LOW-DIAGRAM KEYS FOR "SOIL TAXONOMY"

Soil moisture and temperature regimes, and diagnostic horizons and properties for organic soils.

R.F. THOMAS, L.C. BLAEMORE, and D.J. KINLOCH
FLOW-DIAGRAM KEYS FOR "SOIL TAXONOMY"

B. SOIL MOISTURE AND TEMPERATURE REGIMES, AND DIAGNOSTIC HORIZONS AND PROPERTIES FOR ORGANIC SOILS

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The design symbolises the role of the scientific study of soil in assisting the natural endowments of sunshine and rain to promote plant growth.

Forest and pasture (both depicted) are the predominant forms of land use in New Zealand. However, recent increases in more intensive uses of land have demanded more detailed soil information and a greater degree of land-use interpretation.

The original mural, of which this is an oblique photograph, is constructed in relief on the northern wall of Soil Bureau's Taylor Building in Lower Hutt, New Zealand.

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<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>iv</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>iv</td>
</tr>
<tr>
<td>Introduction</td>
<td>v</td>
</tr>
<tr>
<td>List of flow diagrams</td>
<td>vii</td>
</tr>
<tr>
<td>List of appendices</td>
<td>vii</td>
</tr>
<tr>
<td>Flow diagrams</td>
<td>ix</td>
</tr>
<tr>
<td>Appendices</td>
<td>xi</td>
</tr>
</tbody>
</table>
ABSTRACT

This is the second volume in a series which seeks to explain, in flow diagram form, the definitions and keys given in the USDA Agriculture Handbook "Soil Taxonomy". In this volume flow diagrams, consisting of step-by-step decision trees (together with explanatory notes where appropriate), are presented for the soil moisture and soil temperature regimes (pages 51-7 and 57-63, respectively, of "Soil Taxonomy") and for the diagnostic horizons and properties of organic soils (Chapter 4, pages 65-70, of "Soil Taxonomy"). USDA-approved amendments as at 2 June 1978 are incorporated, and appendices present approximations designed to assist the conversion of existing New Zealand temperature data into the form used in USDA determinations.

The flow diagrams are intended to permit easier interpretation of the definitions and are likely to be particularly useful to persons not yet fully conversant with the text. They are not intended to replace the original formal text.

Key Words: soil classification; soil taxonomy; soil water; soil moisture regimes; soil temperature; soil temperature regimes; soil horizons; Histosols; soil organic composition

ACKNOWLEDGMENTS

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INTRODUCTION

The U.S. system of soil classification, as given in "Soil Taxonomy" (Soil Survey Staff 1975), has been adopted by Soil Bureau, DSIR, for trial in New Zealand.

To assist our understanding of the classification we initially prepared flow diagrams for the basic definitions and for the diagnostic horizons and properties of mineral soils. These diagrams were published as volume A of N.Z. Soil Bureau Scientific Report 59. The present volume (B) contains diagrams for soil moisture and temperature regimes and for the diagnostic horizons and properties of organic soils. Volume C will contain diagrams for the key to soil orders. In preparation are sets of flow diagrams for each order, so that eventually a soil may be classified to at least great group level by this method.

The flow diagrams and additional notes presented here represent the definitions of soil moisture and soil temperature regimes (pp 51-7 and 57-63, respectively, of "Soil Taxonomy") and of the diagnostic horizons and properties of organic soils (Chapter 4, pp 65-70, of "Soil Taxonomy"), and incorporate the approved amendments circulated by USDA on 2 June 1978 (amendments dated 5 May 1978). Appendices provide approximations designed to assist the conversion of existing New Zealand temperature data into the form used in USDA determinations.

To allow for the probability of future amendments or additions (as with "Soil Taxonomy" itself) the pages in this publication are not numbered in the usual way. Instead, each of the items listed has been given a reference number (B1, B2, etc. - the B refers to this volume) and individual pages of each section are then numbered B1.1, B1.2, etc. Although this volume has been produced with a staple binding we expect that users may wish to remove the binding and punch the pages for use in some form of ring binder. This would also make it easy to add the new or amended sections which may be provided from time to time.

Finally, we emphasise that any errors in this volume are our responsibility, and that these flow diagrams and notes are not intended to replace the full definitions provided in "Soil Taxonomy". In instances where we felt that the text meaning was unclear or inconsistent we have chosen to accept a particular interpretation and to explain our action in a footnote. In any case where our interpretation seems doubtful, however, the original text should be consulted.

Reference

SOIL SURVEY STAFF 1975: "Soil Taxonomy, a basic system of soil classification for making and interpreting soil surveys".
### LIST OF FLOW DIAGRAMS

**SOIL MOISTURE AND TEMPERATURE REGIMES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Reference No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil moisture control section and moisture status</td>
<td></td>
</tr>
<tr>
<td>(a) Rough guide to limits</td>
<td>B1a</td>
</tr>
<tr>
<td>(b) Definition of limits</td>
<td>B1b</td>
</tr>
<tr>
<td>Soil moisture regimes</td>
<td>B2</td>
</tr>
<tr>
<td>Soil temperature measurement</td>
<td></td>
</tr>
<tr>
<td>(a) Estimation from direct measurements</td>
<td>B3</td>
</tr>
<tr>
<td>(b) Estimation from air temperature data</td>
<td>B3b</td>
</tr>
<tr>
<td>Soil temperature regimes/classes</td>
<td></td>
</tr>
<tr>
<td>(a) Regimes at suborder and great group level</td>
<td>B4</td>
</tr>
<tr>
<td>(b) Regimes/classes in the lower categories</td>
<td>B4b</td>
</tr>
</tbody>
</table>

**DIAGNOSTIC HORIZONS AND PROPERTIES FOR ORGANIC SOILS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Reference No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinds of organic soil materials</td>
<td>B5</td>
</tr>
<tr>
<td>(a) Fibres</td>
<td>B5a</td>
</tr>
<tr>
<td>(b) Fibric, hemic and sapric soil materials</td>
<td>B5b</td>
</tr>
<tr>
<td>(c) Humilluvic materials</td>
<td>B5c</td>
</tr>
<tr>
<td>(d) Limnic materials</td>
<td>B5d</td>
</tr>
<tr>
<td>Thickness of organic materials</td>
<td>B6</td>
</tr>
</tbody>
</table>

† A flow diagram for this property is not included because the present definition is not sufficiently precise for such an interpretation to be made. Reference should be made to the text, p67 "Soil Taxonomy".

### LIST OF APPENDICES

**SOIL MOISTURE AND TEMPERATURE REGIMES**

<table>
<thead>
<tr>
<th>Description</th>
<th>Reference No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil temperature measurement</td>
<td></td>
</tr>
<tr>
<td>(a) Estimation from direct measurements</td>
<td>App.B3a</td>
</tr>
<tr>
<td>(b) Estimation from air temperature data</td>
<td>App.B3b</td>
</tr>
</tbody>
</table>
FLOW DIAGRAMS
61 SOIL MOISTURE CONTROL SECTION¹ AND MOISTURE STATUS²
(a) Rough guide to limits³

**IS PARTICLE SIZE CLASS FINE-LOAMY, COARSE-SILTY, FINE-SILTY OR CLAYEV?**

**IS THERE A ROCK⁴ CONTACT AT ≤10 cm DEPTH?**

**SPCS IS BETWEEN 10 cm AND 30 cm OR SHALLOWER ROCK⁴ CONTACT. GO TO §.**

**IS PARTICLE SIZE CLASS COARSE-LOAMY?**

**IS THERE A ROCK⁴ CONTACT AT ≤20 cm DEPTH?**

**SPCS IS BETWEEN 20 cm AND 60 cm OR SHALLOWER ROCK⁴ CONTACT. GO TO §.**

**IS PARTICLE SIZE CLASS SANDY?**

**ESTIMATION UNRELIABLE. SEE DEFINITION OF LIMITS.**

**IS THERE A ROCK⁴ CONTACT AT ≤30 cm DEPTH?**

**NO**
1 Hereafter abbreviated to SPSC.

2 Soil moisture status is derived from relevant statements on pages 52 and 53 of "Soil Taxonomy".

3 This diagram is derived from the "Rough Guide to the Limits" given on p.54 of "Soil Taxonomy" with modification to allow for situations where there is a shallow "rock" contact. It may be used where more precise determination of the soil moisture condition section is impracticable.

4 Rock contact = lithic or paralithic contact, or upper boundary of petrocalcic or petroalbic horizon or duripan.

5 When water stands in an unlined borehole such that the capillary fringe reaches the soil surface or the top of the horizon in question, the soil or horizon is considered to be saturated.
B1 SOIL MOISTURE CONTROL SECTION ¹ AND MOISTURE STATUS ²

(a) Definition of limits ³

YES

DOES 2.5 cm OF WATER MOISTEN SOIL DOWN TO A ROCK⁴ CONTACT WITHIN 24 HOURS⁵?

NO

SPCS IS THE ROCK⁴ CONTACT ITSELF.

UPPER BOUNDARY OF SPACS IS DEPTH TO WHICH 2.5 cm OF WATER MOISTENS SOIL WITHIN 24 HOURS⁶.

YES

DOES 7.5 cm OF WATER MOISTEN SOIL DOWN TO A ROCK⁴ CONTACT WITHIN 48 HOURS⁷?

NO

LOWER BOUNDARY OF SPACS IS THE ROCK⁴ CONTACT.

LOWER BOUNDARY OF SPACS IS DEPTH TO WHICH 7.5 cm OF WATER MOISTENS SOIL WITHIN 48 HOURS⁸.

DRY

YES

IS WATER HELD IN SOIL AT TENSION ≥ 15 BAR?

NO

MOIST⁹

MOIST⁹

YES

DOES UPPER BOUNDARY OF ROCK OR CEMENTED HORIZON HAVE A THIN FILM OF WATER?

NO

DRY

¹ Hereafter abbreviated to SPACS

² Soil moisture status is derived from relevant statements on pages 52 and 53 of "Soil Taxonomy".
Bib.2

3 This diagram is derived from the notes defining the soil moisture control section as given on pages 53-4 of "Soil Taxonomy".

4 Rock contact = lithic or paralithic contact, or upper boundary of petrographic or petrocalcic horizon or duripan.

5 Excluding of the depth of moisture along any cracks or animal burrows open to the surface. If moisture otherwise still occurs unevenly, the weighted average depth of moisture in a pedon is used for defining the limits of the soil moisture control section.

6 When water stands in an unlined borehole such that the capillary fringe reaches the soil surface or the top of the horizon in question, the soil or horizon is considered to be saturated.
B2 SOIL MOISTURE REGIMES*
These definitions assume that at time of sampling the soil is neither being fallowed nor being artificially irrigated.

The phrase "most years" is sometimes stated as "6 or more years out of 10". These are assumed to have the same meaning.

Permanently frozen soils and the very cold and dry soils are excluded from these soil moisture regimes. No provision is presently made in "Soil Taxonomy" for them to have moisture regimes and they are classified, where appropriate, on a basis of soil temperature regimes only.

SPCS = Soil moisture control section, as defined in flow diagram B1.

At this point the soil moisture regime is regarded as Udic because "it is implicit in the concept [of the Aquic regime] that the soil temperature is above biologic zero (SPC) at some time while the soil or the horizon is saturated" (column 1, p.55, "Soil Taxonomy"). Thus, even if the soil is saturated in this instance it cannot have an Aquic moisture regime.

Identification of the Aquic regime depends on establishing the existence of a reducing regime at some time in part or all of the soil. If the whole soil is saturated it may be Aquic in the higher categories; if only lower horizons are affected it may be Aquic at subgroup level. The period described as "at least a few days" (column 1, p.55, "Soil Taxonomy") is not known with accuracy.

The question used here to distinguish Aquic from Udic regimes is regarded as equivalent to the statement (column 2, p.55, "Soil Taxonomy") that a Udic regime "requires, except for short periods, a three-phase system, solid-liquid-gas, in part, but not necessarily in all, of the soil ...".
B3 SOIL TEMPERATURE MEASUREMENT

Soil temperature parameters needed for the definition of soil temperature regimes may be estimated from direct measurements as outlined in (a), or from air temperature data if this is available for the locality in question, as in (b).

Please note that approximations outlined here are subject to local verification and may need to be modified in individual cases if found inappropriate for a particular locality.

Throughout this section, the following meanings are implied:

**Summer** = June, July, August in northern hemisphere.
  = December, January, February in southern hemisphere.

**Winter** = December, January, February in northern hemisphere.
  = June, July, August in southern hemisphere.
B3 SOIL TEMPERATURE MEASUREMENT

(a) Estimation from direct measurements

Mean summer soil temperature

= Mean of soil temperature measurements taken at 50 cm depth on 15th day of each of the summer months.

[or = (2 x Mean annual soil temperature) - Mean Winter soil temperature]

Mean winter soil temperature

= Mean of soil temperature measurements taken at 50 cm depth on 15th day of each of the winter months.

[or = (2 x Mean annual soil temperature) - Mean Summer soil temperature]

Mean annual soil temperature

= Soil temperature measured in a deep bore (> 10 m depth) at any time of year.

or = Mean of soil temperature measurements taken at 50 cm depth on 4 days equally spaced throughout the year.

[or = (Mean summer soil temperature + Mean winter soil temperature) / 2]

*Note that the necessary data to estimate all 3 principal parameters can, if deep augering (> 10 m) is possible, be obtained in 2 months in either summer or winter. Expressions in brackets allow calculation of the third temperature parameter once 2 of them are known.*
B3 SOIL TEMPERATURE MEASUREMENT

(b) Estimation from air temperature data

Mean summer soil temperature
  = Mean summer air temperature - 0.6°C

Mean annual soil temperature
  = Mean annual air temperature + 1°C

Mean winter soil temperature
  = (2 × Mean annual soil temperature) - mean summer soil temperature
B4 SOIL TEMPERATURE REGIMES/CLASSES

Soil temperature characteristics are used in three ways in "Soil Taxonomy":

(i) To establish classes at suborder and great group level where the prefixes "bor-" and "cry-" are used;

(ii) To establish classes at lower categories in the taxonomy;

(iii) To define "soil temperature classes" at the level of family differentiae.

In the first, only three temperature regimes are distinguished: pergelico, cryico and frigid. Their identification is outlined in flow diagram (a) following.

In the remaining two, eight temperature regimes/classes are distinguished: frigid, mesic, thermic, hyperthermic, iso-frigid, isomesic, isothermic and isohyperthermic. They are defined in the same way in each instance and their identification is outlined in flow diagram (b) following.
* Mean summer, winter and annual soil temperatures are all measured at 50 cm depth or at a shallower lithic or paralithic contact. "Summer" and "winter" have the meanings defined in the section "Soil Temperature Measurement".

* Refers to the control section for organic soils as defined in the section "Thickness of Organic Materials" on p.68 of "Soil Taxonomy" (or flow diagram 96, this publication).

* Elsewhere in the section on cryic regimes (pp.62-3, "Soil Taxonomy") it is stated that "all isopodid soils without permafrost are considered to have a cryic temperature regime".

* This question derives from point 1b(2) of the definition of the cryic regime on p.62 of "Soil Taxonomy". The alternative point 1b(1) does not specifically exclude soils with a histic epipedon but seems to assume that where there is no O horizon there will be no histic epipedon either.
B4 SOIL TEMPERATURE REGIMES/CLASSES

(a) Regimes/classes in the lower categories

DO MEAN SUMMER AND MEAN WINTER SOIL TEMPERATURES* DIFFER BY > 5°C?

FRIGID

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 10°C?

NO

MESIC

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 15°C?

NO

THERMIC

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 22°C?

NO

HYPERThERMIC

ISOFRIGID

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 10°C?

NO

ISONECIC

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 15°C?

NO

ISOTHERMIC

YES

IS MEAN ANNUAL SOIL TEMPERATURE* < < 22°C?

NO

ISOHYPER-THERMIC

* MEAN SUMMER, WINTER AND ANNUAL SOIL TEMPERATURES ARE ALL MEASURED AT 50 CM DEPTH OR AT A SMALLER LITHIC OR PARA-LITHIC CONTACT. "SUMMER" AND "WINTER" HAVE THE MEANINGS DEFINED IN THE SECTION "SOIL TEMPERATURE MEASUREMENT".
B5 KINDS OF ORGANIC SOIL MATERIALS

Identification of the three main types of organic soil materials (fibric, hemic and sapric) is outlined in flow diagram B5b, derived from the definitions on pages 66-7 of "Soil Taxonomy".

As the definitions of the different types depend largely on estimation of the fibre content, it is necessary first to identify the fibres themselves. The definition of fibres (from p.66, "Soil Taxonomy") is outlined in flow diagram B5a.

Limnic materials, which may be present in organic soils in certain situations, are defined, and the various types (coprogenous earth, diatomaceous earth, marl) distinguished in flow diagram B5d (derived from pages 67-8 of "Soil Taxonomy"). They are not exclusive, and will normally be found in conjunction with other organic soil materials.

A flow diagram has not been prepared for humic materials (B5c in the list of flow diagrams) as the definition (p.67 "Soil Taxonomy") at present is not sufficiently precise.
B5 KINDS OF ORGANIC SOIL MATERIALS

(a) Fibres

- **YES**
  - Does fragment retain recognisable plant cellular structure?  
  - **NO**  
    - Not a fibre

- **YES**
  - Is fragment large enough to be retained on a sieve having 0.15 mm dia. openings, after dispersion in sodium hexameta-
    phosphate?
  - **NO**  
    - Not a fibre

- **YES**
  - Is fragment > 2 cm in cross-section (or smallest dimension)?  
    - **NO**  
      - FIBRE

- **FIBRE**
  - Can fragment be crushed and shredded with fingers?
  - **NO**  
    - Not a fibre. Coarse fragment

* Excluding live plant roots.
85 Kinds of Organic Soil Materials

(a) Fibric, humic and sapric soil materials

**FIBRIC**

- EXCLUDING COARSE FRAGMENTS (≥ 2 cm) AND MINERAL LAYERS, IS FIBRE CONTENT AFTER RUBBING > 3/4 OF SOIL VOLUME?
  - YES
  - NO

  - EXCLUDING COARSE FRAGMENTS (≥ 2 cm) AND MINERAL LAYERS, IS FIBRE CONTENT AFTER RUBBING > 2/3 OF SOIL VOLUME?
    - YES
    - NO

    - WHEN TREATED WITH SODIUM PYROPHOSPHATE DOES EXTRACT COLOUR ON WHITE CHROMATOGRAPHIC PAPER HAVE VALUE AND CHROMA OF 7/2, 7/2, 8/1, 8/2 OR 8/3?*
      - YES
      - NO

      - EXCLUDING COARSE FRAGMENTS (≥ 2 cm) AND MINERAL LAYERS, IS FIBRE CONTENT AFTER RUBBING < 1/6 OF SOIL VOLUME?
        - YES
        - NO
          - SAPRIC

      - WHEN TREATED WITH SODIUM PYROPHOSPHATE DOES EXTRACT COLOUR ON WHITE CHROMATOGRAPHIC PAPER HAVE VALUE AND CHROMA LYING BELOW OR TO THE RIGHT OF CHIPS 5/1, 6/2 AND 7/3?*
        - YES
        - NO
          - HEMIC

  - SAPRIC
    - YES
    - NO
      - HEMIC

* As indicated on figure 24, p. 67, "Soil Taxonomy".

* If there are few or no fibres, material not meeting the sodium pyrophosphate extract requirements for sapric may be an organic limnic material. See pp. 67-8 of "Soil Taxonomy", or flow diagram 85d.
B6 Kinds of Organic Soil Materials

(a) Limnic materials

Limnic materials may be either organic or inorganic, and have been either:
(a) Deposited in water by precipitation or through action of aquatic organisms, or
(b) Derived from subaqueous or floating aquatic plants and subsequently modified by aquatic animals.

Three types of limnic materials are identified:
1. Coprogenous earth, containing many faecal pellets;
2. Diatomaceous earth, which is highly siliceous;
3. Marl, which is mainly calcium carbonate.

The following diagrams may be used to confirm the suspected presence of any of these.

(i) Coprogenous earth

- **Yes**
  - Is colour value (moist) < 5?
  - No
    - **Not Coprogenous**

- **Yes**
  - Does material contain many faecal pellets (a few hundredths to a few tenths of a millimetre in diameter)?
  - No
    - **Not Coprogenous**

- **Yes**
  - Does material form a slightly viscous suspension in water?
  - No

- **Yes**
  - Is material slightly plastic but not sticky?
  - No

- **Yes**
  - Does material shrink when dried, forming clouds which adhere with difficulty or which appear laminated?
  - No
    - **Not Coprogenous**

When treated with saturated sodium pyrophosphate, does extract colour on white filter paper have higher value and colour chroma than IoYR 7/3? 

- **Yes**
  - Coprogenous Earth
  - No
DOES

UTW

CDUM

011

YllK

FILm

PMR

PUCCI

IN

A PASTE

MnlM

IN

SATMATED

SWIM

mlf

SOLU71011

IVE

HIWR

VAWE

AIOL

CWiW

nrrJl

1WR

1/37

(a) Diatomaceous earth

YES

IS COLOUR VALUE OF MATRIX (NOT PREVIOUSLY DRIED) 5 TO 5?

NO

NOT DIATOMACEOUS

YES

DOES COLOUR VALUE CHANGE IRREVERSIBLY ON DRYING?

NO

NOT DIATOMACEOUS

DIATOMACEOUS

YES

DOES EXTRACT COLOUR ON WHITE FILTER PAPER PLACED IN A PASTE OF SOIL MATERIAL IN SATURATED SODIUM PYROPHOSPHATE SOLUTION HAVE A HIGHER VALUE AND LOWER CHROMA THAN 10YR 7/3?

NO

DIATOMACEOUS

DIATOMACEOUS

YES

IS C.E.C. \( \leq 240 \text{ mm} \) OF ORGANIC MATTER (MEASURED BY LOSS ON IGNITION)?

NO

NOT DIATOMACEOUS

(b) Marl

YES

IS COLOUR VALUE (MOIST) \( \geq 5 \)?

NO

NOT MARL

MARL

YES

DOES MATERIAL REACT WITH DILUTE HCL TO EVOLVE CO\(_2\)?

NO

NOT MARL

* In the definition of coprogenous earth (p.68, "Soil Taxonomy"), item 4 states "is normally but not necessarily nearly devoid of fragments of plants that can be recognised with the eye". Because this is not a firm requirement it has been omitted from the flow diagram. It may, however, be used as a corroboratory characteristic.

* Item 3 (p.68, "Soil Taxonomy") states this as: "... often tend to crack along horizontal planes".

* Method not stated
B6 THICKNESS OF ORGANIC MATERIALS

IS ORGANIC MATERIAL FIBRIL, WITH AT LEAST THREE QUARTERS OF FIBRES DERIVED FROM SPARRAHUM OR MOSSES?

YES → IS BULK DENSITY OF ORGANIC MATERIAL < 0.1 M3/m3?

YES → IS THERE FROZEN SOIL WITHIN 95 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

YES → SURFACE TIER AND CONTROL SECTION TERMINATE AT CONTACT

YES → SURFACE TIER AND CONTROL SECTION TERMINATE AT CONTACT OR WATER

YES → IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?

YES → SURFACE TIER AND CONTROL SECTION TERMINATE 25 cm BELOW TOP OF FROZEN LAYER

NO → SURFACE TIER IS 0-60 cm

NO → IS THERE A LITHIC OR PARALITHIC CONTACT, OR THICK LAYER OF WATER WITHIN 60 cm OF SURFACE?

YES → SURFACE TIER AND CONTROL SECTION TERMINATE AT CONTACT OR WATER

NO → IS THERE FROZEN SOIL WITHIN 95 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

YES → SUBSURFACE TIER AND CONTROL SECTION TERMINATE AT CONTACT

NO → IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?
SUBSURFACE TIER AND
CONTROL SECTION TERMINATE AT CONTACT OR WATER

IS THERE A LITHIC OR PARALITHIC CONTACT, OR THICK LAYER OF WATER* WITHIN 120 cm OF SURFACE?

NO
SUBSURFACE TIER IS 60-120 cm

NO

IS THERE FROZEN SOIL WITHIN 135 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

NO

IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?

NO

BOTTOM TIER AND CONTROL SECTION TERMINATE AT CONTACT

BOTTOM TIER AND CONTROL SECTION TERMINATE 25 cm BELOW TOP OF FROZEN LAYER

IS THERE A LITHIC OR PARALITHIC CONTACT, OR THICK LAYER OF WATER* WITHIN 160 cm OF SURFACE?

NO

BOTTOM TIER IS 120-160 cm. CONTROL SECTION IS 0-160 cm

NO

IS THERE FROZEN SOIL WITHIN 5 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

NO

SURFACE TIER AND CONTROL SECTION TERMINATE AT CONTACT

IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?

NO

SURFACE TIER AND CONTROL SECTION TERMINATE 25 cm BELOW TOP OF FROZEN LAYER

YES

YES

YES

YES

YES
IS THERE A LITHIC OR PARALITHIC CONTACT, OR THICK LAYER OF WATER* WITHIN 30 cm OF SURFACE?

IS THERE FROZEN SOIL WITHIN 65 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?

IS THERE A LITHIC OR PARALITHIC CONTACT, OR THICK LAYER OF WATER* WITHIN 90 cm OF SURFACE?

IS THERE FROZEN SOIL WITHIN 105 cm OF SURFACE, 2 MONTHS AFTER SUMMER SOLSTICE?

IS THERE A LITHIC OR PARALITHIC CONTACT WITHIN 25 cm BELOW TOP OF FROZEN LAYER?
This flow diagram, derived from the definitions on p.68-9 of "Soil Taxonomy", defines the control section for organic soils and determines the limits of the surface, subsurface and bottom tiers.

Notes:

(1) In the definition of the limits of the surface tier (p.69, "Soil Taxonomy") no provision is made for this tier to be foreshortened in the event that a lithic or paralithic contact or other terminating feature occurs within the normal depth of the tier. However, a soil consisting of a thin (<30 cm or <60 cm thick, depending on the nature of the organic material) layer of organic soil material over a lithic or paralithic contact is, nevertheless, within the definition of a Histosol (p.211, "Soil Taxonomy"), and it seems clear from figure 25 (p.69, "Soil Taxonomy") also that a surface tier must still be recognised. Consequently, in this flow diagram, any lithic or paralithic contact or thick layer of water beginning within the stated surface tier depth (30 or 60 cm), or a frozen layer beginning at >25 cm above that depth, is regarded as terminating both the surface tier and the control section.

(11) The surface tier is exclusive of loose surface litter or living mosses.

(111) If there is a distinct microrelief of mounds, these may need to be levelled prior to determining tier thicknesses (see, p.68, "Soil Taxonomy").

† Extending down to 160 cm or more.

‡ Extending down to 130 cm or more.
APPENDICES
Soil temperatures in New Zealand have long been measured at 30 cm depth rather than 50 cm as now required by Soil Taxonomy. To convert 30 cm-derived figures to 50 cm figures, the following relationships (Aldridge, 1977) can be used:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean summer soil temperature at 50 cm</td>
<td>Mean summer soil temperature at 30 cm depth - 0.6°C</td>
</tr>
<tr>
<td>Mean winter soil temperature at 50 cm</td>
<td>Mean winter soil temperature at 30 cm depth + 0.6°C</td>
</tr>
<tr>
<td>Mean annual soil temperature at 50 cm</td>
<td>Mean annual soil temperature at 30 cm depth</td>
</tr>
<tr>
<td>Seasonal temperature range at 50 cm</td>
<td>Seasonal temperature range at 30 cm depth - 1.2°C</td>
</tr>
</tbody>
</table>

Reference:

App. B3 SOIL TEMPERATURE MEASUREMENT

(b) Estimation from air temperature data

The approximation for mean annual soil temperature has been tested in New Zealand and revised in relation to a 30 cm test depth as follows (Aldridge 1977):

North Island:

Mean annual soil temperature at 30 cm depth = Mean annual air temperature normal + 1.6°C

South Island:

Mean annual soil temperature at 30 cm depth = Mean annual air temperature normal + 0.9°C

In addition, a method of estimating mean annual soil temperature from altitude and latitude data only has been derived for New Zealand as follows:

Mean annual soil temperature at 30 cm depth (°C) = 36.63 - 0.00450 (Altitude (m)) - 0.554 (Latitude (degrees and tenths))

This may be used where air temperature data is unavailable.

Reference: