Soil properties for plant growth

A guide to recognising soil attributes relevant to plant growth and plant selection

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Landcare Research

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Introduction

This guide is designed to support the needs of two sets of users:

- Those using the soil key as a diagnostic element in 'PlanterGuide'[1]. The key uses a number of soil terms to identify soil orders. This guide provides user-friendly explanations of these soil terms.
- Those who know the soil and site requirements of particular plants and wish to check the suitability of a proposed site.

Information on soil attributes relevant to plant growth can be gathered by:

- Reading a soil map (See www.mwpress.co.nz)
- Reading the landscape (to relate the position of a site in the landscape to expected properties of depth, drainage, alluvial influence, microclimate, etc.)
- Reading a soil profile

The emphasis in this guide is on the last line of evidence – reading a soil profile.

Key soil attributes

The soil serves the needs of the plant by providing

- Water
- Air
- Nutrients
- Stability

The ability of a soil to provide these services may be evaluated by key soil attributes (see table following).

Key soil attribute	Relevance to plants
Wetness	Water supply, exclusion of air and, consequently, exclusion of oxygen
Root barrier	Controls the depth of soil available for roots to extract water and nutrients, and to anchor the plant
Stoniness	Stones and rocks dilute the volume of soil within the root depth that is available for water storage and nutrients
Porosity	Promotes stability by allowing deep rooting. Drains excess water, and circulates air to roots
Natural nutrient status	Controls nutrient supply and reserves
Drought proneness	An interaction between climate and soil attributes

[1] PlanterGuide is an interactive plant selection tool for eco restoration and landscaping hosted by the NZERN web site (www.bush.org.nz)

Observing the soil

The best way of observing the soil is to dig a pit, large enough to clearly see features to at least 70 cm depth. One side of the pit is cut clean with a spade to reveal structure, colour and layering.

Otherwise, road cuttings or other exposures can be used, but these can be misleading because exposure to the weather may mask some important soil attributes. It is necessary to dig back into the cutting (20–30 cm) to expose natural soil.

With some experience an auger can be used to rapidly sample the soil to depths up to 1 m. This is particularly useful after examining a pit to see how features seen in the pit vary in the landscape.

Examination procedure

1. Clean loose soil from the exposure and use a spade or large knife to reveal undisturbed soil from the ground surface to at least 70 cm depth.
2. If the information is to be recorded then describe site features on the description sheet (Appendix 1).
3. Note obvious layers and mark their boundary.
    a. The first layer is usually the topsoil. The lower boundary of the topsoil is where darker-coloured topsoil (where organic matter is concentrated) passes into underlying lighter-coloured subsoil (with less organic matter).
    b. Then within the subsoil look for layers marked by changes in colour, colour patterns, networks of cracks, or relative hardness to dig.
    c. Note the layers and their depths on the description sheet (Appendix 1).
    d. Continue the following examination layer by layer.
4. Examine colour patterns for evidence of wetness – looking for rust or reddish coloured mottles and grey patches, and changes with depth. See page 6.
5. Determine if any layers are a root barrier. See page 9.
6. Continue examination only in the layers above the root barrier (if present).
7. Examine stone content. See page 12.
8. Examine porosity. See page 13.
9. Consider natural nutrient status. See page 16.
10. Consider drought proneness if the site is in an area with a seasonally dry climate. See page 18.

Figure 1. The ultimate soil pit dug deep and wide to provide an excellent view of soil layers. The soil scientist is measuring soil colour using a soil colour chart.

Figure 2. A soil with four clearly defined layers (or horizons). The soil is a "Podzol" formed in a deep deposit of pumice. The leached layer (known as an albic horizon) is pale coloured because colouring agents have been leached out by acids and chelates from the vegetation.

Description of key soil attributes

The key soil attributes are described and illustrated on the following pages. What these indicate about the soil is noted. A brief explanation is given of the soil processes responsible for the attributes.

A soil description form is provided in Appendix 2. This helps as a systematic guide through the soil description process. It may also be used to keep a record of soil attributes at observation sites.

Wetness

When a soil is very wet for a prolonged time the supply of air to roots may be limited. This level of wetness may be observed directly, but regular episodes of wetness can be indicated by soil colour when it is not currently wet.

The features to look for in each layer

- Rust-coloured mottles
- Dominant grey colours
- Depth at which these features occur
- Peaty topsoil

Observing the features

Rust-coloured mottles

Rust- or reddish-coloured spots or streaks (of a few millimetres width) occur. The mottles may be surrounded by grey-coloured soil or accompanied by patches of grey soil. If grey colours are present they are not dominant.

Rust-coloured mottles indicate saturation with water by an intermittent water table. Saturation may be present for only a few weeks, probably in winter and early spring.

Figure 3. Rust mottles indicate intermittent saturation by water. Some patches of grey occur but are are not dominant.

Dominant grey colours (usually accompanied by mottles)

Light grey to mid-grey is the dominant colour throughout the soil. On the sides of cracks the colour may be totally grey. Mottles are usually present, but in some soils that are totally grey, mottles may be absent.

Dominant grey colours indicate prolonged saturation with water by a water table. Saturation is likely at least through the winter and early spring, and may be moist throughout the year. In Figure 2, the second layer could be confused with a dominant grey layer. The lack of rust mottles is a clue that the layer is a not a dominantly grey layer horizon and therefore not subject to significant periods of wetness.

Figure 4. Dominant grey colours indicate prolonged saturation by water in a water table. Dominance of grey is more obvious in the upper half. More rust colored mottles are obvious in the lower half but brownish grey still dominates.

Figure 5. The topsoil is peaty in this soil and the peat extends to depth. A peaty topsoil can also overly mineral soil material comprising some mixture of sand, silt or clay.

Peaty topsoil

The topsoil is peat, which is mainly made of decomposed plant fragments. Sometimes the plant fragments are hard to see but the peat is usually spongy. The colour is black or sometimes very dark brown in colour. The subsoil beneath the peaty topsoil usually has dominant grey colours, or is dark grey or black.

Peat in the topsoil, or extending to greater depth, indicates saturation for most of the year.

Depth to rust-coloured mottles or dominant grey colours

Depth in centimetres from the ground surface to the top of a rust-coloured mottled or dominant grey layer.

Depth indicates the depth from the surface to the intermittent or prolonged water table and is used to classify the soil's drainage status.

Figure 6. A soil profile with a dominantly grey layer at depth indicating prolonged saturation with water. The water table commonly occupies this zone. A mottled layer frequently overlies the dominant grey layer, as in this profile, and indicates that the water table intermitantly rises close to the ground surface.

What wetness means

The amount of wetness experienced by plants depends on the depth to the water table, and the length of time of wetness. Wetness for short intermittent periods is indicated by rust-coloured mottles, and wetness for prolonged periods is indicated by dominant grey colours. These factors are expressed by drainage classes.

1. No rust-coloured mottles or dominant grey layer within 90 cm depth
   Yes **Well drained**
   No Go to 2
2. Either, rust-coloured mottles between 30 and 90 cm depth, **or** predominant grey colours between 60 and 90 cm depth
   Yes **Moderately well drained**
   No Go to 3
3. Either, rust-coloured mottles shallower than 30 cm depth, **or** predominant grey colours between 30 and 60 cm depth
   Yes **Imperfectly drained**
   No Go to 4
4. Predominant grey colours shallower then 30 cm depth
   Yes **Poorly drained**
   No Go to 5
5. Has a peaty topsoil
   Yes **Very poorly drained**

Explanation

Saturation by water reduces the supply of air through pores in the soil. After a period of time microbes that use oxygen exhaust the available supply and the soil becomes 'anaerobic'. This affects the roots of many plants and initiates a number of chemical changes in the soil. One chemical change is experienced by iron that occurs naturally in mineral soil. Iron is an element responsible for the brown to red colours of soil and remains as an insoluble colouring agent in the presence of oxygen. Anaerobic conditions cause some of the iron to become soluble and to migrate. It moves towards areas of relatively high oxygen content where it concentrates into rust-coloured patches or spots (mottles). The areas depleted of iron have lost their colouring agent and become grey.

Root barrier

Root barriers control the depth of soil that is available for roots to extract water and nutrients, and to anchor the plant.

Features to look for in each layer

- Tightly packed very stony layer
- Sandy very stony layer
- Rock
- Hard pan
- Compact soil layer, or
- Wetness in the form of high, prolonged, water table.

Observing the features

Check the soil layers for the following barriers, and measure the depth to the barrier.

Tightly packed, very stony barrier

The layer is dominated by stones that are so common that most are touching their neighbours. The gaps between stones are filled with soil material that is compact – so that it is difficult to remove stones by hand.

The nature of the soil material in the gaps between the stones is important, as it constitutes the only part of the soil that plants can utilise. If the material between the stones is loamy, silty or clayey (see Appendix 1 for texture identification) and not compacted, then roots will probably be able to penetrate. If, however, the material is tightly packed (especially when it is when moist) then it will represent a depth barrier.

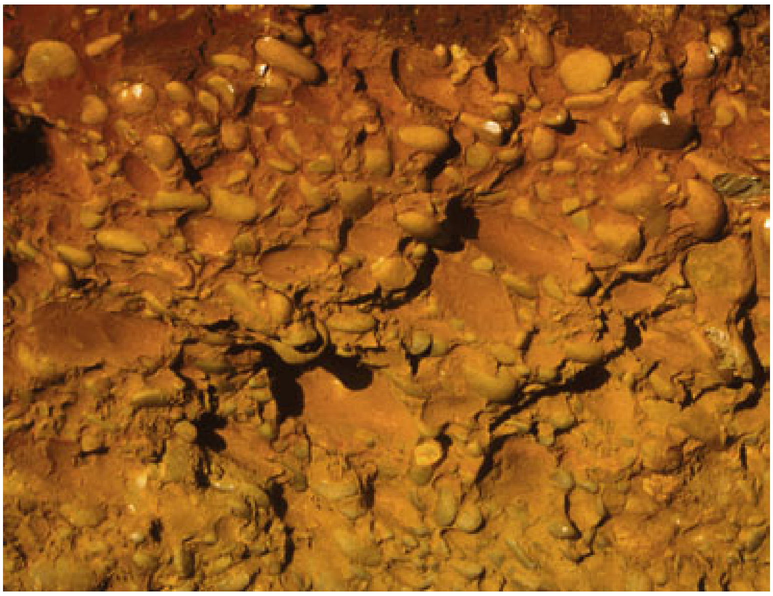

Figure 7. A very stony layer in which the material between the stones in compact and limits root penetration. The rust colour of the material between the stones is due to deposition of iron-aluminium-organic matter complexes.

Sandy, very stony barrier

Stones that are so common that most are touching their neighbours dominate the layer. The gaps between stones are filled with sand and the stones are loose and easily removed by hand.

If the gap material is loose and sandy then it will have a low capacity for water and nutrient storage. A few roots will grow down through it only during a wet season.

Rock barrier

A rock barrier may be solid bedrock, hard rock that is cracked or shattered, or rock, like mudstone, that can be easily broken by a hammer, but is impenetrable to roots.

Figure 8. Rock as a root barrier.

Hard pan barrier

A hard pan is a soil layer that is very hard and forms a very distinct root barrier. A fragment is very difficult to break in the hand. In the case of an iron pan it may be a few millimetres or many centimetres thick (Figure 9) but forms a continuous, clearly defined, rust-coloured barrier. In the case of a fragipan (densely compacted silty subsoil – Figure 10) it may extend to more than 1 m in thickness.

Figure 9. Thin iron pan that acts as a root barrier. Note that mottling and grey colours above the pan indicate wetness caused by restriction of water drainage through the pan.

Compact soil barrier

A compact soil layer is similar to other layers in the soil and is not as distinct as a hard pan. Some roots may penetrate it. However, soil cracks are few or absent and the layer is a nearly continuous mass of soil material so that it takes firm pressure to break a sample in the hand. A compact soil layer may or may not be stony.

Wet layer

A wet layer is recognised by the presence of dominant grey colours with or without rust-coloured mottles (see 'Wetness' above). These conditions are caused by a water table that is high for several months of the year.

If in doubt check the roots

If the barrier is difficult to judge, cut out and carefully examine blocks of soil to see if roots are present (roots as few as one to a 10-cm-sized block of soil indicate a restriction).

Top of
hard pan
(fragipan)

Figure 10. Soil profile showing a hard pan barrier (fragipan) in silty loess. The pan limits the penetration of roots and drainage of water. The grey streaks indicate polonged saturation of water – in this case due to a water table that perches on top and within the very slowly draining pan.

What root barriers mean

1. If the root barrier is less than 45 cm depth, it is likely to have a significant effect on plant growth and stability.
2. If less than 25 cm the root barrier will have a very severe effect.

The depths suggested here are only a guide and need to be modified for some plants. Some shallow rooting plants will thrive in shallow soils, e.g. grasses and annual weeds. Others are deep rooting and may require much greater depth than 45 cm to thrive, e.g. most trees and shrubs. A few are capable of penetrating quite dense soils – cabbage tress and pines.

The significance of a wet layer depends on the plant. It will not be a barrier to the roots of wetland plants but may be a barrier to many other plants. Wetland species have internal tissues that can conduct air to roots in water-logged anaerobic soils.

Explanation

Most plants have a concentration of roots in the topsoil that are particularly important for nutrition. Deeper roots are needed not only to supplement nutrition but also to tap deeper sources of water in drought and provide anchorage for stability. Roots have only limited ability to force their way through soil and usually extend by exploiting existing pores. Soil with good porosity is therefore the best root medium.

Stoniness

Stones and rocks dilute the volume of soil within the root depth that is available for water storage and nutrients. They have an especially important effect on water storage in soils in seasonally dry climates.

Features to look for in each layer

- Stones or rocks

Observing the features

Stones or rocks

Stones range in size from boulders to fine gravel (down to 2 mm diameter). A large number of stones in the soil restricts the volume of soil that is available for roots to explore for water and nutrients.

What the stoniness means

If the volume of stones is more than about a third of the volume of the soil, then it is likely to have a significant effect on water storage and available fertility. The effect will be particularly significant if there are sufficient stones that they are mostly in contact with one another.

Figures 11. Stones in the form of scoria in a soil formed from weatherd basalt at Mt Wellington, Auckland. The scoria ditutes the volume of soil avaliable for storage of water and for roots to extract nutrietnts. In a wet climate however, water storage is not as critical as in a dry climate. The material bewteen the stones is loose and water is able to drain, and roots penetrate easily through it.

Porosity

Soil pores are cracks or tubular holes in the soil filled with water or air. They can store water or circulate air to roots, and larger pores drain excess water.

Features to look for in each layer

- Sandy texture
- Weak soil strength
- Cracking patterns
- Roots

Description of features in each layer

Sandy texture (Note that in stony soils we are concerned only with material between the stones)

A soil with sandy texture:

(1) Feels gritty when rubbed in the fingers.

(2) When a moist sample is crushed in the hand and an attempt is made to roll it to form a ball, it is either too crumbly to form a ball or the ball when squeezed quickly cracks (see Appendix 1 on the identification of sandy, loamy, silty and clayey soil textures).

Sandy-textured soil will have good porosity because the spaces between the sand grains have few finer particles of silt or clay to fill these spaces.

Weak soil strength

The aim is to distinguish weak-strength soil from stronger soil.

(1) Take an undisturbed golf-ball-sized lump of soil and crush it between the extended thumb and forefinger. It is best done when the soil is moist, when there is sufficient moisture for plants to grow (dry soils are generally stronger than moist soils).

(2) A soil with weak strength is easily crushed with only gentle force. Stronger soil will require moderate force to crush it. Some topsoils have so many roots that they are difficult to crush. Such soils usually have weak strength.

Weak-strength soil is likely to have good porosity. The pores comprise fine tubes and the spaces between fine aggregates. The aggregates may be too small to be seen but will be effective in allowing root penetration, air circulation and water drainage.

Figure 12. Soil with good porosity because of weak strength and good aggregation. There is wide distribution of soil pores sizes, from large pores between fine aggregates (peds) that enable drainage of water and entry of air to roots, and fine pores within aggregates that provide good water storage.

Cracking patterns

Cracks and gaps in soil occur between natural lumps called soil aggregates (also known as peds) of soil material. Where the aggregates are well formed the cracks and gaps will be clearly defined and will easily circulate air and allow drainage of water.

Choose one of the following three grades of cracking patterns:

(1) Well cracked – aggregates and the cracks between them are clearly visible in the side of the pit, or when fist sized lumps of soil are prised out of the side of the soil pit with a spade or knife. The cracks are less than 40 mm apart.

(2) Moderately cracked – aggregates and the cracks between them are not clearly seen, or there are only a few cracks visible. The cracks are more than 40 mm apart but less than 150 mm apart.

(3) Poorly cracked – There are no aggregates visible and the soil layer is either one unbroken mass, or any visible cracks are more than 150 mm part.

Figure 13. Stongly developed soil structure in the subsoil of a clayey ancient soil (Ultic Soil) in Northland. The structure comprises blocky aggregates (peds) with large open pores paces between them. The roots indicate scale.

What porosity means

Key to estimate porosity in each layer

1. The soils is sandy
   Yes **Porosity good**
   No Go to 2.

2. Soil strength is weak
   Yes **Porosity good**
   No Go to 3.

3. The layer is well cracked
   Yes **Porosity good**
   No Go to 4.

4. The layer is moderately cracked
   Yes **Porosity moderate**
   No Go to 5.

5. The layer is poorly cracked
   Yes **Porosity poor**

Soils with good porosity will have good air supply to roots, and will easily drain water. It is possible for soils to have too much porosity. If the soil is very loose roots may not be able to establish good contact with the soil. For this reason soil should be pressed down around roots when planting to fill large air gaps.

Soils with moderate porosity may have some restriction to root penetration and when wet the pores may fill with water and restrict air supply. This will usually be indicated by signs of wetness (see Wetness).

Soils with poor porosity will restrict root penetration, air circulation and drainage of water.

Double check – look to the roots

The distribution of existing roots will provide an indication of porosity. Patches where the roots are absent are likely to have poor porosity.

Explanation:

Soils may be only a third to half solid material, with the remaining pore space occupied by water or air. The pore space includes very fine pores of micron-sized up to millimetre-sized spaces between soil aggregates. The range of pore sizes influences the retention and drainage of water and the ease by which air can circulate to roots. A predominance of very fine pores will provide good water storage but a significant proportion of water will be so tightly trapped in fine pores that it is too hard for roots to suck it out. Predominance of coarse pores will provide less storage but good drainage of excess water.

Natural nutrient status

The natural nutrient status includes both the ability of soil to make nutrients readily available to plant roots and to store nutrients in reserves that will become available in the future as the soil matures. It is an expression of the fertility in the absence of fertilisers.

A soil analysis is required to confidently establish the present nutrient status of a soil. However, some useful clues to natural nutrient status (nutrient status prior to artificial fertilisation) can be derived from observations of the soil and the site.

The concepts of weathering and leaching

Weathering is the amount of change in the soil material from the original parent material. Over long periods of time (thousands of years) the original parent material decays, sand and silt particles break down into clay, iron in minerals turns to rust, percolating rain water leaches out nutrients, and acidity increases. These and many other processes lead to the formation of distinct soil layers (or horizons). These alterations are indicated by a combination of clay content, colour, and the extent of decay of any stones that may be present.

What features to look for

It is helpful to recognise three age-classes of soils: young soils, mature soils and ancient soils. The features used to recognise these age classes include weathering, landform, and geographic location.

Observing the features

Key to soil age classes

1. (a) Soils on young landforms (in which the land surface is only decades to a few hundred years old) on:
   Beach sand dunes or gravel ridges
   Estuaries
   River floodplains
   Steep slopes
   Sides of active volcanos
   Active hydrothermal areas
   Land at altitudes subject to strong frost action, or
   Recently eroded land

   OR

   (b) Topsoils overlie soil material that is very similar to the deeper parent material. There has been little alteration (weathering) of the parent material and soil formation is confined mainly to the topsoil.

Either 1(a) or (b)	Yes	**Young soils**
	No	Go to 2.

2. (a) Soils on subdued, easy hill and rolling landforms in Northland and in parts of Auckland and Waikato, and limited areas of coastal Nelson, Marlborough Sounds and Wellington (where the land surfaces are older than about 100 000 years old).

   AND

   (b) The soils are clayey, and if there are any stones they are soft and easily broken in the hand. Colours of subsoils range from reddish brown, to dark brown to yellow (some have the grey colours that indicate wetness).

Both 2(a) and (b)	Yes	**Ancient soils**
	No	**Mature soils**

What soil age means in terms of natural nutrient status

Young soils

Young soils are likely to have good supplies of phosphorous, potassium, calcium and magnesium and moderate or low acidity. If the topsoil is only weakly developed and there is little organic matter, then nitrogen is probably limited. Both introduced and native legumes (that fix their own nitrogen) establish well.

Young soils may be unstable due either to erosion or to sedimentation of flood deposits or eroded debris on slopes.

Ancient soils

Ancient soils are usually strongly acid with very low levels of potassium, magnesium, calcium, and phosphorous. The available fertility tends to be concentrated in the organic-rich topsoils and may only be slowly available to plants.

Mature soils

Mature soils will have levels of phosphorous, potassium, calcium and magnesium between the higher levels of young soils and the lower levels of ancient soils. They will generally have levels of nitrogen similar to ancient soils.

Nutrient levels of mature soils are related to climate and rainfall.

For soils on the common light or grey-coloured hard rocks (greywacke, schist, granite, mudstone, sandstone, granite, and rhyolite), or from sediments derived from these rocks, the natural nutrient status is strongly related to climate. Generally under dry climates, nutrients (other than nitrogen) are relatively high and similar to associated young soils. As mean annual rainfall increases, nutrient levels decrease because the soils are subject to higher leaching.

Soils on other parent materials will have nutrient status influenced by the parent material as well as rainfall. For example, soils on limestone or lime-rich rocks will have high calcium, but may have deficiencies of phosphorous. Soils in mixtures of lime and other material may be optimal for plant growth.

Modification by fertilisers

The natural soil nutrient status may have been modified by fertilisers, including lime, which lowers acidity and enhances the availability of some nutrients. In which case the predicted natural status will differ from the nutrient status at the site.

Plants as fertility indicators

Plants are indicators of soil fertility and acidity, and can be used to reinforce soil clues. For example, restiads, manuka, heaths, fescue tussock, beech, kauri, and cupressoid plants generally indicate low fertility and acid soils. Kahikatea, matai, kanuka, silver tussock, and large leafy trees indicate high fertility.

Portable pH test kits

Simple universal indicator pH kits are available for a few dollars. These allow estimation of soil acidity within about 1 pH unit, and since pH is correlated with fertility it is a useful indicator. Kits can be purchased from most garden shops.

Drought proneness

Drought proneness is mainly a climate factor but in seasonally dry areas soil properties affect the severity of drought experienced by plants.

Drought is related to the amount of water stored in the soil and available for plant survival or growth. The water available to plants can be predicted by inputs from rainfall, losses by evapotranspiration and drainage, and the water storage in the soil. The focus here is only on the soil water storage in the soil.

Features to look for in each layer

The relative potential for drought at a site is indicated by:

- Depth barriers
- Stones
- Sandy texture

Observing the features

Depth barriers

See the section on root barriers (page 9).

Stoniness

See the section on stoniness (page 12).

Sandy texture

See description of sandy texture in the section on porosity (page 13).

What the drought proneness features mean

Water storage in a soil is strongly influenced by a shallow root barrier, stoniness and sandy texture.

Water storage is significantly reduced by any of the following:

1. Depth to a root barrier of less than 45 cm
2. Stone contents more than 35% of the soil in layers above the root barrier.
3. Sandy-textured group in layers above the root barrier.

Figure 14. Sandy soil formed in dune sand. The topsoil is very thin because the soil is very young. The porosity is due to the spaces between sand grains, and an abundance of coarse pores provides good drainage. However, because there is almost no silt or clay, there are very few fine pores to store water so in low rainfall areas the soil can be droughty.

Explanation

See the explanation box in the porosity section.
Soil water is stored in soil pores. Large pores provide water that is easy for the plant to extract and fine pores provide water that is harder to extract. The coarse pore water is extracted first. Water reserves for drought are held in the very fine pores. In sandy soils, sand grains pack together in a way that leaves only coarse pores. When this is exhausted by drainage and by water extraction by roots, there is little reserve. Stones and root barriers reduce the soil volume available for water storage.

Further help

The best soils text for New Zealand conditions is:

McLaren, R.G.; Cameron, K.C. 1996: Soil science, sustainable production and environmental protection, 2nd edn. Oxford, Oxford University Press. 304 p.

The definitions of New Zealand soil classes are given in:

Hewitt, A.E. 1998: New Zealand soil classification. Landcare Research Science Series No.1, 2nd edn. Lincoln, New Zealand, Manaaki Whenua Press.

A general account of New Zealand soils and landscapes with a summary of orders of the *New Zealand Soil Classification* in an appendix:

Molloy L. 1998: Soils of the New Zealand landscape, the living mantle, 2nd edn. Wellington, Mallinson Rendel. Pp. 229–245.

Soil attributes as they are defined and used in New Zealand are defined in:

Taylor N.H.; Pohlen, I.H. 1979: Soil survey method. *Soil Bureau Bulletin 25*. DSIR. Wellington. 241pp.

Milne, J.D.G.; Clayden, B.; Singleton, P.L.; Wilson, A.D. 1995: Soil description handbook. Lincoln, Manaaki Whenua Press. 156 p.

The New Zealand Soil Science Society web site has links to many sites describing soils and their attributes

http://nzsss.rsnz.org/page2.php?portal=1&section=publications

A good description of New Zealand soils, their variation, and salient properties, provided by Peter Singleton on CD is outlined at

http://www.4fronttech.co.nz/MarketingProducts/NZSoils/prod_nzsoils_a.htm

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I gratefully acknowledge funding from Department of Conservation and much help in translating pedology into English by Colin Meurk, Grant Hunter, Edith Jones and Mike Peters.

Appendix 1

Identifying soil texture groups

(Adapted from Milne, J.D.G.; Clayden, B.; Singleton, P.L.; Wilson, A.D. 1995: Soil description handbook. Lincoln, Manaaki Whenua Press. 156 p.)

A sample is wet up gradually, kneading thoroughly between finger and thumb until aggregates are broken down. Disgard any gravel present. The soil is at the required consistency when plastic and mouldable like moist putty. Maintain at the correct water constant by periodic addition of water, adding more soil if it becomes too wet.

Does the soil have a dominantly sandy (gritty feel)?

Sandy (dominated by sand with less than 8% clay and less than 40% silt)

Does the soil mould to form an easily deformed ball and feel smooth and silky?

Silty (More than 40% silt and less than 35% clay)

Does the soil mould to form a strong ball, which smears but does not take a polish?

Loamy (9–35% clay and less than 40% silt)

Does the soil mould like plasticine, take a polish and feel very sticky when wet?

Clayey (more than 35% clay)

Appendix 2

Soil description card

Site

Site ID number: ____________________

Date ____________ Observers name: ____________________

Location: ____________________

Soil

Layers	1	2	3	4	5
Depth to base of layer (In cm)					
Mottles (Indicate if present)					
Dominant grey (Indicate if present)					
Root barrier (Indicate if present)					
Stoniness (Estimate %)					
Sandy Texture (Indicate if present)					
Weak soil strength (Indicate if present)					
Cracking patterns (Well, moderately, poorly)					
Porosity (Derived from key)					
Roots (In what layer do roots become rare)					

Peaty topsoil present: Yes / No

Drainage class (See key): ____________________

Estimate of soil age class (See key): ____________________

Seasonally dry climate: Yes/ No,

If Yes - Drought proneness (See key): ____________________

Notes

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