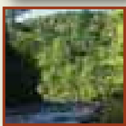
Forest Ecosystem Classification for Nova Scotia

Part II: Soil Types (2010)



prepared by
Nova Scotia Department of Natural Resources

REPORT FOR 2011-3

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Kevin Keys, Peter Neily, Eugene Quigley

Nova Scotia Department of Natural Resources
Renewable Resources Branch

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Introduction

In 2000 the Nova Scotia Department of Natural Resources (NSDNR) began a long-term project to systematically identify and describe stand-level forest ecosystems in Nova Scotia – known as the *Forest Ecosystem Classification (FEC)* project. To date, over 1,500 FEC plots have been assessed throughout the province using a detailed sampling and assessment protocol (Keys et al. 2007). This has resulted in several publications describing regional forest vegetation types, soil types, and ecosites (Keys et al. 2003; Neily et al. 2006, 2007; Keys 2007).

In 2010 results from 10 years of FEC project work were synthesized to produce a comprehensive provincial FEC guide which is presented in three documents: *Forest Ecosystem Classification for Nova Scotia: Part I Vegetation Types (2010)*; *Part II Soil Types (2010)*; and *Part III Ecosites (2010)*. This three-part guide builds upon, but also supersedes, all earlier FEC publications.

Questions arising from use of provincial FEC guides should be directed to the Ecosystem Management Group, Forestry Division, NSDNR. All FEC guide documents are subject to revision and update on a periodic basis. Users should check the NSDNR website for current editions of FEC component guides.

Why Classify Forest Ecosystems

At a landscape level, ecosystem classification provides a framework for landscape analysis and planning which can then be ecologically linked to operational (stand-level) planning and management (Sims et al. 1995). NSDNR has already produced a comprehensive ecological landscape classification (ELC) system for Nova Scotia (Neily et al. 2005). This hierarchical system begins with ecozone and moves through ecoregions, ecodistricts, ecosections, and finally ecosites – the level where the ELC and FEC systems converge.

At a stand level, classifying forest ecosystems based on vegetation, soil and site attributes allows users to recognize similar ecosystem units on the ground and to develop a common understanding of these units (Baldwin and Meades 1999; Ponomarenko and Alvo 2001). This allows for ongoing development of guidelines and best management practices which recognize opportunities and constraints associated with different ecosystem units, thereby leading to more predictable and sustainable forest management.

FEC Definitions

Definitions for provincial FEC units are given below. A glossary (Appendix J) contains definitions for other ecological and management related terms found in this guide.

Forest Groups are groups of forest Vegetation Types (VTs) with similar species composition, site conditions, and successional pathways. These groups assist in the classification and presentation of unique VTs.

Vegetation Types are recurring and identifiable forest plant communities which reflect differences in site conditions, disturbance regimes, and/or successional stage (see *Forest Ecosystem Classification for Nova Scotia: Part I Vegetation Types (2010)* for more details).

Variants are used to distinguish less common stands from the "typic" or average VT condition (based on minor variations in species composition or site features). Relative to differences among VTs, features used to define variants have weaker ecological and classification significance.

Soil Types are soils differentiated based on texture, drainage, fertility, and depth; all of which influence site productivity and other management interpretations.

Phases are used to identify features within a soil type which are important for management interpretations, but which do not warrant establishment of a separate unit.

Ecosites are units that represent ecosystems that have developed under a variety of conditions and influences, but which have similar moisture and nutrient regimes. An ecosite is associated with a finite range of soil and site conditions and a finite range of VTs that grow naturally under those conditions.

Ecosite Groups represent ecoregion and ecodistrict units with similar climate conditions which can be grouped for FEC purposes. Two ecosite groups have been identified, the Acadian group and Maritime Boreal group (see *Forest Ecosystem Classification for Nova Scotia: Part III Ecosites (2010)* for more details).

About this Guide

This guide is part of the Nova Scotia FEC system. It describes all currently recognized FEC Soil Types (STs) in the province along with related management interpretations. Although presented as a separate document, this guide is designed to be used in conjunction with provincial vegetation type and ecosite guides to support ecosystem based, stand-level forest management in Nova Scotia.

Soil types were derived from 1,456 provincial FEC field plots sampled between 2000 and 2010. Data from an additional 102 non-FEC plots assessed by the Atlantic Canada Conservation Data Centre and NSDNR Wildlife Division were also used (Basquill 2001–2008; Basquill and Benjamin 2009).

A total of 19 soil types and 6 soil type phases have been identified to date (Table 1). These STs have been differentiated based on general features of ecological and/or management related significance, namely:

- thickness and type of surface organic horizons
- mineral soil depth
- presence of organically enriched Ah or Ap mineral horizons
- dominant particle size and soil texture classes within the soil profile
- soil drainage condition
- soil coarse fragment content
- surface stoniness

Table 1. Soil types (STs) and phases within the provincial forest ecosystem classification (FEC) system

Code	Soil Type Name	Code	Soil Type Name
ST1	Dry - MCT	ST11	Rich Fresh - FMT
ST2	Fresh - MCT	ST12	Rich Moist - FMT
ST3	Moist - MCT	ST13	Rich Wet - FMT
ST4	Wet - MCT	ST14	Organic
ST5	Fresh - FMT	ST15	Dry Shallow - MCT
ST6	Moist - FMT	ST16	Moist Shallow - MCT
ST7	Wet - FMT	ST17	Rich Dry Shallow - MCT
ST8	Rich Fresh - MCT	ST18	Rich Moist Shallow - MCT
ST9	Rich Moist - MCT	ST19	Talus
ST10	Rich Wet - MCT		

Soil Type Phases		Applicable Soil Types
C	Coarse phase	ST8, ST9
G	Granite phase	ST1, ST2, ST3, ST4, ST15, ST16
L	Loamy phase	ST2, ST3, ST15, ST16
M	Mafic phase	ST19
S	Stony phase	All STs except ST19
U	Upland phase	ST14

(MCT = medium to coarse textured, FMT = fine to medium textured)

Users of the 2007 soil type guide (Keys 2007) will notice several changes in the 2010 guide. These are summarized below:

- The granite (G) phase has been added to ST1 and ST4;
- The coarse (C) phase has been added to ST9;
- A new stony (S) phase has been added to most soil types;
- A new soil type (ST19) has been created to describe young talus deposits;
- Soil type keys have been clarified and converted to a text format;
- Definitions have been adjusted slightly for some soil types;
- A more detailed section on wet soil features has been added;
- Soil texture and use of the texture key have been clarified;
- Management interpretations have been updated;
- Photographs and assessment tips have been added to aid soil type classification; and
- Information is now presented by soil type fact sheet.

Determining Soil Type

A soil type key (Figure 1) and soil texture class key (Figure 3) have been developed to aid soil type classification. Use of these keys requires digging or augering a small soil pit in an area (or areas) representative of the forest stand being assessed (see the section on Soil Type Field Assessment for more details). With practice and experience, soil type assessments generally take less than five minutes, especially when using a soil auger.

The soil type key (Figure 1) is hierarchical, with the user working down through decision points until ST is determined. Information from the soil texture class key (Figure 3) is needed when using the soil type key. Soil type can be assessed any time the soil is not frozen.

Once a soil type has been keyed out, general ST descriptions and photographs can be consulted to verify the decision. If the description does not fit the soil being sampled, then ST should be re-assessed.

Assessors should recognize that forest stands based on vegetation type boundaries can (and often do) contain more than one soil type which can impact management decisions. The section on Soil Type Field Assessment contains information on how to assign soil type under these conditions.

Details on soil terminology used in this guide can be found in Appendix A.

Not all soil types occur everywhere in the province. With time, users of this guide will become familiar with the STs found within their region of interest.

Figure 1. Key to forest soil types in Nova Scotia (also see information on stony phase soils at end of key)

1a. Surface organic thickness is ≥ 40 cm . . . . go to **ORGANIC SOIL key**

1b. Not as above 2

2a. Surface is mainly covered by bare, angular stones from talus deposits (includes non-vegetated patches of stone) . . . . go to **TALUS SOIL key**

2b. Not as above 3

3a. Average mineral soil depth is ≤ 30 cm over bedrock or a fully cemented soil horizon . . . . go to **SHALLOW SOIL key**

3b. Not as above 4

4a. CLAY content is ≥ 20% in the majority of soil between 30 cm and 60 cm below the mineral soil surface (i.e. soil particle size class is fine-loamy, fine-silty, or fine-clayey) . . . . go to **FINE SOIL key**

4b. Not as above 5

5a. Soil has a ≥ 10 cm thick layer, starting within the top 30 cm of mineral soil, with CLAY content ≥ 20% (i.e. soil has fine and coarse layers near the surface). . . . . go to **FINE SOIL key**

5b. Not as above. . . . . go to **COARSE SOIL key**

ORGANIC SOIL key

1a. Soil has an O horizon (Of, Om, Oh) derived from wetland vegetation (e.g. *Sphagnum spp., Carex spp.,* etc.) starting within 40 cm of surface (usually associated with Wet Coniferous or Wet Deciduous vegetation types) **ST14**

1b. Not as above **ST14-U**

TALUS SOIL key

1a. Talus deposit is made up of > 50% mafic rock (basalt and/or gabbro). **ST19-M**

1b. Not as above **ST19**

SHALLOW SOIL key

1a. REDOX features are present > 5 cm above the bedrock or cemented layer (i.e. soil is imperfectly drained or worse) 2

1b. Not as above 7

2a. REDOX features are present within 5 cm of mineral soil surface (i.e. soil is poorly drained) 3

2b. Not as above 4

3a. Soil has a well developed, unbroken Ah or Ap horizon ≥ 3 cm thick **ST10**

3b. Not as above **ST4**

4a. Soil has a well developed, unbroken Ah or Ap horizon ≥ 3 cm thick **ST18**

4b. Not as above 5

5a. Granite surface stoniness class is VERY STONY or higher **ST16-G**

5b. Not as above 6

6a. SAND content is < 50% within top 20 cm of mineral soil (i.e. surface texture class is silt, silt loam, and/or loam) **ST16-L**

6b. Not as above **ST16**

7a. Soil has a well developed, unbroken Ah or Ap horizon ≥ 3 cm thick **ST17**

7b. Not as above 8

8a. Granite surface stoniness class is VERY STONY or higher **ST15-G**

8b. Not as above 9

9a. SAND content is < 50% within top 20 cm of mineral soil (i.e. surface texture class is silt, silt loam, and/or loam) **ST15-L**

9b. Not as above **ST15**

FINE SOIL key

1a. Soil has a well developed, unbroken Ah or Ap horizon ≥ 3 cm thick . . 2

1b. Not as above 4

2a. REDOX features are <u>present</u> within top 30 cm of mineral soil (i.e. soil is imperfectly drained or worse) 3

2b. Not as above **ST11**

3a. REDOX features are <u>dominant</u> within top 30 cm of mineral soil (i.e. soil is poorly drained) **ST13**

3b. Not as above **ST12**

4a. REDOX features are present within the top 30 cm of mineral soil
(i.e. soil is imperfectly drained or worse) 5

4b. Not as above **ST5**

5a. REDOX features are dominant within top 30 cm of mineral soil
(i.e. soil is poorly drained) **ST7**

5b. Not as above. **ST6**

COARSE SOIL key

1a. Soil has a well developed, unbroken Ah or Ap horizon ≥ 3 cm thick . . 2

1b. Not as above 6

2a. REDOX features are present within top 30 cm of mineral soil
(i.e. soil is imperfectly drained or worse) 3

2b. Not as above 5

3a. REDOX features are dominant within top 30 cm of mineral soil

(i.e. soil is poorly drained) **ST10**

3b. Not as above. 4

4a. SAND content is ≥ 75% within top 40 cm of mineral soil OR
GRAVEL + COBBLE content > 50% within top 40 cm of mineral soil. **ST9-C**

4b. Not as above **ST9**

5a. SAND content is ≥ 75% within top 40 cm of mineral soil OR
GRAVEL + COBBLE content > 50% within top 40 cm of mineral soil **ST8-C**

5b. Not as above **ST8**

6a. REDOX features are present within the top 30 cm of mineral soil
(i.e. soil is imperfectly drained or worse) 7

6b. Not as above 11

7a. REDOX features are dominant within top 30 cm of mineral soil

(i.e. soil is poorly drained) 8

7b. Not as above. 9

8a. Granite surface stoniness class is VERY STONY or higher **ST4-G**

8b. Not as above **ST4**

9a. Granite surface stoniness class is VERY STONY or higher **ST3-G**

9b. Not as above 10

10a. SAND content is < 50% within top 20 cm of mineral soil (i.e. surface texture class is silt, silt loam, and/or loam) **ST3-L**

10b. Not as above **ST3**

11a. SAND content is ≥ 75% within top 40 cm of mineral soil OR GRAVEL + COBBLE content > 50% within top 40 cm of mineral soil.................. 12

11b. Not as above 13

12a. Granite surface stoniness class is VERY STONY or higher **ST1-G**

12b. Not as above. **ST1**

13a. Granite surface stoniness class is VERY STONY or higher **ST2-G**

13b. Not as above 14

14a. SAND content is < 50% within top 20 cm of mineral soil (i.e. surface texture class is silt, silt loam, and/or loam) **ST2-L**

14b. Not as above **ST2**

Key Points

Refer to the section on Soil Texture and Particle Size Class for more information on texture determination.

Refer to the section on Soil Type Field Assessment for details on what constitutes present and dominant REDOX features and a fully cemented horizon.

For G-phase determination, granite includes all granite family rocks (granite, granodiorite, orthogneiss).

When present, the organically enriched Ah or Ap horizon must be well developed to move from typic to rich STs. Thin (< 3 cm) or broken Ah/Ap horizons do not qualify, and Ahe horizons do not qualify.

STONY PHASE

Many soils have a stony phase which can further impact management interpretations. Rather than complicate soil type keys by adding this possibility for every unit, assessors should add the S-phase descriptor as needed to soil types already listed above.

The STONY PHASE applies when:

> The upper 30 cm of **mineral soil** contains 60% or more cobbles, stones, and/or boulders such that rooting into the mineral soil is being restricted (or potentially restricted) by the presence of these coarse fragments.
>
> In the case of **organic soils** (which have a minimum 40 cm surface organic thickness) the zero point is the ground surface, not the top of the mineral soil. If cobble, stone, and/or boulder content is greater than 60% within this upper 40 cm organic layer, then the organic soil is classed as stony.

Key Points

Stoniness often begins at the interface between forest floor organic layers and the mineral soil below which can sometimes make it look like there is little to no mineral soil present. If these coarse fragments are below the forest floor, they mark the beginning (zero point) of the mineral soil layer.

In most cases, stones and/or boulders will make up the majority of coarse fragment volume in S-phase soils, but cobble-size rock is also included since these will often fill voids between larger rocks. Gravel-size coarse fragments are not counted in this assessment.

Coarse fragment content will often decrease with depth in S-phase soils since concentration of rock near the surface can be the result of both deposition and post-deposition processes such as frost heaving and surface stone weathering.

Although granite (G) phase soils are pre-disposed to stoniness, not all G-phase soils will show the increased restrictions associated with S-phase conditions.

The S-phase designation is possible for all soil types except ST19 and ST19-M which are already stony by definition.

Soil Texture and Particle Size Class

Soil texture refers to the percentage of sand, silt and clay in a soil (sand ranges in size from 0.05–2.0 mm; silt from 0.002–0.05 mm, and clay < 0.002 mm). Texture influences many soil attributes including moisture and nutrient retention, soil structure and aeration porosity, soil temperature, soil strength, and soil trafficability.

Texture is often described using classes which have defined ranges of sand, silt and clay. Several classification schemes have been developed to meet the needs of soil surveyors, engineers, agriculturalists and other resource managers. Choosing which classification to use depends, in part, on how well classification units meet interpretation needs. Two such classification schemes are shown in Figure 2 (adapted from SCWG 1998) and both are used in this guide to help differentiate soil types and phases for management purposes.

Soil Type Texture Breakpoints

The boundary between coarse-loamy and fine-loamy particle size classes (Figure 2a) coincides with clay percentages (about 20%) which are associated with increased plasticity and compaction hazard in forest soils (Curran 2001). This is the breakpoint used to differentiate fine soils from coarse soils in the FEC soil type system. The sandy particle size class (beginning at about 75% sand) is another breakpoint used to separate soils which have reduced moisture and nutrient retention capabilities compared to coarse-loamy soils. However, the coarse-loamy unit is too broad for other interpretations (e.g. erosion and frost heave hazards) which need to account for smaller differences in sand content. In this case a breakpoint of 50% sand is used to separate loamy (L-phase) soils from typic soils. This roughly coincides with the breakpoint between sandy loam and loam (Figure 2b).

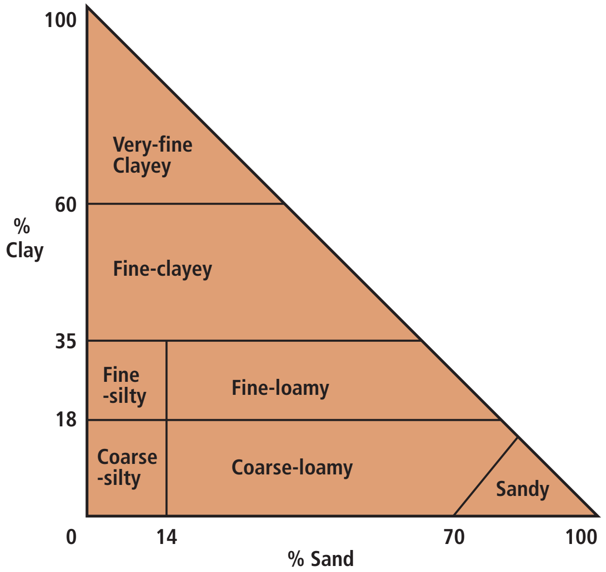
Many users of this guide are already familiar (at least by name) with soil texture classes shown in Figure 2b. These units are used to describe soils in a wide range of literature, including provincial soil survey reports, and it is therefore important for users to understand the relationships between texture class, particle size class, and soil type as defined in this guide.

The soil texture and particle size class key (Figure 3) was designed to allow users to estimate required texture information for soil typing, and to relate this information to both particle size and texture class units.

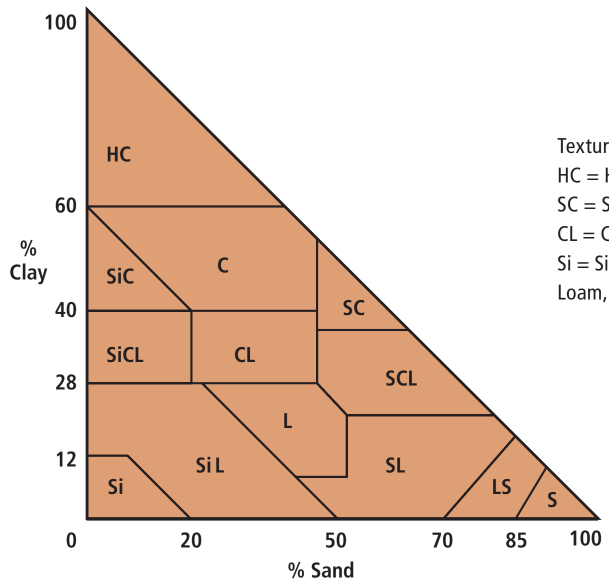
Figure 2. Soil particle size and texture class triangles

Soil particle size and texture class triangles showing relative clay and sand percentages by class unit (% silt is inferred by knowing other values). In general, fine textured soils are higher in clay, medium textured soils are higher in silt, and coarse textured soils are higher in sand.

(a) Particle Size Class Triangle



(b) Texture Class Triangle



Texture classes:
HC = Heavy Clay, SiC = Silty Clay, C = Clay, SC = Sandy Clay, SiCL = Silty Clay Loam, CL = Clay Loam, SCL = Sandy Clay Loam, Si = Silt, SiL = Silt Loam, L = Loam, SL = Sandy Loam, LS = Loamy Sand, S = Sand

Using the Texture Key

To use the texture key, start by placing a small mass of soil on the middle of your three largest fingers (palm side) and remove any obvious organic material and rock (all solid particles over 2 mm in size are considered coarse fragments and are not part of the texture assessment). If the sample being assessed has many small coarse fragments (rocks), you must mentally disregard these when assessing the sample (but consider them when estimating gravel content).

Next, moisten the sample until it is wet enough to stay in place when inverted (when you turn your hand over), but not so that the sample is runny or excess water is present (see photos on next page). Rub the moistened sample between your thumb and fingers to assess relative grittiness and smoothness (you must rub hard to feel all sand sizes). All grittiness, no matter how fine, is due to sand content (smoothness is due to both silt and clay). Based on relative grittiness, estimate sand content by going down the left hand column of the key until the description matches your sample.

If your sample has < 75% sand you also need to assess clay content. To do this, lift your thumb up and down from the fingers to assess relative stickiness within your moist sample. Only the clay fraction causes stickiness (silt just feels smooth). The more clay in your soil, the stickier it will feel when moist. Move across the key from left to right (beginning from where you established sand content) until the stickiness description matches your sample. This will lead you to your estimated texture class.

Once you have estimated soil texture, look up the associated particle size class to determine which soil type key you should use (fine or coarse).

It will take some training and calibration for assessors to confidently estimate soil texture in the field. However, for FEC soil type classification, assessors only need to become comfortable with three texture breakpoints: 20% clay, 75% sand, and 50% sand — everything else is extra (20% clay corresponds with the "distinctly sticky" threshold in the texture key).

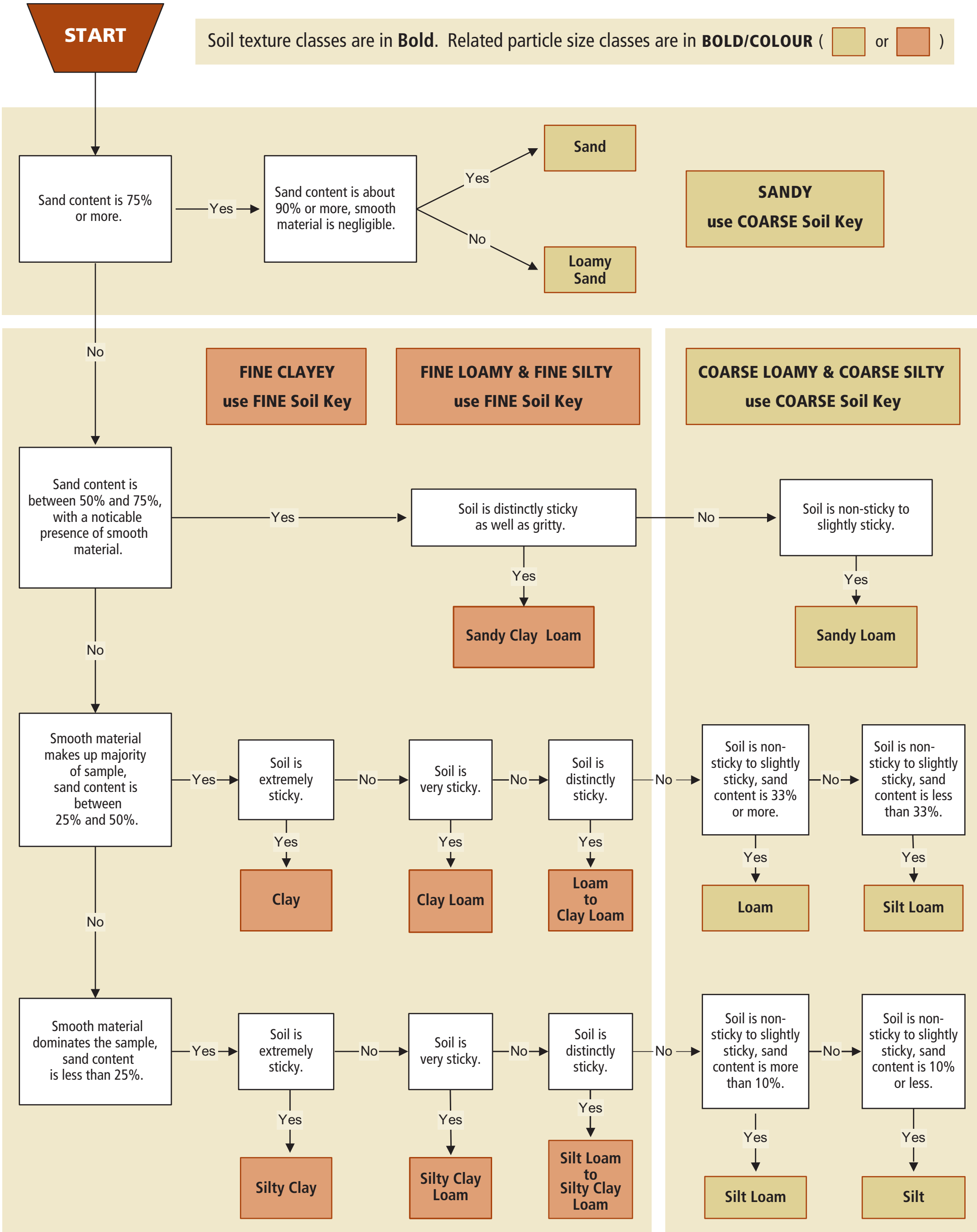
Soil sample before moistening

Soil sample after moistening, ready for texture / particle size class determination

Rubbing sample hard to a thin film between the thumb and fingers to ensure all sand sizes are being assessed — if sample is not rubbed hard, sand content will be underestimated

Lifting thumb from fingers to assess relative clay content (stickiness) — if the sample is too dry or too wet, stickiness (clay content) will be underestimated

Figure 3. Soil texture class and particle size class key



Soil Type Field Assessment

Use of the soil type keys requires digging a small soil pit or auger hole in an area (or areas) **representative** of the forest stand being assessed. Attention must be paid to slope position, microtopography and flow channels, as well as signs of local disturbance.

It is very important that soil type changes be recognized during stand assessment and incorporated into management planning. Not recognizing soil type changes can lead to unwanted and unpredictable management responses. Assigning an average soil type to a stand defeats the purpose of site assessment.

Where it is obvious that stand boundaries based on vegetation type include more than one soil type, several options for mapping and management exist:

- If the soil type change is continuous and large (e.g. a large ST3 lower slope area adjacent to an upper and middle slope ST2), then the stand can be divided and mapped as separate units for management purposes. This acknowledges that soil differences are just as valid as cover type differences when identifying stand boundaries.

- If more than one soil type is found which covers a large area, but soils cannot be mapped as separate units (e.g. a well drained ST8 and imperfectly drained ST9 in hummocky terrain), then the stand can be mapped as a complex with soil types separated by a slash, e.g. **ST8/ST9** (if one soil type is more dominant, it should be listed first). Where soil type complexes exist, the worst hazard rating for each management interpretation should be used for planning purposes.

- If a soil type is found as a significant inclusion within a relatively uniform site (e.g. a shallow ST15-L over bedrock within a larger ST2-L unit), then the stand can be mapped as a dominant soil type with inclusions listed in brackets, e.g. **ST2-L (ST15-L)**. More than one inclusion type can be listed if present. Knowledge of these inclusions is important for operational planning.

It is possible that both complexes and inclusions are found in a single stand. For example, an FEC label for a red spruce / balsam fir stand on hummocky terrain could be:

Vegetation Type:	**SH6 (WC6)**
Soil Type:	**ST3/ST2 (ST4)**
Ecosite:	**ES11/ES10 (ES8)**

Label translation: A stand dominated by SH6 (Red spruce – Balsam fir / Stair-step moss – Sphagnum) on a complex of imperfectly and moderately well drained, medium to coarse textured soil (ST3/ST2) which also includes pockets of WC6 (Balsam fir / Cinnamon fern – Three seeded sedge / Sphagnum) on poorly drained, medium to coarse textured soil (ST4). This combination of VTs and STs is associated with Ecosites 11 and 10 (moist to fresh, medium fertility) and pockets of Ecosite 8 (wet, poor fertility).

Soil Pits

Soil pits do not need to be as large as those shown in soil type photographs, these pits were used for data collection and research purposes. To key out soil types, pits only need to be large enough to expose and assess soil to a maximum depth of 50–60 cm, approximately two shovel head depths. Using a soil auger can be an even more efficient way to determine soil type, as shown in Figure 4.

A recommended procedure for auger assessment is given below. Each full auger sample depth is approximately 15 cm which can be used to estimate depth of soil features found (it generally takes 3–4 turns to fill the auger barrel). After some experience, assessors will likely not need soil type keys for most soils since the main decision points are easily memorized.

- Use the first mineral soil auger sample to visually determine if you have a well developed Ah or Ap horizon, or the more common Ae or Ahe horizon (Figure 4a). Next, do a quick texture assessment and visual check for redox features. (Note: depending on forest floor thickness, you may need to auger more than once before hitting mineral soil).
- For the next auger depth (Figure 4b), do another check for redox features if none were found in the first mineral soil sample. Be sure to keep an on-going estimate of auger depth into mineral soil for using the soil type key. If texture assessment in the first mineral sample showed 75% or more sand, or 20% or more clay, do another texture assessment in the second auger sample to determine if these conditions are still dominant. (Note: the outside of samples taken at depth may be smeared by material from the top of the auger hole; assessors should take a section of soil out of the auger barrel and break it open to look for redox features and for texture determination).
- A third mineral soil auger depth should take you below 30 cm. This is only necessary if you have not already determined that clay content is 20% or more in the samples above or if you are unsure whether you have fully assessed the top 30 cm for redox features.
- A fourth auger sample (from approximately the 45–60 cm mineral soil depth) is only needed if you have not already determined that clay content is 20% or more in the samples above and you suspect that clay content is increasing with depth. Otherwise, you should have all the information you need to use the soil type keys or to have already determined soil type by memorization of decision points.

Figure 4. Soil auger assessment samples

Figure 4. **(a)** An initial auger sample which contains (from right to left) organic forest floor horizons, a pinkish-grey Ae horizon, and the top portion of an orange-brown Bf horizon. **(b)** A second auger sample which contains faint to distinct, orange redox concentrations which are clearly seen in the sample which has been broken open in the hand.

It is important to not underestimate sampling depth when soil typing. Although a soil auger can often be used to estimate depth of sampling, this does not always work if auger samples are not full or if the auger is angled. Depth markers can be put on the shaft of the auger to help assess depth, or a tape measure can be used when necessary.

Wet Soil Features

Typical moisture condition is an important feature differentiating FEC soil types. Visible soil characteristics can be used to identify imperfectly to poorly drained soils even when they are relatively dry at time of assessment. These characteristics are collectively called redoximorphic features from the reduction/oxidation (redox) reactions that produce them (Richardson and Vepraskas 2001).

Redoximorphic (redox) features result when a microbially active soil lacks oxygen (air) for long periods, as in prolonged saturation with water. Under these conditions, reactions occur which alter iron (Fe) and manganese (Mn) chemistry in the soil, as well as organic matter condition, leaving telltale visible features.

Oxidized Fe (and to a lesser extent Mn) is responsible for much of the red, orange, and yellow colours associated with well aerated soils. These elements, along with organic matter, are the "paint" that gives colour to soils. Under prolonged saturation, oxidized Fe and Mn are chemically reduced and made soluble in water which leads to the "paint" being stripped off soil particles and diffused or washed out of the soil. The extent of this colour change depends on the length of time under reducing conditions and on the original soil colour.

Non-red soils:

Soils which are not derived from reddish parent materials tend to turn a dull grey colour under long-term saturation conditions. These soils are said to be depleted of Fe and Mn (Figure 5a). In some cases, soils may also turn a bluish or greenish grey colour, also called gley colour (Figure 5b). When oxygen occasionally gets back into these soils and reaches areas where diffused Fe and Mn has accumulated, prominent redox concentrations (red/orange blotches) form where reduced Fe and Mn become oxidized and show their original colours in contrast to the now depleted matrix (background) colour (Figure 5a, Figure 6a). Permanently saturated soils may also show depleted or gley colours without any redox concentrations.

Under less extreme saturation conditions (e.g. when soils are only seasonally wet, as after spring snowmelt), soils are not subject to as much Fe and Mn loss so that when oxygen reenters the soil, colour contrast between redox concentrations and the soil matrix is only faint to distinct (Figure 7a,b).

In some A horizons that have been depleted (and/or leached), prolonged saturation with water high in dissolved organic compounds can also cause organic staining which gives the horizon variable shades of grey (Figure 5a, Figure 6b).

In all cases, the depth where redox features begin coincides with the depth of prolonged saturation, with features often becoming more pronounced with depth.

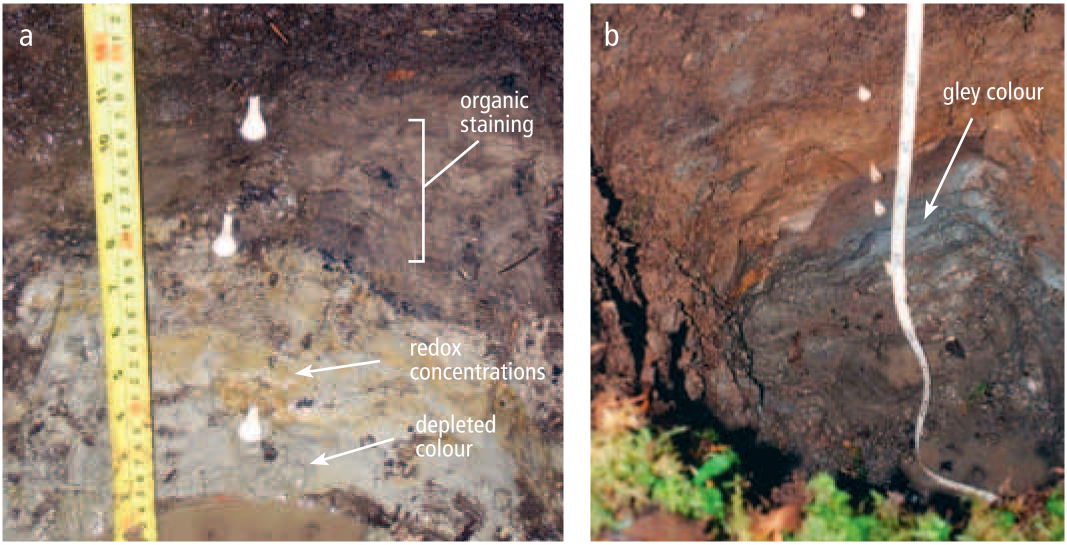


Figure 5. Depleted matrix and gley colours in poorly drained, non-red soils

(a) A poorly drained soil showing Fe/Mn depletion (low chroma grey colours) throughout the profile, prominent (orange) redox concentrations in the middle horizon, and organic staining in the upper horizon. Redox concentrations are also found in the stained A horizon, but their prominence has been masked by organic staining. **(b)** Blue-grey (gley) colour in bottom of soil profile caused by prolonged saturation and related redox reactions.

In older literature, redox concentrations and redox depletions are referred to as ***mottles*** *and* ***grey mottles*** *respectively. These older terms are less precise and so are not used in this guide. For example, mottling in soils is not always associated with restricted drainage, other factors may cause these colour patterns (e.g. the physical mixing of soil horizons).*

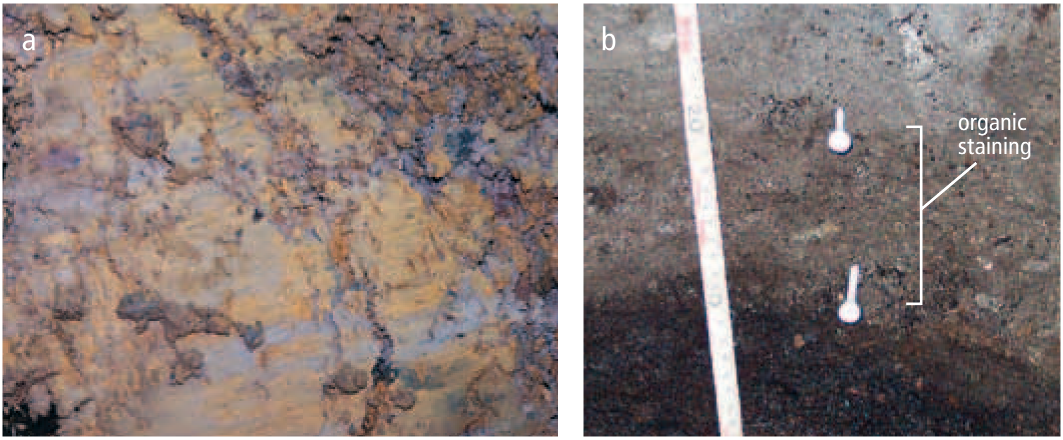


Figure 6. Prominent redox concentrations and organic staining in poorly drained, non-red soils

(a) Close-up of soil with many, coarse, prominent (orange) redox concentrations within a depleted (grey) soil matrix. **(b)** Organic staining in the bottom section of a leached and depleted Ae horizon where water periodically pools on top of a cemented and impermeable B horizon.

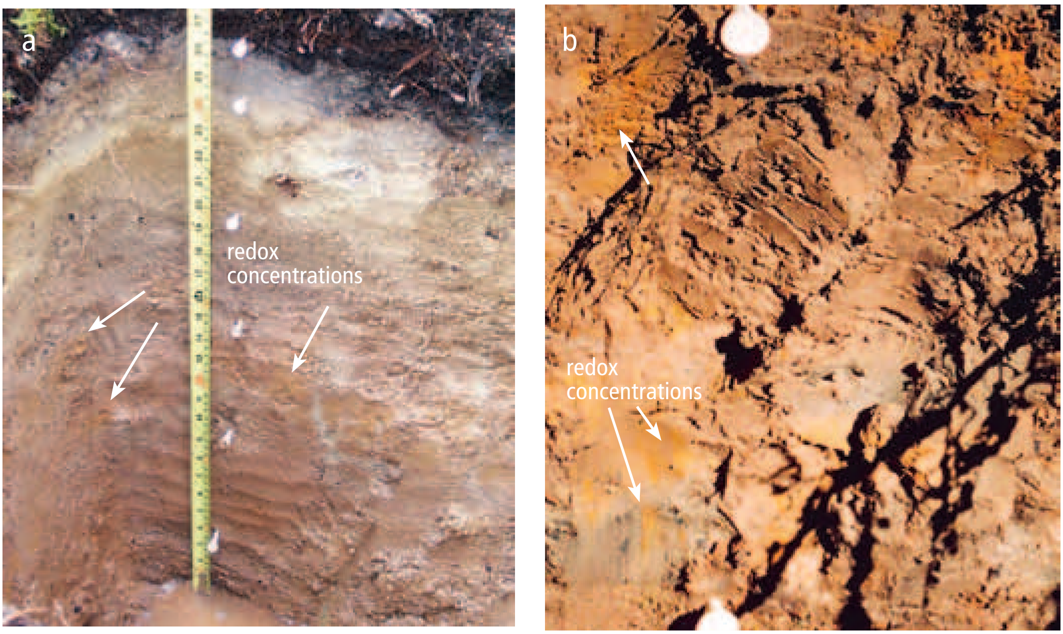


Figure 7. Faint to distinct redox concentrations in imperfectly drained, non-red soils

(a) An imperfectly drained soil showing faint to distinct redox concentrations indicative of a fluctuating water table where saturation conditions do not last long enough to cause excess loss of Fe and Mn. **(b)** Close-up view of faint to distinct (orange) redox concentrations against a light brown soil matrix.

Red soils:

For reasons not fully understood, soils derived from reddish parent materials do not always undergo full colour change under prolonged saturation. Instead, these soils tend to have a mix of red and grey colours and/or grey redox depletions (instead of red/orange concentrations) within a reddish soil matrix (Figure 8a). Redox depletions and concentrations are sometimes also found together in the same soil (Figure 8b).

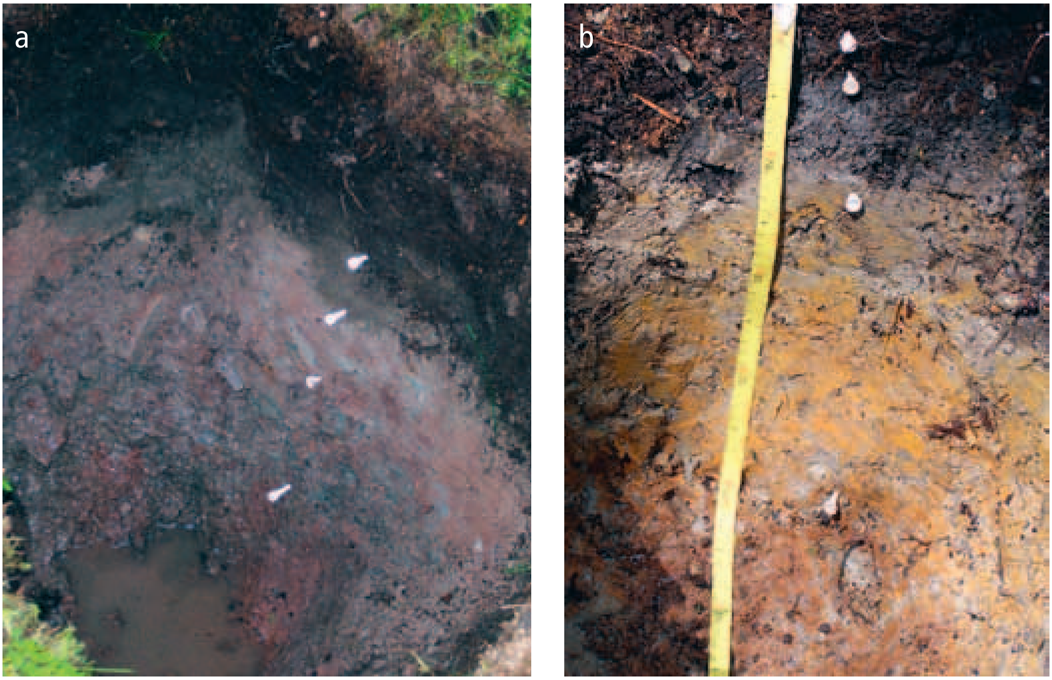


Figure 8. Redox depletions and concentrations in poorly drained, red soils

(a) A poorly drained soil derived from reddish parent material showing a mix of red and grey (depletion) colours. Pockets of organic staining are also visible in this profile. **(b)** Close-up view of prominent (orange) redox concentrations near the surface of a soil underlain by massive, clay-rich (red) soil with grey redox depletions. This soil is affected by a seasonal, perched water table that was dry at time of soil assessment.

Present versus Dominant Redox Features:

For purposes of using the soil type key, redox features are considered dominant when they visually dominate the top 30 cm of mineral soil. This includes all redox features (depleted matrix, gleyed matrix, redox concentrations, redox depletions, organic staining). In the case where redox concentrations and/or depletions are the only features present, they must be found within the top 10 cm of mineral soil and make up at least 2% of the soil volume in which they occur to be considered dominant (see Appendix B for percent area/volume charts).

In the special case of soils with thick (≥ 10 cm) Ah or Ap horizons which can mask the appearance of redox features, redox concentrations and/or depletions must be present directly below the Ah/Ap horizon and make up at least 2% of the soil volume in which they occur to be considered dominant.

Where redox features are found in the top 30 cm of soil, but do not meet the criteria above, they are considered present but not dominant.

The presence of redox features should be in keeping with other site conditions which suggest that imperfect or poor drainage is likely. It is usually site clues which alert assessors to a probable change in drainage condition; soil features are then used to confirm this change.

Site clues to look for include:

- Slope position where moisture can collect (lower, depression, level);
- Slope length (longer slopes have increased seepage potential);
- Proximity of surface water bodies and wetlands (near-surface water table); and
- Presence of hydrophytic vegetation (wet site plant indicators)

Appendix H contains a list of common wet site plant indicators in Nova Scotia forests.

Poorly drained soils are usually easy to recognize, it is imperfectly drained soils which are most easily missed, but which are important to recognize because of differences in productivity and operability.

Ah and Ap Horizons

Well-developed Ah and Ap horizons can be identified based on several features:

- Increased organic matter in Ah/Ap horizons gives the soil a more brownish or blackish colour compared to horizons below. This is in contrast to the leached, light colours found in Ae horizons, or the mixed colours found in Ahe horizons.
- Ah/Ap horizons often have a high percentage of fine roots because of the availability of nutrients in these horizons. This is in contrast to the low fine root percentages found in most Ae horizons.
- Ah/Ap horizons often have a distinctive granular structure due to earthworm activity; worms may also be visible during sampling.

Cemented Soils

Cemented horizons (orstein and fragipan) act as barriers to rooting and restrict or reduce the vertical flow of water. When encountered, these horizons strongly resist penetration with an auger or shovel, as if they were frozen or rock-like.

Orstein horizons (Bfc, Bhfc, Bhc) are generally associated with well drained, sandy and/or gravelly soils. Fragipan horizons (Bx, BCx) are loamy, dense, and frequently show bleached fracture planes. In both cases, these horizons are found below more friable or loose surface horizons.

To be considered "fully cemented" and potentially associated with shallow soil types (ST15, ST16), these cemented horizons need to be continuous and very firm or very hard (i.e. only penetrated with difficulty with a shovel or auger and barely breakable with finger or hand pressure).

If a cemented horizon is found within 30 cm of the surface, additional checks should be made nearby to determine if cementation is continuous within that depth. Also, the degree of cementation should be assessed. If when using an auger it feels like you are only spinning on top of the horizon despite putting significant downward pressure on the auger as you turn it, consider the consistence very firm or very hard. If when using a shovel you are only able to chip at the horizon as you try to dig through, consider the consistence very firm or very hard.

If orstein and fragipan horizons are discontinuous and/or show only partial cementation (i.e. shows resistance, but can be penetrated), then they do not qualify as fully cemented horizons.

Stony Phase Soils

Exposed stones from windthrow and repeated refusals when attempting to auger or dig into surface soils are good indicators of stony phase conditions (Figure 9).

When dealing with S-phase soils, assessors still need to determine soil type based on features below the stony surface layer. This can often be accomplished by removing one or two stones from the surface to allow deeper access. In those cases where deeper access is not possible or practical, assessors must use professional judgement in assigning soil type based on site conditions, available soil information, and nearby soil type assignments.

Very Gravelly Soils

Very gravelly and/or cobbly soils (> 50% of soil volume) are easily assessed using a shovel, but auger assessment is often more difficult. Although small gravel sizes can be captured in auger samples, larger pieces and cobbles can cause difficulty in sampling and/or eventual refusal.

Assessors should watch for the presence of numerous, small gravel pieces when checking auger samples, especially in soils derived from granitic glacial tills. Persistent difficulty in augering should also alert assessors to the possibility of high gravel and/or cobble volumes (Figure 10).

Appendix B contains percent area/volume charts to aid estimation of gravel and cobble content.

Figure 9. Sample stony phase soil features

(a) Stony phase soils have increased windthrow hazard. High stone content visible below windthrown trees is a good indicator of stony phase conditions. **(b)** Straight down view of a partially excavated pit showing high stone content in the top 30 cm of mineral soil. This soil would have caused repeated refusals when attempting to auger or dig.

Figure 10. Sample very gravelly and cobbly soil profiles

(a) Soil with high gravel and cobble content in lower half of profile. **(b)** Soil with high gravel content throughout the profile.

Soil Type Fact Sheets

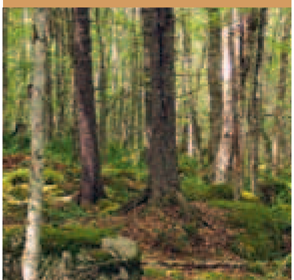
The following section contains fact sheets describing all soil types and phases in the FEC system. Below is a summary of information found in each fact sheet.

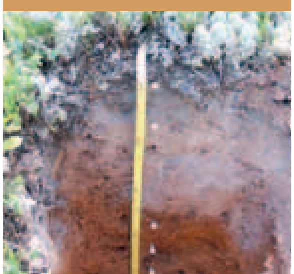
1. The soil type **number** and **name**.
2. A general **description** of the soil type and range of conditions found during field sampling.
3. Possible **phases** associated with each soil type.
4. **Associated soil series** which have characteristics matching soil type features or which are likely to contain inclusions which match soil type features (see Appendix F for a list of provincial soil survey reports).
5. Comments on soil type **distribution** across the province (see Appendix I for a map of ecoregions and ecodistricts of Nova Scotia).
6. **Ecological features** related to fertility, vegetation types, and humus forms.
7. Soil type **hazard ratings** (see the section on Management Interpretations for more details).
8. **Photographs** showing representative soil type profiles and/or features.
9. **Tips** for field assessment.

Users of this guide are reminded that, due to variability in site/soil conditions and the limitations of mapping scales, many soil types can potentially be found within a mapped soil series polygon — this is especially true for soil type changes related to drainage (or moisture) class.



Soil Types





ST1
Dry – Medium to Coarse Textured

Description

ST1 is associated with dry, sandy or dry, very gravelly to very cobbly coarse-loamy soils. In both cases, the ability to retain moisture and nutrients is reduced due to high sand and/or coarse fragment content. Gravel plus cobble content in surface horizons is often > 50%, but may also be absent in sandy glaciofluvial deposits. Stone and boulder content also varies by parent material type. Site drainage is usually well or rapid, but can be moderately well in lower or level slope positions. ST1 profiles usually contain a thick, well developed Ae horizon and may also contain partially or fully cemented B horizons.

Phases

ST1-G, ST1-GS, ST1-S

Associated Soil Series

ST1 (ST1-S): Canning, Coastal Beach, Cornwallis, Digby, Gibraltar, Gulliver, Hebert, LaHave, Medway, Nictaux, Pomquet Sand, Portapique, Somerset, Torbrook, Truro

ST1-G (ST1-GS): Gibraltar

Distribution

ST1 can be found scattered throughout the province, but is most common in the Western (700) ecoregion where it is associated with coarse, granitic glacial till; in the Annapolis Valley (610) and Minas Lowlands (620) ecodistricts where it is associated with sandy outwash (glaciofluvial) deposits; and in the Northumberland / Bras d'Or ecoregion (mainly Cumberland County) where it is associated with sandstone enriched glacial till.

Ecological Features

ST1 is generally very poor to poor in fertility and prone to drought. It is usually associated with spruce pine (SP) or open woodland (OW) vegetation types, but may support selected vegetation types from other forest groups (especially where deep-rooting trees can access additional moisture). Associated humus forms are mainly Hemimor and Humimor, with Resimor also common (especially where ericaceous species dominate the shrub layer).

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST1	L	L	L	L-M	L	VH
ST1-G	L	L	L	L-M	L	VH
ST1-GS	L	L	L-M	M	L	VH
ST1-S	L	L	L-M	M	L	VH

ST1 derived from a sand-capped, gravelly and cobbly glaciofluvial deposit.

ST1 derived from a sandy glacial till deposit. Note the well developed (almost white) Ae horizon which is common in ST1 soils because of their coarse texture and good internal drainage.

ST1-S with high stone content in a thick, sandy Ae horizon. Note the concentration of stones near the surface (edges protruding from profile) which decreases with depth.

Assessment Tips

Watch for the presence of cemented (orstein) soils which are relatively common in well to rapidly drained, sandy soils. Where a fully cemented layer occurs within 30 cm of the mineral soil surface, ST1 soils become shallow ST15 soils.

ST2
Fresh – Medium to Coarse Textured

Description

ST2 is mainly associated with fresh, coarse-loamy soils dominated by sandy loam texture. Coarse fragment content is generally low to moderate in surface horizons, but levels can be higher in soils derived from granite, quartzite, or sandstone tills. Site drainage is usually well, but ranges between rapid and moderately well depending on slope position, slope percent, and subsoil permeability. ST2 profiles usually contain a well developed Ae horizon, but Ahe horizons can also be found, particularly in loamy soils (ST2-L). Cemented B horizons are also possible.

Phases

ST2-G, ST2-GS, ST2-L, ST2-LS, ST2-S

Associated Soil Series

ST2 (ST2-S): Berwick, Bridgetown, Bridgewater, Cobequid, Farmville, Folly, Gibraltar, Glenmont, Halifax, Hansford, Merigomish, Mersey, Perch Lake, Portapique, Port Hebert, Pugwash, Rodney, Shulie, Somerset, Thom, Tormentine, Truro, Westbrook, Woodville, Wyvern, Yarmouth

ST2-G (ST2-GS): Bridgetown, Farmville, Gibraltar, Port Hebert, Wyvern

ST2-L (ST2-LS): Barney, Bridgewater, Bryden, Elmsdale, Glenmont, Hopewell, Kirkhill, Kirkmount, Morristown, Pelton, Rawdon, Rossway

Distribution

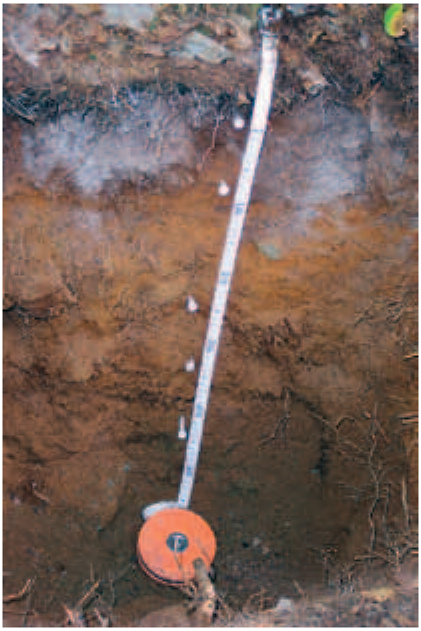
ST2 is the most common upland forest soil type in Nova Scotia and is found throughout the province, particularly where softwoods and mixedwoods are the dominant cover. ST2-G is mainly found in the Western (700), Eastern (400), and Atlantic Coastal (800) ecoregions; while ST2-L is common in the Nova Scotia Uplands (300) and Fundy Shore (900) ecoregions, and on drumlin ecosections throughout the province.

Ecological Features

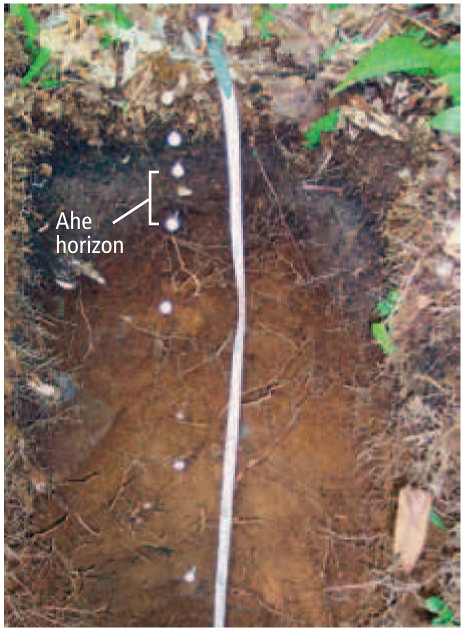
ST2 is generally poor to medium in fertility, but is sometimes richer (especially ST2-L). Moisture may be somewhat limiting during the growing season (especially in coarser soils), but usually not severely so. ST2 is associated with all forest groups except wet coniferous (WC), wet deciduous (WD) and floodplain (FP). Associated humus forms range from acidic mors (mainly Hemimor and Humimor) on softwood dominated sites, to medium fertility moders (mainly Mormoder) under mixedwood and hardwood cover. Resimors are also possible, especially in coastal (CO) and Highland (HL) softwood stands.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST2	L-M	L	L	L-M	L	H
ST2-G	L	L	L	L-M	L	VH
ST2-GS	L	L	L-M	M	L	VH
ST2-L	M	L-M	M	H	L-M	M-H
ST2-LS	L-M	L	M-H	H-VH	L	H
ST2-S	L	L	L-M	M	L	VH



ST2 dominated by sandy loam texture. Note the well developed, but broken, Ae horizon and dominant orange/brown colours below signifying well aerated (good drainage) conditions.



ST2-L derived from a loamy glacial till deposit. L-phase soils often have an Ahe horizon (as is the case here) and/or thinner Ae horizons than typic soils.

A site with high granite stoniness leading to a G-phase designation (in this case ST2-G).

Assessment Tips

Watch for the presence of numerous, small coarse fragments when assessing soils derived from granitic glacial tills (e.g. Gibraltar and Wyvern series). These coarse fragments, which are usually large quartz grains left over from weathered rock, can cause ST2 to shift to ST1.

ST2-L can sometimes be found in a complex with ST5 where depth to clay enrichment is variable.

ST3
Moist – Medium to Coarse Textured

Description

ST3 is mainly associated with moist, coarse-loamy soils dominated by sandy loam texture, but also includes moist sandy soils. Coarse fragment content is generally low to medium in surface horizons, but levels can be higher in soils derived from granite, quartzite or sandstone tills. Site drainage is moderately well to imperfect due to slope position (middle, lower, level) and/or restricted vertical drainage in areas of gentle slope. ST3 profiles usually contain a well developed Ae horizon, but Ahe horizons can also be found, particularly in loamy soils (ST3-L) or where seepage inputs have increased site fertility. Cemented B horizons are also possible.

Phases

ST3-G, ST3-GS, ST3-L, ST3-LS, ST3-S

Associated Soil Series

ST3 (ST3-S): Annapolis, Avonport, Bayswater, Comeau, Danesville, Debert, Deerfield, Kentville, Kingsport, Liverpool, Lydgate, Mira, Springhill

ST3-G (ST3-GS): Bayswater, Lydgate

ST3-L (ST3-LS): Kentville, Millbrook, Riverport, Roxville

Distribution

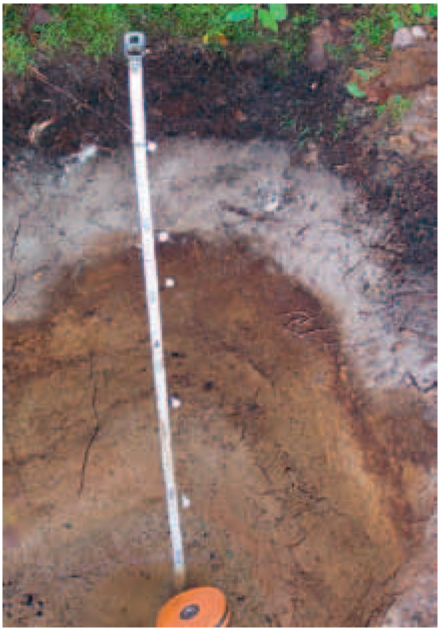
ST3 is the imperfectly drained equivalent of ST1 and ST2 and is found in association with these better drained soils throughout the province (usually in lower slope positions and level areas). ST3-G is mainly found in the Western (700), Eastern (400), and Atlantic Coastal (800) ecoregions; while ST3-L is common in the Nova Scotia Uplands (300) and Fundy Shore (900) ecoregions, and on the lower slopes of drumlin ecosections throughout the province.

Ecological Features

ST3 is generally poor to medium in fertility, but is sometimes richer (especially ST3-L) with increased fertility often due to seepage inputs. Imperfect drainage means moisture levels can be excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but is rarely limiting during the summer. ST3 can be associated with all forest groups except floodplain (FP), but mainly occurs with spruce pine (SP), spruce hemlock (SH), intolerant hardwood (IH), mixedwood (MW), coastal (CO) and Highland (HL) vegetation types. Associated humus forms range from acidic mors (mainly Hemimor and Humimor) on softwood dominated sites, to medium fertility moders (mainly Mormoder) under mixedwood and hardwood cover. Resimors are also possible, especially in coastal and Highland softwood stands.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST3	M-H	M-H	M	M-H	M	M
ST3-G	M-H	M	M	M-H	M	H
ST3-GS	M	L-M	M-H	H	L-M	H
ST3-L	H-VH	H	H	H-VH	M-H	M
ST3-LS	M-H	M	H	VH	M	M-H
ST3-S	M	L-M	M-H	H	L-M	H



ST3 dominated by sandy loam texture. Note the thick forest floor and well developed (grey) Ae horizon. Redox features are visible in the B and BC horizons in this photo.

ST3-L derived from a loamy glacial till deposit. L-phase soils often have thinner Ae horizons than typic soils (as is the case here). Redox features are more noticeable with depth in this photo.

A site with high granite stoniness leading to a G-phase designation (in this case ST3-G). Surface stones are often completely moss covered on imperfectly to poorly drained sites, but can be easily identified by peeling back the moss layer.

Assessment Tips

Faint redox features are often hard to see in coarse or gravelly soils, be sure to look for other site clues that suggest imperfect drainage conditions. Watch for stony (S) phase conditions in ST3 due to increased frost heave potential.

ST4
Wet – Medium to Coarse Textured

Description

ST4 is mainly associated with wet, coarse-loamy soils dominated by sandy loam texture, but also includes wet sandy and wet shallow soils. In all cases, potential rooting is restricted by poor drainage due to slope position (lower, level, depression), restricted vertical drainage in areas of gentle slope, and/or a near-surface water table. Coarse fragment content can vary from low to high depending on parent material characteristics. ST4 profiles often contain a well developed Ae horizon which shows redox concentrations and/or variable shades of grey due to organic staining and/or additional iron depletion. Ahe horizons (or wet variants) can also be found.

Phases

ST4-G, ST4-GS, ST4-S

Associated Soil Series

ST4 (ST4-S): Arichat, Aspotogan, Economy, Masstown, Meteghan, Middlewood, Millar, Pitman, Roseway, Seely, Tiddville

ST4-G (ST4-GS): Aspotogan, Roseway

Distribution

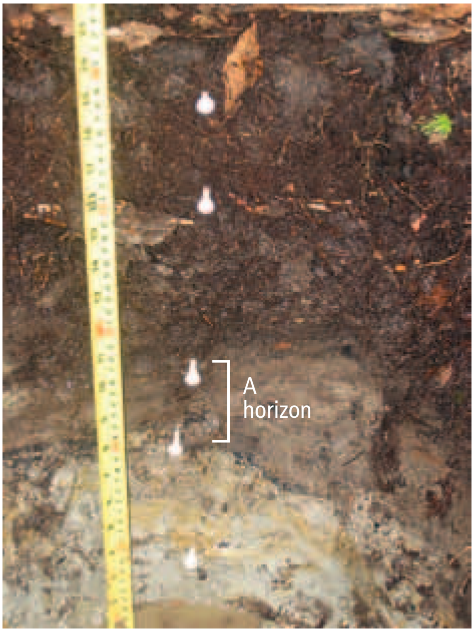
ST4 is the poorly drained equivalent of ST1, ST2, ST3, ST15 and ST16, and is found in association with these soils throughout the province. In most cases, ST4 occurs as small pockets or patches within larger areas dominated by ST2 and ST3. However, ST4 coverage can be more extensive in the Cape Breton Taiga (100) ecoregion; and the Cape Breton Highlands (210), Bras d'Or Lowlands (510), Northumberland Lowlands (530), Central Lowlands (630) and Sable (760) ecodistricts where matrix forests are often dominated by wet forest vegetation types. ST4-G is mainly found in the Western (700), Eastern (400), and Atlantic Coastal (800) ecoregions.

Ecological Features

ST4 is generally poor to medium in fertility, with differences often due to seepage inputs or ground water quality. Poor drainage means moisture levels are usually excessive during the growing season, but levels are sometimes lower in summer dry periods. ST4 is mainly associated with wet coniferous (WC) and wet deciduous (WD) vegetation types, but can also be found with some coastal (CO), Highland (HL), and cedar (CE) vegetation types. Associated humus forms are mainly Fibrimor, Mesimor and Saprimoder; with Hydromor and Hydromoder also possible.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST4	M-H	H	L-M	–	H	H
ST4-G	M-H	H	L-M	–	H	VH
ST4-GS	M	M	M	–	M-H	VH
ST4-S	M	M	M	–	M-H	VH



ST4 with organic staining in the A horizon suggesting this soil is often saturated above the mineral soil surface and into the forest floor.

ST4 with a well developed Ae (Aeg) horizon above a depleted B (Bg) horizon with many, prominent redox concentrations.

ST4-S with thick, mossy forest floor. Note the stones that came from the top of this pit, and the standing water at the surface.

Assessment Tips

ST4 can sometimes appear relatively dry in late summer, but redox features should still be obvious near the surface. Also, watch for ST4 grading into ST14 as you move further into the middle of wet forest sites.

ST5
Fresh – Fine to Medium Textured

Description

ST5 is mainly associated with fresh to fresh-moist, fine-loamy soils dominated by silt loam, loam, clay loam, and/or sandy clay loam texture. Surface horizons are often more loamy, with clay content increasing with depth. Coarse fragment content (all sizes) is usually low to medium in surface horizons. Drainage is usually moderately well, but sites can also be well drained depending on slope position, slope percent, and subsoil permeability. ST5 profiles usually contain Ae horizons, but Ahe or thin/broken Ah horizons are also common. Redox features are often found in lower BC and C horizons due to restricted drainage and/or poor aeration in the fine textured subsoil.

Phases

ST5-S

Associated Soil Series

ST5 (ST5-S): Barney, Elmsdale, Falmouth, Wolfville, Woodbourne

Distribution

ST5 is one of the least common forest soil types found in Nova Scotia. This is because higher clay content (combined with gentle topography) usually results in restricted drainage leading to moist ST6 (or ST12) conditions. Where ST5 is found it is typically in association with ST6 or ST2-L. ST5 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is virtually absent from the Western (700) ecoregion (except for northern Lunenburg County) as well as most areas associated with Maritime Boreal ecosites, but may be scattered elsewhere.

Ecological Features

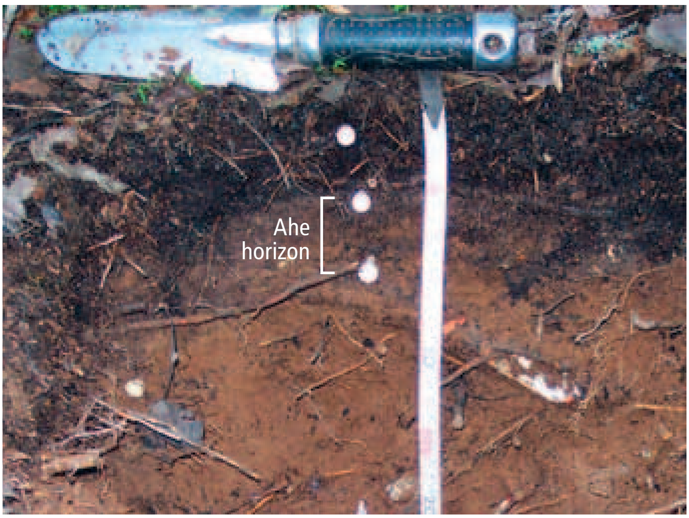
ST5 is generally medium in fertility, but is sometimes poorer or richer, as often indicated by vegetation type association. Moisture is usually not limiting during the growing season. ST5 is associated with all forest groups except wet coniferous (WC), wet deciduous (WD), floodplain (FP), open woodland (OW) and Highland (HL). Associated humus forms range from acidic mors (mainly Hemimor and Humimor) on softwood dominated sites, to medium fertility moders (mainly Mormoder) under mixedwood and hardwood cover. Leptomoders are also possible where thin Ah horizons are found.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST5	M	L-M	M	H	M	M
ST5-S	L-M	L	M-H	H-VH	L-M	M-H

ST5 with a loamy surface layer and clay content increasing with depth (reddish brown colour). Soil type in this stand could shift to ST2-L where loamy conditions extend deeper into the profile (> 45 cm).

ST5 with high clay content near the surface. Note the smooth, chiseled appearance of the enriched (reddish-brown) clay horizon.



Close up view of a thin, greyish-brown Ahe horizon. Ahe and/or thin Ah horizons are common in ST5 profiles.

Assessment Tips

ST5 is defined by the unusual combination of good drainage with higher clay content, so the presence of this ST is very much topography driven (usually found in upper slope positions). Watch for the strong likelihood of other soil types forming a complex with ST5 (e.g. ST2-L, ST11), or for ST5 occurring as inclusions within a more imperfectly drained site condition (ST6).

ST6
Moist – Fine to Medium Textured

Description

ST6 is mainly associated with moist to moist-wet, fine-loamy soils dominated by silt loam, loam, clay loam, and/or sandy clay loam texture. Near-surface horizons are sometimes coarser due to inputs from weathered rock and/or clay loss to deeper horizons. Coarse fragment content (all sizes) is usually low to medium in surface horizons, but can be high on some sites. Site drainage is generally imperfect due to slope position (middle, lower, level), gentle slope, high clay content in surface horizons, and/or poor subsoil permeability. ST6 profiles usually contain Ae horizons, but Ahe or thin/broken Ah horizons are also common. Lower slope seepage potential may be high due to restricted vertical drainage in the fine textured subsoil.

Phases

ST6-S

Associated Soil Series

ST6 (ST6-S): Avonport, Diligence, Fash, Hantsport, Middleton, Millbrook, Queens, Wolfville, Woodbourne

Distribution

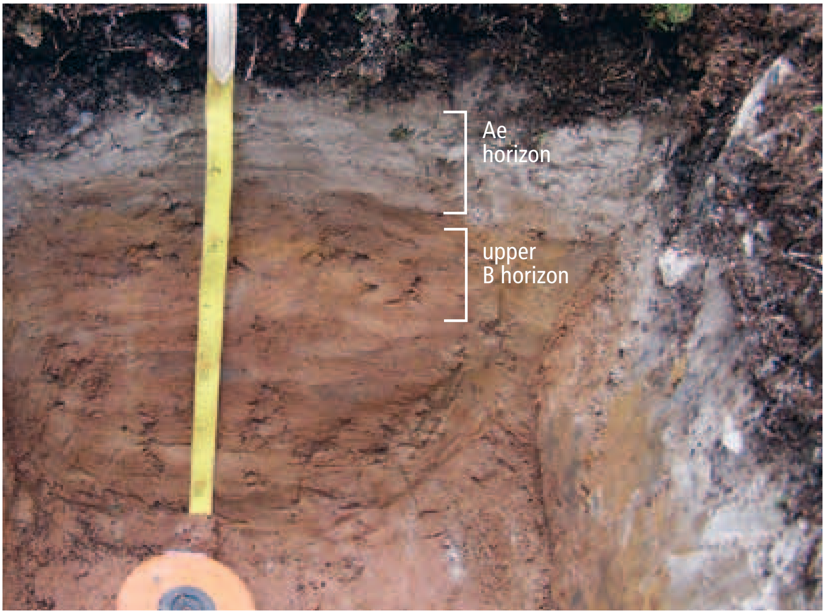
ST6 is the most common fine textured soil type found in Nova Scotia. This is because higher clay content (combined with gentle topography) usually results in restricted drainage leading to moist ST6 conditions. Also, acidic soils common to Nova Scotia generally do not allow development of Ah horizons associated with ST12. ST6 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is virtually absent from the Western (700) ecoregion (except for northern Lunenburg County) as well as most areas associated with Maritime Boreal ecosites, but is scattered elsewhere.

Ecological Features

ST6 is generally medium in fertility, but is sometimes poorer or richer, as often indicated by vegetation type association. Imperfect drainage and higher clay content means moisture levels are often excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but rarely limiting during the summer. ST6 is associated with all forest groups except floodplain (FP), open woodland (OW) and Highland (HL). Associated humus forms range from acidic mors (mainly Hemimor and Humimor) on softwood dominated sites, to medium fertility moders (mainly Mormoder) under mixedwood and hardwood cover. Leptomoders are also possible where thin Ah horizons are found.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST6	H-VH	H	H	H-VH	H	M
ST6-S	H	M-H	H	VH	M-H	M-H



ST6 with a well developed Ae horizon and redox features visible in the upper B horizon. ST6 sites can be relatively dry in mid to late summer, but are easily wetted again after major rain events.

ST6 with a very thin Ah horizon just below the forest floor. Note the high moisture level in this soil at time of assessment which is common in ST6. This soil is very susceptible to compaction and rutting damage in this condition.

Assessment Tips

Typical redox features often don't form (or are hard to see) in red parent materials common to ST6. Be sure to look for redox depletions (as well as concentrations) and other site clues that suggest imperfect drainage conditions. Also, watch for stony (S) phase conditions in ST6 due to increased frost heave potential.

ST7
Wet – Fine to Medium Textured

Description

ST7 is mainly associated with wet, fine-loamy soils dominated by silt loam, loam, silty clay loam, clay loam, and/or sandy clay loam texture. Near-surface horizons are sometimes coarser due to inputs from weathered rock and/or clay loss to deeper horizons. Coarse fragment content (all sizes) is usually low to medium in surface horizons, but can be high on some sites. Site drainage is generally poor due to slope position (lower, level, depression), high clay content in surface horizons, poor subsoil permeability, and/or a near-surface water table. ST7 profiles usually contain Ae horizons, but Ahe or thin/broken Ah horizons are also common. Redox features are visually dominant in A and B horizons.

Phases

ST7-S

Associated Soil Series

ST7 (ST7-S): Fash, Joggins, Kingsville, Lawrencetown, Mahone, Millbrook, Queens

Distribution

ST7 is the poorly drained equivalent of ST5 and ST6 and is generally found as small pockets or patches in association with these soils. However, it is also sometimes found embedded within coarser upland soils (e.g. ST2 and ST3) where wet forests have developed on old pond sites underlain by lacustrine deposits. ST7 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is rare in the Western (700) ecoregion and most areas associated with Maritime Boreal ecosites, but is scattered elsewhere.

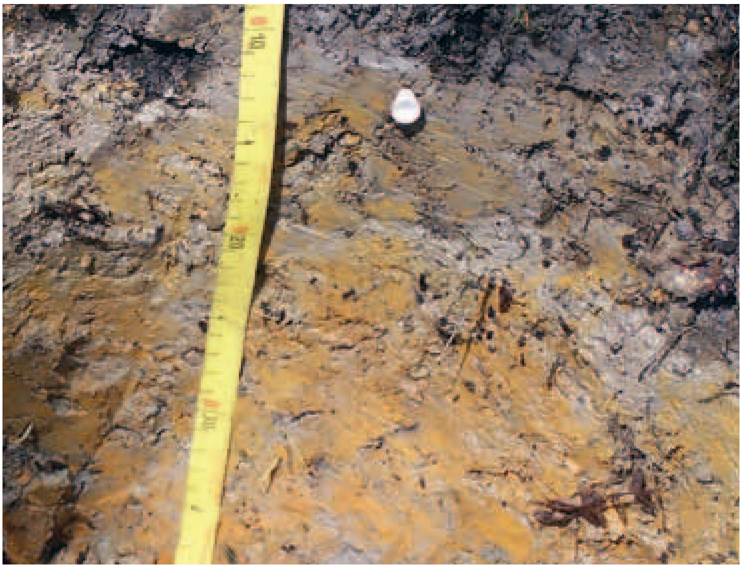
Ecological Features

ST7 is generally medium in fertility, but is sometimes poorer or richer, as often indicated by vegetation type association. Fertility differences are usually due to seepage inputs and/or ground water quality. Poor drainage and higher clay content mean moisture levels are usually excessive during most (if not all) of the growing season. ST7 is mainly associated with wet coniferous (WC) and wet deciduous (WD) vegetation types, but can also be found with some coastal (CO), old field (OF) and cedar (CE) vegetation types. Associated humus forms are mainly Fibrimor, Mesimor and Saprimoder; with Hydromor and Hydromoder also possible.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST7	H-VH	VH	M	–	VH	H
ST7-S	H	H	M-H	–	H	VH

ST7 profiles showing thick forest floors derived mainly from sphagnum mosses; variable organic staining and depletion in the Ae (Aeg) horizons; and many, distinct redox concentrations in upper B horizons. The reddish colour often associated with clay rich soils in Nova Scotia is also visible in the left photograph (along with grey redox depletions).



Close up view of prominent redox concentrations found near the surface of this sample ST7 profile. Only prolonged saturation conditions can produce this type of prominent colour contrast.

Assessment Tips

A soil auger is very handy in assessing wet forest soil types since samples can be easily obtained even when soils are saturated or ponded. Watch for the possibility of ST7 in wet, layered soils (coarse/fine/coarse).

ST8
Rich Fresh – Medium to Coarse Textured

Description

ST8 is mainly associated with fresh, coarse-loamy soils dominated by loam to sandy loam texture, but also includes rich, sandy and/or very gravelly soils (ST8-C). In all cases, soils show significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon), or through pasturing or tillage (Ap horizon). Coarse fragment content (all sizes) is usually low to medium in surface horizons, but levels can be higher in some soils (e.g. gravelly alluvium deposits, colluvium deposits high in basalt). Site drainage is usually well, but ranges between rapid and moderately well depending on slope position, slope percent, sand content, coarse fragment content, and subsoil permeability. On non-floodplain sites, ST8 profiles may contain an Ae horizon below the Ah or Ap horizon, especially when organic enrichment is relatively new or artificial.

Phases

ST8-C, ST8-CS, ST8-S

Associated Soil Series

ST8 (ST8-S): Berwick, Bridgewater, Cobequid, Cumberland, Glenmont, Hopewell, Kirkmount, Morristown, Mossman, Pelton, Rawdon, Rossway, Wolfville, Yarmouth

ST8-C (ST8-CS): Cumberland, Gulliver, Mossman

Distribution

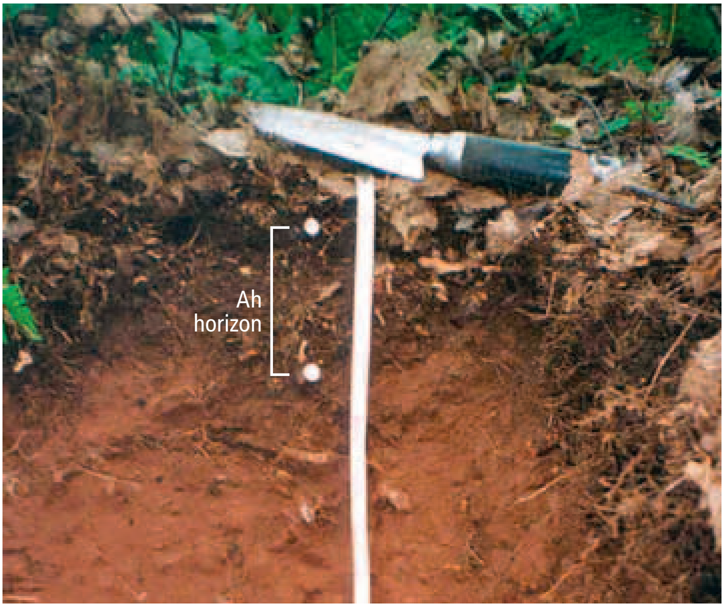
ST8 is the rich equivalent of ST2 and ST2-L and is found in association with these soils throughout the province, especially under tolerant hardwood vegetation types. It is also the most common soil type found on well drained floodplains and old field sites. ST8 is particularly common in the Nova Scotia Uplands (300) and Fundy Shore (900) ecoregions, and on drumlin ecosections throughout the province. It is likely absent from the Cape Breton Taiga (100) ecoregion.

Ecological Features

ST8 is generally medium to rich in fertility, but is sometimes very rich (as on floodplain sites). Moisture is usually not limiting during the growing season. ST8 is mainly associated with floodplain (FP), old field (OF), tolerant hardwood (TH), and karst (KA) vegetation types, but is occasionally found with select vegetation types in other forest groups. Associated humus forms include Vermimull, Rhizomull, Mullmoder and Leptomoder.

Hazard Ratings

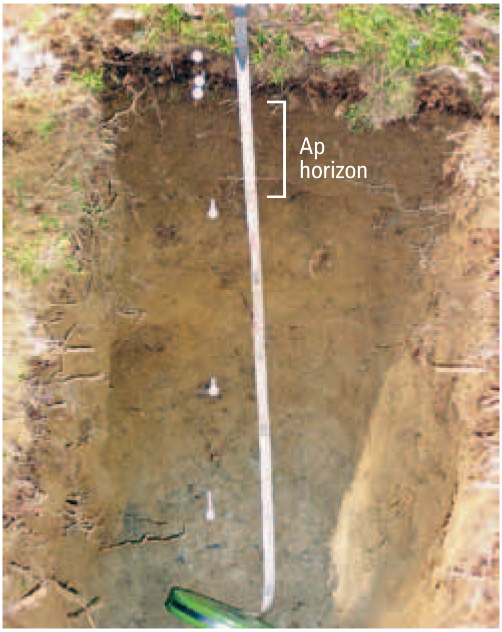
Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST8	M	L-M	L-M	M	L-M	L
ST8-C	L	L	L	L-M	L	L-M
ST8-CS	L	L	L-M	M	L	M
ST8-S	L-M	L	M	M-H	L	L-M



ST8 with a well developed, granular Ah horizon (dark brown colour) below a thin forest floor derived from hardwood and herbaceous plant litter. Note the extensive fine rooting in this rich soil.

Assessment Tips

If an Ah horizon is found unexpectedly, or is broken or thin, it is best to check other nearby locations to confirm A horizon condition. Local disturbances can sometimes create conditions for Ah horizon formation that is not representative of the overall stand being assessed.



ST8 profile under an old field site. This soil likely had a thin Ae horizon before tillage converted it to an organically enriched Ap horizon.

ST8-CS profile from a floodplain site with white spruce cover and a thin moss layer. This soil is both sandy and stony.

ST9
Rich Moist – Medium to Coarse Textured

Description

ST9 is mainly associated with moist, coarse-loamy soils dominated by loam to sandy loam texture, but also includes rich, sandy and/or very gravelly soils (ST9-C). In all cases, soils have significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon), presence of graminoid species (Ah horizon), or through pasturing or tillage (Ap horizon). Coarse fragment content (all sizes) is usually low to medium in surface horizons, but levels can be higher in some soils (e.g. gravelly alluvium deposits, colluvium deposits high in basalt, lower slope seepage sites in stony glacial till). Site drainage is usually imperfect due to slope position (middle, lower, level), restricted vertical drainage in areas with gentle slope, and/or a near-surface water table. On non-floodplain sites, ST9 profiles may contain an Ae horizon below the Ah or Ap horizon, especially when organic enrichment is relatively new or artificial.

Phases

ST9-C, ST9-CS, ST9-S

Associated Soil Series

ST9 (ST9-S): Bridgeville, Cherryfield, Cobequid, Deerfield, Glenmont, Hopewell, Kirkmount, Pelton, Riverport, Roxville, Stewiacke, Wolfville

ST9-C (ST9-CS): Bridgeville, Cherryfield

Distribution

ST9 is the imperfectly drained equivalent of ST8 and is found in association with these soils throughout the province, mainly under tolerant hardwood vegetation types. It is also the most common soil type found on imperfectly drained floodplains and old field sites. ST9 is particularly common in the Nova Scotia Uplands (300) and Fundy Shore (900) ecoregions, and on lower slope drumlin ecosections throughout the province. It is likely absent from the Cape Breton Taiga (100) ecoregion.

Ecological Features

ST9 is generally medium to rich in fertility, but is sometimes very rich as on floodplain or seepage sites. Imperfect drainage means moisture levels can be excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but is rarely (if ever) limiting during the summer. ST9 is mainly associated with floodplain (FP), old field (OF) and tolerant hardwood (TH) vegetation types, but is occasionally found with select vegetation types in other forest groups. Associated humus forms include Vermimull, Rhizomull, Mullmoder and Leptomoder.

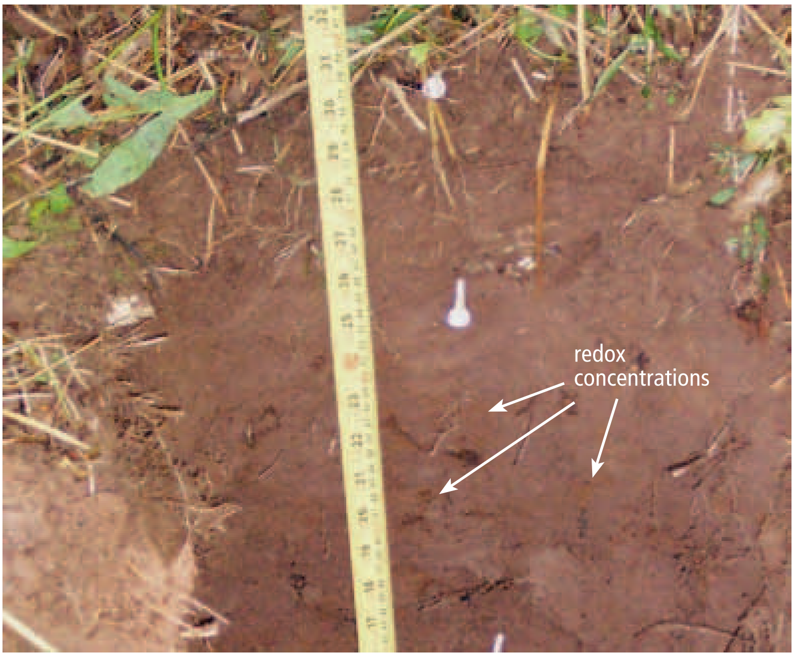
Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST9	H	H	M-H	H	M	L
ST9-C	M	M	L-M	M	L	L-M
ST9-CS	L-M	L-M	M	M-H	L	M
ST9-S	M-H	M	H	H-VH	L-M	L-M

ST9-C with high gravel content throughout the profile

Assessment Tips

Where seepage inputs reduce acidity and increase fertility, ST9 (and related phases) can sometimes be found in association with well drained ST2 instead of ST8. Watch for this, especially in mixedwood and tolerant softwood cover types.



ST9 from a floodplain site. Note the orange redox concentrations in the middle horizon of this photo.

ST10
Rich Wet – Medium to Coarse Textured

Description

ST10 is mainly associated with wet, coarse-loamy soils dominated by loam to sandy loam texture, but also includes wet sandy and wet shallow soils. In all cases, soils have significant organic matter enrichment in the A horizon through the presence of graminoid species (Ah horizon), natural mixing by soil fauna (Ah horizon), or pasturing (Ap horizon). Potential rooting is restricted by poor drainage due to slope position (lower, level, depression), restricted vertical drainage in areas of gentle slope, and/or a near-surface water table. Coarse fragment content (all sizes) is usually low to medium in surface horizons, but levels can be higher in some soils (e.g. gravelly alluvium deposits, lower slope seepage sites in stony glacial till). On non-floodplain sites, ST10 profiles may contain an Aeg horizon below the Ah or Ap horizon, but this is not common.

Phases

ST10-S

Associated Soil Series

ST10 (ST10-S): Bridgeville, Chaswood, Chegoggin, Cherryfield, Stewiacke, Tidville

Distribution

ST10 is a relatively uncommon soil type which usually occurs as small pockets or patches within larger areas dominated by ST8 and ST9 (and possibly ST2 and ST3). ST10 is not associated with any particular ecoregion or ecodistrict, but is found on poorly drained floodplains, riparian zones and/or seepage enriched depressions.

Ecological Features

ST10 is generally medium to rich in fertility, but is sometimes very rich (as on floodplain, seepage, or rich ground water sites). Poor drainage means moisture levels are usually excessive during the growing season, but levels are sometimes lower in summer dry periods. ST10 is mainly associated with wet deciduous (WD) and wet coniferous (WC) vegetation types, but is occasionally found with select vegetation types in other forest groups. Associated humus forms are Hydromull, Hydromodor and Saprimoder.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST10	H	VH	L	–	M-H	L-M
ST10-S	M-H	H	L-M	–	M	M

ST10 enriched by seepage inputs.

Assessment Tips

Dark soil colours often associated with ST10 can make it difficult to discern redox features. Be sure to look for other site clues that suggest poor drainage conditions and make the call based on all available information. Where seepage inputs reduce acidity and increase fertility, ST10 can sometimes be found in association with well drained ST2 instead of ST8.

ST10 with organic enrichment associated with the decay of graminoid roots, in this case mainly sedges.

ST11
Rich Fresh – Fine to Medium Textured

Description

ST11 is mainly associated with fresh to fresh-moist, fine-loamy soils dominated by silt loam, loam, clay loam, and/or sandy clay loam texture. Surface horizons are often more loamy with clay content increasing with depth. Soils also show significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon) or through pasturing or tillage (Ap horizon). Coarse fragment content (all sizes) is usually low to medium in surface horizons, and may be absent from alluvium soils. Drainage is usually moderately well, but sites can also be well drained depending on slope position, slope percent, and subsoil permeability. On non-floodplain sites, ST11 profiles may contain an Ae horizon below the Ah or Ap horizon, especially when organic enrichment is relatively new or artificial. Redox features are often found in lower BC and C horizons due to restricted drainage and/or poor aeration in the fine textured subsoil.

Phases

ST11-S

Associated Soil Series

ST11 (ST11-S): Barney, Elmsdale, Falmouth, Wolfville, Stewiacke, Woodbourne

Distribution

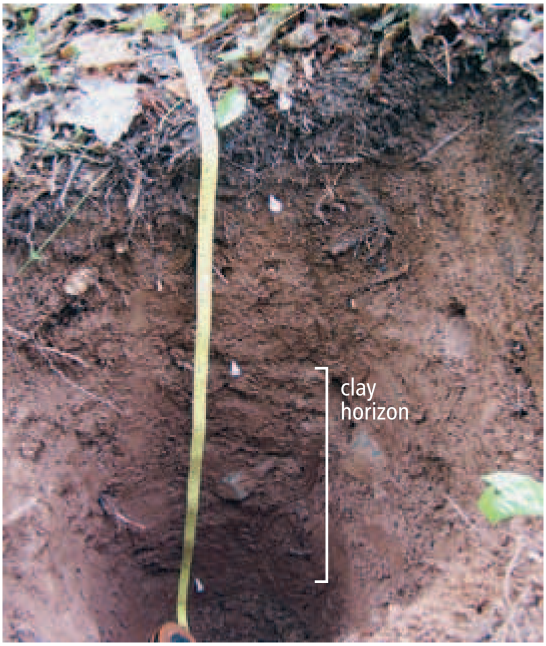
Along with ST5, ST11 is one of the least common forest soil types found in Nova Scotia. This is because higher clay content (combined with gentle topography) usually results in restricted drainage leading to moist ST6 (or ST12) conditions. Where ST11 is found it is typically in association with ST12, ST5 or ST8. ST11 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is virtually absent from the Western (700) ecoregion (except for northern Lunenburg County) as well as most areas associated with Maritime Boreal ecosites, but may be scattered elsewhere.

Ecological Features

ST11 is generally medium to rich in fertility, but is sometimes very rich as on floodplain sites. Moisture is usually not limiting during the growing season. ST11 is mainly associated with old field (OF), tolerant hardwood (TH) and floodplain (FP) vegetation types, but can be found with select vegetation types in other forest groups. Associated humus forms include Vermimull, Rhizomull, Mullmoder and Leptomoder.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST11	M	M	L-M	M-H	L-M	L
ST11-S	L-M	L-M	M	H	L	L-M



ST11 with high clay content near the surface. Note the smooth, chiseled appearance of the enriched (reddish-brown) clay horizon.

Assessment Tips

If an Ah horizon is found unexpectedly, or is broken or thin, it is best to check other nearby locations to confirm A horizon condition. Watch for the strong likelihood of other soil types forming a complex with ST11 (e.g. ST5, ST8), or for ST11 occurring as inclusions within a more imperfectly drained site condition (ST12).

ST11 from an old field site.

ST12
Rich Moist – Fine to Medium Textured

Description

ST12 is mainly associated with moist to moist-wet, fine-loamy soils dominated by silt loam, loam, clay loam, and/or sandy clay loam texture. Surface horizons are often more loamy with clay content increasing with depth. Soils also show significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon), presence of graminoid species (Ah horizon), or through pasturing or tillage (Ap horizon). Coarse fragment content (all sizes) is usually low to medium in surface horizons, and may be absent from alluvium soils. Site drainage is usually imperfect due to slope position (middle, lower, level), gentle slope, high clay content in surface horizons, poor subsoil permeability, and/or a near-surface water table. On non-floodplain sites, ST12 profiles may contain an Ae horizon below the Ah or Ap horizon, especially when organic enrichment is relatively new or artificial.

Phases

ST12-S

Associated Soil Series

ST12 (ST12-S): Avonport, Diligence, Fash, Hantsport, Middleton, Millbrook, Queens, Stewiacke, Wolfville, Woodbourne

Distribution

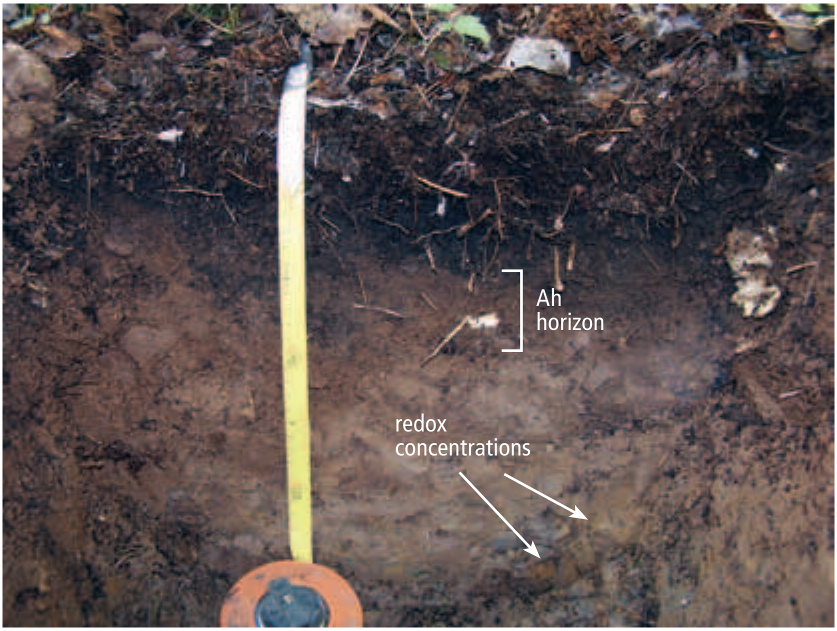
ST12 is the rich equivalent of ST6 and is often found in association with this more common soil type within its geographic range. Other associates include ST5, ST11 and ST9. ST12 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is virtually absent from the Western (700) ecoregion (except for northern Lunenburg County) as well as most areas associated with Maritime Boreal ecosites, but is scattered elsewhere.

Ecological Features

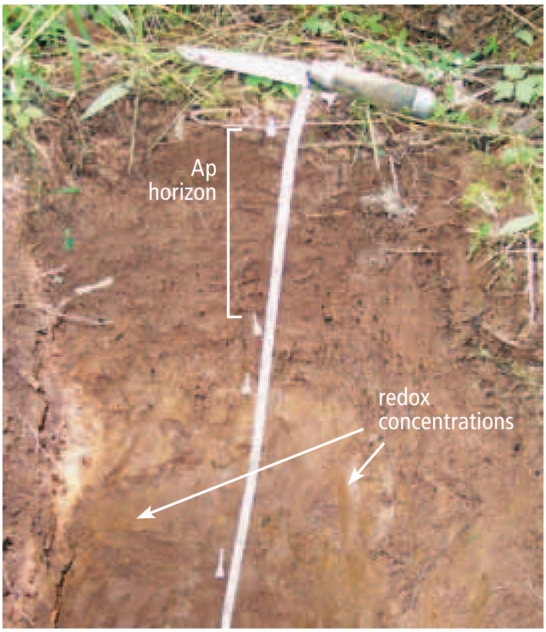
ST12 is generally medium to rich in fertility, but is sometimes very rich (as on floodplain sites). Imperfect drainage and higher clay content mean moisture levels are often excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but rarely (if ever) limiting during the summer. ST12 is mainly associated with old field (OF), tolerant hardwood (TH) and floodplain (FP) vegetation types, but can be found with select vegetation types in other forest groups. Associated humus forms include Vermimull, Rhizomull, Mullmoder and Leptomoder.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST12	H-VH	H-VH	M-H	H	M-H	L
ST12-S	H	H	H	H-VH	M	L-M



ST12 with brown, wavy Ah horizon above a lighter coloured B horizon. Redox features are clearly visible in the bottom right of this photo.



ST12 from an old field site. Note the thick Ap horizon above the clay enriched B horizon with many, distinct redox concentrations.

Assessment Tips

Typical redox features often don't form (or are hard to see) in red parent materials common to ST12. Be sure to look for redox depletions (as well as concentrations) and other site clues that suggest imperfect drainage conditions. Watch for the strong likelihood of other soil types forming a complex with ST12 (e.g. ST6, ST9, ST13).

ST13
Rich Wet – Fine to Medium Textured

Description

ST13 is mainly associated with wet, fine-loamy soils dominated by silt loam, loam, silty clay loam, clay loam, and/or sandy clay loam texture. Surface horizons are often more loamy with clay content increasing with depth. Soils also show significant organic matter enrichment in the A horizon through the presence of graminoid species (Ah horizon), natural mixing by soil fauna (Ah horizon), or pasturing (Ap horizon). Coarse fragment content (all sizes) is usually low to medium in surface horizons, and may be absent from alluvium soils. Site drainage is generally poor due to slope position (lower, level, depression), high clay content in surface horizons, poor subsoil permeability, and/or a near-surface water table. On non-floodplain sites, ST13 profiles may contain an Aeg horizon below the Ah or Ap horizon, but this is not common. Redox features are visually dominant in A and B horizons.

Phases

ST13-S

Associated Soil Series

ST13 (ST13-S): Acadia, Fash, Joggins, Kingsville, Lawrencetown, Mahone, Stewiacke

Distribution

ST13 is a relatively uncommon soil type which usually occurs as small pockets or patches within larger areas dominated by ST6 and ST12. However, it is also sometimes found embedded within coarser upland soils (e.g. ST2, ST3, ST8, ST9) where wet forests have developed on old pond sites underlain by lacustrine deposits. ST13 is mainly found in the Valley and Central Lowlands (600) and Northumberland Bras d'Or (500) ecoregions, and in the Cape Breton Hills (310) ecodistrict. It is rare in the Western (700) ecoregion and most areas associated with Maritime Boreal ecosites, but is scattered elsewhere.

Ecological Features

ST13 is generally medium to rich in fertility, but is sometimes very rich (as on floodplain, seepage, or rich ground water sites). Poor drainage and higher clay content means moisture levels are usually excessive during most (if not all) of the growing season. ST13 is mainly associated with wet deciduous (WD) and wet coniferous (WC) vegetation types, but is occasionally found with select vegetation types in other forest groups. Associated humus forms are mainly Hydromull, Hydromodor and Saprimoder

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST13	H-VH	VH	L-M	–	H	L-M
ST13-S	H	H	M	–	M-H	M

ST13 with a relatively thick, well decomposed forest floor above a brown Ah horizon.
Note the redox features in the lower B horizon and high moisture level at time of assessment.

Assessment Tips

Dark soil colours often associated with ST13 can make it difficult to discern redox features. Be sure to look for other site clues that suggest poor drainage conditions and make the call based on all available information. Watch for the possibility of ST13 in wet, layered soils (coarse/fine/coarse).

ST13 with many, prominent redox concentrations near the surface. The Ah horizon can appear lighter in colour when it is drier.

ST14
Organic

Description

ST14 is mainly associated with thick organic layers derived from wetland (hydrophytic) vegetation, but also includes thick, upland organic deposits (ST14-U). Transition profiles with wetland O horizons (Of, Om, Oh) capped by upland LFH horizons are also possible. Mineral soil (if reached) can be of variable texture and coarse fragment content can be low to high. Drainage is poor to very poor for ST14 sites due to level or depression slope position, seepage inputs, poor subsoil permeability, and/or a near-surface water table. ST14-U sites usually have moderately well to imperfect drainage and are often associated with mid to lower slope positions.

Phases

ST14-S, ST14-U, ST14-US

Associated Soil Series

ST14 (ST14-S): Castley, Organic, Peat, Rockland, Rossignol, Swamp

ST14-U (ST14-US): Bayswater, Danesville, Gibraltar, Halifax, Lydgate, Port Hebert, Rockland

Distribution

Wet ST14 occurs throughout Nova Scotia usually as small pockets or patches within larger upland areas. However, coverage can be more extensive in the Bras d'Or Lowlands (510), Northumberland Lowlands (530), Central Lowlands (630) and Sable (760) ecodistricts where matrix forests are often dominated by wet forest vegetation types. In all cases, ST14 is often found as a complex with wet mineral soil types (ST4, ST7, ST10, ST13). ST4-S is mainly found in the Western (700), Eastern (400) and Atlantic Coastal (800) ecoregions where granite and quartzite surface stones have become buried by organic deposits.

ST14-U is mainly found in the Atlantic Coastal (800) and Cape Breton Taiga (100) ecoregions, and the Cape Breton Highlands (210) ecodistrict (i.e. areas associated with Maritime Boreal ecosites). It is rare elsewhere in Nova Scotia, but sometimes occurs in the Western (700) ecoregion – usually on cool, moist, lower slope positions with softwood cover.

Ecological Features

Wet ST14 fertility can range from poor to rich, with differences mainly due to seepage inputs or ground water quality. However, fertility is generally in keeping with nearby upland conditions. Poor to very poor drainage means moisture levels are usually excessive during the growing season. ST14 is only associated with wet coniferous (WC), wet deciduous (WD) and wet cedar (CE) vegetation types. Associated humus forms are Fibrimor, Mesimor and Saprimoder.

ST14-U is generally very poor to poor in fertility. Moderate to imperfect drainage, combined with the enhanced water holding capacity of organic matter, means moisture levels are often excessive early and late in the growing season (i.e. after spring snowmelt and fall rains). ST14-U is mainly associated with spruce hemlock (SH), spruce pine (SP), open woodland (OW), coastal (CO) and Highland (HL) vegetation types. Associated humus forms are Hemimor and Resimor, with Lignomor also possible.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST14	L	VH	–	–	–	–
ST14-S	L	VH	–	–	–	–
ST14-U	L	H-VH	–	–	–	–
ST14-US	L	H-VH	–	–	–	–

ST14-US with well developed Resimor intermixed with quartzite. Soils in this stand were a complex of ST14-US and ST2-S.

Assessment Tips

As softwood swamps develop, it is not uncommon for a cap of conifer litter (LFH) to develop on top of O horizons which were primarily derived from sphagnum moss. These soils are still classed as wet ST14 until the LFH becomes 40 cm thick. An easy way to check for organic thickness (especially on wet sites) is to push in your soil auger until it meets resistance. An auger will easily move through organic material without turning, but usually not through mineral soil.

ST14-U with well developed Humimor.

Classic ST14 derived from sphagnum moss.

ST15
Dry Shallow – Medium to Coarse Textured

Description

ST15 is mainly associated with dry to fresh, coarse-loamy, shallow soils over near-surface cemented horizons or bedrock (including exposed bedrock). Coarse fragment content (all sizes) can vary from low to high depending on parent material characteristics. Site drainage is usually rapid or well, but can be moderately well depending on slope position. ST15 profiles usually contain an Ae horizon, but Ahe horizons can also be found, particularly in loamy soils (ST15-L). In some cases, ST15 also appears as only forest floor material over a thin rind of weathered rock.

Phases

ST15-G, ST15-GS, ST15-L, ST15-LS, ST15-S

Associated Soil Series

(b = bedrock, c = cementation)

ST15 (ST15-S): Canning (c), Cornwallis (c), Digby (c), Gibraltar (bc), Hebert (c), Medway (c), Nictaux (c), Port Hebert (c), Rockland (b), Somerset (c), Springhill (c)

ST15-G (ST15-GS): Gibraltar (bc), Port Hebert (c), Rockland (b)

ST15-L (ST15-LS): Hopewell (b), Kirkhill (b)

Distribution

Bedrock controlled ST15 (and phases) can be found scattered throughout Nova Scotia wherever near-surface bedrock is found. ST15 caused by natural cementation (orstein horizons) is mainly associated with coarse, granitic tills and glaciofluvial deposits found in the Western (700) ecoregion and the South Shore (830) and Annapolis Valley (610) ecodistricts, but can be found elsewhere wherever similar parent materials exist.

Ecological Features

ST15 is generally very poor to poor in fertility, but is sometimes poor to medium, as often indicated by vegetation type association. Fertility differences are mainly related to parent material and/or bedrock mineralogy. Shallow soils and well to rapid drainage mean ST15 sites are often droughty during the growing season. ST15 is mainly associated with spruce pine (SP), open woodland (OW) and coastal (CO) vegetation types, but may support selected vegetation types in other forest groups. Associated humus forms are mainly acidic mors (Hemimor, Humimor, Resimor), with Mormoder also possible on richer sites.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST15	M	L	M-H	H	L	H-VH
ST15-G	L-M	L	M-H	H	L	VH
ST15-GS	L	L	H	VH	L	VH
ST15-L	M-H	L-M	H	VH	L-M	H
ST15-LS	M	L	VH	VH	L	VH
ST15-S	L-M	L	H	VH	L	VH

ST15 over bedrock. Previous disturbance in this soil has caused a mixing of A and B horizons leading to a mottled appearance, but these are not redox features.

Assessment Tips

It is sometimes difficult to tell whether you are hitting bedrock or just stones/boulders when assessing soil depth. If bedrock is near the surface, you should also see some evidence of outcrops (exposures) in or near the stand being assessed. Road cuts can also show evidence of near-surface bedrock.

A site with high granite stoniness leading to a G-phase designation (in this case ST15-G).

ST16
Moist Shallow – Medium to Coarse Textured

Description

ST16 is mainly associated with moist, coarse-loamy, shallow soils over near-surface cemented horizons or bedrock (including exposed bedrock). Coarse fragment content (all sizes) can vary from low to high depending on parent material characteristics. Site drainage is usually imperfect due to slope position (middle, lower, level) and restricted vertical flow. ST16 profiles usually contain an Ae horizon, but Ahe horizons can also be found, particularly in loamy soils (ST16-L). Seepage inputs are common in lower slope positions.

Phases

ST16-G, ST16-GS, ST16-L, ST16-LS, ST16-S

Associated Soil Series

(b = bedrock, c = cementation)

ST16 (ST16-S):	Bayswater (bc), Comeau (c), Debert (c), Kingsport (c), Lydgate (c), Rockland (b), Roseway (c)
ST16-G (ST16-GS):	Bayswater (bc), Lydgate (c), Rockland (b), Roseway (c)
ST16-L (ST16-LS):	Hopewell (b), Kirkhill (b)

Distribution

ST16 is the imperfectly drained equivalent of ST15 and is often found in association with this soil type. Bedrock controlled ST16 (and phases) can be found scattered throughout Nova Scotia wherever near-surface bedrock is found. ST16 caused by natural cementation (orstein horizons) is mainly associated with coarse, granitic tills and glaciofluvial deposits found in the Western (700) ecoregion and the South Shore (830) and Annapolis Valley (610) ecodistricts, but can be found elsewhere wherever similar parent materials exist. ST16 associated with fragipan horizons are less common, but have been noted in the Northumberland Bras d'Or (500) ecoregion (mainly Cumberland County) and in the Minas Lowlands (620) ecodistrict.

Ecological Features

ST16 is generally very poor to poor in fertility, but is sometimes poor to medium, as often indicated by vegetation type association. Fertility differences are mainly related to parent material and/or bedrock mineralogy along with seepage inputs. Shallow soils combined with imperfect drainage mean ST16 sites can range from fresh to moist depending on local conditions. Moisture levels can be excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but also limiting during summer dry periods. ST16 is mainly associated with spruce pine (SP), open woodland (OW), and coastal (CO) vegetation types, but may support selected vegetation types in other forest groups. Associated humus forms are mainly acidic mors (Hemimor, Humimor, Resimor), with Mormoder also possible on richer sites.

Assessment Tips

Redox concentrations are sometimes found directly above bedrock where a thin film of water is allowed to sit for prolonged periods in local depressions. To indicate significant drainage problems in shallow soils, redox features must be found more than 5 cm above the bedrock (or cemented layer), otherwise the soil is classed as ST15.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST16	H	M-H	H	VH	M-H	H
ST16-G	M-H	M	H	VH	M-H	H-VH
ST16-GS	M	L-M	VH	VH	M	VH
ST16-L	H-VH	H	VH	VH	H	M-H
ST16-LS	H	M	VH	VH	M-H	H
ST16-S	M-H	L-M	VH	VH	M	H-VH

Imperfectly drained ST16 over bedrock. Redox features are mainly visible in the bottom half of this soil (bedrock starts where the tape measure bends).

Close up view of a cemented (orstein) horizon which restricts vertical flow in this soil. Note the very dark, reddish colour (from the organic and iron oxide cement), high coarse fragment content, and high moisture (shiny areas).


ST16 over bedrock with seepage flow at time of assessment.

ST17
Rich Dry Shallow – Medium to Coarse Textured

Description

ST17 is mainly associated with dry to fresh, coarse-loamy, shallow soils over near-surface basalt or gabbro bedrock (including exposed bedrock). Soils show significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon) or sometimes pasturing (Ap horizon). Coarse fragment content (all sizes) can vary from low to high. Site drainage is usually well, but can be rapid or moderately well depending on slope position. ST17 profiles are unlikely to have Ae horizons below the Ah/Ap horizon.

Phases

ST17-S

Associated Soil Series

ST17 (ST17-S): Glenmont, Rossway

Distribution

ST17 is mainly associated with near-surface basalt bedrock in the North Mountain (920) ecodistrict, but can also be found in other parts of the province (e.g. on gabbro bedrock sites in the Cape Breton Hills (310) ecodistrict). Where ST17 is a result of pasturing (Ap horizon), soils would mainly be inclusions within a larger area dominated by ST8.

Ecological Features

ST17 is generally medium in fertility, with limitations mainly the result of shallow depth. Shallow soils and good drainage mean moisture levels can be limiting during summer dry periods. However, soil organic matter helps retain moisture making ST17 less drought prone than ST15. ST17 is mainly associated with tolerant hardwood (TH) and spruce hemlock (SH) vegetation types, but may support selected vegetation types in other forest groups. Associated humus forms are Vermimull, Rhizomull and Mullmoder, with Leptomoder also possible on some sites.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST17	M	L-M	M-H	H	L-M	L-M
ST17-S	L-M	L	H	VH	L	M

ST17 over basalt bedrock. Note the well developed Ah horizon and extensive fine rooting in this rich (but shallow) soil. Where slope position does not allow for good drainage, ST17 becomes imperfectly drained ST18.

Assessment Tips

It is sometimes difficult to tell whether you are hitting bedrock or just stones/boulders when assessing soil depth. If bedrock is near the surface, you should also see some evidence of outcrops (exposures) in or near the stand being assessed. Road cuts can also show evidence of near-surface bedrock.

ST18
Rich Moist Shallow – Medium to Coarse Textured

Description

ST18 is mainly associated with moist, coarse-loamy, shallow soils over near-surface basalt or gabbro bedrock (including exposed bedrock). Soils show significant organic matter enrichment in the A horizon through natural mixing by soil fauna (Ah horizon) or sometimes pasturing (Ap horizon). Coarse fragment content (all sizes) can vary from low to high. Site drainage is usually imperfect due to slope position (middle, lower, level) and restricted vertical flow. Seepage inputs are common in lower slope positions.

Phases

ST18-S

Associated Soil Series

ST18 (ST18-S): Rossway, Roxville

Distribution

ST18 is the imperfectly drained equivalent of ST17 and is often found in association with this soil type. It is mainly found in the North Mountain (920) ecodistrict, but is also scattered in other parts of the province (e.g. on gabbro bedrock sites in the Cape Breton Hills (310) ecodistrict). In some cases, ST18 can be found in association with ST15 where seepage inputs have increased fertility in lower slope positions. Where ST18 is a result of pasturing (Ap horizon), soils would mainly be inclusions within a larger area dominated by ST8 and/or ST9.

Ecological Features

ST18 is generally medium in fertility, but seepage inputs can increase fertility on some sites. Shallow soils combined with imperfect drainage mean ST18 sites can range from fresh to moist depending on local conditions. Moisture levels can be excessive early and late in the growing season (i.e. after spring snowmelt and fall rains), but also limiting during summer dry periods. ST18 is mainly associated with tolerant hardwood (TH) and spruce hemlock (SH) vegetation types, but may support selected vegetation types in other forest groups. Associated humus forms are Vermimull, Rhizomull and Mullmoder, with Leptomoder also possible on some sites.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST18	H	H	H	VH	M-H	L-M
ST18-S	M-H	M	VH	VH	M	M

Basalt bedrock exposure associated with ST17/ST18. Fractured surface rock can lead to stony (S-phase) conditions on some sites.

Assessment Tips

Redox concentrations are sometimes found directly above bedrock where a thin film of water is allowed to sit for prolonged periods in local depressions. To indicate significant drainage problems in shallow soils, redox features must be found more than 5 cm above the bedrock, otherwise the soil is classed as ST17.

ST19
Talus

Description

ST19 is derived from, and characterized by, talus rock deposits which are still relatively active or young (older talus deposits would generally be classed as a stony phase of a more mature soil type). The surface is mainly covered by bare, angular stones with pockets of organic matter found on or between rock fragments. Mineral soil may or may not be present below the surface rock. Surface conditions are generally dry, but overall drainage conditions can be variable due to seepage inputs. ST19-M is similar to ST19, but has talus deposits dominated by mafic rock (basalt and/or gabbro) which generally allows for increased fertility. ST19-M deposits can also be thinner and more likely associated with mineral soil than ST19 deposits due, in part, to the faster weathering rates of mafic rock.

Phases

ST19-M

Associated Soil Series

ST19 (ST19-M): Cobequid, Rossway, Thom

Distribution

ST19 and ST19-M are very site specific, requiring both bedrock exposures and adequate slopes to allow talus deposition. ST19 is mainly found in the Cape Breton Hills (310) and Cape Breton Highlands (210) ecodistricts, while ST19-M is mainly found in the North Mountain (920) ecodistrict. Both types may occur in the Cobequid Hills (340) and Pictou Antigonish Highlands (330) ecodistricts.

Ecological Features

ST19 and ST19-M are considered poor and medium in fertility (respectively), but seepage inputs may increase potential fertility on some sites. Moisture levels can vary with depth due to seepage inputs, but surface conditions are often droughty due to excessive rock cover. ST19 and ST19-M are currently only associated with one vegetation type each within the open woodland (OW) forest group.

Hazard Ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST19	L	L	L	L	L	VH
ST19-M	L	L	L	L-M	L	VH

Assessment Tips

ST19-M may transition into ST8-S on some sites. Watch for this possibility, especially when vegetation type starts to move from an open woodland (OW) condition to a forest condition (e.g. TH, MW, SH).

ST19 from Cape Breton associated with woodland cover. Note the patches of bare surface rock commonly associated with ST19 sites.

ST19-M from the North Mountain area. Note the clean, angular lines characteristic of fractured basalt.

Management Interpretations

As noted on soil type fact sheets, management interpretations related to soil compaction hazard, rutting hazard, erosion hazard, frost heave hazard, and sensitivity to forest floor loss have been made for all FEC soil types (Table 2). This section provides details on these hazard ratings, along with a combined soil type / site exposure windthrow hazard chart for use in forest management planning (Table 3).

All hazards listed are influenced by soil texture, soil moisture content, soil organic matter content, soil depth and stoniness – the same features used to differentiate soil types and phases in the FEC system. Based on the condition of each soil type feature (and its relative importance), overall risk ratings for each hazard type were assigned, ranging from low to very high.

In general:

- **Low (L)** hazard means there is a minor risk of damage or negative impacts under normal operating conditions.
- **Moderate (M)** hazard means caution should be exercised as there is potential for some damage or negative impacts under normal operating conditions (if mitigative measures are not taken).
- **High (H)** hazard means there is a potential for significant damage or negative impacts under normal operating conditions (if mitigative measures are not taken).
- **Very High (VH)** hazard means there is potential for severe damage or negative impacts under normal operating conditions (if mitigative measures are not taken).

Compaction Hazard

Soil compaction can damage a site by increasing soil bulk density, reducing aeration porosity, altering water flows, and changing soil temperature regimes (Racey et al. 1989; Krause 1998). Compaction becomes damaging when root function and growth is restricted leading to reduced site productivity. Where damaging compaction has occurred, impacts are usually long-lasting (years or decades) even in soils subject to freeze/thaw action (e.g. Corns 1988).

The main soil factors influencing compaction hazard are moisture content, texture, coarse fragment content, and (to a lesser extent) organic matter content.

In general, **compaction hazard increases** as:

- **soil moisture content increases**: soil aggregates are less stable as soil moisture increases.
- **soil texture becomes finer**: because of particle size distributions, fine to medium textured soils are more easily compacted than coarse textured (sandy) soils.
- **coarse fragment content decreases**: high coarse fragment content can reduce the impact of compaction (Childs and Flint 1990).
- **soil organic matter content decreases**: the compressibility of soil at a given moisture content increases as organic matter content decreases (Krause 1998).

Compaction hazard is highest when soils are moist or near field capacity (McNabb 1999). When soils are saturated, buoyant forces can oppose additional compression, limiting the extent of compaction. Despite this resistance, wet soils are still susceptible to damage through significant loss of structure and porosity (puddling) which affects potential productivity in much the same way as compaction (Carr et al. 1991). For this reason, compaction hazard ratings in this guide have not been reduced for wet soils.

Rutting Hazard

Soil rutting can damage a site through alteration of surface and subsurface water flows, and by exposure of less fertile subsoils. Loss of soil structure and porosity in rutted (puddled) soils is also of concern. The main soil factors influencing rutting hazard are moisture content, texture, and organic matter content.

In general, **rutting hazard increases** as:

- **soil moisture content increases** – soil bearing capacity decreases with increasing moisture content.
- **soil texture becomes finer** – when wet, silty and clayey soils have lower shear strength than sandy soils.
- **soil organic matter content increases** – organic matter contributes to reduced bearing capacity in soils.

In most cases, soils which are susceptible to compaction are also susceptible to rutting.

Erosion Hazard

Erosion can damage a site through loss of fertile A and B horizons (i.e. topsoil). Stream water quality and aquatic habitat can also be severely impacted by erosion deposits, both on and off-site.

The main soil factors influencing erosion hazard are moisture content, texture, organic matter content, and depth – all factors related to a soil's ability to absorb and store water. The main site factors affecting erosion hazard are presence of surface organic horizons and/or vegetative cover, degree of slope and slope length.

In general, **erosion hazard increases** as:

- **soil moisture content increases** – soils with high inherent moisture are less able to store additional water.
- **soil texture becomes finer** – soils high in silt and fine sand are more prone to erosion because these particle sizes are mobile and can easily clog pore space, thereby reducing infiltration capacity. Also, soil permeability generally decreases as soil texture becomes finer.
- **soil organic matter content decreases** – organic matter contributes to soil aggregate strength and related soil porosity, weak aggregates are more likely to breakdown and clog pore space, reducing infiltration capacity. Also, organic matter has a high moisture absorption capacity – the lower the organic matter content, the lower the water storage capacity of the soil.
- **stoniness increases** – stony phase soils limit water storage capacity and also channel water flows which can increase erosive energy.
- **soil depth decreases** – shallow soils are less able to store water.

Despite high moisture levels in wet soils, these soil types are generally given low erosion hazard ratings in this guide because they tend to be found on level areas or in depressions which lack slope conditions to promote erosion.

With respect to site factors, the presence of forest floor horizons and/or vegetative ground cover can significantly reduce erosion potential by absorbing the impact of rain and by increasing water storage capacity. In this guide, hazard ratings assume exposed mineral soil. Where well developed forest floor horizons and/or ground cover remain intact, ratings can be reduced.

All other things being equal, the steeper and/or longer the slope, the greater the potential for erosion on a given site (Wall et al. 2002). Two erosion hazard ratings are given in this guide: one for slopes 10% or less and one for slopes 11–30%. Slopes over 30% have high erosion hazard regardless of soil texture (Gillies 2007) and should be considered accordingly. Erosion hazard ratings assume slope length to be less than 100 m. Where longer slopes are found, ratings should be increased.

Frost Heave Hazard

Frost heave can result in poor growth or mortality of planting stock and natural regeneration. The main soil factors influencing frost heave hazard are moisture content, texture, and pore structure which influences soil water tension (Beckingham et al. 1996). Soils with low macropore percentages readily move water through capillary action, raising the likelihood of frost heave.

In general, **frost heave hazard increases** as:

- **soil moisture content increases** – moisture is necessary for frost action.
- **soil texture becomes finer** – fine textured soils tend to have less macropore space than coarse textured soils.
- **soil organic matter content decreases** – organic matter contributes to soil structure and macroporosity.

The presence of forest floor horizons can significantly reduce frost heave hazard by reducing temperature fluctuations which promote frost formation. In this guide, hazard ratings assume exposed mineral soil. Where well developed forest floor horizons and/or ground cover remain intact, ratings can be reduced.

Forest Floor Loss

This hazard refers to the potential for serious decreases in site fertility (nutrient and moisture availability) when surface organic horizons are removed or redistributed on a site (i.e. through scalping or gouging which exposes bare mineral soil). Forest floor horizons are an important source of nutrients, especially for tree seedlings. Forest floor horizons also regulate moisture supply and temperature extremes near the soil surface.

The main factors influencing sensitivity to forest floor loss are soil moisture content, soil texture, soil organic matter content, stoniness, and overall soil depth.

In general, **forest floor loss sensitivity increases** as:

- **soil moisture content becomes too dry or too wet** – in drier soils, loss of forest floor horizons can lead to desiccation near the surface. In wet soils, loss of forest floor horizons means loss of nutrient supply and rooting medium since mineral horizons are often too wet for root access.
- **soil texture becomes coarser** – coarse textured soils lack the moisture and nutrient holding capacities of medium and fine textured soils.
- **soil organic matter decreases** – lack of soil organic matter means decreased moisture and nutrient holding capacities, as well as reduced nutrient sources.
- **stoniness increases** – stony phase soils limit rooting access to mineral soil, so loss of forest floor horizons means loss of nutrient supply and rooting medium.
- **soil depth decreases** – shallow soils do not have the same nutrient and moisture reserves as deeper soils, all other things being equal.

Table 2. Summary of soil type hazard ratings

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST1	L	L	L	L-M	L	VH
ST1-G	L	L	L	L-M	L	VH
ST1-GS	L	L	L-M	M	L	VH
ST1-S	L	L	L-M	M	L	VH
ST2	L-M	L	L	L-M	L	H
ST2-G	L	L	L	L-M	L	VH
ST2-GS	L	L	L-M	M	L	VH
ST2-L	M	L-M	M	H	L-M	M-H
ST2-LS	L-M	L	M-H	H-VH	L	H
ST2-S	L	L	L-M	M	L	VH
ST3	M-H	M-H	M	M-H	M	M
ST3-G	M-H	M	M	M-H	M	H
ST3-GS	M	L-M	M-H	H	L-M	H
ST3-L	H-VH	H	H	H-VH	M-H	M
ST3-LS	M-H	M	H	VH	M	M-H
ST3-S	M	L-M	M-H	H	L-M	H

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST4	M-H	H	L-M	–	H	H
ST4-G	M-H	H	L-M	–	H	VH
ST4-GS	M	M	M	–	M-H	VH
ST4-S	M	M	M	–	M-H	VH
ST5	M	L-M	M	H	M	M
ST5-S	L-M	L	M-H	H-VH	L-M	M-H
ST6	H-VH	H	H	H-VH	H	M
ST6-S	H	M-H	H	VH	M-H	M-H
ST7	H-VH	VH	M	–	VH	H
ST7-S	H	H	M-H	–	H	VH
ST8	M	L-M	L-M	M	L-M	L
ST8-C	L	L	L	L-M	L	L-M
ST8-CS	L	L	L-M	M	L	M
ST8-S	L-M	L	M	M-H	L	L-M
ST9	H	H	M-H	H	M	L
ST9-C	M	M	L-M	M	L	L-M
ST9-CS	L-M	L-M	M	M-H	L	M
ST9-S	M-H	M	H	H-VH	L-M	L-M
ST10	H	VH	L	–	M-H	L-M
ST10-S	M-H	H	L-M	–	M	M
ST11	M	M	L-M	M-H	L-M	L
ST11-S	L-M	L-M	M	H	L	L-M
ST12	H-VH	H-VH	M-H	H	M-H	L
ST12-S	H	H	H	H-VH	M	L-M
ST13	H-VH	VH	L-M	–	H	L-M
ST13-S	H	H	M	–	M-H	M
ST14	L	VH	–	–	–	–
ST14-S	L	VH	–	–	–	–
ST14-U	L	H-VH	–	–	–	–
ST14-US	L	H-VH	–	–	–	–

Type	Compaction	Rutting	Erosion (slope ≤ 10%)	Erosion (slope 11–30%)	Frost Heave	Forest Floor Loss
ST15	M	L	M-H	H	L	H-VH
ST15-G	L-M	L	M-H	H	L	VH
ST15-GS	L	L	H	VH	L	VH
ST15-L	M-H	L-M	H	VH	L-M	H
ST15-LS	M	L	VH	VH	L	VH
ST15-S	L-M	L	H	VH	L	VH
ST16	H	M-H	H	VH	M-H	H
ST16-G	M-H	M	H	VH	M-H	H-VH
ST16-GS	M	L-M	VH	VH	M	VH
ST16-L	H-VH	H	VH	VH	H	M-H
ST16-LS	H	M	VH	VH	M-H	H
ST16-S	M-H	L-M	VH	VH	M	H-VH
ST17	M	L-M	M-H	H	L-M	L-M
ST17-S	L-M	L	H	VH	L	M
ST18	H	H	H	VH	M-H	L-M
ST18-S	M-H	M	VH	VH	M	M
ST19	L	L	L	L	L	VH
ST19-M	L	L	L	L-M	L	VH

Notes: Erosion hazard ratings assume slope length less than 100 m. Where slope length is longer, ratings should be increased.

Erosion and frost heave hazard ratings assume exposed mineral soil. Where well developed forest floor horizons and/or ground cover remain intact, ratings can be reduced.

Windthrow Hazard

Windthrow hazard is a function of site (wind) exposure as well as soil limitations. Stand density, tree species rooting patterns, tree crown dimensions, and overall tree health are also important factors. The main soil factor influencing windthrow hazard is potential rooting depth which is related to soil moisture content, soil texture, stoniness, and overall soil depth.

In general, **windthrow hazard increases** as:

- **soil moisture content increases** – high or fluctuating water tables do not allow for deep or stable rooting.
- **soil texture becomes finer** – fine textured soils tend to become more massive in structure with depth, thereby reducing potential rooting depth. Also, clayey soils lack shear strength, particularly when wet.
- **stoniness increases** – stony phase soils do not allow for deep or stable rooting.
- **soil depth decreases** – naturally shallow soils (bedrock, cementation) do not allow deep rooting regardless of species type.

Table 3 shows windthrow hazards associated with soil type and site exposure rating (NSDLF 1988) for use in evaluating site suitability for partial cut harvesting and/or commercial thinning operations (see McGrath 2010). This chart uses three hazard ratings: Low (green), Moderate (yellow) and High (red).

Table 3. Windthrow hazard ratings based on soil type and site exposure

	Exposure Class				
Soil Type	Sheltered	Moderately Sheltered	Moderate	Moderately Exposed	Exposed
1, 1-G, 2, 2-G, 2-L, 8, 8-C	Green	Green	Green	Yellow	Red
(Stony phases of above)	Green	Green	Yellow	Red	Red
3, 3-G, 3-L, 5, 9, 9-C, 11	Green	Green	Yellow	Red	Red
(Stony phases of above)	Green	Yellow	Red	Red	Red
6, 12	Green	Yellow	Yellow	Red	Red
(Stony phases of above)	Yellow	Yellow	Red	Red	Red
All wet, organic, moist shallow, and talus soil types (ST4, ST7, ST10, ST13, ST14, ST16, ST18, ST19)	Yellow	Red	Red	Red	Red
Dry shallow soil types (ST15, ST17) with 0–15 cm depth or stony (S) phase	Yellow	Red	Red	Red	Red
Dry shallow soil types (ST15, ST17) with 16–30 cm depth and non-stony phase	Yellow	Yellow	Red	Red	Red

Green = LOW hazard, Yellow = MODERATE hazard, Red = HIGH hazard

Soil Hazard Mitigation

Soil hazard ratings are meant to alert managers to the potential for soil damage or negative off-site impacts when conducting harvesting and silviculture treatments. Management planning directly related to soil type information includes:

- Choice of harvest method and/or silviculture treatment to apply
- Choice of road and trail layout and design
- Timing of operations to avoid (or minimize) high hazard conditions
- Choice of harvest system (machine types) to minimize site impact
- Pre-treatment mitigation planning required to minimize on- and off-site impacts
- Establishment of site-specific operational protocols to address hazards (as needed)

More information on avoiding soil and site damage from forestry operations can be found in Archibald et al. (1997), Arnup (2000), Sutherland (2005), Keys and Quigley (2005) and Gillies (2007). Examples of mitigation measures are given below.

Compaction and Rutting

Soils with high compaction and rutting hazards are best travelled when frozen or dry. When moist, it is possible for some soils to be damaged with only one or two vehicle passes (McNabb 1999; Keys 2005). If operations must occur when soils are moist or wet, machine travel should be minimized and equipment with low ground pressures should be used. Traffic damage should also be focused on fewer trails which are strategically located and designed to withstand high use (i.e. through use of corduroy and/or slash mats which can be very effective in reducing soil compaction). Finally, if mitigation measures are insufficient to avoid excessive damage, then operations should cease until soil conditions improve.

- **Frozen Soils** – To reduce or prevent machine traffic damage, mineral soils need to be frozen to a depth of 15 cm or more and organic soils to a depth of 50 cm or more (Sutherland 2005). For many areas in Nova Scotia, this condition is not often achieved, or is only achieved for short periods of time. To avoid serious soil damage during winter operations, adequate frost penetration should be confirmed before operations begin. In some cases, management techniques can be used to promote frost penetration (see Sutherland 2005).

- Dry Soils – Fine to medium textured soils remain moist for long periods after summer rain events and, depending on weather patterns, may never reach a truly dry condition. However, when (or if) these soils do become dry, managers should schedule harvesting and/or site preparation activities to take advantage of these favourable conditions.

Erosion

To avoid erosion on high hazard sites, forest floor organic layers should be kept intact or vegetative ground cover maintained or re-established as soon as possible after disturbance. In addition, compaction and rutting should be minimized (especially rutting perpendicular to slope). Compaction can increase erosion hazard by reducing infiltration capacity. Rutting can produce artificial flow channels leading to erosion.

Frost Heave

To reduce the occurrence of frost heave on high hazard sites, forest floor organic layers should be kept intact and soil compaction should be minimized. Forest floor horizons insulate against temperature fluctuations thereby reducing frost heave potential. Soil compaction increases micropore percentage which contributes to frost heave hazard.

Forest Floor Loss

To avoid damaging sites which are sensitive to forest floor loss, mineral soil exposure should be kept to a minimum during all treatment operations. Also, for sites and soils prone to drought, operations should try to leave some residual shade to reduce desiccation of forest floor horizons.

Understanding and Applying Soil Type Information

As outlined above, soil types are mainly differentiated based on texture, moisture condition, fertility and depth. Relationships between soil types can be shown using a matrix table (Figure 11) which allows users to see how soils are related to each other by these features.

Figure 11. Matrix table showing relationships (logic connections) between soil type units

Typical Moisture Condition	Medium to Coarse Textured				Fine to Medium Texture		Organic	Talus
	Typic	Rich	Shallow	Shallow/ Rich	Typic	Rich		
Dry	ST1		ST15					ST19
Fresh	ST2	ST8		ST17	ST5	ST11		
Moist	ST3	ST9	ST16	ST18	ST6	ST12	ST14-U	
Wet	ST4	ST10	ST4	ST10	ST7	ST13	ST14	

Figure 11 is particularly useful in assessing the impact of changing moisture conditions on day-to-day forestry operations. Moisture condition associated with each soil type is the typical (or dominant) growing season condition, but every soil can be in a dry, fresh, moist or wet condition on any given day (based on season and weather). This concept is very important in understanding and assessing soil compaction and rutting hazards.

For example:

- During and shortly after a significant rain event, a well drained (fresh) ST2 will react to machine traffic like a wet ST4 or moist ST3 until such time as excess water has drained away (approximately 2 days on average). If operations continue during this time, ST4 and/or ST3 hazard ratings would apply.

- Similarly, ST5 will react to machine traffic like a wet ST7 or moist ST6 after heavy rain. However, because ST5 is fine to medium textured, it will tend to stay moist for a longer period of time after rain events compared to ST2. This means an ST5 site could be associated with an ST7 and/or ST6 hazard class for several days after a major rain event.

- Periodic rain events may mean fine to medium textured, imperfectly drained ST6 stays in a moist (or wet) condition throughout most of the growing season, even in what would normally be considered the dry season. This possibility needs to be incorporated into management planning. Moisture level checks and specific operational protocols would need to be implemented to minimize soil/site damage under these conditions.

- Sites underlain by well drained coarse soils (ST1, ST2, ST8, ST15, ST17) would become operable sooner after spring snowmelt than sites which are typically moist due to drainage restrictions (e.g. ST3, ST9, ST16, ST18) and/or which have higher clay content (e.g. ST5, ST6, ST11, ST12). This information should be considered in annual operating plans.

In summary, knowledge of soil type relationships (Figure 11) and soil hazard ratings (Tables 2 and 3) can be used to aid both management plan development and day-to-day forestry operations.

Knowledge of day-to-day moisture content is particularly important in fine to medium textured soils because of related compaction and rutting hazards. See Appendix C for information on assessing moisture condition in these soils.

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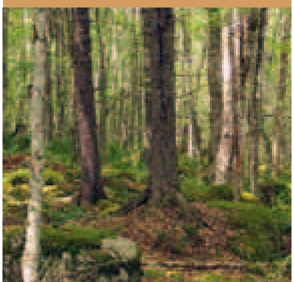
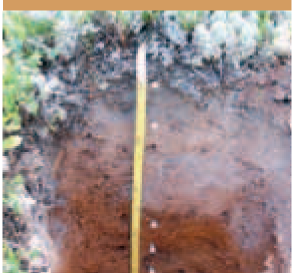




Appendices

Appendix A
Soil terminology and conventions

In describing soils, this guide generally follows the terminology and conventions outlined in *The Canadian System of Soil Classification* (SCWG 1998) and *The Canadian Soil Information System (CanSIS) Manual for Describing Soils in the Field* (ECSS 1983). Reference should be made to these publications when more detailed information on soil terms is sought.

Mineral Soil Horizons

Mineral soil horizons are described using various letter combinations. Capital letters are used to symbolize main soil horizons (A, B, C), and lower case letters (suffixes) are used to describe horizon features. Explanations of the more common soil horizon descriptors are given below.

A Horizon

Mineral horizon formed at or near the surface of the soil, generally immediately beneath the forest floor. It is usually formed:

(i) by leaching or loss of iron and aluminum, clay, and organic matter content to form an **Ae** horizon;

(ii) by accumulation of partially decomposed organic matter from the forest floor to form an **Ah** horizon;

(iii) by a combination of leaching and organic matter accumulation to form an **Ahe** horizon;

(iv) by incorporation of organic matter through cultivation (or other human disturbance) to form an **Ap** horizon; or

(v) by additional influence of prolonged anaerobic (reducing) conditions to form an **Aeg**, **Ahg**, **Aheg** or **Apg** horizon.

B Horizon

Mineral horizon characterized by enrichment of material lost from the A horizon above, and/or through transformations (weathering) within the horizon itself.

C Horizon

Mineral horizon relatively unaffected by the soil formation processes active in the A and B horizons above. A transition horizon between the **B** and **C** horizons (and one which has features of both) is called a **BC** horizon.

Mineral horizon descriptors:

b Indicates a buried horizon.

c Used with **B** or **BC** horizon, it denotes a naturally cemented horizon.

e Used with **A** horizon only, it denotes a horizon that has been leached of iron and aluminum, clay, and organic matter (alone or in combination), resulting in a horizon with a greyish-white colour (or pinkish colour in red soils).

f Used with **B** horizon only, it denotes an accumulation of iron and aluminum from the A horizon above. The increased iron content is evident by a change in soil colour.

g Used with **A**, **B**, or **C** horizon, it denotes a horizon characterized by depleted/gley colours, prominent redox concentrations, or both, indicating permanent or prolonged anaerobic (reducing) conditions.

h Used with **A** or **B** horizon, it denotes an accumulation of organic matter by various processes. In the A horizon, the accumulation is through physical means (mixing); in the B horizon, the accumulation is through chemical means (solution deposit). In both cases, accumulation is indicated by a change in soil colour.

j Used as a modifier, when placed to the right of another suffix it denotes a weak expression of the horizon characteristic. For example, **Bfgj** denotes a Bf horizon with evidence of periodic reducing conditions.

m Used with **B** horizon only, it denotes a horizon mainly formed through in-place weathering with minor accumulation of materials from the A horizon above.

p Used with **A** horizon only, it denotes a surface horizon disturbed by human activities (e.g. cultivation, logging, habitation) usually leading to an increase in organic matter content.

t Used with **B** horizon only, it denotes an accumulation of clay from the A horizon above.

x A dense, compact horizon of fragipan character.

Organic Horizons

Organic horizons are divided into four main types:

L (Litter) – An upland organic horizon consisting of relatively fresh organic material in which entire original structures are discernible (e.g. leaves, needles, twigs).

F (Fermented) – An upland organic horizon comprised of more-or-less disintegrated plant residues, but which is still identifiable as to origin (even though decomposition is very apparent). Fine rooting is often abundant in this horizon because of the release of nutrients during decomposition.

H (Humus) – An upland organic horizon dominated by fine substances in which the organic materials are no longer identifiable as to origin. Fine rooting is common, but often less so than in the F horizon.

O (Organic) – Horizons developed mainly from sphagnum mosses, rushes and other plant material associated with wetland ecosystems (hydrophytic vegetation). They are divided into fibric (**Of**), mesic (**Om**) and humic (**Oh**) horizons, depending on the level of decomposition (see Appendix E for more details).

Parent Material

Soils can develop from a variety of parent material types, the characteristics of which influence soil development and site quality. Parent material types discussed in this guide are (adapted from ECSS 1983):

Aeolian – Material deposited by wind action. Aeolian deposits are usually high in silt and/or fine sand and may show internal structures such as cross-bedding.

Alluvium – Sediments deposited by streams and rivers (floodplains, deltas, etc.). These deposits are younger than glacial deposits and may or may not contain rock (gravel/cobbles).

Colluvium – Deposits of sand, silt, clay, organic matter and/or rock which have reached their position by gravity-induced movement. These deposits are younger than glacial deposits.

Glacial Till – Unstratified deposits of sand, silt, clay and rock that have been released from glacier ice. Some glacial deposits also have recognizable landform features such as drumlins.

Glaciofluvial – Deposits which were partly or wholly stratified by glacial meltwater. Glaciofluvial deposits are often high sand and/or gravel.

Lacustrine – Sediments deposited in quiet waters (lakes and ponds) which may or may not have been directly associated with glaciers. These deposits tend to be high in silt and clay and generally do not contain rock.

Marine – Sediments deposited in salt or brackish water or through shoreline processes. Marine deposits are generally stratified, of variable texture, and may contain shells and gravel.

Organic – Built up plant debris which does not easily decompose because of high moisture and low soil temperatures.

Organic/Bedrock – Combination of upland organic over weathered, near-surface bedrock.

Till/Bedrock – Combination of thin glacial till over weathered, near-surface bedrock.

Coarse Fragments

Coarse fragments (CF) are rock fragments found in soil which are larger than 2 mm in size. Abundance classes used in this guide are: Low (< 20%), Moderate (20–50%) and High (> 50%).

Coarse fragment size classes (from ECSS 1983)		
Size	**Rounded/Angular**	**Flat**
Gravel	0.2 – 7.5 cm diameter	0.2 – 15 cm long
Cobble	7.6 – 25 cm diameter	16 – 38 cm long
Stone	26 – 60 cm diameter	39 – 60 cm long
Boulder	> 60 cm diameter	> 60 cm long

Soil Structure

Structure refers to the aggregation of primary soil particles into relatively stable compound particles called aggregates (or peds) which are separated from adjoining aggregates by planes of weakness. Soil structure is described by shape, size, and degree of expression. Structure classes found in Nova Scotia soils are (modified from SCWG 1998):

Blocky – Soil particles arranged around a point with rectangular (flattened) faces and sharp vertices.

Sub-angular Blocky – Soil particles arranged around a point with sub-rectangular faces and mostly oblique or sub-rounded vertices.

Granular – Spheroidal aggregates characterized by rounded vertices.

Platy – Soil particles arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces.

Single Grain – A loose, incoherent mass of individual particles as in sands (structureless).

Massive – A coherent mass which shows no evidence of any distinct arrangement of soil particles (structureless).

Soil Consistence

Consistence relates to degree of soil aggregate resistance to deformation under force (moist and dry condition), or to the degree and kind of soil cohesion/adhesion (wet condition).

Soil consistence classes (modified from ECSS 1983)

Moist Condition		Dry Condition		Wet Condition
Consistence	Failure Force (N)	Consistence	Failure Force (N)	Consistence
Loose	na	Loose	na	Non-Sticky
Very Friable	< 8	Soft	< 8	Slightly Sticky
Friable	8–20	Slightly Hard	8–40	Sticky
Firm	21–40	Hard	41–80	Very Sticky
Very Firm	41–80	Very Hard	81–160	
		Extremely Hard	161–800	

N = Newton = kg m/s^2

Moist Soil	General Description
Loose	The soil material is non-coherent.
Very Friable	The soil material is crushed under very gentle pressure, but coheres when pressed together.
Friable	The soil material is easily crushed under gentle to moderate pressure and coheres when pressed together.
Firm	The soil material can be crushed under moderate pressure, but resistance is distinctly noticeable.
Very Firm	The soil material can be crushed between the thumb and forefinger, but strong pressure is required.

Dry Soil	General Description
Loose	The soil material is non-coherent.
Soft	The soil material is weakly coherent and fragile.
Slightly Hard	The soil material is easily broken between the fingers.
Hard	The soil material is barely breakable between the fingers.
Very Hard	The soil material is not breakable between the fingers but is between the hands.
Extremely Hard	The soil material cannot be broken with the hands.

Wet Soil	General Description
Non-Sticky	After the release of pressure, practically no soil material adheres to the thumb and finger.
Slightly Sticky	After pressure has been applied, the soil material adheres to both the thumb and finger, but comes off one or the other rather cleanly.
Sticky	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger, and tends to stretch somewhat and pulls apart rather than pulling free from either digit.
Very Sticky	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger, and is stretched when they are separated.

Moisture Regime

Soil moisture regime represents average moisture availability for plant growth. It is assessed by integrating moisture supply (as related to climate) with soil drainage and moisture holding capacities. In general, very dry to dry moisture regimes are associated with severe to moderate moisture deficits; fresh to moist moisture regimes are associated with little to no moisture deficits; and wet moisture regimes are associated with excess moisture during the growing season.

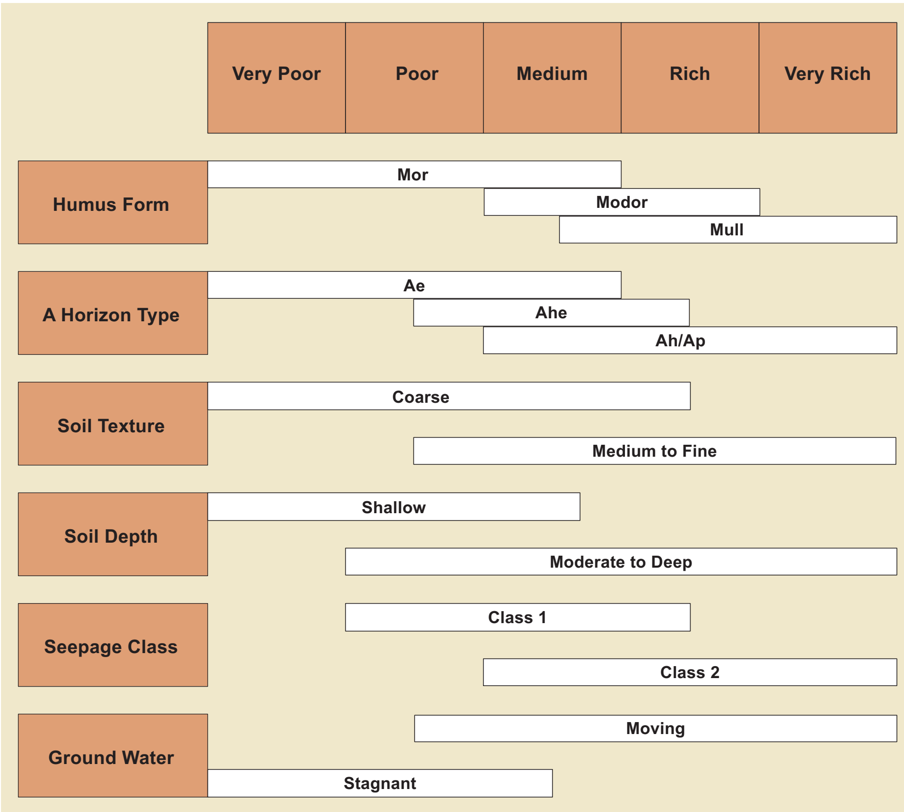
Soil moisture regime as a function of site and soil conditions (modified from Meades and Moores 1994).

Moisture Regime	General Site and Soil Features
Very Dry	Rapidly drained, coarse textured and/or shallow soils not influenced by ground water or seepage.
Dry	Deeper, well drained, coarse textured soils not influenced by ground water or seepage; and shallow soils not rapidly drained or influenced by ground water or seepage.
Fresh	Deeper, well drained, medium to fine textured soils; moderately well drained coarse textured soils; or well drained coarse textured soils influenced by ground water.
Fresh/Moist	Deeper, moderately well drained, medium to fine textured soils often with some evidence of anaerobic (reducing) conditions in lower BC and C horizons.
Moist	Soils with imperfect drainage, but with surface soil still well aerated during most of the growing season. Evidence of anaerobic (reducing) conditions in upper B horizons.
Moist/Wet	Poorly drained soils with water levels near the surface for most of the year, but with well aerated surface conditions during dry periods.
Wet	Very poorly drained soils with water levels near the surface for most of the year – often associated with wetland organic soils.

Nutrient Regime

Soil nutrient regime represents the relative availability of nutrients for plant growth. Determination of nutrient regime requires consideration and integration of several environmental parameters.

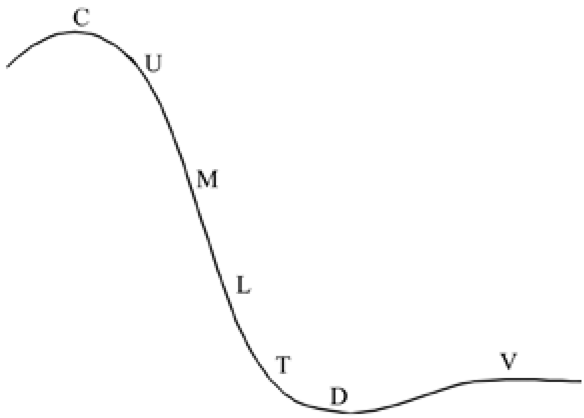
Soil nutrient regime as a function of site and soil conditions (modified from Beckingham and Archibald 1996).



Note: For seepage class definitions, see Keys et al. (2007).

Topographic Position

Topographic position describes the relative slope position of a site within the landscape. Position classes are illustrated and described below (adapted from ECSS 1983):



Crest (C): The generally convex upper-most portion of a hill, it is usually convex in all directions with no distinct aspect.

Upper (U): The upper portion of a hill immediately below the crest – it has a convex surface profile with a specific aspect.

Middle (M): The area of a hill between the upper slope and lower slope with a specific aspect.

Lower (L): The area toward the base of a hill with a specific aspect.

Toe (T): The area below the lower slope usually demarcated by an abrupt leveling of the slope.

Depression (D): An area that is concave in all directions, generally at the foot of a hill or in a level area.

Level (V): Any level area not immediately adjacent to a hill. The surface profile is generally horizontal with no aspect. Level areas can be lower or upper elevations.

Drainage

Soil drainage class reflects the length of time it takes water to be removed from a soil in relation to supply. Several factors affect drainage class, including: (i) slope position, (ii) slope percent and aspect, (iii) soil texture, (iv) depth to impermeable layer, (v) coarse fragment content, and (vi) abundance and type of vegetation (evapotranspiration).

Six drainage classes used in this guide are described below (adapted from ECSS 1983):

Rapid: Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is permeable, or laterally if vertical flow is restricted. The water source is precipitation. Soils do not show any redoximorphic features within the profile.

Well: Water is removed from the soil readily, but not rapidly. Excess water flows downward if underlying material is permeable or laterally if vertical flow is restricted. The water source is precipitation. Soils usually do not show redoximorphic features within the first metre, but may show features below this depth.

Moderately Well: Water is removed from the soil somewhat slowly in relation to supply – due to low permeability and lack of slope, shallow water table, seepage inputs, or some combination of these. The water source is precipitation in medium to fine textured soils, and precipitation and seepage flow in coarse textured soils. Soils commonly show redoximorphic features in lower BC and C horizons.

Imperfect: Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major supply. If seepage water or groundwater (or both) is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Soils commonly show redoximorphic features in upper B horizons and sometimes in A horizons.

Poor: Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time (when not frozen). Seepage inputs or groundwater flow (or both), in addition to precipitation, are the main water sources. There may also be a perched water table with precipitation exceeding evapotranspiration. Soils usually show redoximorphic features throughout the profile.

Very Poor: Water is removed from the soil so slowly that the water table remains at or near the surface for the greater part of the time (when the soil is not frozen). Groundwater flow and seepage inputs are the major water sources. Precipitation is less important, except where there is a perched water table with precipitation exceeding evapotranspiration. Soils usually show redoximorphic features throughout the profile and are often organic.

Exposure

Exposure refers to the relative openness of a site to weather conditions, particularly wind and sun. Exposure can affect moisture conditions on a site and severely impact the height growth of trees. Exposure classes are described below (adapted from NSDLF 1988).

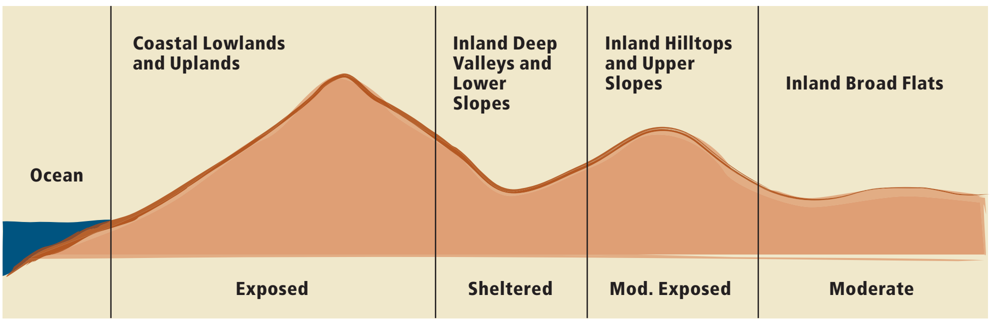
Exposed: Sites with extreme exposure – includes upper slopes of moderate ridges immediately along the coastline and steep upper slopes of uplands open to winds from two or more directions.

Moderately Exposed: Intermediate between Exposed and Moderate – includes upper slopes of inland ridges or hills, except where sheltered by a larger hill.

Moderate: The topographically neutral category – includes broad flats, lower and middle slopes of strong ridges (plus sheltered upper slopes), and upper slopes of gentle relief in a flat landscape.

Moderately Sheltered: Intermediate between Moderate and Sheltered – includes middle slopes between high ridges and broad basins which are afforded some wind protection from one or more directions.

Sheltered: The most extreme category of protection from wind and atmospheric drought stress, best illustrated by lower slopes of deep valleys where protection is provided on all sides.



Surface Stoniness

Stoniness describes the percentage area of a site covered by exposed stones and boulders (minimum 25 cm in diameter or length).

Surface stoniness class based on stone size and approximate distance (from ECSS 1983).

Code	Class	Distance Apart (m) Stones 25 cm Diameter	Distance Apart (m) Stones 60 cm Diameter	Distance Apart (m) Stones 120 cm Diameter
NS	Non-stony	> 25	> 60	> 120
SS	Slightly Stony	8–25	20–60	37–120
MS	Moderately Stony	1–8	3–20	6–37
VS	Very Stony	0.5–1	1–3	2–6
ES	Exceedingly Stony	0.1–0.5	0.2–1	0.5–2
XS	Excessively Stony	< 0.1	< 0.2	< 0.5

Surface Rockiness

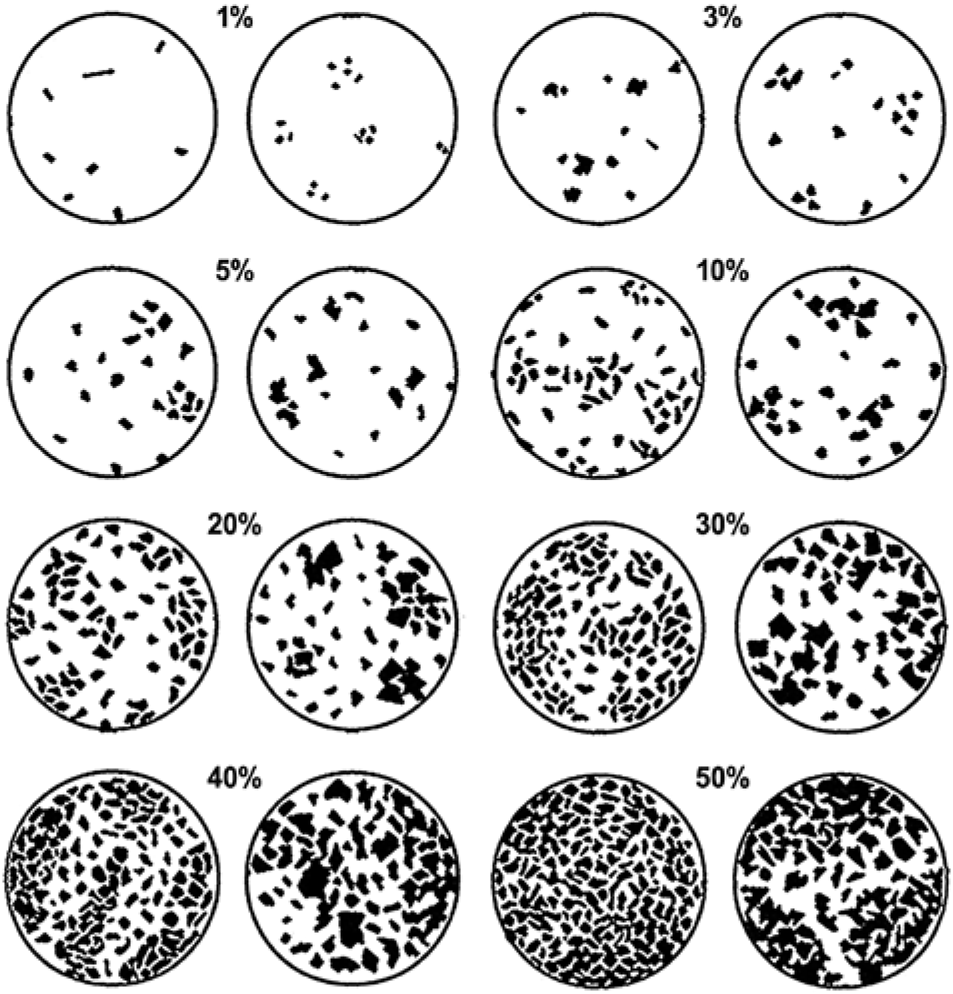
Rockiness describes the percentage area of a site with bedrock outcrops.

Surface rockiness class based on percent cover of exposed bedrock (from ECSS 1983).

Code	Class	Percent Cover
NR	Non-rocky	< 2
SR	Slightly Rocky	2–10
MR	Moderately Rocky	11–25
VR	Very Rocky	26–50
ER	Exceedingly Rocky	51–90
XR	Excessively Rocky	> 90

Appendix B
Percent area/volume charts

(adapted from Terry and Chilingar 1955)



Appendix C
Soil moisture assessment for fine to medium textured soil

(adapted from Sutherland 2005)

Obtain a soil sample from the wettest area within the top 30 cm of soil and mould it into a clod.

If when squeezed or flattened the soil clod does not crumble, it is in a wet condition.

If the soil is easy to mould, but breaks when squeezed, it is in a moist condition.

If the soil cannot be moulded by hand, but is still friable, it is in a fresh condition.

Appendix D
Humus form classification (from Green et al. 1993)

Humus Form Key

1a. Well to imperfectly drained sites – humus form NOT saturated for prolonged periods:

- 2a. Combined thickness of **FH** horizons > 2 cm (or ≤ 2 cm if **Ah** < 2 cm):
  - 3a. **F** horizon does NOT include **Fz** or **Fa**
    - 4a. Decaying wood > 35% of **OM** volume in humus form profile: . . . . **Lignomor**
    - 4b. Decaying wood ≤ 35% of **OM** in humus form profile:
      - 5a. **F** horizon > 50% of **FH** thickness: . . . . **Hemimor**
      - 5b. **Hh** horizon > 50% of **FH** thickness: . . . . **Humimor**
      - 5c. **Hr** horizon > 50% of **FH** thickness: . . . . **Resimor**
  - 3b. **F** horizon includes **Fz** and/or **Fa**
    - 4a. Decaying wood > 35% of **OM** volume in humus form profile: . . . . **Lignomoder**
    - 4b. Decaying wood ≤ 35% of **OM** in humus form profile:
      - 5a. **Fa** horizon > 50% of **F** thickness or Fm horizon present:. . . . . . . **Mormoder**
      - 5b. **Fz** horizon > 50% of **F** thickness:
        - 6a. **FH** thickness ≥ **Ah** thickness:. . . . .**Leptomoder**
        - 6b. **FH** thickness < **Ah** thickness:. . . . .**Mullmoder**
- 2b. Combined thickness of FH horizons ≤ 2 cm with **Ah** > 2 cm:
  - 3a. **Ah** horizon formed from decomposition of dense fine roots:. . . . .**Rhizomull**
  - 3b. **Ah** horizon formed from actions of abundant earthworms:. . . . . **Vermimull**

1b. Poor to very poorly drained sites – humus form saturated for prolonged periods:

- 2a. Combined thickness of **F**, **H**, and **O** horizons ≤ 2 cm with **Ah** > 2 cm: . . . . **Hydromull**
- 2b. Combined thickness of **FH** horizons > 2 cm (or ≤ 2 cm if **Ah** < 2 cm):
  - 3a. **FH** thickness ≥ **O** thickness:
    - 4a. **F** horizon does NOT include **Fz** or **Fa**: . . . .**Hydromor**
    - 4b. **F** horizon includes **Fz** and/or **Fa**: . . . . **Hydromoder**
  - 3b. **O** thickness > **FH** thickness:
    - 4a. **Of** horizon > 50% of **O** thickness: . . . . **Fibrimor**
    - 4b. **Om** horizon > 50% of **O** thickness:. . . . .**Mesimor**
    - 4b. **Oh** horizon > 50% of **O** thickness: . . . . **Saprimoder**

Horizon Descriptions

Ln (new): an L horizon composed of newly accreted and essentially unfragmented plant residues. These materials have recently accumulated on the ground surface (usually less than one year old). They are generally loose, show essentially no structural change and may be somewhat discoloured.

Lv (variative): an L horizon exhibiting initial decay and strong discolouration. These materials are comprised of less recently accreted plant residues in which disintegration and discolouration have occurred, but fragmentation and fine substances are lacking.

Fm (mycogenous): an F horizon in which plant residues are aggregated in a matted structure with a tenacious consistence. The matted fabric typically features a felty character due to abundant fungal mycelia. Faunal droppings may be present, but only with low frequency and abundance. Roots may be abundant, contributing to the formation of the matted fabric.

Fz (zoogenous): an F horizon in which plant residues are weakly aggregated with a loose or friable consistency. The friable fabric reflects the presence of active populations of soil meso and microfauna. Faunal droppings are typically numerous and easily observable under magnification with a hand lens or binocular microscope. Fungal mycelia may be present, but rarely in large amounts. Root residues comprise a moderate proportion of plant residues and are typically less abundant than in Fm horizons.

Fa (amphi): an F horizon in which plant residues are aggregated into a weak to moderate, non-compact matted structure. This is an intergrade between the Fm and Fz horizons, and as such, reflects properties of both. The structure of the materials is not strong, therefore aggregates disrupt relatively easily when disturbed. Often the fabric is variable, featuring clumps of aggregated material with pockets of loose material. Fungal mycelia and faunal droppings may occur; however, neither predominates over the other.

Hh (humic): an H horizon predominated by fine substances with very few if any recognizable plant residues. The organic material has a greasy character when moist, with a massive or block structure. The colour is typically black and the material stains fingers when rubbed.

Hz (zoogenous): an H horizon predominated by fine substances with very few if any recognizable plant residues – faunal droppings constitute most of the fabric. The organic material is typically a black colour, with a fine granular structure. The abundance of very small cylindrical or spherical faunal droppings gives the appearance of fine black "sawdust".

Hr (residues): an H horizon predominated by fine substances but that also contains recognizable plant residues, usually from fine roots, bark, and wood. The organic material has a slightly greasy character when moist and does not stain the fingers with dark colours when rubbed. This reflects a lower content of dark-coloured, mature humic substances relative to Hh and Hz horizons. Hr horizons are typically dark reddish brown, with hues around 2.5 YR, and are at least one or two hues redder than underlying Hh horizons (if present).

Of an O horizon consisting largely of poorly decomposed plant residues that are readily identifiable as to origin (von Post 1–4).

Om an O horizon consisting of partly decomposed plant residues which are at a stage of decomposition intermediate between Of and Oh horizons (von Post 5–6).

Oh an O horizon consisting of well decomposed plant residues that for the most part have been transformed into humic materials (von Post 7–10, sometimes 6)

Ah an A horizon enriched with humified organic matter. The only mineral soil horizon used in humus form classification.

Appendix E
von Post scale of decomposition (adapted from SCWG 1998)

Fibric (Of)

VP1 Undecomposed: plant structure distinct; yields only clear water, coloured light yellow brown.

VP2 Almost undecomposed: plant structure distinct; yields only clear water, coloured light yellow brown.

VP3 Very weakly decomposed: plant structure distinct; yields distinctly turbid brown water, no peat substance passes between the fingers, residue not mushy.

VP4 Weakly decomposed: plant structure distinct; yields strongly turbid water, no peat substance escapes between the fingers, residue rather mushy.

Mesic (Om)

VP5 Moderately decomposed: plant structure clear but becoming indistinct; yields much turbid brown water, some peat escapes between the fingers, residue very mushy.

VP6 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.

Humic (Oh)

VP7 Strongly decomposed: plant structure indistinct but recognizable, about half the peat escapes between the fingers.

VP8 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.

VP9 Almost completely decomposed: plant structure almost unrecognizable; nearly all the peat escapes between the fingers.

VP10 Completely decomposed: plant structure unrecognizable; all the peat escapes between the fingers.

Appendix F
Chronological list of Nova Scotia soil surveys

Cann, D.B., J.D. Hilchey, and G.R. Smith. 1954. Soil survey of Hants County, Nova Scotia. Nova Scotia Soil Survey Report No. 5. Can. Dept. of Agric. 65 pp. (plus map).

Cann, D.B. and J.D. Hilchey. 1954. Soil survey of Antigonish County, Nova Scotia. Nova Scotia Soil Survey Report No. 6. Can. Dept. of Agric. 54 pp. (plus maps).

Cann, D.B. and J.D. Hilchey. 1958. Soil survey of Lunenburg County, Nova Scotia. Nova Scotia Soil Survey Report No. 7. Can. Dept. of Agric. 48 pp. (plus maps).

Cann, D.B. and J.D. Hilchey. 1959. Soil survey of Queens County, Nova Scotia. Nova Scotia Soil Survey Report No. 8. Can. Dept. of Agric. 48 pp. (plus maps).

Hilchey, J.D., D.B. Cann, and J.I. MacDougall. 1960. Soil survey of Yarmouth County, Nova Scotia. Nova Scotia Soil Survey Report No. 9. Can. Dept. of Agric. 47 pp. (plus maps).

MacDougall, J.I., D.B. Cann, and J.D. Hilchey. 1961. Soil survey of Shelburne County, Nova Scotia. Nova Scotia Soil Survey Report No. 10. Can. Dept. of Agric. 38 pp. (plus maps).

Hilchey, J.D., D.B. Cann, and J.I. MacDougall. 1962. Soil survey of Digby County, Nova Scotia. Nova Scotia Soil Survey Report No. 11. Can. Dept. of Agric. 58 pp. (plus maps).

Cann, D.B., J.I. MacDougall, and J.D. Hilchey. 1963. Soil survey of Cape Breton Island, Nova Scotia. Nova Scotia Soil Survey Report No. 12. Can. Dept. of Agric. 85 pp. (plus maps).

MacDougall, J.I., D.B. Cann, and J.D. Hilchey. 1963. Soil survey of Halifax County, Nova Scotia. Nova Scotia Soil Survey Report No. 13. Can. Dept. of Agric. 53 pp. (plus maps).

Hilchey, J.D., D.B. Cann, and J.I. MacDougall. 1964. Soil survey of Guysborough County, Nova Scotia. Nova Scotia Soil Survey Report No. 14. Can. Dept. of Agric. 55 pp. (plus maps).

Cann, D.B., J.I. MacDougall, and J.D. Hilchey. 1965. Soil survey of Kings County, Nova Scotia. Nova Scotia Soil Survey Report No. 15. Can. Dept. of Agric. 97 pp. (plus maps).

MacDougall, J.I., J.L. Nowland, and J.D. Hilchey. 1969. Soil survey of Annapolis County, Nova Scotia. Nova Scotia Soil Survey Report No. 16. Can. Dept. of Agric. 84 pp. (plus maps).

Nowland, J.L. and J.I. MacDougall. 1973. Soil survey of Cumberland County, Nova Scotia. Nova Scotia Soil Survey Report No. 17. Can. Dept. of Agric. 133 pp. (plus maps).

Webb, K.T. 1990. Soils of Pictou County, Nova Scotia. Nova Scotia Soil Survey Report No. 18. Research Branch, Agric. Can. 183 pp. (plus maps).

Webb, K.T., R.L. Thompson, G.J. Beke, and J.L. Nowland. 1991. Soils of Colchester County, Nova Scotia. Nova Scotia Soil Survey Report No. 19. Research Branch, Agric. Can. 201 pp. (plus maps).

Electronic versions of soil survey reports and maps are available on-line from Agriculture and Agri-Food Canada at: http://sis2.agr.gc.ca/cansis/

Appendix G
List of provincial forest vegetation types

Provincial vegetation types (VTs), VT variants and their associated ecosite groups (AC = Acadian, MB = Maritime Boreal).

VT Code	VT Name	AC	MB
CE1	Eastern white cedar / Speckled alder / Cinnamon fern / Sphagnum	X	
CE1a	(Poison ivy variant)	X	
CE2	Eastern white cedar – Balsam fir / Stair-step moss	X	
CO1	Black spruce – Balsam fir / Foxberry / Plume moss		X
CO2	White spruce – Balsam fir / Foxberry / Twinflower		X
CO2a	(Black crowberry Headland variant)		X
CO3	Red spruce / Mountain-ash / Foxberry		X
CO4	Balsam fir / Foxberry – Twinflower		X
CO5	White birch – Balsam fir / Foxberry – Wood aster		X
CO6	Red maple – Birch / Bunchberry – Sarsaparilla		X
CO7	White spruce / Bayberry		X
FP1	Sugar maple – White ash / Ostrich fern – Wood goldenrod	X	
FP2	Red maple – Red oak / Bellwort – Nodding trillium	X	
FP2a	(Sugar maple variant)	X	
FP3	Red maple / Sensitive fern – Rough goldenrod	X	
FP4	Balsam poplar – White spruce / Ostrich fern – Cow-parsnip	X	
FP5	Black cherry – Red maple / Rough goldenrod – Jack-in-the-pulpit	X	
FP6	White spruce / Wood goldenrod / Shaggy moss	X	
HL1	Balsam fir / Mountain-ash / Large-leaved goldenrod		X
HL1a	(White birch / Wood sorrel variant)		X
HL2	White spruce / Wood aster		X
HL3	Yellow birch – Balsam fir / Eastern spreading wood fern – Wood sorrel		X
HL4	Birch / Wood fern – Wood sorrel		X
IH1	Large-tooth aspen / Lambkill / Bracken	X	
IH1a	(Red oak variant)	X	
IH2	Red oak – Red maple / Witch-hazel	X	
IH2a	(Red oak variant)	X	

VT Code	VT Name	AC	MB
IH3	Large-tooth aspen / Christmas fern – New York fern	X	
IH4	Trembling aspen / Wild raisin / Bunchberry	X	
IH5	Trembling aspen – White ash / Beaked hazelnut / Christmas fern	X	
IH6	White birch – Red maple / Sarsaparilla – Bracken	X	
IH6a	(Aspen variant)	X	
IH7	Red maple / Hay-scented fern – Wood sorrel	X	
KA1	Hemlock / Christmas fern – White lettuce – Wood goldenrod	X	
KA2	Sugar maple / Christmas fern – Rattlesnake fern – Bulblet bladder fern	X	
MW1	Red spruce – Yellow birch / Evergreen wood fern	X	
MW2	Red spruce – Red maple – White birch / Goldthread	X	
MW2a	(Aspen variant)	X	
MW3	Hemlock – Yellow birch / Evergreen wood fern	X	
MW4	Balsam fir – Red maple / Wood sorrel – Goldthread	X	
MW5	White birch – Balsam fir / Starflower	X	
OF1	White spruce / Aster – Goldenrod / Shaggy moss	X	X
OF2	Tamarack / Speckled alder / Rough goldenrod / Shaggy moss	X	X
OF3	White pine – Balsam fir / Shinleaf – Pine-sap	X	
OF4	Balsam fir – White spruce / Evergreen wood fern – Wood aster	X	X
OF5	Trembling aspen – Grey birch / Rough goldenrod – Strawberry	X	
OW1	Jack pine / Huckleberry / Black crowberry / Reindeer lichen	X	X
OW2	Black spruce / Lambkill / Reindeer lichen	X	X
OW3	Red spruce / Red-berried elder / Rock polypody	X	
OW4	Red pine – White pine / Broom crowberry / Gray reindeer lichen	X	
OW5	Red oak / Huckleberry / Cow-wheat – Rice grass / Reindeer lichen	X	
OW6	White birch – Red oak – White ash / Marginal wood fern – Herb-Robert	X	
SH1	Hemlock / Pin cushion moss / Needle carpet	X	
SH2	Hemlock – White pine / Sarsaparilla	X	
SH3	Red spruce – Hemlock / Wild lily-of-the-valley	X	
SH4	Red spruce – White pine / Lambkill / Bracken	X	
SH4a	(Red spruce variant)	X	
SH5	Red spruce – Balsam fir / Schreber's moss	X	
SH6	Red spruce – Balsam fir / Stair-step moss – Sphagnum	X	
SH7	White spruce – Red spruce / Blueberry / Schreber's moss	X	
SH8	Balsam fir / Wood fern / Schreber's moss	X	

VT Code	VT Name	AC	MB
SH9	Balsam fir – Black spruce / Blueberry	X	
SH10	White spruce – Balsam fir / Broom moss	X	
SP1	Jack pine / Bracken – Teaberry	X	X
SP1a	(Black spruce variant)	X	X
SP2	Red pine / Blueberry / Bracken	X	
SP2a	(Black spruce variant)	X	
SP3	Red pine – White pine / Bracken – Mayflower	X	
SP3a	(Black spruce variant)	X	
SP4	White pine / Blueberry / Bracken	X	X
SP4a	(Black spruce variant)	X	X
SP4b	(Huckleberry variant)	X	X
SP5	Black spruce / Lambkill / Bracken	X	X
SP6	Black spruce – Red maple / Bracken – Sarsaparilla	X	X
SP7	Black spruce / False holly / Ladies' tresses sphagnum	X	X
SP8	Black spruce – Aspen / Bracken – Sarsaparilla	X	
SP9	Red oak – White pine / Teaberry	X	
SP10	Tamarack / Wild raisin / Schreber's moss	X	
TH1	Sugar maple / Hay-scented fern	X	
TH1a	(Beech variant)	X	
TH1b	(Yellow birch variant)	X	
TH2	Sugar maple / New York fern – Northern beech fern	X	
TH2a	(Yellow birch variant)	X	
TH3	Sugar maple – White ash / Christmas fern	X	
TH4	Sugar maple – White ash / Silvery spleenwort – Baneberry	X	
TH5	Beech / Sarsaparilla / Leaf litter	X	
TH6	Red oak – Yellow birch / Striped maple	X	
TH7	Yellow birch – White birch / Evergreen wood fern	X	
TH8	Red maple – Yellow birch / Striped maple	X	
TH8a	(White ash variant)	X	
WC1	Black spruce / Cinnamon fern / Sphagnum	X	X
WC2	Black spruce / Lambkill – Labrador tea / Sphagnum	X	X
WC2a	(Huckleberry – Inkberry variant)	X	X
WC3	Jack pine – Black spruce / Rhodora / Sphagnum	X	X
WC3a	(Black spruce variant)	X	X

VT Code	VT Name	AC	MB
WC4	Red pine – Black spruce / Huckleberry – Rhodora / Sphagnum	X	
WC5	Red spruce – Balsam fir / Cinnamon fern / Sphagnum	X	X
WC6	Balsam fir / Cinnamon fern – Three seeded sedge / Sphagnum	X	X
WC7	Tamarack – Black spruce / Lambkill / Sphagnum	X	X
WC7a	(Huckleberry – Inkberry variant)	X	X
WC8	Hemlock / Cinnamon fern – Sensitive fern / Sphagnum	X	
WD1	White ash / Sensitive fern – Christmas fern	X	
WD2	Red maple / Cinnamon fern / Sphagnum	X	X
WD3	Red maple / Sensitive fern – Lady fern / Sphagnum	X	X
WD4	Red maple / Poison ivy / Sphagnum	X	X
WD4a	(Huckleberry – Inkberry variant)	X	X
WD5	Trembling aspen / Beaked hazelnut / Interrupted fern / Sphagnum	X	
WD6	Red maple – Balsam fir / Wood aster / Sphagnum	X	X
WD7	Balsam fir – White ash / Cinnamon fern – New York fern / Sphagnum	X	
WD8	Red spruce – Red maple / Wood sorrel – Sensitive fern / Sphagnum	X	

Appendix H
Common wet site plant indicators

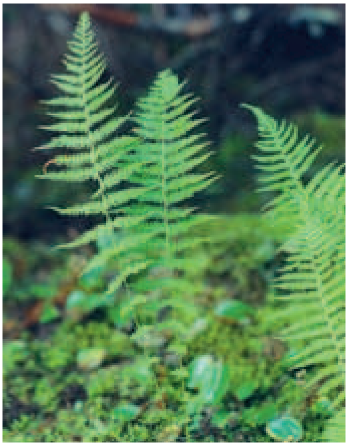
Drainage	Plants			
	Mosses	Ferns	Shrubs	Herbs
Imperfect	Stair-step moss	New York fern	False holly [(a)]	Creeping snowberry [(a)]
				Dwarf raspberry
		Lady fern	Speckled alder	
		Interrupted fern		
			Winterberry	Sedges [(a)]
			Willow *spp.*	Poison ivy [(w)]
		Cinnamon fern [(a)]		Cranberry *spp.*
				Jewelweed
		Crested wood fern	Labrador tea	Blue flag
				Three-leaf false Solomon's seal
				Cotton grass
Poor	*Sphagnum spp.* [(a)]	Sensitive fern	Leatherleaf	Pitcher plant

[a] = the greater the abundance, the wetter the site

[w] = western Nova Scotia

Stair-step moss

Common green sphagnum



New York fern *(photo: John Gillis)*

Lady fern

Interrupted fern

Cinnamon fern

Crested wood fern

Sensitive fern

False holly

Speckled alder

Winterberry

Willow
(photo: Robert H. Mohlenbrock @ USDA–NRCS PLANTS Database)

Labrador tea

Leatherleaf

Creeping snowberry

Dwarf raspberry

Sedge (Carex sp.)

Poison ivy

Cranberry (photo: John Gillis)

Jewelweed

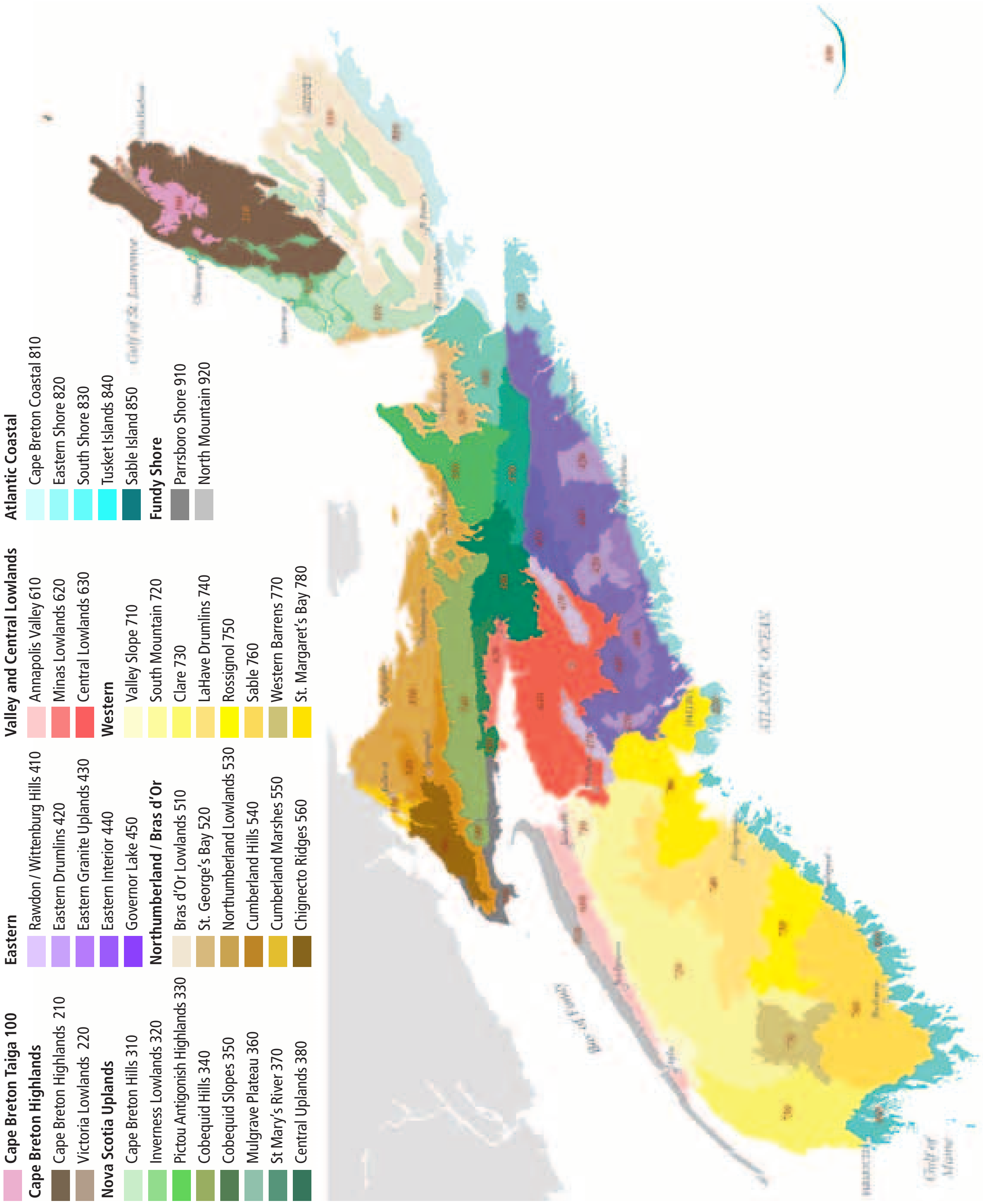
Blue flag (photo: John Gillis)

Three-leaf false Solomon's seal

Cottongrass

Pitcher plant

Appendix I
Ecoregions and ecodistricts of Nova Scotia



Appendix J
Glossary

Ecological and forest management related terms found in this guide are defined below. References are given where definitions (or portions thereof) have been taken directly from other sources. For more on soil terminology and conventions, see Appendix A.

Aeration porosity – in soils, pore space mainly associated with gas exchange.

Anaerobic (reducing) conditions – in microbially active soils, a condition where oxygen is absent or in very low concentrations for a prolonged period usually due to water saturation.

Aspect – the direction of a downhill slope expressed in degrees or as a compass point.

Bearing capacity – the capacity of soil to support a load or pressure without failure (Craig 1997).

Capillary action – in soils, the condition by which water is drawn up through small diameter pores as a result of surface tension (AGI 1984).

Disturbance – a discreet force that causes significant change in structure and/or composition of a forest (Dunster and Dunster 1996). Also see Natural disturbance.

Drumlin – A low, smoothly rounded, elongate hill of compact glacial till built under the margin of the ice and shaped by its flow. Its long axis is parallel to the direction of ice movement (AGI 1984).

Ecodistrict – a subdivision of ecoregion and the third level within the Nova Scotia ecological land classification system. It is based on distinct assemblages of relief, geology and landform.

Ecological land classification – a classification of lands from an ecological perspective based on factors such as climate, physiography, and site conditions. It is a framework used to delineate ecosystems at different landscape scales and includes five levels: ecozone, ecoregion, ecodistrict, ecosection and ecosite.

Ecoregion – the second level in the Nova Scotia ecological land classification system used to characterize a distinctive regional climate as expressed by vegetation. There are nine ecoregions identified in Nova Scotia.

Ecosite – a unit which represent ecosystems that have developed under a variety of conditions and influences, but which have similar moisture and nutrient regimes. Ecosite is found in both the landscape-level ecological land classification and the stand-level forest ecosystem classification systems.

Edatopic grid – a two-dimensional diagram used to plot ecosystems (and subsequently ecosites) with respect to their relative moisture and nutrient regimes.

Ericaceous – plants in or related to the heather family (Ericaceae) usually found on acidic (nutrient poor) soils including (*Kalmia spp.*, *Vaccinium spp*. and *Rhododendron spp.*) (Dunster and Dunster 1996).

Forest – in this guide, sites which can (and normally do) support a minimum of 30% crown closure by trees.

Forest floor – a general term encompassing the layer of undecomposed organic matter (leaves, twigs and plant remains in various stages of decomposition) lying on top of the mineral soil (Dunster and Dunster 1996). Often referred to as the duff layer.

Graminoid – grasses (Poaceae family) and grass-like plants such as sedges (*Carex spp.*) and rushes (*Juncus spp.*).

Ground water – that part of subsurface water that is in the zone of saturation, including underground streams (AGI 1984).

Humus form – a system for describing and classifying organic (forest floor) horizons. See Appendix D for more details.

Landscape – an expanse of land with landforms, land cover, habitats, and natural features which are repeated in similar form and that, taken together, form a composite (Dunster and Dunster 1996).

Mafic – referring to igneous rock composed chiefly of dark, ferromagnesian minerals (AGI 1984) (i.e. basalt and gabbro).

Matrix forest – a widespread forest community which dominates the landscape and forms the background in which other smaller scale communities occur (Thompson 2002).

Natural disturbance – a natural force that causes significant change in forest stand structure and/or composition such as fire, wind, flood, insect damage, and disease.

Natural disturbance regime – the frequency and type of natural disturbances that influence the arrangement of forested ecosystems and their biodiversity on a given landscape. Three disturbance regimes recognized in Nova Scotia are:

Frequent: Disturbances which result in the rapid mortality of an existing stand and the establishment of a new stand of relatively even-age. The time interval between stand initiating events typically occurs more frequently than the longevity of the climax species that would occupy the site – therefore, evidence of gap dynamics and understory recruitment is usually absent. This regime results in the establishment and perpetuation of early to mid successional vegetation types.

Infrequent: Stand initiating disturbances which result in the rapid mortality of an existing stand and the establishment of a new stand of relatively even-age but the time interval between events is normally longer than the average longevity of the dominant species – thereby allowing gap dynamics and understory recruitment to evolve and become evident (eventually creating uneven-aged stands). This regime generally leads to the establishment and/or perpetuation of mid to late successional vegetation types.

Gap replacement: Stand initiating disturbances are rare. Instead disturbances are characterized by gap and small patch mortality, followed by understory recruitment, resulting in stands with multiple age classes. This regime generally leads to the establishment and/or perpetuation of late successional vegetation types.

Open woodland – in this guide, upland sites which (due to natural disturbances and/or site conditions) are generally limited to less than 30% crown closure by trees.

Patch forest – a discrete forest community nested within a matrix forest (Thompson 2002).

Seepage – in this guide, all lateral subsurface water flow (includes precipitation and spring sources).

Shear strength – the ability of a material or body to resist tangential movement against frictional and cohesion forces (AGI 1984).

Soil bulk density – the ratio of soil solid mass to total soil volume including voids.

Stand – in the case of forests, a group of trees in a specific area which are sufficiently uniform in composition, age, arrangement and condition to be distinguishable from adjacent forest areas (Dunster and Dunster 1996).

Windthrow – a disturbance where a tree (or trees) has been uprooted by the force of the wind. Over time, windthrow leads to the development of mound and pit microtopography. Windthrow is synonymous with blowdown.