An Introduction to Soil Types

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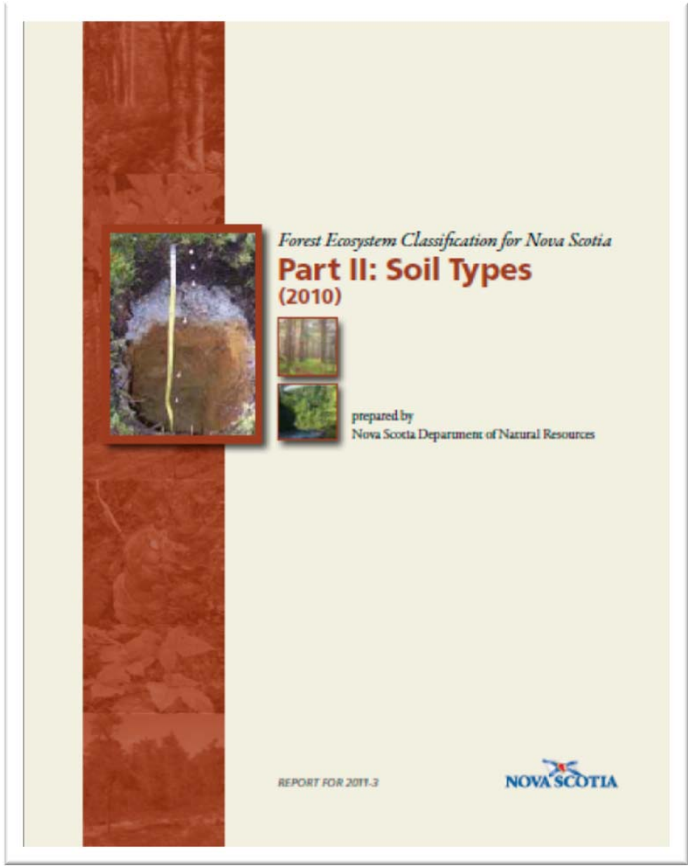
An Introduction to Soil Types

How to use Nova Scotia's new Forest Ecosystem Classification manual to identify soil types, and use this information to help manage your forested land.

In this presentation we will provide an overview of Part II of the Forest Ecosystem Classification Manual for Nova Scotia, which is devoted to soil types.



Introduction to Soils

What soils are made of and why it matters.

Soil is where most life is based, where we grow our food, what grows our trees and builds our forest ecosystems and what filters our drinking water.

It is important to understand the soils on a site in order to know what it is capable of growing there.

Information about soils also is used to limit damage to the site and ensure the long-term health of your woodlot.

Soil is mostly composed of rock that has been broken down by natural processes. This referred to as the *mineral* component.

In addition to minerals, soils contain:

- *Organic* material, which is derived from animals and plants.
- *Pore space*, which is occupied by water or air.
- Complex plant, animal and microbial communities responsible for decomposition and nutrient cycling.

Mineral soil is often covered by a layer of organic material called the *forest floor* or *duff layer*.

The mineral component of soil is divided into *sand*, *silt* or *clay* depending on the size of the soil particles.

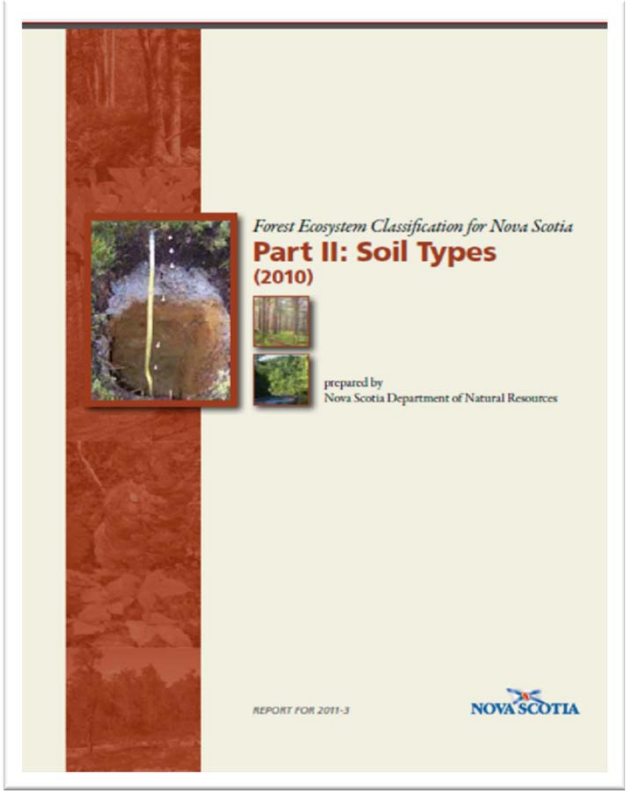
Particles more than 2 mm in size are called *coarse fragments.* These include gravel, cobbles, stones and boulders.

The balance of clay, sand and silt in the soil affects what plants can grow in the soil and how well the plants will grow. Factors that influence plant growth include:

- How well the soil holds moisture (soil drainage).
- How fertile the soil is (that is, whether moisture and nutrients are available for plant growth).

A soil that is about 40% sand, 40% silt and 20% clay is called a *loam*. From an agricultural perspective, loams are considered highly productive because they can grow a wide variety of commercially valuable plants.

Part II of the Forest Ecosystem Classification manual includes extensive information on soils, soil types and hazards associated with conducting forestry operations on different types of soils.



Introduction to Soil Types & Soil Phases

What soil types and soil phases are. What you need to know in order to identify them.

Introduction

What are soil types and how are they distinguished from one another?

The FEC manual identifies 19 soil types in Nova Scotia. Each is known as *ST* (for *soil type*) plus a number.

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		

Of the 19 soil types, 17 are distinguished based on the following characteristics:

- **Texture**: Texture may be *medium to coarse* (MCT) or *fine to medium* (FMT).
- **Moisture content**: Soils may be *wet*, *moist*, *fresh* or *dry*.
- **Fertility**: Specified only if the soil is considered *rich*.
- **Depth**: Specified only if the soil is considered *shallow*.

There are six fine-to-medium textured soil types (that is, types with a clay content of 20% or more). These are distinguished from each other based on moisture and fertility.

FMT Soils		
		Rich
Dry		
Fresh	ST5	ST11
Moist	ST6	ST12
Wet	ST7	ST13

There are 11 medium-to-coarse textured soil types (that is, with a clay content less than 20% plus a range of sand content). These are distinguished from each other based on moisture, fertility and depth.

MCT Soils				
		Rich	Shallow	Rich & Shallow
Dry	ST1		ST15	ST17
Fresh	ST2	ST8		
Moist	ST3	ST9	ST16	ST18
Wet	ST4	ST10		

The remaining two soil types are:

- **Organic (ST14)**: This soil is composed of a deep layer of decomposing plant and animal material.
- **Talus (T19):** Talus is broken rock produced by weathering of a rock face, and is typically found at the bottom of a slope or cliff.

In order to identify soil types, it is usually necessary to dig a soil pit:

- **Choose** an area or areas representative of the forest stand being assessed.
- **Dig** a hole to a depth of about two shovel heads. This is approximately 60 cm (2 feet).

Instead of using a shovel, it is also possible to use a tool called a *soil auger*. This is the easiest way to confirm soil type. The Soil Types manual contains instructions for using this tool.

Talus Soils, Organic Soils, Shallow Soils

What is a talus soil? What is an organic soil? How do you identify a shallow soil?

In order to identify a soil type, you will first need to be able to determine whether the soil is

- An organic soil.
- A talus soil.
- A shallow soil.

Talus soils are mainly found on or at the foot of slopes in the Cape Breton Highlands and the North Mountain area but may occur in the Cobequid Hills and Pictou Antigonish Highlands.

The surface of a talus soil will be mainly covered by bare, angular stone with pockets of organic matter between the rock fragments.

An organic soil is identified based on the depth of surface organic material. This material is primarily composed of plant material such as leaves. These materials may still be visible in the soil, or they may be partially or entirely rotted or decomposed.

If surface organic material is at least 40 cm deep the soil is classified as organic.

Below the organic material on the surface is the mineral soil. To determine the depth of mineral soil, measure the distance between the layer of organic material on the surface and either *bedrock* or *fully cemented soil*:

- **Bedrock** is the underlying rock from which much of the mineral soil originates.
- **A cemented soil** will strongly resist being penetrated by a shovel. It will appear to be frozen or rock-like.

If the average depth of mineral soil is equal to or less than 30 cm, the soil is considered shallow.

How to Determine Soil Texture

What is soil texture? How is it determined? What does it mean? What do you need to know about soil *texture* in order to determine soil *type*?

Soil texture is based on particle size, which in turn depends on the amount of sand, clay and silt present in the soil:

- **Sand** has relatively large particles (0.05-2.0 mm).
- **Silt** has medium-sized particles (0.002-0.05 mm).
- **Clay** has small particles (less than 0.002 mm).

Soil scientists classify soil textures into more than a dozen combinations of these basic ingredients.

1. Heavy clay
2. Silty clay
3. Clay
4. Sandy clay
5. Silty clay loam
6. Clay loam
7. Sandy clay loam
8. Silt
9. Silt loam
10. Loam
11. Sandy loam
12. Loamy sand
13. Sand

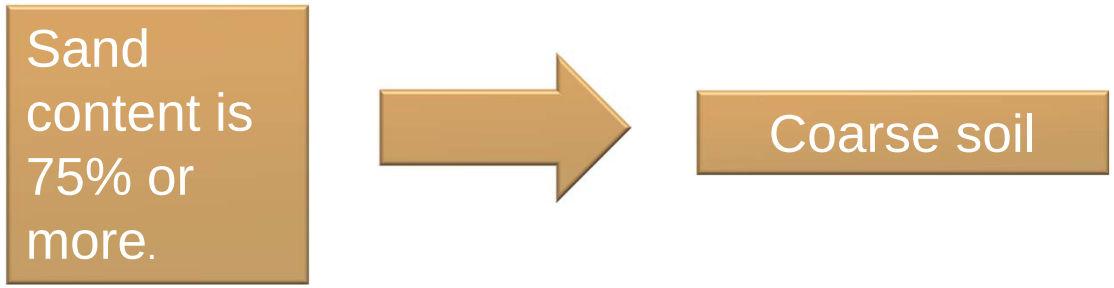
Fortunately, in order to determine soil type, it is only necessary to know:

- Whether the soil is more than 75% sand.
- Whether the soil is more than 20% clay.

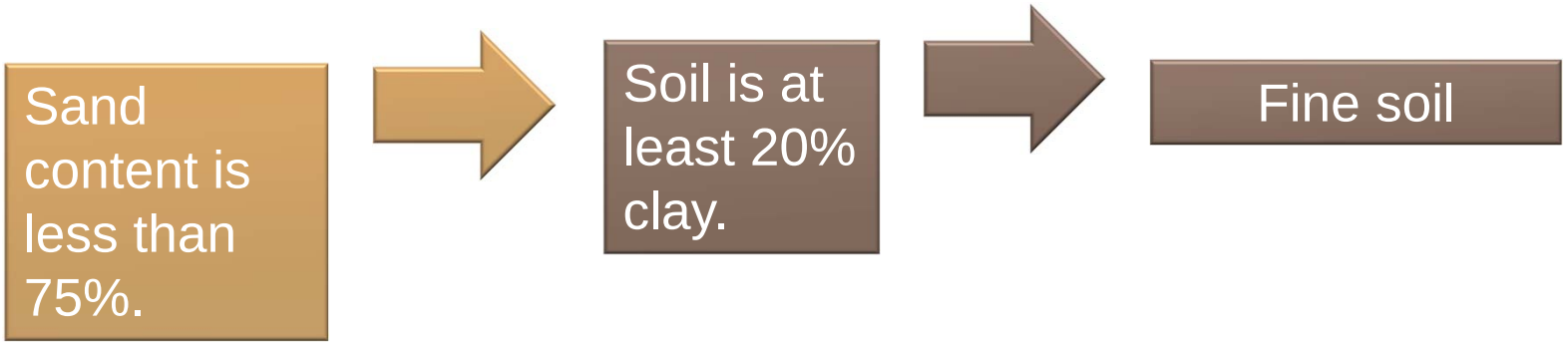
A third *threshold point*, 50% sand, is used to determine one of the soil phases.

This is done by examining a soil sample. The Soil Types manual has instructions and photographs on how to do this.

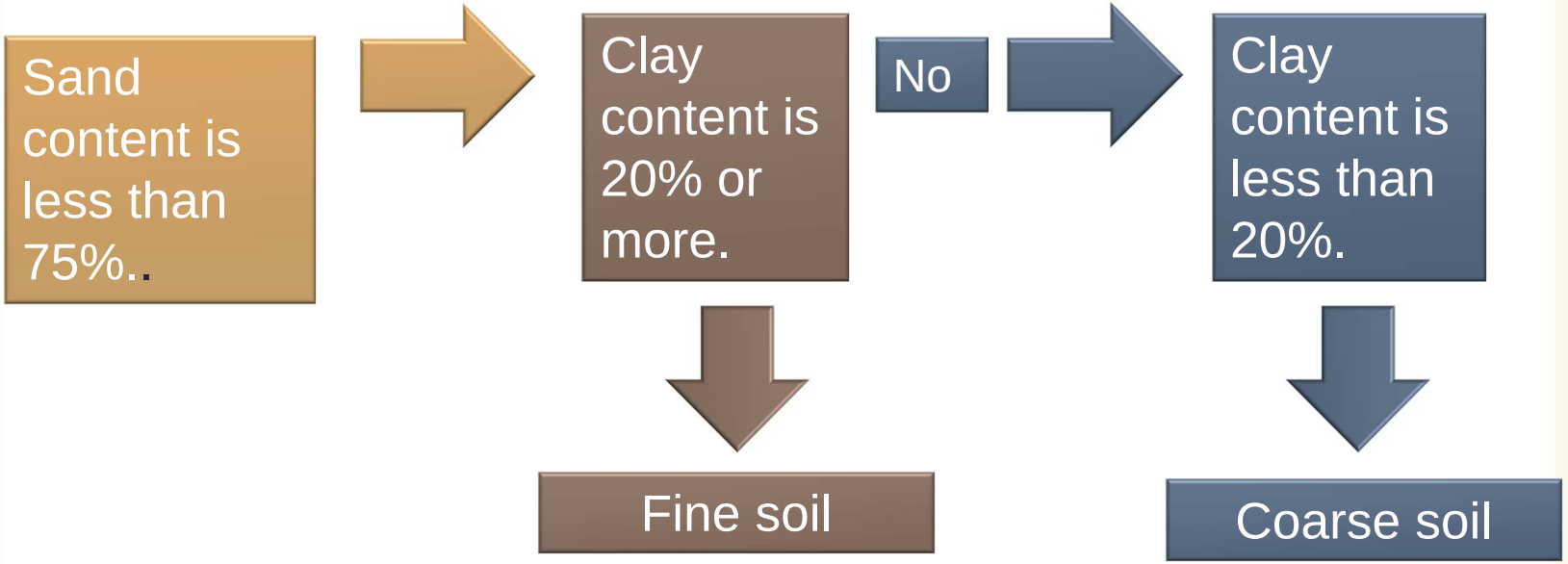
If sand content is more than 75%, there will not be a noticeable amount of smooth material in the soil sample. This is a coarse soil.



The more clay in the soil, the stickier it will feel when moist. If the soil is distinctly, very or extremely sticky, it is at least 20% clay. This is a **fine** soil.



If the soil is less than 75% sand and the clay content is *less than* 20% (is no more than slightly sticky), it is a **coarse** soil.



If clay is less than 20% and sand is less than 50%, the soil will feel mainly smooth (but not overly sticky), and the soil is medium-textured or *loamy*.

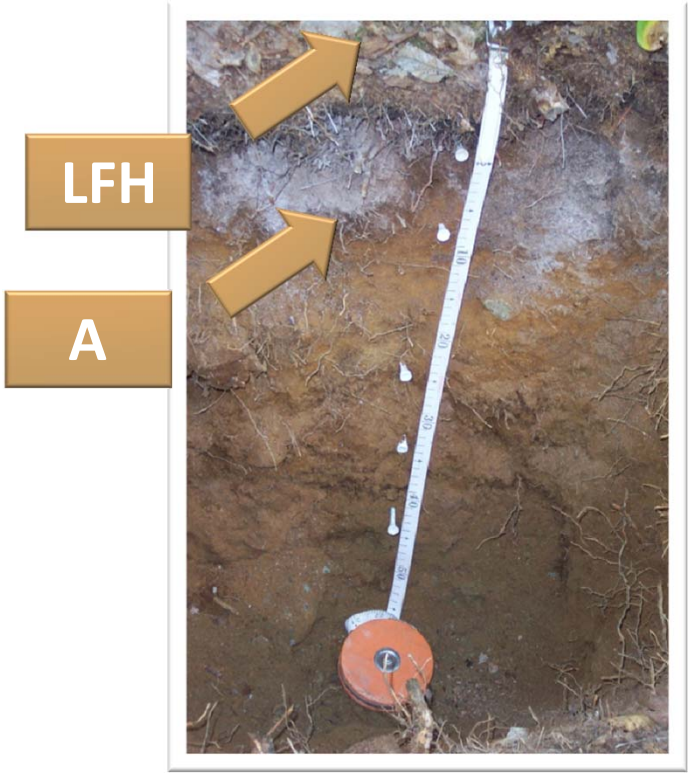
How to Identify Organically Enriched Mineral Soil

What is a soil horizon? What are Ah and Ap horizons? How do you distinguish them from other soil horizons?

Soils are formed in layers called *horizons*. These layers can be distinguished from one another based on characteristics such as colour and texture.

Soil scientists identify soil horizons using capital letters. For upland sites, an *LFH horizon*, if present, consists of organic material. Wetland organic horizons are called *O horizons*.

The top level of mineral soil is the *A horizon*.



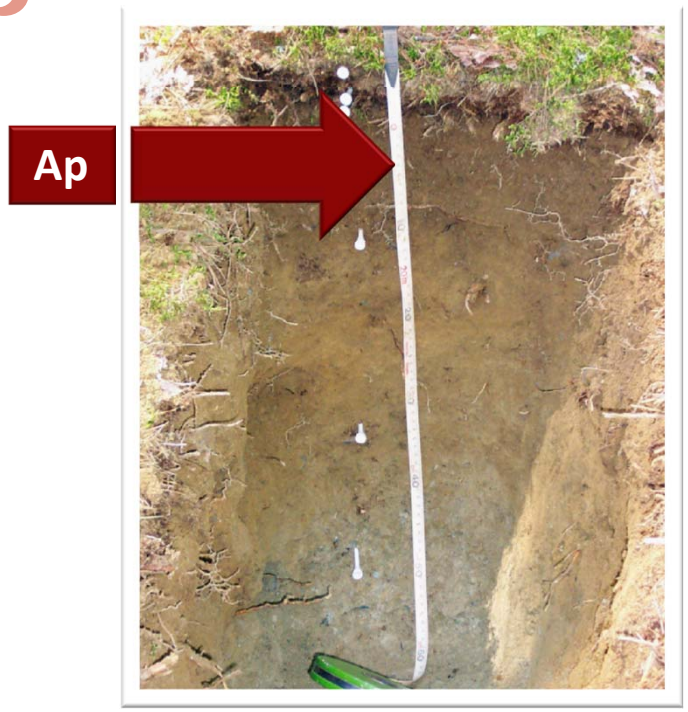
Mineral soil in the A horizon may be enriched with organic material. Such soil will be coloured black or dark brown due to the presence of organic material.

There are two types of organically enriched mineral soils:

- ***Ah* horizons** are caused by natural mixing of organic matter with mineral soil, mainly by worms.
- ***Ap* horizons** occur when human activities such as agriculture mix organic materials with mineral soil.

Both will be a solid dark colour. Also look for:

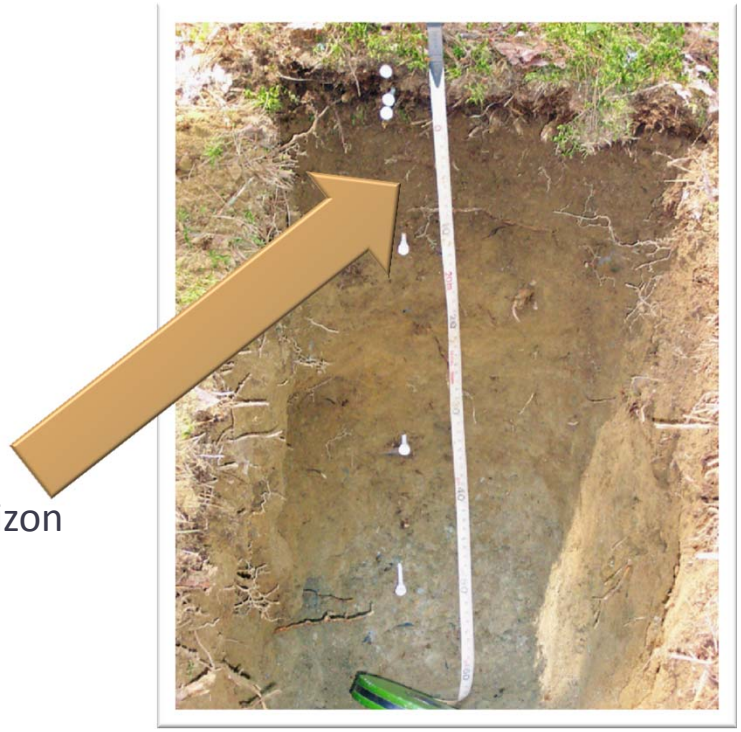
- Large number of fine plant roots due to availability of nutrients.
- Distinctive granular structure due to earthworm activity.



Well-developed Ah and Ap horizons will be unbroken (with no gaps).

Well-developed Ah horizon

A well-developed Ah or Ap horizon will also be at least 3 cm thick.



Well-developed Ap horizon

A soil that does not contain organic material will often be whitish or pinkish in colour.

This is known as an Ae horizon. Ae horizons are much more common than Ah horizons in Nova Scotia, especially under softwood and mixedwood cover.

How to assess soil drainage condition

What factors affect soil drainage? What site features provide clues that the site may be poorly or imperfectly drained? What are redoximorphic (REDOX) features?

Soil drainage is affected by a number of factors, including soil texture and depth. Coarser and shallower soils tend to be drier than deeper and finer soils.

Slope position can also be used as an indicator of moisture condition:

- Soils found on exposed ridges and upper slopes tend to be dry.
- Soils found on mid-slopes tend to be fresh.
- Soils found on lower slopes tend to be moist.
- Soils found at the base of slopes or in depressions between slopes tend to be wet.

Some site features are clues that a site is probably wet:

- Proximity to surface water and wetlands.
- Location in a depression or other area where water can collect.
- Position on a level area along a longer slope, where water may seep in and collect from higher on the slope.
- Presence of plants that are associated with wet sites, such as sphagnum moss and cinnamon fern.

A key consideration in identifying some soil types is the presence or absence of what are known as *redoximorphic* or *REDOX* features.

These features generally develop in soils when they are saturated with water for long periods of time, depriving them of oxygen. When this happens, iron in the soil can undergo chemical (REDOX) reactions that change the appearance and colour of the soil.

REDOX features include soil with a “mottled” appearance and/or soils dominated by dull, grey colours. The Soil Types manual contains information and photos to aid in identification.

Quick Overview of Soil Phases

What are the soil phases? How are they identified?

The Soils Types manual discusses six soil *phases*.

These are soil features that may be important when making management decisions but are not so significant that they signify a different soil type.

A particular soil phase may be found in more than one soil type. They are not a concern in all soils.

For example, an organic soil may be considered to have an **upland (U) phase** if the soil did *not* originate with wetland vegetation such as sphagnum moss.

This is only a concern if you are dealing with an organic soil.

Most of the other phases are only a concern when working with some medium-to-coarse textured soils:

- **Coarse-phase (C) soils** are identified based on sand content or the content of gravel and cobble in the soil.
- **Granite-phase (G) soils** are identified based on presence of granite stones on the soil surface.
- **Loamy-phase (L) soils** are identified when the mineral soil is less than 50% sand and 20% clay.

Stony (S) phase is the only phase that can occur in almost any soil type. It is determined based on the amount of coarse rock fragments, such as stones and boulders, in the soil.

The FEC Soils Type manual explains how to identify the various soil phases.

How to Use a Soil Key

What a soil key is and how it's used.

Just like the forest group key and vegetation type key introduced in the discussion of the Vegetation Types manual, a soil key is a series of yes/no questions that, if followed correctly, leads to identification of the item you are studying.

To use the Soils Type key, start with item one, which asks whether the soil is organic. If the answer is no, the key directs you to item 2.

1a. Surface organic thickness is ≥ 40 cm	go to **ORGANIC SOIL key**
1b. Not as above	2

Item 2 asks whether this is a talus soil. If not, the key says to proceed to item 3, which asks whether the soil is shallow.

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

If the soil is not shallow, the key says to proceed to item 4, which asks about clay content.

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

If the clay content is less than 20% in the majority of soil between 30 cm and 60 cm below the mineral soil surface, the key directs you to Item 5.

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

If the soil does not have fine and coarse layers near the surface, as described in the key, the key directs you to the **coarse soil key**.

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**

The first item on the coarse soil key asks about organically enriched mineral soil. If the soil fits the description in Item 1a, the key directs you to Item 2.

COARSE SOIL key

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

1b. Not as above 6

Item 2 asks about REDOX features. If REDOX features are present in the top 30 cm of mineral soil, the key directs you to Item 3.

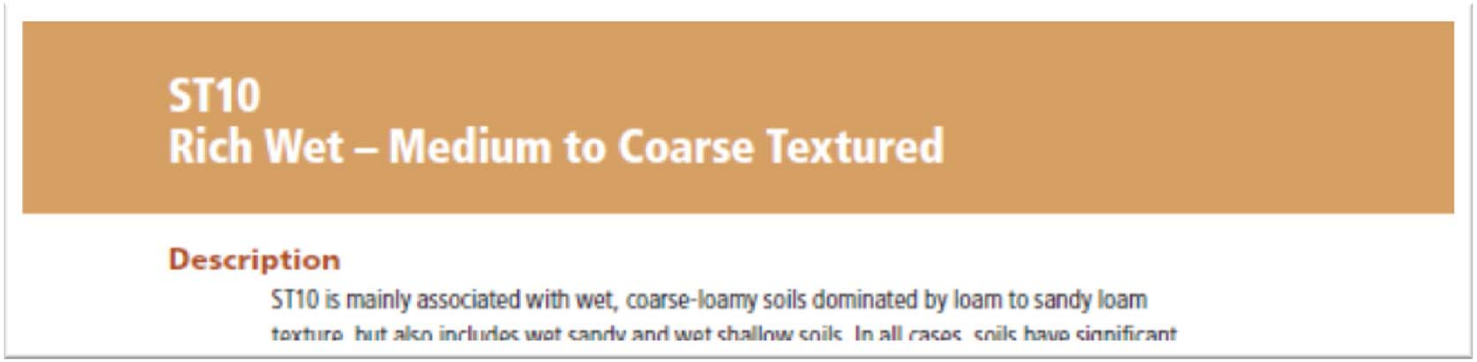
2a. REDOX features are present within top 30 cm of mineral soil (i.e. soil is imperfectly drained or worse) 3

2b. Not as above 5

If REDOX features are dominant in the top 30 cm of mineral soil, the key tells you that this is Soil Type 10.

3a.	REDOX features are dominant within top 30 cm of mineral soil (i.e. soil is poorly drained) **ST10**
3b.	Not as above. 4

Refer to the fact sheet for this soil type for more information.



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

The information will include a detailed description …

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.

Information about soil phases ...

This *S* indicates that an S (stony) phase is possible for this soil type, but other phases are not a concern.

Where these soils are typically found …

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 such as fertility, moisture, drainage and vegetation types associated with the soil type …

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.

Photographs …

And hazard ratings that tell you risks of conducting specific operations on this soil type.

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

Use the description and photographs for the soil type in order to confirm your identification. If the description does not fit the soil type, go back and re-assess.

Introduction to Hazard Ratings

How information in the Soil Types manual can help to limit hazards associated with different soil types.

Hazard ratings tell you which soil types pose the greatest risk of various types of damage. Hazards are classified as:

- **Low**
- **Moderate**
- **High**
- **Very high**

The hazards associated with different soil types are:

- **Soil compaction**
- **Rutting**
- **Erosion**
- **Frost heave**
- **Sensitivity to forest floor loss**

In addition, **windthrow** is also a possible hazard. The manual explains how to assess windthrow hazard based on a combination of soil type and site exposure.

The Soil Types manual includes sections on each hazard, including what factors increase or decrease risk. This is followed by a discussion of ways to prevent negative impacts during operations.

The manual also explains that hazards change depending on day-to-day moisture conditions. The manual explains a method for determining how wet a soil is on a given day.

Credits

Designed by Flora Johnson using Microsoft PowerPoint® software. Text by Flora Johnson, Patricia Amero RPF and staff of the Nova Scotia Department of Natural Resources. All photos from the NSDNR Forest Ecosystem Classification Manual.