Size** criteria.

Examples of Soil Structure Types



Example of Wedge Structure, Gilgai Microfeatures, & Microrelief



(modified from: Lynn and Williams, 1992)

(SOIL) STRUCTURE - GRADE

Grade	Code	Criteria
Structureless	0	No discrete units observable in place or in hand sample.
Weak	1	Units are barely observable in place or in a hand sample.
Moderate	2	Units well-formed and evident in place or in a hand sample.
Strong	3	Units are distinct in place (undisturbed soil), and separate cleanly when disturbed.

(SOIL) STRUCTURE - SIZE

Size Class	**Code**		**Criteria: structural unit size [1] (mm)**		
	Conv.	**NASIS**			
			Granular Platy [2] Thickness	Columnar, Prismatic, Wedge [3]	Angular & Subangular Blocky
Very Fine (Very Thin)[2]	vf (vn)	VF (VN)	< 1	< 10	< 5
Fine (Thin) [2]	f (tn)	F (TN)	1 to < 2	10 to < 20	5 to < 10
Medium	m	M	2 to < 5	20 to < 50	10 to < 20
Coarse (Thick) [2]	co (tk)	CO (TK)	5 to < 10	50 to < 100	20 to < 50
Very Coarse (Very Thick) [2]	vc (vk)	VC (VK)	≥ 10	100 to < 500	≥ 50
Extr. Coarse	ec	EC	—	≥ 500	—-

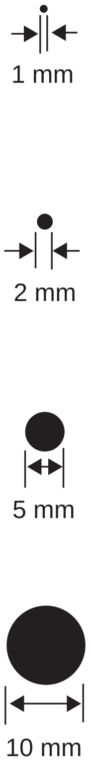
[1] Size limits always denote the smallest dimension of the structural units.

[2] For platy structure only, substitute *thin* for *fine* and *thick* for *coarse* in the size class names.

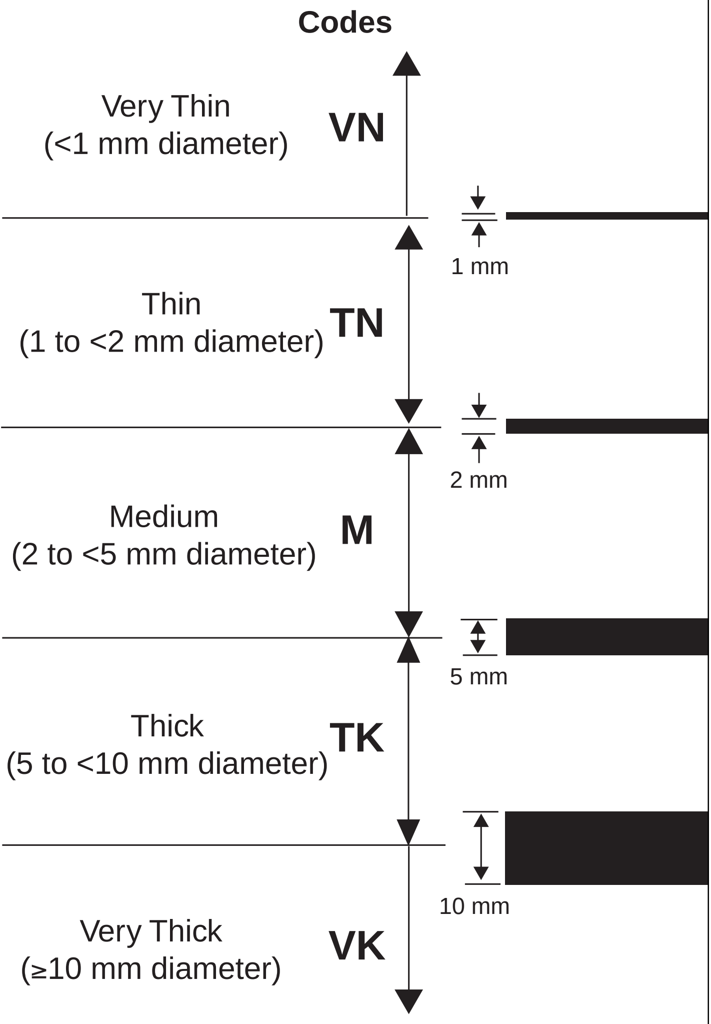
[3] Wedge structure is generally associated with Vertisols (for which it is a requirement) or related soils with high amounts of smectitic clays.

Granular

	Codes
Very Fine (<1 mm diameter)	**VF**
Fine (1 to <2 mm diameter)	**F**
Medium (2 to <5 mm diameter)	**M**
Coarse (5 to <10 mm diameter)	**CO**
Very Coarse (≥10 mm diameter)	**VC**



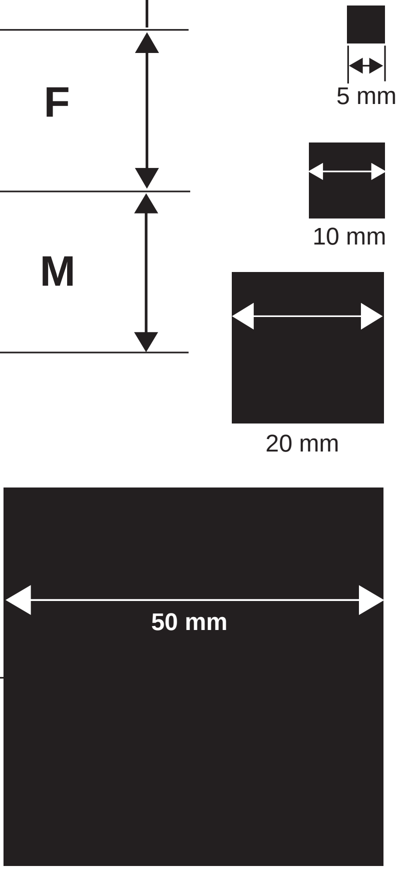
Platy


Codes
Very Thin
(<1 mm diameter)
VN
1 mm
Thin
(1 to <2 mm diameter)
TN
2 mm
Medium
(2 to <5 mm diameter)
M
5 mm
Thick
(5 to <10 mm diameter)
TK
10 mm
Very Thick
(≥10 mm diameter)
VK

Angular & Subangular Blocky

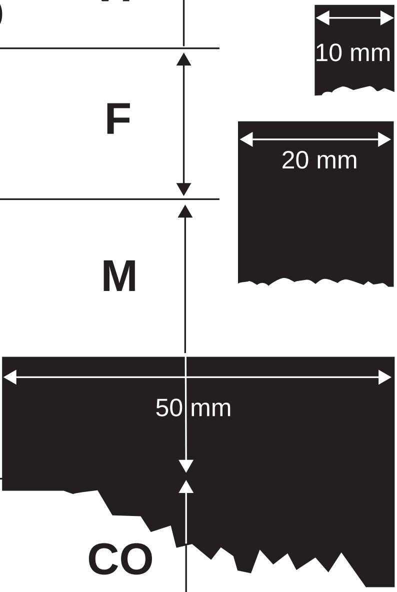
Codes

Very Fine (<5 mm diameter)	**VF**
Fine (5 to <10 mm diameter)	**F**
Medium (10 to <20 mm diameter)	**M**
Coarse (20 to <50 mm diameter)	**CO**
Very Coarse (≥50 mm diameter)	**VC**



Prismatic and Columnar

	Codes
Very Fine (<10 mm diameter)	**VF**
Fine (10 to <20 mm diameter)	**F**
Medium (20 to <50 mm diameter)	**M**
Coarse (50 to <100 mm diameter)	**CO**
Very Coarse (100 to <500 mm diameter)	**VC**
Extremely Coarse (≥500 mm diameter)	**EC**

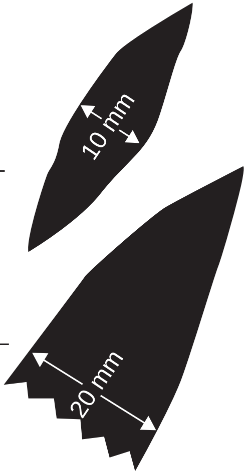


[100 mm not shown]

[500 mm not shown]

Wedge

	Codes
Very Fine (<10 mm thick)	**VF**
Fine (10 to <20 mm thick)	**F**
Medium (20 to <50 mm thick)	**M**
Coarse (50 to <100 mm thick)	**CO**
Very Coarse (100 to <500 mm thick)	**VC**
Extremely Coarse (≥500 mm thick)	**EC**



50 mm
not shown

100 mm
not shown

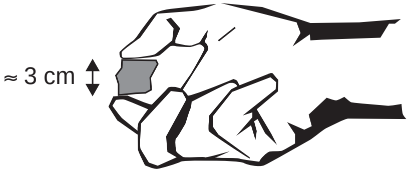
500 mm
not shown

CONSISTENCE

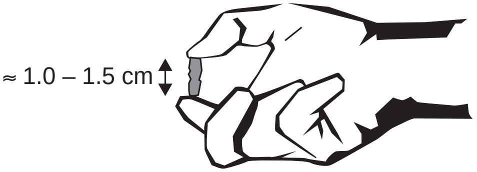
Consistence is the degree and kind of cohesion and adhesion that soil exhibits, and/or the resistance of soil to deformation or rupture under an applied stress. Soil-water state strongly influences consistence. Field evaluations of consistence include: **Rupture Resistance** (Blocks, Peds, and Clods; or Surface Crusts and Plates), **Resistance to Penetration**, **Plasticity**, **Stickiness**, and **Manner of Failure**. Historically, consistence applied to dry, moist, or wet soil as observed in the field. Wet consistence evaluated Stickiness and Plasticity. **Rupture Resistance** now applies to dry soils and to soils in a water state from moist through wet. **Stickiness** and **Plasticity** of soil are independent evaluations.

RUPTURE RESISTANCE - A measure of the strength of soil to withstand an applied stress. Separate estimates of **Rupture Resistance** are made for **Blocks/Peds/Clods** and for **Surface Crusts and Plates** of soil. Block-shaped specimens should be approximately 2.8 cm across. If 2.8 cm cubes (e.g., ≈ 2.5 - 3.1 cm, or 1 inch) are not obtainable, use the following equation and the table below to calculate the stress at failure: [(2.8 cm / cube length cm)^2 X estimated stress (N) at failure)]; e.g., *for a 5.6 cm cube* $[(2.8/5.6)^2 \times 20\ N] = 5\ N \Rightarrow$ *Soft Class*. Plate-shaped specimens (surface crusts or platy structure) should be approximately 1.0 - 1.5 cm long by 0.5 cm thick (or the thickness of occurrence, if < 0.5 cm thick).

Blocks/Peds



Crusts/Plates



RUPTURE RESISTANCE FOR:

Blocks, Peds, and Clods - Estimate the class by the force required to rupture (break) a soil unit. Select the column for the appropriate soil water state (*dry* vs. *moist*) and/or the *Cementation* column, if applicable.

Dry [1]		**Moist** [1]		**Cementation** [2]		**Specimen Fails Under**
Class	**Code** [3]	**Class**	**Code** [3]	**Class**	**Code** [3]	
Loose	L d(lo)	Loose	L m(lo)	*[Not Applicable]*		*Intact specimen not obtainable*
Soft	S d(so)	Very Friable	VFR m(vfr)	Non-Cemented	NC	Very slight force between fingers. <8 N
Slightly Hard	SH d(sh)	Friable	FR m(fr)	Extremely Weakly Cemented	EW	Slight force between fingers. 8 to < 20 N
Mod. Hard	MH d(h)	Firm	FI m(fi)	Very Weakly Cemented	VW	Moderate force between fingers. 20 to < 40 N
Hard	HA d(h)	Very Firm	VFI m(vfi)	Weakly Cemented	W c(w)	Strong force between fingers. 40 to < 80 N
Very Hard	VH d(vh)	Extr. Firm	EF m(efi)	Moderately Cemented	M	Moderate force between hands. 80 to < 160 N
Extremely Hard	EH d(eh)	Sli*ghtly* Rigid	SR m(efi)	Strongly Cemented	ST c(s)	Foot pressure by full body weight. 160 to < 800 N
Rigid	R d(eh)	Rigid	R m(efi)	Very Strongly Cemented	VS	Blow of < 3 J but not body weight. 800 N to < 3 J
Very Rigid	VR d(eh)	Very Rigid	VR m(efi)	Indurated	I c(I)	Blow of ≥ 3 J. *(3 J = 2 kg weight dropped 15 cm).*

[1] Dry Rupture Resistance column applies to soils that are moderately dry or drier *(Moderately Dry* and *Very Dry* **Soil Water State** sub-classes). Moist column applies to soils that are slightly dry or wetter (*Slightly Dry* through *Satiated* **Soil Water State** sub-classes; Soil Survey Staff, 1993; p. 91).

[2] This is not a field test; specimen must first be air dried and then submerged in water for a minimum of 1 hour prior to test (Soil Survey Staff, 1993; p. 173).

[3] Codes in parentheses (e.g., d(lo); Soil Survey Staff, 1951) are obsolete.

Soil Moisture Status (Consistence) (OBSOLETE) - Historical classes (Soil Survey Staff, 1951).

(d)[1] Dry Soil Class [2]	**Code**	**(m)[1] Moist Soil Class**	**Code**	**Cementation Class**	**Code**
Loose	(d) lo	Loose	(m) lo	Weakly Cemented	(c) w
Soft	(d) so	Very Friable	(m) vfr		
Slightly Hard	(d) sh	Friable	(m) fr	Strongly Cemented	(c) s
Hard [2]	(d) h	Firm	(m) fi		
Very Hard	(d) vh	Very Firm	(m) vfi	Indurated	(c) I
Extr. Hard	(d) eh	Extr. Firm	(m) efi		

[1] Historically, consistence prefixes (*d* for dry, *m* for moist) were commonly omitted, leaving only the root code; e.g., *vfr* instead of *mvfr*.

[2] *Hard Class (Dry)* was later split into *Moderately Hard* and *Hard* (Soil Survey Staff, 1993).

Surface Crust and Plates

Class (air dried)	**Code**	**Force [1] (Newtons)**
Extremely Weak	EW	*Not Obtainable*
Very Weak	VW	Removable, < 1N
Weak	W	1 to < 3N
Moderate	M	3 to < 8N
Moderately Strong	MS	8 to < 20N
Strong	S	20 to < 40N
Very Strong	VS	40 to < 80N
Extremely Strong	ES	≥ 80N

[1] For operational criteria [field estimates of force (N)] use the *Fails Under* column, in the “Rupture Resistance for Blocks, Peds, Clods” table.

CEMENTING AGENTS - Record kind of cementing agent, if present.

Kind	**Code [1]**
carbonates	K
gypsum	G
humus	H
iron	I
silica (SiO_2)	S

[1] Conventional codes traditionally consist of the entire material name or its chemical symbols; e.g., *silica* or *SiO_2*. Consequently, the *Conv.* code column would be redundant and is not shown in this table.

MANNER OF FAILURE - The rate of change and the physical condition soil attains when subjected to compression. Samples are moist or wetter.

Failure Class	**Code**		**Criteria: Related Field Operation**
	PDP	**NASIS**	
BRITTLENESS			**Use a 3 cm block. (Press between thumb & forefinger.)**
Brittle	B	BR	Ruptures abruptly ("pops" or shatters).
Semi-Deformable	SD	SD	Rupture occurs before compression to < 1/2 original thickness.
Deformable	D	DF	Rupture occurs after compression to ≥ 1/2 original thickness.
FLUIDITY			**Use a palmful of soil. (Squeeze in hand.)**
Nonfluid	NF	NF	No soil flows through fingers with full compression.
Slightly Fluid	SF	SF	Some soil flows through fingers, most remains in the palm, after full pressure.
Moderately Fluid	MF	MF	Most soil flows through fingers, some remains in palm, after full pressure.
Very Fluid	VF	VF	Most soil flows through fingers, very little remains in palm, after gentle pressure.
SMEARINESS			**Use a 3 cm block. (Press between thumb & forefinger.)**
Non-Smeary [1]	NS	NS	At failure, the sample does not change abruptly to fluid, fingers do not skid, no smearing occurs.
Weakly Smeary [1]	WS	WS	At failure, the sample changes abruptly to fluid, fingers skid, soil smears, little or no water remains on fingers.
Moderately Smeary [1]	MS	MS	At failure, the sample changes abruptly to fluid, fingers skid, soil smears, some water remains on fingers.
Strongly Smeary [1]	SM	SM	At failure, the sample abruptly changes to fluid, fingers skid, soil smears and is slippery, water easily seen on fingers.

[1] *Smeariness* failure classes are used dominantly with Andic materials, but may also be used with some spodic materials.

STICKINESS - The capacity of soil to adhere to other objects. Stickiness is estimated at the moisture content that displays the greatest adherence when pressed between thumb and forefinger.

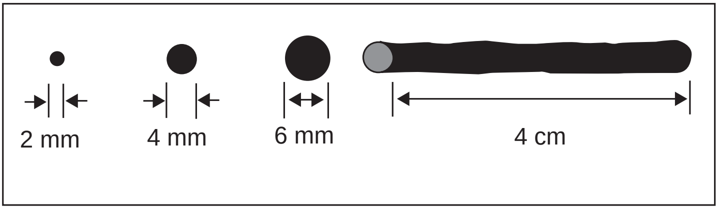
Stickiness Class	Code			Criteria: Work moistened soil between thumb and forefinger
	Conv	PDP	**NASIS**	
Non-Sticky	(w) so	SO	SO	Little or no soil adheres to fingers, after release of pressure.
Slightly Sticky	(w) ss	SS	SS	Soil adheres to both fingers, after release of pressure. Soil stretches little on separation of fingers.
Moderately Sticky[1]	(w) s	S	MS	Soil adheres to both fingers, after release of pressure. Soil stretches some on separation of fingers.
Very Sticky	(w) vs	VS	VS	Soil adheres firmly to both fingers, after pressure release. Soil stretches greatly upon separation of fingers.

[1] Historically, the *Moderately Sticky* class was simply called *Sticky*.

PLASTICITY - The degree to which "puddled" or reworked soil can be permanently deformed without rupturing. The evaluation is made by forming a roll (wire) of soil at a water content where the maximum plasticity is expressed.

Plasticity Class	Code			Criteria: Make a roll of soil 4 cm long
	Conv	PDP	**NASIS**	
Non-Plastic	(w) po	PO	PO	Will not form a 6 mm diameter roll, or if formed, can't support itself if held on end.
Slightly Plastic	(w) ps	SP	SP	6 mm diameter roll supports itself; 4 mm diameter roll does not.
Moderately Plastic [1]	(w) p	P	MP	4 mm diameter roll supports itself, 2 mm diameter roll does not.
Very Plastic	(w) vp	VP	VP	2 mm diameter roll supports its weight.

[1] Historically, the *Moderately Plastic* class was simply called *Plastic*.



PENETRATION RESISTANCE - The ability of soil in a confined (field) state to resist penetration by a rigid object of specified size. A pocket penetrometer (Soil-Test Model CL-700) with a rod diameter of 6.4 mm (area 20.10 mm^2) and insertion distance of 6.4 mm (note line on rod) is used for the determination. An average of five or more measurements should be used to obtain a value for penetration resistance. In PDP, record the **Penetration Resistance** value in megapascals (MPa), **Orientation** of the rod (vertical (V) or horizontal (H)), and **Water State** of the soil.

NOTE: The pocket penetrometer has a scale of 0.25 to 4.5 tons/ft^2 (tons/ft^2 $\approx$ kg/cm^2). The penetrometer does not directly measure penetration resistance. The penetrometer scale is correlated to, and gives a field estimate of unconfined compressive strength of soil as measured with a Tri-Axial Shear device. The table below converts the scale reading on the pocket penetrometer to penetration resistance in MPa. Penetrometer readings are dependent on the spring type used. Springs of varying strength are needed to span the range of penetration resistance found in soil.

Penetrometer Scale Reading	**Spring Type** [1, 2, 3]			
tons/ft^2	Original MPa	Lee MPa	Jones 11 MPa	Jones 323 MPa
0.25	**0.32 L**	**0.06 VL**	**1.00 M**	**3.15 H**
0.75	0.60	**0.13 L**	1.76	4.20
1.00	0.74	0.17	**2.14 H**	4.73
1.50	**1.02 M**	0.24	2.90	5.78
2.75	1.72	0.42	4.80	**8.40 EH**
3.50	**2.14 H**	0.53	—	—-

[1] On wet or “soft” soils, a larger “foot” may be used (Soil Survey Staff, 1993).

[2] Each bolded value highlights the force associated with a rounded value on the penetrometer scale that is closest to a *Penetration Resistance Class* boundary. The bolded letter represents the *Penetration Resistance Class* from the following table (e.g., **M** indicates the *Moderate* class).

[3] Each spring type spans only a part of the range of penetration resistance possible in soils; various springs are needed to span all *Penetration Resistance Classes*.

Penetration Resistance Class	Code	Criteria: Penetration Resistance (MPa)
Extremely Low	EL	< 0.01
Very Low	VL	0.01 to < 0.1
Low	L	0.1 to < 1
Moderate	M	1 to < 2
High	H	2 to < 4
Very High	VH	4 to < 8
Extremely High	EH	≥ 8

EXCAVATION DIFFICULTY - The relative force or energy required to dig soil out of place. Describe the **Excavation Difficulty Class** and the moisture condition (*moist* or *dry*, but not wet); use the "(Soil) Water State Table"; e.g., *moderate, moist* or *M, M*. Estimates can be made for either the most limiting layer or for each horizon.

Class	Code	Criteria
Low	L	Excavation by tile spade requires arm pressure only; impact energy or foot pressure is not needed.
Moderate	M	Excavation by tile spade requires impact energy or foot pressure; arm pressure is insufficient.
High	H	Excavation by tile spade is difficult, but easily done by pick using over-the-head swing.
Very High	VH	Excavation by pick with over-the-head swing is moderately to markedly difficult. Backhoe excavation by a 50-80 hp tractor can be made in a moderate time.
Extremely High	EH	Excavation via pick is nearly impossible. Backhoe excavation by a 50-80 hp tractor cannot be made in a reasonable time.

ROOTS

Record the **Quantity**, **Size**, and **Location** of roots in each horizon.
NOTE: Describe **Pores** using the same **Quantity** and **Size** classes and criteria as **Roots** (use the combined tables). A complete example for roots is: *Many, fine, roots In Mat at Top of Horizon* or *3, f (roots), M*.

ROOTS (and **PORES) – QUANTITY** (Roots and Pores) - Describe the quantity (number) of roots for each size class in a horizontal plane. (***NOTE***: Typically, this is done across a vertical plane, such as a pit face.) Record the average quantity from 3 to 5 representative unit areas. ***CAUTION***: The unit area that is evaluated varies with the *Size Class* of the roots being considered. Use the appropriate unit area stated in the *Soil Area Assessed* column of the "Size (Roots and Pores)" table. In NASIS and PDP, record the actual number of roots/unit area (which outputs the appropriate class). Use class names in narrative description.

Quantity Class [1]	**Code**		**Average Count** [2] **(per assessed area)**
	Conv.	**NASIS**	
Few	1	#	< 1 per area
Very Few [1]	—	#	< 0.2 per area
Moderately Few [1]	—	#	0.2 to < 1 per area
Common	2	#	1 to < 5 per area
Many	3	#	≥ 5 per area

[1] The *Very Few* and *Moderately Few* sub-classes can be described for roots (optional) but do not apply to pores.

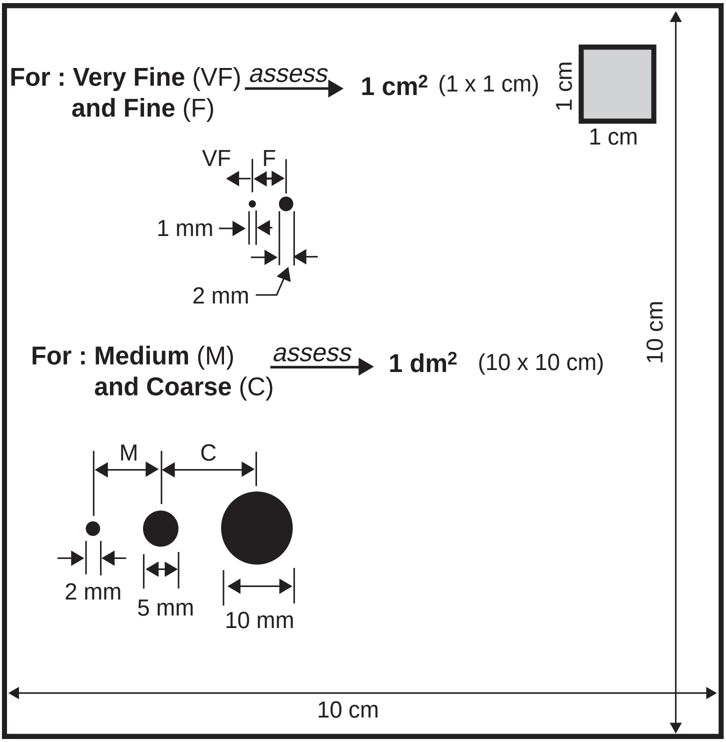
[2] The applicable area for appraisal varies with the size of roots or pores. Use the appropriate area stated in the *Soil Area Assessed* column of the "Size (Roots and Pores) Table" or use the following graphic.

ROOTS (and **PORES) – SIZE** - See the following graphic for size.

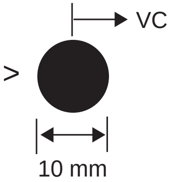
Size Class	**Code**		**Diameter**	**Soil Area Assessed** [1]
	Conv.	**NASIS**		
Very Fine	vf	VF	< 1 mm	1 cm^2
Fine	f	F	1 to < 2 mm	1 cm^2
Medium	m	M	2 to < 5 mm	1 dm^2
Coarse	co	C	5 to < 10 mm	1 dm^2
Very Coarse	vc	VC	≥ 10 mm	1 m^2

[1] One dm^2 = a square that is 10 cm on a side, or 100 cm^2.

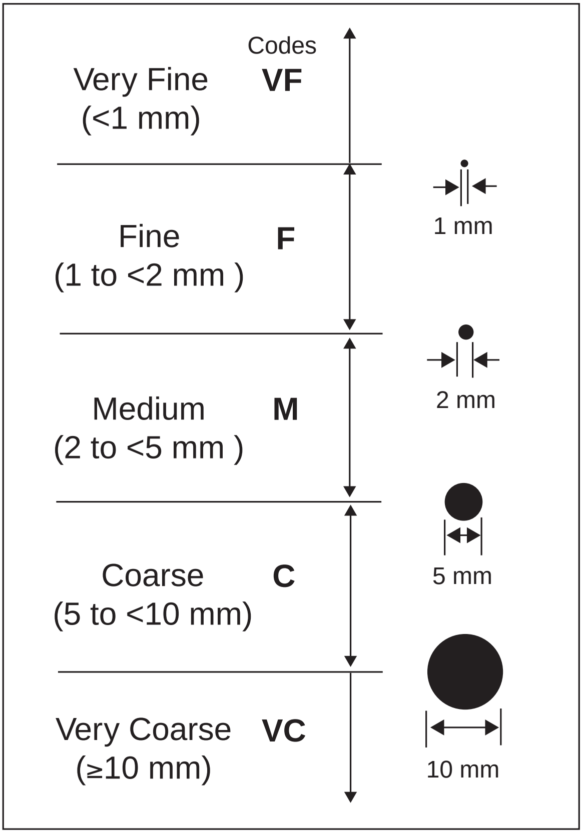
ROOTS (and **PORES) - QUANTITY** - Soil area to be assessed.



For : Very Coarse (VC) *assess* → **1 m^2** (100 x 100 cm)
(box not shown)



Root and Pore Size Classes



ROOTS - LOCATION (Roots only) - Identify where roots occur.

Location	Code
Between peds	P
In cracks	C
Throughout	T
In mat at top of horizon [1]	M
Matted around rock fragments	R

---

[1] Describing a root mat at the top of a horizon rather than at the bottom or within the horizon, flags the horizon that restricts root growth.

PORES (DISCUSSION)

Pores are the air or water filled voids in soil. Historically, description of soil pores, called “nonmatrix” pores in the Soil Survey Manual (Soil Survey Staff, 1993), excluded inter-structural voids, cracks, and in some schemes, interstitial pores. *Inter-structural voids* (i.e., the sub-planar fractures between peds; also called interpedal or structural faces/planes), which can be inferred from soil structure descriptions, are not recorded directly. *Cracks* can be assessed independently (Soil Survey Staff, 1993). *Interstitial pores* (i.e. visible, primary packing voids) may be visually estimated, especially for fragmental soils, or can be inferred from soil porosity, bulk density, and particle size distribution. Clearly, one cannot assess the smallest interstitial pores (e.g., < 0.05 mm) in the field. Field observations are limited to those that can be seen through a 10X hands lens, or larger. Field estimates of interstitial pores are considered to be somewhat tenuous, but useful.

PORES

Record **Quantity** and **Size** of pores for each horizon. Description of soil pore **Shape** and **Vertical Continuity** is optional. A complete example for pores is: *common, medium, tubular pores, throughout* or *c, m, TU (pores), T*.

PORES - QUANTITY - See and use **Quantity (Roots and Pores)**.

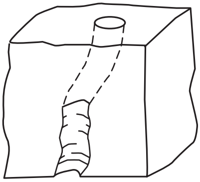
PORES - SIZE - See and use **Size (Roots and Pores)**.

PORES - SHAPE (or Type) - Record the dominant form (or “type”) of pores discernible with a 10X hand lens and by the unaided eye. [See following graphic.]

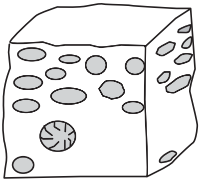
Description	**Code**		**Criteria**
	PDP	**NASIS**	
SOIL PORES [1]			
Dendritic Tubular	TE	DT	Cylindrical, elongated, branching voids; e.g., *empty root channels*.
Irregular	—	IG	Non-connected cavities, chambers; e.g., *vughs*; various shapes.
Tubular	TU	TU	Cylindrical and elongated voids; e.g., *worm tunnels*.
Vesicular	VS	VE	Ovoid to spherical voids; e.g., *solidified pseudomorphs of entrapped, gas bubbles concentrated below a crust*; most common in arid to semi-arid environments.
PRIMARY PACKING VOIDS [2]			
Interstitial	IR	IR	Voids between sand grains or rock fragments.

[1] Called “Nonmatrix Pores” in the Soil Survey Manual (Soil Survey Staff, 1993).

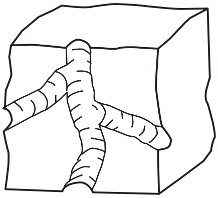
[2] *Primary Packing Voids* include a continuum of sizes. As used here, they have a minimum size that is defined as pores that are visible with a 10X hand lens. *Primary Packing Voids* are called “Matrix Pores” in the Soil Survey Manual (Soil Survey Staff, 1993).



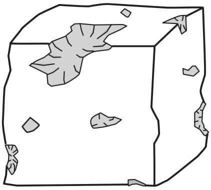
Tubular
(e.g. small worm tunnels)



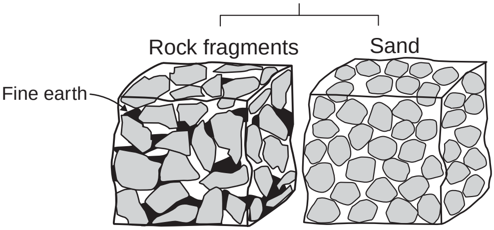
Vesicular
(e.g. isolated, spherical-ovoid cavities)



Dendritic Tubular
(e.g. abandoned root channels)



Irregular
(e.g.,\ vughs)



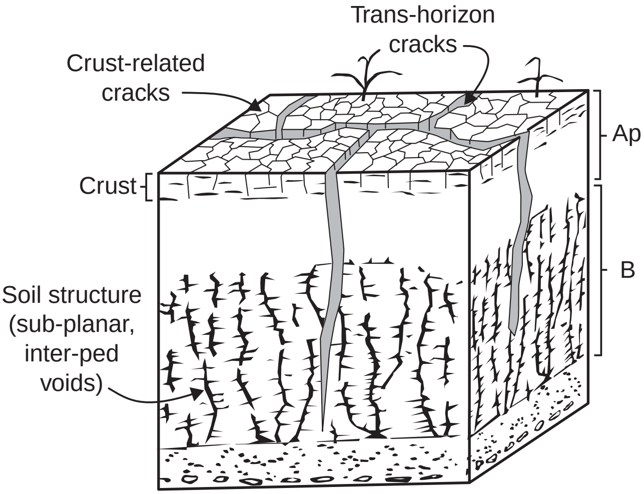
Interstitial
(e.g., primary packing voids)

PORES - VERTICAL CONTINUITY - The average vertical distance through which the minimum pore diameter exceeds 0.5 mm. Soil must be moist or wetter.

Class	**Code**		**Criteria:**
	Conv.	**NASIS**	**vertical distance**
Low	—	L	< 1 cm
Moderate	—	M	1 to < 10 cm
High	—	H	≥ 10 cm

CRACKS

Cracks (also called "Extra-Structural Cracks"; Soil Survey Staff, 1993) are fissures other than those attributed to soil structure. Cracks are commonly vertical, sub-planar, polygonal, and are the result of desiccation, dewatering, or consolidation of earthy material. Cracks are much longer and can be much wider than planes that surround soil structural units such as prisms, columns, etc. Cracks are key to preferential flow, also called "bypass flow" (Bouma, et al., 1982) and are a primary cause of temporal (transient) changes in ponded infiltration and hydraulic conductivity in soils (Soil Survey Staff, 1993). Cracks are primarily associated with, but not restricted to, clayey soils and are most pronounced in high shrink-swell soils (high COLE value). Record the **Relative Frequency** (estimated average number per m^2), **Depth** (average) and **Kind**. A complete example is: *3, 25 cm deep, reversible trans-horizon cracks*.



CRACKS - KIND - Identify the dominant types of fissures.

Kind	Code [1]	General Description
CRUST-RELATED CRACKS [2] (shallow, vertical cracks related to crusts; derived from raindrop-splash and soil puddling, followed by dewatering / consolidation and desiccation)		
Reversible Crust-Related Cracks [3]	RCR	Very shallow (e.g., *0.1 - 0.5 cm*); very transient (generally persist less than a few weeks); formed by drying from surface down; minimal, seasonal influence on ponded infiltration (e.g., *rain–drop crust cracks*).
Irreversible Crust-Related Cracks [4]	ICR	Shallow (e.g., *0.5 - 2 cm*); seasonally transient (not present year-round nor every year); minor influence on ponded infiltration (e.g., freeze-thaw crust and associated cracks).
TRANS-HORIZON CRACKS [5] (deep, vertical cracks that commonly extend across more than one horizon and may extend to the surface; derived from wetting and drying or original dewatering and consolidation of parent material)		
Reversible Trans-Horizon Cracks [6]	RTH	Transient (commonly seasonal; close when rewetted); large influence on ponded infiltration and K_{sat}; formed by wetting and drying of soil; (e.g.Vertisols, vertic subgroups).
Irreversible Trans-Horizon Cracks [7]	ITH	Permanent (persist year-round; see Soil Taxonomy), large influence on ponded infiltration and K_{sat} (e.g., extremely coarse subsurface fissures within glacial till; drained polder cracks).

[1] No conventional codes, use entire term; NASIS codes are shown.

[2] Called “Surface-Initiated Cracks” (Soil Survey Staff, 1993).

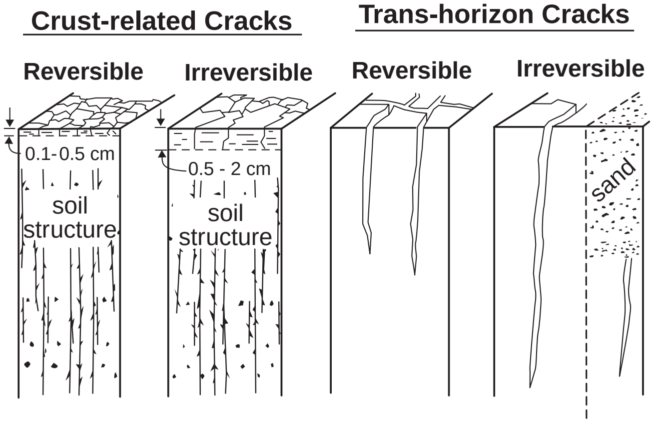
[3] Called “Surface-Initiated Reversible Cracks” (Soil Survey Staff, 1993).

[4] Called “Surface-Initiated Irreversible Cracks” (Soil Survey Staff, 1993).

[5] Also called “Subsurface-Initiated Cracks” (Soil Survey Staff, 1993).

[6] Called “Subsurface-Initiated Reversible Cracks” (Soil Survey Staff, 1993).

[7] Called “Subsurface-Initiated Irreversible Cracks” (Soil Survey Staff, 1993).



CRACKS - DEPTH - Record the **Average**, **Apparent Depth** (also called a "depth index value" in the Soil Survey Manual), measured from the surface, as determined by the wire-insertion method (≅ 2 mm diameter wire). ***NOTE***: This method commonly gives a standard but conservative measure of the actual fracture depth. Do not record this data element for cracks that are not open to the surface. Depth (and apparent vertical length) of subsurface cracks can be inferred from the *Horizon Depth* column of layers exhibiting subsurface cracks.

CRACKS - RELATIVE FREQUENCY - Record the **Average Number of Cracks**, per meter, across the surface or **Lateral Frequency** across a soil profile as determined with a line-intercept method. This data element cannot be assessed from cores or push tube samples.

SOIL CRUSTS (DISCUSSION)

C. Franks, R. Grossman, and P. Schoeneberger, NRCS, Lincoln, NE

A soil crust is a thin (e.g. <1 cm up to 10 cm thick) surface layer of soil particles bound together by living organisms and / or by minerals into a horizontal “mat” or small polygonal plates. Soil crusts form at the soil surface and have different physical and /or chemical characteristics than the underlying soil material. Typically soil crusts change the infiltration rate of the mineral soil and stabilize loose soil particles and aggregates. There are two general categories of Soil Crusts: I) Biological Crusts, and II) Mineral Crusts.

I) **Biological Crusts** (also called *biotic, cryptogamic, microbiotic,* or *microphytic* crusts)**:** a thin, biotically dominated surface layer or mat formed most commonly by cyanobacteria (blue green algae), green and brown algae, mosses, and/or lichens (NRCS, 1997: NRCS, 2001a) that forms in or on the soil surface. Various types of microbiotic crusts have been recognized based on the biological communities of which they are composed (no prevailing consensus on types of biological crusts, at present).

II) **Mineral Crusts** (also called *abiotic, non-biotic* or *non-microbiotic* crusts)**:** a thin surface layer composed of reversibly bonded soil particles or secondary mineral crystals, sometimes laminated, that is <u>*not*</u> physically dominated by a microbiotic “mat”.

1. **Chemical Crusts** (e.g. salt incrustations)**:** a thin surface layer that is dominated by macro- or microcrystalline evaporites of halite (NaCl), $MgSO_4$, mirabilite ($Na_2SO_4 \bullet 10H_2O$), thenardite (Na_2SO_4), epsomite ($MgSO_4 \bullet 7H_2O$), hexahydrite ($MgSO_4 \bullet 6H_2O$), bloedite ($Na_2Mg(SO_4)_2 \bullet 4H_2O$), konyaite ($Na_2Mg(SO_4)_2 \bullet 5H_2O$), loeweite ($Na_{12}Mg_7(SO_4)_{13} \bullet 15H_2O$), gypsum ($CaSO_4 \bullet 2H_2O$); (Singer and Warrington, 1992; Doner and Lynn, 1998), or other minerals. Other surficial mineral incrustations (e.g. from acid mine drainage or other sources) are included within this group.

2. **Physical Crusts:** a physically reconstituted, reaggregated, or reorganized surface layer composed predominantly of primary mineral particles.

   a). **Raindrop Impact Crust** (also called a *structural* crust)**:** a thin layer that forms due to <u>raindrop impact</u>, which causes the clay in the soil to disperse, and subsequently hardens into a massive structureless or platy surface layer when it dries (Singer and Warrington, 1992).

b). **Depositional Crust** – (also called a "*fluventic zone*"; Soil Survey Staff, 1993) is a surface layer, commonly laminated and of variable thickness, consisting of small aggregates of primary mineral grains deposited by short-range runoff, and subsequently dried (Singer and Warrington, 1992).

c). **Freeze – Thaw Crust** – (Soil Survey Staff, 1993). A seasonal, 1 – 5 cm thick surface sediment layer occurring on bare ground that has been disaggregated or puddled by radiant heating and cooling to produce freeze / thaw cycles while *Very Moist* or *Wet*. Commonly, the layer is composed of interlocking, 5-20 cm diameter polygonal plates, separated by 1-2 cm wide cracks which extend to the base of the crust and do not completely close upon wetting; Dry Rupture Resistance is ≤ *Moderate*.

d). **Vesicular Crust** – a surface soil layer or zone characterized by 0.5 - 2 mm diameter, spherical or ovoid, <u>discontinuous</u> pores that are visible to the naked eye, and comprise a substantial portion of the matrix volume (i.e. ≥ 20 % cross-sectional area). These vesicles are believed to form when the pores between clay particles in platy soil structure are subjected to repeated wetting and drying. If soil aggregates become particularly unstable when they become saturated, air pressure may form small round voids (e.g. "bubbles") that remain when the soil dries (Blackburn, et al., 1975). Vesicular crusts occur primarily in arid and semi-arid areas.

SOIL CRUSTS

Soil Crusts – Record the presence of any surface crust. In NASIS, record under **Special Features** (*proposed as a separate NASIS data element*). No entry implies that no crust is present.

Description: Soil crusts can be identified and recorded by **Kind**. Additional suggested descriptions may include: **Rupture Resistance** (**Surface Crusts and Plates**), **Porosity (Kind)**, **Size**, **Diameter**, **Thickness**, **Amount** (Cross-sectional ground coverage), and **Color**.

SOIL CRUSTS - KIND :

Kind	Criteria:
BIOLOGICAL CRUSTS	*(biotically dominated surface "mat" of algae, lichens, mosses, etc.; also called biotic, cryptogamic, microbiotic or microphytic crusts; slightly flexible when moist)*
MINERAL CRUSTS	*(reversibly bonded primary, secondary mineral grains; not biotically dominated; rigid when moist or dry)*
Chemical Crusts	*(evaporite crystals, e.g. NaCl)*
Physical Crusts	*(reorganized, reconstituted)*
raindrop impact crust	*(dispersed, puddled, dried)*
depositional crust	*(sediments of variable thickness)*
freeze – thaw crust	*(bare ground, small polygons)*
vesicular crust / zone	*(substantial discontinuous, spherical or ovoid pores; e.g., 0.5 – 4 mm diameter)*

SPECIAL FEATURES

Record the **Kind** and **Area (%) Occupied**. Describe the special soil feature by kind, and estimate the cross sectional area (%) of the horizon that the feature occupies. In PDP, three items are grouped in this data element: 1) **Special Features** - both Kind (e.g., *krotovinas* and *tongues*) and the Percent (%) of Area Covered (the area a feature occupies within a horizon); 2) **Percent of Profile** - estimate the area of the profile an individual horizon comprises; and 3) **Percent (Volume) of Pedon** occupied; e.g. *lamellae, 15%*.

SPECIAL FEATURES - KIND [Called **Horizon Feature Kind** in NASIS] Identify the kind of special soil feature.

Kind	Code [1]	Criteria
desert pavement	DP	A natural, concentration of closely packed and polished stones at the soil surface in a desert (may or may not be an erosional lag).
hydrophobic layer	HL	Either a surface or subsurface layer that repels water (e.g. dry organic materials; scorch layers in chaparral, etc.).
ice wedge cast	IC	A vertical, often trans-horizon, wedge-shaped or irregular form caused by infilling of a cavity as an ice wedge melts, commonly stratified.
krotovinas	KR	Filled faunal burrows.
lamellae [2]	LA	Thin (e.g., > 0.5 cm), pedogenically formed plates or intermittent layers.
lamina	LN	Thin (e.g., < 1 cm), geogenically deposited strata or layers of alternating texture (e.g., silt and fine sand or silt and clay).
microbiotic crust	MC	Thin, biotically dominated ground or surface crusts; e.g., cryptogamic crust (algae, lichen, mosses, or cyanobacteria), biological or microphytic.
stone line	SL	A natural concentration of rock fragments caused by water erosion or transport erosional lag (i.e. carpedolith).
tongues of albic material	E	Small areas or lobes of albic material that dip down (interfinger) more than 5 cm into non-albic material.
tongues of argillic material	B	Small areas or lobes of argillic material that dip down (interfinger) more than 5 cm into non-argillic material.

[1] Conventional codes consist of the entire name; e.g., *Tongues of Albic Material*. Consequently, no *Conv. code* is shown.

[2] In NASIS, described under **Diagnostic Horizon or Property-Kind**

SPECIAL FEATURES - AREA (%) OCCUPIED - Estimate the cross sectional area (%) of the horizon that the feature occupies.

PERMEABILITY / SATURATED HYDRAULIC CONDUCTIVITY (DISCUSSION)

Permeability — The NRCS concept of permeability was originally derived from the "permeability coefficient" as used by engineers (Soil Survey Staff, 1951). Specifically, the permeability coefficient represents the ability of a porous medium to transmit fluids or gases. It is a unitless coefficient totally independent of the working fluid (e.g., water, air, hydrocarbons, molasses) or interaction between the fluid and the medium it passes through.

Permeability (as traditionally used by NRCS) considers only water, at field saturation, as the working fluid. This results in units of length / time; (e.g., inches / hour, cm / hr, micrometers / sec, etc.) and values that can't be extrapolated to other fluids (e.g., hydrocarbons). Furthermore, permeability (as used by NRCS) has changed through time. The original work (O'Neal, 1952) conducted under constant head, but not at unity, measured a "percolation rate" for a limited number of soil cores and referred to the *permeability coefficient*. Over time, the term "coefficient" was dropped and the percolation rates became the basis for SCS (NRCS) percolation classes. Extrapolation and inference from the original, modest "percolation rate" data set resulted in widespread estimations of the ability of other soils to internally transmit water. Hence, permeability (as used by NRCS) is now a qualitative estimate whose "values" (i.e., classes) are inferred from soil texture or other proxies instead of actual measurements (Exhibit 618-9, NSSH; Soil Survey Staff, 2001). It is a soil quality, as is soil tilth, which can be estimated but not directly quantified. Therefore, permeability and permeability classes are not K_{sat}.

Hydraulic Conductivity (K) — is a seemingly similar, yet different parameter for measuring a soil's ability to transmit water. Hydraulic conductivity quantifies a material's ability to transmit water under standard conditions and units (pressure, length, cross-sectional area). Hydraulic conductivity is a numerical variable in an equation that can be either measured or estimated. It is one of the terms in Darcy's law: $Q = K A i$, [where "Q" is outflow (volume), "K" is the hydraulic conductivity of the material, "A" is the area through which the fluid moves per unit time, and "i" is the pressure gradient (Δ Head / Δ Length); (Amoozegar and Warrick, 1986; Bouma, et al., 1982)].

Hydraulic conductivity under saturated conditions is called **Saturated Hydraulic Conductivity (K_{sat})** and is the easiest condition to assess. It is also the most common reference datum used to compare water movement in different soils, layers, or materials and has become the current "industry standard".

Permeability is a qualitative estimate of the relative ease with which soil transmits water. Hydraulic conductivity is a specific mathematical coefficient (quantitative) that relates the rate of water movement to the hydraulic gradient.

Direct measurement of saturated hydraulic conductivity (K_{sat}) is strongly recommended rather than an estimation of permeability inferred from other soil properties. ***NOTE***: It's highly recommended to determine the K_{sat} of a soil layer by averaging at least three determinations (≈ replications); more reps (e.g., ≥ 5) are preferred. K_{sat} is notoriously variable due to unequal distribution of soil pores and temporal changes in some soil voids (e.g., cracks, bio-pores, etc.). Replications help to capture the natural variation of K_{sat} within soils and to reduce the influence of data population outliers.

NOTE: Permeability and K_{sat} are not synonyms and should not be treated as such.

PERMEABILITY

Estimate the **Permeability Class** for each horizon. Guidelines for estimating permeability are found in Exhibit 618-9, NSSH (Soil Survey Staff, 2001).

Permeability Class	**Code**		**Criteria: estimated in / hr** [1, 2]
	PDP	**NASIS**	
Impermeable	IM	IM	< 0.0015
Very Slow	VS	VS	0.0015 to < 0.06
Slow	S	SL	0.06 to < 0.2
Moderately Slow	MS	MS	0.2 to < 0.6
Moderate	M	MO	0.6 to < 2.0
Moderately Rapid	MR	MR	2.0 to < 6.0
Rapid	RA	RA	6.0 to < 20
Very Rapid	VR	VR	≥ 20

[1] These class breaks were originally defined in English units and are retained here, as no convenient metric equivalents are available.

[2] To convert µm / sec (NASIS Permeability, Ksat units) to in / hr, multiply µm / sec by 0.1417; e.g. (100 µm / sec) x (0.1417) = 14.17 in / hr. To convert in / hr to µm / sec multiply by 7.0572.

SATURATED HYDRAULIC CONDUCTIVITY (K_{sat})

Saturated Hydraulic Conductivity is used to convey the rate of water movement through soil under (field) saturated conditions. Record the **Average K_{sat} (X)**, **Standard Deviation (s)**, and **Number of Replications (n)** of each major layer/ horizon as measured with a constant-head method (e.g., Amoozemeter, Guelph Permeameter, etc.). ***NOTE***: This data element should be measured rather than estimated and subsequently placed into classes. Estimates of water movement based on texture or other proxies must use the preceding "Permeability Class Table."

K_{sat} Class	Code [1]		Criteria [2]	
	PDP	NASIS	cm / hr	in / hr
Very Low	1	#	< 0.0036	< 0.001417
Low	2	#	0.00360 to < 0.036	0.001417 to < 0.01417
Mod. Low	3	#	0.0360 to < 0.360	0.01417 to < 0.1417
Mod. High	4	#	0.360 to < 3.60	0.1417 to < 1.417
High	5	#	3.60 to < 36.0	1.417 to < 14.17
Very High	6	#	≥ 36.0	≥ 14.17

[1] There are no "codes" for K_{sat}; record the average of measured K_{sat} values (#) which can then be assigned to the appropriate class.

[2] For alternative units commonly used for these class boundaries [e.g., Standard International Units (Kg s / m^3)], see the Soil Survey Manual (Soil Survey Staff, 1993; p 107).

CHEMICAL RESPONSE

Chemical response is the response of a soil sample to an applied chemical solution or a measured chemical value. Responses are used to identify the presence or absence of certain materials; to obtain a rough assessment of the amount present; to measure the intensity of a chemical parameter (e.g., pH.); or to identify the presence of chemical species (e.g. Fe^{+2}) in the soil.

REACTION (pH) - (Called Field pH in NASIS) Record **pH** and **Method**; record the pH value to the precision limit of the method (e.g. to the nearest tenth). The preferred method is pH meter for 1:1 (water:soil). In PDP and NASIS, record **pH** and the method used (e.g., *1:1 water:soil*, *$CaCl_2$*, *Lamotte,* etc.).

Descriptive Term	Code [1]	Criteria: pH range
Ultra Acid	#	< 3.5
Extremely Acid	#	3.5 to 4.4
Very Strongly Acid	#	4.5 to 5.0
Strongly Acid	#	5.1 to 5.5
Moderately Acid	#	5.6 to 6.0
Slightly Acid	#	6.1 to 6.5
Neutral	#	6.6 to 7.3
Slightly Alkaline	#	7.4 to 7.8
Moderately Alkaline	#	7.9 to 8.4
Strongly Alkaline	#	8.5 to 9.0
Very Strongly Alkaline	#	> 9.0

[1] No "codes"; enter the measured value.

EFFERVESCENCE - The gaseous response (seen as bubbles) of soil to applied HCl (carbonate test), H_2O_2 (MnO_2 test), or other chemicals. Commonly, ≈1 N HCL is used. Apply the chemical to the soil matrix (for HCL, Effervescence Class refers only to the matrix; do not include carbonate masses, which are described separately as "Concentrations"). Record the observed response (**Effervescence Class**) and the **Chemical Agent** used. A complete example is: *strongly effervescent with 1N-HCL* or *2, I*. In PDP, record percent of carbonate (measured with a carbonate field kit) as a **Field Measured Property**.

Effervescence - Class

Effervescence Class	**Code**		**Criteria**
	PDP	**NASIS**	
Noneffervescent	4	NE	No bubbles form.
Very Slightly Effervescent	0	VS	Few bubbles form.
Slightly Effervescent	1	SL	Numerous bubbles form.
Strongly Effervescent	2	ST	Bubbles form a low foam.
Violently Effervescent	3	VE	Bubbles form a thick foam.

Effervescence - Location - [obsolete in NASIS] Use locations and codes from **(Ped and Void) Surface Features - Location**. ***NOTE***: The requirement to apply chemical agents (e.g., HCL acid) to the soil matrix makes many Location choices invalid.

Effervescence - Chemical Agent

Effervescence Agent	**Code**		**Criteria**
	PDP	**NASIS**	
HCl (unspecified) [1]	H	H1	Hydrochloric Acid: Concentration Unknown
HCl (1N) [1, 2]	I	H2	Hydrochloric Acid: Concentration = 1 Normal
HCl (3N) [1, 3]	J	H3	Hydrochloric Acid: Concentration = 3 Normal
HCl (6N) [1, 4]	—	H4	Hydrochloric Acid: Concentration = 6 Normal
H_2O_2 (unspecified) [5, 6]	P	P1	Hydrogen Peroxide: Concentration Unknown
H_2O_2 [5, 6]	O	P2	Hydrogen Peroxide: Concentration 3-4%

[1] Positive reaction indicates presence of carbonates (e.g., $CaCO_3$).

[2] Concentration of acid preferred for the Effervescence field test.
NOTE: A (1N HCl) solution is made by combining 1 part concentrated (37%) HCl (which is widely available) with 11 parts distilled H_2O.

[3] This concentration is not used for determining **Effervescence Class**, but is required for the Calcium Carbonate Equivalent test (CO_2 evolution, rather than "effervescence"). An approximately 3N HCl solution (actually 10% HCl or 2.87N) is made by combining 6 parts concentrated (37%) HCl (which is widely available) with 19 parts distilled H_2O.

[4] This concentration is not used for determining **Effervescence Class** for soil carbonates (see footnote 2). A 6N HCl solution is used to distinguish between calcium carbonates and dolomitic carbonates. A 6N HCl solution is made by combining 1 part concentrated (37%) HCl (which is widely available) with 1 part distilled H_2O. Soil sample should be saturated in a spot plate and allowed to react for 1-2 minutes; froth = positive response. Reaction is slower and less robust than $CaCO_3$ effervescence.

[5] Rapid, positive reaction indicates presence of manganese oxides (e.g., MnO_2).

[6] Some forms of organic matter will react slowly with (3-4%) H_2O_2, whereas Mn–oxides reacts rapidly.

REDUCED CONDITIONS -(called **Reaction to alpha-dipyridl** in NASIS)

Chemical Agent	**Code**	**Criteria**
α, α '-dipyridyl [1] (0.2% conc. [2])	P (= *positive*)	red or pink color develops
	N (= *negative*)	no color develops

[1] Positive reaction indicates presence of Fe^{+2} (i.e., reduced conditions).
[2] Childs, 1981

SALINITY - The concentration of dissolved salts (more soluble than gypsum; e.g., NaCl) in a saturated paste extract. Estimate the **Salinity Class**. If the electrical conductivity is measured, record the actual value and method used.

Salinity Class	**Code**	**Criteria: [1] (Electrical Conductivity) dS/m (mmhos/cm)**
Non-Saline	0	< 2
Very Slightly Saline	1	2 to < 4
Slightly Saline	2	4 to < 8
Moderately Saline	3	8 to < 16
Strongly Saline	4	≥ 16

[1] As determined by Saturated Paste Extract method.

SODIUM ADSORPTION RATIO (SAR) - An estimate of the equilibrium between sodium (Na) in solution and exchangeable Na adsorbed on the soil (Soil Survey Staff, 1995). It is applied to soil solution extracts and irrigation waters. The SAR is expressed as a ratio. It is calculated as: SAR = $[Na^+] / [([Ca^{+2}] + [Mg^{+2}]) / 2]^{0.5}$, where the cation concentration in milliequivalents per liter. As a field method, it is commonly determined with soil paste and an electronic wand.

ODOR

Record the presence of any strong smell, by horizon. No entry implies no odor.

Odor - Kind	Code	Criteria
None	N	No odor detected
Petrochemical	P	Presence of gaseous or liquid gasoline, oil, creosote, etc.
Sulphurous	S	Presence of H_2S (hydrogen sulfide); “rotten eggs”; commonly associated with strongly reduced soil containing sulfur compounds.

MISCELLANEOUS FIELD NOTES

Use additional adjectives, descriptors, and sketches to capture and convey pertinent information and any features for which there is no pre-existing data element or code. Record such additional information as free-hand notes under **Field Notes** (“User Defined Entries” in PDP).

MINIMUM DATA SET (for a soil description)

Purpose, field logistics, habits, and soil materials all influence the specific properties necessary to “adequately” describe a given soil. However, some soil properties or features are so universally essential for interpretations or behavior prediction that they should always be recorded. These include: **Location**, **Horizon**, **Horizon Depth**, **Horizon Boundary**, **Color**, **Redoximorphic Features**, **Texture**, **Structure**, and **Consistence**.

PROFILE DESCRIPTION DATA SHEET

Over the decades, field data for soils have been documented in various ways. For many years soil descriptions were made on small blue cards (SCS-SOI-232 form: USDA-SCS; various versions, dates, and locations of issuance). In recent years much data was entered into multi-page PEDON (PDP) data sheets (SCS-SOI-232; 3/87). Since NRCS reorganization in 1995, many MLRA Soil Survey Region Offices (MO's) and other groups have generated informal, locally-tailored data sheets.

The following data sheet is provided as an option to record basic soil description information. It was developed from a 5/97 draft produced at the NRCS-MO6 office (Lakewood, CO). This revised data sheet contains the most widely used soil descriptors (e.g. Depth, Color, etc.). Other descriptors (called data elements in NASIS) should be added as needed in blank boxes or in the **Miscellaneous Field Notes** box.

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PROFILE DESCRIPTION EXAMPLE

A completed profile description data sheet is included to demonstrate recording soil information in the field.

Most field descriptions will likely be entered into an electronic database by the describer or must be deciphered by other scientists. Therefore, descriptions should use reasonably pneumonic abbreviations, standard codes, a combination of these, or be written in "longhand" (using complete words). The example uses all of these notations.

Soil descriptions in Soil Survey Reports or other NRCS products should follow proscribed formats and descriptor sequences (i.e. NSSH – Part 614; Soil Survey Staff, 2001b).

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PROFILE DESCRIPTION REPORT EXAMPLE (for Soil Survey Reports)

[To be developed.]

USDA-NRCS

PEDON DESCRIPTION

PEDON ID #:

DRAFT 3/2002

Series or Component Name:
Map Unit Symbol:
Photo #:
Classification:
Soil Moist. Regime (Tax.)**:**

Describer(s):
Date:
Weather:
Temp.: *Air:* *Soil:* *Depth:*
Latitude: ° ' " **N**
Longitude: ° ' " **W**
Datum:
Location: Sec. T. R.

UTM: *Zone :* *mE:* *mN:*
Topo Quad:
Site ID: *Yr:* *State:* *County:* *Pedon #:*
Soil Survey Area:
MLRA / LRU:
Transect: *ID:* *Stop #:* *Interval:*

Landscape:
Landform:
Microfeature:
Anthro:
Elevation:
Aspect:
Slope (%)**:**
Slope Complexity:
Slope Shape: *(Up & Dn / Across)*

Hillslope Profile Position:
Geom. Component:
Microrelief:
Physio. Division:
Physio. Province:
Physio. Section:
State Physio. Area:
Local Physio. Area:

Drainage:
Flooding:
Ponding:
Soil Moisture Status:
Permeability:
K_{sat}:
Land Cover / Use:

Parent Material:
Bedrock: *Kind:* *Fract.:* *Hard.:* *Depth:*
Lithostrat. Units: *Group:* *Formation:* *Member:*

Erosion: *Kind:* *Degree:*
Runoff:
Surface Frag %: *GR:* *CB:* *ST:* *BD:* *CN:* *FL:*
Kind:
Diagnostic Horz. / Prop.: *Kind:* *Depth:*

P. S. Control Section : *Ave. Clay %:* *Ave. Rock Frag %:*
Depth Range:

VEGETATION :

SYMBOL	COMMON NAME	% GD COVER

MISCELLANEOUS FIELD NOTES / SKETCH :

Component Name: **Map Unit Symbol:** **Date:**

	Obser. Method	Depth	Horizon	Bnd	Matrix Color		Texture	Rock Frags	Structure	Consistence				Mottles
		(in) (cm)			Dry	Moist		Knd % Rnd Sz	Grade Sz Type	Dry	Mst	Stk	Pls	% Sz Cn Col Mst Sp Loc
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

	Redoximorphic Features	Concentrations	Ped / V. Surface Features	Roots	Pores	pH Effer Clay CCE	Notes
	% Sz Cn Hd Sp Kd Loc Bd Col	% Sz Cn Hd Sp Kd Loc Bd Col	% Dst Cont Kd Loc Col	Qty Sz Loc	Qty Sz Shp	(meth) (agent) %	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

USDA-NRCS **PEDON DESCRIPTION** **PEDON ID #:** **DRAFT 3/2002**

Series or Component Name: Caveat Emptor

Map Unit Symbol: CaC

Photo #: 127A

Classification: fine, smectitic, mesic, Typic Argiudoll

Soil Moist. Regime (Tax.)**:** Udic (≈ 27" annual)

Describer(s): PJS & DAW

Date: 10/12/2000

Weather: sunny

Temp.: Air: 78 °F Soil: Depth:

Latitude: 40 ° 49 ' 10.0 " N

Longitude: 96 ° 46 ' 06.1 " W

Datum: NAD '83

Location: NE 1/4, SW 1/4 Sec. 20 T. 10N R. 6E

UTM: Zone : mE: mN:

Topo Quad: Emerald, NE 7.5 topo 1978

Site ID: Yr: State: County: Pedon #: S 2002 NE - 109 - 006

Soil Survey Area: Lancaster, Co

MLRA / LRU: 106

Transect: ID: 2 Stop #: 6 Interval: 10m

Landscape: upland

Landform: low hill

Microfeature: ———

Anthro: furrow

Elevation: 1240 '

Aspect: 34 °E

Slope (%)**:** 6%

Slope Complexity: simple

Slope Shape: (Up & Dn / Across) V V (convex, convex)

Hillslope Profile Position: shoulder

Geom. Component: nose slope

Microrelief: micro-low

Physio. Division: Interior Plains

Physio. Province: Central Lowland

Physio. Section: Dissected Till Plain

State Physio. Area: ———

Local Physio. Area: Middle Creek Basin

Drainage: WD (Well Drained)

Flooding: none

Ponding: none

Soil Moisture Status: moist

Permeability: slow (est.)

K_{sat}: low (ave.= 0.011 cm/hr; n=3; depth: 35–50 cm)

Land Cover / Use: Soybeans (CRC)

Parent Material: loess, over pedisediment, over till

Bedrock: Kind: Fract.: Hard.: Depth: Sandstone (in adjacent gully) > 15 m

Lithostrat. Units: Group: Formation: Member: Peoria Loess, Gillman Canyon, unnamed pedisediment,unnamed till

Erosion: Kind: R (Rill) Degree: 1

Runoff: VH (Very High)

Surface Frag %: GR: CB: ST: BD: CN: FL: – 0 – Kind:

Diagnostic Horz. / Prop.:

Kind:	Depth:
mollic	0 – 30 cm
argillic	30 – 90 cm

P. S. Control Section : Depth Range: 30 – 80 cm Ave. Clay %: 37% Ave. Rock Frag %: < 1%

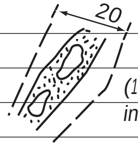
VEGETATION :

SYMBOL	COMMON NAME	% GD COVER
GLYCI	Soybean stubble	1%
DIGIT2	Crabgrass	5%

MISCELLANEOUS FIELD NOTES / SKETCH :

deep polygonal joints in till:

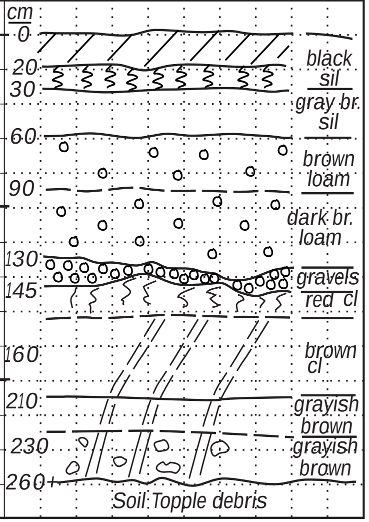
≈ 30° angle; 10 - 20 cm diam.



white, $CaCO_3$ lined seams (1-4 cm diam.) in center

bounded by brown / black Fe / Mn zone which is bounded by yellow / br. Fe (goethite) halo at 250 cm depth.

Unit	Description	Horizon (M)
		0
Peoria Loess	loess	Ap
		A
		Bt 1
	colluvial loess with scattered gr.	Bt 2
		1
Gillman Canyon	colluvial loess	2 Bt 3
pedisediment →		
	red paleosol	3B
Pre-Illinoian till	weathered, oxidized leached	4Bt 1 4Bt 2 2
	mottled, unoxidized, leached	4 BC
	mottled, unoxidized, unleached	4C



Component Name: **Map Unit Symbol:** **Date:**

	Obser. Method	Depth	Horizon	Bnd	Matrix Color		Texture	Rock Frags	Structure	Consistence				Mottles
		(in) [✓ (cm)]			Dry	Moist		Knd % Rnd Sz	Grade Sz Type	Dry	Mst	Stk	Pls	% Sz Cn Col Mst Sp Loc
1	LP	0 – 20	Ap	Abrupt Smooth	10YR 4/2	10YR 3/1	silt loam (sil)	— 0 —	common, fine & med. granular	Slightly Hard	Friable	non-sticky	non-plastic	None
2	LP	20 – 30	A	CW	10YR 4/2	10YR 3/1	sil	— 0 —	3 f,m abk.	MH	FI	SO	PO	
3	LP	30 – 60	Bt1	GW	2.5 Y 6/2	10YR 5/3	sicl	— 0 —	2 m,c sbk	H	VFI	SS	MP	
4	LP	60 – 90	2Bt2	GW	10YR 6/3	70% 10YR 4/3 30% 10YR 5/3	sicl	2% scattered f,m rounded gr.	2 m pr ⇒ 2 m sbk	H	VFI	SS	MP	
5	LP	90 – 130	2Bt3	AW	10YR 4/4	40% 7.5YR 4/3 60% 7.5YR 3/3	sil	2% scattered f,m rounded gr.	1 m, co. pr ⇒ 2 m sbk	MH	FI	SS	SP	
6	LP	130 – 145	3B	AW	7.5YR 5/4	7.5YR 4/6	xgrscl	85% f, m, co. rounded gravels mixed lithology	0 sg	L	L	SO	SO	
7	LP	145 – 160	4Bt1	GW	7.5YR 5/6	7.5YR 4/6	cl	10% f, rounded gr., mixed lithology	2 m sbk ⇒ 3 vf,f sbk	VH	EF	MS	MP	
8	LP	160 – 210	4BT2	DW	7.5YR 4/4	7.5YR 4/4	cl	1% f,m rounded gr., mixed lithology	3 co., vco pr ⇒ 3 f, m sbk	EH	SR	MS	MP	15% coarse, faint, 10 YR 4/3 mottles, M, irregular, on ped faces
9	LP	210 – 230	4BC	DI	2.5YR 7/2	2.5YR 5/2	c	1% f,m rounded gr., mixed lithology	3 co, vco pr ⇒ 2 m sbk	EH	R	VS	VP	None
10	SP	230 – 260+	4C	—	2.5YR 7/2	2.5YR 5/2	c	1% f,m rounded gr., mixed lithology	3 co, vco pr ⇒ 3 f,m abk	R	R	VS	VP	None

	Redoximorphic Features	Concentrations	Ped / V. Surface Features	Roots	Pores	pH	Effer	Clay	CCE	Notes
	% Sz Cn Hd Sp Kd Loc Bd Col	% Sz Cn Hd Sp Kd Loc Bd Col	% Dst Cont Kd Loc Col	Qty Sz Loc	Qty Sz Shp	(meth)	(agent)	%		
1	None	None	None	1 m T 2 vf, f T	few, very fine, dendr. tubular	5.0 *	NE, H2			(* pH by pocket pH meter, 1:1 soil to water)
2				1 m T 2 vf,f T	2 vf TE	6.0	NE, H2			
3				2 vf T 1 f T	2 vf,f TE	6.7	NE, H2			
4				1 vf T 1 f T	2 vf,f TE	6.9	NE, H2			
5				few, very fine, between peds	2 vf TE	7.2	NE, H2			
6			20%, prominent, discontinuous clay films on rock fragments	None	3 vf,f IR	7.1	NE, H2			gravel pavement with scattered, small gully fills
7			85%, P, cont. (C), clay films (CLF) on all ped faces (PF)		2 vf,f TE	7.1	NE, H2			till joint ghosts remain; truncated paleosol; strong argillans & pedo. structure
8	common, med., distinct 10 YR 6/3 iron depletions in matrix		40%, D, discont. (D), CLF on PF		2 vf TE 1 f TE	7.6	NE, H2			till joints ghost and fade upwards to top at 45°; clay & Fe/Mn coated prisms
9	f, 3, P, 10 YR 2/1, MNF, APE		27%, D, patchy (P), CLF on ped and void faces (PVF)		2 vf TE	7.7	SL, H2			polygonal till joints ghost & tip 30° to North (downslope)
10	c, 4, P, 2.5 / N, MNF, on prism faces (APF)	c, vco, P, white, I, $CaCO_3$ nodules along joints (CRK) & in matrix (MAT)	7%, P, discont., pressure faces (PRF) on pf throughout		1 vf,f IG	8.2	SL, H2 (nodules VE)			till joints tip 30° to North (down slope)

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GEOMORPHIC DESCRIPTION

GEOMORPHIC DESCRIPTION SYSTEM

(Version 3.1 - 04/24/2002)

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PART I: PHYSIOGRAPHIC LOCATION

A) Physiographic Division
B) Physiographic Province
C) Physiographic Section
D) State Physiographic Area
E) Local Physiographic / Geographic Name

PART II: GEOMORPHIC DESCRIPTION

A) Landscape
B) Landform
C) Microfeature
D) Anthropogenic Features

PART III: SURFACE MORPHOMETRY

A) Elevation
B) Slope Aspect
C) Slope Gradient
D) Slope Complexity
E) Slope Shape
F) Hillslope - Profile Position
G) Geomorphic Component
  1. Hills
  2. Terraces, Stepped Landforms
  3. Mountains
  4. Flat Plains
H) Microrelief
I) Drainage Pattern

NOTE: Italicized NASIS short-codes, if available, follow each choice.

PART I: PHYSIOGRAPHIC LOCATION

Reference for items **A**, **B**, & **C:** Physiographic Divisions of the U.S. (Fenneman,1946), and Alaskan Physiographic Areas (Wahrhaftig, 1965).

PHYSIOGRAPHIC DIVISIONS (A)		PHYSIOGRAPHIC PROVINCES (B) PHYSIOGRAPHIC SECTIONS (C)	
Laurentian Upland	*LU*	1. Superior Upland	*SU*
Atlantic Plain	*AP*	2. Continental Shelf	*CS*
		3. Coastal Plain	*CP*
		a. Embayed section	*EMS*
		b. Sea Island section	*SIS*
		c. Floridian section	*FLS*
		d. East Gulf Coastal plain	*EGC*
		e. Mississippi alluvial valley	*MAV*
		f. West Gulf Coastal plain	*WGC*
Appalachian Highlands	*AH*	4. Piedmont Province	*PP*
		a. Piedmont upland	*PIU*
		b. Piedmont lowlands	*PIL*
		5. Blue Ridge Province	*BR*
		a. Northern section	*NOS*
		b. Southern section	*SOS*
		6. Valley and Ridge Province	*VR*
		a. Tennessee section	*TNS*
		b. Middle section	*MIS*
		c. Hudson Valley	*HUV*
		7. St. Lawrence Valley	*SL*
		a. Champlain section	*CHS*
		b. St. Lawrence Valley, - northern section	*NRS*
		8. Appalachian Plateau	*AP*
		a. Mohawk section	*MOS*
		b. Catskill section	*CAS*
		c. Southern New York sect.	*SNY*
		d. Allegheny Mountain sect.	*AMS*
		e. Kanawaha section	*KAS*
		f. Cumberland Plateau sect.	*CPS*
		g. Cumberland Mountain sect.	*CMS*

		9. New England Province	*NE*
		a. Seaboard lowland sect.	*SLS*
		b. New England upland sect.	*NEU*
		c. White Mountain section	*WMS*
		d. Green Mountain section	*GMS*
		e. Taconic section	*TAS*
		10. Adirondack Province	*AD*
Interior Plains	*IN*	11. Interior Low Plateaus	*IL*
		a. Highland rim section	*HRS*
		b. Lexington lowland	*LEL*
		c. Nashville basin	*NAB*
		d. Possible western section (not delimited on map)	*WES*
		12. Central Lowland Province	*CL*
		a. Eastern lake section	*ELS*
		b. Western lake section	*WLS*
		c. Wisconsin driftless section	*WDS*
		d. Till plains	*TIP*
		e. Dissected till plains	*DTP*
		f. Osage plain	*OSP*
		13. Great Plains Province	*GP*
		a. Missouri plateau, glaciated	*MPG*
		b. Missouri plateau, unglaciated	*MPU*
		c. Black Hills	*BLH*
		d. High Plains	*HIP*
		e. Plains Border	*PLB*
		f. Colorado Piedmont	*COP*
		g. Raton section	*RAS*
		h. Pecos valley	*PEV*
		i. Edwards Plateau	*EDP*
		k. Central Texas section	*CTS*

This division includes portions of Alaska
(see “Alaskan Physiographic Areas”)

Interior Highlands	*IH*	14. Ozark Plateau	*OP*
		a. Springfield-Salem plateaus	*SSP*
		b. Boston “Mountains”	*BOM*
		15. Ouachita Province	*OU*
		a. Arkansas Valley	*ARV*
		b. Ouachita Mountains	*OUM*

Rocky Mountain System	*RM*	16. Southern Rocky Mountains	*SR*
		17. Wyoming Basin	*WB*
		18. Middle Rocky Mountains	*MR*
		19. Northern Rocky Mountains	*NR*

This division includes portions of Alaska
(see "Alaskan Physiographic Areas")

Intermontane Plateaus	*IP*	20. Columbia Plateau	*CR*
		a. Walla Walla Plateau	*WWP*
		b. Blue Mountain section	*BMS*
		c. Payette section	*PAS*
		d. Snake River Plain	*SRP*
		e. Harney section	*HAS*
		21. Colorado Plateau	*CO*
		a. High Plateaus of Utah	*HPU*
		b. Uinta Basin	*UIB*
		c. Canyon Lands	*CAL*
		d. Navajo section	*NAS*
		e. Grand Canyon section	*GCS*
		f. Datil section	*DAS*
		22. Basin and Range Province	*BP*
		a. Great Basin	*GRB*
		b. Sonoran Desert	*SOD*
		c. Salton Trough	*SAT*
		d. Mexican Highland	*MEH*
		e. Sacramento section	*SAS*

This division includes portions of Alaska
(see "Alaskan Physiographic Areas")

Pacific Mountain	*PM*	23. Cascade-Sierra Mountains	*CM*
		a. Northern Cascade Mtns.	*NCM*
		b. Middle Cascade Mtns.	*MCM*
		c. Southern Cascade Mtns.	*SCM*
		d. Sierra Nevada	*SIN*
		24. Pacific Border Province	*PB*
		a. Puget Trough	*PUT*
		b. Olympic Mountains	*OLM*
		c. Oregon Coast Range	*OCR*
		d. Klamath Mountains	*KLM*
		e. California Trough	*CAT*
		f. California Coast Ranges	*CCR*
		g. Los Angeles Ranges	*LAR*
		25. Lower California Province	*LC*

This division includes portions of Alaska
(see “Alaskan Physiographic Areas”)

Alaskan Physiographic Areas (Warhaftig, 1965)

The following Alaskan-Peninsula physiographic areas are extensions of the preceding North American Physiographic Divisions (e.g., Rocky Mountain System). These Alaskan extensions are presented separately, rather than intermingled with the previous Division / Province lists because they: a) constitute a geographically coherent package (Wahrhaftig, 1965); b) these extensions were not contained within Fennman’s original work which dealt only with the conterminous U.S. (Fenneman, 1931; 1938; & 1946); and c) Wahrhaftig’s map-unit numbers are independent of, and inconsistent with Fenneman’s. Wahrhaftig’s original map unit scheme and numbers are retained here for simplicity in using his map of the Alaskan peninsula. ***CAUTION****:* Wahrhaftig’s map unit numbers should not be confused with similar map unit numbers from Fenneman’s map for the conterminous U.S.

Interior Plains	*IN*	1. Arctic Coastal Plain Province	—
		a. Teshekpuk Hills section	—
		b. White Hills section	—
		2. Arctic Foothills Province	*AF*
		a. Northern Section	—
		b. Southern Section	—

Rocky Mountains System	*RM*	Arctic Mountains Province	*AM*
		3. Delong Mountains section	—
		4. Noatak Lowlands section	—
		5. Baird Mountains section	—
		6. Central & E. Brooks Range sect.	—
		7. Ambler-Chandalar Ridge & Lowland sect.	—

NOTE: The map-unit numbering sequence shown here is from Wahrhaftig (1965), and is independent of, and not consistent with, that of Fenneman.

Intermontane Plateaus	*IP*	Northern Plateaus Province	—
		8. Porcupine Plateau section	—
		a. Thazzik Mountain	
		9. Old Crow Plain section (noted but not described)	—
		10. Olgivie Mountains section	—
		11. Tintina Valley (Eagle Trough) sect.	—
		12. Yukon-Tanana Upland section	—
		a. Western Part	
		b. Eastern Part	
		13. Northway - Tanacross Lowland sect.	—
		14. Yukon Flats section	—
		15. Rampart Trough section	—
		16. Kokrine - Hodzana Highlands sect.	—
		a. Ray Mountains	
		b. Kokrine Mountains	
		Western Alaska Province	—
		17. Kanuti Flats section	—
		18. Tozitna - Melozitna Lowland sect.	—
		19. Indian River Upland section	—
		20. Pah River Section	—
		a. Lockwood Hills	
		b. Pah River Flats	
		c. Zane Hills	
		d. Purcell Mountains	
		21. Koyukuk Flats section	—
		22. Kobuk-Selawik Lowland section	—
		a. Waring Mountains	
		23. Selawik Hills section	—
		24. Buckland River Lowland section	—
		25. Nulato Hills section	—
		26. Tanana - Kuskowin Lowland sect.	—
		27. Nowitna Lowland section	—
		28. Kuskokwim Mountains section	—
		29. Innoko Lowlands section	—
		30. Nushagak - Big River Hills section	—
		31. Holitna Lowland section	—

		32. Nushagak-Bristol Bay Lowland sect.	—
		33. Seward Peninsula Province	*SEP*
		a. Bendeleben Mountains	
		b. Kigluaik Mountains	
		c. York Mountains	
		Bering Shelf Province	*BES*
		34. Yukon- Kuskokwim Coastal Lowland sect.	—
		a. Norton Bay Lowland	
		35. Bering Platform section	—
		a. St. Lawrence Island	
		b. Pribilof Island	
		c. St. Matthew Island	
		d. Nunivak Island	
		36. Ahklun Mountains Province	—

NOTE: The map-unit numbering sequence shown here is from Wahrhaftig (1965), and is independent of, and not consistent with, that of Fenneman.

Pacific Mountain System	*PM*	Alaska - Aleutian Province	*AAC*
		37. Aleutian Islands section	—
		38. Aleutian Range section	—
		39. Alaska Range (Southern Part) sect.	—
		40. Alaska Range (Central & Eastern Parts) section	—
		a. Mentasta - Nutzotin Mtn. segment	
		41. Northern Foothills of the Alaska Range section	—
		Coastal Trough Province	—
		42. Cook Inlet - Susitna Lowland sect.	—
		43. Broad Pass Depression section	—
		44. Talkeetna Mountains section	—
		a. Chulitna Mountains	
		b. Fog Lakes Upland	
		c. Central Talkeetna Mountains	
		d. Clarence Lake Upland	
		e. Southeastern Talkeetna Mountains	
		45. Upper Matanuska Valley section	—
		46. Clearwater Mountains section	—
		47. Gulkana Upland section	—
		48. Copper River Lowland section	—
		a. Eastern Part	
		b. Western Part: Lake Louis Plateau	
		49. Wrangell Mountains section	—
		50. Duke Depression (not described)	
		51. Chatham Trough section	—
		52. Kupreanof Lowland section	—

		Pacific Border Ranges Province	*PBS*
		53. Kodiak Mountains section	—
		54. Kenai - Chugach Mountains sect.	—
		55. St Elias Mountains section	—
		a. Fairweather Range subsection	
		56. Gulf of Alaska Coastal section	—
		57. Chilkat - Baranof Mountains sect.	—
		a. Alsek Ranges subsection	
		b. Glacier Bay subsection	
		c. Chichagof Highland subsection	
		d. Baranof Mountains subsection	
		58. Prince of Whales Mountains sect.	—
		Coast Mountains Province	*COM*
		59. Boundary Pass section	—
		60. Coastal Foothills section	—

Other Physiographic Areas

(not addressed by Fenneman, 1946; or Wahrhaftig, 1965)

Pacific Rim	*PR*	Pacific Islands Province	*PI*
		a. Hawaiian Islands	*HAI*
		b. Guam	*GUM*
		c. Trust Territories * (e.g., Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Palau, Republic of Marshall Islands, American Samoa, etc.)	*TRT*
		d. Other	

* Most of the former U.S. Trust Territories of the Pacific are now independent nations. This designation is used here solely for brevity and to aid in accessing archived, historical data.

Caribbean Basin	*CB*	Caribbean Islands Province	*CI*
		a. Greater Antilles (Puerto Rico, Cuba, Hispaniola, Jamaica)	*GRA*
		b. Lesser Antilles (U.S. Virgin Is., Barbados, Grenada, Martinique, etc.)	*LEA*
		c. Other	
Undesignated	*UN*	Other	*OT*

(reserved for temporary, or international designations)

STATE PHYSIOGRAPHIC AREA (D)

e.g. *Des Moines Lobe* (IA).

(OPTIONAL) (Entries presently undefined; to be developed in conjunction with each State Geological Survey; target scale is approximately 1:100,000).

LOCAL PHYSIOGRAPHIC / GEOGRAPHIC NAME (E)

e.g. *Pilot's Knob* (IA).

(OPTIONAL) (Entries presently undefined; to be developed in conjunction with each State Geological Survey; may include area names found on USGS 7.5 & 15 minute topographic maps; target scale is approximately 1:24,000.)

PART II: GEOMORPHIC DESCRIPTION (OUTLINE)

I) COMPREHENSIVE LISTS:

A) LANDSCAPES

B) LANDFORMS

C) MICROFEATURES

D) ANTHROPOGENIC FEATURES

II) GEOMORPHIC ENVIRONMENTS and OTHER GROUPINGS:

Landscape, Landform, and Microfeature Terms grouped by Geomorphic Process (e.g. Fluvial) or by common settings (e.g. Water Bodies). These lists are <u>not</u> mutually exclusive; some features occur in more than one environment or setting (e.g. *hill*).

1. Coastal Marine and Estuarine
2. Lacustrine
3. Fluvial
4. Solution
5. Eolian
6. Glacial
7. Periglacial
8. Mass Movement
9. Volcanic and Hydrothermal
10. Tectonic and Structural

GEOMORPHIC ENVIRONMENTS

11. Slope
12. Erosional
13. Depressional
14. Wetlands
15. Water Bodies

OTHER GROUPINGS

PART II: GEOMORPHIC DESCRIPTION

Codes: Conventionally, the entire land-feature term is used (e.g. *dune field*). Some data storage programs (e.g. PEDON, NASIS) may have shorthand codes developed for some terms. An italicized code follows each term, if available (e.g. meander belt *MB*); shown for historical purposes.

I) COMPREHENSIVE LISTS:

A) LANDSCAPES (broad assemblages or unique groups of natural, spatially associated features). (LF = Landform)

alluvial plain	—
alluvial plain remnant	—
badlands	*BA*
bajada (also LF)	*BJ*
barrier island (also LF)	—
basin	*BS*
batholith	—
bolson	*BO*
breaks	*BK*
canyonlands	—
coastal plain (also LF)	*CP*
cockpit karst	—
continental glacier	—
delta plain (also LF)	—
drumlin field	—
dune field	—
fan piedmont (also LF)	*FP*
fluviokarst	—
fluviomarine terrace (also LF)	—
foothills	*FH*
hills (singular = LF)	*HI*
ice-margin complex	—
intermontane basin (also LF)	*IB*
island (also LF)	—
karst	*KP*
kegel karst	—
lake plain (also LF)	—
lava field (also LF)	—
lava plain (also LF)	—
lava plateau (also LF)	*LL*
lowland	—
marine terrace (also LF)	—
meander belt	*MB*
mountain range	—
mountains (singular = LF)	*MO*
mountain system	—
outwash plain (also LF)	—
peninsula	—
piedmont	*PI*
piedmont slope	—
plains (also LF)	*PL*
plateau (also LF)	*PT*
rift valley	—
river valley (also LF)	*RV*
sandhills	*SH*
sand plain	—
scabland	*SC*
semi-bolson	*SB*
shore complex	—
sinkhole karst	—
tableland	*TB*
thermokarst	*TK*
till plain (also LF)	*TP*
upland	*UP*
valley (also LF)	*VA*
volcanic field (also LF)	—

B) LANDFORMS

(discrete, natural, individual earth-surface features mappable at common survey scales). (LS = Landscape; Micro = Microfeature; w = water body. Italicized NASIS code follows each term.)

a'a lava flow	—
alas	*AA*
alluvial cone	—
alluvial fan	*AF*
alluvial flat	*AP*
alpine glacier	—
anticline	*AN*
arete	*AR*
arroyo	*AY*
ash flow	*AS*
atoll	*AT*
avalanche chute	*AL*
axial stream	—
backshore	*AZ*
backswamp	*BS*
bajada (also LS)	*BJ*
ballena	*BL*
ballon	*BV*
bar *BR*	
barchan dune	*BQ*
barrier beach	*BB*
barrier flat	*BP*
barrier island (also LS)	*BI*
basin floor	*BC*
basin-floor remnant	*BD*
bay [coast] (w)	*WB*
bay [geom.]	—
bayou (w)	*WC*
beach	*BE*
beach plain	*BP*
beach ridge	*BG*
beach terrace	*BT*
berm	*BM*
beveled base	—
blind valley	*VB*
block field	*BW*
block glide	—
block lava flow	—
block stream	*BX*
blowout	*BY*
bluff	*BN*
bog	*BO*
box canyon	—
braided stream	*BZ*
broad interstream divide	—
butte	*BU*
caldera	*CD*
canyon	*CA*
canyon bench	—
Carolina Bay	*CB*
channel (also Micro)	*CC*
chenier	*CG*
chenier plain	*CH*
cinder cone	*CI*
cirque	*CQ*
cirque floor	—
cirque headwall	—
cirque platform	—
cliff	*CJ*
climbing dune	—
closed depression (also Micro)	—
coastal plain (also LS)	*CP*
cockpit	—
col	*CL*
collapsed ice-floored lakebed	*CK*
collapsed ice-walled lakebed	*CN*
collapsed lake plain	*CS*
collapsed outwash plain	*CT*
collapsed sinkhole	—
complex landslide	—
coulee	*CE*
cove [coast] (w)	—
cove [geom.]	*CO*
craig and tail	—
crater (volcanic)	*CR*
crevasse filling	*CF*
cuesta	*CU*
cuesta valley	—

cutoff	*CV*
debris avalanche	*DA*
debris fall	—
debris flow	*DF*
debris slide	—
debris spread	—
debris topple	—
deflation basin	*DB*
delta	*DE*
delta plain (also LS)	*DC*
depression	*DP*
diapir	*DD*
dike	*DK*
dipslope	*DL*
disintegration moraine	*DM*
divide	*DN*
dome	*DO*
drainageway	*DQ*
draw	*DW*
drumlin	*DR*
drumlinoid ridge	—
dune	*DU*
dune lake (w)	—
dune slack (also Micro)	—
earth flow	*EF*
earth spread	—
earth topple	—
end moraine	*EM*
ephemeral stream (also Micro)	—
eroded fan remnant	—
eroded fan-remnant side slope	—
erosion remnant	*ER*
escarpment	*ES*
esker	*EK*
estuary (w)	*WD*
faceted spur	*FS*
fall	*FB*
falling dune	—
fan	*FC*
fan apron	*FA*
fan collar	—
fanhead trench	*FF*
fan piedmont (also LS)	*FG*
fan remnant	*FH*
fan skirt	*FI*
fault-line scarp	*FK*
fault zone	—
fen	*FN*
fissure vent	—
fjord (w)	*FJ*
flat	*FL*
flood plain	*FP*
flood-plain playa	*FY*
flood-plain splay	*FM*
flood-plain step	*FO*
flow	—
flute (also Micro)	*FU*
fluviomarine terrace (also LS)	—
fold	*FQ*
foredune	*FD*
fosse	*FV*
free face	*FW*
gap	*GA*
geyser	—
geyser basin	—
geyser cone	—
giant ripple	*GC*
glacial drainage channel	*GD*
glacial lake (w)	*WE*
glacial lake (relict)	*GL*
glacial-valley floor	—
glacial-valley wall	—
glacier	—
gorge	*GO*
graben	*GR*
ground moraine	*GM*
gulch	*GT*
gulf [coast]; (w)	—
gut (stream); (w)	*WH*
gut (valley)	*GV*
hanging valley	*HV*
headland	*HE*
head-of-outwash	—
headwall	*HW*
high hill	—
highmoor bog	*HB*
hill	*HI*
hillslope	—
hogback	*HO*
horn	*HR*

horst	*HT*
hot spring	—
ice-contact slope	—
ice-marginal stream	—
ice-pushed ridge	—
inselberg	*IN*
inset fan	*IF*
interdrumlin	—
interdune (also Micro)	*ID*
interfluve (also Geom. Component - Hills)	*IV*
interior valley	—
intermittent stream (also Micro)	—
intermontane basin (also LS)	*IB*
island (also LS)	—
kame	*KA*
kame moraine	*KM*
kame terrace	*KT*
karst cone	—
karst tower	—
karst valley	—
kettle	*KE*
kipuka	—
knob	*KN*
knoll	*KL*
lagoon (w)	*WI*
lahar	*LA*
lake (w)	*WJ*
lakebed (relict)	*LB*
lake plain (also LS)	*LP*
lakeshore	*LF*
lake terrace	*LT*
landslide	*LK*
lateral moraine	*LM*
lateral spread	—
lava field (also LS)	—
lava flow	*LC*
lava flow unit (also Micro)	—
lava plain (also LS)	*LN*
lava plateau (also LS)	*LL*
lava trench (also Micro)	—
lava tube	—
ledge	*LE*
levee [stream]	*LV*
loess bluff	*LO*
loess hill	*LQ*
longitudnal dune	—
longshore bar [relict]	*LR*
louderback	*LU*
low hill	—
lowmoor bog	*LX*
maar	—
main scarp (also Micro)	—
marine terrace (also LS)	*MT*
marsh	*MA*
mawae	—
meander	*MB*
meandering channel	*MC*
meander scar	*MS*
meander scroll	*MG*
medial moraine	*MH*
mesa	*ME*
meteorite crater	—
mogote	—
monadnock	*MD*
monocline	*MJ*
moraine	*MU*
mountain (plural = LS)	*MM*
mountain slope	*MN*
mountain valley	*MV*
mud flat	*MF*
mudflow	*MW*
mud pot	—
muskeg	*MX*
natural levee	*NL*
neck [volcanic]	—
notch	*NO*
nunatak	*NU*
ocean	—
open depression (also Micro)	—
outwash delta	—
outwash fan	*OF*
outwash plain (also LS)	*OP*
outwash terrace	*OT*
overflow stream (channel)	—
oxbow	*OX*
oxbow lake (w)	*WK*
oxbow lake (ephemeral)	*OL*
paha	*PA*
pahoehoe lava flow	—

paleoterrace	—
parabolic dune	*PB*
parna dune	*PD*
partial ballena	*PF*
patterned ground	*PG*
pavement karst	—
peak	*PK*
peat plateau	*PJ*
pediment	*PE*
perennial stream (w)	—
pillow lava flow	—
pinnacle	—
pingo	*PI*
pitted outwash plain	*PM*
pitted outwash terrace	—
plain (also LS)	*PN*
plateau (also LS)	*PT*
playa	*PL*
playa dune (also Micro)	—
playa floor (also Micro)	—
playa lake (w)	*WL*
playa rim (also Micro)	—
playa slope (also Micro)	—
playa step (also Micro)	—
plug [volcanic]	—
plug dome	*PP*
pluvial lake (w)	*WM*
pluvial lake (relict)	*PQ*
pocosin	*PO*
point bar	*PR*
pothole (also Micro)	*PH*
pothole lake (w)	*WN*
pressure ridge [ice]	—
pressure ridge [volc]	*PU*
proglacial lake (w)	*WO*
proglacial lake (relict)	—
pyroclastic flow	—
pyroclastic surge	—
raised beach	*RA*
raised bog	*RB*
ravine	*RV*
recessional moraine	*RM*
reef	*RF*
reworked lake plain	—
ribbed fen	*RG*
ridge	*RI*
rim	*RJ*
rise	—
river (w)	—
river valley (also LS)	—
roche moutonnee (also Micro)	*RN*
rock fall (also Micro)	—
rock fall avalanche	—
rock glacier	*RO*
rock pediment	—
rock spread	—
rock topple	—
rotational debris slide	—
rotational earth slide	—
rotational rock slide	—
rotational slide	*RP*
saddle	*SA*
sag (also Micro)	—
sag pond (w; also Micro)	—
salt marsh	*SM*
salt pond (w; also Micro)	*WQ*
sand flow	*RW*
sand ramp	—
sand sheet	*RX*
scarp	*RY*
scarp slope	*RS*
scree slope	—
sea (w)	—
sea cliff	*RZ*
seif dune	*SD*
shield volcano	—
shoal (w)	*WR*
shoal (relict)	*SE*
shore	—
sill	*RT*
sinkhole	*SH*
slackwater (w)	*WS*
slide	*SJ*
slot canyon	—
slough (ephemeral water)	*SL*
slough (permanent water)	*WU*
slump	*SK*
slump block	*SN*
snowfield	—
soil fall	—
solution sinkhole	—
sound (w)	—

spit	*SP*
spur	*SQ*
stack [coast]	—
stack [geom.]	*SR*
star dune	—
steptoe	*ST*
stock	—
stoss and lee	—
strait (w)	—
strand plain	*SS*
strath terrace	*SU*
stratovolcano	*SV*
stream (w)	—
stream terrace	*SX*
strike valley	—
string bog	*SY*
structural bench	*SB*
submerged–upland tidal marsh	—
swale (also Micro)	*SC*
swallow hole	*TB*
swamp	*SW*
syncline	*SZ*
talus cone	—
talus slope	—
tarn (w; also Micro)	—
terminal moraine	*TA*
terrace	*TE*
thermokarst depression	*TK*
thermokarst lake (w)	*WV*
tidal flat	*TF*
tidal marsh	—
till-floored lake plain	—
till plain (also LS)	*TP*
toe [mass move.]; (also Micro)	—
tombolo	*TO*
topple	—
tor	*TQ*
translational debris slide	—
translational earth slide	—
translational rock slide	—
translational slide	*TS*
transverse dune	*TD*
trough	*TR*
tunnel valley	*TV*
tunnel-valley lake (w)	—
underfit stream	—
U-shaped valley	*UV*
valley	*VA*
valley border surfaces	—
valley flat	*VF*
valley floor	*VL*
valley side	*VS*
valley train	*VT*
volcanic cone	*VC*
volcanic dome	*VD*
volcanic field (also LS)	—
volcano	*VO*
V-shaped valley	*VV*
wash	*WA*
washover fan	*WF*
wave-built terrace	*WT*
wave-cut platform	*WP*
wind gap	*WG*
yardang (also Micro)	—
yardang trough (also Micro)	—

C) MICROFEATURES (discrete, natural earth-surface features typically too small to delineate at common survey scales).

bar	—
channel (also LF)	—
closed depression (also LF)	—
corda	—
cutter	—
dune slack (also LF)	—
earth pillar	—
ephemeral stream (also LF)	—
finger ridge	—
flute (also LF)	—
frost boil	—
groove	—
gully	—
hillock	—
hoodoo	—
interdune (also LF)	—
intermittent stream (w; also LF)	—
karren	—
lava flow unit (also LF)	—
lava trench (also LF)	—
main scarp (also Micro)	—
minor scarp	—
mound	*M*
nivation hollow	—
open depression (also LF)	—
patterned ground microfeatures (see below; used in association with the landform "*patterned ground*"(*PG*))	

a) **Periglacial *"patterned ground"* Microfeatures:**

circle	—
earth hummocks	—
high-center polygons	—
ice wedge polygons	—
low-center polygons	—
non-sorted circles	—
palsa, palsen (= peat hummocks)	—
polygons	—
sorted circles	—
stripes	—
turf hummocks	—

b) **Other *"patterned ground"* Microfeatures:**

bar and channel	—
circular gilgai	—
elliptical gilgai	—
gilgai	*G*
hummocks	—
linear gilgai	—
mima mounds	—
pimple mounds	—

perennial stream (also LF)	—
pinnacle	—
playa dune (also LF)	—
playa floor (also LF)	—
playa rim (also LF)	—
playa slope (also LF)	—
playa step (also LF)	—
pond (w)	—
pool (w)	—
pothole (also LF)	—
pressure ridge [volc.]	—
rib	—

(*continued*)

MICROFEATURES *(continued)*

rill	—
ripple mark	—
rouche moutonnee (also LF)	—
sag (also LF)	—
sag pond (w; also LF)	—
salt pond (w; also LF)	—
sand boil	—
scour (mark)	—
shoreline	—
shrub-coppice dune	*SG*
slip face	—
solifluction lobe	—
solifluction sheet	—
solifluction terrace	—
solution corridor	—
solution fissure	—
spatter cone	—

spiracle	—
strandline	—
swale (also LF)	—
swash zone	—
tank (w)	—
tarn (w; also LF)	—
terracettes	*T*
toe [mass move.] (also LF)	—
tree-tip mound	—
tree-tip pit	—
truncated soil	—
tumulus (tumuli; = pl)	—
vernal pool (seasonal water)	—
yardang (also LF)	—
yardang trough (also LF)	—
zibar	—

D) ANTHROPOGENIC FEATURES [discrete, artificial (human-made), earth-surface features].

artificial collapsed depression	*G*
artificial levee	*A*
beveled cut	—
borrow pit	—
burial mound	*B*
cut (*road, railroad*)	—
cutbank	—
ditch	—
dump	—
fill	—
floodway	—
gravel pit	—
impact crater	—
landfill (see sanitary landfill)	—
leveled land	—
log landing	—
midden	*H*
openpit mine	—
pond (human-made)	—
quarry	—
railroad bed	*D*
reclaimed land	—
rice paddy	*E*
road bed	*I*
sand pit	—
sanitary landfill	—
scalped area	—
sewage lagoon	—
skid trail	—
spoil bank	—
spoil pile	—
surface mine	—
tillage / management features (see below for specific types)	*F*

Tillage / management features (common types):

conservation terrace (*modern*)	—
double-bedding mound (i.e., bedding mound used for timber; lower Coastal Plain)	—
drainage ditch	—
furrow	—
hillslope terrace (e.g., archeological features; China, Peru)	—
inter-furrow	—

truncated soil	—
urban land	—

II) GEOMORPHIC ENVIRONMENTS or OTHER GROUPINGS

(Landscape, Landform, and Microfeature terms grouped by geomorphic process (e.g. Fluvial) or by common setting (e.g. Water Body).
LS = Landscape; LF = Landform; Micro = Microfeature

1. COASTAL MARINE and ESTUARINE

Landscapes:

barrier island (also LF)	—
coastal plain (also LF)	*CP*
fluviomarine terrace (also LF)	—
island (also LF)	—
lowland	—
marine terrace (also LF)	—
peninsula	—
shore complex	—

Landforms:

atoll	*AT*
backshore	*AZ*
bar	*BR*
barrier beach	*BB*
barrier flat	*BF*
barrier island (also LS)	*BI*
beach	*BE*
beach plain	*BP*
beach ridge	*BG*
beach terrace	*BT*
berm	*BM*
bluff	*BN*
chenier	*CG*
chenier plain	*CH*
coastal plain	*CP*
delta	*DE*
delta plain (also LS)	*DC*
flat	*FL*
foredune	*FD*
fluviomarine terrace (also LS)	—
headland	*HE*
island (also LS)	—
lagoon [relict]	*WI*
longshore bar [relict]	*LR*
marine terrace (also LS)	*MT*
mud flat	*MF*
raised beach	*RA*
reef	*RF*
salt marsh	*SM*
sea cliff	*RZ*
shoal (relict)	*SE*
shore	—
spit	*SP*
stack [coast]	—
strand plain	*SS*
submerged–upland tidal marsh	—
tidal flat	*TF*
tidal marsh	—
tombolo	*TO*
washover fan	*WF*
wave-built terrace	*WT*
wave-cut platform	*WP*

Microfeatures:

ripple mark	—
shoreline	—
swash zone	—

2. LACUSTRINE (related to inland water bodies).

Landscapes:

island (also LF)	—	peninsula	—
lake plain (also LF)	—	shore complex	—

Landforms:

backshore	*AZ*	lake terrace	*LT*
bar	*BR*	longshore bar [relict]	*LR*
barrier beach	*BB*	mud flat	*MF*
barrier flat	*BF*	oxbow lake (ephemeral)	*OL*
barrier island	*BI*	playa	*PL*
beach	*BE*	playa floor (also Micro)	—
beach plain	*BP*	playa rim (also Micro)	—
beach ridge	*BG*	playa slope (also Micro)	—
beach terrace	*BT*	playa step (also Micro)	—
berm	*BM*	pluvial lake (relict)	*PQ*
bluff	*BN*	raised beach	*RA*
delta	*DE*	reworked lake plain	—
delta plain (also LS)	*DC*	salt marsh	*SM*
flat	*FL*	shoal (relict)	*SE*
flood-plain playa	*FY*	shore	—
foredune	*FD*	spit	*SP*
headland	*HE*	stack [coast]	—
island (also LS)	—	strand plain	*SS*
lagoon [relict]	*WI*	till-floored lake plain	—
lakebed [relict]	*LB*	tombolo	*TO*
lakebed (water body)	*LB*	wave-built terrace	*WT*
lake plain (also LS)	*LP*	wave-cut platform	*WP*

Microfeatures:

bar	—	ripple mark	—
playa floor (also LF)	—	shoreline	—
playa rim (also LF)	—	strandline	—
playa slope (also LF)	—	swash zone	—
playa step (also LF)	—	vernal pool	—

3. FLUVIAL (Dominantly related to concentrated water flow (channel flow); includes both erosional and depositional features, but excluding glaciofluvial landforms (see *Glacial*), and permanent water features (e.g., river; see *Water Bodies*).

Landscapes:

alluvial plain	—
alluvial plain remnant	—
badlands	*BA*
bajada	*BJ*
breaks	*BK*
canyonlands	—
delta plain	—
fan piedmont	*FP*
meander belt	*MP*
river valley	—
scabland	*SC*

Landforms:

alluvial cone	—
alluvial fan	*AF*
alluvial flat	*AP*
arroyo	*AY*
axial stream (w)	—
backswamp	*BS*
bajada	*BJ*
bar	*BR*
basin-floor remnant	*BD*
block stream	*BX*
box canyon	—
braided stream	*BZ*
canyon	*CA*
channel	*CC*
coulee	*CE*
cutoff	*CV*
delta	*DE*
delta plain (also LS)	*DC*
drainageway	*DQ*
draw	*DW*
ephemeral stream (also Micro)	—
fan apron	—
fan collar	—
fanhead trench	*FF*
fan remnant	—
fan skirt	*FI*
flood plain	*FP*
flood-plain playa	*FY*
flood-plain splay	*FM*
flood-plain step	*FO*
giant ripple	*GC*
gorge	*GO*
gulch	*GT*
gut (valley)	*GV*
inset fan	*IF*
intermittent stream (also Micro)	—
levee [stream]	*LV*
meander scar	*MS*
meander scroll	*MG*
natural levee	*NL*
overflow stream channel	—
oxbow	*OX*
oxbow lake (ephemeral)	*OL*
paleoterrace	—
point bar	*PR*
ravine	*RV*
river valley (also LS)	—
slot canyon	—
strath terrace	*SU*
stream terrace	*SX*
valley border surfaces	—
valley flat	*VF*
wash	*WA*
wind gap	*WG*

FLUVIAL *(continued)*

Microfeatures:

bar	—
bar and channel	—
channel	—
ephemeral stream (also LF)	—
groove	—
gully	—
intermittent stream (also LF)	—
ripple mark	—
swash zone	—

4. SOLUTION (dominated by dissolution, and commonly, subsurface drainage).

Landscapes:

cockpit karst	—
fluviokarst	—
karst	—
kegel karst	—
sinkhole karst	—
thermokarst	*TK*

Landforms:

blind valley	*VB*
cockpit	—
collapse sinkhole	—
interior valley	—
karst cone	—
karst tower	—
karst valley	—
mogote	—
pavement karst	—
pinnacle	—
sinkhole	*SH*
solution sinkhole	—
swallow hole	*TB*
thermokarst depression (also Micro)	*TK*
yardang (also Micro)	—
yardang trough (also Micro)	—

Microfeatures:

cutter	—
karren	—
solution corridor	—
solution fissure	—
thermokarst depression (also LF)	—
yardang (also LF)	—
yardang trough (also LF)	—

5. EOLIAN (dominantly wind related, erosion or deposition).

Landscapes:

dune field	—
sand hills	*SH*
sand plain	—

Landforms:

barchan dune	*BQ*
blowout	*BY*
climbing dune	—
deflation basin	*DB*
dune	*DU*
dune lake (w)	—
dune slack (also Micro)	—
falling dune	—
foredune	*FD*
interdune	*ID*
loess bluff	*LO*
loess hill	*LQ*
longitudinal dune	—
paha	*PA*
parabolic dune	*PB*
parna dune	*PD*
playa dune (also Micro)	—
sand ramp	—
sand sheet	*RX*
seif dune	*SD*
star dune	—
transverse dune	*TD*
yardang (also Micro)	—
yardang trough (also Micro)	

Microfeatures:

dune slack (also LF)	—
interdune (also LF)	—
playa dune (also LF)	—
shrub-coppice dune (also LF)	—
slip face (also LF)	—
yardang (also LF)	—
yardang trough (also LF)	—
zibar	—

6. **GLACIAL** (directly related to glaciers; includes glaciofluvial glaciolacustrine, glaciomarine and outwash features)

Landscapes:

continental glacier	—
drumlin field	—
hills	*HI*
ice-margin complex	—
outwash plain (also LF)	—
till plain (also LF)	—

Landforms:

alpine glacier	—
arete	*AR*
cirque	*CQ*
cirque floor	—
cirque headwall	—
cirque platform	—
col	*CL*
collapsed ice-floored lakebed	*CK*
collapsed ice-walled lakebed	*CN*
collapsed lake plain	*CS*
collapsed outwash plain	*CT*
crag and tail	—
crevasse filling	*CF*
disintegration moraine	*DM*
drumlin	*DR*
drumlinoid ridge	—
end moraine	*EM*
esker	*EK*
fjord (w)	*FJ*
flute (also Micro)	*FU*
fosse	*FV*
giant ripple	*GC*
glacial drainage channel	*GD*
glacial lake (relict)	*GL*
glacial lake (w)	—
glacial-valley floor	—
glacial-valley wall	—
glacier	—
ground moraine	*GM*
hanging valley	*HV*
head-of-outwash	—
ice-contact slope	—
ice-marginal stream (w)	—
ice-pushed ridge	—
interdrumlin	—
kame	*KA*
kame moraine	*KM*
kame terrace	*KT*
kettle	*KE*
lateral moraine	*LM*
medial moraine	*MH*
moraine	*MU*
nunatak	*NU*
outwash delta	—
outwash fan	*OF*
outwash plain (also LS)	*OP*
outwash terrace	*OT*
paha	*PA*
pitted outwash plain	*PM*
pitted outwash terrace	—
pothole (also Micro)	—
pressure ridge [ice]	—
proglacial lake [relict]	—
proglacial lake (w)	—
recessional moraine	*RM*
reworked lake plain	—
roche moutonnee (also Micro)	*RN*
rock glacier	*RO*
snowfield	—
stoss and lee	—

(continued)

GLACIAL *(continued)*

tarn (w; also Micro)	—
terminal moraine	*TA*
till-flooded lake plain	—
till plain (also LS)	*TP*
tunnel valley	*TV*
tunnel-valley lake (w)	—
underfit stream	—
U - shaped valley	*UV*
valley train	*VT*

Microfeatures:

flute (also LF)	—
nivation hollow	—
pothole (also LF)	—
rouche moutonnee (also LF)	—
swale (also LF)	—
tarn (w; also LF)	—

7. PERIGLACIAL [related to non-glacial, cold climate (modern, or relict), including periglacial forms of patterned ground)]. Note: Consider "patterned ground" as a Landform, but treat specific types of patterned ground (singular or plural), as Microfeatures.

Landscapes:

coastal plain	*CP*
hills	*HI*
plains	*PL*
thermokarst	*TK*

Landforms:

alas	*AA*
block field	*BW*
muskeg	*MX*
patterned ground (see Microfeatures below for types)	*PG*
peat plateau	*PJ*
pingo	*PI*
rock glacier	*RO*
string bog	*SY*
thermokarst depression	*TK*
thermokarst lake (w)	—

Microfeatures:

circle	—
earth hummock	—
frost boil	—
high-center polygon	—
ice-wedge	—
low-center polygon	—
nivation hollow	—
non-sorted circle	—
palsa (palsen = plural; = peat hummock)	—
polygon	—
solifluction lobe	—
solifluction sheet	—
solifluction terrace	—
sorted stripes	—
stripes	—
turf hummocks	—

8. MASS MOVEMENT (= MASS WASTING)

(dominated by gravity; including creep forms; also see Mass Movement Types table, p. 5-7)

Landscapes: These generic Landscapes are not Mass Movement features per say, but are commonly modified by, and include localized areas of Mass Movement.

foothills	*FH*	mountain range	—
hills	*HI*	mountains	*MO*

Landforms:

avalanche chute	*AL*	rock glacier	*RO*
block glide	—	rock spread	—
block stream	*BX*	rock topple	—
complex landslide	—	rotational debris slide	—
debris avalanche	*DA*	rotational earth slide	—
debris fall	—	rotational rock slide	—
debris flow	*DF*	rotational slide	*RP*
debris slide	—	sag (also Micro)	—
debris spread	—	sag pond (w; also Micro)	—
debris topple	—	sand flow	*RW*
earth flow	*EF*	scree slope	—
earth spread	—	slide	*SJ*
earth topple	—	slump	*SK*
fall	*FB*	slump block	*SN*
flow	—	soil fall	—
lahar	*LA*	talus cone	—
landslide	*LK*	talus slope	—
lateral spread	—	topple	—
main scarp (also Micro)	—	translational debris slide	—
mudflow	*MW*	translational earth slide	—
rock fall (also Micro)	—	translational rock slide	—
rockfall avalanche	—	translational slide	*TS*

Microfeatures:

		sand boil	—
main scarp (also LF)	—	solifluction lobe	—
minor scarp	—	solifluction sheet	—
rock fall (also LF)	—	solifluction terrace	—
sag (also LF)	—	terracettes	*T*
sag pond (also LF)	—	toe [mass move.] (also LF)	—

9. VOLCANIC and HYDROTHERMAL

Landscapes:

foothills	*FH*	lava plateau (also LF)	—
hills	*HI*	mountains	*MO*
lava field (also LF)	—	volcanic field (also LF)	—
lava plain (also LF)	—		

Landforms:

a'a lava flow	—	louderback	*LV*
ash flow	*AS*	maar	—
block lava flow	—	mawae	—
caldera	*CD*	mud pot	—
cinder cone	*CI*	neck [volc.]	—
crater [volcanic]	*CR*	pahoehoe lava flow	—
fissure vent	—	pillow lava flow	—
geyser	—	plug [volc.]	—
geyser basin	—	plug dome	*PP*
geyser cone	—	pressure ridge [volc.] (also Micro)	*PU*
hot spring	—		
kipuka	—	pyroclastic flow	—
lahar	*LA*	pyroclastic surge	—
lava field (also LS)	—	shield volcano	—
lava flow unit (also Micro)	—	step toe	—
lava flow	*LC*	stratovolcano	*SV*
lava plain (also LS)	*LN*	volcanic cone	*VC*
lava plateau (also LS)	*LL*	volcanic dome	*VD*
lava trench (also Micro)	—	volcanic field (also LS)	—
lava tube	—		

Microfeatures:

corda	—	spatter cone	—
lava flow unit (also LF)	—	spiracle	—
lava trench (also LF)	—	tumulus (tumuli: = plural)	—
pressure ridge [volc.] (also LF)	—		

10. TECTONIC and STRUCTURAL (related to regional or local bedrock structures or crustal movement; recognized only if expressed at or near the land surface).

Landscapes:

batholith	—	mountain system	—
bolson	*BO*	plateau	*PT*
foothills	*FH*	rift valley	—
hills	*HI*	semi-bolson	*SB*
intermontane basin	*IB*	tableland	*TB*
mountain range	—	valley	*VA*
mountains	*MO*		

Landforms:

anticline	*AN*	graben	*GR*
canyon bench	—	hogback	*HO*
cuesta	*CU*	horst	*HT*
cuesta valley	—	louderback	*LU*
diapir	*DD*	meteorite crater	—
dike	*DK*	monocline	*MJ*
dipslope	*DL*	scarp slope	*RS*
dome	*DO*	sill	*RT*
fault-line scarp	*FK*	strike valley	—
fault zone	—	structural bench	*SB*
fold	*FQ*	syncline	*SZ*

Microfeatures:

sand boil	—

11. SLOPE (Terms that tend to be generic and that emphasize their form rather than any particular genesis or process).

Landscapes:

badlands	*BA*
breaks	*BK*
canyonlands	—
foothills	*FH*
hills	*HI*
mountain range	—
mountains	*MO*
mountain system	—
piedmont	*PI*
piedmont slope	—
plateau (also LF)	*PT*
tableland	*TB*
upland	*UP*

Landforms:

beveled base	—
block stream	*BX*
bluff	*BN*
broad interstream divide	—
butte	*BU*
canyon bench	—
cliff	*CJ*
cuesta	*CU*
dome	*DO*
escarpment	*ES*
faceted spur	*FS*
fault-line scarp	*FK*
free face (also Geom. Component-Hills, Mountains)	*FW*
gap	*GA*
headwall	*HW*
high hill	—
hill (plural = LS)	*HI*
hillslope	—
hogback	*HO*
interfluve (also Geom. Component - Hills)	*IV*
knob	*KN*
knoll	*KL*
ledge	*LE*
low hill	—
mesa	*ME*
mountain (plural = LS)	*MM*
mountain slope	*MN*
mountain valley	*MV*
notch	*NO*
paha	*PA*
peak	*PK*
pediment	*PE*
plain (plural = LS)	*PN*
plateau (also LS)	*PT*
ridge	*RI*
rim	*RJ*
rock pediment	—
scarp	*RY*
scarp slope	*RS*
scree slope	—
spur	*SQ*
stack [geom.]	—
structural bench	*SB*
talus cone	—
talus slope	—
tor	*TQ*
valley	*VA*
wind gap	*WG*

Microfeatures:

finger ridge	—
mound	*M*
rib	—
rill	—

12. EROSIONAL (Related dominantly to water erosion but excluding perennial channel flow (i.e. fluvial, glaciofluvial), or eolian erosion).

Landscapes:

badlands	*BA*
breaks	*BK*
canyonlands	—
foothills	*FH*
hills	*HI*
mountain range	—
mountains	*MO*
piedmont	*PI*
piedmont slope	—
plateau (also LF)	*PT*
tableland	*TB*

Landforms:

ballena	*BL*
ballon	*BV*
basin floor remnant	*BD*
beveled base	—
canyon bench	—
col	*CL*
cuesta	*CU*
cuesta valley	—
eroded fan remnant	—
eroded fan-remnant sideslope	—
erosion remnant	*ER*
free face (also Geom. Component-Hills, Mountains)	*FW*
gap	*GA*
hogback	*HO*
inselberg	*IN*
monadnock	*MD*
notch	*NO*
paha	*PA*
partial ballena	*PF*
peak	*PK*
pediment	*PE*
plateau (also LS)	*PT*
rock pediment	—
saddle	*SA*
scarp slope	*RS*
stack [geom.]	*SR*
strike valley	—
structural bench	*SB*
tor	*TQ*
valley border surfaces	—
wind gap	*WG*

Microfeatures:

earth pillar	—
finger ridge	—
groove	—
gully	—
hoodoo	—
pinnacle	—
rib	—
rill	—
swale	—

13. DEPRESSIONAL (low area or declivity features, excluding permanent water bodies).

Landscapes:

basin	*BS*	semi-bolson	*SB*
bolson	*BO*	valley	*VA*

Landforms:

alluvial flat	*AP*	mountain valley	*MV*
basin floor	*BC*	open depression	—
basin floor remnant	*BD*	playa	*PL*
box canyon	—	playa floor (also Micro)	—
canyon	*CA*	playa rim (also Micro)	—
Carolina Bay	*CB*	playa slope (also Micro)	—
closed depression	—	playa step (also Micro)	—
col	*CL*	pothole (also Micro)	*PH*
coulee	*CE*	ravine	*RV*
cove [geom.]	*CO*	saddle	*SA*
cuesta valley	—	sag (also Micro)	—
depression	*DP*	slot canyon	—
drainageway	*DQ*	strike valley	—
gap	*GA*	swale (also Micro)	*SC*
gorge	*GO*	trough	*TR*
gulch	*GT*	U-shaped valley	*UV*
gut (valley)	*GV*	valley	*VA*
intermontane basin	*IB*	valley floor	*VL*
kettle	*KE*	V-shaped valley	*VV*

Microfeatures:

closed depression (also LF)	—	playa step (also LF)	—
open depression (also LF)	—	pothole (also LF)	—
playa floor (also LF)	—	sag (also LF)	—
playa rim (also LF)	—	swale (also LF)	—
playa slope (also LF)	—	tree-tip pit	—

14. WETLANDS

[Related to vegetated and/or shallow water areas, and wet soils. (Provisional list: conventional, geologic definitions; not legalistic or regulatory usage)]

Landscapes:

(no entries)

Landforms:

alas	*AA*
backswamp	*BS*
bog	*BO*
Carolina Bay	*CB*
dune slack (also Micro)	—
ephemeral stream (also Micro)	—
estuary	*WD*
fen	*FN*
flood-plain playa	*FY*
highmoor bog	*HB*
intermittent stream (also Micro)	—
lowmoor bog	*LX*
marsh	*MA*
mud flat	*MF*
muskeg	*MX*
oxbow lake (ephemeral)	*OL*
peat plateau	*PJ*
playa (intermittent water)	*PL*
pocosin	*PO*
pothole (intermittent water; also Micro)	*PH*
raised bog	*RB*
ribbed fen	*RG*
salt marsh	*SM*
slough (intermittent water)	*SL*
string bog	*SY*
swamp	*SW*
tidal flat	*TF*
tidal marsh	—

Microfeatures:

dune slack (also *LF*)	—
ephemeral stream (also *LF*)	—
intermittent stream (also *LF*)	—
pothole (also *LF*)	—
vernal pool (seasonal water)	—

15. WATER BODIES

[Discrete “surface water” features; primarily permanent open water, which in Soil Survey Reports are commonly treated as the generic map unit “water” (e.g., lake), or as a spot / line symbol (e.g., perennial)].

Landscapes:

(no entries)

Landforms:

axial stream	—	playa lake	*WL*
bay [coast]	*WB*	pluvial lake	*WM*
bayou	*WC*	pothole (lake; also Micro)	*WN*
cove [coast]	—	proglacial lake	*WO*
dune lake	—	river	—
estuary	*WD*	sag pond (also Micro)	—
fjord	*FJ*	salt pond (also Micro)	*WQ*
glacial lake	*WE*	shoal	*WR*
gulf [coast]	—	slackwater	*WS*
gut (stream)	*WH*	slough (permanent water)	*WU*
ice-marginal stream	—	sound	—
lagoon	*WI*	strait	—
lake	*WJ*	stream	—
ocean	—	tarn (also Micro)	—
oxbow lake	*WK*	thermokarst lake	*WV*
perennial stream (also Micro)	—	tunnel-valley lake	—

Microfeatures:

channel	—	sag pond (also LF)	—
perennial stream (also LF)	—	salt pond (also LF)	—
pond	—	tank	—
pool	—	tarn (also LF)	—
pothole (permanent water; also LF)	—		

PART III: SURFACE MORPHOMETRY

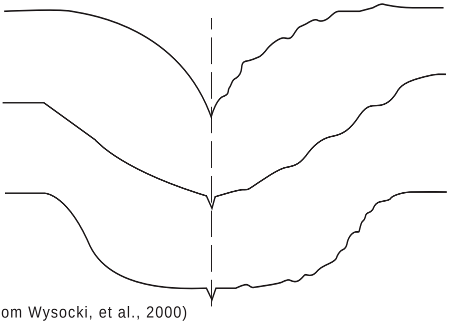
A) **Elevation**: The height of a point on the Earth's surface, relative to mean sea level (msl); indicate units; e.g., *106 m* or *348 ft*.

B) **Slope Aspect**: The compass bearing (in degrees, corrected for declination) that a slope faces, looking downslope. e.g., *287°*

C) **Slope Gradient**: The angle of the ground surface (in percent) through the site and in the direction that overland water would flow. (Commonly referred to as slope.) e.g., *18%*

D) **Slope Complexity**: Describe the relative uniformity (smooth linear or curvilinear = *simple* or *S*) or irregularity (*complex* or *C*) of the ground surface leading downslope through the point of interest; e.g., s*imple* or *S*.

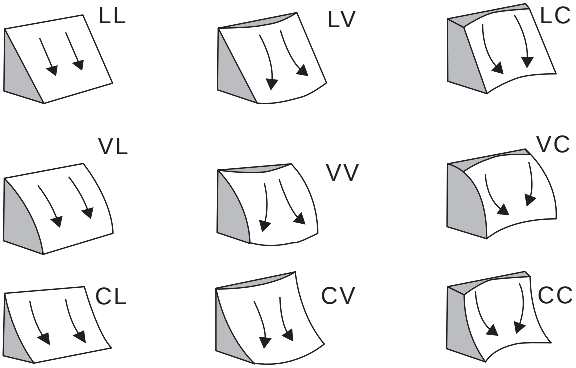
Simple vs. Complex



(adapted from Wysocki, et al., 2000)

E) **Slope Shape**: Slope shape is described in two directions: 1) up and down slope (perpendicular (normal) to the contour); and 2) across slope (along the horizontal contour). In PDP, this data element is split into two sequential parts (Slope Across and Slope Up & Down); e.g., *Linear, Convex,* or *LV*.

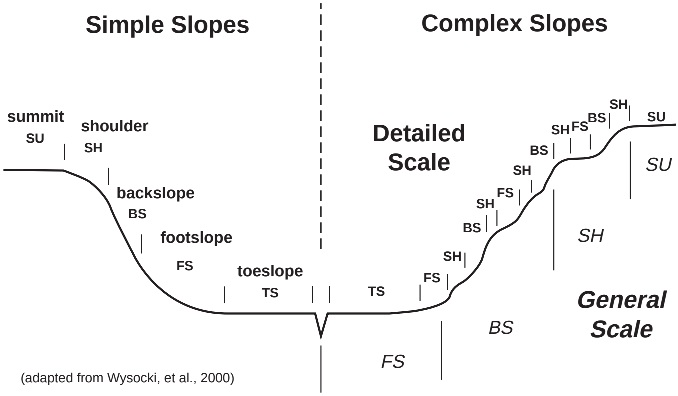
Down Slope (Vertical)	Across Slope (Horizontal)	Code	
		PDP 3.5	**NASIS**
concave	concave	*CC, CC*	*CC*
concave	convex	*CC, CV*	*CV*
concave	linear	*CC, LL*	*CL*
convex	concave	*CV, CC*	*VC*
convex	convex	*CV, CV*	*VV*
convex	linear	*CV, LL*	*VL*
linear	concave	*LL, CC*	*LC*
linear	convex	*LL, CV*	*LV*
linear	linear	*LL, LL*	*LL*



(adapted from Wysocki, et al., 2000)

(F) **Hillslope - Profile Position** (Hillslope Position in PDP): Two-dimensional descriptors of parts of line segments (i.e., slope position) along a transect that runs up and down the slope; e.g., *backslope* or *BS*. This set of terms is best applied to transects or points, not areas.

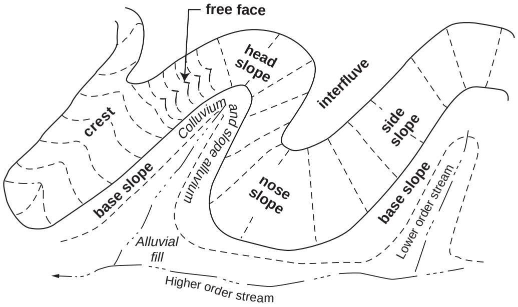
Position	Code
summit	SU
shoulder	SH
backslope	BS
footslope	FS
toeslope	TS



(adapted from Wysocki, et al., 2000)

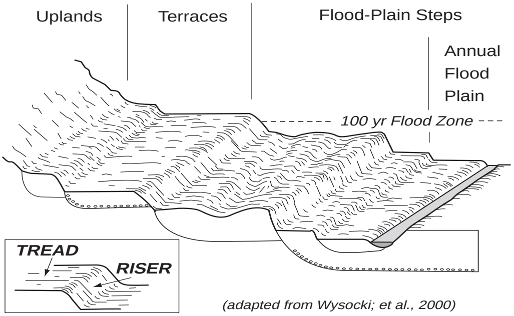
G) **Geomorphic Component** (Geomorphic Position in PDP): Three-dimensional descriptors of parts of landforms or microfeatures that are best applied to areas. Unique descriptors are available for Hills, Terraces, Mountains, and Flat Plains; e.g., (for Hills) *nose slope* or *NS.*

1) Hills	**Code**	
	PDP	**NASIS**
interfluve	IF	IF
crest	CT	CT
head slope	HS	HS
nose slope	NS	NS
side slope	SS	SS
free face	—	FF
base slope	—	BS



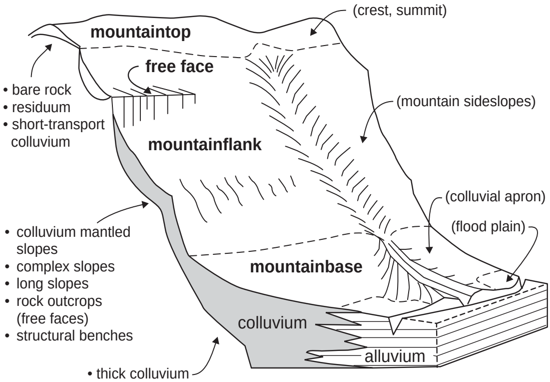
(adapted from Wysocki, et al., 2000)

2) Terraces, Stepped Landforms	Code
riser	RI
tread	TR



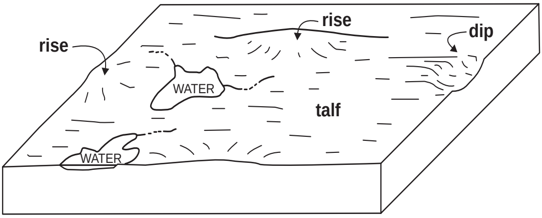
(adapted from Wysocki; et al., 2000)

3) Mountains	Code
mountaintop	MT
mountainflank	MF
upper third - mountainflank	UT
center third - mountainflank	CT
lower third - mountainflank	LT
free face	FF
mountainbase	MB



(adapted from Wysocki, et al., 2000)

4) Flat Plains	Code
dip	DP
rise	RI
talf	TF



(adapted from Wysocki, et al., 2000)

- very low gradients (e.g. slope 0–1%)
- deranged, non-integrated, or incipient drainage network
- “high areas” are broad and low (e.g. slope 1–3%)
- Sediments commonly lacustrine, alluvial, eolian, or till

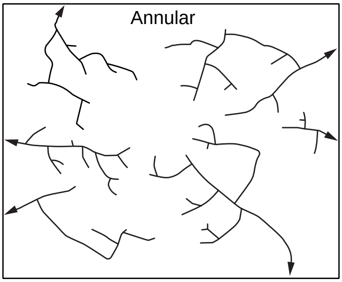
H) **Microrelief**: Small, relative differences in elevation between adjacent areas on the earth’s surface; e.g., *micro-high* or *MH*; or *micro-low* or *ML*.

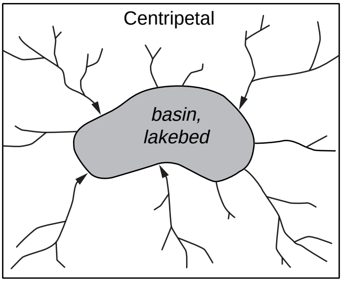
NOTE: Microrelief **Kind** and **Pattern** have been deleted from PDP (obsolete); these phenomena and terms are now indirectly captured within the data element “Microfeature”.

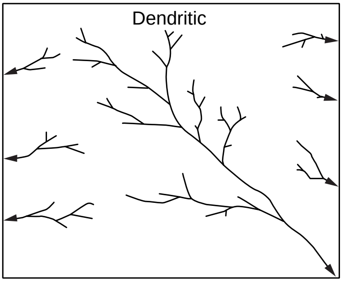
I) **Drainage Pattern:** The arrangement of drainage channels on the land surface; also called drainage network.

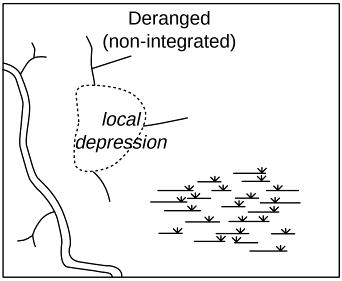
Drainage Pattern	Codes
annular	—
artificial	—
centripetal	—
dendritic	—
deranged	—
karst	—
parallel	—
pinnate	—
radial	—
rectangular	—
thermokarst	—
trellis	—

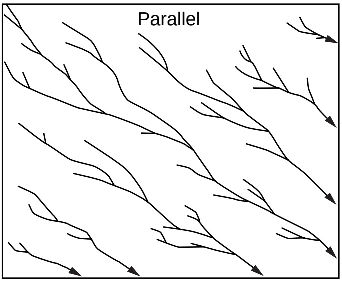
Common Drainage Patterns:

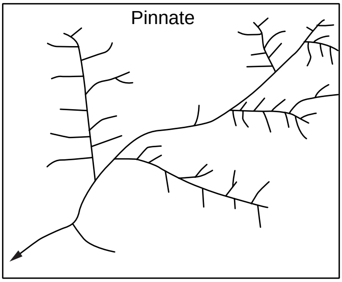


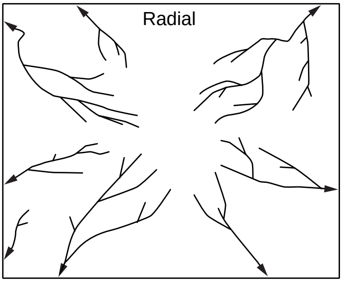


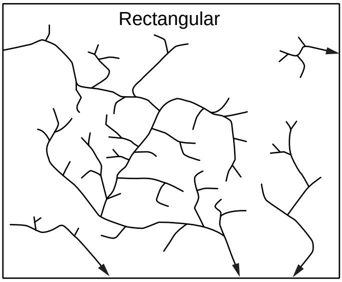




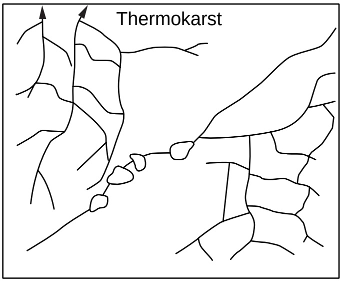


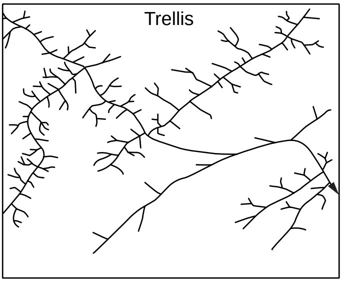






Common Drainage Patterns: (continued)





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SOIL TAXONOMY

INTRODUCTION

The purpose of this section is to expand upon and augment the abbreviated soil taxonomic contents of the “Soil Profile Description Section.”

HORIZON NOMENCLATURE

MASTER AND TRANSITIONAL HORIZONS -

Horizon	Criteria [1]
O	Organic soil materials other than limnic materials. The mineral fraction is commonly a small percent by volume and is less than 80% by weight.
A	Mineral soil, formed at surface or below O, little remnant rock structure, and both or either: 1) accumulation of humified organic matter but dominated by mineral matter, and not E or B; or 2) cultivation properties. Excludes recent eolian or alluvial deposits that retain stratification.
AB (or **AE**)	Dominantly A horizon characteristics but also has some recognizable characteristics of B (or E) horizon.
A/B (or **A/E**) (or **A/C**)	Discrete, intermingled bodies of two horizons: A and B (or E,or C) material; majority of layer is A material.
AC	Dominantly A horizon characteristics but also has some recognizable characteristics of C horizon.
E	Mineral soil, loss of clay, iron, aluminum, and/or organic matter leaving a net concentration of sand and silt; little remnant rock structure; typically lighter color (higher value, chroma) and coarser texture than A.
EA (or **EB,** or **EC**)	Dominantly E horizon characteristics but also has some recognizable characteristics of A (or B, or C) horizon.
E/A (or **E/B**)	Discrete, intermingled bodies of two horizons: E and A (or E and B) material; majority of layer is E horizon material.
E and Bt (or **B and E**)	Presence of thin, heavier textured lamellae (Bt) within a predominantly E horizon with less clay (or thin E layers within a predominantly B horizon).
BA (or **BE**)	Dominantly B characteristics but also has some recognizable attributes of A (or E) horizon.

B/A (or **B/E**)	Discrete, intermingled bodies of two horizons, majority of horizon is B (or E) material.
B	Mineral soil, typically formed below O, A, or E; little or no rock structure; and one or more of the following: 1) illuvial accumulation of silicate clay, Fe, Al, humus, carbonate, gypsum, silica, or salt more soluble than gypsum (one or more); 2) removal of carbonates, gypsum or more soluble salts; 3) residual accumulation of sesquioxides; 4) sesquioxide coatings; 5) alterations that form silicate clays or liberates oxides and forms pedogenic structure; 6) Strong gleying in the presence of aquic conditions (or artificial drainage); Layers with gleying, but no other pedogenic change are not B horizons. Most B horizons are or were subsurface horizons. Some formed at the surface by accumulation of evaporites. Cemented and brittle layers that have other evidence of pedogenesis are included as B horizons.
BC	Dominantly B horizon characteristics but also has some recognizable characteristics of the C horizon.
B/C	Discrete, intermingled bodies of two horizons; majority of horizon is B material.
CB (or **CA**)	Dominantly C horizon characteristics but also has some recognizable characteristics of the B (or A) horizon.
C/B (or **C/A**)	Discrete, intermingled bodies of two horizons; majority of horizon is C material.
C	Mineral soil, soft bedrock (excluding *Strongly Cemented* to *Indurated* bedrock unless highly cracked); layer little affected by pedogenesis and lack properties of O, A, E, or B horizons. May or may not be related to parent material of the solum.
L	Limnic soil materials[2]. Sediments deposited in a body of water (subaqueous) and dominated by organic materials (aquatic plant and animal fragments and fecal material) and lesser amounts of clay.
W	A layer of liquid water (W) or permanently frozen ice (Wf) within the soil (<u>excludes</u> water / ice above soil). [2]
R	Hard bedrock (continuous, coherent *Strongly Cemented* to *Indurated* Cementation Classes).

[1] Soil Survey Staff, 1998.

[2] NRCS Soil Classification Staff, 1999; (Soil Survey Staff, 2001)

HORIZON SUFFIXES -

Horizon Suffixes	Criteria [1]
a	Highly decomposed organic matter (OM); rubbed fiber content < 17% (by vol.); see ***e, i.***
b	Buried genetic horizon (not used with organic materials or to separate organic from mineral materials.
c	Concretions or nodules; significant accumulation of <u>cemented</u> bodies, enriched with Fe, Al, Mn, Ti [cement not specified except <u>excludes</u> silica (see *q*)]; not used for calcite, dolomite, or soluble salts (see *z*).
co [2]	Coprogenous earth (used only with L); organic materials deposited under water and dominated by fecal material from aquatic animals.
d	<u>Physical</u> root restriction due to high bulk density (natural or human-made materials / conditions; e.g., lodgement till, plow pans etc.
di [2]	Diatomaceous earth (used only with L); materials deposited under water and dominated by the siliceous remains of diatoms.
e	Moderately (intermediately) decomposed organic matter; rubbed fiber content 17-40% (by vol.); see *a*, *i*.
f	Permafrost (permanently frozen soil or ice); excludes seasonally frozen ice; continuous subsurface ice.
ff	Dry permafrost [permanently frozen soil; not used for seasonally frozen; no continuous ice bodies (see *f*)].
g	Strong gley (Fe reduced and pedogenically removed); typically ≤ 2 chroma; may have other redoximorphic (RMF) features; not used for geogenic gray colors.
h	Illuvial organic matter (OM) accumulation (with B: accumulation of illuvial, amorphous OM–sesquioxide complexes); coats sand and silt particles and may fill pores; use *Bhs* if significant accumulation of sesquioxides <u>and</u> moist chroma and value ≤ 3.
i	Slightly decomposed organic matter; rubbed fiber content > 40% (by vol.); see *a*, *e*.
j	Jarosite accumulation; e.g., acid sulfate soils.
jj	Evidence of cryoturbation; e.g., irregular or broken boundaries, sorted rock fragments (patterned ground), or O.M. in lower boundary between active layer and permafrost layer.

k	Pedogenic accumulation of carbonates; e.g. $CaCO_3$.
m	Strong pedogenic cementation or induration (> 90% cemented, even if fractured); physically root restrictive; you can indicate cement type by using letter combinations; e.g., *km* - carbonates, *qm* - silica, *kqm* - carbonates and silica; *sm* - iron, *ym* - gypsum; *zm* - salts more soluble than gypsum.
ma [2]	Marl (used only with L); materials deposited under water and dominated by a mixture of clay and $CaCO_3$; typically gray.
n	Pedogenic, exchangeable sodium accumulation.
o	Residual accumulation of sesquioxides.
p	Tillage or other disturbance of surface layer (pasture, plow, etc.). Designate *Op* for disturbed organic surface; *Ap* for mineral surface even if the layer clearly was originally an E, B, C, etc.
q	Accumulation of secondary (pedogenic) silica.
r	Used with C to indicate weathered or soft bedrock (root restrictive saprolite or soft bedrock; partially consolidated sandstone, siltstone, or shale; Excavation Difficulty classes are *Low* to *High*).
s	Significant illuvial accumulation of amorphous, dispersible, sesquioxides and organic matter complexes and moist color value or chroma ≥ 4. Used with B horizon; used with h as *Bhs* if moist color value and chroma is ≤ 3.
ss	Slickensides; e.g., oblique shear faces 20 - 60 ° off horizontal; due to shrink-swell clay action; wedge-shaped peds and seasonal surface cracks are also commonly present.
t	Illuvial accumulation of silicate clays (clayskins, lamellae, or clay bridging in some part of the horizon).
v	Plinthite (high Fe, low OM, reddish contents; firm to very firm moist consistence; irreversible hardening with repeated wetting and drying).
w	Incipient color or pedogenic structure development; minimal illuvial accumulations (excluded from use with transition horizons).
x	Fragipan characteristics (brittleness, firmness, bleached prisms).
y	Pedogenic accumulation of gypsum ($CaSO_4 \cdot 2\,H_2O$).
z	Pedogenic accumulation of salts more soluble than gypsum; e.g., NaCl, etc.

[1] Soil Survey Staff, 1998

[2] NRCS Soil Classification Staff, 1999; Soil Survey Staff, 2001.

HORIZON NOMENCLATURE CONVERSION CHARTS -

Master Horizons and Combinations			
1951 [1]	**1962** [2], **1975** [3]	**1981** [4]	**1998** [5]
—	O	O	O
Aoo	—	(see *Oi*)	(see *Oi*)
Ao	O1	Oi and / or Oe	Oi and / or Oe
—	O2	Oe and / or Oa	Oe and / or Oa
—	—	Oi	Oi
—	—	Oe	Oe
—	—	Oa	Oa
A	A	A	A
A1	A1	A	A
A2	A2	E	E
A3	A3	AB or EB	AB or EB
AB	AB	——	——
A&B	A&B	A / B or E / B	A / B or E / B
AC	AC	AC	AC
—	—	E and Bt	E and Bt
B	B	B	B
B1	B1	BA or BE	BA or BE
B&A	B&A	B / A or B / E	B / A or B / E
B2	B2	B or Bw	B or Bw
G	—	—	—
B3	B3	BC or CB	BC or CB
—	—	B / C, C / B, C / A	B / C, C / B, C / A
C	C	C	C
Cca	—	—	—
Ccs	—	—	—
D	—	—	—
Dr	R	R	R
—	L [3]	—	L [3, 6] (1999)
—	—	—	W

---

[1] Soil Survey Staff, 1951.

[2] Soil Survey Staff, 1962; (same content used in Soil Taxonomy (Soil Survey Staff, 1975) except for addition of Limnic (L) horizon [3].

[3] Soil Survey Staff, 1975. Limnic (L) horizon was adopted 1975, omitted 1981 [4], formally dropped 1985 (National Soil Taxonomy Handbook item 615.30), and resurrected in 1999 [6].

[4] Guthrie and Witty, 1982. Additional changes to lithologic discontinuities.

[5] Soil Survey Staff, 1998

[6] NRCS Soil Classification Staff, 1999; personal communication.

Horizon Suffixes

(also called “Horizon Subscripts,” and “Subordinate Distinctions”)

1951 [1]	1962 [2], 1975 [2]	1981 [3]	1998 [4]	1999 [5]
—	—	a	a	a
b	b	b	b	b
ca	ca	(see *k*)	(see *k*)	(see *k*)
cn	cn	c	c	c
—	co [6]	—	—	co [6]
cs	cs	(see *y*)	(see *y*)	(see *y*)
—	di [6]	—	—	di [6]
—	—	e	e	e
f	f	f	f	f
—	—	—	ff	ff
g	g	g	g	g
h	h	h	h	h
ir	ir	(see *s*)	(see *s*)	(see *s*)
—	—	i	i	i
—	—	—	j	j
—	—	—	jj	jj
(see *ca*)	(see *ca*)	k	k	k
m	m [7]	m	m	m
—	ma [6]	—	—	ma [6]
—	—	n	n	n
—	—	o	o	o
p	p	p	p	p
(see *si*)	(see *si*)	q	q	q
r [8]	—	r	r	r
(see *ir*)	(see *ir*)	s	s	s
—	si	(see *q*)	(see *q*)	(see *q*)
sa	sa	(see *n*)	(see *n*)	(see *n*)
—	—	—	ss (1991)	ss
t	t	t	t	t
u	—	—	—	—
—	—	v	v	v
—	—	w	w	w
—	x	x	x	x
(see *cs*)	(see *cs*)	y	y	y
sa	sa	z	z	z

[1] Soil Survey Staff, 1951.

[2] Soil Survey Staff, 1962; same content also used in Soil Taxonomy (Soil Survey Staff, 1975)

[3] Guthrie and Witty, 1982.

[4] Soil Survey Staff, 1998

[5] NRCS Soil Classification Staff, 1999; personal communication.

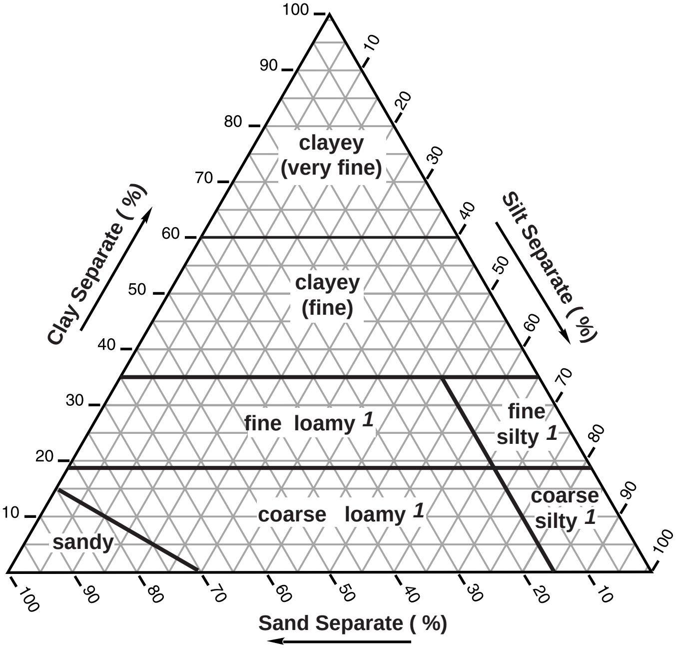
[6] Soil Survey Staff, 1975. Limnic materials (co, di, ma) were adopted in 1975, omitted in 1981 [3], formally dropped in 1985 (National Soil Taxonomy Handbook item 615.30), and resurrected in 1999 [5].

[7] The definition is changed to no longer include fragipans (which become "x").

[8] Definition of **r** (1951; dropped 1962 [2]) is not the same as used since 1981 [3].

Texture Triangle

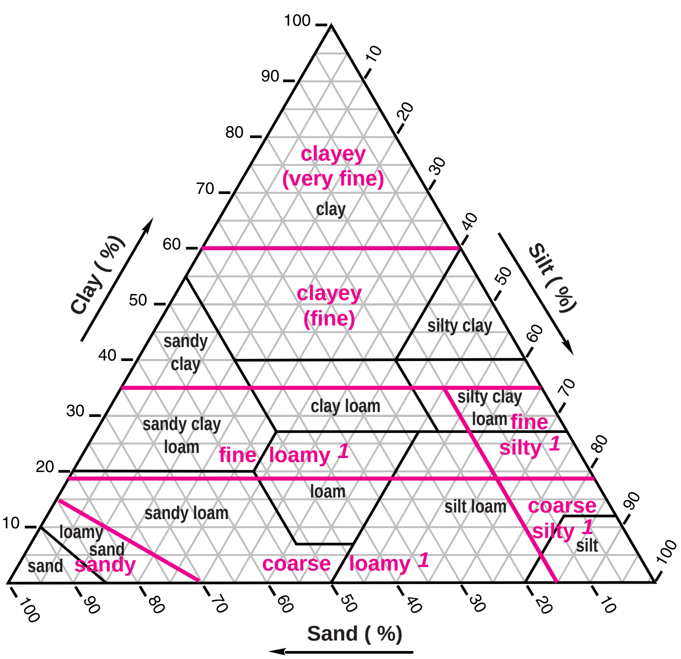
Soil textural family classes (▬)



[1] Very fine sand fraction (0.05 – 0.1 mm) is treated as silt for Soil Taxonomy family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between silty and loamy classes.

Combined Texture Triangles

Fine earth texture classes (——)
Soil textural family classes (——)



[1] Very fine sand fraction (0.05 – 0.1 mm) is treated as silt for Soil Taxonomy family groupings; coarse fragments are considered the equivalent of coarse sand in the boundary between silty and loamy classes.

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GEOLOGY

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INTRODUCTION

The purpose of this section is to expand and augment the geologic information found or needed in the “Site Description Section” and “Soil Profile Description Section”.

BEDROCK - KIND

This table is repeated here from the “Site Selection Section” for convenience in using the following rock charts.

Kind [1]	**Code**		**Kind** [1]	**Code**	
	PDP	**NASIS**		**PDP**	**NASIS**
IGNEOUS - INTRUSIVE					
anorthosite	—	ANO	pyroxenite	—	PYX
diabase	—	DIA	quartz-diorite	—	QZD
diorite	—	DIO	quartz-monzonite	—	QZM
gabbro	—	GAB	syenite	—	SYE
granite	I4	GRA	syenodiorite	—	SYD
granodiorite	—	GRD	tachylite	—	TAC
monzonite	—	MON	tonalite	—	TON
peridotite	—	PER	ultramafic rock [2]	—	UM
IGNEOUS - EXTRUSIVE					
a’a lava	P8	AAL	pahoehoe lava	P9	PAH
andesite	I7	AND	pillow lava	—	PIL
basalt	I6	BAS	pumice *(flow, coherent)*	E6	PUM
block lava	—	BLL	rhyolite	—	RHY
dacite	—	DAC	scoria *(coherent mass)*	E7	SCO
latite	—	LAT	trachyte	—	TRA
obsidian	—	OBS			

Kind [1]	Code		Kind [1]	Code	
	PDP	NASIS		PDP	NASIS
IGNEOUS - PYROCLASTIC					
ignimbrite	—	IGN	tuff, welded	—	TFW
pyroclastics *(consolidated)*	P0	PYR	tuff breccia	P7	TBR
pyroclastc flow	—	PYF	volcanic breccia	P4	VBR
pyroclastic surge	—	PYS	volcanic breccia, acidic	P5	AVB
tuff	P1	TUF	volcanic breccia, basic	P6	BVB
tuff, acidic	P2	ATU	volcanic sandstone	—	VST
tuff, basic	P3	BTU			
METAMORPHIC					
amphibolite	—	AMP	metavolcanics	—	MVO
gneiss	M1	GNE	mica schist	—	MSH
granofels	—	GRF	migmatite	—	MIG
granulite	—	GRL	mylonite	—	MYL
greenstone	—	GRE	phyllite	—	PHY
hornfels	—	HOR	schist	M5	SCH
marble	L2	MAR	serpentinite	M4	SER
metaconglomerate	—	MCN	slate	M8	SLA
metaquartzite	M9	MQT	soapstone *(talc)*	—	SPS
metasedimentary rocks [2]	—	MSR			
SEDIMENTARY - CLASTICS					
arenite	—	ARE	mudstone	—	MUD
argillite	—	ARG	orthoquartzite	—	OQT
arkose	A2	ARK	porcellanite	—	POR
breccia, non-volcanic *(angular fragments)*	—	NBR	sandstone	A0	SST
breccia, non-volcanic, acidic	—	ANB	sandstone, calcareous	A4	CSS
breccia, non-volcanic, basic	—	BNB	shale	H0	SHA
claystone	—	CST	shale, acid	—	ASH
conglomerate *(rounded fragments)*	C0	CON	shale, calcareous	H2	CSH
conglomerate, calcareous	C2	CCN	shale, clayey	H3	YSH
fanglomerate	—	FCN	siltstone	T0	SIS
glauconitic sandstone	—	—	siltstone, calcareous	T2	CSI
graywacke	—	GRY			

Kind [1]	***Code***		***Kind*** [1]	***Code***	
	PDP	**NASIS**		**PDP**	**NASIS**
EVAPORITES, ORGANICS, AND PRECIPITATES					
chalk	L1	CHA	limestone, arenaceous	L5	ALS
chert	—	CHE	limestone, argillaceous	L6	RLS
coal	—	COA	limestone, cherty	L7	CLS
dolomite (*dolostone*)	L3	DOL	limestone, phosphatic	L4	PLS
gypsum	—	GYP	travertine	—	TRV
limestone	L0	LST	tufa	—	TUA
INTERBEDDED *(alternating layers of different sedimentary lithologies)*					
limestone-sandst.-shale	B1	LSS	sandstone-shale	B5	SSH
limestone-sandstone	B2	LSA	sandstone-siltstone	B6	SSI
limestone-shale	B3	LSH	shale-siltstone	B7	SHS
limestone-siltstone	B4	LSI			

[1] Definitions for kinds of bedrock are found in the “Glossary of Landforms and Geologic Terms”, NSSH - Part 629 (Soil Survey Staff, 2001), or in the “Glossary of Geology” (Jackson, 1997).

[2] Generic term; use only with regional or reconnaissance surveys (e.g., Order 3, 4, 5; see Guide to Map Scales and Minimum—Size Delineations—p.7-7).

ROCK CHARTS

The following rock charts (**Igneous**, **Metamorphic**, and **Sedimentary and Volcaniclastic**) summarize grain size, composition, or genetic differences between related rock types. ***NOTE*:** 1) Most, but not all, of the rocks in these tables are found in the NASIS (and PDP) choice lists. Those not in NASIS are uncommon in the pedosphere but are included in the charts for completeness and to aid in the use of geologic literature. 2) Most, but not all of the rocks presented in these tables can be definitively identified in the field; some may require additional laboratory analyses; e.g., grain counts, thin section analyses, etc.

IGNEOUS ROCKS CHART

	KEY MINERIAL COMPOSITION							
CRYSTALLINE TEXTURE	***Acidic*** **(≈felsic)** Potassium (K) Feldspar > 2/3 of total Feldspar content		***Intermediate*** **(---)** Potassium (K) Feldspar and Plagioclase (Na, Ca) Feldspar in about equal proportions		***Basic*** **(≈mafic)** Plagioclase (Na, Ca) Feldspar > 2/3 of total feldspar content			***Ultrabasic*** **(≈ultramafic)** Pyroxene and olivine
					Sodic (Na) Plagioclase		Calcic (Ca) Plagioclase	
	Quartz	*No Quartz*	*Quartz*	*No Quartz*	*Quartz*	*No Quartz*		
PEGMATITIC (very coarse, uneven-sized crystal grains)	**granite pegmatite**	**syenite pegmatite**	← **monzonite-pegmatite** →			**diorite-pegmatite**	**gabbro pegmatite**	**peridotite** (mostly olivine)
PHANERITIC (crystals visible and of nearly equal size)	**granite**	**syenite**	**quartz monzonite**	**monzonite**	**quartz-diorite granodiorite**	**diorite**	**gabbro**	**pyoxenite** (mostly pyroxene)
PORPHYRITIC (relatively few visible crystals within a fine-grained matrix)	**granite porphyry**	**syenite porphyry**	**quartz monzonite porphyry**	**monzonite porphyry**	**quartz-diorite porphyry**	**diorite porphyry**	**diabase**	
	rhyolite porphyry	**trachyte porphyry**	**quartz-latite porphyry**	**latite porphyry**	**dacite porphyry**	**andesite porphyry**	**porphyry basalt**	
APHANITIC (crystals visible only with magnification) micro[1] crypto[2]	**rhyolite**	**trachyte**	**quartz latite**	**latite**	**dacite**	**andesite**	**basalt**	} **lava**[3]
GLASSY (amorphous: no crystalline structure)	obsidian (and its varieties: perlite, pitchstone, pumice , and scoria) pyroclastics are shown on the Sedimentary and Volcaniclastic Rocks chart.							

[1] Microcrystalline – crystals visible with ordinary magnification (hand lens, simple microscope).

[2] Cryptocrystalline – crystals only visible with SEM

[3] Lava – generic name for extrusive flows of non-clastic, aphanitic rocks (rhyolite, andesite, and basalt)

Schoeneberger and Wysocki, 1998

METAMORPHIC ROCKS CHART

NONFOLIATED STRUCTURE			CRUDE ALIGNMENT	FOLIATED STRUCTURE (e.g. banded, etc.)				
CONTACT METAMORPHISM			MECHANICAL METAMORPHISM	REGIONAL METAMORPHISM			PLUTONIC METAMROPHISM	
Low Grade	*Medium Grade*	*High Grade*	*Very Low Grade*		*Low Grade*	*Medium Grade*	*High Grade*	*Extreme Grade*
	granofels **hornfels** **marble** **metaquartzite** **serpentinite** **soapstone** *(talc)*		**crush breccia** **mylonite**	**slate**	**phyllite** **greenstone**	**schist** **amphibolite**	**gneiss** **granulite**	**migmatite**
			← metaconglomerate →					
			← metavolcanics →					

Schoeneberger and Wysocki, 1998

** Not all rock types listed here can be definitively identified in the field (e.g. may require grain counts)*

*** Not all rock types shown here are available on Bedrock-Kind choice list. They are included here for completeness and as aids to using geoligic literature.*

SEDIMENTARY AND VOLCANICLASTIC ROCKS

CLASTIC			
Dominant Grain Size			
Very Fine	**Fine**	**Medium**	**Coarse**
← *(Argillaceous)* →		*(Arenaceous)*	*(Rudaceous)*
<0.002 mm	0.002–0.06 mm	0.06 – 2.0 mm	>2.0 mm
← **argillite** → *(more indurated, less laminated and fissile)*		**Sandstones (ss):** **arenite**	**breccia** *(non-volcanic, angular frags)*
← **shale** → *(laminated, fissile)*		**arkose** *(mainly feldspar)*	
← **mudstone** → *(non-laminated non-fissile)* *(≈ equal clay and silt)*		**glauconitic ss** *("greensand")* **graywacke** *(dark, "dirty" ss)*	**conglomerate** *(non-volcanic, rounded frags)*
claystone *(non-laminated non-fissile)*	**siltstone** *(non-laminated non-fissile)*	**orthoquartzite** *(mainly quartz)*	
VOLCANICLASTICS *(includes Pyroclastics)*			
← **ignimbrite** →			**agglomerate** *(rounded frags)*
← **tuff** →			**volcanic breccia** *(angular frags)*
← **pumice** → *(specific gravity <1.0; highly vesicular)*			
← **scoria** → *(specific gravity >2.0; slightly to moderately vesicular)*			

NONCLASTIC			
Chemical		**Biochemical**	**Organic**
Evaporates	**Precipitates**	**Accretionates**	**Reduzates**
anhydrite *($CaSO_4$)*	**CARBONATE ROCKS** Limestones (ls) (>50% calcite)		
	chemical types	**accretionary types**	**black shale** *(organics and fine sediments)*
gypsum *($CaSO_4 \cdot 2H_2O$)*	**caliche** **travertine** **tufa**	**biostromal ls** **organic reef** **pelagic ls** **(chalk)**	
halite *(NaCl)*		**bio-clastic types** **coquina** **oolitic ls** **lithographic ls**	bituminous ls bog iron ores **coal**
	(altered types): **dolomite** *(>50% calcite + dolomite)* **phosphatic limestone**		
OTHER NONCLASTIC ROCKS			
Siliceous rocks (SiO_2 dominated): **chert (jasper, chalcedony, opal)** **diatomite** **rock phosphate** **iron bearing rocks ($Fe\text{-}SiO_2$ dominated)**			

Schoeneberger and Wysocki, 2000.

Mass Movement (Mass Wasting) Types For Soil Survey

(Landforms, processes, and sediments)

LANDSLIDE

Movement Types :	***FALL*** *(Free fall, bouncing, or rolling)*	***TOPPLE*** *(Forward rotation over a point.)*	***SLIDE **** *(Net lateral displacement along a slip face.)*		***SPREAD*** *(A wet layer becomes "plastic", squeezes up and out and drags along intact blocks or beds; e.g. extrusion, liquefaction.)* **(= Lateral Spread)**	***FLOW*** *(The entire mass, wet or dry, moves as a viscous liquid.)*	***COMPLEX LANDSLIDE*** *[Combination of multiple (2 or more) types of movement.]*
Dominant Material			***Rotational Slide*** *(Lateral displacement along a concave slip face with backward rotation.)* *|←— Compound Slide —→|* *(Intermediate between rotational and translational; e.g. a compound rock slide*	***Translational Slide*** *(Lateral displacement, along a planar slip face; no rotation.)*			
Consolidated : (Bedrock) *(Bedrock masses dominant.)*	**rock fall**	**rock topple**	**rotational rock slide** (e.g. Toreva block)	**translational rock slide** *(=planar slide)* (e.g. **block glide**)	**rock spread** block spread	rock fragment flow *(e.g.* **rockfall avalanche** *=sturzstrom)*	*[no unique sub-types are recognized here, many possible.]* *Option: name the main movement types (e.g. a Complex Rock Spread - Debris Flow Landslide).*
Unconsolidated : Coarser *(Coarse fragments dominant.)*	**debris fall**	**debris topple**	**rotational debris slide** ←— **debris slide** —→	**translational debris slide**	**debris spread**	**debris avalanche** *(drier, steep slope)* **debris flow** *(wetter)* *(e.g.* **lahar***)*	
Finer *(Fine earth particles dominant.)*	earth fall (= **soil fall**)	**earth topple** (= soil topple)	**rotational earth slide**	**translational earth slide**	**earth spread** (e.g. **sand boil**)	**earth flow** (e.g. **creep**, loess flow, **mudflow, sandflow, solifluction**)	

(Slides, especially rotational slides, are commonly and imprecisely called "slumps".)*

Schoeneberger & Wysocki, 2000 *(developed from Cruden and Varnes, 1996)*

NORTH AMERICAN GEOLOGIC TIME SCALE [1]

Geologic Period	Geologic Epoch	Sub-Division	Oxygen Isotope Stage	Years (BP)
QUATERNARY	**Holocene**		(1)	0 to 10-12 ka*
	Late Pleistocene	Late Wisconsin	(2)	10-12 to 28 ka
		Middle Wisconsin	(3, 4)	28 to 71 ka
		Early Wisconsin *Late Sangamon*	(5a - 5d)	71 to 115 ka
		Sangamon	(5e)	115 to128 ka
	Pleistocene *Middle Pleistocene*	Late Middle Pleistocene *(Illinoian)*	(6 - 8)	128 to 300 ka
		Middle Middle Pleistocene	(9 - 15)	300 to 620 ka
		Early Middle Pleistocene	(16 - 19)	620 to 770 ka
	Early Pleistocene			770 ka to 1.64 Ma**
TERTIARY	**Pliocene**			1.64 to 5.2 Ma
	Miocene			5.2 to 23.3 Ma
	Oligocene			23.3 to 35.4 Ma
	Eocene			35.4 to 56.5 Ma
	Paleocene			56.5 to 65.0 Ma
CRETACEOUS	*Late Cretaceous*			65.0 to 97.0 Ma
	Early Cretaceous			97.0 to 145.6 Ma
JURASSIC				145.6 to 208.8 Ma
TRIASSIC				208.8 to ≈ 243.0 Ma
PERMIAN				≈ 243.0 to 290.0 Ma
PENNSYLVANIAN				290.0 Ma to 322.8 Ma
MISSISSIPPIAN				322.8 to 362.5 Ma
DEVONIAN				362.5 to 408.5 Ma
SILURIAN				408.5 to 439.0 Ma
ORDIVICIAN				439.0 to 510.0 Ma
CAMBRIAN				510.0 to ≈ 570.0 Ma
PRE-CAMBRIAN				> ≈ 570.0 Ma

* ka = x 1,000 **Ma = x 1,000,000 (≈ = approximately)

[1] Modified from Morrison, 1991; Sibrava, et al., 1986; and Harland, et al., 1990.

TILL TERMS

Genetic classification and relationships of till terms commonly used in soil survey.
(Schoeneberger and Wysocki, 2000; adapted from Goldthwaite and Matsch, 1988.)

Location (Facies of tills grouped by position at time of deposition)	**Till Types**	
	Terrestrial	**Waterlaid**
Proglacial Till (at the front of, or in front of glacier)	proglacial **flow till**	waterlaid **flow till**
Supraglacial Till (on top of, or within upper part of glacier)	supraglacial **flow till** [1, 3] supraglacial **melt-out till** [1] (ablation till - NP) [1] (lowered till - NP) [2] (sublimation till - NP) [2]	———————
Subglacial Till (within the lower part of, or beneath glacier)	**lodgement till** [1] subglacial **melt-out till** subglacial **flow till** (= “squeeze till” [2, 3]) (basal till - NP) [1] (deformation till - NP) [2] (gravity flow till - NP) [2]	waterlaid **melt-out till** waterlaid **flow till** iceberg till (= “ice-rafted”)

[1] *Ablation till* and *basal till* are generic terms that only describe “relative position” of deposition and have been widely replaced by more specific terms that convey both relative position and process. *Ablation till* (any comparatively permeable debris deposited within or above stagnant ice) is replaced by *supraglacial melt-out till*, *supraglacial flow till*, etc. *Basal till* (any dense, non-sorted subglacial till) is replaced by *lodgement till*, *subglacial melt-out till*, *subglacial flow till*, etc.

[2] Additional (proposed) till terms that are outdated or have not gained wide acceptance, and considered to be *Not Preferred*, and should not be used .

[3] Also called *gravity flow till* (not preferred).

PYROCLASTIC TERMS

(Schoeneberger and Wysocki, 2002)

Pyroclasts and Pyroclastic Deposits (Unconsolidated)

Size
Scale: 0.062 mm [1] 2 mm 64 mm [1]

tephra (all ejecta)			
ash [1]		**cinders** [2] (specific gravity > 1.0 & < 2.0)	**bombs** [1] (fluid-shaped coarse fragments)
fine ash [1]	**coarse ash** [1]		
		lapilli [1] (specific gravity > 2.0)	**blocks** [1] (angular-shaped coarse fragments)
		scoria [2] (slightly to moderately vesicular; specific gravity > 2.0)	
	pumiceous ash [3]	**pumice** (highly vesicular; specific gravity < 1.0)	
Associated Lithified (Consolidated) Rock Types			
fine tuff [1]	**coarse tuff** [1]	**lapillistone** [1] (sp. gr. > 2.0)	**pyroclastic breccia**
welded tuff [1]		**agglomerate** [1] (rounded, volcanic coarse fragments)	
ignimbrite (consolidated ash flows and nuee ardentes)		**volcanic breccia** [1] (angular, volcanic coarse fragments)	

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[1] These size breaks are taken from geologic literature (Fisher, 1989) and based on the modified Wentworth scale. The 0.062 mm break is very close to the USDA's 0.05 mm break between *coarse silt* and *very fine sand* (Soil Survey Staff, 1993). The 64 mm break is relatively close to the USDA's 76 mm break between *coarse gravel* and *cobbles*. (See "Comparison of Particle Size Classes in Different Systems" in the "Profile / Pedon Description Section," under "Soil Texture".)

[2] A lower size limit of 2 mm is required in Soil Taxonomy (Soil Survey Staff, 1994; p. 54), but is not required in geologic usage (Fisher, 1989).

[3] The descriptor for pumice particles < 2 mm, as used in Soil Taxonomy (Soil Survey Staff, 1999). Geologic usage does not recognize any size restrictions for pumice.

HIERARCHICAL RANK OF LITHOSTRATIGRAPHIC UNITS [1, 2, 3]

Supergroup – The broadest lithostratigraphic unit. A supergroup is an assemblage of related, superposed groups, or groups and formations. Supergroups are most useful in regional or broad scale synthesis.

Group – The lithostratigraphic unit next in rank below a supergroup. A group is a named assemblage of related superposed formations, which may include unnamed formations. Groups are useful for small-scale (broad) mapping and regional stratigraphic analysis.

Formation – (Called **Geologic Formation** in NASIS) The basic lithostratigraphic unit used to describe, delimit, and interpret sedimentary, extrusive igneous, metavolcanic, and metasedimentary rock bodies (excludes metamorphic and intrusive igneous rocks) based on lithic characteristics and stratigraphic position. A formation is commonly, but not necessarily, tabular and stratified and is of sufficient extent to be mappable at the Earth's surface or traceable in the subsurface at conventional map scales.

[Formations can be, but are not necessarily, combined to form higher rank units (groups and supergroups), or subdivided into lower rank units (members or beds).]

Member – The formal lithostratigraphic unit next in rank below a formation and always part of a formation. A formation need not be divided selectively or entirely into members. A member may extend laterally from one formation to another.

Specifically defined types of Members:
Lens (or Lentil): A geographically restricted member that terminates on all sides within a formation.

(continued)

Tongue : A wedge-shaped member that extends beyond the main formation boundary or that wedges or pinches out within another formation.

Bed – The smallest formal lithostratigraphic unit of sedimentary rock. A bed is a subdivision of a member based upon distinctive characteristics and/ or economic value (e.g. coal bed). Members need not be divided selectively or entirely into beds.

Flow – The smallest formal lithostratigraphic unit of volcanic rock. A flow is a discrete, extrusive, volcanic body distinguishable by texture, composition, superposition, and other criteria.

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[1] Lithostratigraphic units are mappable rock or sediment bodies that conform to the Law of Superposition (Article 2, Section A).

[2] Proposed as separate data element in NASIS.

[3] Adapted from: North American Stratigraphic Code. (North American Commission on Stratigraphic Nomenclature, 1983)

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LOCATION

Compiled by: P.J. Schoeneberger, W.C. Lynn, D.A. Wysocki, E.C. Benham, NRCS, Lincoln, NE.

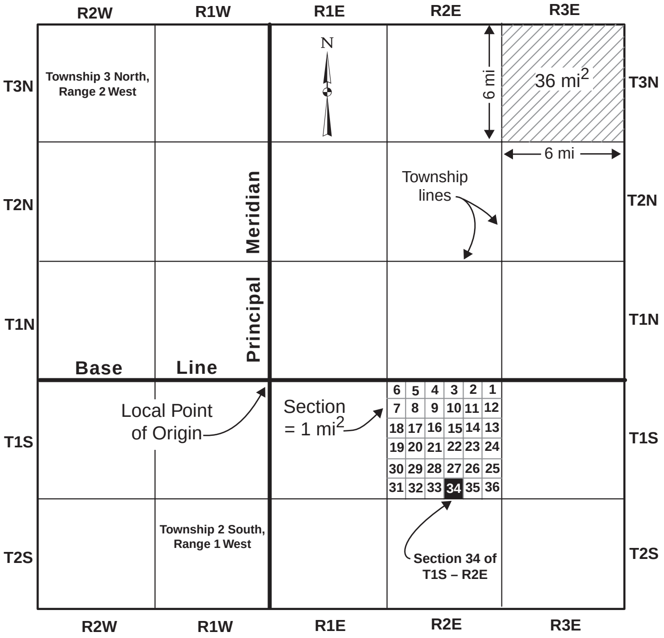
PUBLIC LAND SURVEY

The Public Land Survey is the most widely used scheme in the U.S. for land surveying (legal location). Historically, many soil descriptions have been located using this system. Some states are not part of the Public Land Survey System and use the State Plane Coordinate System. The states include Connecticut, Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio (parts), Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia.

The Public Land Survey System consists of a standard grid composed of regularly spaced squares which are uniquely numbered in reference to north-south Principal Meridians and to various, local, east-west Base lines. These squares are shown on U.S. Geological Survey topographic maps.

TOWNSHIPS and RANGES - The primary grid network consists of squares (6 miles on a side) called townships. Each township can be uniquely identified using two coordinates: 1) **Township** (the north-south coordinate relative to a local, east-west base line); and 2) **Range** (the east-west coordinate relative to a local north-south Principal Meridian). (The local base lines and Principal Meridians for the coterminous U.S. are shown on pp. 82-83, Thompson, 1987.) Commonly in soil survey, the local base line and the Principal Meridian are not recorded. The name of the appropriate USGS topographic 7.5-minute or 15-minute quadrangle is recorded instead; e.g., *Pleasant Dale, NE, 7.5 min. Quad*.

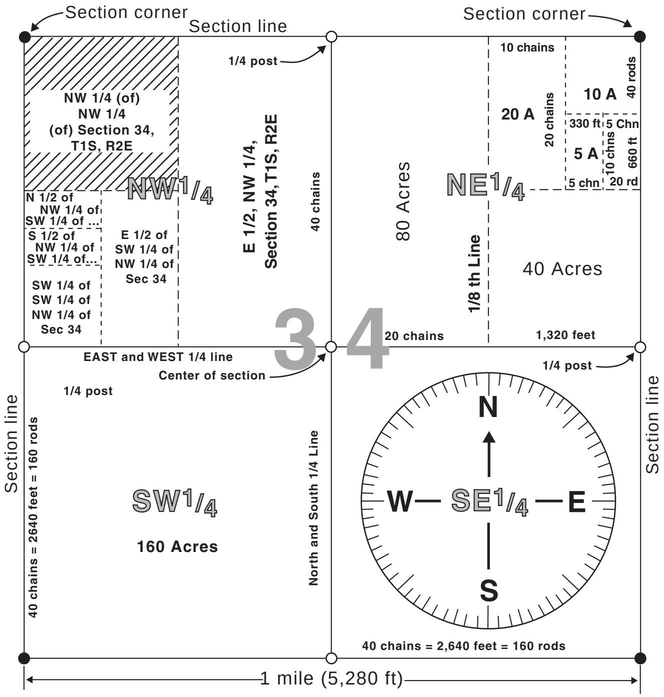
The **Township numbers** run in rows that parallel the local Base line. Each Township row is sequentially numbered relative to the row's distance from, and whether it's north (N) or south (S) of the local Base line; e.g., *T2N* (for the second township row north of the local Base line). The **Range numbers** run in rows that parallel the local Principal Meridian. Range rows are sequentially numbered relative to the row's distance from, and whether it's east (E) or west (W) of the Principal Meridian e.g., *R2E* (for the second Range row east of the Principal Meridian in the area). The combined coordinates identify a unique square in the area; e.g., *T1S, R2E* (for Township 1 South and Range 2 East).



Modified from Mozola, 1989.

SECTIONS - Each township square is further subdivided into smaller squares called **sections**, which make up the secondary grid in this location system. sections are 1 mile on a side (for a total of 36 sections within each township). The section numbers begin in the northeast corner of a township and progress sequentially in east-west rows, wrapping back and forth to fill in the township; e.g., *Section 34, T1S, R2E* (for Section 34 of Township 1 South, Range 2 East).

CAUTION: Due to the curvature of the earth (trying to fit a flat grid to a non-flat surface), inaccessible areas (e.g., large swamps), or to joins to other survey schemes (e.g., pre-existing Metes and Bounds), you will occasionally find irregularities in the grid system. Adjustments to the grid layout result in non-standard sized, partial sections and/or breaks in the usual numbering sequence of sections. In some areas, **Lots** are appended to the northern-most tier of sections in a township to enable the adjoining township to begin along the base line.



Modified from Mozola, 1989.

SUB-DIVISIONS - The tertiary (lower) levels of this system consist of subdividing sections into smaller pieces that are halves or quarters of the Section. The fraction (1/2, 1/4) that the area of land represents of the section is combined with the compass quadrant that the area occupies within the section; e.g., *SW 1/4, Section 34, T1S, R2E* (for the southwest quarter of Section 34, Township 1 South, Range 2 East). Additional subdivisions, by quarters or halves, can be continued to describe progressively smaller areas. The information is presented consecutively, beginning with the smallest subdivision; e.g., *N 1/2, NW 1/4, SW 1/4, NW 1/4, of Section 34, T1S, R2E* (for the north half of the northwest quarter of the southwest quarter of the northwest quarter of Section 34, Township 1 South, Range 2 East).

NOTE: **Point locations** (e.g., soil pits) are measured, traditionally in English units, with reference to a specified section corner or quarter corner (1/4 post); e.g., *660 feet east and 1320 feet north of southwest corner post, Section 34, T1S, R2E*.

STATE PLANE COORDINATE SYSTEM

The State Plane Coordinate System is the second most widely used scheme in the U.S. for land surveying (legal location). Historically, many soil descriptions have been located using this system. The states that have used this system are: Connecticut, Delaware, Georgia, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio (parts), Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia. The other states use the Public Land Survey System.

The State Plane Coordinate System is based upon two Principal lines in the state; a north-south line and an east-west line. Most USGS topographic quadrangle maps indicate the state grids by tick marks along the neatlines (outer-most border) on 7.5-minute topographic maps of states that use State Plane Coordinates.

Specific coordinates for a point are described by distance (commonly in meters) and primary compass direction [north (northing) / south (southing) and east (easting) / west (westing)] relative to the Principal lines; e.g., *10,240 m easting, and 1,234 m northing*.

Contact the local State NRCS Office or the Regional MO Office for state-specific details.

UNIVERSAL TRANSVERSE MERCATOR (UTM) RECTANGULAR COORDINATE SYSTEM

The Universal Transverse Mercator (UTM) Rectangular Coordinate System is widely available and has been advocated as the universal map coordinate standard by the USGS (Morrison, 1987). It is a metric-based system whose primary unit of measure is the meter. The dominant UTM grid circles the globe and spans latitudes from 80 °S through 84 °N (the extreme polar areas require a different projection). The dominant grid is divided into 60 zones around the world. Zones begin at the International Date Line Meridian in the Pacific and progress eastward around the world. Each zone extends from 80 °S through 84 °N latitude and spans 6 degrees of longitude. The logic of the UTM grid is similar to that of State Plane Coordinates. The UTM System uses 2 values and a zone letter to arrive at unique coordinates for any point on the earth’s surface: 1) distance (and direction) away from the Equator called **northing** (or **southing**) to identify the hemisphere, and 2) distance away from the local zone’s meridian called an **easting**.

Around the perimeter of 7.5-minute USGS topographic quadrangle maps are blue tic marks which intersect the map boundary at 1 km intervals. The Northing measures the distance from the Equator northward; e.g., *4, 771,651 meters N* (in the Southern Hemisphere the Southing measures the distance from the Equator southward). The easting measures the distance eastward from the local Meridian (the same Easting designation is used in the Southern Hemisphere); e.g., *305, 904 meters E*. A complete example: *305, 904 meters E; 4, 771,651 meters N; 16, N* (for the location of the capitol dome in Madison, Wisconsin, which is located within zone 16).

If the USGS topographic map has a complete kilometer grid (shown in blue), measure the distance (cm) from the point of interest to the closest north-south reference line (to the west of the point of interest). If the map scale is 1:24000, multiply the measured distance (cm) by 240 to calculate the actual ground distance in meters. If the scale is 1:20000, multiply by 200, etc. Add this partial distance to that of the chosen km reference line to obtain the easting to be recorded.

If no kilometer grid is shown on the topographic map, locate the kilometer tic points along the east-west perimeters immediately south of the point of interest. Place a straight edge between the tic marks and draw a line segment south of the point of interest. Measure the distance (cm) from the point of interest to the east-west line segment. Multiply this distance by the appropriate map scale factor as mentioned above. Add this distance to that of the east-west base line to obtain the Northing (distance from the Equator). The Northing must be identified as *N* for sites north of the Equator and *S* for sites south of the Equator.

Alternatively, a variety of clear UTM templates are commercially available which can be overlain upon the topographic map to facilitate determining distances and coordinates.

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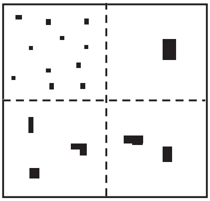
MISC.

MISCELLANEOUS

Compiled by: P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, H.E. LaGarry,
NRCS, Lincoln, NE.

EXAMPLES OF PERCENT OF AREA COVERED

The following graphic can be used for various data elements to convey "Amount" or "Quantity." ***NOTE***: Within any given box, each quadrant contains the same total area covered, just different sized objects.



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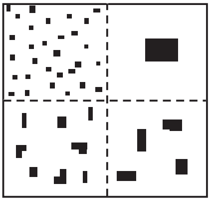

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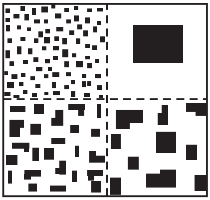

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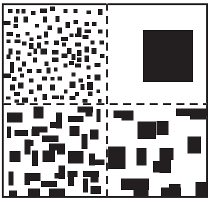

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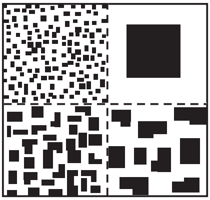

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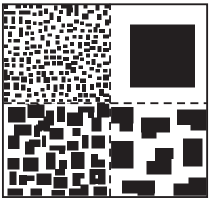

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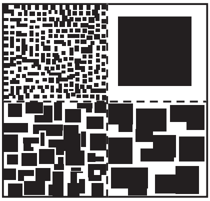

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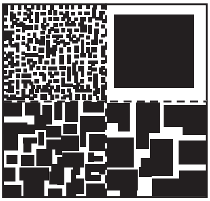

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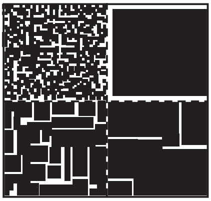


90%

MEASUREMENT EQUIVALENTS & CONVERSIONS

METRIC TO ENGLISH

Known	Symbol	Multiplier	Product	Symbol
LENGTH				
micrometers (microns)	*µm*	3.9370	inches	*in* or ″
(=10,000 Angstrom units)		x 10^{-5}		
millimeters	*mm*	0.03937	inches	*in* or ″
centimeters	*cm*	0.0328	feet	*ft* or ′
centimeters	*cm*	0.3937	inches	*in* or ″
meters	*m*	3.2808	feet	*ft* or ′
meters	*m*	1.0936	yards	*yd*
kilometers	*km*	0.6214	miles (statute)	*mi*
AREA				
square centimeters	cm^2	0.1550	square inches	in^2
square meters	m^2	10.7639	square feet	ft^2
square meters	m^2	1.1960	square yards	yd^2
square kilometers	km^2	0.3861	square miles	mi^2
hectares	*ha*	2.471	acres	*ac*
VOLUME				
cubic centimeters	cm^3	0.06102	cubic inches	in^3
cubic meters	m^3	35.3146	cubic feet	ft^3
cubic meters	m^3	1.3079	cubic yards	yd^3
cubic meters	m^3	0.0008107	acre-feet (= 43,560 ft^3)	*acre-ft*
cubic kilometers	km^3	0.2399	cubic miles	mi^3
liters (=1000 cm≈)	*l*	1.0567	quarts (U.S.)	*qt*
liters	*l*	0.2642	gallons (U.S.)	*gal*
milliliter	*ml*	0.0338	fluid ounces	*oz*
1 milliliter = 1 cm^3 = 1 gm (H_20, at 25°C)				
MASS				
grams	*g*	0.03527	ounces (avdp.)	*oz*
kilograms	*kg*	2.2046	pounds (avdp.)	*lb*
megagrams (= metric tons)	*Mg*	1.1023	short tons (2000 lb)	
megagrams	*Mg*	0.9842	long tons (2240 lb)	

ENGLISH TO METRIC

Known	Symbol	Multiplier	Product	Symbol
LENGTH				
inches	*in* or ″	2.54 x 10^4	micrometers (microns)	*μm*
			[= 10,000 Angstrom units (A)]	
inches	*in* or ″	2.54	centimeters	*cm*
feet	*ft* or ′	30.48	centimeters	*cm*
feet	*ft* or ′	0.3048	meters	*m*
yards	*yd*	0.9144	meters	*m*
miles (statute)	*mi*	1.6093	kilometers	*km*
AREA				
square inches	in^2	6.4516	sq. centimeters	cm^2
square feet	ft^2	0.0929	sq. meters	m^2
square yards	yd^2	0.8361	sq. meters	m^2
square miles	mi^2	2.5900	sq. kilometers	km^2
acres	*ac*	0.405	hectares	*ha*
VOLUME				
acre-feet	*acre-ft*	1233.5019	cubic meters	m^3
acre-furrow-slice	*afs*	= 6 in. thick layer that's 1 acre in area		
≈ 2,000,000 lbs	(assumes b.d. = 1.3 g/cm^3)			
cubic inches	in^3	16.3871	cubic centimeters	cm^3
cubic feet	ft^3	0.02832	cubic meters	m^3
cubic yards	yd^3	0.7646	cubic meters	m^3
cubic miles	mi^3	4.1684	cubic kilometers	km^3
gallons (U.S. liquid)	*gal*	3.7854	liters	*l*
(= 0.8327 Imperial gal)				
quarts (U.S. liquid)	*qt*	0.9463	liters (= 1000 cm^3)	*l*
ounces	*oz*	29.57	milliliters	*ml*
1 milliliter = 1 cm^3 = 1 gm (H_20, at 25 °C)				
MASS				
ounces (avdp.)	*oz*	28.3495	grams	*g*
ounces (avdp.)	(1 troy oz. = 0.083 lb)			
pounds (avdp.)	*lb*	0.4536	kilograms	*kg*
short tons (2000 lb)		0.9072	megagrams	*Mg*
			(= metric tons)	
long tons (2240 lb)		1.0160	megagrams	*Mg*

COMMON CONVERSION FACTORS

Known	Symbol	Multiplier	Product	Symbol
acres	*ac*	0.405	hectares	*ha*
acre-feet	*acre-ft*	1233.5019	cubic meters	m^3
acre-furrow-slice	*afs*	= 6 in. thick layer that's 1 acre square		
≈ 2,000,000 lbs	(assumes b.d. = 1.3 g/cm^3)			
Angstrom units	*A*	1x 10^{-8}	centimeters	*cm*
Angstrom units	*A*	1x 10^{-4}	micrometers	μm
Atmospheres	*atm*	1.0133 x 10^6	dynes/cm^2	
Atmospheres	*atm*	760	mm of mercury (Hg)	
BTU (mean)	*BTU*	777.98	foot-pounds	
centimeters	*cm*	0.0328	feet	*ft* or ′
centimeters	*cm*	0.3937	inches	*in* or ″
centimeters/hour	*cm/hr*	0.3937	inches/hour	*in/hr*
centimeters/second	*cm/s*	1.9685	feet/minute	*ft/min*
centimeters/second	*cm/s*	0.0224	miles/hour	*mph*
chain (US)		66	feet	*ft*
chain (US)		4	rods	
cubic centimeters	cm^3	0.06102	cubic inches	in^3
cubic centimeters	cm^3	2.6417 x 10^{-4}	gallons (U.S.)	*gal*
cubic centimeters	cm^3	0.999972	milliliters	*ml*
cubic centimeters	cm^3	0.0338	ounces (US)	*oz*
cubic feet	ft^3	0.02832	cubic meters	m^3
cubic feet (H_2O, 60 °F)	ft^3	62.37	pounds	*lbs*
cubic feet	ft^3	0.03704	cubic yards	yd^3
cubic inches	in^3	16.3871	cubic centimeters	cm^3
cubic kilometers	km^3	0.2399	cubic miles	mi^3
cubic meters	m^3	35.3146	cubic feet	ft^3
cubic meters	m^3	1.3079	cubic yards	yd^3
cubic meters	m^3	0.0008107	acre-feet (= 43,560 ft^3)	*acre-ft*
cubic miles	mi^3	4.1684	cubic kilometers	km^3
cubic yards	yd^3	0.7646	cubic meters	m^3
degrees (angle)	°	0.0028	circumfrences	
Faradays		96500	coulombs (abs)	
fathoms		6	feet	*ft*
feet	*ft* or ′	30.4801	centimeters	*cm*
feet	*ft* or ′	0.3048	meters	*m*
feet	*ft* or ′	0.0152	chains (US)	
feet	*ft* or ′	0.0606	rods (US)	

Known	Symbol	Multiplier	Product	Symbol
foot pounds		0.0012854	BTU (mean)	*BTU*
gallons (US)	*gal*	3.7854	liters	*l*
gallons (US)	*gal*	0.8327	Imperial gallons	
gallons (US)	*gal*	0.1337	cubic feet	*ft*^{3}
gallons (US)	*gal*	128	ounces (US)	*oz*
grams	*g*	0.03527	ounces (avdp.)	*oz*
hectares	*ha*	2.471	acres	*ac*
horsepower		2545.08	BTU (mean)/hour	
inches	*in* or ″	2.54 x 10^4	micrometers (micron) [= 10,000 Angstrom units (A)]	*μm*
inches	*in* or ″	2.5400	centimeters	*cm*
inches/hour	*in/hr*	2.5400	centimeters/hour	*cm/hr*
inches/hour	*in/hr*	7.0572	micrometers/sec	*μm/sec*
kilograms	*kg*	2.2046	pounds (avdp.)	*lb*
kilometers	*km*	0.6214	miles (statute)	*mi*
joules	*J*	1 x 10^7	ergs	
liters	*l*	0.2642	gallons (US)	*gal*
liters	*l*	33.8143	ounces	*oz*
liters (= 1000 cm^3)	*l*	1.0567	quarts (US)	*qt*
long tons (2240 lb)		1.0160	megagrams	*Mg*
megagrams (= metric tons)	*Mg*	1.1023	short tons (2000 lb)	
megagrams	*Mg*	0.9842	long tons (2240 lb)	
meters	*m*	3.2808	feet	*ft* or ´
meters	*m*	39.37	inches	*in*
micrometers (microns)	*μm*	1.000	microns	*μ*
micrometers/second	*μm/sec*	0.1417	inches/hour	*in/hr*
micron	*μ*	1 x 10^{-4}	centimeters	*cm*
microns (=10,000 Angstrom units)	*μ*	3.9370 x 10^{-5}	inches	*in* or ″
micron	*μ*	1.000	micrometer	*μm*
miles (statute)	*mi*	1.6093	kilometers	*km*
miles/hour	*mph*	44.7041	cent./second	*cm/s*
miles/hour	*mph*	1.4667	feet/second	*ft/s*
milliliter	*ml*	0.0338	fluid ounces	*oz*
1 milliliter ≈ 1 cm^3 = 1 gm (H_2O, at 25 °C)				
milliliter	*ml*	1.000028	cubic centimeters	*cm*^{3}
millimeters	*mm*	0.03937	inches	*in* or ″
ounces	*oz*	29.5729	milliliters	*ml*
1 milliliter ≈ 1 cm^3 = 1 gm (H_2O, at 25 °C)				

Known	Symbol	Multiplier	Product	Symbol
ounces (avdp.)	*oz*	28.3495	grams	*g*
ounces (avdp.) 1 troy oz. = 0.083 lb				
pints (US)	*pt*	473.179	cubic centimeters	cm^3 or *cc*
pints (US)	*pt*	0.4732	liters	*l*
pounds (avdp.)	*lb*	0.4536	kilograms	*kg*
quarts (US liquid)	*qt*	0.9463	liters (= 1000 cm^3)	*l*
rods (US)		0.25	chains (US)	*ft*
rods (US)		16.5	feet (US)	*ft*
short tons (2000 lb)		0.9072	megagrams (= metric tons)	*Mg*
square centimeters	cm^2	0.1550	square inches	in^2
square feet	ft^2	0.0929	square meters	m^2
square inches	in^2	6.4516	sq. centimeters	cm^2
square kilometers	km^2	0.3861	square miles	mi^2
square meters	m^2	10.7639	square feet	ft^2
square meters	m^2	1.1960	square yards	yd^2
square miles	mi^2	2.5900	square kilometers	km^2
square yards	yd^2	0.8361	square meters	m^2
yards	*yd*	0.9144	meters	*m*

Guide to Map Scales and Minimum-Size Delineations [1]

Order of Soil Survey	Map Scale	Inches Per Mile	Minimum Size Delineation [2]	
			Acres	Hectares
Order 1	1:500	126.7	0.0025	0.001
	1:1,000	63.4	0.100	0.004
	1:2,000	31.7	0.040	0.016
	1:5,000	12.7	0.25	0.10
	1:7,920	8.0	0.62	0.25
	1:10,000	6.34	1.00	0.41
Order 2	1:12,000	5.28	1.43	0.6
	1:15,840	4.00	2.50	1.0
	1:20,000	3.17	4.00	1.6
	1:24,000 [3]	2.64	5.7	2.3
Order 3	1:30,000	2.11	9.0	3.6
	1:31,680	2.00	10.0	4.1
Order 4	1:60,000	1.05	36	14.5
	1:62,500 [4]	1.01	39	15.8
	1:63,360	1.00	40	16.2
Order 5	1:80,000	0.79	64	25.8
	1:100,000	0.63	100	40
	1:125,000	0.51	156	63
	1:250,000	0.25	623	252
	1:500,000	0.127	2,500	1,000
	1:750,000	0.084	5,600	2,270
Very General	1:1,000,000	0.063	10,000	4,000
	1:7,500,000	0.0084	560,000	227,000
	1:15,000,000	0.0042	2,240,000	907,000

[1] Modified from: Peterson, F.F. 1981. Landforms of the Basin and Range Province, defined for Soil Survey. Nevada Agricultural Experiment Station, Technical Bulletin No. 28, Reno, NV.

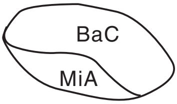
[2] Traditionally, the minimum size delineation is assumed to be a 1/4 inch square, or a circle with an area of 1/16 inches^2. Cartographically, this is about the smallest area in which a conventional soil map symbol can be legibly printed. Smaller areas can, but rarely are, delineated and the symbol "lined in" from outside the delineation.

[3] Corresponds to USGS 7.5-minute topographic quadrangle maps.

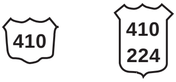
[4] Corresponds to USGS 15-minute topographic quadrangle maps.

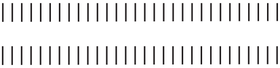
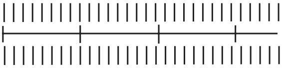
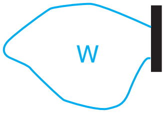
COMMON SOIL MAP SYMBOLS (TRADITIONAL)

(From the National Soil Survey Handbook, Title 170, Part 601, 1990.) The following symbols are common on field sheets (original aerial photograph based soil maps) and in many soil surveys published prior to 1997. Current guidelines for map compilation symbols are in NSSH, Exhibit 627-5, 2001

FEATURE	**SYMBOL**
LANDFORM FEATURES	
SOIL DELINEATIONS:	
ESCARPMENTS:	
Bedrock	V V V V V V V V (Points down slope)
Other than bedrock	▼ ▼ ▼ ▼ ▼ ▼ (Points down slope)
SHORT STEEP SLOPE	• • • • • • • • • • • • •
GULLY	∿∿∿∿∿∿∿∿∿∿∿∿∿∿
DEPRESSION, *closed*	◆
SINKHOLE	◇
Prominent hill or peak	✹
EXCAVATIONS:	
Soil sample site (Type location, etc.)	Ⓢ
Borrow pit	⊠
Gravel pit	
Mine or quarry	
LANDFILL	

FEATURE	SYMBOL
MISC. SURFACE FEATURES:	
Blowout	
Clay spot	
Gravelly spot	
Lava flow	
Marsh or swamp	
Rock outcrop *(includes sandstone and shale)*	
Saline spot	
Sandy spot	
Severely eroded spot	
Slide or slip *(tips point upslope)*	
Sodic spot	
Spoil area	
Stony spot	
Very stony spot	
Wet spot	

FEATURE	SYMBOL
ROAD EMBLEMS:	
Interstate	
Federal	
State	
County, farm or ranch	
CULTURAL FEATURES:	
RAILROAD	
POWER TRANSMISSION LINE *(normally not shown)*	
PIPELINE *(normally not shown)*	
FENCE *(normally not shown)*	

FEATURE	SYMBOL
CULTURAL FEATURES (cont'd)	
LEVEES:	
Without road	
With road	
With railroad	
Single side slope (showing actual feature location)	
DAMS	
Medium or small	
Large	

HYDROGRAPHIC FEATURES:

STREAMS:

Perennial, *double* line (large)	
Perennial, *single* line (small)	
Intermittent	
Drainage end or flow direction	

SMALL LAKES, PONDS AND RESERVOIRS:

Perennial water	
Miscellaneous water	
Flood pool line	
Lake or pond *(perennial)*	

MISCELLANEOUS WATER FEATURES:

Spring	
Well, artesian	
Well, irrigation	

MISCELLANEOUS CULTURAL FEATURES:

Airport	✈
Cemetery	
Farmstead, house *(omit in urban areas)*	■
Church	
School	
Other religion (label)	▲ **Mt Carmel**
Located object (label)	⊙ Ranger Station
Tank (label)	• Petroleum
Lookout tower	
Oil and/or Natural gas wells	
Windmill	
Lighthouse	

FIELD SAMPLING

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NRCS, Lincoln, NE.

INTRODUCTION

This section contains a variety of miscellaneous information pertinent to the sampling of soils in the field.

Additional details of soil sampling for the National Soil Survey Laboratory (NRCS, Lincoln, NE) are provided in Soil Survey Investigations Report No. 42 (Soil Survey Staff, 1996).

SOIL SAMPLING

The objective of the task determines the methodology and the location of the soil material collected for analysis. Sampling for Taxonomic Classification purposes involves different strategies than sampling for soil fertility, stratigraphy, hydric conditions, etc. There are several general types of samples and sampling strategies that are commonplace in soil survey.

SOIL SAMPLE KINDS -

Reference Samples (also loosely referred to as “grab” samples) - This is applied to any samples that are collected for very specific, limited analyses; e.g., only pH. Commonly, reference samples are not collected for all soil layers in a profile; e.g., only the top 10 cm; only the most root restrictive layer, etc.

Characterization Samples - These samples include sufficient physical and chemical soil analyses, from virtually all layers, to fully characterize a soil profile for Soil Taxonomic and general interpretive purposes. The specific analyses required vary with the type of material; e.g., a Mollisol requires some different analyses than does an Andisol. Nonetheless, a wide compliment of data (i.e., pH, particle size analysis, Cation Exchange Capacity, ECEC, Base Saturation, Organic Carbon content, etc.) are determined for all major soil layers.

SAMPLING STRATEGIES - [To be developed.]

Field Equipment Checklist

Digging Tools (commonly choose 1 or 2): see graphic

- Bucket Auger
- Sharp Shooter
- Montana Sharp Shooter (for rocky soils)
- Tile Spade (only for well cultivated or loose material)
- Spade (standard shovel)
- Push Probe (e.g., Backsaver®, Oakfield®, etc.) - include a clean-out tool
- Pulaski

Soil Description

- Knife
- Hand Lens (10X or combination lenses)
- Acid Bottle (1N - HCl)
- Water Bottle
- Color Book (e.g., Munsell®, EarthColors®, etc.)
- Picture Tapes (“pit tape” - metric preferred)
- Tape Measure (metric or English and metric)
- (3) Ultra-Fine Point Permanent Marker Pens
- Pocket pH Kit or Electronic “Wand”
- Pocket Soil Thermometer
- Camera
- Sample bags (for grab samples)
- Soil Description Sheet (232 or PEDON description form)

Site Description

- Field Note Book
- GPS Unit
- Abney Level
- Clinometer
- Compass
- Altimeter (pocket-sized)

Field References

- Field Book for Describing and Sampling Soils
- Aerial Photographs
- Topographic Maps (1:24,000, 7.5 min; 1:100,000)
- Geology Maps
- Soil Surveys (county or area)
- AGI Field Sheets

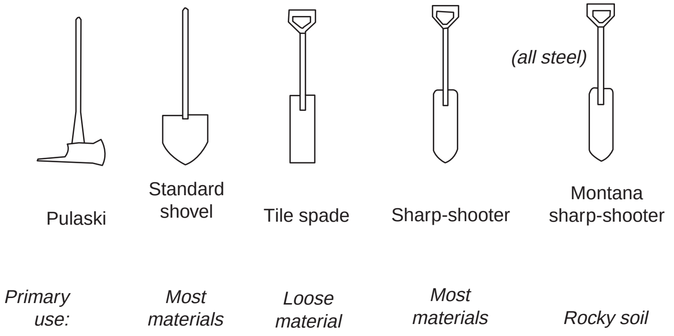
Personal Protective Gear

- Small First Aid Kit
- Leather Gloves
- Sunglasses
- Insect Repellent
- Sunscreen
- Hat
- Drinking water

EXAMPLES OF COMMON FIELD - SAMPLING EQUIPMENT

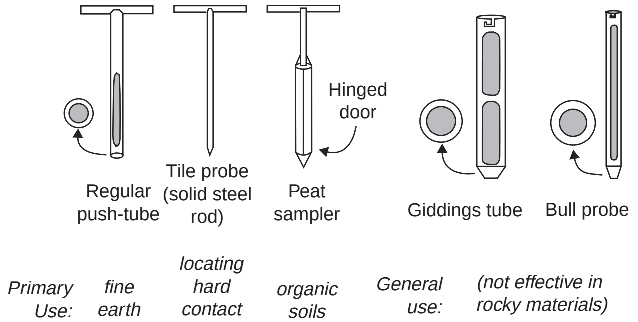
(Use of trade or company names is for informational purposes only and does not constitute an endorsement.)

Digging Tools / Shovel Types

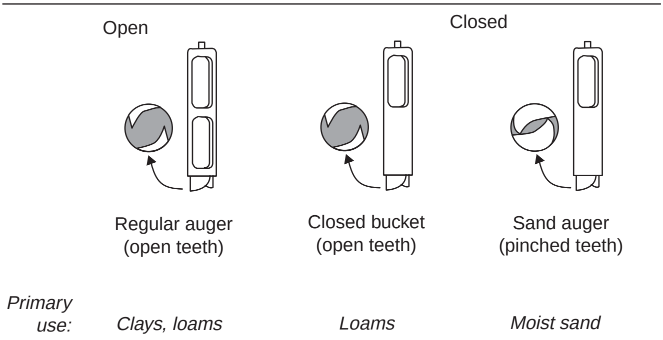


Soil Probes

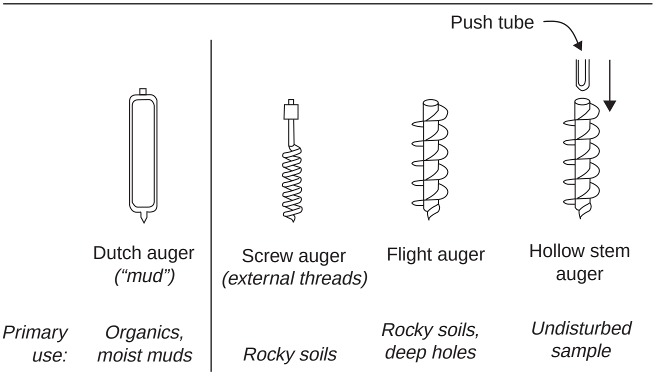
Hydraulic Probes



Bucket Auger Types



External Thread Augers



REFERENCES

Soil Survey Staff. 1996. Soil survey laboratory methods manual. USDA Natural Resources Conservation Service, Soil Survey Investigations Report No. 42, Version 3.0, National Soil Survey Center, Lincoln, NE. 693 pp.

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