Field Guide to the Substrates of Ontario

Ontario Ministry of Natural Resources

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Canadian System of Soil Classification 3rd edition (Agriculture and Agri-Food Canada, 1998)


Describing Ontario’s Ecosystems, Field Data Collection Standards for Ecological Land Classification (Allan G. Harris, Robert F. Foster, Sean McMurray, Peter Uhlig, 2005) provided an excellent starting point for the writing of this manual.

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A glaciofluvial deposit found on the west side of Ile Parisienne in Lake Superior, Ontario.
(courtesy of John A. Johnson)

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Disclaimer

This guide and all related information items are currently under development and are provided as an operational draft. Its approach and main concepts have remained stable for approximately seven years.

These materials will remain constant for a period of one year from the date of this release after which adjustments, additions and clarifications may be made.
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About This Guide
During the period 2005 – 2009, the Ontario Ecological Land Classification (ELC) program has undergone a province wide rationalization and redesign initiative. Some of the main objectives were:

- Nest Ontario’s ELC within the national ELC;
- Create a provincial ELC architecture which definitively specifies standards, practices, products, and uses of ELC components;
- Create an ecological based, conceptual and spatial hierarchy within which multi-scale ELC components can be located and understood;
- Rationalize regional ELC systems into a single, all-encompassing system;
- Classify the entire terrestrial land base of Ontario;
- To nest neatly with or speak to other classifications systems (e.g. Aquatic Ecosystem Classification System of Ontario).

The rationalization process required an evolution from regional and incomplete soil-type systems, to a single, unified system which covers the full range of conditions known, or expected to exist within the province. The inclusion of site conditions not previously or formally defined as “soil” under historic classification schemes made the adoption of the concept of substrate necessary (see “What is a Substrate” below). The Provincial Ecological Land Classification Working Group (ELCwg) undertook the task of designing a system for the classification of all substrates found within Ontario.

This document, the Field Guide to the Substrates of Ontario, is intended as a field aid for the identification and characterization of ELC Substrate Types (s-type). It contains the keys to ELC substrate classes and substrate types, along with a critical subset of supporting materials, classification specifications, and standards as set out in the ELC Data Collection Standards, and in the ELC Data Collection Standards - Field Manual.

Many of these materials were adopted, adapted, modified and/or expanded from the long standing benchmark publications, the Canadian System of Soil Classification 3rd edition (Agriculture and Agri-Food Canada, 1998), and the Field Manual for Describing Soils 4th edition (Ontario Centre for Soil Resource Evaluation 1993). Because of these modifications, it is essential that any practitioner undertaking the identification or interpretation of ELC substrate type (s-type) specifically use the materials within this package which incorporates concepts from the two standards identified above.

These materials are presented in a logical order, but the practitioner is encouraged to modify or adapt this order to suit their specific needs.

Finally, the substrates classification for Ontario is an evolving system. This supporting package will evolve in a parallel manner. These materials are date stamped. Please ensure you have the most recent version in hand before proceeding.

How to Navigate the Keys
By following the navigation rules below, the key will lead the user to a single ELC Substrate Class. The user is then asked to turn to the page containing the appropriate substrate series key where by following the same navigation rules, the user will be led to a single ELC Substrate Type.

Symbols & Terminology:

<table>
<thead>
<tr>
<th>symbol or term</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>“ / ”</td>
<td>something “over” something (sand over bedrock)</td>
</tr>
<tr>
<td>mostly</td>
<td>greater than 50% (&gt; 50%)</td>
</tr>
<tr>
<td>AND</td>
<td>joined conditions are both mandatory</td>
</tr>
<tr>
<td>OR</td>
<td>any or all of the joined conditions are required</td>
</tr>
</tbody>
</table>
Orientation

Substrate vs. Soils

Traditionally in Ontario, substrate classification and terminology has been restricted to forested areas situated on mineral or organic material classified as “soil”. The Canadian System of Soil Classification (CSSC) defines soil as “the naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth’s surface and is capable of supporting plant growth”. Accordingly the CSSC refers to non-soil as bedrock, mineral or organic material less than 10 cm thick and material covered by water for most of the year.

In an effort to quantify all of Ontario, a new substrate classification has been developed that encompasses all the soils and non-soils, including those that have been influenced by humans. Collectively, a substrate consists of any mineral, bedrock, coarse fragment, or organic materials, normally above or covered by standing water that is less than two metres in depth.

Substrate type is a principal factor affecting vegetation community development on a site. Characteristics such as texture, moisture regime, nutrient status, and thickness influence competitive relationships and growth rates of plants. Substrates provide anchorage, nutrients, and moisture for plants. Organic matter in the substrate enhances nutrient cycling, and improves substrate structure and water retention. Substrate water is the solvent medium for nutrients needed by growing plants. Substrate air provides the gases necessary for cell function and nitrogen fixing.

Substrates are assessed through a visual assessment of the surface or inspection of a full profile following excavation of a pit or auger. The method chosen is dependent on the substrate class and required sampling intensity.

This guide has been prepared to assist field surveyors in the identification and assessment of substrates.
Site and Sampling Location

Within this manual, site refers to the physical environment surrounding a substrate observation location. Site is used to provide contextual information useful to the characterisation and identification of a substrate type.

Landscape features closely associated with the substrate are described as part of an initial site assessment. These attributes are considered stable and can be described at a number of different scales depending on the survey requirements.

Understanding and Describing Site

The identification, classification, and understanding of a substrate type may be enriched by considering that substrate in the context of its surrounding environment. Site assessments should be conducted at various scales including the immediate surroundings, the relative position on a landform, and the relative position within the broader landscape upon which it is situated. The recommended approach starts with assessing a substrate in terms of its broad landscape context, and systematically narrowing the scope of assessment to the plot level. The following site description variables follow this “top down” organization.

The Process of Describing Site

Though substrates vary widely in their bio-physical properties, the generalized processes below should be followed for the determination of substrate type (class and series - s-type).

**Start by looking at your site in context of its surroundings.**

1. assess the broad landform and mode of deposition of the sample area .................................................. 4
2. identify a representative sampling location within your sampling area
3. assess the macro-scale slope and topographic characteristics of the broader area .................................. 6
4. assess the meso-scale slope and topographic characteristics of the sample plot or site .......................... 7
5. assess the microtopography and % cover characteristics of the sample plot or site ............................ 10

Mode of Deposition / Landform

Mode of Deposition (MOD) provides a high level organization within which to organize and understand the landform types and characteristic features such as materials commonly associated with each. This knowledge provides valuable clues to the identification and understanding of substrate.

Landform reflects the glacial or postglacial origin of the substrate at the macro (approximately 600 m radius) scale. Landforms can encompass large areas and are important for providing the landscape context to the site and a link to substrate mapping.

To identify landform features, use aerial photographs and make observations en route to the area (road cuts and gravel pits are useful sites). Mollard and James (1984) is an excellent reference for air photo interpretation of landforms. Map sources (e.g. NOEGTS, SOEGTS, and OLI) can also be helpful.
<table>
<thead>
<tr>
<th>code</th>
<th>mode of deposition</th>
<th>description</th>
<th>recognizable features</th>
<th>associated landform examples</th>
</tr>
</thead>
</table>
| MO   | morainal          | Materials deposited by melting ice during a period of glaciation. Generally unconsolidated and heterogeneous materials. | Heterogeneous mixture of stones, sand, silt and clay; angular to rounded; non-sorted; non-stratified; includes ice laid, typically angular to sub rounded, coarse fragment materials such as boulder pavements. | - end moraine
- lateral moraine
- ground moraine
- drumlin, drumlin field
- till plain (ablation, basal)
- kame moraine
- kettle |
| FL   | fluvial           | Materials transported, sorted, and deposited by moving water since the last period of glaciation. | Materials generally coarse textured; well rounded; sorted and often stratified; cross bedding, cuts, and fill. | - alluvial fan
- alluvial plain
- delta
- terrace
- flood plain
- meander scar
- oxbow
- channel |
| GF   | glaciofluvial     | Materials transported, sorted, and deposited by moving glacial melt water during a period of glaciation. | Materials coarse textured; well rounded; sorted and often varved or stratified; sand, gravel, cobble, stone beach deposits or clayey deep water deposits; deposited at time of de-glaciation. | - outwash plain
- kame
- esker
- spillway
- terrace
- valley train
- kettle |
| LA   | lacustrine        | Materials transported by moving water and deposited / sorted in the relatively calm / standing water body of a fresh water pool, pond, or lake. Deposited since the last period of glaciation. | Materials fine to coarse textured; sorted and often varved or stratified; sand, gravel, cobble, stone beach deposits, or clayey deep water deposits. Coarse fragments are usually well rounded. | - lake plain
- delta
- gravel shoreline
- cobble shoreline
- beach |
| GL   | glaciolacustrine  | Materials transported by moving glacial melt water during a period of glaciation, and deposited / sorted in the relatively calm standing water of a freshwater glacial pond, pool, or lake. | Materials fine to coarse textured; sorted and often varved or stratified; with cross bedding, cuts and fill; sometimes clayey deep water deposits which are often varved. Coarse fragments, if present are usually well rounded. | - delta
- cobble shoreline
- gravel shoreline
- beach
- lake plain |
| WA   | marine            | Materials deposited and sorted by standing salt water. Deposited since the last period of glaciation. | Materials fine to coarse textured; well rounded; moderately well sorted; often stratified; often with shells | - marine silts and clay plain
- marine beach
- storm ridge
- tidal flat
- shore |
| GW   | glaciomarine      | Materials deposited and sorted by standing salt water during a period of glaciation. | Materials fine to coarse textured; well rounded; moderately well sorted; often stratified; often with shells | - glaciomarine plain
- marine beach
- storm ridge |
| EO   | eolian            | Materials transported and deposited by wind. | Materials silts to medium sands; very well rounded; very sorted; loose | - dune
- dune field
- loess blanket & veneer |
<table>
<thead>
<tr>
<th>code</th>
<th>mode of deposition</th>
<th>description</th>
<th>recognizable features</th>
<th>associated landform examples</th>
</tr>
</thead>
</table>
| OP   | organic - peat    | Accumulations of organic matter derived from Sphagnum or brown mosses, sedge/grasses and other hydrophytic herbaceous materials. May contain wood. | Hydrophytic plant and moss remains in various stages of decomposition - fibric (Of), mesic (Om), humic (Oh) Develops in a wide variety of wetland environments where prolonged saturation, low oxygen levels and cool site climate combine to permit accumulation. | - bog  
- raised bog  
- patterned bog  
- palsa  
- swamp  
- fen  
- marsh |
| OF   | organic - folic   | Accumulations of upland organic matter like feather mosses, leaves, and woody material. | Upland plant remains in various stages of decomposition - (L, F, H, Hi) Normally, associated with upland substrates. | Wide variety of upland landform conditions |
| CO   | colluvial         | Substrate materials deposited by gravity. | Fine to coarse textured materials, and coarse fragments deposited by mass wasting or accumulations of debris at base of cliffs and bluffs. Composition of materials deposited varies according to origin. | - talus or scree  
- slump  
- landslide |
| RO   | bedrock           | Sites of bedrock (igneous, metamorphic, sedimentary). | Consolidated rock surfaces, varying from very flat and ‘table’ like, to variably broken and irregular, to steep rock slopes. | - escarpment  
- plateau  
- cuesta  
- plain  
- knob  
- ridge  
- cliff |
| AN   | anthropogenic     | Sites containing human modified materials, materials actively altered by human activity and / or materials altered by the removal of materials by human activities. | Natural materials permanently modified by removal or deposition of materials or by ongoing disturbance due to human activity. (asphalt, concrete, pits and quarries, constructed and landscaped sites) | N/A |
| CX   | undifferentiated  | Sites displaying evidence of many modes of deposition, or typically the result of downslope movement and erosional processes resulting in transport, layering and exposure. | A layered sequence of several types of distinctly different surficial materials at a given sample location (pit/auger). Materials so closely arranged that they cannot be separated at most scales of mapping. | - widely variable  
- slump |
Topographic Surface Form

Elevation
Record the elevation of the land at the site in metres, determined using a topographic map or a GPS unit. An estimate of accuracy should be indicated, to the nearest 5 or 10 metres. This will be given by the GPS unit or can be inferred from the contour interval on a map.

Slope
Slope is the inclination of the landscape relative to the horizontal or level plane. Slope directly affects surface runoff and moisture retention. Slope may be measured in either degrees of arc departure from level, or as slope percentage calculated as units of rise divided by units of run of a sloping surface.

Slope is usually measured using a clinometer (e.g., Suunto) or one that is built into a compass (e.g. the Ranger compass type 15TD-CL).

Slope Length
Slope length is the total length of the slope upon which the plot is located. Measure or estimate the distance between the upper and lower extremities of the slope. If the slope length is not determined in the field, it can be estimated from appropriate topographic maps, or aerial photographs.

Topography
Surface shape, slope type, slope shape, and slope aspect are some of the tools used to describe surface expression or topography. Topography can be described at multiple scales ranging from the local plot or site through to the broad landform unit. It is useful to divide and guide the description of the landscape surface into three main categories; macrotopography, mesotopography, and microtopography.

Macrotopography
Topographic surface form features that extend over larger areas (typically ~150 metres or greater).

Topographic Class
Topographic classes are defined by the relative change of elevation or by percentage slope, in combination with horizontal distance, both measured (crest to trough). Use these values with Figure 1 to determine the topographic class.

![Figure 1: topographic class specifications](image)
Use the following topographic class names and codes to describe the site.

<table>
<thead>
<tr>
<th>Topography class</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>(L1)</td>
</tr>
<tr>
<td>Undulating</td>
<td>(U2)</td>
</tr>
<tr>
<td>Rolling</td>
<td>(R3)</td>
</tr>
<tr>
<td>Hilly</td>
<td>(H4)</td>
</tr>
<tr>
<td>Hummocky</td>
<td>(HU5)</td>
</tr>
<tr>
<td>Steep</td>
<td>(S6)</td>
</tr>
</tbody>
</table>

**Mesotopography**
Topographic features that extend over small areas (typically ~20 to ~150 metres). Mesotopography features are often thought of as site level features used to describe and quantify conditions which immediately influence the sample location or site.

**Surface Shape**
Slope shape affects the overall potential of a site to absorb, shed, or collect surface water. Use the following table to describe the overall surface shape trend across the site.

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STR</td>
<td>Straight</td>
<td>Linear, either flat or sloping in one direction.</td>
</tr>
<tr>
<td>CCV</td>
<td>Concave</td>
<td>Surface profile is bowl-shaped, or hollow, in one or several directions.</td>
</tr>
<tr>
<td>CVX</td>
<td>Convex</td>
<td>Surface profile is predominantly rounded, like the exterior of a sphere or circle (inverse of concave).</td>
</tr>
</tbody>
</table>

**% Slope**
Percent slope (%slope) is useful as an indicator of how fast surface water may be drained from the surface, or how much surface water may be in place long enough to infiltrate the substrate medium. Measure % slope by sighting through the plot in the steepest down slope direction, ending at the first major topographic break.

**Slope Length**
Slope length is the total length of the slope from crest to toe, upon which the plot is located. Measure or pace the distance between the upper and lower limits of the slope. If the slope length is not determined in the field, it can be estimated from appropriate topographic maps, or aerial photographs.

**Upslope Length**
Upslope length is the maximum upward length of the slope above the sampling site, which directly acts as the catchment area for moisture supply to the site. Measure or pace the distances from the plot centre to the top of the slope.

**Slope Class**
Slope class provides a qualitative description of the degree of slope at the plot or site scale. Use the table below to assign slope class.
### Table 4: slope class
(modified from OCSRE 1993)

<table>
<thead>
<tr>
<th>code</th>
<th>% slope</th>
<th>degrees</th>
<th>class terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, a</td>
<td>0 – 0.5</td>
<td>0 – 0.3</td>
<td>level</td>
</tr>
<tr>
<td>B, b</td>
<td>0.5 – 2</td>
<td>0.3 – 1.1</td>
<td>nearly level</td>
</tr>
<tr>
<td>C, c</td>
<td>2 – 5</td>
<td>1.1 – 3</td>
<td>very gentle slopes</td>
</tr>
<tr>
<td>D, d</td>
<td>5 – 9</td>
<td>3 – 5</td>
<td>gentle slopes</td>
</tr>
<tr>
<td>E, e</td>
<td>9 – 15</td>
<td>5 – 8.5</td>
<td>moderate slopes</td>
</tr>
<tr>
<td>F, f</td>
<td>15 – 30</td>
<td>8.5 – 16.5</td>
<td>strong slopes</td>
</tr>
<tr>
<td>G, g</td>
<td>30 – 45</td>
<td>16.5 – 24</td>
<td>very strong slopes</td>
</tr>
<tr>
<td>H, h</td>
<td>45 – 70</td>
<td>24 – 35</td>
<td>extreme slopes</td>
</tr>
<tr>
<td>I, i</td>
<td>70 – 100</td>
<td>35 – 45</td>
<td>steep slopes</td>
</tr>
<tr>
<td>J, j</td>
<td>100 – 173</td>
<td>45 – 60</td>
<td>very steep slopes</td>
</tr>
<tr>
<td>V, v</td>
<td>170 – infinity</td>
<td>60 – 90+</td>
<td>vertical or overhang</td>
</tr>
</tbody>
</table>

Slope length > 50m, use upper case letter (A, B, C…)
Slope length < 50m, use lowercase letter (a, b, c…)

* letter designations commonly used in soil surveys.

---

### Slope Aspect

Aspect measures the direction the slope faces. When combined with slope percent, it can be used to predict the amount of incident solar radiation. Measure the aspect from the same position and for the same distance used to determine the percent slope. Measure aspect by sighting downhill with a compass, and record the azimuth. Compensate for magnetic declination of local time and conditions.

**Table 5: slope aspect values**

<table>
<thead>
<tr>
<th>aspect value (degrees true north)</th>
<th>slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt; 0.5%</td>
</tr>
<tr>
<td>1 – 360</td>
<td>≥ 0.5%</td>
</tr>
</tbody>
</table>

Note: True North = 360

---

### Slope Type

Slopes are classified as either simple or complex. Use the figure below to determine the slope type for the plot and for a radius of 300 m surrounding plot centre.

**Figure 2: slope type**

Simple
(one dominant direction for drainage is observed)

Complex
(multiple slopes observed)
Slope Shape
Meso-scale slope shapes can be defined within a 3 dimensional context. Slope shape is described across the plot, and in 2 directions; up and down slope (perpendicular to the contour), and across slope (along the horizontal contour) e.g. Linear, Convex or LV. Use the figure below to assign the slope shapes that defines the site and the general surroundings.

![Slope Shapes Diagram](image)

(S&W, 1996)

Figure 3: slope shape

Slope Position
Slope position strongly influences the moisture status of a site due to lateral water flow. Knowing slope position can provide clues as to a site's potential to shed, absorb, accumulate surface and ground water. Slope position is the relative location of a site, along the slope face upon which it is situated and is usually assessed from plot centre.

When assessing slope position, the intent is to be consistent with the scale of the topography directly affecting surface water flow. The vertical difference is usually between 3 and 300 metres, and the surface area generally exceeds 0.5 ha in size.

![Slope Position Diagram](image)

Figure 4: slope position
(adapted from Field Guide for Describing Terrestrial Ecosystems 2010)
Use the following table to assess and code the slope position of a site.

<table>
<thead>
<tr>
<th>code</th>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>crest</td>
<td>uppermost portion of a slope, shape usually convex or humped; water shedding</td>
</tr>
<tr>
<td>2</td>
<td>upper slope</td>
<td>also called “shoulder slope”, the upper portion of the slope immediately below the crest, slope shape usually convex (diverging); with a specific aspect; water shedding</td>
</tr>
<tr>
<td>3</td>
<td>middle slope</td>
<td>also called “mid slope”, the area of the slope between the upper slope and the lower slope; slope shape usually straight or concave (converging); usually water shedding</td>
</tr>
<tr>
<td>4</td>
<td>lower slope</td>
<td>the lower portion of the slope immediately below and adjacent to the middle slope; slope shape usually concave (converging); water accumulating</td>
</tr>
<tr>
<td>5</td>
<td>toe slope</td>
<td>the lower most portion of the slope, immediately below and adjacent to the lower slope; slope shape is concave, grading rapidly to level; water accumulating</td>
</tr>
<tr>
<td>6</td>
<td>depression</td>
<td>an area that is concave or converging in all directions, often at the foot of a slope or within level topography, water accumulating (e.g. palustrine)</td>
</tr>
<tr>
<td>7</td>
<td>level</td>
<td>any flat area excluding toe slopes, generally horizontal with no distinct aspect; water neutral</td>
</tr>
</tbody>
</table>

**Microtopography**

Microtopography describes the variability in the ground surface of a plot (≤ 20 metres).

**Microtopography Class**

Microtopography influences the variability and diversity of vegetation across the site. Use the following table to help identify the microtopography class.

<table>
<thead>
<tr>
<th>code</th>
<th>class terminology</th>
<th>mound height (m)</th>
<th>interval (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>level</td>
<td>few</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>micro mounded</td>
<td>&lt;0.3</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>slightly mounded</td>
<td>0.3 - 1</td>
<td>&gt;7</td>
</tr>
<tr>
<td>4</td>
<td>moderately mounded</td>
<td>0.3 - 1</td>
<td>3 - 7</td>
</tr>
<tr>
<td>5</td>
<td>strongly mounded</td>
<td>0.3 - 1</td>
<td>1 - 3</td>
</tr>
<tr>
<td>6</td>
<td>severely mounded</td>
<td>0.3 - 1</td>
<td>0.3 - 1</td>
</tr>
<tr>
<td>7</td>
<td>extremely mounded</td>
<td>&gt;1</td>
<td>&gt;3</td>
</tr>
<tr>
<td>8</td>
<td>ultra mounded</td>
<td>&gt;1</td>
<td>&lt;3</td>
</tr>
</tbody>
</table>
Ground Cover Assessment

Ground cover refers to the exposed organic (living or dead) or inorganic material at the ground surface. It provides an indication of the site characteristics (e.g. water, bedrock), litter type, humus form, conditions for bryophyte development, and availability of seed beds for different tree species. Percent covers are estimated for the plot or immediate surrounding representative site. Only the substrate surface is evaluated, ignoring any vegetation above. The total percentage of all ground covers should equal 100%.

% Leaf litter
Look for: undecomposed leaves from any woody, herbaceous, or graminoid species including ferns, fern allies, grasses etc. (not mosses or conifer needles)

% Conifer litter
Look for: undecomposed needles and cones from any conifer species

% Feather Moss
Look for: moss branched in a feathery manner generally forming spreading mats across the forest floor. Feather moss species include: Plitium crista-castrensis – plume moss; Hypnum pallasccens – stumpy pigtail moss; Sanionia unicanta – sickle moss; Callidendium haldanainumi – beautiful branch moss; Thuidium delicatulum – common fern moss; Hylocomium splendens – stair-step moss; Rhytidelphus triquetrus – shaggy moss; Pleurozium schreberi – Schreber’s moss; Tomenthynnum nitens – golden fuzzy fen moss; Bracythecium spp. – ragged moss; Neckera prenatal – feathery neckera moss

% Sphagnum Moss
Look for: upright, clump forming moss generally associated with wet areas. Decomposed sphagnum is commonly referred to as peat and in organic horizons may compose the Of, Om, or Oh layers.

% Other Mosses
Look for: mosses other than feather and sphagnum mosses found on the forest floor. This includes Dicranum spp., Polytrichium spp., Mnium spp., or other bryophytes such as liverworts and hornworts.

% Lichen
Look for: a fungus that grows symbiotically with algae, resulting in a composite organism that characteristically forms a crust like or branching growth on rocks or tree trunks. Four growth forms are possible; leaf, cup/club, shrub, and hair lichens. Lichen genera include: Cladina spp. – coral or reindeer lichen; Cladonia spp. – British soldiers, powered horn lichen, false pixie cup; Peltigera spp. – dog lichen; Stereocaulon spp. – woolly foam lichen

% Wood
Look for: non leaf material derived from woody species, (twigs, branches, or bole wood), and state of decomposition, may include bark. Do not include any part of a living tree that may be found on the surface.

% Permanent Standing Water
Look for: standing or flowing water on the plot which lacks signs of terrestrial vegetation or seasonal drying as evidenced by vernal or ephemeral pooling described below.

% Evidence of Vernal or Ephemeral Pools
Look for: simple pools of water with little vegetation growing in them:
- commonly found in small depressions in upland forests over a relatively impermeable substrate layer;
- they typically lack inlets and outlets
- broad size range from ~1m² to extending over large areas;
- often in groups as a patchwork mosaic of pools and knolls or mounds;
- in dry seasons - look for dark or black staining and matting of leaf litter and humus, in conjunction with little vegetation growth

% Bedrock
Look for: exposed, consolidated material regardless of mineralogy (fractures and cracks may be present). Bedrock normally forms a continuous surface.

% Coarse Fragment
Look for: on or about the surface for exposed gravel, cobbles, stones, and boulders

% Mineral Material
Look for: exposed mineral material

% Humus
Look for: F or H material exposed to the surface
% Burn
Look for: residual or ash material left over from a burn; must be dead and on the ground surface.

% Marl
Look for: loose, earthy deposits consisting chiefly of an intimate mixture of clay and calcium carbonate, formed under freshwater conditions; specifically an earthy substance containing 35-65% clay and 65-35% carbonate. It can form a surface layer or scum on lower slope positions/areas of seepage, the bottoms of vernal pools and on the bottom of richer wetland systems (Tiner 1999; Wetland Indicators).

% Other
Look for: other ground cover such as anthropogenic material
Understanding & Describing Substrates
There are three kinds of substrate material: organic, rock, and mineral. Descriptions of these are found below.

Organic Material
Organic material (also known as humus) contains more than 17% organic carbon (about 30% or more organic material) by weight. They are commonly found at the surface of rock and mineral substrates, or floating on standing water. Organic material may also occur at any depth beneath the surface as buried or submerged layers.

The thickness of organic material reflects the relative rates of litter accumulation and decomposition. Organic materials develop where the rate of accumulation of plant remains exceeds the rate of decomposition. The type and amount of organic material depends on the source of the material, rate and pathway of deposition and decomposition, climate, availability of oxygen, and mineralogy. There are two categories of organic material: folic and peat.

Folic Organic Materials
Folic horizons developed primarily from the accumulation of feathermoss, leaves, twigs, and woody materials with or without a minor component of mosses. They are normally but not exclusively associated with upland forested substrates with imperfect drainage or drier and cooler more humid microclimates.

The decomposition level of folic material is based on how readily discernible the original plant structures are. The four major folic horizon designations are L, F, H, and Hi

Folic Horizon Designation
Example organic material horizon designations are provided below. For full descriptions please refer to the CSSC manual.

Litter (L) Horizons
This organic horizon is characterized by an accumulation of organic matter in which the original structures are easily discernible.

Fermented (F) Horizons
This organic horizon is characterized by an accumulation of partly decomposed organic matter. Some of the original structures are difficult to recognize. The material may be partly comminuted by fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor (a thick mat of undecomposed to partly decomposed litter that is not significantly incorporated into the mineral material; decomposition is accomplished primarily by fungi.).

Humus (H) Horizons
This organic horizon is characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This horizon differs from the F by having greater humification due chiefly to the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with a mineral horizon.

Generally, folic horizons are not further subdivided using lower-case modifiers. The exception is “H”, where the lower-case modifier of “i” meaning “incorporated” can be applied.

Humus Incorporated (Hi) Horizons
This organic horizon is characterized by an accumulation of decomposed organic matter in which the original plant structures are indiscernible. This horizon differs from the H by having an accumulation of spherical or cylindrical organic granules (animal droppings) with considerable intermixing with mineral particles; generally an intermediate stage between H and Ah horizon.
Describing Folic Materials

Folic materials can be divided into horizons and described in terms of the degree of decomposition and material origin, within each. The degree of decomposition for folic material is based on how discernible the original plant structures are. To determine the degree of decomposition gently pull apart the folic material and examine the plant structures. Use the following standards as guides to describing folic materials.

Degree of Decomposition for Folic Material

L Litter: Non decomposed plant matter derived from leaves, needles, twigs, woody materials, and upland mosses. The original plant structures are easily discernible.

F Fermented: Partly decomposed plant matter derived from leaves, needles, twigs, and woody materials, with or without a minor component of mosses. Some of the original plant structures are difficult to recognize. Materials may be comminuted by substrate fauna as in a Moder, or they may be from a partly decomposed mat, permeated by fungal hyphae as in a Mor.

H Humus: Decomposed plant matter derived from leaves, needles, twigs, and woody materials, with or without a minor component of mosses. Original plant structures are indiscernible. It may be partly incorporated into the mineral soil as in a Moder (see Hi below)

Hi Spherical or cylindrical organic granules (animal droppings) with considerable intermixing with mineral particles. This often represents an intermediate stage in development between an H and an Ah horizon.

Note: Organic material horizons are currently under review by the national Expert Committee on Soil Science Working Group (ECSS).

Descriptors of Folic Materials

He Hemic: Folic material dominated by a moderately decomposed F horizon. Consisting of partly decomposed material generally derived from leaves, needles, twigs, and woody materials, with or without a minor component of mosses. Often containing numerous live and dead roots. H and O horizons must be less than 10 cm thick.

Hu Humic: Folic material dominated by well decomposed H horizons. Consisting of well decomposed material generally derived from leaves, needles, twigs, and woody materials, with or without a minor component of mosses. Contains numerous live and dead roots. May have subdominant F and O horizons each < 10 cm thick.

Li Lignic: Folic material dominated by F or H, horizons. Composed of moderately to well decomposed woody material (occupying > 30% by area of the excavated face. The source of woody material is generally trees that have been blown down in either periodic or continual processes.

Hi Histic: Folic material dominated by F or H horizons that are underlain by a significant (> 10 cm) O horizon. Originally peaty substrate where the accumulation became deep enough to produce surface conditions suitable for forest development and the encroachment of Folisol development.
Peat Organic Materials
Peat materials develop from the accumulation of organic matter derived primarily from Sphagnum or brown mosses, sedge/grasses and other hydrophytic herbaceous materials. They may contain dead and decomposing wood. Peat deposits accumulate in a wide variety of wetland environments where prolonged saturation, cool site climate, and low oxygen levels result in slow decomposition. These environments may or may not be forested.

There are two broad forms of peat generally recognized. Graminoid peats are comprised of decomposing plant materials derived from grasses, sedges and other hydrophytic vegetation. Moss peats are comprised of the decomposing remains of Sphagnum or brown mosses.

Peat materials can be divided into horizons and described in terms of the degree of decomposition and material origin, within each. Peat material has only one major horizon designation, “O” and lower-case modifiers “f”, “m”, or “h”, are appended based on the level of decomposition.

Peat Horizon Designations
Descriptions of organic material horizon designations are provided below, for a full description please refer to the CSSC manual.

Fibric horizons (Of)
A peat horizon comprised of poorly decomposed plant residues. Fibric horizons have the least decomposed organic material, containing large amounts of well-preserved fibre that can be identified as to plant species origin. They contain 40 % or more of rubbed fibre by volume.

Mesic horizons (Om)
A peat horizon comprised of partly decomposed plant residues. Mesic horizons have organic materials at an intermediate stage of decomposition. They contain 10 to 40 % rubbed fibre by volume.

Humic horizons (Oh)
A peat horizon comprised of well-decomposed plant residues. Humic horizons have the most highly decomposed organic material, with few recognizable plant remains. They contain less than 10 % rubbed fibre by volume.

Other Conditions Associated With Peat Materials

Hydric Layer (W)
Lateral zones or layers of water can be found within or under organic profiles and are known as hydric layers. Hydric layer are considered part of the organic substrate profile. If a hydric layer is encountered note the upper and lower extent of each layer, assign a horizon designation of “W”, and continue sampling any material below.

Hydric layers differ from the floating mat condition in that they are not continuous, and the sites are less likely to quake or wave as one bounces up and down on the surface.

Wood Layer
It is common to find layers of woody material, ranging from relatively undecomposed logs to strongly decomposed, barely discernable fibrous materials within an organic core or profile. Woody layers may act as a physical barrier to further sampling, but it is usually possible to work a sampling device through and around these materials, and continue sampling other organic layers below.

Wood should be removed from the sample prior to von Post evaluation.

Cumulic Layer
Layers of mineral material can occur within organic substrates. A cumulic layer is noted when the combined mineral layer thickness is more than 5 cm, or a single mineral layer of >5 – 30 cm occurs. Cumulic layers are typically found in areas of periodic deposition (e.g. flood plains, slope creep).

If a cumulic layer is encountered note the upper and lower extent of each layer, assign an appropriate mineral material horizon designation, and determine the texture of each layer.

Lithic (Bedrock) Layer
Peat materials are not necessarily deep, bedrock can be encountered. A lithic or bedrock layer occurs when bedrock is encountered within 10-160 cm of the surface of organic materials.

If a lithic layer is encountered, record where it was encountered in relation to the surface of the organic material, assign the horizon designation “R”, and record a rock code of “BR”.

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Terric Layer
Peat materials are not necessarily deep, mineral materials can be encountered. A terric layer is a mineral layer not underlain by further organic matter, or a single mineral layer. > 30 cm thick, occurring within the middle or bottom tier and underlain by organic material within a depth of 1.6 m from the organic substrate surface.

If a terric layer is encountered, record the upper and lower extent of each layer, assign an appropriate mineral material horizon designation, and determine the texture of the layer.

Limnic Layers
Peat materials can also include layers of organic (e.g., aquatic plant debris modified by aquatic animals) and inorganic materials (shells and/or precipitate) deposited in water. Distinct from the remainder of the peat materials they can include Coprogenous earth, marl and diatomaceous earth.

If a limnic layer is encountered, record the upper and lower extent of each layer, assign the horizon designation “Oco” for coprogenous earth, “Ck” for marl, and “C” for diatomaceous earth. No texture is determined for the layer.

Describing Peat Material
The decomposition level of peat materials is estimated from the appearance and properties of the plant remains. The most commonly used methods for assessing the degree of decomposition in peat materials are the Rubbed Fibre test and the von Post Scale of Decomposition.

Rubbed Fibre Test
In this test a small amount of peat is rubbed between the finger and thumb. Rubbed fibre is the fibre that remains after rubbing a sample about 10 times, and is expressed as a percentage of the original sample.

The von Post Scale of Decomposition
The most commonly used test for peaty organic material is the von Post Scale of decomposition where peat is assigned to ten classes of decomposition. These classes are commonly grouped into three categories categories of decomposition: Fibric, Mesic, and Humic.

The degree of decomposition for peat material is based on how discernible the original plant structures are in both a pressured and squeezed states, amount of felt fibre, degree of greasiness, amount of peat that escapes when compressed in the hand relative to the original unsqueezed amount, amount of water which was squeezed from a sample, and the turbidity of the expressed water. To further determine the degree of decomposition, gently pull apart the peat material and examine the plant structures. Then use the von Post Scale of Decomposition to assess the degree of decomposition.

Method:
1. Select just as much organic matter sample as can be held in a loose fist.
2. Remove any recognizable pieces of woody material and note the nature of the fibres.
3. Gently squeeze the sample by closing the hand to remove almost all excess water and noting the quantity of water expressed.
4. Slowly and firmly squeeze the sample one final time and observe the colour and turbidity of the last few drops of water expressed.
5. Examine the quantity and properties of any material expressed between the fingers.
6. Note the nature of the fibres, and the proportion of the original sample that remains in the hand.
7. Select the best fit from the ten classes of decomposition below and record the class code.

<table>
<thead>
<tr>
<th>Fibric Peat</th>
<th>Mesic Peat</th>
<th>Humic Peat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fibric Peat</strong></td>
<td><strong>Mesic Peat</strong></td>
<td><strong>Humic Peat</strong></td>
</tr>
<tr>
<td>vP1 (Of1)</td>
<td>vP5 (Om5)</td>
<td>vP7 (Oh7)</td>
</tr>
<tr>
<td>Undecomposed: plant structure distinct; yields only water coloured light yellow brown</td>
<td>Moderately decomposed: plant structure clear but becoming indistinct; yields much turbid brown water, some peat escapes between the fingers, residue very mushy</td>
<td>Strongly decomposed: plant structure indistinct but recognizable, about half the peat escapes between the fingers</td>
</tr>
<tr>
<td>vP2 (Of2)</td>
<td>vP6 (Om6)</td>
<td>vP8 (Oh8)</td>
</tr>
<tr>
<td>Almost undecomposed: plant structure distinct; yields only clear water coloured light yellow brown</td>
<td>Strongly decomposed: plant structure somewhat indistinct but clearer in the squeezed residue than in the undisturbed peat; about a third of the peat escapes between the fingers, residue strongly mushy</td>
<td>Very strongly decomposed: plant structure very indistinct; about two-thirds of the peat escapes between the fingers, residue almost entirely resistant remnants such as root fibres and wood</td>
</tr>
<tr>
<td>vP3 (Of3)</td>
<td>vP9 (Oh9)</td>
<td>vP9 (Oh9)</td>
</tr>
<tr>
<td>Very weakly decomposed: plant structure distinct; yields distinctly turbid brown water, no peat substance passes between the fingers, residue not mushy</td>
<td>Almost completely decomposed: plant structure almost unrecognizable; nearly all the peat escapes between the fingers</td>
<td>Almost completely decomposed: plant structure almost unrecognizable; nearly all the peat escapes between the fingers</td>
</tr>
<tr>
<td>vP4 (Of4)</td>
<td>vP10 (Oh10)</td>
<td>vP10 (Oh10)</td>
</tr>
<tr>
<td>Weakly decomposed: plant structure distinct; yields strongly turbid water, no peat substance escapes between the fingers, residue rather mushy</td>
<td>Completely decomposed: plant structure unrecognizable; all the peat escapes between the fingers</td>
<td>Completely decomposed: plant structure unrecognizable; all the peat escapes between the fingers</td>
</tr>
</tbody>
</table>
Humus form development is influenced by climate, edaphic and biological conditions, and reflects local site conditions, thus its classification can provide insight into these environmental factors. Decaying organic materials release various organic substances and nutrients. The incorporation of these decomposed organic substances into the upper mineral substrate strata plays an important role in substrate formation by affecting pore size, cation exchange capacity, and chemical weathering. Forest humus forms also influence substrate moisture, temperature, and erosion, and act as a reservoir of nutrients and seeds (Sims and Baldwin 1996). Thus decaying organic materials strongly affect substrate nutrient dynamics.

Humus (both folic and peat) can be classified in terms of depth, relative thickness of layers, material origin, degree of decomposition, and degree of incorporation with mineral substrate.

**Humus Form** is one such classification. Use the key to Humus Form Classification below to classify the entire organic portion (folic and peat) of a substrate. The gray shaded cells represent the class name; the white cells are the series level of classification.

**Figure 5**: key to humus form classification (adapted from OCSRE 1993)
Rock Material
Two broad types of rock material are used: bedrock and coarse fragment.

Bedrock
Bedrock is consolidated rock material deposited by larger geologic processes. Some crevices and cracks and large blocks are permitted.

Bedrock is described on the basis of its geologic origin and geochemical properties (pH). There may or may not be a thin covering of mineral or organic material, and if so there is < 5 cm of mineral and/or < 10 cm organic. There is little or no fine mineral or organic material in the interstitial spaces.

Bedrock is denoted by a single code (BR).

Coarse Fragments
Coarse Fragments are the result of some form of physical breakdown or weathering of bedrock. Coarse fragments are unconsolidated rock material. Coarse fragments range from 2 mm in size or greater along their long axis and are coded according to size.

Coarse fragments must occupy > 90% of the substrate volume AND there must be inadequate fine mineral or organic material to fill the interstitial spaces. There may or may not be a thin covering of mineral or organic material, and if so it is < 5 cm of mineral and/or < 10 cm organic.

Coarse fragments are described based on their dominant size classes and geochemical properties.

Coarse fragments can be found associated with talus slopes or scree, gravel and cobble shorelines, and boulder lag.

Coarse Fragment Size Class
There are four size classes of coarse fragments recognized. The following table describes the coarse fragment size classes as recognized by the ELC program.

<table>
<thead>
<tr>
<th>coarse fragment size prefix</th>
<th>name</th>
<th>size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gr</td>
<td>gravel</td>
<td>0.2 - 8</td>
</tr>
<tr>
<td>co</td>
<td>cobble</td>
<td>8 - 25</td>
</tr>
<tr>
<td>st</td>
<td>stone</td>
<td>25 - 60</td>
</tr>
<tr>
<td>bo</td>
<td>boulder</td>
<td>&gt; 60</td>
</tr>
</tbody>
</table>

Substrate Classes of Rock Materials
There are two substrate classes of rock materials. Bedrock substrate class and Coarse Fragment substrate class are determined by the following criteria. These two classes can be further classified to various substrate types by using the criteria set out in the Key to Ontario Substrate Classes key (page 55).

Bedrock Substrate Class
To be classed as a bedrock substrate these conditions must apply:
- > 80% of area is exposed rock and coarse fragments, the majority of which is rock;
  **OR**
- organic material ≤ 10 cm AND ≤ 5 cm of mineral material over bedrock

Coarse Fragment Substrate Class
To be classed as a coarse fragment substrate these conditions must apply:
- > 80% of area is exposed coarse fragments and rock AND the majority of which is coarse fragments;
  **OR**
- organic material ≤ 10 cm, AND there is ≤ 5 cm of mineral material over mainly coarse fragment material
Rock Material Chemistry (Carbonates)

To test rock or coarse fragment material for carbonates, place a drop of 10% hydrochloric acid (HCl) on a fresh clean surface and look and/or listen for any effervescence. If no reaction is present, scrape a fresh sample surface to create a fine powder and repeat the test. Based on the observations, select one of the following:

<table>
<thead>
<tr>
<th>Observation</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>visible or audible effervescence</td>
<td>k</td>
<td>calcareous</td>
</tr>
<tr>
<td>no visible or no audible effervescence</td>
<td>n</td>
<td>non calcareous</td>
</tr>
</tbody>
</table>
Mineral Materials

Mineral material is composed of unconsolidated (i.e. loose), non-organic particles < 2 mm in size, and may contain ≤ 90% coarse fragments (≥ 2 mm) by volume, derived from physically and chemically weathered rock matter. Some particles may be formed by precipitation or coalescence of dissolved rock compounds. Mineral material contains 17% or less organic carbon (about 30% or less organic matter) by weight. They consist of variable mixture of particles and are classed by size as sand, silt, or clay, and may be intermixed with varying amounts of coarse fragments (gravel, cobbles, stones, and boulders). The type and amount of mineral material and coarse fragment is dependent on the source of the material, type of weathering, mode of deposition, meso/microclimate, and mineralogy.

Mineral Particle Size Class

The particle size range of mineral materials can be divided into three classes (sand, silt, or clay). Sand is further divided into 5 grades (very coarse, coarse, medium, fine, and very fine). The following table describes the mineral particle size classes as recognized by the ELC program.

<table>
<thead>
<tr>
<th>particle size class</th>
<th>code</th>
<th>diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>very coarse sand</td>
<td>vcS</td>
<td>2.0 - 1.0</td>
</tr>
<tr>
<td>coarse sand</td>
<td>cS</td>
<td>1.0 - 0.5</td>
</tr>
<tr>
<td>medium sand</td>
<td>mS</td>
<td>0.5 - 0.25</td>
</tr>
<tr>
<td>fine sand</td>
<td>fS</td>
<td>0.25 - 0.10</td>
</tr>
<tr>
<td>very fine sand</td>
<td>vfS</td>
<td>0.10 - 0.05</td>
</tr>
<tr>
<td>silt</td>
<td>Si</td>
<td>0.05 - 0.002</td>
</tr>
<tr>
<td>clay</td>
<td>C</td>
<td>&lt; 0.002</td>
</tr>
</tbody>
</table>
Describing Mineral Materials

Texture

The texture triangle shows the breakdown of the proportions of sand, silt, and clay into texture classes. The sum of the percentage of sand, silt, and clay should equal 100%. It follows then that the percent of silt is equal to 100 - % sand – % clay. Percentage of sand and clay are represented along the horizontal and vertical axes. Percentage of silt is inferred from an imaginary axis running diagonally between the sand and clay axis.

The texture triangle is useful when discriminating between closely related classes and should be consulted regularly when field texturing.

Texture Triangle

Notes:
The sand portion of the sand, loamy sand, sandy loam and silty sand texture classes are described more specifically based on the dominant sand size class. For example: very coarse sand, loamy very fine sand and fine sandy loam.

The texture classes may be modified by adding suitable adjectives when coarse fragments occupy > 15% of the substrate volume. For coarse fragment volumes 15 - 35% use coarse fragment modifier plus texture (e.g. gravelly sandy loam). For coarse fragment volumes > 35 - ≤ 90% use the additional adjective “very” (e.g. very gravelly sandy loam).

Figure 6: texture triangle
(adapted from OCSRE 1993)
Textural classes are coded as follows. Remember that the classes for Sand, Loamy Sand, Silty Sand, and Sandy Loam are further refined bases upon the dominant sand size class present.

### Table 11: mineral texture class & codes

<table>
<thead>
<tr>
<th>Texture class code</th>
<th>Texture class</th>
<th>Sand size modifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>sand</td>
<td>mandatory (choose only one)</td>
</tr>
<tr>
<td>LS</td>
<td>loamy sand</td>
<td>vc = very coarse</td>
</tr>
<tr>
<td>SiS</td>
<td>silty sand</td>
<td>c = coarse</td>
</tr>
<tr>
<td>SL</td>
<td>sandy loam</td>
<td>m = medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = fine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vf = very fine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>examples: vfS, SiSfS</td>
</tr>
<tr>
<td>L</td>
<td>loam</td>
<td>no sand size modifier</td>
</tr>
<tr>
<td>SiL</td>
<td>silt loam</td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>silt</td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td>sandy clay</td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>clay loam</td>
<td></td>
</tr>
<tr>
<td>SiCL</td>
<td>silty clay loam</td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td>sandy clay</td>
<td></td>
</tr>
<tr>
<td>SIC</td>
<td>silty clay</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>clay</td>
<td></td>
</tr>
</tbody>
</table>

examples: vfSL = very fine sandy loam, mS = medium sand, SiCL = silty clay loam

### Texture Family

ELC groups textures into texture families. These are:

### Table 12: texture families of mineral material

<table>
<thead>
<tr>
<th>ELC texture family</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>sandy S</td>
<td>coarse sandy</td>
</tr>
<tr>
<td></td>
<td>vcS, LvcS, cS, LcS, mS, LmS</td>
</tr>
<tr>
<td></td>
<td>fine sandy</td>
</tr>
<tr>
<td></td>
<td>fS, LfS</td>
</tr>
<tr>
<td>coarse loamy cL</td>
<td>coarse loamy</td>
</tr>
<tr>
<td>silty Si</td>
<td>silty</td>
</tr>
<tr>
<td></td>
<td>Si, SiL</td>
</tr>
<tr>
<td>fine loamy fL</td>
<td>fine loamy</td>
</tr>
<tr>
<td></td>
<td>SCL, CL, SiCL</td>
</tr>
<tr>
<td>clayey C</td>
<td>clayey</td>
</tr>
<tr>
<td></td>
<td>SIC, C, SC</td>
</tr>
</tbody>
</table>
How to Determine Mineral Substrate Texture

The proportions of sand, silt, and clay can be estimated in the field through the finger assessment of mineral material which include feel, moist cast, taste, ribbon, and shine tests. Field texture tests allow the approximate midpoint of a texture class to be determined. Substrates near the boundaries of texture classes on the texture triangle are more difficult to assign correctly in the field. Field determination of mineral substrate texture is subjective and can only be accomplished consistently with training and experience. Practice is essential. It is useful to test yourself with samples of known texture (i.e. lab textured samples). Mineral substrate texture may be more accurately determined in the laboratory.

1. To begin, select or obtain a representative sample of the material to be assessed
2. Estimate the percent by volume of coarse fragment content, either in situ, in the hand, or on the auger or shovel.
3. Remove only the coarse fragments (≥ 2 mm) and set aside.
4. The remaining material should then be thoroughly crushed, kneaded, or reworked, to break apart any aggregated primary particles.
5. Determine the mineral substrate texture using the charts and tables found below.

Field Tests for Assessing Mineral Materials

Table 13: field tests for assessing texture of mineral materials (adapted from OCSRE 1993)

<table>
<thead>
<tr>
<th>test</th>
<th>description of test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graininess Feel Test</td>
<td>Mineral material is rubbed between thumb and fingers to assess the % sand. Sand feels grainy.</td>
</tr>
<tr>
<td>Dry Feel Test</td>
<td>For mineral material with &gt; 50% sand. Mineral material is rubbed in the palm of the hand to dry it and to separate and estimate the size of the individual sand particles. The sand particles are then allowed to fall out of the hand and the amount of finer materials (silt &amp; clay) remaining is noted.</td>
</tr>
<tr>
<td>Moist Cast Test</td>
<td>Compress some moist mineral material by clenching it in your hand. If the substrate holds together (i.e. forms a cast), then test the strength of the cast by tossing it from hand to hand. The more durable it is the more clay is present.</td>
</tr>
<tr>
<td>Ribbon Test</td>
<td>Moist mineral material is rolled into a cigarette shape and then squeezed out between the thumb and forefinger to form the longest and thinnest ribbon possible. Mineral substrates with high silt content will form flakes or peel-like thumb imprints rather than a ribbon.</td>
</tr>
<tr>
<td>Taste Test</td>
<td>A small amount of mineral material is worked between the front teeth. Sand is distinguished as individual grains which grit sharply against the teeth. Silt particles are identified as a general fine grittiness, but individual grains cannot be identified. Clay particles are not gritty.</td>
</tr>
<tr>
<td>Shine Test</td>
<td>A small amount of moderately dry mineral material is rolled into a ball and rubbed once or twice against a hard, smooth object such as a knife blade or thumb nail. A shine on the ball indicates clay in the mineral material.</td>
</tr>
<tr>
<td>Stickiness Feel Test</td>
<td>Mineral material is mixed and gradually wetted with water to the point of saturation. Compress material between the pads of thumb and forefinger, then observe closely as the thumb and finger are slowly separated. Degree of stickiness is determined by noting how strongly it adheres to the thumb and forefinger upon release of pressure and how much it stretches.</td>
</tr>
</tbody>
</table>
### Field Tests Characteristics of Mineral Texture Classes

<table>
<thead>
<tr>
<th>Texture Class</th>
<th>Field Test</th>
<th>Shake Test</th>
<th>Tast Test</th>
<th>Ribbon Test</th>
<th>Moist Test</th>
<th>Dry Test</th>
<th>Feel Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>none</td>
<td>necessary</td>
<td>unnecessary</td>
<td>necessary</td>
<td>none</td>
<td>very weak cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Loam Sand</td>
<td>none</td>
<td>necessary</td>
<td>unnecessary</td>
<td>necessary</td>
<td>none</td>
<td>very weak cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>weak cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Loam</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>weak cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Silty Loam</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>moderate cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Sandy Clay</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>strong cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Clay Loam</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>strong cast</td>
<td>very strong cast</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>necessary</td>
<td>strong cast</td>
<td>very strong cast</td>
</tr>
</tbody>
</table>

Table 14: Field Tests Characteristics of Mineral Texture Classes (adapted from OCSRE 1993)
Finger Assessment of Mineral Texture Class

**Texture Class**

- **SAND (S)**
  - Ribbon Test: none
  - Feel Tests: very grainy, little floury material*
  - Moist Cast Test: no cast

- **LOAMY SAND (LS)**
  - Ribbon Test: none
  - Feel Tests: very grainy, slight floury material*
  - Moist Cast Test: very weak cast

- **SILTY SAND (SIS)**
  - Ribbon Test: almost flakes or silt portion is F or FS
  - Feel Tests: very grainy, moderate floury material*
  - Moist Cast Test: weak cast

- **SANDY LOAM (SL)**
  - Ribbon Test: barely ribbons (1.5 – 2.5 cm)
  - Feel Tests: very grainy, moderate floury material*
  - Moist Cast Test: moderate cast

- **SANDY CLAY LOAM (SCL)**
  - Ribbon Test: thick & short (2.5 – 5 cm)
  - Feel Tests: grainy, slightly to moderately sticky
  - Moist Cast Test: moderate cast

- **SANDY CLAY (SC)**
  - Ribbon Test: thin, long (5 – 7.5 cm) holds own weight
  - Feel Tests: grainy, sticky
  - Moist Cast Test: strong cast

* Guide to Floury Material Descriptions
  - “little” < 10% by volume
  - “slight” 10 to 30% by volume
  - “moderate” 30 to 50% by volume
  - “very” > 50% by volume

Floury material is comprised of silt and clay particles that may be present in a field sample, and are distinct from clearly recognizable grains of sand material.
Horizon Designation

Figure 8: general mineral horizons (adapted from OCSRE 1993)

Mineral substrates can be described in detail by dividing the profile into horizons and describing the properties of each. Three major mineral substrate horizon designations are commonly used.

A Horizons
Typically the upper-most horizons in the profile, unless buried. Near surface horizons from which materials are removed and transported in suspension or in solution (leaching or eluviation). This is the zone of maximum in situ accumulation of organic matter. Incorporation of organic matter darkens the surface substrate (Ah). Conversely, the removal of organic matter is usually expressed by a lightening of the substrate colour in the upper part of the solum (Ae).

B Horizons
Typically underlying the A horizons. This is the region of the substrate profile where leached materials are being transported to, and where they accumulate. Chemical decomposition leads to leaching and accumulations of silicate clays, iron and aluminum oxides, gypsum, and calcium carbonate (marl). Organic materials also get washed and migrate to the B horizons.

C Horizons
Typically the lowest horizons in the profile, underlying the A and B horizons. These are the mineral layers that are comparatively unaffected by weathering, and typically referred to as the parent material.

Subdivisions of mineral horizons are labelled by adding lower-case suffixes to some of the major horizon symbols, for example Ae, Bm, or Cg. Please refer to the CSSC (1989) for a complete list of lower-case modifiers.
Following are some of the more common horizon names associated with profile development in mineral substrates on Ontario:

- **Ah, Ap**: dark coloured, mineral surface horizon, enriched with organic matter (p – man modified, plough layer)
- **Ae**: light coloured near surface horizon. Horizon of loss of iron, aluminium, organic matter or clay
- **AB**: transition horizon from A to B
- **Bt**: brownish, subsurface horizon enriched with clay that has been moved from the Ae horizon
- **Btgj**: Bt horizon containing distinct mottles and without gray gley colours. The suffix “gj” is also applied to other horizons containing distinct mottles without gray gley colours e.g. Bmgj, Ckgj.
- **Bm**: brownish subsurface horizon with only slight addition or iron, aluminium or clay
- **Bf, Bhf**: reddish brown subsurface horizon with significant accumulation of iron, aluminium and/or clay
- **Bg**: horizons with gray gley colours or prominent mottling or both. The suffix “g” is also applied to other horizons with these characteristics
- **BC**: transition horizon from B to C
- **C**: relatively unweathered material from which the substrate profile has developed
- **Ck**: C horizon containing calcium and/or magnesium carbonates that will effervesce with diluted HCl (10%)
- **II Bt**
  - Bt horizon which has developed in materials which are significantly different in texture (mode of deposition) from the horizons above
  - Roman numerals which precede the horizon designation indicate a significant change in texture (mode of deposition) within the profile e.g. where silt loam occurs over coarse sand, the horizon(s) of coarse sand are preceded by II.

For a more complete and detailed list of soil/substrate horizon names and their define criteria, refer to the CSSC manual.

**Substrate Colour Description**

Mineral material colour is an indication of parent material, substrate development, substrate drainage and water table fluctuations. Substrate material and horizon may be described in terms of three colour criteria. These are matrix colour, mottle colour, and gley colour, and these are described later in this section.

For accuracy and consistency, all soil related colours must be referenced using the Munsell Soil Color Chart system.

**Munsell Soil Color Chart Standard**

Standardized description of substrate color is obtained using the Munsell Soil Color Charts which quantify colour in terms of HUE, VALUE, and CHROMA, and documented in that order to form a Munsell color notation. The HUE represents a page in the Munsell Soil Color Charts and is the letter abbreviation (R for red, YR for yellow-red, Y for yellow) preceded by a number from 0 – 10. As the numbers increase within each letter range the HUE becomes more yellow and less red. The VALUE represents the relative lightness of a colour. The CHROMA represents the relative purity, strength or saturations of a colour.

![Munsell Soil Color Chart](image)

Figure 9: Munsell Soil Color Charts (adapted from OCSRE 1993)
Using Standard Munsell Soil Color Charts

The steps for using the standard Munsell Soil Color Charts are:
1. select the appropriate Hue Card
2. hold the sample directly behind the apertures separating the closest matching colour chips
3. record the substrate colour using the Munsell Notation HUE VALUE/CHROMA (e.g. 10 YR 5/6)
4. record the moisture condition of the substrate

In the field, colours are normally assessed with a sample that is at field moisture. It is also important to record the moisture condition of the material if it is not at field moisture as colour changes upon drying.

Matrix Colour Description

The matrix colour is the overall average or background colour of a material or horizon. Among other things, it indicates the long term condition or equilibrium of material oxidation (aerobic state). For each horizon:
1. identify the matrix
2. assess and record the Munsell colour
3. indicate if the material is moist or dry

Mottle Description

Mottles are irregularly shaped patches or blotches within a horizon that differ from the matrix color. They are generally redder in color that the matrix colour. Mottles are characterized on the basis of abundance, size, and contrast to the matrix colour.

Abundance

<table>
<thead>
<tr>
<th>Few</th>
<th>Common</th>
<th>Many</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2%</td>
<td>2 – 20%</td>
<td>&gt; 20%</td>
</tr>
</tbody>
</table>

![Figure 10: mottle abundance guide](adapted from OCSRE 1993)

Size

The diameter of the mottle if round, or the greatest dimension if length is not more than 2-3 times the width, or the width if the mottle is long and narrow (the long axis diameter).

| Table 15: mottle size class (adapted from OCSRE 1993) |
|---|---|
| size | dimension (mm) |
| fine | < 5 |
| medium | 5 – 15 |
| coarse | > 15 |
Contrast
Contrast is a measure of the difference between the mottle colour and the matrix colour. It is necessary to use the “Munsell Soil Color Charts” for accurate assessment of hue, value, and chroma.

Contrast is a measure of the difference between the mottle colour and the matrix colour. It is necessary to use the “Munsell Soil Color Charts” for accurate assessment of hue, value, and chroma.

<table>
<thead>
<tr>
<th>difference from matrix</th>
<th>hue</th>
<th>value</th>
<th>chroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>faint</td>
<td>0</td>
<td>≤ 2</td>
<td>≤ 1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>distinct</td>
<td>0</td>
<td>3 – 4</td>
<td>2 – 4</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>≤ 2</td>
<td>≤ 1</td>
</tr>
<tr>
<td>prominent</td>
<td>0</td>
<td>≥ 4</td>
<td>≥ 4</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>≥ 2</td>
<td>≥ 1</td>
</tr>
<tr>
<td></td>
<td>2+</td>
<td>≥ 0</td>
<td>≥ 0</td>
</tr>
</tbody>
</table>

Table 16: mottle contrast
(adapted from OCSRE 1993)

Hue, Value, and Chroma must be determined using the Munsell Soil Color Charts.

Gley
Poorly and very poorly drained substrates are anaerobic due to their constant saturated and stagnant moisture status. This inhibits oxidization, and promotes reduction of the parent material which strongly influences its colour expression. This colour expression is diagnostic of long term anaerobic state and excess moisture condition of a substrate material or horizon, and is referred to as gley colour.

Gley colours can be found on the Munsell Gley Color Charts, and generally as low chroma colors on many other Hue pages. They typically are grey, grey green, grey blue, or low chroma colours.

Specifically gley colours meet one or more of the following conditions:
- be found on the Munsell Gley Color Charts
- chroma 1 or less; any hue
- chroma 2 or less in hues 7.5YR or 10YR
- chroma 3 or less on hues more yellow than 10YR
- any chroma with hue bluer than 10Y
- any chroma with hue of 5YR or redder

(adapted from OCSRE 1993)

Note: In subsequent charts we use the term “grey gley” to capture the wide range of gley colours, even though not all gley colors are grey.

Gley Soil Color Charts
These pages are found in many Munsell Soil Color Chart books, or can be obtained separately. They are a collection of the many common gley colour expressions found in substrate materials.

The matrix colour may be a gley colour found on one of the gley color charts. If so, the hue is found along the bottom of the page, the value is located along the left hand side of the page, and the chroma is indicated on the colour name diagram page. An example of a colour from the gley page would be 5G 4/1.

Challenges with High Chroma Parent Materials
Mottles and gley can be very hard to pick up or recognize in materials that are very red or brown. It can be especially challenging to identify mottles and gley in red to brown materials (e.g. “red clays”), luvisols, and materials with significant organic staining. Due diligence should be exercised when evaluating these, so as to not under evaluate their mottled or gleyed condition. Local expertise and experience are valuable allies for these situations.

Challenges with Low Chroma Parent Materials
Gley colours, mottles, and “B” horizons can be challenging to discern when observing materials of naturally low chroma (e.g. Bright Sands in north western Ontario). The mineralogy of these substrates will at best only produce weak and muted colors, even when well drained and highly aerated. Mottles form but are generally weaker in expression. One should look at secondary indications of drainage and aerobic state throughout a profile. Consider things like the presence/absence of mottles above a gley zone, or the presence/absence of peat. Using a more holistic approach to assessment of moisture regime will yield more accurate and consistent results.
**Carbonate Description**

Calcareaousness is an estimate of the amount of carbonate (CaCO₃) present in the mineral material. Calcareaousness is assessed in the field by adding a small quantity of 10% hydrochloric acid (HCl) to the substrate and evaluating the reaction or effervescence. Substrates with carbonates present will produce a visible bubbling or foaming, or an audibly hissing or crackling, when 10% HCl is applied to the substrate material.

For detailed surveys the carbonate content can be assessed by assigning a calcareaous class to the mineral material. In general, noting if the mineral material is calcareaous (k), including the depth where first observed, or not (n) is sufficient.

<table>
<thead>
<tr>
<th>ELC calcareaous code</th>
<th>calcareaous class</th>
<th>name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>N</td>
<td>non-calcareaous</td>
<td>Absence of bubbling or foaming. Hissing and/or crackling are not heard. CaCO₃ ~ 0%</td>
</tr>
<tr>
<td>k</td>
<td>W</td>
<td>weakly calcareaous</td>
<td>Bubbles readily observed. Hissing and/or crackling present but not easily heard. CaCO₃ &lt; 5%</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>moderately calcareaous</td>
<td>Bubbles forming low foam. Hissing and/or crackling are easily heard. CaCO₃ 5 - 15%</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>strongly calcareaous</td>
<td>Bubbles forming thick foam. Strong hissing and/or crackling very easily heard. CaCO₃ 15 - 25%</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>very strong</td>
<td>Bubbles forming very thick foam. Very strong hissing and/or crackling. CaCO₃ 25 - 40%</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>extremely calcareaous</td>
<td>Bubbles form very thick foam. Materials react violently when acid is added. Extremely strong hissing and/or crackling heard. CaCO₃ &gt; 40%</td>
</tr>
</tbody>
</table>
Coarse Fragment Content

After a texture is assigned to a mineral horizon, the coarse fragment load should be assessed based on size class and quantity. Use the two tables below for this determination.

There are four size classes of coarse fragments recognized. These are:

<table>
<thead>
<tr>
<th>Table 18: coarse fragment size</th>
</tr>
</thead>
<tbody>
<tr>
<td>coarse fragment size prefix</td>
</tr>
<tr>
<td>code</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>gr</td>
</tr>
<tr>
<td>co</td>
</tr>
<tr>
<td>st</td>
</tr>
<tr>
<td>bo</td>
</tr>
</tbody>
</table>

There are three levels of coarse fragment load recognized. These are:

<table>
<thead>
<tr>
<th>Table 19: coarse fragment load</th>
</tr>
</thead>
<tbody>
<tr>
<td>coarse fragment load (by volume)</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>≤ 15%</td>
</tr>
<tr>
<td>&gt;15 to ≤ 35%</td>
</tr>
<tr>
<td>&gt; 35 to ≤ 90%</td>
</tr>
<tr>
<td>examples:</td>
</tr>
</tbody>
</table>
## ELC Materials Overview

The following table is an overview of material types and related properties described above.

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Organic Material Type</th>
<th>Degree of Decomposition</th>
<th>Organic Modifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>organic</td>
<td>folic</td>
<td>L, F, H, Hi</td>
<td>H, humic, L, lignic, H, historic</td>
</tr>
<tr>
<td></td>
<td>upland organic material derived from upland vegetation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>peat</td>
<td>vp1, vp2, vp3, vp4, vp5, vp6, vp7, vp8, vp9, vp10</td>
<td>W denotes a hydric layer and its use is restricted to peaty organic substrates.</td>
</tr>
<tr>
<td></td>
<td>lowland organic material derived from hydrophytic vegetation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** coarse fragment description not applicable

<table>
<thead>
<tr>
<th>Rock Material Type</th>
<th>Rock Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>bedrock</td>
<td>BR</td>
</tr>
<tr>
<td>coarse fragments</td>
<td>Gr, Co, St, Bo</td>
</tr>
</tbody>
</table>

**Figure 11:** overview of ELC Substrate Materials

<table>
<thead>
<tr>
<th>ELC Texture Family</th>
<th>Texture</th>
<th>Mineral Modifiers</th>
</tr>
</thead>
</table>
| sandy              | coarse sandy | *coarse fragment modifiers:*
|                    | fine sandy   | >15% to 35% by volume |
| coarse loamy       | coarse loamy | Prefix texture class with the appropriate coarse fragment adjective(s). |
|                    | note: includes all very fine sands, and all silty sands | gr = gravely 2 mm - 8 cm |
| silty              | silty     | co = cobbly 8 cm - 25 cm |
| fine loamy         | fine loamy | st = stony 25 cm - 60 cm |
| clayey             | clayey    | bo = bouldery > 60 cm |
|                    | all mineral materials with > 35% clay particles | > 35 to ≤ 90% by volume |
|                    |           | Prefix the coarse fragment modifier(s) with "v" meaning "very". |
Sampling Substrates

Pedon
The pedon is the basic unit of soil in the Canadian classification system. ELC has extended the meaning of pedon by replacing the concept of a soil with the broader concept of a substrate. ELC defines a pedon as the smallest three-dimensional unit that captures the local range of variation of a particular s-type or condition.

The minimal size of a pedon is generally accepted to be 1 m$^2$ as revealed by an excavation that extends from the zero mark point to a depth of at least 1.2 m unless bedrock, coarse fragments, or water is encountered. In frozen substrates the pedon is at least 3.5 m wide and 2 m deep.

Sampling Protocols
ELC endorses three sampling protocols (visual assessment, auger, and pit) that are used to represent the concept of a pedon. They are described below.

Visual Assessment Protocol
A number of substrate classes such as limnetic, vertical, and parts of saline, rock, and active are evaluated using a 3 x 3 m visual assessment. The visual assessment identifies the dominant substrate condition.

Do the following steps when performing a visual assessment protocol:
1. The 3 x 3 m visual assessment should be as close to plot centre as possible. An alternate location may be needed if the site is not representative.
2. Using a measuring tape or ruler, measure and mark out the corners of the plot.
3. Record the required data.

Minimum Sample Requirements for 3 x 3 m Visual Assessment
- % surface covers
- ELC moisture regime
- chemistry
- s-type
**Pit Protocol**

Substrates are normally described on the basis of a substrate pit, which permits close examination of the substrate profile. The actual depth necessary to determine the moisture regime and drainage class is dependent upon the characteristics of the substrate profile.

Generally, a pit is excavated to the maximum depth permitted by conditions or 120 cm, and then an auger is utilized to probe deeper to a suggested depth of up to 200 cm, and into the C-horizon to determine the depth to mottling. At least 25 cm of the parent material horizon should be exposed. Normally pits are excavated to 1 wide and at least 1.2 m deep, unless bedrock or a water table is encountered before reaching this depth. A depth of 2 m is required as a minimum observation for moderately fresh sites with a very open pore pattern (see ELC Moisture Regime - Chart C). In Cryosols a substrate pit would consist of a minimum width of 3.5 m and a minimum depth of 2 m.

In all situations, Health and Safety Guidelines dictate that excavations beyond 120 cm should not be entered unless proper shoring has been put in place. It is acceptable to use an auger to extend the depth of a pit beyond this limit when required.

**Do the following steps when performing a pit protocol:**

1. The pit should be as close to the centre of the plot as possible. Choose an alternate location if the plot centre is not representative of the predominant site condition.
2. Complete vegetation work before digging the pit.
3. Select the face of the pit to be used for delineation of the horizons. Position the pit so that the profile faces the brightest sunlight. Ensure that these faces are kept in good condition when digging. You can place a jacket or safety vest on the side of the face as a reminder.
4. Expose at least two good faces to reveal the variation in the profile.
5. Remove the litter layer and upper horizons as relatively intact divots. Place them safely to the side as surface organic measurements may be taken from the divot or the cut face. When the work is complete they are replaced on the surface.
6. Place excavated material neatly to one side of the pit to prevent contamination of the face and compaction of the upper horizons. This also makes it easy to refill the pit.
7. Pits are at least 120 cm deep, unless bedrock, coarse fragments, impermeable layer, or water table are encountered before reaching this depth. Make a note if it is impossible to reach the C-horizon because of boulders, bedrock, cemented layers, water or ice.
8. Record the required data.
9. After sampling, return the pit to as natural a state as possible to minimize the impact to the site. Replace any coarse fragments, coarse woody debris or roots in the pit and fill in the pit with the excavated substrate. Replace the surface divots and tamp down.

Some helpful hints for digging a pit are:

- If necessary an auger can be used to extend an excavation through or around impassable objects such as large stones, water in the pit, cemented layers, and basal till.
- Augers can be used to extend the depth of observation beyond 120 cm from the bottom of excavated pits when required (e.g., sands)

**Minimum Sample Requirements for Pit**

- thickness of folic material
- thickness of peat material
- thickness of mineral material
- depth class of substrate
- effective texture
- depth to distinct / prominent mottles
- depth to gley
- ELC moisture regime
- chemistry
- s-type
Auger Protocol

There may be times when substrate conditions make digging a substrate pit very difficult or the required level of sampling intensity does not require a pit. An alternative to digging a pit would be to use an auger. Augers are used to sample substrates up to 120 cm deep or shallower when stones or bedrock are encountered. They are either pushed or screwed into the substrate to fill the auger barrel. Be aware that the pushing or screwing motion of the auger can compress or twist substrate samples, which can lead to either stretching or compaction of the sample and mixing of substrate layers. Holding the auger perpendicular to the ground surface and using it carefully will reduce stretching, compaction and mixing of substrate layers. It can be a challenge to remove auger samples so that they accurately represent depths at which features (e.g. mottles) occur.

Do the following steps when performing an auger protocol:

1. The auger should be as close to plot centre as possible. Choose an alternate location if plot centre is not representative of the site.
2. Complete any vegetation work before augering.
3. Remove an organic surface divot with at least one vertical side, and set aside. Surface organic measurements may be taken from the divot or the cut face from which it was removed.
4. Place the auger head on the exposed substrate so that the barrel is perpendicular to the ground.
5. Turn the auger 3 – 4 half turns and gently remove the auger. Avoid forcing more substrates into the auger.
6. Lay substrate samples on the ground in the order in which they were extracted. This will make it easier to measure the depths of the horizons, etc.
7. Organic substrates should be sampled to at least a depth of 120 cm. A scratch pit can be utilized to obtain a depth greater than 120 cm. If mineral material is reached at less than 120 cm, auger into the mineral material to determine texture.
8. Record the required data.
9. Replace substrate into the auger hole.

Some helpful hints for auguring are:

- For a Dutch auger, 3 – 4 half turns of the auger will fill the barrel.
- When you finish turning the auger into the substrate for a sample, mark the depth of the auger sample by placing and holding your thumb on the auger at the substrate surface. Alternately tie a piece of flagging tape on the auger and slide it to the substrate surface prior to removing the sample from the hole.
- Keep your thumb there while you remove the auger from the hole.
- Line up your thumb with the top of your sample (i.e. substrate surface) that is laid out on the ground.
- In loose, dry, sandy material, it can be useful to slowly and carefully add approximately 1 litre of water to the auger hole. This will help prevent the augured material from falling out of the auger flukes when bring up a sample. Allow time for the water to be absorbed by the substrate material before auguring and Repeat as required.
- In saturated materials, suction can result in material being pulled out of the auger flukes when the auger is raised too quickly. Work carefully, raising the auger slowly, and applying a slight rotation as if filling the auger. If sample cannot be fully excavate, refer to the Problematic Site Key for guidance on how to treat the site.
- In weekly decomposed or loose organic materials – it is often not possible to extract a sample.
  - Use a shovel or knife to remove a divot of the upper material and attempt to auger with that divot.
  - Keep track of depth, lay out a “too scale” profile that may contain empty spaces, and continue auguring down in hopes of finding more consolidated peat material. Measure the model profile carefully, recording any depths, stages of decomposition, water, or changes in material type.
- Remove the sample and place it according to where your thumb indicates it should go, rather than lining it up with the bottom of your last sample.
- Expect some overlapping of samples.
- In loose sandy substrates and wet organics, substrates can slump from the sides of the auger hole and make it difficult to make depth measurements.

Minimum Sample Requirements for Auger

- thickness of folic material
- thickness of peat material
- thickness of mineral material
- depth class of substrate
- effective texture
- depth to distinct / prominent mottles
- depth to gley
- ELC moisture regime
- chemistry
- s-type
Selection of Sampling Protocol

The provincial ELC substrate sampling protocol includes three different methodologies; visual assessment, auger, and pit.

1. Use the Sample Protocol Selection Key to select the appropriate protocol for each situation.
2. Next, review the appropriate sampling protocol description.
3. Then select the Zero Point for Substrate Measurement Key to determine the appropriate zero point.
4. Proceed to describe the substrate.
5. If you are unable to properly execute a prescribed sampling protocol, refer to the Problematic Site Protocol section and logic key for a possible resolution.

Sampling Protocol Selection Key

To choose which sampling protocol to use walk around the site and apply the Sampling Protocol Key below.

![Sampling Protocol Key Diagram]

**Start**

- Water normally above substrate surface, includes tidal zone
  - Visual Assessment 3 x 3 m surface

- Substrate has a slope of > 60° or 173% AND a height > 3 m
  - Visual Assessment 3 x 3 m face

- Substrate always frozen (permafrost) within: 1 m of surface (mean annual soil temperature ≤ 0° C ) OR 2 m with marked patterned ground
  - Auger / Pit Minimum pedon representative of 3.5 wide x 2 m deep

- Sample area > 80% exposed bedrock and / or coarse fragments (ignore cover by bryophytes, lichen, or algae) AND little or no mineral or organic material present
  - Visual Assessment 3 x 3 m surface

- ≤ 5 cm of mineral material over bedrock or coarse fragments AND thickness of organic material ≤ 10 cm
  - Auger / Pit Minimum pedon representative of 1 wide x 1.2 m deep

Figure 12: sampling protocol selection key
Substrate Measurement Standards

The benchmarks (zero point) from which measurements are taken when describing substrates varies depending on s-type and the attributes being measured. Below are a series of rules and the “Zero Point Key” which sets out the correct procedures for substrate measurements.

Living Moss Rule

In all instances (universally applied) of measuring the upper limits of surface organic horizons, the living matter is excluded. The upper point of measure lies directly below the living portion. For mosses, the living portion of the plant is the green and obviously fresh portion of the stem immediately adjacent to the brown portion. This roughly equates to the photosynthesising portion of the plant.

Thickness of Folic Material

Measured from the upper limit (living moss rule), to the lower limit of folic material (interface with peat, rock, or mineral materials).

Thickness of Peat Material

Measured from the upper limit (living moss rule), to the lower limit of folic material (interface with rock, or mineral materials).

Thickness of Mineral Material

Measured from the upper limit (organic-mineral interface) to the lower limit mineral material (usually rock/mineral material interface).

Depth to Distinct or Prominent Mottles

Measured from the organic-mineral interface, to the uppermost level of distinct or prominent mottles.

Depth to Gley

Measured from the organic-mineral interface, to the uppermost level of Gley.

Depth to Carbonates

Measured from the organic-mineral interface, to the uppermost level of carbonates.

Total Depth to Water

Measured from the surface (see living moss rule) to the upper limit of observed water.

Total Depth of Observation

Measured from the surface (see living moss rule) to the maximum depth of auger, pit, or excavation.

Total Depth to Bedrock

Measured from the surface (see living moss rule), to observed bedrock.
Zero Point Key for Substrate Measurements

The reference point for horizon depth measurements are primarily based on substrate material (is the substrate organic, mineral, or rock). The zero point for vertical surfaces regardless of material is at the surface. Use the following to key determine where the zero point is located.

Remember to apply the “Living Moss Rule”

---

**Start**

Vertical sites (cliffs, bluffs) where:
- slope >60° or 173%
- **AND** height >3 m.

---

Exposed bedrock or coarse fragments makeup >80% of sample area with little or no mineral or organic material present.

---

≤ 5 cm of mineral material over bedrock or coarse fragments **AND** thickness of organic material ≤ 10 cm

---

>40 cm of **peat** +/- **folic** material **OR** any floating organic mat

---

>10 to ≤ 40 cm of **folic** material **AND** thickness of organic: mineral > 2 : 1

---

>10 to ≤ 40 cm of **peat** material ≤ 30 cm of mineral material over bedrock or coarse fragments

---

Mineral
- **zero at mineral surface**
- **auger/pit**

---

**Vertical Sites**
- **zero at material face**
- 3 x 3 m surface area

---

**Rock**
- **zero at rock surface**
- 3 x 3 m surface area

---

**Organic (folisol and peat)**
- **zero at organic surface**
- **auger/pit**

---

**Shallow Folic**
- **zero at organic surface**
- **auger/pit**

---

**Shallow Peat**
- **zero at organic surface**
- **auger/pit**

---

**ELC 2015/03/05**

**Application:** This key is applicable for the determination of the zero point when describing rock, vertical, organic, and mineral materials.

**Limitations:** It is not applicable to limnetic, active, anthropogenic, cryosolic, saline, and subterranean s-types.

---

Figure 13: zero point key for substrate measurements
The following figure demonstrates the zero points for organic and mineral profiles.

Figure 14: example organic and mineral profiles
Substrate Profile Confirmation

Use the following charts to compare the amount of each material type in order to determine the type of substrate profile (e.g., Organic folic or peat, Rock, or Mineral). For each site the Zero Key (Figure 13, page 38) and these charts should match. Applicable to non-vertical surfaces only.

The vertical axis represents the thickness of organic material. The horizontal axis represents the thickness of mineral material over rock. The intersection of these values identifies the substrate class as stated in the shaded areas.

Choose either of the following conditions:

1.) Use this figure for sites where the organic material is mostly Folic.

![Figure 15: thickness criteria if organic material is mainly folic](image)

2.) Use this figure for sites where the organic material is mostly Peat.

![Figure 16: thickness criteria if organic material is mainly peat](image)
The Process of Describing Substrates

Though substrates vary widely in their bio-physical properties, the generalized processes below should be followed for the determination of substrate type (class and series - s-type).

### Start

1. using the sampling protocol tool, select either a visual assessment, or an auger / pit protocol ........................................... 36
2. proceed to A or B below
3. then Proceed to C below

### A. If you are conducting an auger or pit assessment:

1. excavate sample location (auger or dig pit) ................................................................. 34
2. if augering or digging is impeded (Problematic Site) .................................................. 48
3. determine your zero point .................................................................................................. 38
4. identify and assess horizons
   (designate the upper and lower depth limits for each horizon, name each horizon as required) ........................................... 13
5. measure depth to water ....................................................................................................... 37
6. measure depth of total excavation ..................................................................................... 37

**Assess any organic materials:**

7. determine organic material type (folic or peat) ............................................................... 13
8. for folic horizons - determine the degree of decomposition ................................................. 14
9. for peaty horizons - complete the rubber fibre and the von Post tests to determine the degree of decomposition .... 16

**Assess any rock materials:**

10. measure depth to rock material ...................................................................................... 37
11. describe calcareousness of rock material ........................................................................ 19

**Assess any mineral materials:**

12. describe calcareous class of minerals ............................................................................. 30
13. assess textures (hand-textured) ...................................................................................... 23
14. assess coarse fragments .................................................................................................. 31
15. assess colours (matrix, mottle, gley) ............................................................................... 27
16. assign pore patterns .......................................................................................................... 44
17. determine if profile is stratified ...................................................................................... 45
18. measure depth to carbonates ......................................................................................... 37
19. measure depth to prominent / distinct mottles ............................................................... 37
20. measure depth to gley ....................................................................................................... 37

### B. If you are conducting a visual assessment:

1. lay out 3 x 3 m square
2. assess any organic materials
   folic materials................................................................................................................. 14
   peat materials .................................................................................................................. 16
3. assess any rock materials
   bedrock ............................................................................................................................. 18
   coarse fragment ................................................................................................................ 18
   calcareousness of rock material ...................................................................................... 19
4. assess any mineral materials if present (as above) ........................................................ 23

### C. Derive substrate variables:

1. assign humus form ............................................................................................................. 17
2. assign depth class ............................................................................................................. 42
3. determine dominant decomposition class for folic and peat materials .............................. 42
4. assign effective texture if mineral substrate type .............................................................. 46
5. assign texture family or material type ............................................................................ 32
6. assign moisture regime .................................................................................................... 50
7. assign drainage ................................................................................................................. 43
8. determine and record s-type (substrate class and series) .................................................. 55
9. select and add record mandatory and optional substrate modifier codes .......................... 67
10. confirm s-type and modifiers with substrate coding guide ........................................... 71
Derived Variables

Once baseline substrate measurements and assessments have been completed, the minimum required substrate variables can be derived and used to assign a substrate type and substrate modifiers.

Depth Class

Substrates require depth classes as a defining criterion. The tables below describe the depth classes for both organic, mineral, and rock substrates.

In general, depth class is assigned based on depth of auger or pit excavation. When augering or digging is impeded by an impassable layer please use the problematic site key (Figure 20, page 48) to determine depth class.

Make a note if depth excavated does not correspond to the assigned depth class.

<table>
<thead>
<tr>
<th>Table 20: ELC organic substrate depth classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
</tr>
<tr>
<td>shallow folic</td>
</tr>
<tr>
<td>deep folic</td>
</tr>
<tr>
<td>shallow peat</td>
</tr>
<tr>
<td>deep peat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 21: ELC rock and mineral substrate depth classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
</tr>
<tr>
<td>rock</td>
</tr>
<tr>
<td>very shallow</td>
</tr>
<tr>
<td>shallow</td>
</tr>
<tr>
<td>moderate</td>
</tr>
<tr>
<td>moderately deep</td>
</tr>
<tr>
<td>deep</td>
</tr>
</tbody>
</table>

Dominant Decomposition Class for Organic Materials

In peat profiles with more than or equal to 120 cm peat material, the dominant decomposition class corresponds to the most abundant degree of decomposition of the middle tier (40-120 cm).

In peat profiles with less than 120 cm peat material or folic profiles the dominant decomposition class corresponds to the decomposition class making up greater than 50% of the sampled profile.
Drainage Class

Drainage class is the rapidity and extent of the removal of water from substrates in relation to moisture additions. Use the following chart to assign a drainage class to the substrate.

Figure 17: drainage class
(modified from OCSRE 1993)
Pore Pattern

Pore pattern (PP) refers to the number and size of spaces between mineral material particles, and is a useful tool to determine the moisture regime and drainage characteristics of a profile. PP is inferred from mineral material texture. Textures with similar properties are grouped into broader classes based on PP, structure, compaction, and the way in which the mineral material and stones combine to form more or less continuous strata, discontinuous lenses, mineral material horizons, etc.

Pore pattern involves a combination of mineral material structure and stratigraphy. In many cases, there will be pore pattern variations found between the horizons of a mineral profile. In fact, pore pattern is one of the distinguishing features used to differentiate horizons within a profile.

Determining Pore Pattern
1. For each mineral horizon, determine the mineral horizon texture as described on page 23.
2. For each horizon, determine the pore pattern by referring to the table below

Table 22: pore pattern of mineral materials
(from “ELC Moisture Regime - Chart C” to obtain the Pore Pattern for each horizon)

| Perviousness Class | Texture (no compression) | Pore Pattern (class | symbol) |
|--------------------|--------------------------|---------------------|
| rapidly            | all materials > 2.0 mm   | extremely open 0     |
|                    | very coarse & coarse sands loamy very coarse & coarse sands silty very coarse & coarse sands | very open 0       |
|                    | medium sands loamy medium sands silty medium sands | open 1           |
|                    | fine sand loamy fine sand silty fine sand | moderately open 2   |
| moderately         | sandy loams very fine sand loamy very fine sand silty very fine sand | moderately retentive 3 |
|                    | loam silt loam sandy clay loam structured silty clay & clay (aggregates < 10 mm) | retentive 4       |
|                    | silt silty clay loam clay loam, sandy clay structured silty clay & clay (aggregates > 10 mm) | very retentive 5  |
| slowly             | structureless silty clay & clay | moderately restricted 6 |
**Stratified Mineral Substrates**

Mineral substrates can be stratified or non-stratified. Stratified mineral substrate profiles contain horizons or layers that contrast sharply in texture, stoniness or bulk density. They are often composed of layers of different parent materials that may be a result of more than one mode of deposition (e.g. lacustrine sediments overlying a moraine deposit), and exhibit corresponding contrasts in texture occurring within a single substrate profile. As a result, the pore patterns in adjacent horizons may be significantly different. Changes in pore pattern within a substrate profile are called particle size discontinuities or pore pattern discontinuities (PPD). This can alter the moisture regime and drainage characteristics of the site. Substrate stratification can have important effects on the movement and retention of water through the substrate profile and on vegetation development due to variations in porosity, water holding capacity and rate of water movement.

The criterion used to classify a substrate as stratified is a function of horizon or layer thickness, and the contrast in pore pattern between layers. The sharper the contrast in pore pattern, the thinner the horizon or layer may be to qualify a substrate as stratified.

**Determination of Substrate Stratification**

To determine if a mineral substrate is stratified:

- **First**, combine all adjacent textural layers with the same pore pattern (PP) and sum their thicknesses to create a pore pattern layer (PPL). Horizons or layers less than 5 cm thick can generally be ignored unless they occur in series (in which case they should be combined, summed and treated as one horizon or texture layer and treated as above).

- **Next**, test the resulting PPLs to determine if they qualify as stratified using the following criteria.

For a mineral substrate to be designated as stratified it must meet both of the following conditions:

1. minimum mineral depth > 60 cm

   **AND**

2. two adjacent PPLs must differ from each other by one of the following criteria for contrast and thickness:
   - a pore pattern change of 1, **AND** at least 15 cm thick
   - a pore pattern change of 2, **AND** at least 10 cm thick
   - a pore pattern change of 3 or more, **AND** at least 5 cm thick

Lastly, if a profile does not qualify as stratified as per the above criteria, it is deemed to be non-stratified.
Effective Texture in Mineral Substrates

The substrate texture deemed to have the greatest influence on substrate moisture regime and drainage is assigned as the substrate’s Effective Texture (ET). ET is determined on the basis of substrate depth, texture, thickness of the strata, and for stratified soils, the presence of mottles or gley.

Determining Effective Texture for Mineral Substrates

Effective texture is assigned using one of the following three methods:
- In non-stratified substrates, the effective texture is the most abundant texture in the profile.
- In stratified substrates where a representative layer is clearly identified using the process below, the effective texture is the texture in the representative layer.
- In stratified substrates where an intermediate value was achieved using the process below, the effective texture is the most abundant texture of the last two PPLs compared using the process below.

The following logic tree sets out the process of assigning effective texture and MR to mineral substrate.

Figure 18: effective texture & moisture regime assignment overview
Determining Effective Texture and Moisture Regime for Stratified Mineral Substrates

In stratified mineral substrates, effective texture is determined by the following multi-stage procedure:

1. Using the logic tree “Determining Effective Texture and Moisture Regime for Stratified Mineral Substrate > 60 cm Deep” to compare the upper two most PPLs and choose which is to be considered representative of the two.
2. The two PPLs are then combined and assigned the effective texture of the representative layer and the summed thickness of both layers. This combined layer is now considered to be the upper PPL.
3. Repeat steps 1 and 2 until all PPLs in the profile have been considered.

Start

- **grey gley colours in upper layer OR mottles in upper & lower layers**
  
  - **coarser textured layer over finer textured layer**
    
    - **thickness of upper layer > 90 cm** → **U**
    
    - **thickness of upper layer ≤ 60 cm** → **L**
  
  - **finer textured layer over coarser textured layer**
    
    - **upper & lower layer pore pattern differ by one class only** refer to ELC Moisture Regime - Chart C for pore pattern class
      
      - **assign an intermediate value** of moisture regime after using upper layer texture and the lower layer texture to determine potential limits
        
        - **thickness of upper layer > 40 cm** → **U**
        
        - **thickness of upper layer ≤ 30 cm** → **L**

**ELC 2010/03/26**

**U** use “upper layer texture” as effective texture, and Chart B or Chart C to determine moisture regime / drainage class

**L** use “lower layer texture” as effective texture, and Chart B or Chart C to determine moisture regime / drainage class

Figure 19: determining effective texture for stratified mineral substrates > 60 cm deep
(modified from OCSRE 1993)
Problematic Site Protocol

A problematic site occurs when attempts to auger are impeded due to impassable materials encountered. Many situations occur that may prevent achieving full depth of inspection. Normal sampling protocol requires reaching materials down to 120 cm or verified bedrock; and will require a pit excavation be made to access and describe materials below the impassable layer.

Use of the problematic site key should be minimized and only used only as a last resort in specific types of operational sampling.

Some examples of impassable layers where this protocol may be applied are ice, basil till, cemented layer, bedrock, and concentrations of coarse fragments. Further information on other problematic sites can be found in the ELC Data Collection Standards Manual.

A minimum of 4 auger / pit attempts in representative locations should be made to obtain the full observation depth of 120 cm. If after 4 attempts a 120 cm observation depth cannot be achieved, use the depth achieved in conjunction with the local observations, local knowledge, auguring clues, and the following key for guidance on how to proceed.

![Diagram of problematic site protocol key]

**Bedrock Clues:** include sound (ringing), exposed bedrock outcrops, surface bedrock expression, mottles above obstruction, coarse fragments above obstruction, and poorly growing vegetation.

**Coarse Fragment Clues:** include sound (clunk), variable surface stoniness, and lack of exposed bedrock outcrops in immediate area.
Problematic Site Coding Conventions

A unique coding convention may be used to note that a full sample depth was not attained, and that the depth class was inferred.

Always record the depth actually excavated and note in the comment section any basis for the problematic site assessment.

A depth call should always be made except when node 6 of Figure 20 best describes the site and an accurate call cannot be made and the sample cannot be completed. Should this occur, record the following conventions:

<table>
<thead>
<tr>
<th>Intended variable</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>s-type</td>
<td>“NC” (not completed)</td>
</tr>
<tr>
<td>sample depth</td>
<td>depth of auguring attempt</td>
</tr>
<tr>
<td>substrate depth</td>
<td>“NC” (not completed)</td>
</tr>
<tr>
<td>substrate texture class</td>
<td>use texture class of sample</td>
</tr>
<tr>
<td>texture family</td>
<td>use the texture family of sample</td>
</tr>
<tr>
<td>depth class</td>
<td>“NC” (not completed)</td>
</tr>
<tr>
<td>depth to distinct mottles</td>
<td>observed depth or “NC” if not encountered</td>
</tr>
<tr>
<td>depth to gley</td>
<td>observed depth or “NC” if not encountered</td>
</tr>
<tr>
<td>depth to carbonate</td>
<td>observed depth or “NC” if not encountered</td>
</tr>
<tr>
<td>depth to water</td>
<td>observed depth or “NC” if not encountered</td>
</tr>
<tr>
<td>ELC moisture regime</td>
<td>“NC”</td>
</tr>
</tbody>
</table>
Moisture regime (MR) is an estimated relative ranking of substrate moisture supply throughout the growing season. Estimates of moisture regime are based on variations in texture and pore pattern, substrate depth, topographical position, and drainage as indicated through mottled and gley colours.

Four charts are presented below to allow the assignment of an ELC Moisture Regime to common substrates found in Ontario. Starting on Chart A, the users are directed to the appropriate chart where they can determine the appropriate MR for their substrate.

**ELC Moisture Regime - Chart A (Selection of Appropriate ELC Moisture Regime Chart)**

Steps to selection of appropriate moisture regime (MR) chart:
1. Determine if the substrate is Active, Vertical, Organic, Rock, or Mineral.
2. Determine substrate depth.
3. Determine effective texture for mineral substrates.
   a. If mineral texture is not stratified or ≤ 60 cm deep, use the profile’s dominant texture as the effective texture for determining MR.
   b. If mineral material is stratified AND depth of mineral material > 60 cm, determine effective texture for assigning MR using the process set out in “Determining Effective Texture for Stratified Mineral Substrates > 60 cm Deep”.
4. Use the key below to determine which ELC Moisture Regime Chart to use in order to determine substrate moisture regime.

![Diagram of ELC Moisture Regime Chart A]

**Figure 21: ELC Moisture Regime - Chart A (modified from OCSRE 1993)**
ELC Moisture Regime - Chart B (Very Shallow, Shallow, Moderate, & Moderately Deep Substrates)

Use this chart for mineral material depths of > 5 cm to ≤ 120 cm over bedrock or coarse fragments. Do not consider mottles in lower 5 cm of substrate over bedrock.

**VERY SHALLOW and SHALLOW MINERAL SUBSTRATE**

- mineral material depth over bedrock > 5 to ≤ 30 cm
  - grey gleys colours present
    - mottles in upper half of substrate
      - vs, cs, ms, fs, LvsS, LcsS, LmsS, Lfs
      - Very Moist (6) / Imperfect (1)
      - Fresh (2) / Well (W)
      - Dry (0) / Very Rapid (VR)
      - 0/R

**MODOERATE MINERAL SUBSTRATE**

- mineral material depth over bedrock > 30 to ≤ 60 cm
  - grey gleys present
    - mottles present (ignore mottles within 5 cm over bedrock)
      - mottles in upper half of substrate
        - mottles 0 - 15 cm
          - vs, cs, ms, fs, LvsS, LcsS, LmsS, Lfs
          - 5/I
          - 6/P
    - mottles in lowest 15 cm only
      - vs, cs, ms, fs, LvsS, LcsS, LmsS, Lfs
      - 3/MW - I
      - 4/I-MW
      - 2/W - MW
      - 0/R - VR

**MODERATELY DEEP MINERAL SUBSTRATE**

- mineral material depth over bedrock > 60 to ≤ 120 cm
  - grey gleys or mottles present
    - mottles in upper half of mineral material
      - vs, cs, ms, LvsS, LcsS, LmsS
      - vs, cs, ms, LvsS, LcsS, LmsS
      - 4/I - MW
      - 3/MW - 1
      - 1/R - W
      - 2/W - MW
      - 0/R - VR

Note: It is difficult to differentiate between adjacent detailed (numbered) moisture regime drainage classes because even a small difference in substrate depth within the very shallow substrates results in a large difference in the moisture retained for plant growth. Consequently the broad moisture regime drainage classes are indicated first. The numbered/lettered classes shown in the brackets merely indicate the centres of the broad classes.

Figure 22: ELC Moisture Regime - Chart B (adapted from OCSRE 1993)
Use this chart for Deep Mineral (> 120 cm), Deep Peat Organic (> 40 cm), or Floating Mat Substrates.

### ELC Moisture Regime - Chart C (modified from OCSRE 1993)

#### DEEP MINERAL SUBSTRATES (> 120 cm)

<table>
<thead>
<tr>
<th>PORE PATTERN 1 of MINERAL MATERIALS</th>
<th>DRY (d)</th>
<th>MOD. DRY 0</th>
<th>MOD. FRESH 1</th>
<th>VERY FRESH 2</th>
<th>MOD. MOIST 4</th>
<th>MOIST (m, v)</th>
<th>MOD. WET 7</th>
<th>WET 8</th>
<th>VERY WET 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERVERUSNESS CLASS 1</td>
<td></td>
<td>MOD. FRESH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MOD. WET</td>
<td>WET</td>
<td>VERY WET</td>
</tr>
<tr>
<td>CLASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAPIDLY</td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All materials &gt; 2.0 mm</td>
<td></td>
<td>Extremely Open</td>
<td>All slopes</td>
<td></td>
<td></td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very coarse and coarse sands, loamy very coarse and coarse sands and silt, very coarse and coarse sands</td>
<td>R/VR</td>
<td>R/VR</td>
<td>MWII</td>
<td>MWII</td>
<td>i/P</td>
<td>PII</td>
<td>R/W</td>
<td>R/W</td>
<td>MWII</td>
</tr>
<tr>
<td>MODERATELY</td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy loams, very fine sand, loamy very fine sand, silty very fine sand</td>
<td>W</td>
<td>MWII</td>
<td>MWII</td>
<td>i/P</td>
<td>PII</td>
<td>G 60 - 120</td>
<td>0%</td>
<td>v ≥ 100 cm</td>
<td>0%</td>
</tr>
<tr>
<td>Loam, silt loam, sandy clay loam, structured silty clay and clay (aggregates &lt; 10 mm)</td>
<td>W/MW</td>
<td>MWII</td>
<td>MWII</td>
<td>i/P</td>
<td>PII</td>
<td>g/ G 60 - 120</td>
<td>0%</td>
<td>v ≥ 100 cm</td>
<td>0%</td>
</tr>
<tr>
<td>Silt, clay loam, clay loam, sandy clay, structured silty clay and clay (aggregates &gt; 10 mm)</td>
<td>W/MW</td>
<td>MWII</td>
<td>MWII</td>
<td>i/P</td>
<td>PII</td>
<td>s &gt; 100% g/ G 60 - 120</td>
<td>0%</td>
<td>v ≥ 100 cm</td>
<td>0%</td>
</tr>
<tr>
<td>SLOWLY</td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structureless silty clay and clay</td>
<td>MW</td>
<td>MW</td>
<td>MW</td>
<td>i/P</td>
<td>PII</td>
<td>g/ G 60 - 120</td>
<td>0%</td>
<td>v ≥ 100 cm</td>
<td>0%</td>
</tr>
</tbody>
</table>

---

See next page for more information on the use of this table.
Symbols

\( g \)  mottles: A layer with distinct or prominent mottles indicative of periodic saturation and aeration.

\( G \)  gley: A gley horizon indicative of prolonged saturation.

Please use Munsell Soil Color Charts to assess mottle, matrix and gley colors.

\( s \)  slope: degree of slope which results in significant surface run-off.

Drainage Class

| VR  | very rapid |
| R   | rapid      |
| W   | well       |
| MW  | moderately well |
| I   | imperfect  |
| P   | poor       |
| VP  | very poor  |

A compounded symbol (e.g. R/W) shows the most probable drainage classes where the dominant drainage class is shown in the first position.

How to Use the Chart

Deep Mineral Substrate:

1. If the depth of organic material over mineral material is less than that required for an organic substrate (see right side of chart) and the mineral substrate is > 120 cm over bedrock, do the following steps:
   1. First determine the pore pattern from the texture.
   2. Next, determine if and where mottles (designated ‘g’) or a gley layer (designated ‘G’) are present in the substrate profile.

   If g and G are absent, proceed horizontally into the centre section of the chart, along the appropriate pore pattern line, to the heavily outlined box.

   If the box is labelled ‘All Slopes’, read the moisture regime class at the top of that column.

   If the box has a slope designation (‘s’), determine the degree of slope on which the site is located, then choose the appropriate box between the heavily outlined box and the box to the left and read the moisture regime at the top of the appropriate column.

   If g or G is present, measure the minimum depth from the top of the mineral substrate to g or G and proceed horizontally along the appropriate pore pattern line to the box containing the correct depth value. Then read the moisture regime at the top of that column.

Peat Substrate:

Start by assessing the depth of organic material against the criterion for MR 7. If the depth of organic material criteria exceeds the requirement for MR 7, choose between MR 8 and MR 9 based on “upper part saturation”, “floating mat”, or “windows & flarks” criterion.

Footnotes:

1. Pore Pattern and Perviousness Class indicate the number and size of spaces (pores) between the substrate particles which affect the drainage and moisture retention characteristics of the substrate. The classes are inferred from substrate texture, structure, and compaction.

2. Substrate moisture regime is an integration of all the variations in substrate moisture supply throughout the complete vegetation cycle. The moisture regime classes are inferred from the pore pattern and depth of the mineral substrate material, the topographic position of the site and characteristics of the substrate profile such as mottling or gley horizons which indicate impeded drainage. Substrate drainage is the rapidity and extent of removal of water from substrates in relation to additions.
ELC Moisture Regime - Chart D (for non-standard situations)

Use this chart for non-standard situations that cannot be resolved using ELC Moisture Regime Charts B or C.

**Start Here**

Moisture Regime (MR) can be determine using ELC Moisture Regime Chart(s)

**Go to**

ELC Moisture Regime Chart A

---

**Saturated (s)**
- Saturated conditions typically occur on lower slopes or bedrock systems where rock surface shape causes accumulation or persistence of water. Seeps from bedrock cracks or crevasses may be visible.
- Lichen and bryophytes abundant and reflective of wetter environment.
- Organic accumulations typically derived from Sphagnum or graminoid peats.
- Vascular or treed vegetation may be sparse to absent.

**Xeric (x)**
- Xeric conditions typically occur on upper portions / steep / exposed rock outcrops.
- Vegetation cover typically restricted to lichen and bryophytes.
- Vascular or treed vegetation absent or very sparse, and growth is generally restricted to cracks and crevices.

---

**Some or all of the following conditions apply:**
- ≤ 5 cm mineral material over bedrock or coarse fragments
- Organic substrates are folic (derived from upland species)
- Not in close proximity to modifying influence of water
- Aspect: south to west facing slope
- < 25% direct shading
- No evidence of seepage, ponding, or pooling

---

**Some or all of the following conditions apply:**
- ≤ 5 cm mineral material over bedrock or coarse fragments
- If organic substrate, typically peat
- Water flowing through system, at or near the surface
- Close proximity to modifying influence of water
- > 20% of sample area showing signs of seepage
- > 25% direct shading
- Evidence of seepage, ponding, or pooling

---

**Some or all of the following conditions apply:**
- ≤ 5 cm mineral material over bedrock or coarse fragments
- If organic substrate, typically peat but may be folic
- Close proximity to water
- North-northwest to south east facing slope
- > 25% direct shading
- < 20% of sample area showing signs of seepage
- Very limited or no evidence of seepage, ponding, or pooling

---

**Humid (h)**
- Humid conditions typically occur on lower slopes and rock outcrops sheltered from climatic extremes by aspect or surrounding vegetation.
- Lichen and bryophyte cover typically abundant.
- Vascular and treed vegetation common.

---

*Figure 24: ELC Moisture Regime - Chart D*
Determining Substrate Class and Type

Equipped with all the substrate information collected or determined as described in earlier sections of this manual, it is possible to determine the substrate class and substrate series by using the next set of keys.

The key to the Substrate Classes is used to identify the substrate class and direct the user to the appropriate secondary key where the Substrate Type is determined. The organization of the Key to ELC Substrate Classes follows the Hierarchy of Influence approach adopted by the ELC program. The subsequent Substrate Type keys are organized for convenient use in the field.

Key to ELC Substrate Class

Start

- Substrate significantly altered by human activity
  for example gravel pits, mines, peat extraction

  → Key M
  Anthropogenic

- Water normally above substrate surface, includes tidal

  → Key K
  Limnetic

- Substrate exposed to high energy inputs - wind, water, ice scour.
  May contain: algae + crustose lichens
  AND < 2% vascular plant cover of sample area
  AND < 10% bryophyte + foliose lichen of sample area

  → Key J
  Active

- Substrate always frozen (permafrost) within:
  1 m of surface (mean annual soil temp. ≤ 0°C),
  OR 2 m of surface with marked patterned ground

  → Key N
  Cryosolic (Frozen)

- Substrate saturated or periodically flooded by salt water.
  OR Secondary enrichment of salt by ground water / dry deposition.

  → Key L
  Saline

- Cave or crevice with minimum opening of 50 cm, deeper
  than 5 m, with 3 or more sides, within or under substrate,

  → Key I
  Subterranean

- Substrate has a slope > 60° (173%)
  AND > 3 m height

  → Key H
  Vertical

continued on next page

Figure 25: key to ELC substrate classes
continued from previous page

Sample area > 80% exposed bedrock and/or exposed coarse fragments (ignore cover by bryophytes, lichens, or algae), AND little or no mineral or organic material present.

Key A - Part 1 Rock

≤ 5 cm of mineral material over bedrock or coarse fragments AND thickness of organic material ≤ 10 cm

Key A - Part 2 Rock

Depth of organic material > 40 cm OR any floating mat

Key B - Part 1 Organic

≤ 5 cm of mineral material over bedrock or coarse fragments AND thickness of organic material > 10 cm

Key B - Part 2 Organic

> 10 cm to ≤ 40 cm of folic material over > 5 cm of mineral AND thickness of organic: mineral material > 2:1

Shallow Folic (O1)

> 10 cm to ≤ 40 cm of peat material over > 5 to ≤ 30 cm mineral material

Shallow Peat (O2)

Key C Very Shallow

Depth of mineral material > 5 cm to ≤ 15 cm

Key D Shallow

Depth of mineral material > 15 cm to ≤ 30 cm

Key E Moderate

Depth of mineral material > 30 cm to ≤ 60 cm

Key F Moderately Deep

Depth of mineral material > 60 cm to ≤ 120 cm

Key G Deep

Depth of mineral material > 120 cm
Key A – Rock Substrate Type

Start Part 1

Substrate is mostly exposed bedrock → Bedrock (R1)

Substrate is coarse fragments → Coarse Fragments (R2)

3 m x 3 m visual assessment

Start Part 2

Material overlying bedrock is mostly organic → Folic / Bedrock (R4)

Material overlying bedrock is mostly folic → Peat / Bedrock (R5)

Material overlying bedrock is peat → Mineral / Bedrock (R3)

Material overlying coarse fragments is mostly organic

Material overlying coarse fragments is mostly folic → Folic / Coarse Fragments (R7)

Material overlying coarse fragments is peat → Peat / Coarse Fragments (R8)

Material overlying coarse fragments is mineral → Mineral / Coarse Fragments (R5)

Pedon: 1 x 1 m

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Key B – Organic Substrate Type

Start Part 1

1. Floating mat of any depth → Floating Mat (O7)
2. Depth of organic material > 40 cm → OR
   a. Organic material mostly folic → Folic (O3)
   b. folic material > 40 cm thick →
      i. Organic material mostly graminoid peat → Graminoid Peat (O4)
      ii. Organic material in middle tier mostly fibric peat → Fibric Peat (O5)
      iii. Organic material in the middle tier mesic & humic peat → Mesic & Humic Peat (O6)

Pedon: 1 x 1 m

Key C – Very Shallow Substrate Type

Start

1. Texture family sandy or coarse loamy → Very Shallow, Coarse Mineral (VS1)
2. Texture family silty, fine loamy, or clayey → Very Shallow, Fine Mineral (VS2)

Pedon: 1 x 1 m, Depth: > 5 cm to ≤ 15 cm

Key D – Shallow Substrate Type

Start

1. Texture family sandy or coarse loamy → Shallow, Coarse Mineral (S1)
2. Texture family silty, fine loamy, or clayey → Shallow, Fine Mineral (S2)

Pedon: 1 x 1 m, Depth: > 15 cm to ≤ 30 cm
Key E – Moderate Substrate Type

Start
Accumulations of > 15 cm of organic peat over mineral

Moisture Regime 6
Texture family sandy or coarse loamy

Texture family silty, fine loamy, or clayey

Moderate, Coarse Mineral, Peaty Phase (M10)

Moderate, Fine Mineral, Peaty Phase (M11)

Moderate, Coarse Mineral, Very Moist (M8)

Moderate, Fine Mineral, Very Moist (M9)

Texture family sandy

Moisture Regime 0 or 0

Moderate, Sandy, Dry (M1)

Moisture Regime 1, 2 or 3

Moderate, Sandy, Fresh (M2)

Moderate, Sandy, Moist (M3)

Texture family coarse loamy

Moisture Regime 0, 1, 2 or 3

Moderate, Coarse Loamy, Fresh (M4)

Moisture Regime 4 or 5

Moderate, Coarse Loamy, Moist (M5)

Texture family silty, fine loamy, or clayey

Moisture Regime 1, 2 or 3

Moderate, Silty, Fine Loamy, or Clayey, Fresh (M6)

Moisture Regime 4 or 5

Moderate, Silty, Fine Loamy, or Clayey, Moist (M7)

Pedon: 1 x 1 m
Depth: > 30 cm to ≤ 60 cm
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Key F – Moderately Deep Substrate Type

Start
Accumulations of > 15 cm of peat over mineral

Moisture Regime

Texture family sandy or coarse loamy

Texture family silty, fine loamy, or clayey

Moderately Deep, Coarse Mineral, Peaty Phase (MD14)

Moderately Deep, Fine Mineral, Peaty Phase (MD15)

Moderately Deep, Coarse Mineral, Very Moist (MD12)

Moderately Deep, Fine Mineral, Very Moist (MD13)

Texture family sandy

Moisture regime 3 or 0

Moisture regime 1, 2, or 3

Moisture regime 4 or 5

Moderately Deep, Sandy, Dry (MD1)

Moderately Deep, Sandy, Fresh (MD2)

Moderately Deep, Sandy, Moist (MD3)

Texture family coarse loamy

Moisture regime 0, 1, 2, or 3

Moisture regime 4 or 5

Moderately Deep, Coarse Loamy, Fresh (MD4)

Moderately Deep, Coarse Loamy, Moist (MD5)

Texture family silty

Moisture regime 1, 2, or 3

Moisture regime 4 or 5

Moderately Deep, Silty, Fresh (MD6)

Moderately Deep, Silty, Moist (MD7)

Texture family fine loamy

Moisture regime 1, 2, or 3

Moisture regime 4 or 5

Moderately Deep, Fine Loamy, Fresh (MD8)

Moderately Deep, Fine Loamy, Moist (MD9)

Texture family clayey

Moisture regime 1, 2, or 3

Moisture regime 4 or 5

Moderately Deep, Clayey, Fresh (MD10)

Moderately Deep, Clayey, Moist (MD11)

Pedon: 1 x 1 m
Depth: > 80 cm to ≤ 120 cm

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Key G – Deep Substrate Type

Start

Accumulations of > 15 cm of peat over mineral → Texture family sandy or coarse loamy → Deep, Coarse Mineral, Peaty Phase (D14)

Moisture Regime 6

Texture family silty, fine loamy, or clayey → Deep, Fine Mineral, Peaty Phase (D15)

Texture family sandy or coarse loamy → Deep, Coarse Mineral, Very Moist (D12)

Texture family silty, fine loamy, or clayey → Deep, Fine Mineral, Very Moist (D13)

Texture family sandy →

Moisture regime 0 or 0 → Deep, Sandy, Dry (D1)

Moisture regime 1, 2, or 3 → Deep, Sandy, Fresh (D2)

Moisture regime 4 or 5 → Deep, Sandy, Moist (D3)

Texture family coarse loamy →

Moisture regime 0, 1, 2, or 3 → Deep, Coarse Loamy, Fresh (D4)

Moisture regime 4 or 5 → Deep, Coarse Loamy, Moist (D5)

Texture family silty →

Moisture regime 1, 2, or 3 → Deep, Silty, Fresh (D6)

Moisture regime 4 or 5 → Deep, Silty, Moist (D7)

Texture family fine loamy →

Moisture regime 1, 2, or 3 → Deep, Fine Loamy, Fresh (D8)

Moisture regime 4 or 5 → Deep, Fine Loamy, Moist (D9)

Texture family clayey →

Moisture regime 1, 2, or 3 → Deep, Clayey, Fresh (D10)

Moisture regime 4 or 5 → Deep, Clayey, Moist (D11)

Pedon: 1 x 1 m
Depth: > 120 cm

ELC 2010/04/07
Key H – Vertical Substrate Type

Start
Exposed bedrock cover > 80% of sample area
May be covered by bryophytes, lichens, or algae.
Little or no mineral or organic material present

Vertical, Bedrock (V1)

Texture family mostly sandy or coarse loamy

Vertical, Coarse Mineral (V2)

Texture family silty, fine loamy or clayey

Vertical, Fine Mineral (V3)

3 x 3 m visual assessment

Key I – Subterranean Substrate Type

Exposed bedrock cover > 80% of sample area.
May be covered by bryophytes, lichens, or algae.
Little or no mineral or organic material accumulation.

Subterranean Bedrock (U1)

Mineral substrate

Subterranean Mineral (U2)

To be determined
Key J – Active Substrate Type

Start
Substrate has a slope > 60° (173%) AND > 3 m height

Exposed bedrock cover > 80% of sample area. May be covered by crustose lichens or algae. Little or no mineral or organic material accumulation.

- Active, Vertical, Bedrock (A1)
- Active, Vertical, Coarse Mineral (A4)
- Active, Vertical, Fine Mineral (A5)

Exposed bedrock cover > 80% of sample area. May be covered by crustose lichens or algae. Little or no mineral or organic material accumulation.

- Active, Bedrock (A2)

Exposed coarse fragments cover > 80% of sample area. May be covered by crustose lichens or algae. Little or no mineral or organic material accumulation.

3 x 3 m visual assessment

- Active, Coarse Fragments (A3)
- Active, Coarse Mineral (A6)
- Active, Fine Mineral (A7)

Texture family sandy or coarse loamy

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Texture family silty, fine loamy, or clayey

Pedon, 1 x 1 m
**Key K – Limnetic Substrate Type**

Start

- Substrate exposed to high energy inputs (wind, water, ice scour)
  - Surface may be covered by algae + crustose lichens
  - **AND** < 2% vascular plant cover on sample area
  - **AND** < 10% bryophyte + foliose lichen on sample area

  Limnetic, Active (L1)

  Exposed bedrock cover > 80% of sample area. May be covered by bryophytes, lichens, or algae. Little or no mineral or organic material present.

  Limnetic, Bedrock (L2)

  Exposed coarse fragments cover > 80% of sample area. May be covered by bryophytes, lichens, or algae. Little or no mineral or organic material present.

  Limnetic, Coarse Fragment (L3)

  Substrate composed mostly of organic material, typically sedimentary peat

  Limnetic, Organic (L6)

  Texture family mostly sandy or coarse loamy

  Limnetic, Coarse Mineral (L4)

  Texture family silty, fine loamy, or clayey

  Limnetic, Fine Mineral (L5)

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3 x 3 m visual assessment
Key L – Saline Substrate Type

Start
Exposed bedrock cover > 80% of sample area. May be covered by bryophytes, lichens, or algae. Little or no mineral or organic material present.

Exposed coarse fragments cover > 80% of sample area. May be covered by bryophytes, lichens, or algae. Little or no mineral or organic material present.

Substrate has a slope > 60° (173%) AND > 3 m height

3 x 3 m visual assessment

Depth of organic material > 40 cm OR
Bedrock or coarse fragments covered by ≤ 5 cm and thickness of organic material > 10 cm

Texture family sandy or coarse loamy

ELC 2010/04/07

Texture family silty, fine loamy, or clayey

Pedon – 1 x 1 m

To be determined: Return to the Main Key, start at the second question box. Record and circle your resulting code. Make notes on your field sheet.

Key M – Anthropogenic Substrate Type

To be determined: Return to the Main Key, start at the second question box. Record and circle your resulting code. Make notes on your field sheet.
Key N – Cryosolic Substrate Type

Start
- Thickness of organic material > 40 cm
  OR
- Thickness of organic material > 10 cm thick overlying bedrock, coarse fragments, or ice layer (ice > 30 cm thick)
  OR
- Bedrock or coarse fragments covered by ≤ 5 cm and thickness of organic material > 10 cm

Mineral contact within 1 m of the surface
  OR
- Mineral layer is > 30 cm thick with upper boundary within 1 m

Evidence of cryoturbation
- Accumulation of > 15 cm of peat overlying mineral material

Accumulation of > 15 cm of peat overlying mineral material
- Texture family sandy or coarse loamy
  OR
- Texture family silty, fine loamy, or clayey

Pedon – minimum 3.5 m wide and minimum 2 m deep

Organic material mostly folic
- Cryosolic, Terric, Folic (C7)
  OR
- Organic material mostly fibric
    - Cryosolic, Terric, Peat, Fibric (C8)
  OR
- Organic material mesic or humic
    - Cryosolic, Terric, Peat, Mesic or Humic (C9)

Organic material mostly folic
- Cryosolic, Folic (C10)
  OR
- Organic material in the middle tier mostly fibric
    - Cryosolic, Peat, Fibric (C11)
  OR
- Organic material in the middle tier mesic or humic
    - Cryosolic, Peat, Mesic or Humic (C12)

Organic material in the middle tier mesic or humic
- Cryosolic, Peat, Mesic or Humic (C12)

Cryosolic, Turbic, Peaty Phase (C3)
- Cryosolic, Turbic, Coarse Mineral (C1)
  OR
- Cryosolic, Turbic, Fine Mineral (C2)

Cryosolic, Turbic, Fine Mineral (C2)
- Cryosolic, Static, Peaty Phase (C6)
  OR
- Cryosolic, Static, Coarse Mineral (C4)
  OR
- Cryosolic, Static, Fine Mineral (C5)

ELC 2010/04/07
Substrate Coding

Substrate type and optional modifiers are determined through the collection of field data. Substrate properties such as effective texture, degree of decomposition, moisture regime, depth, and presence of carbonates are required to determine substrate class, series, and applicable modifiers.

The substrate code conventions have been designed for maximizing flexibility while maintaining structure and integrity of the information values. To determine an s-type:

1. Gather field data and use the “Key to ELC Substrate Classes” to determine the substrate class and the appropriate secondary key to determine the substrate series. If you reach the final question regarding “depth of mineral material > 120 cm” and the answer is no please proceed to the top of the key and carefully reread each question.
2. Use the appropriate substrate series key and proceed through that key until a substrate series is determined. The substrate series is identified by a code (i.e. O3; MD1) and a description (i.e. Folic; Moderately Deep, Sandy, Dry).
3. Next, determine the s-type. This process involves refining the substrate series with the addition of multiple modifiers. Modifiers will vary from series to series, and not all modifiers are applicable to all series types. For example an organic modifier is not applied to a mineral substrate and a chemistry modifier is not applied to an organic substrate. The absolute minimum coding required for an s-type includes the substrate series, moisture modifier, and chemistry modifier (where applicable). To facilitate which modifier is appropriate for each s-type substrate coding guides have been developed (see page 71).
4. Validate the resulting substrate code to ensure it is complete and logical.

Required Substrate Type Code and Structure

The minimum code requirement for an s-type is compiled from a string of a substrate series code, a moisture modifier, and a chemistry modifier.

\[ \text{minimum s-type code} = \text{substrate series} + \text{moisture modifier} + \text{chemistry modifier} \]

- **moisture**: You may select one of the following: *d*-dry, *f*-fresh, *m*-moist, *v*-very moist, *w*-wet, *x*-xeric, *h*-humid, or *s*-saturated. For limnetic systems a moisture modifier is not assigned.
- **chemistry**: You may select one of the following: *k*-calcareous, *n*-non calcareous (note: This is not applicable to organic material.)

For limnetic systems the salinity of the water is coded with a ‘z’ or left blank if the water is not saline.

**examples:**
- “d7mk” = deep, silty, moist; moist; calcareous
- “o4w” = graminoid peat; wet

Optional Substrate Type Code Modifiers

It is often desirable to enrich the information portrayed by the minimum substrate code by the addition of optional modifiers.

**Mineral**
- You may indicate if the substrate has a greater than 35% by volume, coarse fragment content (fragment size > 2 mm). If this condition is present an “r” meaning skeletal is added to the end of the substrate name string.

**Organic**
- You may select one of the following:
  - for peat materials: *Of* (fibric peat), *Om* (mesic peat), or *Oh* (humic peat). In addition the modifier M-moss or Gr-graminoids can be used in conjunction with Of, Om, and Oh to indicate the composition of the peat. These are added to the end of the substrate name string.

**examples:**
- “O1xLi” = very shallow folic, xeric, lignic
- “O5wOfGr” = fibric peat, wet, fibric, graminoid

**note:** Further descriptions of eligible modifiers are found in the “Substrate Modifiers” section below.
Substrate Code Modifiers

Substrate modifiers can be broken up into three categories: chemistry, moisture, and organic. The combination of modifiers that can be applied to each substrate series is dependent on the series.

Moisture Modifiers

<table>
<thead>
<tr>
<th>code</th>
<th>modifier name</th>
<th>description</th>
</tr>
</thead>
</table>
| d    | dry           | - for all mineral substrates: MR Charts B and C  
- includes Moisture Regime ‘0’ |
| f    | fresh         | - for all mineral substrates: MR Charts B and C  
- includes Moisture Regime ‘1’, ‘2’ and ‘3’ |
| m    | moist         | - for all mineral substrates: MR Charts B and C  
- includes Moisture Regimes ‘4’ and ‘5’ (non-hydric substrates) |
| v    | very moist    | - for all mineral substrates: MR Charts B and C  
- includes Moisture Regimes ‘6’ (hydric substrates) |
| w    | wet           | - for all mineral substrates: MR Charts B and C  
- includes Moisture Regime ‘7’, ‘8’ and ‘9’ |
| x    | xeric         | - reserved for special conditions where MR Charts B or C do not apply  
- may apply to substrate series in the following classes Active, Subterranean, Vertical, Rock, and Organic  
- most common on upper portions / steep slopes, exposed rock outcrops  
- vegetation cover typically restricted to lichen and bryophytes  
- vascular or treed vegetation absent or very sparse, and growth is generally restricted to cracks and crevices  
**May apply to areas with:**  
- not in close proximity to modifying influence of water  
- aspect: south to west facing slopes  
- < 25% direct shading  
- no evidence of seepage, ponding, or pooling  
- organic substrates are folic (derived from upland species) |
| h    | humid         | - reserved for special conditions where MR Charts B or C do not apply: (i.e. where persistent features like mottling and gleying are not available for measurement)  
- may apply to substrate series in the following classes Active, Frozen, Saline, Subterranean, Vertical, Rock, and Organic  
- most common on lower slopes and rock outcrops sheltered from climatic extremes by aspect or surrounding vegetation  
- lichen and bryophyte cover typically abundant. Vascular and treed vegetation common.  
**May apply to areas with:**  
- close proximity to water  
- aspect: north-northwest to southeast facing slopes  
- > 25% direct shading  
- < 20% of sample area showing signs of seepage  
- very limited evidence of ponding / pooling |
| s    | saturated     | - reserved for special conditions where MR Charts B or C do not apply: (i.e. where persistent features like mottling and gleying are not available for measurement)  
- may apply to substrate series in the following classes Active, Frozen, Saline, Vertical, Rock, and Organic  
- most common on lower slopes or bedrock systems where rock surface shape causes accumulation or persistence of water where seeps from bedrock cracks or crevasse may be visible  
- lichen and bryophyte abundant and reflective of wetter environment  
- organic accumulations typically derived from Sphagnum or graminoid peats  
**May apply to areas with:**  
- water flowing through system, at or near the surface  
- close proximity to modifying influence of water  
- aspect: northwest to east facing slopes  
- > 25% direct shading  
- if organic substrate, typically peat  
- > 20% of sample area showing signs of seepage  
- evidence of ponding / pooling |
Only one modifier is possible.

Xeric, humid, and saturated are reserved for special conditions where MR Chart B or C does not apply (i.e. bedrock, folisol, active systems.)

### Chemistry Modifiers

Table 25: eligible substrate modifiers for chemistry

<table>
<thead>
<tr>
<th>code</th>
<th>modifier name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>saline</td>
<td>- substrate saturated by salt water or secondary enrichment of salt by ground water / dry deposition</td>
</tr>
<tr>
<td>k</td>
<td>calcareous</td>
<td>- mineral material or rock substrate that contain carbonate minerals which will produce an effervescence (bubbling, hissing, crackling, or foaming) when 10% HCl is added to the substrate</td>
</tr>
<tr>
<td>n</td>
<td>non-calcareous</td>
<td>- rock or mineral material or rock substrates that do not contain carbonate minerals and will not produce a effervescence (bubbling, hissing, crackling, or foaming) when 10% HCl is added to the substrate</td>
</tr>
</tbody>
</table>

- Only one modifier is possible.
- Saline (Z) overrides all other chemistry modifiers.

### Mineral Substrate Modifier

Table 26: eligible substrate modifiers for coarse fragment load

<table>
<thead>
<tr>
<th>code</th>
<th>modifier name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>skeletal</td>
<td>- greater than 35% / volume coarse fragments and fragment size &gt; 8 cm</td>
</tr>
</tbody>
</table>

### Peat Modifiers

Table 27: eligible peat substrate modifiers

<table>
<thead>
<tr>
<th>modifier type</th>
<th>code</th>
<th>modifier name</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>degree of decomposition</td>
<td>Of</td>
<td>fibric peat</td>
<td>- the least decomposed organic peat developed mainly from mosses (sphagnum, brown mosses) and graminoids. - contains large amounts of well-preserved fibre by volume (&gt; 40% rubbed fibre by volume) - von Post scale of decomposition 1 to 4</td>
</tr>
<tr>
<td></td>
<td>Om</td>
<td>mesic peat</td>
<td>- intermediate stage of decomposed organic peat developed mainly from mosses (sphagnum, brown mosses) or graminoids. - contains minimal amounts of well-preserved fibre by volume (10 – 40% rubbed fibre by volume) - von Post scale of decomposition 5 and 6</td>
</tr>
<tr>
<td></td>
<td>Oh</td>
<td>humic peat</td>
<td>- the most decomposed organic peat developed mainly from mosses (sphagnum, brown mosses) or graminoids. - contains only small amounts of well-preserved fibre by volume (&lt; 10% rubbed fibre by volume) - von Post scale of decomposition 7 to 10</td>
</tr>
<tr>
<td>material origin</td>
<td>M</td>
<td>mosses</td>
<td>- used in conjunction with Of, Om, or Oh to indicate that the peat material is mostly derived from mosses (sphagnum, brown mosses)</td>
</tr>
<tr>
<td></td>
<td>Gr</td>
<td>graminoids</td>
<td>- used in conjunction with Of, Om, or Oh to indicate that the peat material is mostly derived from graminoids</td>
</tr>
</tbody>
</table>

- These modifiers are reserved for substrates that have been identified as peat.
- Only one decomposition modifier is possible. Choose the modifier which corresponds to the type of peat material that comprises most of the profile. In deep peats (> 40 cm) this would correspond to the degree of decomposition of the middle tier (40-120 cm), very shallow organic substrates this would correspond to the organic material making up greater than 50% of the sampled profile.
- Additionally, one material origin modifier may be added to the end of the code string.
### Folic Modifiers

<table>
<thead>
<tr>
<th>Code</th>
<th>Modifier Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>Hemic folisol</td>
<td>- organic folisol developed mainly from feathermoss, leaves, twigs, and wood&lt;br&gt;- composed dominantly of moderately decomposed F horizon in the control section</td>
</tr>
<tr>
<td>Hu</td>
<td>Humic folisol</td>
<td>- organic folisol developed mainly from feathermoss, leaves, twigs, and wood&lt;br&gt;- composed dominantly of well-decomposed H horizon in the control section</td>
</tr>
<tr>
<td>Li</td>
<td>Lignic folisol</td>
<td>- organic folisol developed mainly from feathermoss, leaves, twigs, and wood&lt;br&gt;- dominated by F or H horizons, which are composed primarily of moderately to well-decomposed woody materials</td>
</tr>
<tr>
<td>Hi</td>
<td>Histric folisol</td>
<td>- organic folisol developed mainly from feathermoss, leaves, twigs, and wood&lt;br&gt;- dominated by F or H horizons, directly underlain by a &gt; 10 cm O horizon</td>
</tr>
</tbody>
</table>

- These modifiers are reserved for substrates that have been identified as folic.
- Only one decomposition modifier is possible. Choose the modifier which corresponds to the type of folic material that comprises most of the profile.

**Table 28: eligible folic substrate modifiers**
Substrate Code Validation

The following tables assist in the correct identification or naming of substrates. Each s-type code must contain a substrate series code followed by mandatory modifiers. This may be followed by optional modifiers to add richness to the substrate information communicated by the substrate code string. Each substrate class is represented in its own table, along with the appropriate modifiers for that class. Whenever a shaded series name, or a shaded “s”, “v”, or “w”, is assigned, that s-type is considered a hydric site.

### Table 29: limnetic substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory chemistry (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>series</td>
<td>saline * calcareous non-</td>
</tr>
<tr>
<td>L1    Active</td>
<td>k n</td>
</tr>
<tr>
<td>L2    Bedrock</td>
<td>k n</td>
</tr>
<tr>
<td>L3    Coarse Fragments</td>
<td>k n</td>
</tr>
<tr>
<td>L4    Coarse Mineral</td>
<td>k n</td>
</tr>
<tr>
<td>L5    Fine Mineral</td>
<td>k n</td>
</tr>
<tr>
<td>L6    Organic</td>
<td>k n</td>
</tr>
</tbody>
</table>

2015-02-02 * saline trumps k or n

### Table 30: active substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory chemistry (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>series</td>
<td>humid standard calcareous</td>
</tr>
<tr>
<td>Active</td>
<td>k n</td>
</tr>
<tr>
<td>A1    Vertical, Bedrock</td>
<td>h k n</td>
</tr>
<tr>
<td>A2    Bedrock</td>
<td>h k n</td>
</tr>
<tr>
<td>A3    Coarse Fragments</td>
<td>h k n</td>
</tr>
<tr>
<td>A4    Vertical, Coarse Mineral</td>
<td>h s k n</td>
</tr>
<tr>
<td>A5    Vertical, Fine Mineral</td>
<td>h s k n</td>
</tr>
<tr>
<td>A6    Coarse Mineral</td>
<td>h s k n</td>
</tr>
<tr>
<td>A7    Fine Mineral</td>
<td>h s k n</td>
</tr>
</tbody>
</table>

2015-02-02

### Table 31: cryosolic substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory moisture (one of)</th>
<th>optional organic (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>series</td>
<td>humid standard</td>
<td>calcareous k or n</td>
</tr>
<tr>
<td>C1    Tubic, Coarse Mineral</td>
<td>x h</td>
<td></td>
</tr>
<tr>
<td>C2    Tubic, Fine Mineral</td>
<td>x h</td>
<td></td>
</tr>
<tr>
<td>C3    Tubic, Peaty Phase</td>
<td>h s</td>
<td></td>
</tr>
<tr>
<td>C4    Static, Coarse Mineral</td>
<td>x h</td>
<td></td>
</tr>
<tr>
<td>C5    Static, Fine Mineral</td>
<td>x h</td>
<td></td>
</tr>
<tr>
<td>C6    Static, Peaty Phase</td>
<td>h s</td>
<td></td>
</tr>
<tr>
<td>C7    Terric Folic</td>
<td>h</td>
<td>he hu N li</td>
</tr>
<tr>
<td>C8    Terric Peat, Fibric</td>
<td>s Of</td>
<td>M Gr</td>
</tr>
<tr>
<td>C9    Terric Peat, Mesic &amp; Humic</td>
<td>s Om Oh</td>
<td>M Gr</td>
</tr>
<tr>
<td>C10   Folic</td>
<td>h</td>
<td>he hu N li</td>
</tr>
<tr>
<td>C11   Peat, Fibric</td>
<td>s Of</td>
<td>M Gr</td>
</tr>
<tr>
<td>C12   Peat, Mesic &amp; Humic</td>
<td>s Om Oh</td>
<td>M Gr</td>
</tr>
</tbody>
</table>

2015-02-02
### Table 32: saline substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory moisture (one of)</th>
<th>optional moisture (one of)</th>
<th>organic moisture (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>class code</td>
<td>series</td>
<td>dry</td>
<td>fresh</td>
</tr>
<tr>
<td>Z1 Bedrock</td>
<td>x h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z2 Coarse Fragments</td>
<td>x h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z3 Vertical, Mineral</td>
<td>x h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z4 Coarse Mineral</td>
<td>d f m v</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z5 Fine Mineral</td>
<td>d f m v</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z6 Peat, Fibric</td>
<td>w</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z7 Peat Mesic &amp; Humic</td>
<td>w</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Table 33: subterranean substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory moisture (one of)</th>
<th>chemistry (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>class code</td>
<td>series</td>
<td>xeric</td>
</tr>
<tr>
<td>U1 Bedrock</td>
<td>x h s k n</td>
<td></td>
</tr>
<tr>
<td>U2 Mineral</td>
<td>x h s k n</td>
<td></td>
</tr>
</tbody>
</table>

2015-02-02

### Table 34: vertical substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory moisture (one of)</th>
<th>chemistry (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>class code</td>
<td>series</td>
<td>xeric</td>
</tr>
<tr>
<td>V1 Bedrock</td>
<td>x h s k n</td>
<td></td>
</tr>
<tr>
<td>V2 Coarse Mineral</td>
<td>x h s k n</td>
<td></td>
</tr>
<tr>
<td>V3 Fine Mineral</td>
<td>x h s k n</td>
<td></td>
</tr>
</tbody>
</table>

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### Table 35: rock substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory moisture (one of)</th>
<th>chemistry (one of)</th>
<th>organic moisture (one of)</th>
<th>organic moisture (one of)</th>
<th>organic moisture (one of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>class code</td>
<td>series</td>
<td>xeric</td>
<td>xeric</td>
<td>humid</td>
<td>saturated</td>
</tr>
<tr>
<td>R1 Bedrock</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2 Coarse Fragments</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3 Mineral over Bedrock</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4 Folic over Bedrock</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5 Peat over Bedrock</td>
<td>h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6 Mineral over Coarse Fragments</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7 Folic over Coarse Fragments</td>
<td>x h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R8 Peat over Coarse Fragments</td>
<td>h s k n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2015-02-02
### Table 36: organic substrates

<table>
<thead>
<tr>
<th>Substrate Class / Series / Available Modifiers</th>
<th>mandatory</th>
<th>chemistry</th>
<th>organic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>moisture (one of)</td>
<td>chemistry (one of)</td>
<td></td>
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<tr>
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<tr>
<td>Organic</td>
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### Table 39: moderate substrates

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### Table 40: moderately deep substrates

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### Table 41: deep substrates
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Appendix A - Percent Cover Diagrams

% Diagrams

1%  2%  15%  20%

3%  5%  25%  30%

7%  10%  40%  50%

*After Richard D. Terry and George V. Chilingan. 1955.*