

# *Reference Guideline #3*

## Soils Evaluation Guide



Ministry of  
Community, Sport and  
Cultural Development

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### SECTION ONE – LOT DESCRIPTION

#### Site Photos

Any photographs taken (35 mm or digital) should be documented by recording the roll number (if applicable) and the photo number(s) in this field. To facilitate photo retrieval, the Project Code and the Plot Number should be written on the back of prints. Digital image files should be named with project code and plot number and placed in a project specific directory.

#### Aerial Photography

Information on site location is often readily obtainable from aerial photographs. The site location should be clearly marked on the air

photo. Stereo coverage of the assessment area is recommended. In general, it is a good idea to use the largest scale and most recent photos available. In most cases the largest scale photos will not be the most recent available. In such cases, two sets of photos may be required. An abbreviated set of directions to the site might also be helpful. Record the aerial survey roll number (the letters followed by the four or five digit number, (e.g. AS1514) and the photo number (e.g. 170) of the air photo on which the sampled plot is located.

#### Topography

Topography refers to the physical features of an area, taken collectively, especially the relief and contours of the land. This is a macro view of the landscape and is not intended to represent the small area (e.g. slough) in which the excavation site is located.

**TABLE 1. Code definitions and descriptions**

CODE DESCRIPTION	
<i>Duned</i>	Mounds or ridges of sand piled up by the wind.
<i>Floodplains</i>	The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.
<i>Hummocky</i>	A complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. Slope lengths are usually quite short and the upper slopes are commonly eroded. Hummocky landforms are often described in terms of relief (the vertical distance from the top of the knolls to the bottom of the depressions). Three relief categories are used: 1) Low relief (3-10m), 2-10% slopes; 2) Moderate relief (5-20m), 5-15% slopes; and 3) High relief (>10m), >10% slopes. Indicate the appropriate relief category in the comments section.
<i>Inclined</i>	A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities.
<i>Level</i>	A flat or very gently sloping, unidirectional surface not broken by marked elevations or depressions, slopes generally less than 2%.
<i>Ridged</i>	A sequence of long, narrow elevations of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.
<i>Rolling</i>	A very regular sequence of moderate slopes extending from rounded, sometimes confined, concave depressions to broad, rounded convexities. Slopes are generally greater than 400m with a crest-depression-crest cycle distance of about 0.5-1 km.
<i>Stream Channels</i>	A stream channel which includes both valley walls and the watercourse itself.
<i>Undulating</i>	A sequence of gentle slopes that extend from rounded, sometimes confined concavities to broad, rounded convexities producing a wavelike pattern of low local relief (usually less than 5m). Slopes are generally less than 5%.
<i>Water</i>	The land surface is dominated by water.

### Slope

Record the slope of the land at the site to the nearest 1 percent. This data is to be collected using a clinometer or Abney level. Table 2 provides a few conversions between degree measurements and percent slope. The algebraic conversion from degrees to percent slope is:

$$\text{slope \%} = \tan (\text{degrees}) \times 100$$

*e.g., a 20-degree slope has a tangent of 0.36 and a slope of 36 percent*

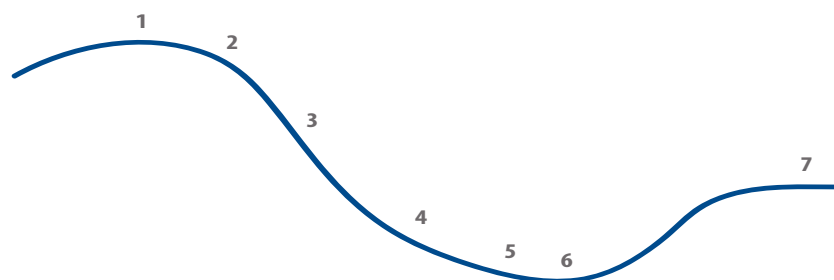
A slope of 0 % should be recorded for those sites that have no slope (a level site).

### Site Position

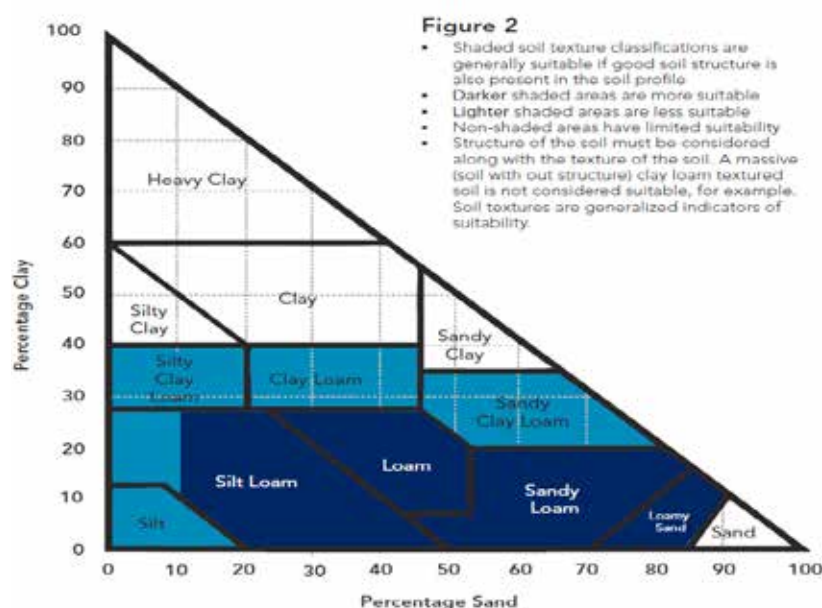
Site position describes the relative position of the sampling site within a catchment area, which is often within one of the major slope segments that are part of the regional landscape. The intent is to make it consistent with the scale of topography affecting surface water flow. The vertical difference between topographic highs and lows at this scale is usually between 3 m and 300 m, and the surface area exceeds 0.5 ha in size. Figure 1 illustrates the relationship of each site position relative to each other. For an explanation of the terms and the associated codes, see Table 1.

**TABLE 2.** Relationship between percent slope gradient and degrees slope gradient

DEGREES	PERCENT	DEGREES	PERCENT
0°	0	20°	36.4
2°	3.5	25°	46.6
4°	7	30°	57.7
6°	10.5	34°	70
8°	14	40°	83.9
10°	17.6	45°	100
12°	21.2	50°	119.2
15°	26.8		

**FIGURE 1.** Schematic cross sectional diagram illustrating application of terms of describe site position**TABLE 3.** Site Position definitions

POSITION	DEFINITION
<i>Crest (1)</i>	The uppermost portion of a hill, usually convex in all directions.
<i>Upper Slope (2)</i>	The upper portion of a slope immediately below the crest, it has a convex surface profile with a specific aspect (direction of view).
<i>Mid Slope (3)</i>	The area of the slope between the upper and lower slope. The mid slope generally is neither convex nor concave.
<i>Lower Slope (4)</i>	The lower portion of the slope immediately above the toe, it has a concave surface profile with a specific aspect.
<i>Toe (5)</i>	The lower most portion of the slope, marked by an abrupt decrease in slope percentage below and adjacent to the lower slope.
<i>Depression (6)</i>	Any area that is concave in all directions.
<i>Level (7)</i>	Any area that is horizontal with no distinct aspect.

**FIGURE 2.** Percentage of Clay and Sand

### Soil Subgroup

Soil taxonomy is classified according to The Canadian System of Soil Classification (Soil Classification Working Group 1998). Classification is to the subgroup level, which is a subdivision of a great group. The subgroup descriptor code is recorded to the left of the period and the great group code is recorded to the right of the period. For example:

Soil great group and subgroup codes and characteristics are listed in The Canadian System of Soil Classification (Soil Classification Working Group 1998).

**FIGURE 3. Soil Subgroup**

SOIL SUBGROUP	
	O. BLC
<i>for</i>	Orthic Black Chernozemic

### Parent Material

Parent material descriptions correspond to those in the Canadian System of Soil Classification (Soil Classification Working Group 1998), the Physical Land Classification Methodology (Kocaoglu 1990) and the Alberta Wetland Inventory Standards (Halsey et al. In prep.). The definitions and allowable codes for parent material are listed and defined in Table 5. These definitions have been extracted from the previously mentioned publications unless specified otherwise.

**TABLE 4. Codes and descriptions for parent material/Unconsolidated & Consolidated Mineral Components**

CODE	DESCRIPTION
<i>Till</i>	Unsorted and unstratified drift deposited directly by and underneath a glacier. It consists of a heterogeneous mixture of clay, silt, sand, gravel and boulders ranging widely in size and shape.
<i>Glaciolacustrine</i>	These materials are mainly well sorted, stratified sediments settled from suspension in lakes formed at the margins of glaciers.
<i>Glaciofluvial</i>	These deposits consist mainly of well sorted, stratified sediments deposited by running waters of streams and rivers associated with glaciers. Different types of glaciofluvial materials can be distinguished. Valley train materials are gravelly, coarse textured sediments in which the constituent sands and coarse fragments are well rounded and well sorted. Ice-contact materials are gravelly, coarse to fine textured materials; they are poorly sorted materials with angular to well rounded coarse fragments. Sandy outwash is very coarse to moderately coarse textured material that is non- to slightly stony.
<i>Lacustrine</i>	Post-glacial sediments that have settled from suspension in water occurring in depressions in the landscape. These are mainly thin deposits that are generally dark gray to grayish brown in colour. They are stone-free, and moderately fine, fine and very fine textured.
<i>Fluvial (Alluvium)</i>	These are variably textured, layered materials deposited by running water in stream channels, and fans and aprons at the base of steep slopes.
<i>Colluvial</i>	These are variably textured materials formed by downslope movement of materials. Colluvial materials are mainly associated with the relatively steep terrain of the foothills and mountains, and to some extent with the banks of coulees and river valleys.
<i>Eolian</i>	Sandy and silty materials that have been transported and deposited by wind action. Wind-blow, highly silty materials are called loess. Eolian materials commonly accumulate in dune formations and on the lee slopes of steep ridges.
<i>Organic</i>	Peat deposits and other organic remains in various stages of decomposition.
<i>Rock</i>	Bedrock which has been dug or blasted to create the pipeline trench.



### Soil Moisture

Soil moisture is recorded in general terms as an estimate of the soil moisture content (dry, moist, or wet) at the time of assessment.

### Soil Drainage

The classes defined in the CanSIS Manual for Describing Soils in the Field (Agriculture Canada Expert Committee on Soil Survey 1983), which are the classes officially adopted by the Canada Soil Survey Committee, are used in this manual. The soil drainage classes are defined in terms of

(1) actual moisture content in excess of field moisture capacity; and

(2) the extent of the period during which such excess water is present in the plant- root zone.

It is recognized that permeability, level of groundwater and seepage are factors affecting moisture status. These conditions are not easily observed or measured in the field; therefore, they generally cannot be used as criteria for drainage classes.

It is further recognized that soil profile morphology (e.g. mottling) normally, but not

always, reflects soil drainage. Although soil morphology may be a valuable field indicator of drainage class, it should not be the overriding criterion. For example, a soil may exhibit the morphology of a poorly drained soil, but recent changes (either natural or artificial) may result in the soil being imperfectly drained. Some well-drained soils are permanently mottled because of the nature and the distribution of minerals within them. Other soils subject to prolonged saturation under seepage conditions may retain bright colors and be un-mottled because saturating waters are oxygenated. Therefore, soil drainage classes cannot be based solely on the presence or absence of mottling.

Topographic position and vegetation, as well as other soil characteristics, are useful field criteria for assessing soil drainage classes. For codes and recommended definitions for the soil drainage classes, see Table 6. Additional comments provided with each class, indicate some of the pertinent soil morphological features that are commonly, but not exclusively found.

**TABLE 5. Soil Drainage Classes**

DRAINAGE	DESCRIPTION
<i>Very rapidly drained</i>	The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions. Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very limited water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse textured, or shallow, or both. Water source is precipitation.
<i>Rapidly drained</i>	The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions. Soils are free from any evidence of gleying or mottling throughout the profile. Rapidly drained soils often occur on steep slopes.
<i>Well drained</i>	The soil moisture content seldom exceeds field capacity in any horizon (except possibly the C) for a significant part of the year. Soils are usually free from mottling in the upper 1 m, but may be mottled below this depth.
<i>Moderately well drained</i>	The soil moisture remains in excess of field capacity for a small but significant period of the year. Soils are often faintly mottled in the lower B and C horizons or below a depth of 0.7 m. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium textured soils that have a slowly permeable layer below the A and B horizons. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.
<i>Imperfectly drained</i>	The soil moisture remains in excess of field capacity in subsurface horizons for moderately long periods during the year. Soils are often distinctly mottled in the B and C horizons; the Ae horizon (see Table 4), if present, may be mottled. The matrix generally has a lower chroma than in the well drained soil on similar parent material. Soils are generally “gleyed” subgroups of mineral soil orders.
<i>Poorly drained</i>	The soil moisture remains in excess of field capacity in all horizons for a large part of the year. The soils are usually strongly gleyed. Except in high chroma parent materials, the B, if present and upper C horizons usually have matrix chromas of three or fewer, prominent mottling may occur throughout. Soils are generally in the Gleysolic or Organic order.
<i>Very poorly drained</i>	Free water remains at or within 30 cm of the surface most of the year. The soils are usually strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present within 30 cm or at depth in the profile. Soils are generally in the Gleysolic or Organic order; mineral soils are usually a peaty phase.

### ***Samples***

The following procedure, taken from Describing Ecosystems in the Field (Luttmerding et al. 1990) is recommended for collecting soil samples. The value of laboratory analysis depends on the appropriate selection of sampling sites, the care with which samples are collected and the degree to which laboratory data can be related to the field descriptions. Soil samples should be related to the soil profile description. At a minimum, one sample should be collected from the soil profile at a depth below the proposed installation depth of the treatment system. Any potentially restrictive soil horizons or layers should also be sampled separately. For detail descriptions, each soil horizon identified on the description form should be sampled and samples should be representative of the entire cross section of the horizon. The soil should be fully described and the pit face cleaned from the top down and sampled from the bottom up to prevent contamination. Samples should be double bagged and labeled. The label should contain at least the following information:

#### ***Project Identification:***

- ▶ Assessor name and agency
- ▶ Date sample was taken
- ▶ Borehole, Pit, or Lot number
- ▶ Depth of the sample

#### ***Horizon Designation***

A soil horizon is a layer of mineral or organic soil, or soil material approximately parallel to the land surface that has characteristics determined by processes of soil formation. It differs from adjacent horizons in properties such as colour, structure, texture and consistency, and in chemical, biological and mineralogical composition. The Canadian System of Soil Classification (Soil Classification Working Group 1998) provides definitions of mineral and organic soil horizons, and definitions of diagnostic horizons and layers for soil classification purposes. Rules concerning horizon and transitional horizon

designations are also given. All organic and mineral soil horizon and layer designations should be coded in the allotted spaces: the uppermost (surface) horizon/layer first, followed by all subsequent horizons/layers in order, proceeding downward through the soil profile.

#### ***Discontinuity***

Discontinuities define layers (rock, water or other nonconforming, unconsolidated mineral layers) throughout or below the control section which are unaffected by soil forming processes. Discontinuities are to be recorded using the conventional Roman numerals (I, II, III).

#### ***Horizon***

The major mineral horizons are A, B and C. The major organic horizons are L, F and H, which are comprised mainly of forest litter in the various stages of decomposition, and O, which is derived primarily from wetland vegetation. Table 5 provides the characteristics of soil horizons, which contain organic material. See Soil Classification Working Group (1998) for further information regarding soil horizons. Record the appropriate upper case code for each horizon.

#### ***Suffixes***

Suffixes are utilized to further describe features of the major horizons. A complete listing of suffixes to be used for mineral horizons may be found on pages 12 to 16 of The Canadian System of Soil Classification (Soil Classification Working Group 1998). Table 5 indicates the suffixes to be used with organic horizons. Record the appropriate lower case suffix code for each of the distinguishable horizons.

#### ***Subdivision***

Subdivisions are utilized to distinguish several similar horizons occurring within the soil profile. The uppermost subdivision is represented by the number 1 and each successive subdivision down through the soil profile is represented by the following number in the sequence (e.g. Ah1, Ah2).

**TABLE 6. Structure Codes**

CODE	DESCRIPTION
<b>L - F - H</b>	Well drained decomposing plant litter, primarily leaves, twigs, woody materials. L – slightly decomposed F – partly decomposed H – well decomposed
<b>O</b>	Poorly drained decomposing peat, mainly mosses, rushes, woody materials. Of - fibric – least decomposed; Om - mesic – moderately decomposed; Oh - humic – most highly decomposed.
<b>A</b>	Organo – mineral horizons at or near the surface. Ah – dark coloured, humus-rich horizon. Ae – light coloured, eluviated horizon, characterized by removal of clay, iron, aluminum or organic matter, light colour and platy structure. Ahe – same eluviation evident – salt and pepper appearance or platy structure. Ap – horizons disturbed by agricultural (cultivation or pasturing)
<b>AB,BA</b>	Horizons transitional to A and B.
<b>B</b>	Weather subsurface – can have the following characteristics: Bm – slightly altered by hydrolysis, oxidation, or solution or all three, to give a change in colour, or structure or both. Bt – a significant accumulation of silicate clay. Bn – a columnar or prismatic structure, hard consistence when dry and significantly high exchangeable sodium g – a significant expression of gleying
<b>BC</b>	A horizon transitional to B and C
<b>C</b>	Parent material – a horizon comparatively unaffected by soil forming processes, except for: ca – an accumulation of lime. sa – an accumulation of water-soluble salts. g – a significant expression of gleying <sup>1</sup> • – denotes the presence of salts, including gypsum (CoSO <sub>4</sub> ) k – denotes the presence of lime
<b>R</b>	A consolidated bedrock layer
<b>W</b>	A layer of water

**Horizon Depth**

Horizon depth denotes the average depth, in centimetres, of the upper and lower boundaries of the soil horizon being described. The location from which depths are measured is different for mineral and organic soils. The top of the uppermost mineral horizon is considered as zero depth for mineral soils. Zero depth for organic soils is the top of the organic material. Organic litter layers (except those that are buried) are listed in descending order of depth. Mineral horizons and layers in organic soils are listed in ascending order of depth.

**Mineral Soil Texture**

Soil texture is defined in terms of the size distribution of primary mineral particles (2 mm diameter or less) as determined by sieve or sedimentation analysis, or field estimation. Soil texture is not determined on organic samples. “Organic” soil samples are those that contain more than 30% organic matter (17% organic carbon). Where field determinations differ from laboratory results, the field entries on the form should be changed to reflect the laboratory analyses. The basic textural classes, in terms of percent clay (less than 0.002 mm diameter) and sand (0.05 to 2.0 mm diameter), are indicated in Figure 2. The texture codes are indicated in the textural triangle.



**SAND** means soil material that contains 85% or more sand; the percentage of silt plus 1.5 times the percentage of clay does not exceed 15; sand has the following sub-classes:

- a. Coarse sand means 25% or more very coarse and coarse sand and less than 50% any other one grade of sand. Coarse sand has a size limit that ranges between 1.0 to 0.5 mm. Very coarse sand has a size limit that ranges between 1.0 to 2.0 mm.
- b. Medium sand means 25% or more very coarse, coarse, and medium sand, and less than 50% fine or very fine sand. Medium Sand has a size limit that ranges between 0.5 and 0.25 mm.
- c. Fine sand means 50% or more fine sand or less than 25% very coarse, and medium sand and less than 50% very fine sand. Fine sand has a size limit that ranges between 0.25 and 0.10 mm.
- d. Fine sand means 50% or more fine sand or less than 25% very coarse, coarse, and medium sand and less than 50% very fine sand. Fine sand has a size limit that ranges between 0.25 and 0.10 mm.
- e. Very fine sand means 50% or more very fine sand. Very fine sand has a size limit that ranges between 0.10 to 0.05 mm.

**LOAMY SAND** means soil material that contains at the upper limit 85 to 90% sand, and the percentage of silt plus 1.5 times the percentage of clay is not less than 15, at the lower limit it contains not less than 70 to 85% sand, and the percentage of silt plus twice the percentage of clay does not exceed 30; loamy sand has the following sub-classes:

- a. Loamy coarse sand means 25% or more very coarse and coarse sand and less than 50% any other one grade of sand.
- b. Loamy medium sand means 25% or more very coarse, coarse, and medium sand and less than 50% fine or very fine sand.

- c. Loamy fine sand means 50% or more fine sand or less than 25% very coarse, coarse, and medium sand and less than 50% very fine sand.
- d. Loamy very fine sand means 50% or more is very fine sand.

**SANDY LOAM** means soil material that contains either 20% or less clay, with a percentage of silt plus twice the percentage of clay that exceeds 30, and 52% or more sand; or less than 7% clay, less than 50% silt, and between 43% and 52% sand; sandy loam has the following sub-classes:

- a. Coarse sandy loam means 25% or more very coarse and coarse sand and less than 50% any other one grade of sand.
- b. Medium sandy loam means 30% or more very coarse, coarse, and medium sand, but less than 25% very coarse sand, and less than 30% very fine sand or fine sand.
- c. Fine sandy loam means 30% or more fine sand and less than 30% very fine sand or between 15 and 30% very coarse, coarse sand, and medium sand.
- d. Very fine sandy loam means 30% or more very fine sand or more than 40% fine sand and very fine sand, at least half of which is very fine sand, and less than 15% very coarse, coarse sand, and medium sand.

### ***Field Determination of Texture***

The relative proportion of fine fraction particles (sand, silt and clay) can be estimated through feeling the matter by hand. Sand can always be felt as individual grains, but silt and clay generally cannot. Dry silt feels floury while wet silt is slippery or soapy, but not sticky. Dry clay forms hard lumps, is very sticky when wet, and plastic when moist.

Most soils are a mixture of sand, silt, and clay, so the graininess, slipperiness, or stickiness varies depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together more strongly, form

stronger casts and longer, stronger worms (more stickiness). As sand and silt increase, the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed.

The field determination of soil texture is subjective and can only be accomplished consistently with training and experience. The following field tests are provided to assist in the field determinations. They are also outlined in Figure 6.

### Graininess Test

Rub the soil between your fingers. If sand is present, it will feel grainy. Determine whether sand comprises more or less than 50% of the sample.

### Moist Cast Test

Compress some moist soil by clenching it in your hand. If the soil holds together (e.g. forms a cast), then test the durability of the cast by tossing it from hand to hand. The more durable it is the more clay is present.

### Stickiness Test

Wet the soil thoroughly and compress it between thumb and forefinger. Determine degree of stickiness by noting how strongly the soil adheres to the thumb and forefinger upon the release of pressure, and how much it stretches.

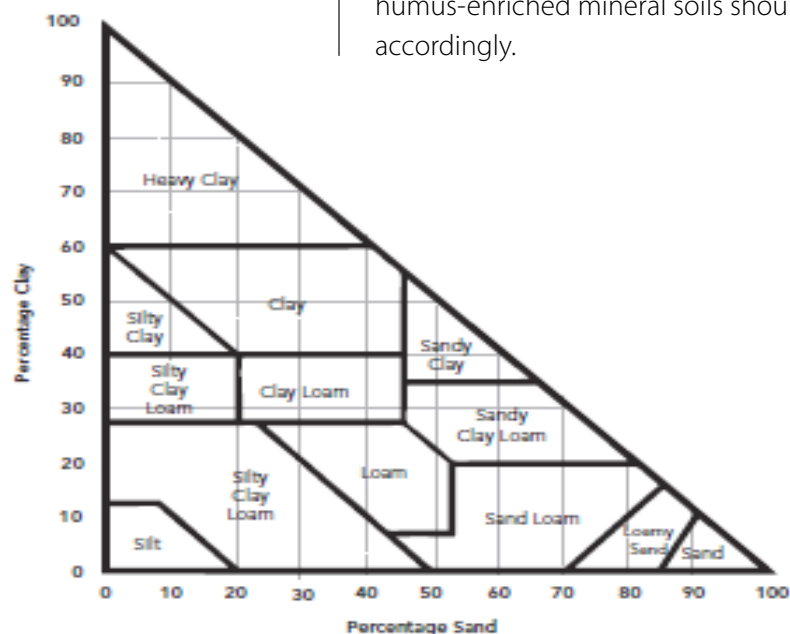
### Worm Test

Roll some moist soil between the palms of your hands to form the longest, thinnest worm possible. The more clay present, the longer, thinner and more durable the worm will be.

### Taste Test

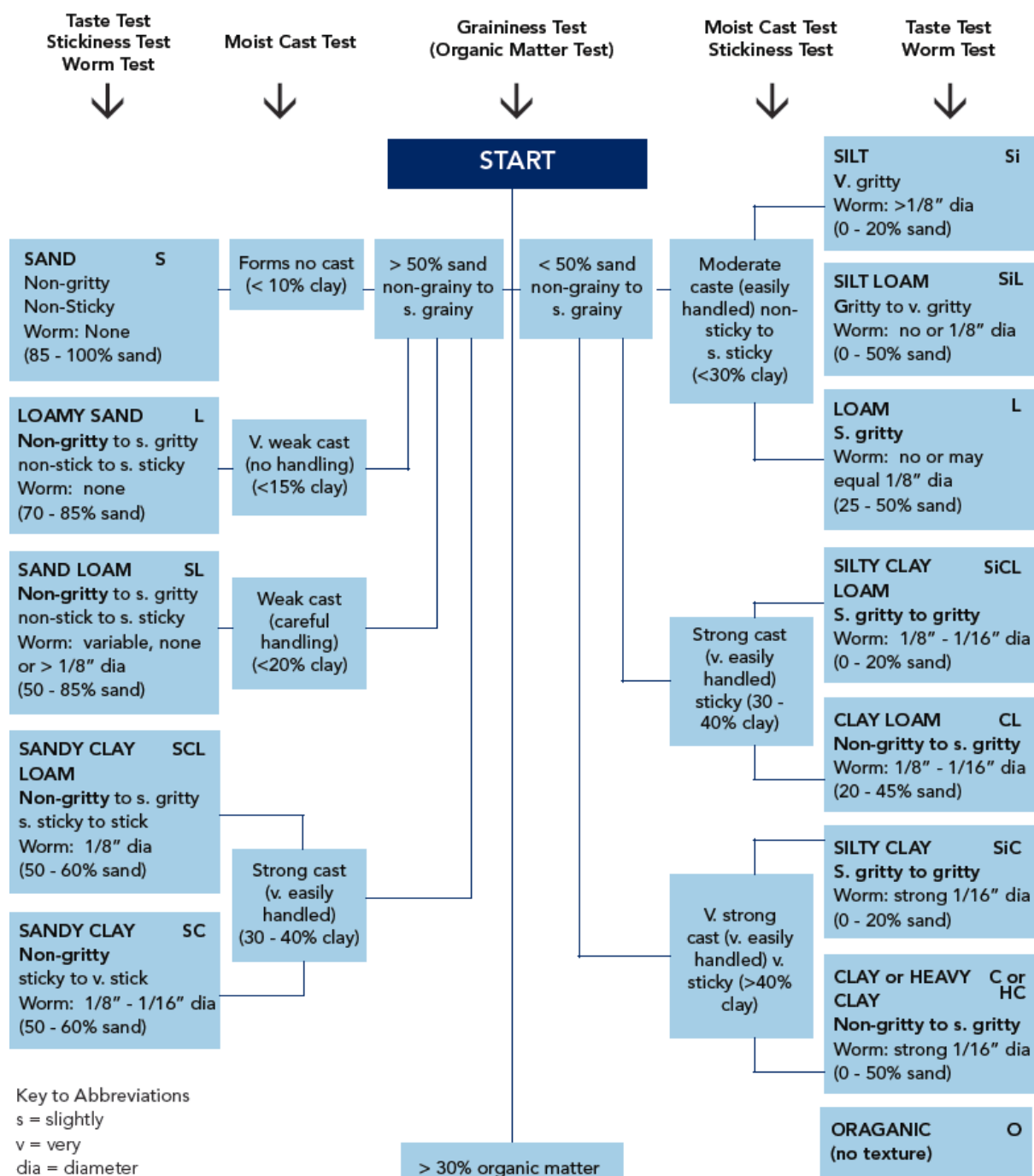
Work a small amount of soil between your front teeth. Silt particles are distinguishable as fine "grittiness", unlike sand, which is distinguished as individual grains (e.g. graininess). Clay has no grittiness. Well-decomposed organic matter (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery when moist, but not sticky or plastic. However, when subjected to the taste test, it feels non-gritty. It is generally very dark in colour when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur in wet sites and in grasslands. Humus is not used as a determinant of soil texture: an estimate of the silt content of humus-enriched mineral soils should be reduced accordingly.

**FIGURE 5.** Soil textural triangle



**FIGURE 6.** *Field determination of soil texture*

*Various Types of Soil Texture Field Tests*



## **Colour**

Although colour has little direct influence on the functioning of soil, it is a useful property for soil identification and appraisal, because other properties that are not easily observed can be inferred from it. The importance of soil colour as a diagnostic property is greatest within the confines of a limited geographic area. Reliable correlations may be determined, for example, between soil colour and soil organic matter content, reducing (wet) conditions, or materials high in iron. Note that some soils exhibit colour directly inherited from the parent rock.

### ***Light Conditions for Measuring Colour***

The quality and intensity of the incident light on a sample affect the light reflected from the sample to the eye, as does the moisture content and roughness of the sample surface. Since the visual impression of colour from the standard colour chips is accurate only under standard light conditions, it is important that (1) light quality is near enough to white light that the reflected light is not unduly affected by colour from the light source itself and (2) the amount of light is adequate for visual distinctions among the colour chips. Precise colour determinations should not be attempted early in the morning or in the evening when the sun is low in the sky and light reaching the sample is reddish.

### ***Determination of Soil Colour***

Soil colour is determined by comparison with standard colour charts from the Munsell colour system. This system specifies the relative degrees of the three simple variables of colour: hue, value and chroma. Hue notations indicate the visual relationship of a colour to red, yellow, green, blue or purple, or intermediates of these. Value expresses the relative lightness of colour. Chroma refers to the relative purity, strength, or saturation of a colour.

Record the dominant (matrix) colour of the soil (either non-gleyed or gleyed, as appropriate) using the Munsell Soil Colour charts. Either the Munsell notation of colour (e.g., 10YR 5/2) or the colour name (e.g., grayish brown) associated with the nearest-match colour chip may be used. Pay special attention to any mottling and/or gley (blue-green) colours. When determining if a soil section is gleyed or non-gleyed, refer to the gley colour chart and the drainage of a site.

Generally, very rapidly to moderately well drained soils are non-gleyed, imperfectly drained soils are mottled and may or may not be gleyed, and poorly to very poorly drained soils are gleyed and may or may not be mottled. In general, use the 10R or 2.5Y colour charts for mottles, the GLEY colour chart for gleyed or blue-green soils and the 10YR colour chart for all other colours. Record the moisture conditions (dry, moist, or wet-preferably dry) of the soil when the colour is recorded.

### ***Gleying***

Gleying is determined based on soil colour (gray to bluish gray to greenish gray), which is considered to indicate the influence and degree of periodic or sustained reducing conditions during soil genesis (development). The darker and more intense the colour, the more reducing the environment is. The categories provided allow for a direct classification of the soil gleying conditions in the field and provide a level of information regarding the soil moisture regime and saturation periods at the site. In general, the stronger or more intense the colours, the longer a site is saturated.

TABLE 7.

CODE	DESCRIPTION
<i>Intense</i>	Dark bluish to dark greenish-gray colours
<i>Strong</i>	Dark gray colours
<i>Moderate</i>	Light to drab gray colours
<i>Slight</i>	Patches of light grayish-brown colours

### Mottles

Mottles are defined as spots or blotches of different colour or shades of colour interspersed with the dominant soil colour, formed mainly by the effects of impeded drainage. The colour patterns are developed due to partial anaerobism, or the reduction of iron due to short periods of water-logging. Mottles are most commonly reddish-brown and result from the oxidation of iron in the soil. They appear very much like rust spots. In some of the reddish soils found in Eastern Canada, mottles may be gray in colour.

### Abundance

The quantity of mottles is indicated by abundance classes based on the percent of the exposed soil surface that is occupied by mottles of a given kind (See Table 9).

### Size

Mottle sizes refer to their approximate dimensions as seen on a plane surface. Mottle length determines the size class when it is not more than 3 times the width; the width is the determinant if the mottle is long and narrow. The three relative size classes are provided in Table 9.

### Contrast

Contrast of mottles refers to the degree of visual distinction between mottles of a given kind and the "matrix". When colours of both mottles and matrix are recorded, the degree of contrast is relatively evident from the notations. However, the judgment of contrast in the field is useful, for it is often not a simple matter of comparing one colour with another, but a visual impression of the prominence of one colour against a background of one or several colours. Table 9 presents numerical definitions for three mottle contrast classes in terms of various combinations of Munsell colour units of hue, value, and chroma. Faint, distinct, and prominent mottles are defined in Table 9.

TABLE 8. Mottle Descriptions

PARAMETER	CODE	DESCRIPTION
<i>Abundance</i>	<i>Few</i>	<2% of the exposed surface
	<i>Common</i>	2-20% of the exposed surface
	<i>Many</i>	>20% of the exposed surface
<i>Size</i>	<i>Fine</i>	< 5 mm
	<i>Medium</i>	5-15 mm
	<i>Coarse</i>	>15 mm
<i>Contrast</i>	<i>Faint</i>	Evident only on close examination. Faint mottles commonly have the same hue as the colour to which they are compared and differ by no more than 1 unit of chroma or 2 units of value. Some faint mottles of similar but low chroma and value can differ by 2.5 units of hue.
	<i>Distinct</i>	Readily seen, but contrast only moderately with the colour to which they are compared. Distinct mottles commonly have the same hue as the colour to which they are compared, but differ by 2 to 4 units of chroma or 3 to 4 units of value; or differ from the colour to which they are compared by 2.5 units of hue but by no more than 1 unit of chroma or 2 units of value.
	<i>Prominent</i>	Contrast strongly with the colour to which they are compared. Prominent mottles are commonly the most obvious colour feature in a soil. Prominent mottles that have medium chroma and value commonly differ from the colour to which they are compared by at least 5 units of hue if chroma and value are the same; or at least 1 unit of chroma or 2 units of value if hue differs by 2.5 units.



## Structure

Soil structure refers to the aggregation of primary soil particles into compound particles that are separated from adjoining aggregates by persistent natural surfaces of weakness formed by pedogenic processes. Soil structure is classified in term of grade (distinctness, durability), class (size), and kind (shape). Both primary and secondary structures are determined when soils have compound structure consisting initially of large peds that break down to smaller peds, or when structures take one form when in place and another when disturbed. If a soil has only one structural form, it is referred to as primary. When soil materials have structures that are other than pedological in origin, a 'kind' modified is indicated.

A natural soil aggregate is called a ped and should not be confused with a clod (a transient mass formed by disturbances such as plowing), a fragment (formed when the soil cracks or breaks through the soil matrix), or a concretion (formed by local concentration of compounds that cement the individual soil grains together). Breakage into pieces larger than soil grains, but without some orderly shape and size, and without surfaces that infer persistence, should not be confused with soil structure.

The presence of two or more simultaneously occurring structures in a soil horizon is referred to as complex structure. The variation in

structure results from impacts by the various soil-forming processes. The presence or absence of complex structure may provide information related to other aspects of ecological processes (e.g. activity by soil fauna has a considerable impact on nutrient cycling in the surface and other horizons). The presence of complex soil structure should be noted in the "Comments".

## Grade

Grade is the degree of distinctness of aggregation of soil particles. It expresses the differential between cohesion within the aggregates (peds) and adhesion between aggregates. Field determination assesses the ease with which the soil separates into discrete persistent peds and also the durability of the peds when they are separated from the soil volume.

Grade varies with the moisture content of the soil. When soils are described in the field, structure is determined at the existing soil moisture state, which should be specified for each horizon. If representative soil descriptions are prepared, structure is described for the soil moisture content most common for the soil, and that state is specified. Changes in structure under the varying moisture conditions can be recorded in the "Comments".

Definitions of the three basic structure grades are given in Table 10. Codes are provided for these and for two additional intermediate grades.

**TABLE 9. Structure grade codes and definitions**

CODE		STRUCTURE GRADE DEFINITION
<i>W</i>	<i>Weak</i>	Peds are either indistinct and barely evident in place, or observable in place but incompletely separated from adjacent peds. When disturbed, the soil material separates into a mixture of only a few entire peds, many broken peds and much unaggregated material.
<i>WM</i>	<i>Weak to Moderate</i>	
<i>M</i>	<i>Moderate</i>	Peds are moderately durable, and are evident but not distinct in the undisturbed soil. When disturbed, the soil material parts into a mixture of many well formed entire peds, some broken peds, and little unaggregated material. The peds may be handled without breaking and they part from adjoining peds to reveal nearly entire surfaces which have properties distinct from those caused by fracturing.
<i>MS</i>	<i>Moderate to Strong</i>	
<i>S</i>	<i>Strong</i>	Peds are durable and evident in the undisturbed soil, adhere weakly to one another, withstand displacement and separate cleanly when the soil is disturbed. When removed, the soil material separates mainly into entire peds. Surfaces of unbroken peds have distinctive properties, compared to surfaces that result from fracturing.

### ***Class***

The recognized structure classes (size ranges) vary with the kind of structure, as indicated in Table 13 and illustrated in Figure 8. Measurement should be made in the smallest dimension for platy (vertical dimension or plate thickness), prismatic and columnar peds (horizontal dimension) and in the largest dimension for blocky and granular peds. Table 10 contains the five basic size classes for each kind of structure. Where more than one class occurs in a single horizon, record the dominant class. Intermediate classes can be recorded. See Table 11 for structure class codes.

### ***Kind***

The shape of peds is designated as the type of soil structure, but is not recorded. The type, in turn, is sub-divided into kinds of structure, based on the character of the ped faces and edges of the aggregates. The four main structure types and their subdivision into eight kinds of soil structure are listed in Table 12 and illustrated in Figure 8.

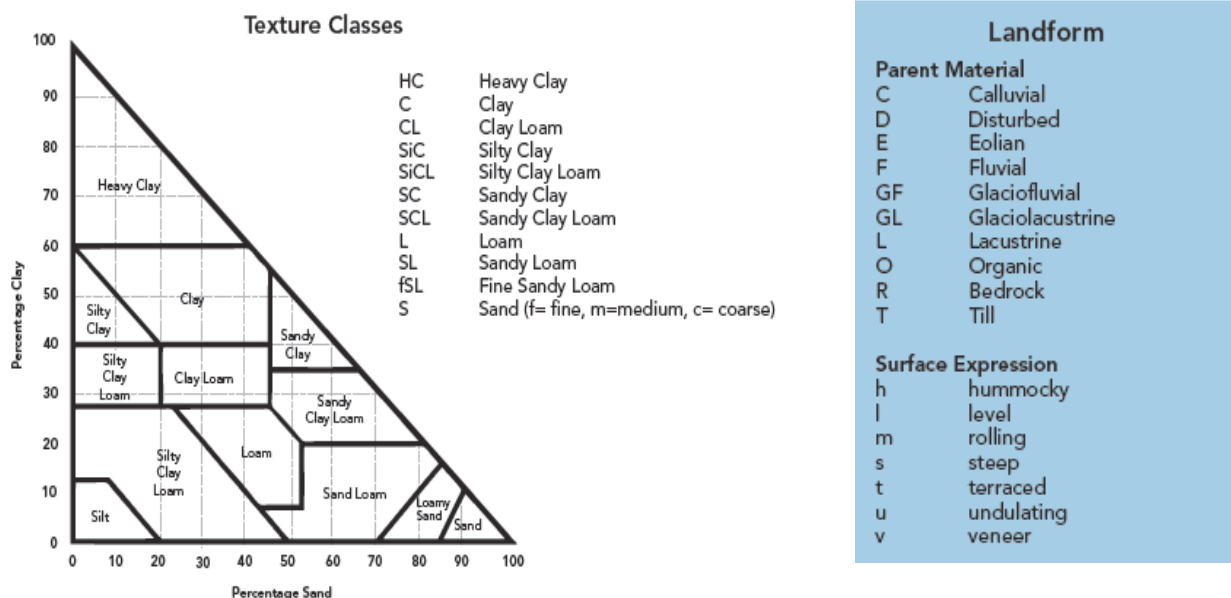
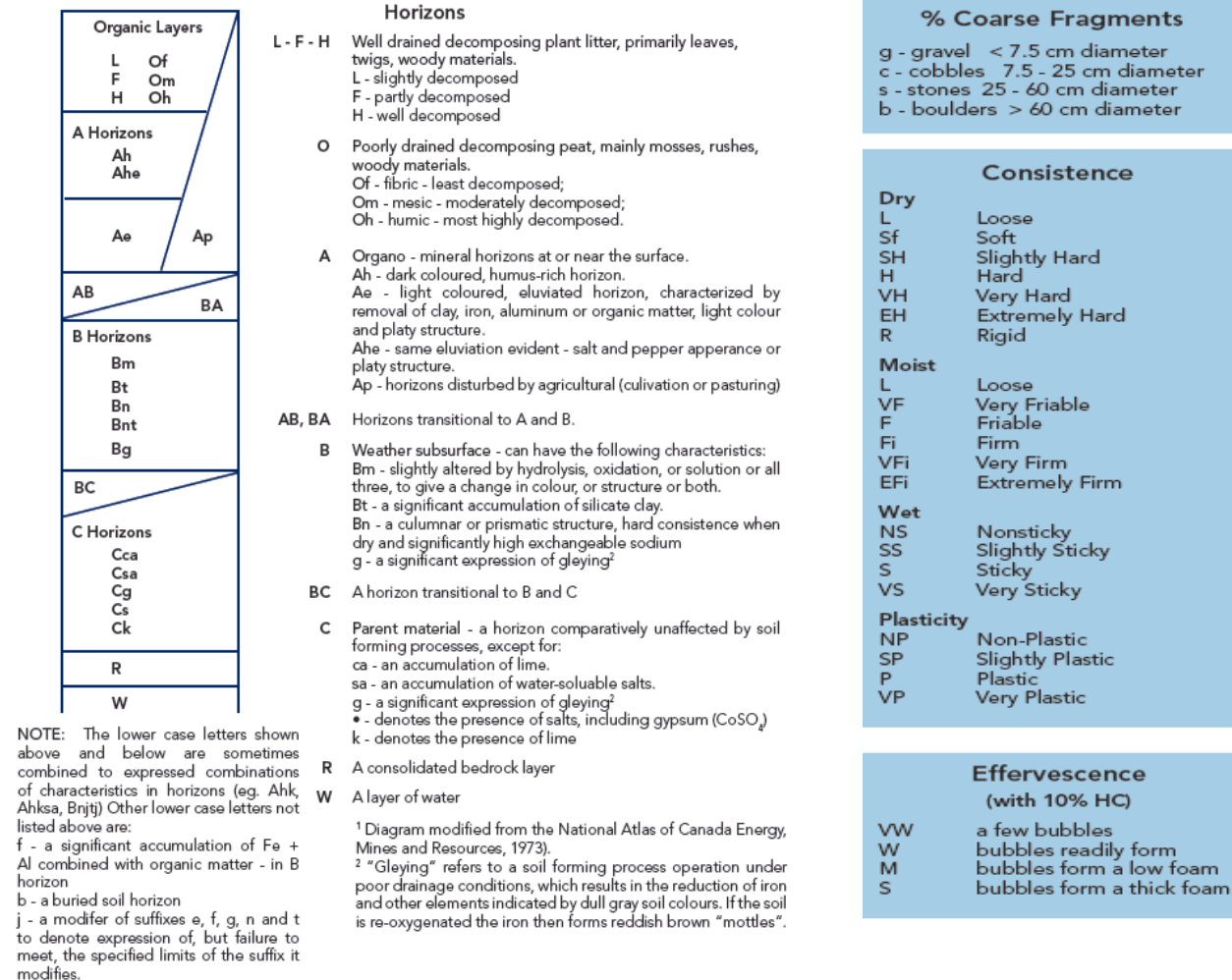
**TABLE 10. *Structure class codes***

CODE	STRUCTURE CLASS	CODE	STRUCTURE CLASS
<i>VF</i>	Very Fine	<i>M</i>	Medium
<i>VFF</i>	Very Fine to Fine	<i>MC</i>	Medium to Coarse
<i>1F</i>	Fine	<i>C</i>	Coarse
<i>FM</i>	Fine to Medium	<i>VC</i>	Very Coarse

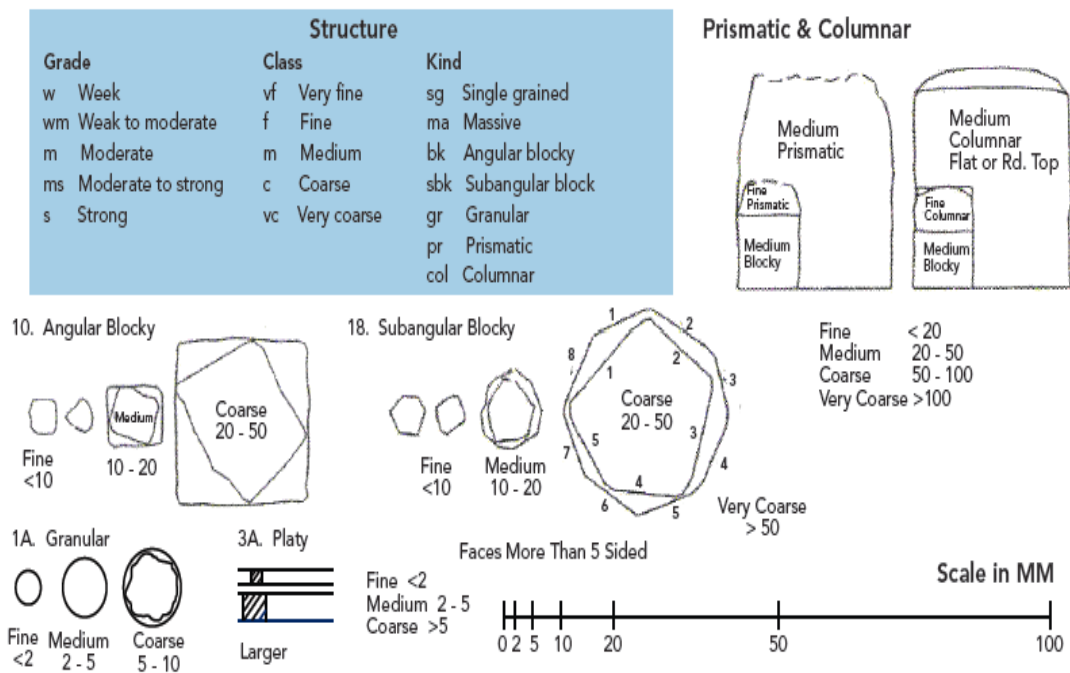
**TABLE 11. Types, kinds and classes of soil structure**

TYPE	KIND & CODE	STRUCTURE CLASS & CODE	SIZE1(MM)
<b>BLOCKLIKE:</b> Soil particles arranged around a point and bounded by flat or rounded surfaces	ANGULAR BLOCKY (ABK): Peds bounded1 (by flattened, rectangular faces intersecting at relatively sharp angles	VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<5 5-10 10-20 20-50 >50
SUBANGULAR BLOCKY (SBK): Peds bounded by slightly rounded, subrectangular faces with vertices2 of their intersections mostly subrounded		VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<5 5-10 10-20 20-50 >50
GRANULAR (GR): Spheroidal peds bounded by curved or very irregular faces that do not adjoin those of adjacent peds		VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<1 1-2 2-5 5-10 >10
<b>PLATELIKE:</b> Soil particles arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces	PLATY (PL): Peds flat or platelike; horizontal planes more or less well developed	VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<1 1-2 2-5 5-10 >10
<b>PRISMLIKE:</b> Soil particles arranged around a vertical axis and bounded by relatively flat vertical surfaces.	PRISMATIC (PR): Vertical faces of peds well defined and vertices2 angular (edges sharp); prism tops essentially flat	VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<10 10-20 20-50 50-100 >100
COLUMNAR (COL): Vertical edges near top of columns not sharp (vertices2 subrounded); column tops flat, rounded, or irregular		VF: Very fine angular blocky F: Fine angular blocky M: Medium angular blocky C: Coarse angular blocky VC: Very coarse angular blocky	<10 10-20 20-50 50-100 >100
<b>STRUCTURELESS:</b> No observable aggregation of primary particles or no definite orderly arrangement around natural lines of weakness	SINGLE GRAINED (SGR)	Loose, incoherent mass of individual primary particles, as in sands	
	MASSIVE (MA)	Amorphous; a coherent mass showing no evidence of any distinct arrangement of soil particles; separates into clusters of particles; not peds	
CLODDY (CDY): Not a structure; used to indicate the condition of some ploughed surface, grade, class, and shape too varied to be described in standard terms.			

FIGURE 7. Canadian System of Soil Classification



**FIGURE 8.** Diagrammatic representation of soil structure



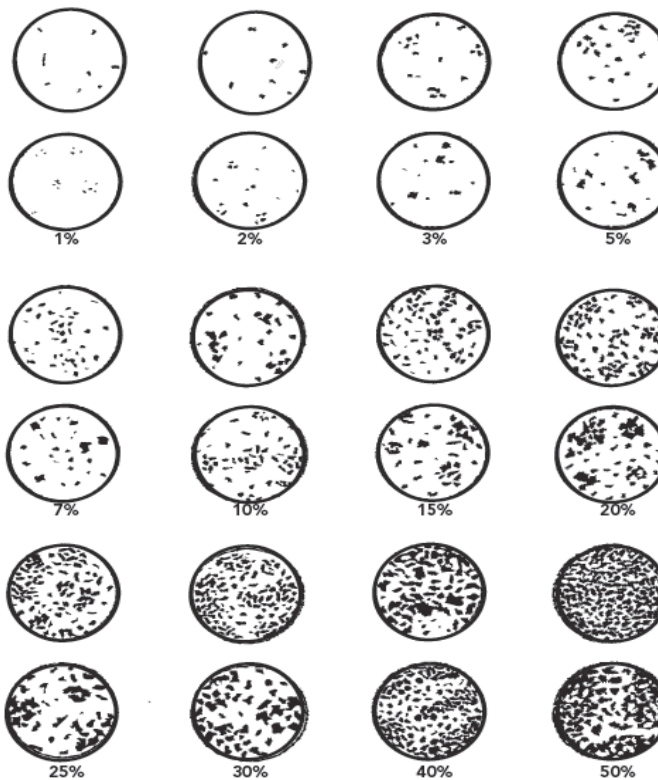
Slope Classes of Local Landings		
Class & Slope	Aprx°	Description
1	0 - 0.5	0 level
2	0.5 - 2.5	0.3 - 1.5 nearly level
3	2 - 5	1 - 3 very gentle slopes
4	6 - 9	3.5 - 5 gentle slopes
5	10 - 15	6 - 8.5 moderate slopes
6	16 - 30	9 - 17 strong slopes
7	31 - 45	17 - 24 very strong slopes
8	46 - 70	25 - 35 extreme slopes
9	71 - 100	35 - 45 steep slopes
10	>100	>45 very steep slopes

Surface Stones		
	Surface Area	Distance Apart (cm)
S0 non-stony	<0.01%	>30
S1 slightly stony	0.01-0.1%	10 - 30
S2 moderately stony	0.1- 3 %	2 - 10
S3 very stony	3 - 15%	1 - 2
S4 exceedingly stony	15 - 50%	0.1 - 5
S5 excessively stony	50%	0.1

Slope Position	
c	crest
u	upper slope
m	mid-slope
l	lower slope
t	toe
d	depression
l	level

Drainage	
VR	Very Rapidly
R	Rapidly
W	Well
M	Moderately Well
I	Imperfectly
P	Poorly
VP	Very Poorly

#### Percent Areas





## Consistency

The consistency of mineral soil refers to its resistance to deformation and rupture (soil strength), and to its degree of internal cohesion and adhesion. All mineral soil material has consistency irrespective of whether the mass is large or small, in a natural condition or greatly disturbed, aggregated or structure less, or wet, moist or dry. Soil consistency should be evaluated under standard conditions of water content, specimen size and force application. If evaluations are not made under standardized conditions, meaningful comparisons between soils (or horizons) cannot be made. Soil consistency is highly dependent on the soil water content. Terminology includes separate terms for description at three standard moisture contents: dry, moist, and wet. Plasticity is always described in the wet state.

## Dry and Moist Consistence

Dry and moist soil consistency is determined under field conditions by estimating the soil strength (resistance to crushing of an unconfined volume of soil). Since soil strength often depends on the size of the test specimen, its shape and the way force is applied, a uniform system of testing should be used if results are to be comparable.

If the soil is not loose (single-grained), remove a ped or soil fragment from the profile and trim it to form an equi-dimensional standard test specimen with sides 2.5 cm long and two roughly parallel bearing surfaces. Apply stress slowly, squeezing the specimen between thumb and forefinger until failure is just perceptible. The amount of force required to produce failure is the criterion for dry and moist consistency classes (See Table 13 and Table 14, respectively). Estimation of the force exerted can be refined with practice in compressing standard mechanical devices, or by exerting force on specimens of the same origin as those that have failed from crushing or breaking under weights of known force.

**TABLE 12. Dry consistence codes and descriptions**

CODE	DRY CONSISTENCE
<i>Loose</i>	The soil material is non-coherent (falls apart into individual grains).
<i>Soft</i>	The soil material is weakly coherent and fragile, and breaks to a powder or individual grains under very slight pressure; the specimen fails under less than 0.8 kg of force (very gentle pressure).
<i>Slightly hard</i>	The soil material is weakly resistant to pressure and easily crushes between the thumb and forefinger; the specimen withstands 0.8 kg of force but fails under 4 kg of force (4 kg of force corresponds to firm pressure between the extended thumb and forefinger of many people, but is significantly less than the maximum force that can be exerted slowly).
<i>Hard</i>	The soil material is moderately resistant to pressure; it can be crushed in the hands only with difficulty, and is not crushable between the thumb and forefinger; the specimen withstands 4 kg of force but fails under 8 kg of force (8 kg of force is near the maximum force than can be exerted between the extended thumb and forefinger of most people).
<i>Very hard</i>	The soil material is very resistant to pressure; it can be crushed in the hands only with difficulty and is not crushable between thumb and forefinger; the specimen withstands 8 kg of force but fails under 16 kg of force (16 kg of force corresponds approximately to the force that can be applied slowly by compression between two hands); compression means "squeezing together" and does not mean shearing or slamming the soil material.
<i>Extremely hard</i>	The soil material is extremely resistant to pressure and cannot be crushed in the hands; the specimen withstands 16 kg of force but fails under 80 kg of force (80 kg of force is near the pressure of full body weight for many people, applied between the foot and a hard surface).
<i>Rigid</i>	The soil material cannot be crushed except by extreme pressure; the specimen withstands 80 kg of force.

### **Wet Consistence**

Wet consistence, referred to as “stickiness”, is determined at moisture levels that are at, or slightly above, field capacity. Stickiness is the degree of adhesion to other objects or materials (See Table 15) and it changes as soil structure is destroyed and as the soil moisture content changes. Stickiness in the field is determined by the fine earth fraction particles passing

through a #10 sieve (2mm in diameter). The sample should be crushed in the hand, water added (if necessary) to bring it to the wet state and then thoroughly puddled. The puddled soil should then be pressed between the thumb and forefinger, and its adherence to the digits noted. To adjust water content, the sample should be worked in the hand to remove water, or have water added to achieve the maximum stickiness.

**TABLE 13. Moist consistence codes and descriptions**

CODE	MOIST CONSISTENCE
<i>Loose</i>	The soil material is non-coherent (falls apart into individual grains).
<i>Very friable</i>	The soil material is crushed under very gentle pressure and coheres when pressed together; the specimen fails under less than 0.8 kg of force (very gentle pressure).
<i>Friable</i>	The soil material is easily crushed under gentle to moderate pressure between the thumb and forefinger and coheres when pressed together; the specimen withstands 0.8 kg of force, but fails under 2 kg of force (gentle pressures).
<i>Firm</i>	The soil material is crushed under moderate pressure between the thumb and forefinger, but resistance is distinctly noticeable; the specimen withstands 2 kg of force but fails under 4 kg of force (4 kg of force corresponds to firm pressure between the extended thumb and forefinger of many people, but it is considerably less than the maximum force that can be exerted slowly).
<i>Very firm</i>	The soil material can be crushed between the thumb and forefinger, but strong pressure is required; the specimen withstands 4 kg of force but fails under 8 kg of force (8 kg of force is near the maximum force that can be exerted between the extended thumb and forefinger for many people).
<i>Extremely firm</i>	The soil material cannot be crushed between the thumb and forefinger; indurated horizons are examples.

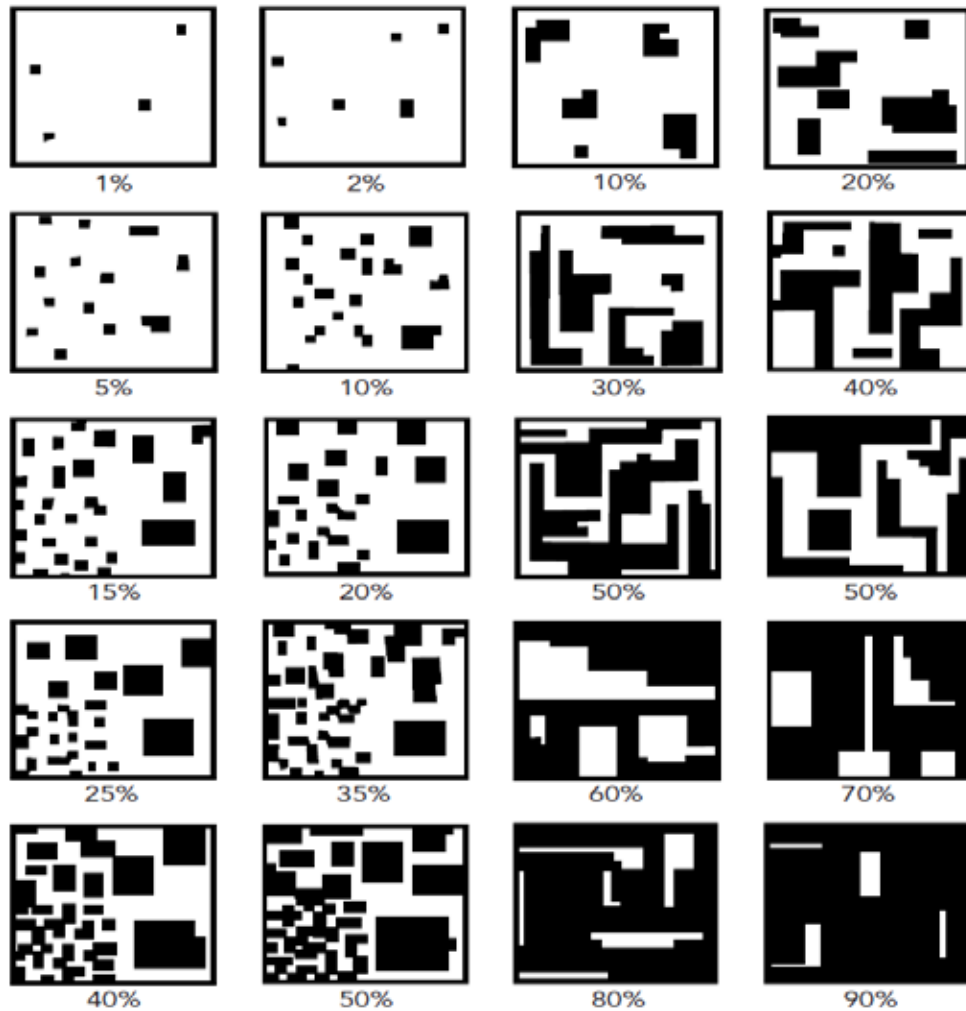
**TABLE 14. Wet consistence codes and descriptions**

CODE	WET CONSISTENCE (STICKINESS)
<i>Non sticky</i>	After the release of pressure, practically no soil material adheres to either the thumb or finger.
<i>Slightly sticky</i>	After pressure has been applied, the soil material adheres to both the thumb and finger, but comes off one or the other rather cleanly. The soil is not appreciably stretched when the digits are separated.
<i>Sticky</i>	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and tends to stretch somewhat and pull apart rather than pulling free from either digit.
<i>Very sticky</i>	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and is decidedly stretched when they are separated, then breaks and remains on both digits.

### ***Coarse Fragment Description***

Coarse fragments in the soil are defined as rock or mineral fragments (gravel, stones, and rocks) greater than 2 mm in diameter. The coarse fragment content is estimated volumetrically by visual examination and recorded as a percentage of the total volume of soil. Refer to the following area percentage charts when determining the volumetric content of coarse fragments in the soil profile.

### ***Area Percentage Charts***



### ***Soil Depths***

Depths are measured downward in cm from the top of the control section, which in mineral soils is the top of the mineral horizons and in organic soils is the surface, to the feature. An exception occurs in the case of peaty phase mineral soils, for which depth to these features is measured from the surface, similar to organic soils. If the feature is encountered in the LFH horizons or at the top of the mineral soil, the depth should be recorded as 0 cm (more detail may be recorded in the “Comments” section of the Site Assessment Form). This is the measured depth of the water table at the time of sampling.

It is not inferred from such evidence as mottles or gleying. The water table represents the surface of the water saturation zone. Allow the water level to reach equilibrium in the soil pit prior to measuring the depth.

### ***Seasonally Saturated Soil***

This is the depth to periodic high water table level and may be inferred from such evidence as mottling or gleying. High water tables for even short periods can reduce the performance of a treatment system and may lead to contamination of a potable water source.

### ***Limiting Layer***

This is the depth to soil layers or horizons that can restrict the vertical movement of water. Examples of limiting layers include bedrock, frozen layers (e.g. permafrost), significant textural contrasts, and soil layers that significantly restrict root penetration such as hardpans, cemented or indurated horizons, and compacted materials.

### ***Permeable Layer***

This is the depth to soil layers or horizons that are significantly more permeable than the materials above or below, such as sand lenses.

### ***Limiting Layer Characteristics***

Identify the type of limiting or permeable layer.

### ***Limiting Topography***

If limiting topography is present on the proposed site, identify why it is limiting and indicate its approximate location on the lot diagram. Steep slopes and concave or convex slopes are of primary concern.