

Model Process Technical Resources

**Updated Model Process Technical Resources to the Suitability and Viability of
Subdivisions Relying on Private Sewage Systems (2011)**

Prepared by the Alberta Association of Municipal Districts & Counties
in partnership with Alberta Municipal Affairs

February 1, 2011



Partners in Advocacy & Business

Model Process Technical Resources

Updated Model Process Technical Resources to Guide Municipal Consideration
of Subdivision and Development Using Private Sewage Treatment Systems (2011)

Prepared by the Alberta Association of Municipal Districts and Counties

In partnership with Alberta Municipal Affairs

Based on Model Process Reference Document to Guide Municipal Consideration
of Subdivision and Development Using Private Sewage Treatment Systems (2004)

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The Model Process Technical Resources details the requirements for the site evaluation, methodology, soil log, lot diagrams, water quality and impact risk Assessment.

Introduction

The Model Process is divided into two distinct documents that separate the process of approval requirements from the technical work that is required to complete the submission. Such a division is meant to provide more clarity and interpretation and to make the documents more useful to different review and approval departments within the municipality. These documents are titled:

1. Model Process Guidance Document
2. Model Process Technical Resources

The Model Process Guidance Document provides details of the municipal process to approve subdivision in cases where private sewage is proposed. The document indicates the level of assessment and required information to support the subdivision application.

The Model Process Technical Resources detail the requirements for the site evaluation, methodology, soil log, lot diagrams, water quality, and impact risk assessment.

Technical Resources to Support Model Process

A number of reference documents have been created to augment the Model Process Guidance Document. The following documents are ones that support the Model Process Guidance Document:

1. **Detailed Site Evaluation Methodology** – A detailed checklist that outlines a common methodology for the site evaluation.
2. **Private Sewage Treatment System Soil Log Form** – An example log form for a soils evaluation and description.
3. **PSTS Soil Description Manual** – A detailed manual for completing soil description and characterization. Provided by EBA Engineering
4. **Technical Guideline for Private Sewage Disposal Systems** – A guideline for water quality impact risk assessment.
5. **Example Level Three Site Assessment Report** – An example report submitted to the AAMDC for a Level Three site review (available separately).

The above reference documents were created to support the Model Process and provide regulators, site evaluators, designers, and installers an additional resource for determining the feasibility of a site for onsite wastewater treatment and disposal.



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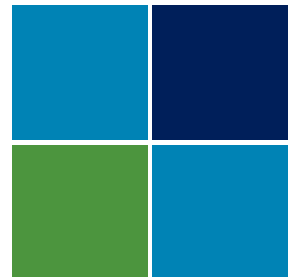
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This document sets out a common methodology for site evaluation to gather information that supports the Model Process. For information on the number of test pits/boreholes or other information required to properly assess a particular site, please refer to **Site Assessment Guidelines and Requirements for the Site Evaluator (Model Process Tool #2)**.

Target Audience: Site Evaluators



1 Detailed Site Evaluation Methodology

Overall Site Evaluation

Process Steps for Overall Site Evaluation

- Identify limiting characteristics affecting system placement on the parcel.

Information to be Collected

- Take pictures of overall site
- Take pictures of particular soils and any anomalies
- Note slope, direction of slope and possible drainage courses
- Note position of system on slope (crest, upper slope, etc.)
- Note the dominant vegetation and proximity and type of trees
- Note the existence of any structurally deficient soils subject to major wind or water erosion events (i.e., slide zones and dunes)
- Report the existence of any designated flood plains
- Note the location of any existing encumbrances (i.e., wells, water sources, surface water, outcrops of bedrock or restrictive layers, buildings, property lines, lines of easement, interceptors or drainage ditches, cuts, banks, fills, driveways or parking areas, existing on-site sewer systems, or underground utilities).



Select Test Pit/Borehole Location

Once a potential location has been chosen for a sewage system, an on-site investigation of soil properties is undertaken. Before any disturbance of the ground is conducted, it is necessary to have buried utility lines located and marked. The area of ground to be disturbed should be marked with flags so the area under investigation is clearly delineated.

To ensure that all underground utilities and structures are located, the proponent should complete the following.

- a. Contact Alberta One Call.
 - i. Web: alberta1call.com – click on “submit locate request”
 - ii. Phone: 1-800-242-3447
 - iii. Fax: 1-800-940-3447
- b. Contact the local gas co-op and find out if there are any pipelines or service lines at your location (or ask your private locator to do this).
- c. Contact the Energy Resources Conservation Board (ERCB) and find out if there are any pipelines at your location (or ask your private locator to do this).
- d. Have a private line location company conduct a survey for underground utilities and structures in the area where you plan to dig.
- e. It is recommended that anyone conducting ground disturbance activities complete a ground disturbance training course.

Process Steps for Selecting Test Pit/Borehold Location(s)

- Pick site(s) near, but not under proposed onsite system
- The depth of investigation should be based on the depth below the infiltration layer to limiting features required for the proposed system: at least 1.0 m below for secondary treatment and 1.5 m below for primary treatment.

Information to be Collected

- Location of soil absorption field
- Location of test hole(s)
- The reason for the depth to which the soil was assessed should be documented in the report

Excavation Pit(s)

- Excavate pit to maximum depth of 1.5 m (5 feet) for entry and examination of pit walls (follow Alberta Occupational Health and Safety Guidelines Part 10, section 171, 172, and 173).
- Orient pit so sunlight illuminates vertical face of pit

Information to be Collected

- Soil profile examination depth





Drill Borehole(s)

Process Steps for Drilling Bore Hole(s)

- Push Shelby tube to 1.5 m with drill truck if soil is suitable
- Driller will set soil core on flat surface for examination (tail gate with plywood surface works well)
- Drill to 3 m to obtain deeper soil sample
- Examine soil on auger flights and take samples at appropriate depths

Intact Core(s)

Process Steps for Drilling Intact Cores

- Push core tube to 1.5 m with equipment if soil is suitable
- Driller will set soil core on flat surface for examination (tail gate with plywood surface works well)
- Drill to 3 m to obtains deeper soil sample
- Examine soil on auger flights and take samples at appropriate depths

Acquire Soil from Below 1.5m for Examination if Required for Proposed System Type

Process Steps for Acquiring Soil from Below 1.5m

- Have hoe operator bring soil from below 1.5 m to the surface for examination (do not enter a test pit that is more than 1.5 m deep without proper cribbing)

Information to be Collected

- Soil texture and structure changes
- Signs of seasonally saturated conditions

Expose Natural Soil Structure

Process Steps for Exposing Natural Soil Structure

- Use soil knife, blade, screwdriver or other tool to pick at area 0.5 m wide along full height of pit wall
- Use soil knife, blade etc to cut open soil brought up from below 1.5 m by hoe bucket
- Use soil knife, blade etc to cut open soil core
- Use soil knife, blade etc to scrape off smeared outer layer of soil on auger

Information to be Collected

- Soil characteristics of the soil profile (horizons), e.g. Soil texture, structure, and indicators of conditions that affect on-site system design.





Describe Soil Horizons

Process Steps for Describing Soil Horizons

- Note master soil horizon layers
- Describe features of each horizon

Information to be Collected

- List soil horizon features using CSSC soil descriptions:
 - Depth of horizon, thickness
 - Name of soil horizon (A,B,C)
 - Colour (hue, value, chroma)
 - Identify mottling, gleying (abundance, size, distinctness)
 - Size, shape, type of rock
 - Texture of < 2mm fraction of horizon
 - Soil structure
 - Soil consistence (friable, firm, hard)
 - Abundance, size distribution of roots
 - Moisture content
 - Volumetric percentage of rock (coarse fragments)
 - Presence/absence of carbonates
 - Presence/absence of precipitates (i.e. salts, iron staining)
 - Parent material (lacustrine [lake deposit], fluvial [river deposit], eolian [wind deposit] or till)
 - Inclusions (coal fragments, iron stones).

Determine Soil Changes Across Site Area

Process Steps for Determining Soil Changes Across Site

- Look for lateral changes in soil profile
- Use auger and/or compare to profile of second pit

Information to be Collected

- Determine changes, if any, in soil profile across proposed site

Interpret Results

Process Steps for Interpreting Results

- Identify limiting depths
- Identify soil textures and structure that are the key design factors.

Information to be Collected

- Check vertical separation distances
- Identify mottled layers, gleying.
- Determine depth to saturated soils
- Measure depth to limiting soil layers
- Identify highly permeable layers and depth



Take Samples for Laboratory Sample Analysis

Process Steps for Lab Texture Analysis

- Take a sample of the soil below the infiltration depth
- Take a sample of the soil in the limiting layer
- Submit samples to an accredited lab for particle size analysis

Information to be Collected

- Document depth of samples taken
- Document results of particle size analysis

Report Site Evaluation Findings

Process Steps for Reporting Findings

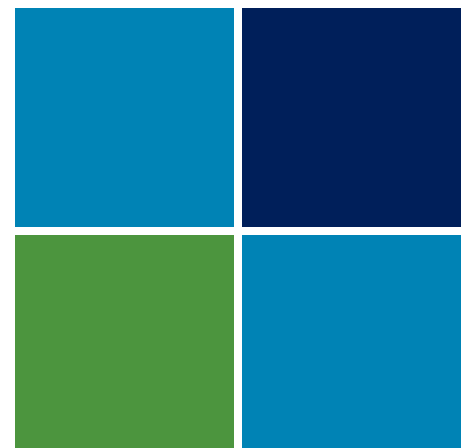
- Log all data in required format (Soil Log Form)
- Complete Lot Diagram

Summarize Limiting Features of the Parcel/Site

- Depth to groundwater or seasonally saturated soils
- Soil characteristics that limit selection of treatment system types
- Render opinion of level of suitability of soils for on-site systems (see Model Process Tool #10 "Determining Parcel/Site Suitability Type")
- Offer opinion on merits of various system types and best type of system for the site.
- Develop system design, size, shape/layout, depth, initial treatment requirements, and location and installation recommendations

Some Additional Resources

- Soil surveys have been done to provide a partial inventory of soil resources in Alberta. The soil survey reports are available from Alberta Agriculture, Food and Rural Development (AAFRD). They are an excellent resource for preliminary assessment of soils in an area.
- AAFRD also maintains a digital database (AGRASID) consisting of seamless Geographic Information System (GIS) coverages and relational data files that describe the soil landscapes for the agricultural area of Alberta. The AGRASID system can be found on-line at <http://www.agric.gov.ab.ca/soil/agrasid/manual.html>.
- Use soil names and particle size limits found in the Canadian System of Soil Classification (CSSC).
- Use the PSTS Soil Description Manual adapted by EBA.





2 Soils Log Form

Private Sewage Treatment System Soil Log Form

Owner Name or Job ID:	
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Legal Land Location					Plan	Block	Lot	GPS Coordinates
LSD-1/4	Sec	Twp	Rg	Mer				

Aerial Photos	
General Vegetation	

Topography	
Overall Site Slope %	
Slope Position of System	

Test Hole #	Soil Subgroup	Parent Material	Drainage Class	Sample 1 Depth	Sample 2 Depth

Horizon	Depth (cm)	Texture	Colour	Gleyed	Mottled	Structure	Consistence	Moisture	%CF

Depth to Groundwater	
Depth to Seasonally Saturated Soil	
Limiting Topography	

Limiting Soil Layer Char. (describe)	
Dept to Limiting Soil Layer	
Depth to Highly Permeable Layer	

Key Limiting System Design Characteristic	
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Comments

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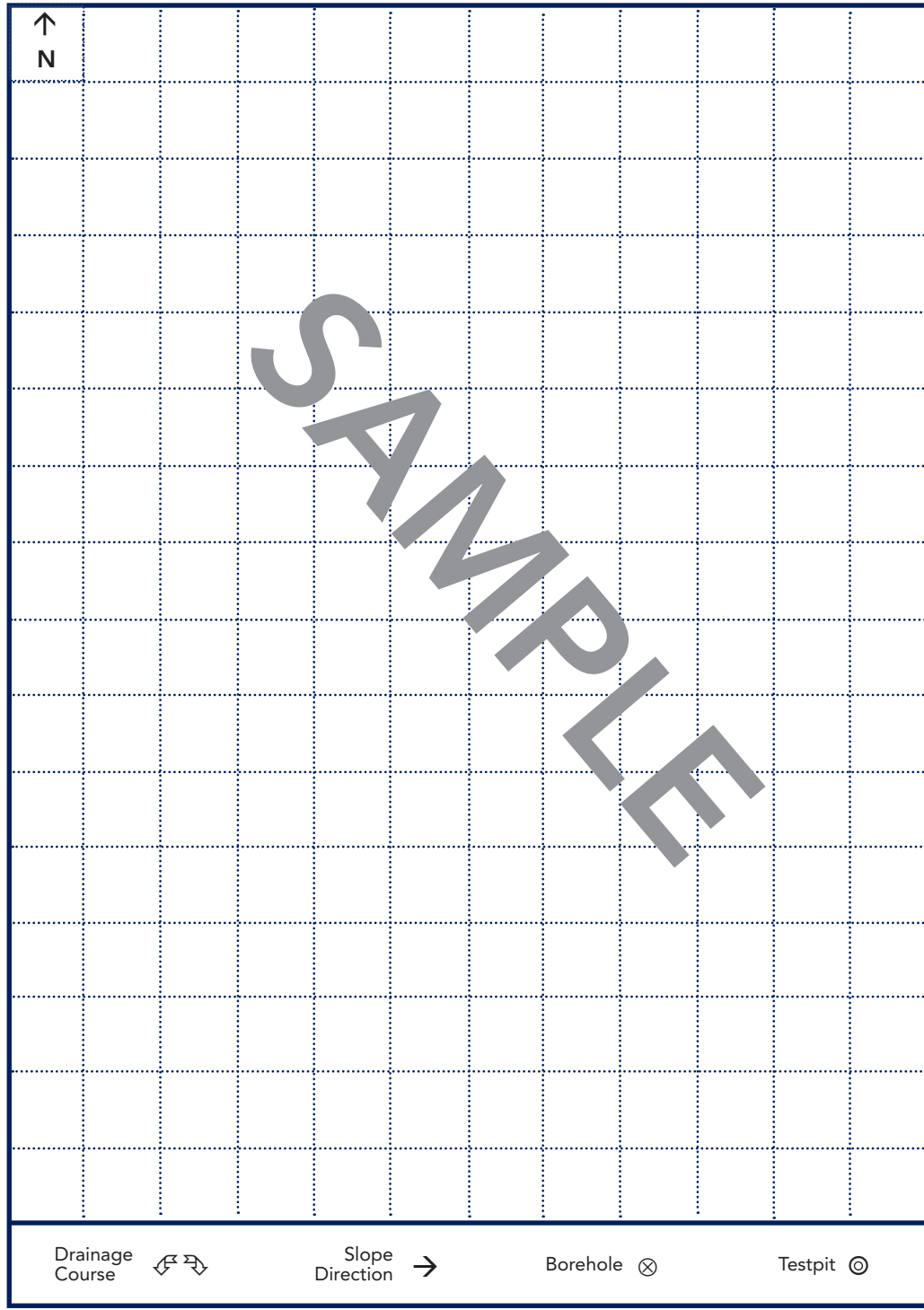
Note: Use soil names, description and particle size limits found in the Canadian System of Soil Classification (CSCC)



3 Lot Evaluation Diagram

Sample Onsite Sewage System Evaluation Diagram

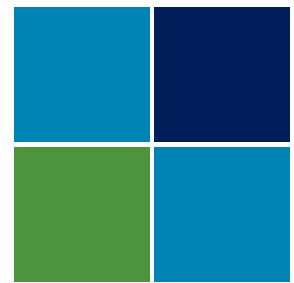
Project Name:	Lot or Legal Dscp	Date
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- Directions**
 Show the proposed location of the onsite sewage system and the following items indicating their distance from the proposed system:
- trees
 - floodplains
 - wells
 - water sources
 - surface water
 - bedrock
 - outcrops
 - buildings
 - property lines
 - easement lines
 - ditches or interceptors
 - banks or steep slopes
 - fills
 - driveways
 - existing sewage systems
 - underground utilities
 - borehole or pit locations

Comments





4 Soils Evaluation Guide*

Section One Site Photos

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

Aerial Photography

Information on site location is often readily obtainable from aerial photographs. The site location should be clearly marked on the air photo. Stereo coverage of the assessment area is recommended. In general, it is a good idea to use the largest scale and most recent photos available. In most cases the largest scale photos will not be the most recent available. In such cases, two sets of photos may be required. An abbreviated set of directions to the site might also be helpful.

Record the aerial survey roll number (the letters followed by the four or five digit number, (e.g. AS1514) and the photo number (e.g. 170) of the air photo on which the sampled plot is located.

* — Adapted From: Ecological Land Survey Site Description Manual (2nd Edition) February 2003 by EBA Engineering Consultants Ltd. and the Model Process Project Team (November 2003)





Topography

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

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

Slope

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

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

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

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

Table 1. Relationship between percent slope gradient and degrees slope gradient

Degrees	Percent	Degrees	Percent
0°	0.0	20°	36.4
2°	3.5	25°	46.6
4°	7.0	30°	57.7
6°	10.5	34°	70.0
8°	14.0	40°	83.9
10°	17.6	45°	100.00
12°	21.2	50°	119.2
15°	26.8		





Site Position

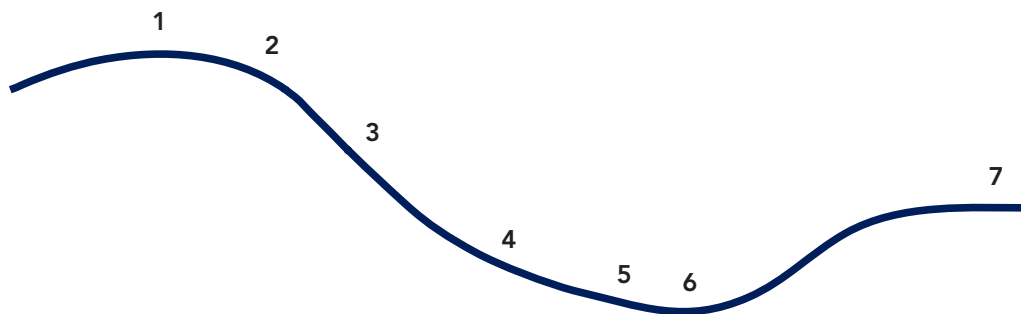
Site position describes the relative position of the sampling site within a catchment area, which is often within one of the major slope segments that are part of the regional landscape. The intent is to make it consistent with the scale of topography affecting surface water flow. The vertical difference between topographic highs and lows at this scale is usually between 3 m and 300 m, and the surface area exceeds 0.5 ha in size. Figure 1 illustrates the relationship of each site position relative to each other. For an explanation of the terms and the associated codes, see Table 2.

Section Two Soil Description

Table 2. Site Position definitions

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

Figure 1. Schematic cross sectional diagram illustrating application of terms to describe site position





Soil Subgroup

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

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

Soil Subgroup
O. BLC
for Orthic Black Chernozemic

Parent Material

Parent material descriptions correspond to those in the Canadian System of Soil Classification (Soil Classification Working Group 1998), the Physical Land Classification Methodology (Kocaoglu 1990) and the Alberta Wetland Inventory Standards (Halsey et al. In prep.).

The definitions and allowable codes for parent material are listed and defined in Table 3. These definitions have been extracted from the previously mentioned publications unless specified otherwise.

Table 2. Codes and descriptions for parent material - unconsolidated and consolidated mineral components and organic components.

Unconsolidated & Consolidated Mineral Components

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





Soil Moisture

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

Soil Drainage

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

The soil drainage classes are defined in terms of (1) actual moisture content in excess of field moisture capacity and (2) the extent of the period during which such excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater and seepage are factors affecting moisture status. These conditions are not easily observed or measured in the field; therefore, they generally cannot be used as criteria for drainage classes.

It is further recognized that soil profile morphology (e.g. mottling) normally, but not always, reflects soil drainage. Although soil morphology may be a valuable field indicator of drainage class, it should not be the overriding criterion. For example, a soil may exhibit the morphology of a poorly drained soil, but recent changes (either natural or artificial) may result in the soil being imperfectly drained. Some well-drained soils are permanently mottled because of the nature and the distribution of minerals within them. Other soils subject to prolonged saturation under seepage conditions may retain bright colors and be unmottled because saturating waters are oxygenated. Therefore, soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation, as well as other soil characteristics, are useful field criteria for assessing soil drainage classes.

For codes and recommended definitions for the soil drainage classes, see Table 4. Additional comments provided with each class, indicate some of the pertinent soil morphological features that are commonly, but not exclusively found.



Table 4. Drainage codes and descriptions

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





Samples

The following procedure, taken from Describing Ecosystems in the Field (Luttmerding et al. 1990) is recommended for collecting soil samples.

The value of laboratory analysis depends on the appropriate selection of sampling sites, the care with which samples are collected and the degree to which laboratory data can be related to the field descriptions.

Soil samples must be related to the soil profile description. At a minimum, one sample should be collected from the soil profile at a depth below the proposed installation depth of the treatment system. Any potentially restrictive soil horizons or layers should also be sampled separately. For detail descriptions, each soil horizon identified on the description form should be sampled. Samples should be representative of the entire cross section of the horizon.

The soil should be fully described and the pit face cleaned from the top down and sampled from the bottom up to prevent contamination. Samples should be double bagged and each sample labeled. The label should contain at least the following information:

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

Horizon Designation

A soil horizon is a layer of mineral or organic soil, or soil material approximately parallel to the land surface that has characteristics determined by processes of soil formation. It differs from adjacent horizons in properties such as colour, structure, texture and consistency, and in chemical, biological and mineralogical composition.

The Canadian System of Soil Classification (Soil Classification Working Group 1998) provides definitions of mineral and organic soil horizons, and definitions of diagnostic horizons and layers for soil classification purposes. Rules concerning horizon and transitional horizon designations are also given.

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

Discontinuity

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

Horizon

The major mineral horizons are A, B and C. The major organic horizons are L, F and H, which are comprised mainly of forest litter in the various stages of decomposition, and O, which is derived primarily from wetland vegetation. Table 6 provides the characteristics of soil horizons, which contain organic material. See Soil Classification Working Group (1998) for further information regarding soil horizons. Record the appropriate upper case code for each horizon.

Suffixes

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





Subdivision

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

Table 5. Horizon and suffix codes along with associated descriptions for horizons.

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

Horizon Depth

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

¹ "Gleying" refers to a soil forming process operation under poor drainage conditions, which results in the reduction of iron and other elements indicated by dull gray soil colours. If the soil is re-oxygenated the iron then forms reddish brown "mottles".





Mineral Soil Texture

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

Table 6. Soil textural classes

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

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

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

- i. **Loamy coarse sand** means 25% or more very coarse and coarse sand and less than 50% any other one grade of sand.
- ii. **Loamy medium sand** means 25% or more very coarse, coarse, and medium sand and less than 50% fine or very fine sand.
- iii. **Loamy fine sand** means 50% or more fine sand or less than 25% very coarse, coarse, and medium sand and less than 50% very fine sand.
- iv. **Loamy very fine sand** means 50% or more is very fine sand.

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

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





Field Determination of Texture

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

Most soils are a mixture of sand, silt, and clay, so the graininess, slipperiness, or stickiness varies depending upon how much of each particle size is present. As the amount of clay increases, soil particles bind together more strongly, form stronger casts and longer, stronger worms. As sand and silt increase, the soil binding strength decreases, and only weak to moderately strong casts and worms can be formed.

The field determination of soil texture is subjective and can only be accomplished consistently with training and experience. The following field tests are provided to assist in the field determinations. They are also outlined in Figure 3.

Graininess Test

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

Moist Cast Test

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

Stickiness Test

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

Worm Test

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

Taste Test

Work a small amount of soil between your front teeth. Silt particles are distinguishable as fine “grittiness”, unlike sand, which is distinguished as individual grains (i.e. graininess). Clay has no grittiness.

Well-decomposed organic matter (humus) imparts silt-like properties to the soil. It feels floury when dry and slippery when moist, but not sticky or plastic. However, when subjected to the taste test, it feels non-gritty. It is generally very dark in colour when moist or wet, and stains the hands brown or black. Humus-enriched soils often occur in wet sites and in grasslands. Humus is not used as a determinant of soil texture: an estimate of the silt content of humus-enriched mineral soils should be reduced accordingly.

Figure 2. Soil textural triangle

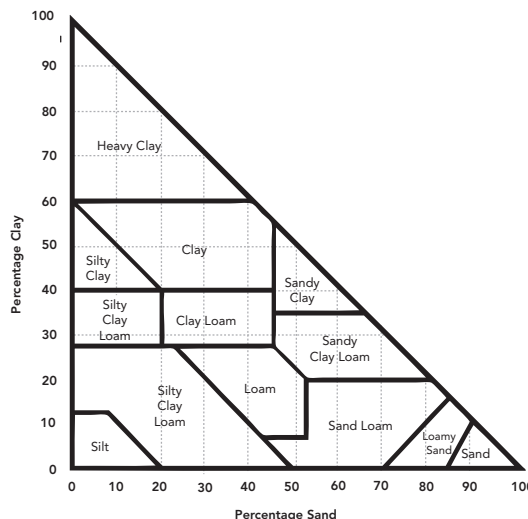
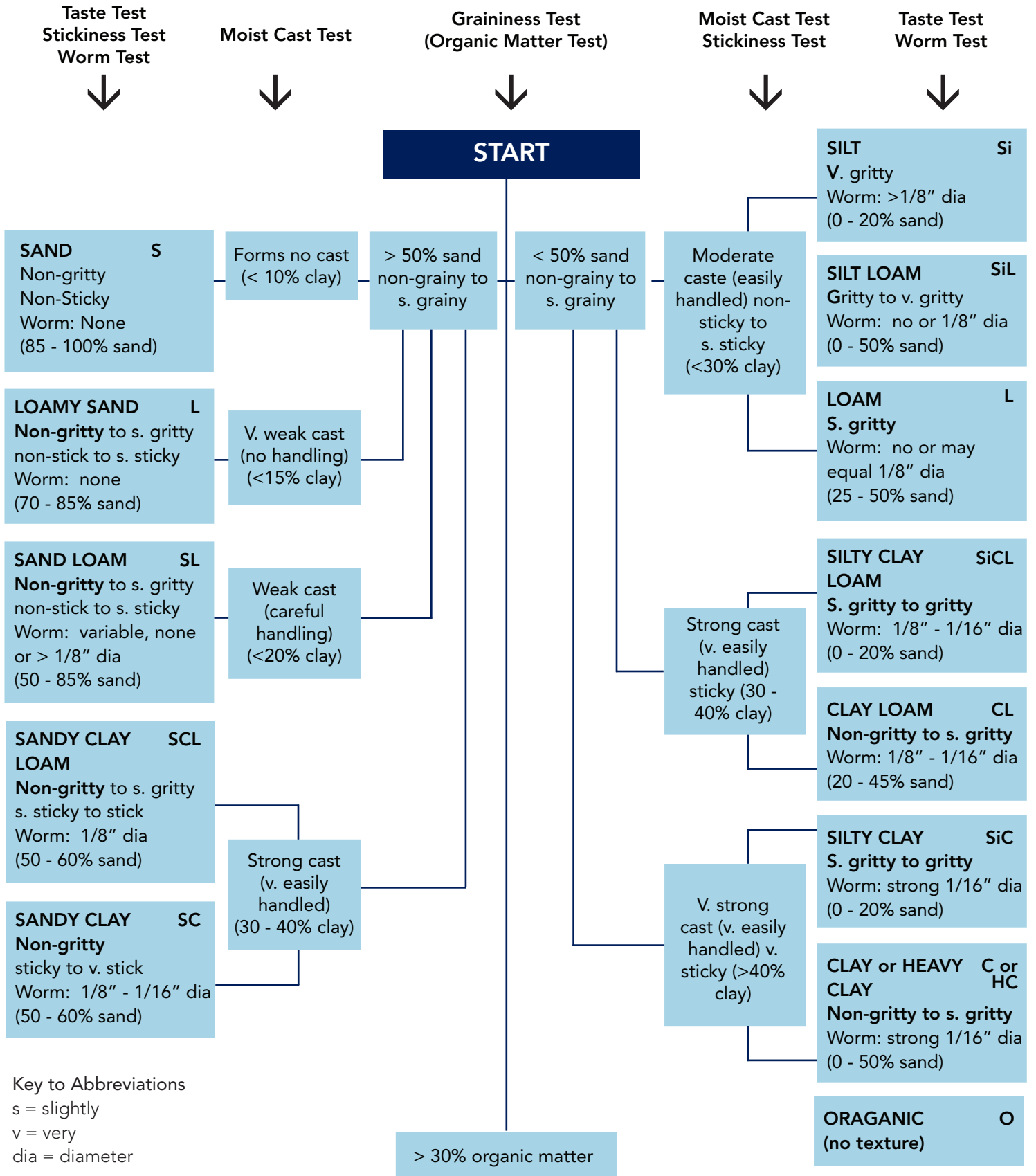




Figure 3. Field determination of soil texture





Colour

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

Light Conditions for Measuring Colour

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

Determination of Soil Colour

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

Record the dominant (matrix) colour of the soil (either non-gleyed or gleyed, as appropriate) using the Munsell Soil Colour charts. Either the Munsell notation of colour (e.g., 10YR 5/2) or the colour name (e.g., grayish brown) associated with the nearest-match colour chip may be used. Pay special attention to any mottling and/or gley (blue-green) colours. When determining if a soil section is gleyed or non-gleyed, refer to the gley colour chart and the drainage of a site. Generally, very rapidly to moderately well drained soils are non-gleyed, imperfectly drained soils are mottled and may or may not be gleyed, and poorly to very poorly drained soils are gleyed and may or may not be mottled. In general, use the 10R or 2.5Y colour charts for mottles, the GLEY colour chart for gleyed or blue-green soils and the 10YR colour chart for all other colours.

Record the moisture conditions (dry, moist, or wet - preferably dry) of the soil when the colour is recorded.

Gleying

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

Code	Description
Intense	Dark bluish to dark greenish-gray colours.
Strong	Dark gray colours.
Moderate	Light to drab gray colours.
Slight	Patches of light grayish-brown colours.





Mottles

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

Abundance

The quantity of mottles is indicated by abundance classes based on the percent of the exposed soil surface that is occupied by mottles of a given kind (See Table 7).

Size

Mottle sizes refer to their approximate dimensions as seen on a plane surface. Mottle length determines the size class when it is not more than 3 times the width; the width is the determinant if the mottle is long and narrow. The three relative size classes are provided in Table 7.

Contrast

Contrast of mottles refers to the degree of visual distinction between mottles of a given kind and the “matrix”. When colours of both mottles and matrix are recorded, the degree of contrast is relatively evident from the notations. However, the judgement of contrast in the field is useful, for it is often not a simple matter of comparing one colour with another, but a visual impression of the prominence of one colour against a background of one or several colours. Table 7 presents numerical definitions for three mottle contrast classes in terms of various combinations of Munsell colour units of hue, value, and chroma. Faint, distinct, and prominent mottles are defined in Table 7.

Table 7. Mottle descriptions

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





Structure

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

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

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

Grade

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

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

Definitions of the three basic structure grades are given in Table 8. Codes are provided for these and for two additional intermediate grades.

Table 8. Structure grade codes and definitions

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





Class

The recognized structure classes (size ranges) vary with the kind of structure, as indicated in Table 10 and illustrated in Figure 4. Measurement should be made in the smallest dimension for platy (vertical dimension or plate thickness), prismatic and columnar peds (horizontal dimension) and in the largest dimension for blocky and granular peds. Table 10 contains the five basic size classes for each kind of structure. Where more than one class occurs in a single horizon, record the dominant class. Intermediate classes can be recorded. See Table 9 for structure class codes.

Table 9. Structure class codes

Code	Structure Class	Code	Structure Class
VF	Very Fine	M	Medium
VFF	Very Fine to Fine	MC	Medium to Coarse
1F	Fine	C	Coarse
FM	Fine to Medium	VC	Very Coarse

Kind

The shape of peds is designated as the type of soil structure, but is not recorded. The type, in turn, is subdivided into kinds of structure, based on the character of the ped faces and edges of the aggregates. The four main structure types and their sub-division into eight kinds of soil structure are listed in Table 10 and illustrated in Figure 4.





Table 10. Types, kinds and classes of soil structure

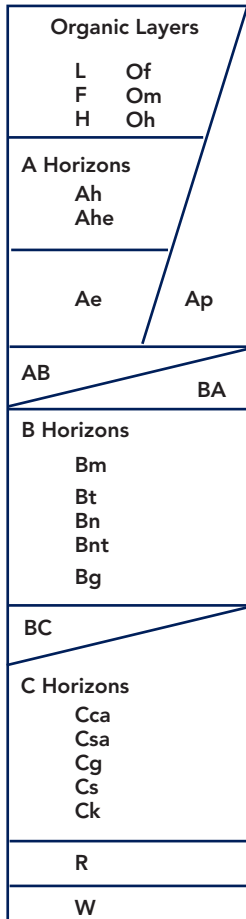
Type	Kind & Code	Structure Class & Code	Size ¹ (mm)
Blocklike - soil particles arranged around a point and bounded by flat or rounded surfaces	Angular blocky (ABK): peds bounded ¹ (by flattened, rectangular faces intersecting at relatively sharp angles	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<5 5-10 10-20 20-50 >50
	Subangular blocky (SBK): peds bounded by slightly rounded, subrectangular faces with vertices ² of their intersections mostly subrounded	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<5 5-10 10-20 20-50 >50
Platelike: soil particles arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces	Granular (GR): spheroidal peds bounded by curved or very irregular faces that do not adjoin those of adjacent peds	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<1 1-2 2-5 5-10 >10
	Platy (PL): peds flat or platelike; horizontal planes more or less well developed	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<1 1-2 2-5 5-10 >10
Prismlike: soil particles arranged around a vertical axis and bounded by relatively flat vertical surfaces.	Prismatic (PR): vertical faces of peds well defined and vertices ² angular (edges sharp); prism tops essentially flat	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<10 10-20 20-50 50-100 >100
	Columnar (COL): vertical edges near top of columns not sharp (vertices ² subrounded); column tops flat, rounded, or irregular	VF: very fine angular blocky F: fine angular blocky M: medium angular blocky C: coarse angular blocky VC: very coarse angular blocky	<10 10-20 20-50 50-100 >100
Structureless: no observable aggregation of primary particles or no definite orderly arrangement around natural lines of weakness	Single Grained (SGR)	Loose, incoherent mass of individual primary particles, as in sands	
	Massive (MA)	Amorphous; a coherent mass showing no evidence of any distinct arrangement of soil particles; separates into clusters of particles; not peds	
Cloddy (CDY): not a structure; used to indicate the condition of some ploughed surface, grade, class, and shape too varied to be described in standard terms.			

¹ The size limits refer to measurements in the smallest dimension of platy, prismatic, and columnar peds and to the largest of the nearly equal dimensions of blocky and granular peds.

² Definition of vertex (plural, vertices): the intersection of two planes of a geometrical figure.



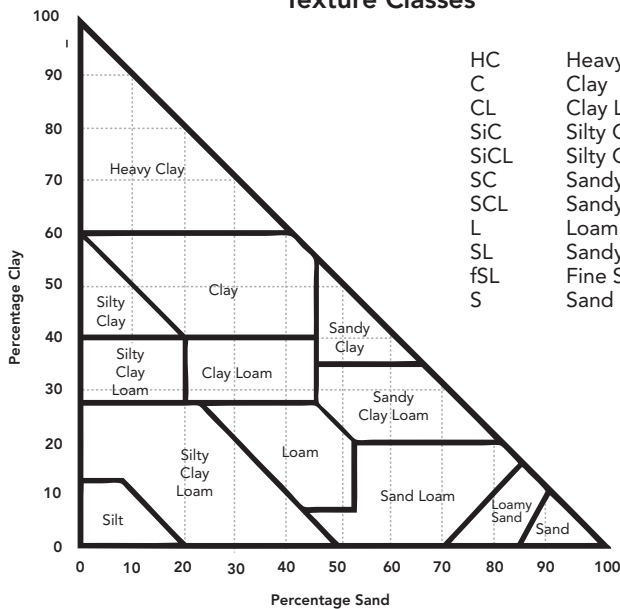
Canadian System of Soil Classification



- Horizons**
- L - F - H** Well drained decomposing plant litter, primarily leaves, twigs, woody materials.
L - slightly decomposed
F - partly decomposed
H - well decomposed
 - O** Poorly drained decomposing peat, mainly mosses, rushes, woody materials.
Of - fibric - least decomposed;
Om - mesic - moderately decomposed;
Oh - humic - most highly decomposed.
 - A** Organo - mineral horizons at or near the surface.
Ah - dark coloured, humus-rich horizon.
Ae - light coloured, eluviated horizon, characterized by removal of clay, iron, aluminum or organic matter, light colour and platy structure.
Ahe - same eluviation evident - salt and pepper appearance or platy structure.
Ap - horizons disturbed by agricultural (cultivation or pasturing)
 - AB, BA** Horizons transitional to A and B.
 - B** Weather subsurface - can have the following characteristics:
Bm - slightly altered by hydrolysis, oxidation, or solution or all three, to give a change in colour, or structure or both.
Bt - a significant accumulation of silicate clay.
Bn - a columnar or prismatic structure, hard consistence when dry and significantly high exchangeable sodium
g - a significant expression of gleying²
 - BC** A horizon transitional to B and C
 - C** Parent material - a horizon comparatively unaffected by soil forming processes, except for:
ca - an accumulation of lime.
sa - an accumulation of water-soluble salts.
g - a significant expression of gleying²
• - denotes the presence of salts, including gypsum (CoSO₄)
k - denotes the presence of lime
 - R** A consolidated bedrock layer
 - W** A layer of water

NOTE: The lower case letters shown above and below are sometimes combined to expressed combinations of characteristics in horizons (eg. Ahk, Ahksa, Bnjt) Other lower case letters not listed above are:
f - a significant accumulation of Fe + Al combined with organic matter - in B horizon
b - a buried soil horizon
j - a modifier of suffixes e, f, g, n and t to denote expression of, but failure to meet, the specified limits of the suffix it modifies.

Texture Classes



- HC Heavy Clay
- C Clay
- CL Clay Loam
- SiC Silty Clay
- SiCL Silty Clay Loam
- SC Sandy Clay
- SCL Sandy Clay Loam
- L Loam
- SL Sandy Loam
- fSL Fine Sandy Loam
- S Sand (f= fine, m=medium, c= coarse)

% Coarse Fragments

- g - gravel < 7.5 cm diameter
- c - cobbles 7.5 - 25 cm diameter
- s - stones 25 - 60 cm diameter
- b - boulders > 60 cm diameter

Consistence

- Dry**
- L Loose
 - Sf Soft
 - SH Slightly Hard
 - H Hard
 - VH Very Hard
 - EH Extremely Hard
 - R Rigid

- Moist**
- L Loose
 - VF Very Friable
 - F Friable
 - Fi Firm
 - VFi Very Firm
 - Efi Extremely Firm

- Wet**
- NS Nonsticky
 - SS Slightly Sticky
 - S Sticky
 - VS Very Sticky

- Plasticity**
- NP Non-Plastic
 - SP Slightly Plastic
 - P Plastic
 - VP Very Plastic

Effervescence

(with 10% HC)

- VW a few bubbles
- W bubbles readily form
- M bubbles form a low foam
- S bubbles form a thick foam

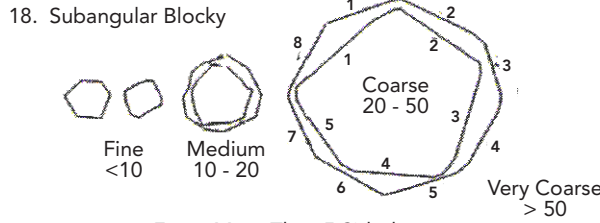
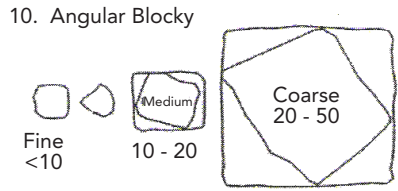
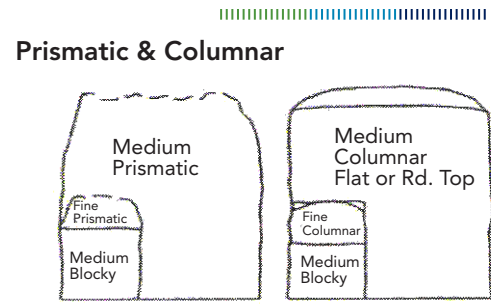
Landform

- Parent Material**
- C Calluvial
 - D Disturbed
 - E Eolian
 - F Fluvial
 - GF Glaciofluvial
 - GL Glaciolacustrine
 - L Lacustrine
 - O Organic
 - R Bedrock
 - T Till

- Surface Expression**
- h hummocky
 - l level
 - m rolling
 - s steep
 - t terraced
 - u undulating
 - v veneer

Figure 4. Diagrammatic representation of soil structure

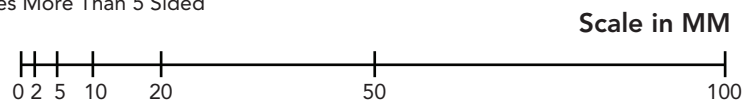
Structure		
Grade	Class	Kind
w Week	vf Very fine	sg Single grained
wm Weak to moderate	f Fine	ma Massive
m Moderate	m Medium	bk Angular blocky
ms Moderate to strong	c Coarse	sbk Subangular blocky
s Strong	vc Very coarse	gr Granular
		pr Prismatic
		col Columnnar



Fine < 20
Medium 20 - 50
Coarse 50 - 100
Very Coarse >100

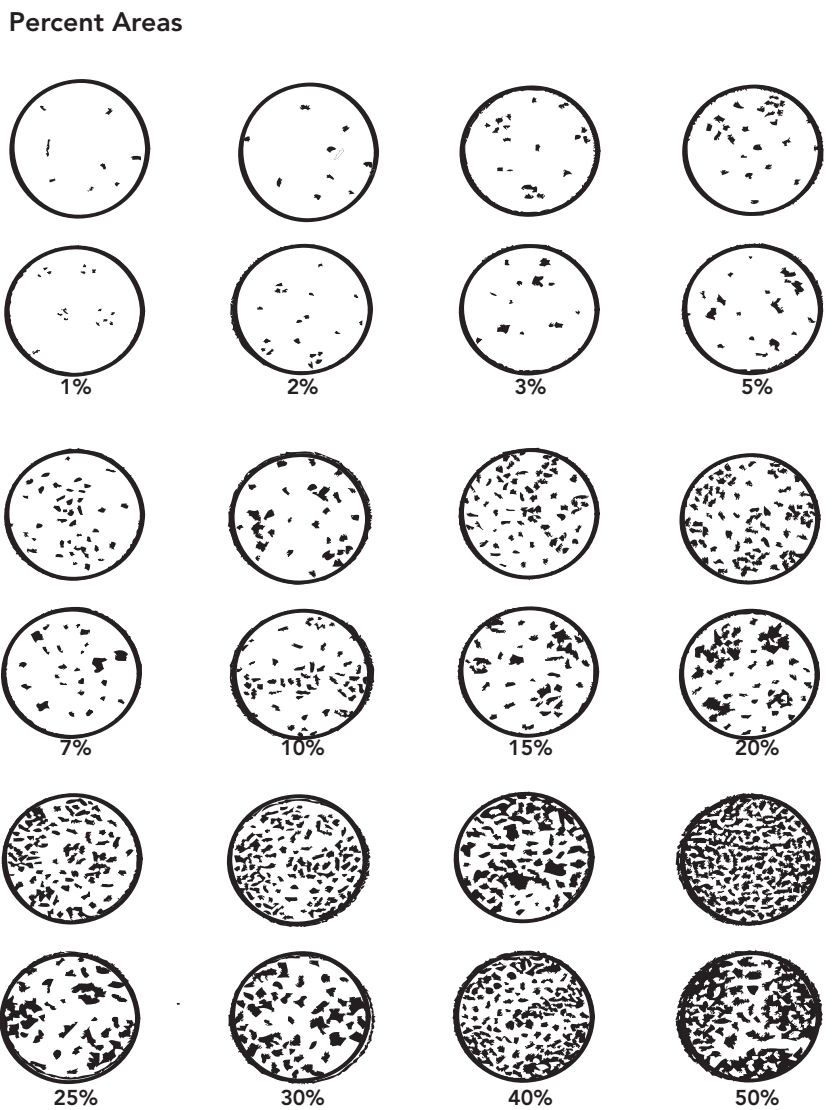


Fine < 2
Medium 2 - 5
Coarse > 5



Slope Classes of Local Landings

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



Surface Stones

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

Slope Position

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

Drainage

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



Consistency

The consistency of mineral soil refers to its resistance to deformation and rupture (soil strength), and to its degree of internal cohesion and adhesion. All mineral soil material has consistency irrespective of whether the mass is large or small, in a natural condition or greatly disturbed, aggregated or structureless, or wet, moist or dry.

Soil consistency should be evaluated under standard conditions of water content, specimen size and force application. If evaluations are not made under standardized conditions, meaningful comparisons between soils (or horizons) cannot be made. Soil consistency is highly dependent on the soil water content. Terminology includes separate terms for description at three standard moisture contents: dry, moist, and wet. Plasticity is always described in the wet state.

Dry and Moist Consistence

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

If the soil is not loose (single-grained), remove a ped or soil fragment from the profile and trim it to form an equi-dimensional standard test specimen with sides 2.5 cm long and two roughly parallel bearing surfaces. Apply stress slowly, squeezing the specimen between thumb and forefinger until failure is just perceptible. The amount of force required to produce failure is the criterion for dry and moist consistency classes (See Table 11 and Table 12, respectively). Estimation of the force exerted can be refined with practice in compressing standard mechanical devices, or by exerting force on specimens of the same origin as those that have failed from crushing or breaking under weights of known force.

Table 11. Dry consistence codes and descriptions

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



Wet Consistence

Wet consistence, referred to as “stickiness”, is determined at moisture levels that are at, or slightly above, field capacity. Stickiness is the degree of adhesion to other objects or materials (See Table 13). It changes as soil structure is destroyed and as the soil moisture content changes. Stickiness in the field is determined by the fine earth fraction particles passing through a #10 sieve (2 mm in diameter). The sample should be crushed in the hand, water added (if necessary) to bring it to the wet state and then thoroughly puddled. The puddled soil should then be pressed between the thumb and forefinger, and its adherence to the digits noted. To adjust water content, the sample should be worked in the hand to remove water, or have water added to achieve the maximum stickiness.

Table 12. Moist consistence codes and descriptions

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

Table 13. Wet consistence codes and descriptions

Code	Wet Consistence (stickiness)
Non sticky	After the release of pressure, practically no soil material adheres to either the thumb or 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. The soil is not appreciably stretched when the digits are separated.
Sticky	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and tends to stretch somewhat and pull apart rather than pulling free from either digit.
Very sticky	After pressure has been applied, the soil material adheres strongly to both the thumb and forefinger and is decidedly stretched when they are separated, then breaks and remains on both digits.

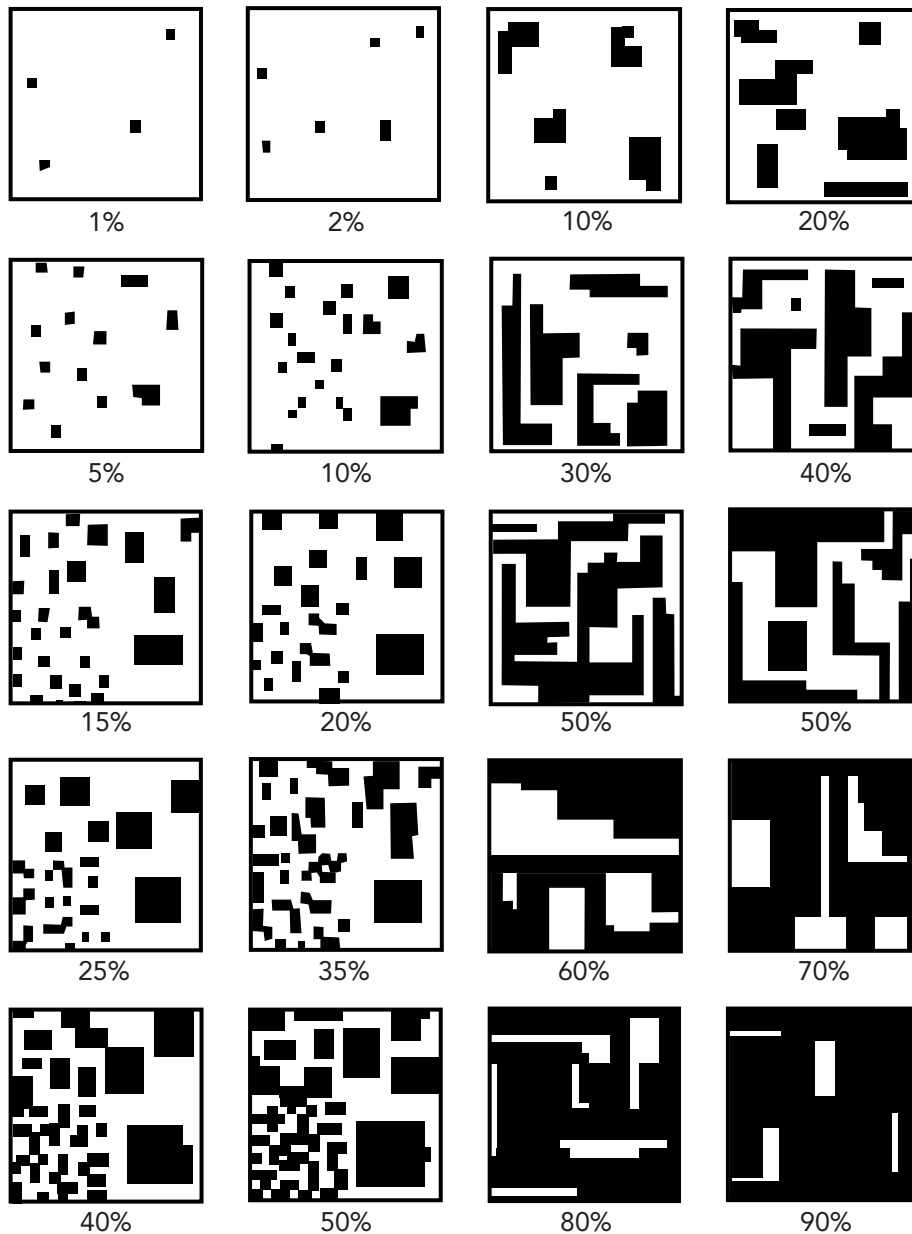




Coarse Fragment Description

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

Area Percentage Charts





Depth to ...

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

... Groundwater

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

... Seasonally Saturated Soil

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

... Limiting Layer

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

... Permeable Layer

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

Limiting Layer Characteristics

Identify the type of limiting or permeable layer.

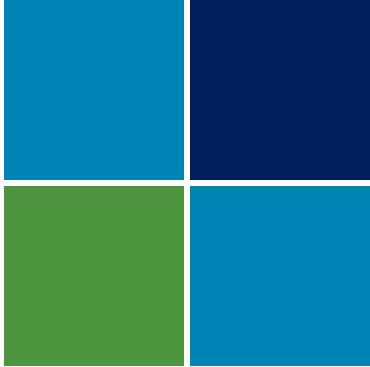
Limiting Topography

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





The purpose of this guideline is to protect the environment and public health by ensuring that development utilizing private sewage disposal systems proceeds at a density and scale which will not result in, or cause degradation of, groundwater resources beyond acceptable limits. Compliance with acceptable limits shall be demonstrated through a prediction of the development’s nitrate impact on the groundwater at the development boundary.



The Guideline is intended to encourage the assessment of the potential for degradation on the basis of a technically based and technically defensible evaluation of the proposal.

5 Technical Guideline For Private Sewage Disposal Systems: Water Quality Impact Risk Assessment

Objectives

The objectives of this guideline are as follows:

- To provide technical guidance to professionals involved in land development (in particular, hydrogeologists) in assessing the potential for unacceptable groundwater impacts resulting from the use of private sewage disposal systems, through a three-stage assessment process.
- To ensure that proposals are submitted with the required technical support to allow the subdivision officer to either support the proposed development, or to recommend against approval.

Application Of The Guideline

This guideline applies to the combined or total impact on groundwater of a development proposal of more than six parcels per quarter with private sewage disposal systems. The guideline applies to residential, commercial and industrial proposals that use private sewage disposal systems for the treatment of domestic waste. Application of the guideline to subdivision and development proposals of six or fewer parcels can be undertaken at the discretion of the municipal subdivision authority. Municipalities are encouraged to retain, on their behalf, professionals with demonstrated expertise in hydrogeology with emphasis on development relying on private sewage disposal systems, to review studies or reports prepared in accordance with this Guideline.

This guideline does not apply to the following:

- Municipal or communal sewage disposal systems because they are not considered private and fall under a different jurisdiction of Alberta Environment. The principle of the water quality impact risk assessment is still valid for these systems.
- The assessment of impacts of existing private sewage disposal systems
- Applications for approval of private sewage systems that are replacements due to the failure of the original system.

This guideline may not apply to non-standard private sewage disposal systems that are specifically designed to reduce nitrate loadings.





Sensitive Areas and Conditions

It is important to note that even though an applicant may meet the requirements of Section 4 of this guideline, the Municipality reserves the right to require a more detailed assessment on any site it deems to be sensitive. The likelihood of this occurring is greater where:

- Conditions outlined in Section 4 are not met;
- The proposed development has a higher density than previous developments in the municipality;
- The scale of the proposal is such that any increased degree of assurance is appropriate, or
- It is known that there are existing high levels of groundwater contamination by nitrate-nitrogen.

Although the Subdivision Authority may support a subdivision application involving private sewage disposal systems on a sensitive area or under sensitive conditions, the Municipality does not assume responsibility for failure of the system(s), for correcting damage to adjacent properties, or for the construction of new sewage systems. This is the responsibility of the proponent/owner of the system.

Groundwater Impact Assessment

General Evaluation

The groundwater impact assessment will address the ability of the lands, identified by and restricted to the subdivision proposal, to treat sewage effluent to meet acceptable limits. Subdivision Authorities should only consider support for subdivision applications involving private sewage disposal systems where the proponent and/or the consultant has:

- a. Successfully defended the ability of the site to support a private sewage disposal system;
- b. Determined the representative existing background nitrate-nitrogen levels in the receiving groundwater. This determination will involve the collection of groundwater samples from various locations on and adjacent to the development site. The consultant must provide a clear rationale for the number of times the site is sampled, the period of time over which the sampling has been undertaken (capturing seasonal variations), and the manner in which this information is used in the assessment. The consultant must discuss the existing background nitrate-nitrogen concentrations relative to nitrate sources, and the susceptibility of groundwater to contamination.
- c. The Subdivision Authority should not normally support development in areas where background nitrate-nitrogen concentrations exceed 10 mg/L. Where nitrate concentrations between 0 and 10 mg/L are found, the Subdivision Authority may also decide not to support development if the proponent's consultant cannot provide a reasonable explanation for the existing levels of nitrate concentration in the groundwater. However, if it can be demonstrated that existing levels of nitrates are the result of historical agricultural practices on the site, the proponent may be able to argue that the nitrate levels will decline after development, and
- d. demonstrate that the area is not obviously hydro-geologically sensitive (for example, karstic areas, areas of fractured bedrock exposed at surface, areas of thin soil cover, or areas of highly permeable soils).

It is not the intent of the Municipality to promote the development of areas with high infiltration rates (for example, sandy overburden deposits). Due to lack of effective effluent treatment, proposed development relying on private sewage disposal systems should not be approved in soils that have high infiltration rates.





Three-Step Assessment Process

Every proposed development involving private sewage disposal systems requires an assessment of the groundwater impact potential. The purpose of the assessment is to ensure that the combined effluent discharges from all the individual private sewage disposal systems in a development will have a minimal effect on the groundwater or adjacent properties. For the purposes of this Guideline, the standard of 10 mg/L of nitrate-nitrogen is used as an indicator of groundwater impact potential. This Guideline does not define a precise methodology for determining the expected level of impact; however, it does set out the major considerations that should be included in a defensible assessment of the impact potential.

The assessment involves the three-step process. The need to advance to the next step depends on the conditions defined in the previous step. The process is dependent on first satisfying the general requirements defined in Sections 3.0 and 4.1.

The first step involves a definition of the proposed development’s minimum lot size. If the minimum lot size is smaller than that defined in Section 4.4, the assessment must progress to the second step, which involves evaluating the relationship between the private sewage disposal system and the groundwater. Where it cannot be demonstrated that the systems are isolated from existing or potential groundwater supplies, it will be necessary to progress to the final step of the assessment, which involves a detailed examination of contaminant loading to the groundwater.

Where a report is found to be incomplete, draft or preliminary, or makes unsubstantiated claims, the Municipality will advise the proponent by letter with regard to the report’s deficiencies. The Municipality may not make a decision on a subdivision application until such time as a complete report (i.e. One that satisfies, in the opinion of the Municipality, the requirements of this Guideline) has been submitted.

Fundamental Considerations

- a. Groundwater impact predictions shall be calculated for the development site property boundary.
- b. The consultant must make recommendations regarding the optimum location and orientation of leaching beds. In general, the attenuative capabilities of a site can be optimized by maximizing separation distances between individual private sewage disposal systems and down-gradient wells and property boundaries.
- c. Where applicable, the impact of the on-site discharge of sewage effluent into surface water must be evaluated. This work must be done by qualified individuals and must address potential impact from phosphorus and other parameters that may be of concern. The concentration of phosphate used in assessing the potential impact of sewage effluent should normally be 15 mg/L.



Step One: Lot Size Considerations

For developments where the lot size for each private residence within the development is one hectare (approximately 2.5 acres) or larger, the risk that the boundary limits imposed by these guidelines may be exceeded by private sewage disposal systems is considered acceptable in most cases. Developments consisting of lots that average 1 hectare (with no lot being smaller than 0.8 hectares – or 2 acres), may not require a detailed hydrogeological assessment, provided that it can be demonstrated that the area is not hydro-geologically sensitive. In such circumstances, it is the responsibility of the proponent to obtain a professional analysis from a qualified consultant that the area is not hydro-geologically sensitive.

It is assumed that attenuative processes within a one-hectare lot will be sufficient to reduce the nitrate-nitrogen to an acceptable concentration in groundwater below adjacent properties. It should be noted that sufficient attenuative processes may not be present in hydro-geologically sensitive environments, or where there is little water surplus available.

Step Two: System Isolation Considerations

Where proposed lot sizes are less than 1 hectare (approximately 2.5 acres), the proponent and/or the consultant is/are responsible for assessing the potential risk to groundwater. Developments will normally be considered as low risk where it can be demonstrated that sewage effluent is hydro-geologically isolated from existing or potential supply aquifer(s). In making such an assessment, the proponent and/or the consultant must complete two important steps:

- a. Evaluate the most probable groundwater receiver for sewage effluent: its definition must be defended by hydrogeological data and information obtained through a test pit, auger hole and/or test drilling program; and
- b. Define the most probable lower hydraulic or physical boundary of the groundwater receiving the sewage effluent.

The consultant must clearly define those portions of the subsurface that will be affected by the effluent. Detailed predictions of the shape of individual contaminant plumes and a description of specific contaminant concentrations over space and time may not be required.

The potential for isolation must be assessed on a site-specific basis and may involve assessments of geologic and/or hydraulic boundaries. (Please note that this may require hydro geologic assessment of lands up to 500 meters beyond the actual development boundary).

In some cases, it may be necessary to demonstrate isolation from sensitive surface water environments.

When it is demonstrated that the sewage effluent will not enter supply aquifers, the lot density of the proposed development may be dictated by factors such as the need for sewage system replacement or contingency area, and by the minimum distances between private sewage disposal installations and wells as defined by the Private Sewage Disposal Systems Regulation.

Step Three: Contaminant Attenuation Considerations

Where it cannot be demonstrated that the sewage effluent is hydro-geologically isolated from all existing or potential supply aquifers, a hydro geologic study is required to assess the risk that the development's private sewage disposal systems will cause concentrations of nitrate-nitrogen in groundwater to exceed 10 mg/L at the down-gradient property boundary. As described below, there are various methods by which this detailed risk assessment can be done.





Monitoring-Based Assessments

The Subdivision Authority recognizes that groundwater, infiltrating precipitation and sewage effluent will not be completely mixed at the property boundary. It is also recognized that processes such as absorption, denitrification, filtration and biodegradation may attenuate contaminants as the effluent passes down through the unsaturated zone and moves into the saturated zone. Since these processes are extremely difficult to quantify with any accuracy, they are usually only considered as a safety factor. However, if the consultant can provide documentation to the satisfaction of the Municipality regarding the presence and extent of these processes on-site, their impact on nitrate concentrations can be considered. As discussed below, there is a number of ways in which this can be done.

a. Existing Development

In some situations, there may be nearby private sewage disposal system-based development in a similar hydrogeological environment. If this development has been in place for a lengthy period, information on existing groundwater quality could be used to demonstrate the combined effect of all available attenuative processes. This empirical information may then be used to help predict the impact of the proposed development.

The onus is on the proponent and/or the consultant to demonstrate adequately that,

- i. the existing and proposed developments are located in similar hydrogeological environments;
- ii. sewage effluent (quantity and quality) from the existing and proposed developments are comparable;
- iii. monitoring produces results that accurately represent water quality conditions beneath the existing development. The consultant must provide a clear rationale for the number of times the site is sampled, the period of time over which the sampling has been undertaken (capturing seasonal variations), and the rationale for the way in which this information is used in the assessment.

b. Phased Development

In situations where there is no existing development, it may be possible to develop lands considered in the planning document in phases, beginning with the up-gradient portion. Information obtained from monitoring effluent discharged from private sewage disposal systems in the up-gradient phase, and its impact on groundwater, can then be used to determine the extent to which the down-gradient portion of the site can be developed. Before approving such a phased development, the Subdivision Authority must be satisfied that adequate planning controls are in place to regulate development of the down-gradient portion of the site.

Predictive Assessment – Residential Development

The Municipality should require the following considerations and assumptions in assessing the combined impact of individual on-site sewage systems at the boundary of residential developments:

- a. **Contaminant Source:** In most cases total nitrogen (all species) converted to nitrate-nitrogen is considered as the critical contaminant. For the purposes of predicting the potential for groundwater impacts, a nitrate loading of at least 40 grams/lot/day per residential dwelling unit shall normally be used. (This is based on expected actual flows of 1000 L/day and a minimum value of 40 mg/L nitrate-nitrogen in the discharged from a private sewage disposal system treating domestic/household sewage.)
- b. **Contaminant Attenuation:**
 - i. In assessing contaminant attenuation, only dilution should be accepted by the Municipality as a quantifiable attenuation mechanism for nitrate.
 - ii. Dilution models involve dilution with infiltrating precipitation. Mixing with groundwater flowing through the site will normally not be allowed because it is usually not possible to control up-gradient land uses. Flow-through will not be considered where sensitive hydrogeological conditions exist. However, where up-gradient lands have been fully developed for a considerable period of time, the quantity and quality of groundwater flow available to dilute the effluent entering the receiving groundwater may be considered.
 - iii. The amount of available moisture surplus should normally be obtained from Environment Canada. Where available, reliable, long-term, site-specific information, obtained for detailed water balance and/or groundwater studies, can be used.
 - iv. Estimates of the amount of surplus that infiltrates the ground must be based on site-specific factors such as soils, topography, surface geology, and impermeable areas (including rooftops and paved areas).
 - v. The volume of sewage effluent, if used as dilution water in mass balance calculations, should not exceed 1000 L/day/lot.
 - vi. Mathematical (computer) models may be used to assess the impact potential. Although the selection of model software will be left to the proponent, the Ministry must be provided with information on the model's validation and how its limitations and assumptions affect the results. All model simulations must include appropriate sensitivity analyses.

The Municipality should allow the use of only those dilution models that are reasonable and can be defended on a site-specific basis.



Predictive Assessment – Industrial/Commercial Development

This guideline only applies to developments that have an average daily flow of less than 4,500 L/day/lot. Developments with larger flows should be assessed by Alberta Environment. In addition, the sewage assessed should consist of domestic wastes only. No industrial/commercial cooling or process wastewater is to be considered.

The nitrate loading from industrial/commercial private sewage disposal systems can vary greatly depending on the type and intensity of use. Since specific uses for each lot or block are not necessarily known at the subdivision application and review stage, it is necessary to determine how much nitrate can be discharged from each private sewage disposal system without exceeding the recommended 10 mg/L threshold at the property boundary. The following procedure is recommended for use in setting maximum allowable effluent flows for each lot.

a. Available Infiltration

- i. The amount of available moisture surplus should normally be obtained from Environment Canada. Where available, reliable, long-term, site-specific information, obtained from detailed water balance and/or groundwater studies can be used.
- ii. Estimates of the amount of moisture surplus that infiltrates into the ground must be based on site-specific factors such as soils, topography, surface geology, and impermeable areas (including rooftops and paved areas).

b. Maximum Allowable Flow

The maximum allowable flow for each lot or block in the industrial/commercial development can be calculated by dividing the amount of available infiltration (from (a) above) by a factor of three.

c. Maximum Number of Users

Restrictions regarding the allowable number of users will normally be incorporated as recommendations in the consultant's assessment, and the recommendations should be implemented by provisions contained in the development agreement between the proponent and the municipality.

Additional Research

The Municipality recognizes that the assumptions required for allowing a predicted level of 10 mg/L of nitrate-nitrogen to be used as a boundary target criterion, for exempting lots of one hectare (2.5 acres), or for using nitrate-nitrogen as the critical contaminant etc., may not be technically supported in every case. Municipalities recognize that as research continues, information and technologies may become available which warrant minor or substantial revisions to this guideline.

