Manaaki Whenua
Landcare Research

Hydric soils – field identification guide

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Hydric soils – field identification guide

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Summary

This guide is to help the identification of hydric soil features in the field. 'Hydric soils' is a general term for soils that are poorly or very poorly drained and have a water table above, at, or near the surface long enough during the growing season to develop anaerobic conditions in the upper layers. Gley soils and Organic soils are the two main orders of hydric soils. Gley soils have pale subsoils often with reddish mottles. These colours are indicators of saturated low oxygen conditions. Organic soils are also formed in saturated conditions and have at least 30 cm of peaty material.

This guide provides explanations and descriptions of soil characteristics that help identify hydric soil features in the field. There is also a field identification key for hydric soil features and a list of New Zealand's hydric soils.

Drainage has altered the water regime of many wet soils, but they are often still saturated during wet periods because of slow soil permeability and fluctuating water tables that can rise to the surface. In some cases the soil has hydric features but because of land drainage is no longer saturated. Confirmation of the saturated status of the soil, and hydric soil features, are both required for identification of a hydric soil where land has been drained.

The methods used in this field guide are based on the Pocket Guide to Hydric Soil Field Indicators (Wetland Training institute 2017), the New Zealand Soil Description Handbook (Milne et al. 1995) and New Zealand Soil Classification (Hewitt et al. 2010).

1 Background

1.1 Wetland identification

The New Zealand Resource Management Act (1991) defines wetlands as 'permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions'. This definition is very broad and has proved difficult to apply consistently in the field. As the identification of wetlands is an important part of resource management in New Zealand, regulatory agencies require a consistent set of criteria to define wetlands on the ground for consent and planning purposes.

The United States of America has developed a scientifically robust wetland delineation system (Environment Laboratory 1987, and updates, including US Army Corps of Engineers 2008, 2010) that is applied widely and could be adapted for New Zealand wetlands. In the USA three diagnostic environmental characteristics or criteria are used for wetland delineation:

- wetland vegetation
- hydric soils and
- wetland hydrology.

Under USA legislation (section 404 Clean Water Act and regulations promulgated therefrom), all three criteria are required to classify a site as a wetland.

In New Zealand, the availability of simple guidelines and criteria for wetland delineation, similar to those used in the USA, would be extremely useful. This requires development of the three major characteristics of wetlands that are suitable for New Zealand conditions as follows:

- Vegetation Tool Categorise New Zealand wetland plant species (hydrophytes) and set decision rules regarding species abundance in relation to meeting the wetland threshold (completed; Clarkson 2014).
- Soil Tool Define and provide a field guide for identification of hydric soils and how they relate to the New Zealand soil classification system.
- Hydrology Tool Define the hydrological conditions that would be required for wetland criteria (yet to commence).

This project covers Stage 2 on the Hydric Soil Tool. It adapts New Zealand soils and conditions to the latest approach to identifying wet soils in the field as outlined in the 'Pocket Guide to Hydric Soil Field Indicators' (Wetland Training Institute 2017).

1.2 Hydric soils

Hydric soils can be defined as:

> Soils that have formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic (low oxygen) conditions in at least the upper 30 cm of the soil (based on Federal Register 1994).

Hydric soils can be the result of soil or site characteristics. Often low soil porosity results in slow drainage, causing the soil to be wet for prolonged periods. The other cause of hydric soil is being located in low areas of the landscape that have a high water table. Such locations can be near rivers or where drainage water accumulates on its way downslope. Hydric soils can occur on flat or sloping land.

Drainage of agricultural land has reduced the extent of wet soils but the inherent properties that cause slow drainage still cause them to be wet, particularly in periods of prolonged rainfall. In these circumstances they can still pond and their water table can rise to the surface.

Wet, saturated conditions permanently alter the colour of the soil. Prolonged wet conditions can also result in the formation of black peaty or humic material. These features can be used to identify hydric soils in the field.

Generally hydric soils are peaty or humic, or have pale light grey subsoil colours caused by saturation and a lack of oxygen. Blotches (mottles) of redder colour can occur in the topsoil or subsoil where air can get into the soil and oxidises iron minerals to form redder colours.

The New Zealand Soil Classification groups the main hydric soils into either Gley or Organic Soil Orders. These soils are poorly or very poorly drained (see Milne et al. (1995) for definitions of soil drainage classes) and have features that indicate periodic or prolonged saturation at or near the soil surface. Other Soil Orders in the New Zealand Soil Classification can have soils that cover a range of drainage classes (defined at the group and sub-group level) but they are usually not as wet as Gley or Organic soils, however, there can be groups and sub-groups within other Soil Orders that are poorly or very poorly drained and are covered in this guide.

2 Features of hydric soils

The first steps in identifying hydric soils are to assess the site for features that indicate the likely presence of wet soil conditions. This would cover:

1 landscape position

2 vegetation type

3 drainage and wetness

The second step is to assess the soil for characteristics that indicate anaerobic conditions such as:

4 soil colours

- matrix
- mottles

2.1 Position in the landscape

Wet soil conditions are clues to the presence of hydric soils. The positions in the landscape that are most likely to be wet are low lying areas adjacent to open water such as lakes, ponds, rivers, and the sea. Other areas on sloping land can also have wet conditions. These include areas at the base of slopes or valleys where seepage water accumulates and drains away (Figs 1–3).

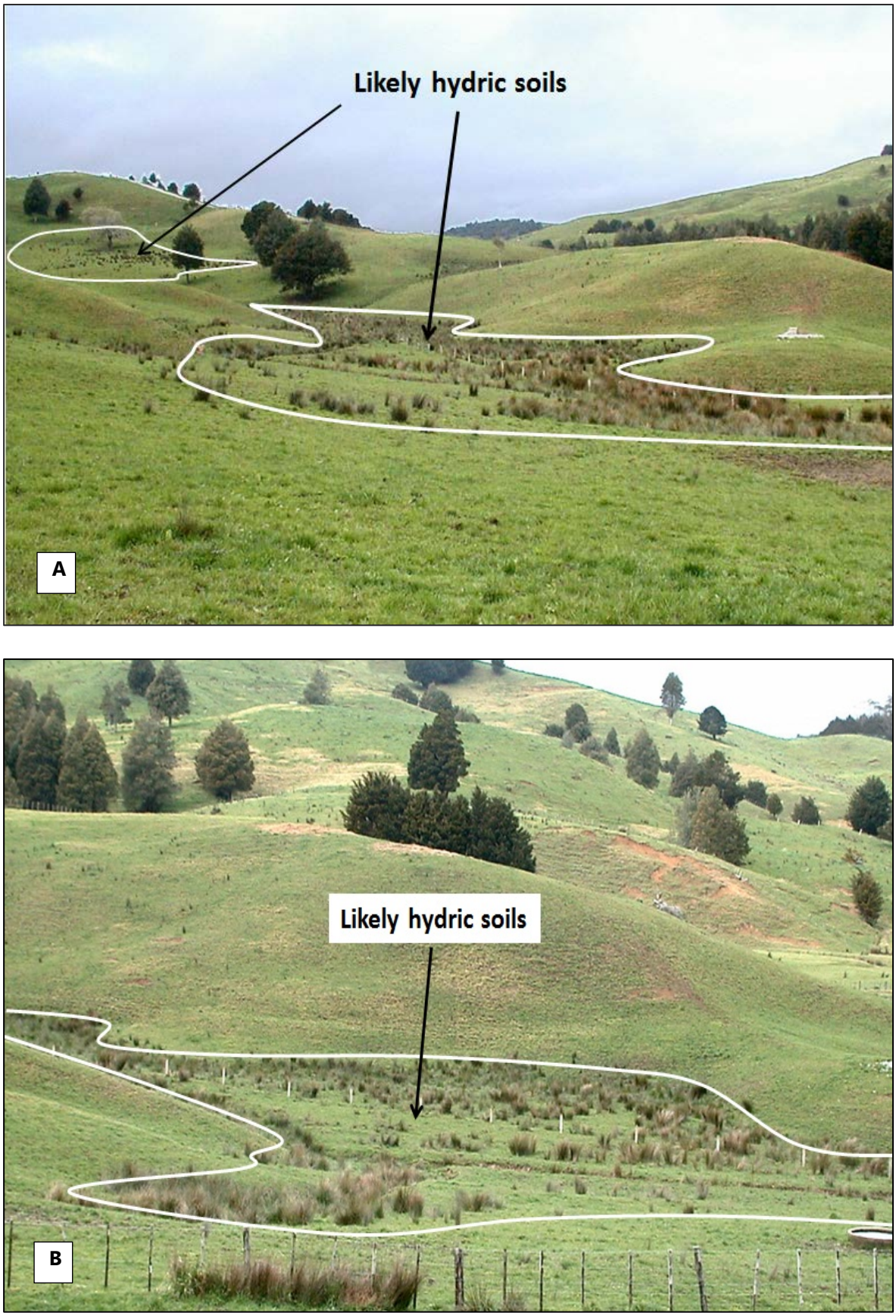


Figure 1A, B. Low areas in the landscape receive drainage water from the surrounding slopes and the presence of rushes are both indicators of possible hydric soils.

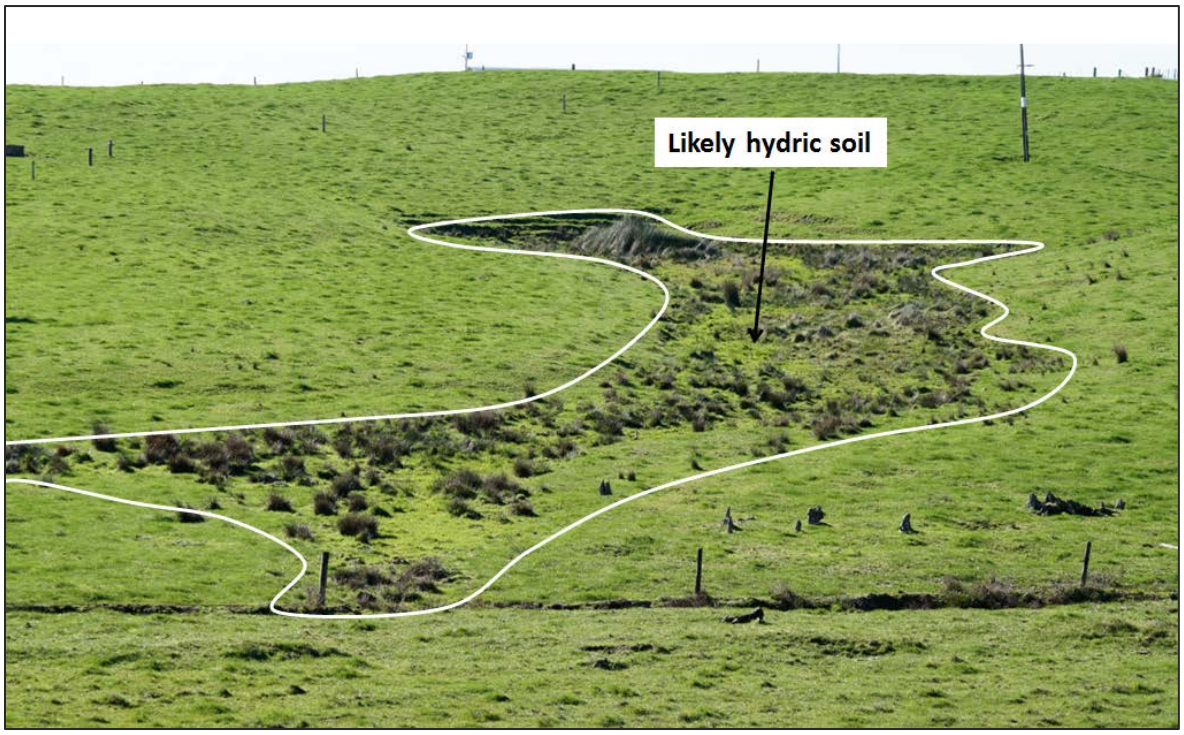


Figure 2. An area on a hill side where groundwater emerges as seepage.

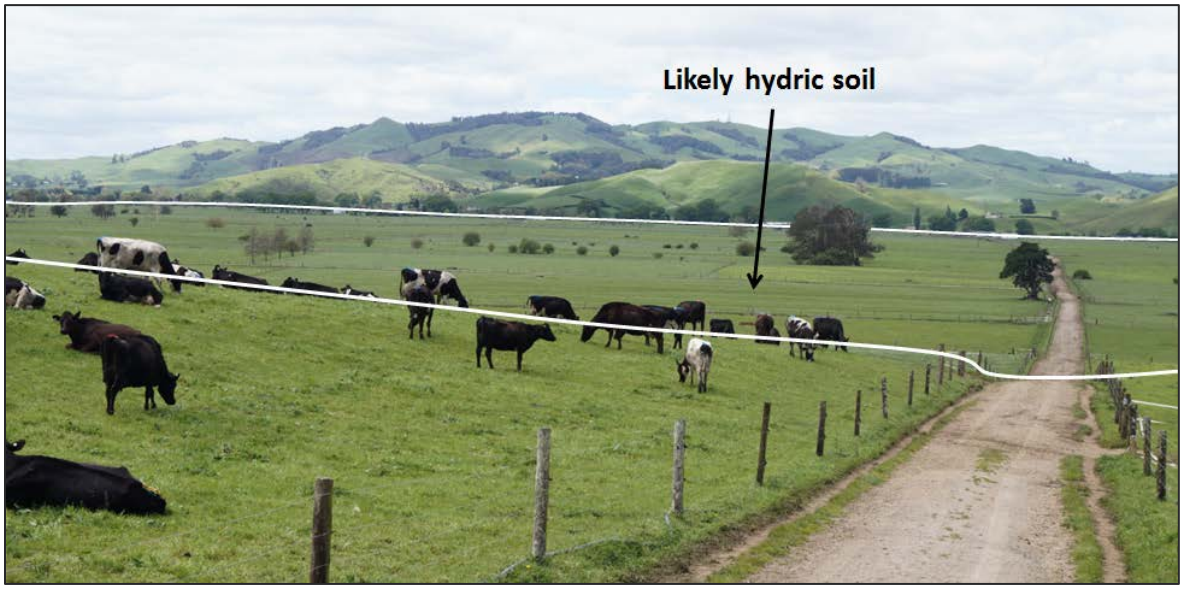


Figure 3. Flat low areas in the landscape can have high water tables. This is an area of peatland.

2.2 Vegetation pattern

Changes in vegetation are often associated with wetter soil conditions. This can result in differences in leaf colour or plant composition (Figs 4, 5 & 6). The vegetation aspect of hydric soil identification is covered in Clarkson (2014).

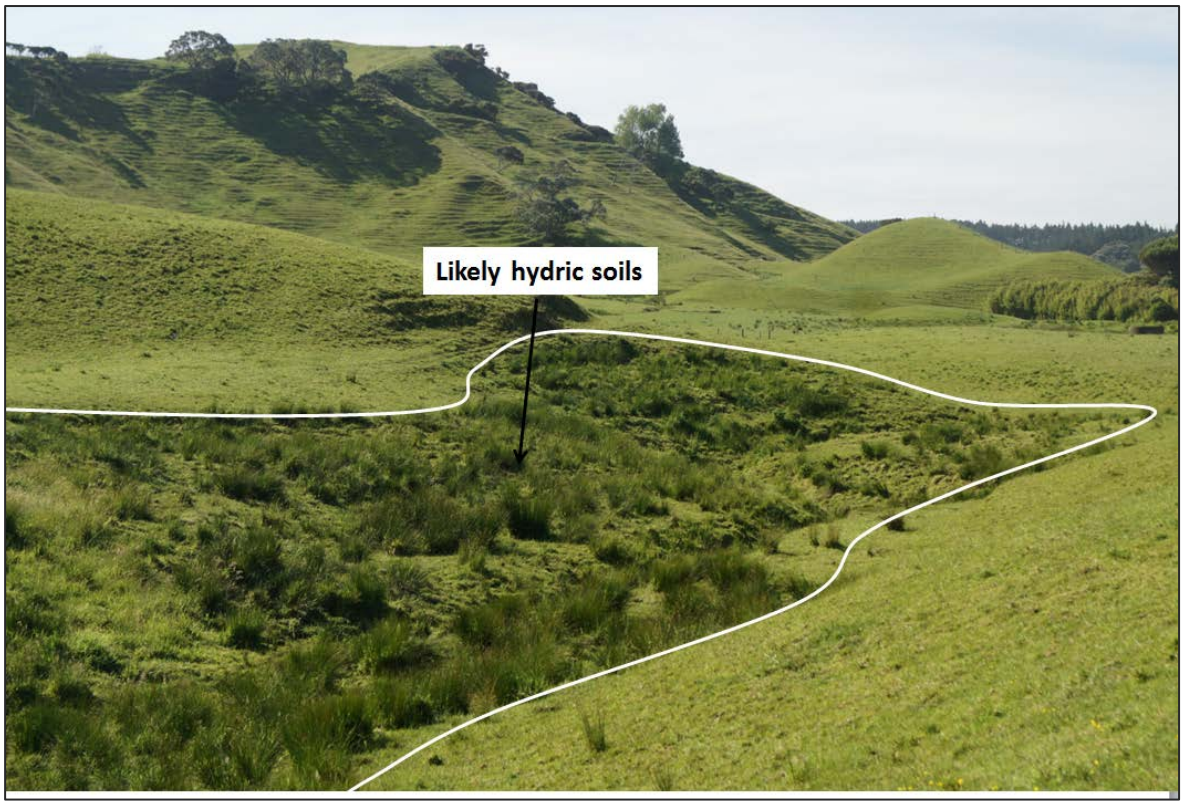


Figure 4. Vegetation at the base of a slope indicating the presence of hydric soils.

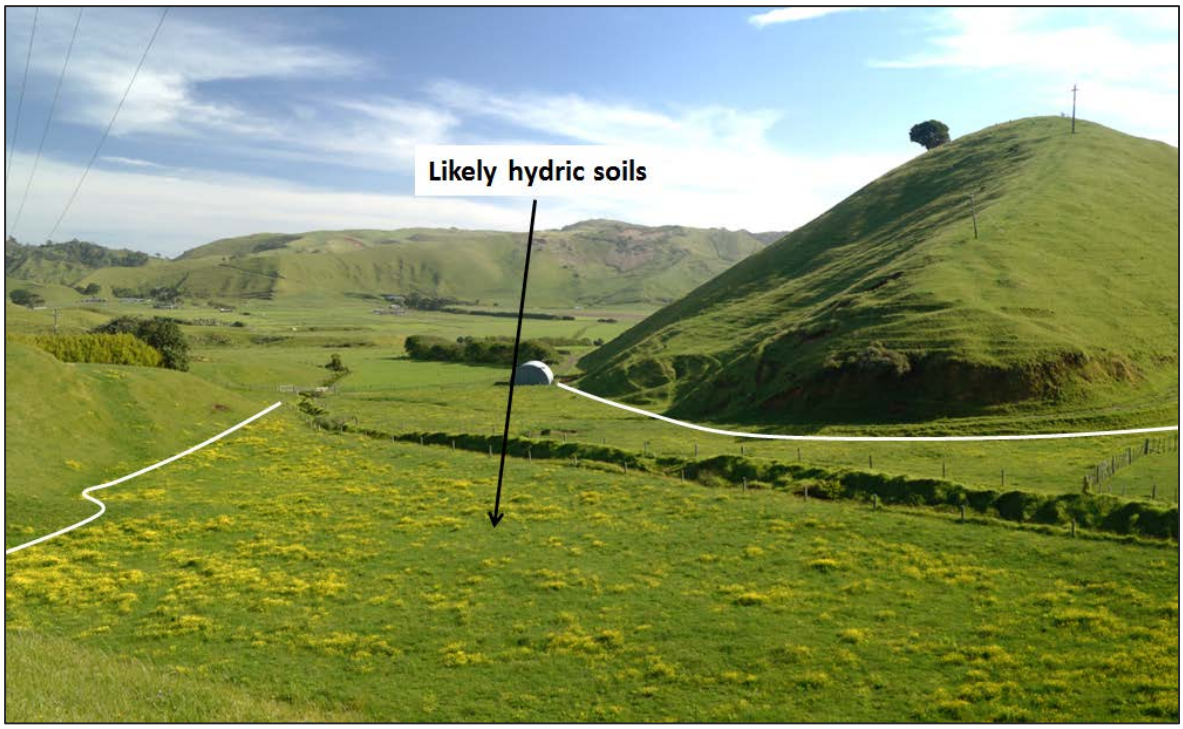


Figure 5. Vegetation on a flat area indicating the likely presence of hydric soils.

Figure 6. Boggy ground formed by water perching on a compact slow permeability subsoil pan.

2.3 Drainage and wetness

Another sign of hydric soil conditions is the drainage pattern. Closely spaced open drains often indicate poorly drained conditions. The drains may not always be successful in draining the soil. For example, in low lying areas there may not be enough fall and water tables can remain high, or the soil has low porosity and cannot drain easily so remains wet even if drains are nearby (Figs 7 & 8).

In some cases, the soil can be wet and soft underfoot or there are signs of pugging damage from cattle or damage from vehicles (Figs 6 & 9).

Figure 7. Even though an area is drained it may still be wet because there is little fall and the water table remains high.

Figure 8. A persistent high water table, despite being drained.

Figure 9. Rough pugged ground formed by hoof prints in wet soft soil.

2.4 Soil colour

It is important to remember that not all hydric soils are permanently wet – sometimes water tables are low and the soil is quite dry. Under these conditions, there may be some clues to wet soil condition in the vegetation, surface pugging, or position in the landscape. However, in these cases it is necessary to inspect the soil in detail.

Fortunately, saturation can permanently alter the colour of the soil in characteristic ways. These colour changes are significant clues for identifying hydric soils.

Under saturated conditions, decomposition and other soil chemical processes can use all the available oxygen. This causes removal of iron in the soil and produces pale light grey (low chroma) colours instead of the usual yellowish and brownish (high chroma) colours. These changes are most obvious in the subsoil (Fig. 10). As topsoils are often dark due to humus, these changes are not observable. Instead topsoils may have what are termed mottles. Mottles form where the air can enter the soil. This is usually along pores or cracks. Oxygen in the air causes iron to oxidise to yellowish, reddish and brownish colours. These often take the form of lines along root channels (such as in the topsoil) or blotches in the paler subsoil. These differences in colour are known as mottles (Figs 11 & 12). Appendix 1 explains these colour changes and the common terms that refer to the process.

There can be an accumulation of organic material as soils become progressively wetter. Topsoils become humic and as wetness increases, peat can form. These soils are

characteristically black and are formed from predominantly decomposed or partly decomposed plant material (Fig. 13).

While subsoil colour is one of the main indicators of hydric soils, not all soils with pale low chroma subsoils are hydric. Young soils formed from pale low chroma parent materials such as pumice and alluvium from mudstone, or highly leached soils where iron minerals have been removed may have low chroma colours not associated with saturated anaerobic conditions. These 'uncertain' soils are dealt with in Section 6.

Figure 10. The dramatic difference in subsoil colour between a poorly drained soil (A) and a well-drained soil (B).

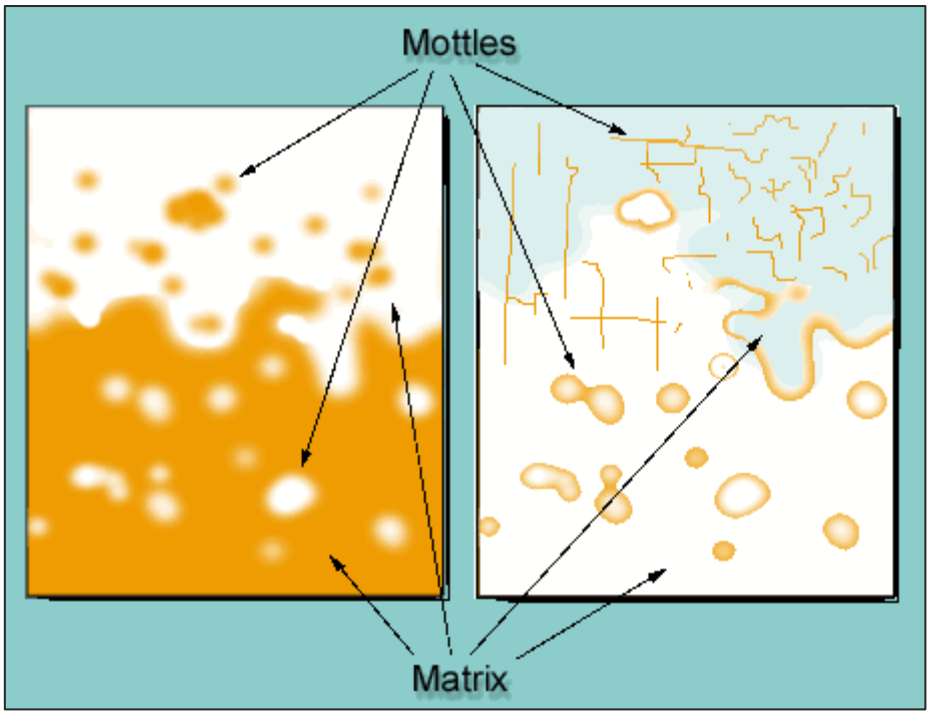


Figure 11. Mottles in a soil can be lines or blotches.

Figure 12. Reddish mottles and the pale matrix in a sample of subsoil.

Figure 13. The dark colours of organic soil. The organic material has stained the lower subsoil dark brown.

3 Definitions of hydric soil features

The New Zealand Soil Classification uses several terms to describe soil features that form in wet low oxygen conditions. These terms refer either to the layers or horizons within the soil or to the depth or profile of the soil (Fig. 14).

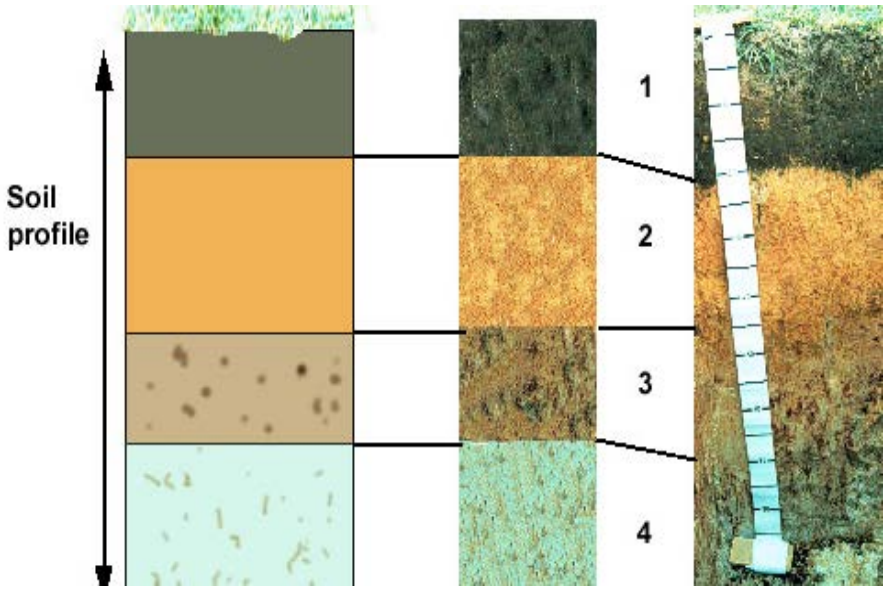


Figure 14. Example of a soil profile showing how it is composed of soil horizons.

To describe soil colour soil scientists use a soil colour book (e.g. Munsell Soil Color Book 2009) that contains pages with a range in colour chips, rather like a paint chart. These are used to distinguish colour characteristic features of hydric soils. Describing a colour requires three components: hue, value, and chroma. Hue refers to the colour (e.g. red, orange, yellow), value describes how light or dark the colour is, and chroma rates how bright or vibrant the colour is. An individual colour can be identified using a colour chart and assigned a code (e.g. 10YR 8/1, Fig. 15) that uses these three colour attributes. Colour is always assessed using moist soil.

The nature of the water table is indicated by the association of low and high chroma colours. If subject to reduction by perched water, the low chroma colours are likely to be at ped or pore surfaces and the high chroma colours are likely to be within the soil matrix. If the soil is subject to reduction by groundwater, the low chroma colours are likely to be within the soil matrix and the high chroma colours are likely to be at ped or pore surfaces. This relates to the duration of anaerobic conditions: perched water tends towards intermittent anaerobic conditions causing reduction of iron minerals on surfaces, but not within the matrix, while groundwater tends towards more prolonged anaerobic conditions with the matrix iron reduced while intermittent drying allows oxygen to penetrate down pores and oxidise just the ped faces.

3.1 Reductimorphic Horizon

A reductimorphic horizon is a horizon strongly affected by reducing conditions as indicated by greyish colours consistent with long saturation by water (Fig. 16). The prolonged wetness may be caused by a water-table perched on a slowly permeable layer (for example figure 31) within the soil profile or by a high groundwater-table.

A reductimorphic horizon has a slightly peaty texture class, or has low chroma colours (moist chroma 2 or less, or moist chroma 3 with value 6 or more – Fig. 15) that occupy 50% or more of the matrix exposed in a cut face of the horizon or are dominant on ped faces. A reductimorphic horizon includes any subjacent layers or interlayers of peaty soil material.

3.2 Gley Profile Form

A gley profile form is defined by the presence of a reductimorphic horizon with an upper boundary within either 15 cm of the base of the A horizon (topsoil horizon) or 30 cm of the mineral soil surface.

Soils with a gley profile form have usually been recognised as poorly or very poorly drained soils.

3.3 Redox-mottled horizon

A redox-mottled horizon is a horizon affected in parts by reducing conditions, indicated by the presence of redox-segregations. These usually indicate intermittent saturation of the soil by water.

A redox-mottled horizon has 2% or more redox segregations. If low chroma colours (moist chroma 2 or less, or moist chroma 3 with value 6 or more) occur, they must occupy less than 50% of the matrix exposed in a cut face of the horizon and are not dominant on ped faces.

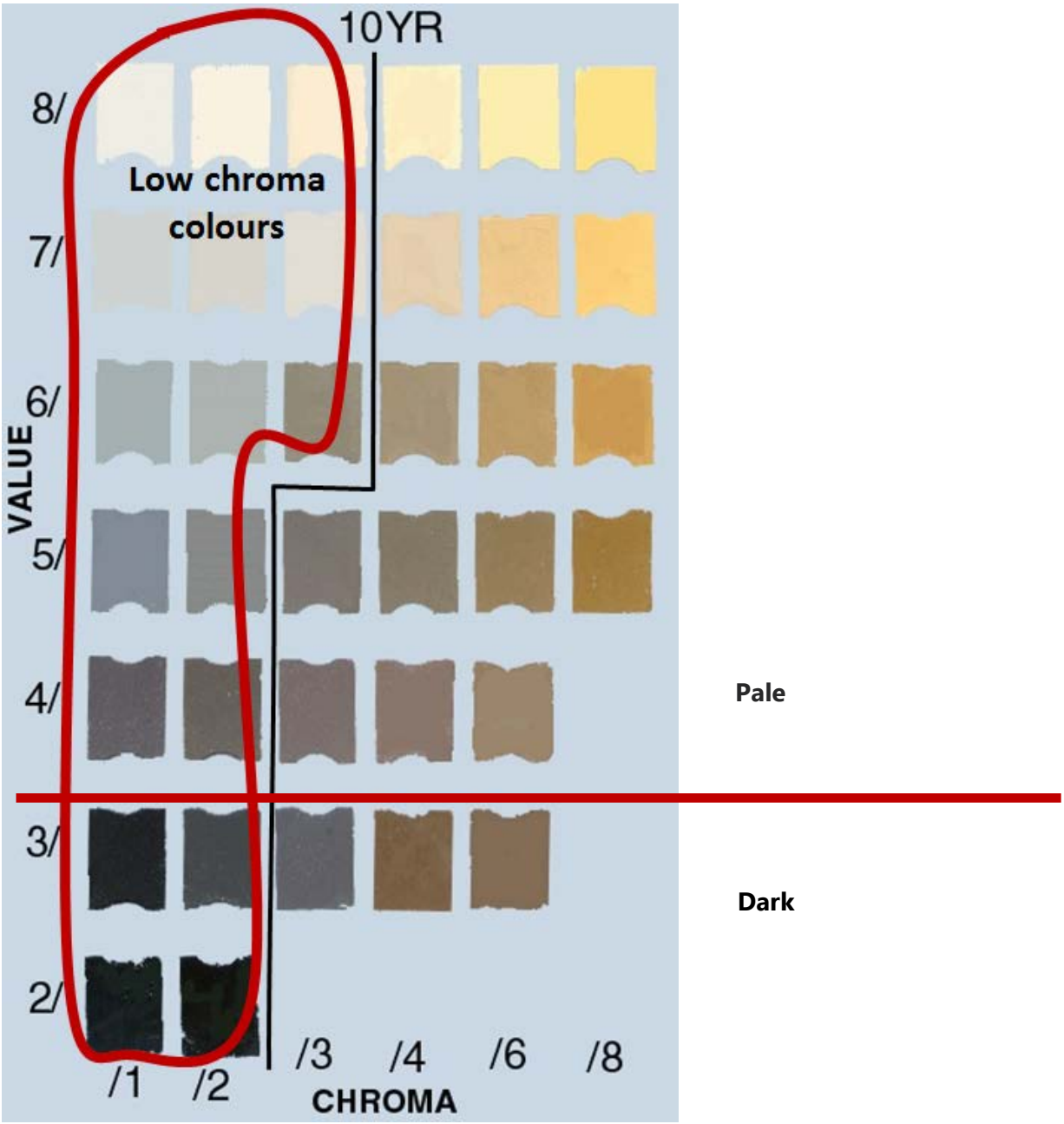


Figure 15. Example of the 10YR hue page from a soil colour chart showing the low chroma colours typical of hydric soils. Note that dark topsoil colour values of 3 or less are not good indicators of hydric soils as many topsoils have colours in this range.

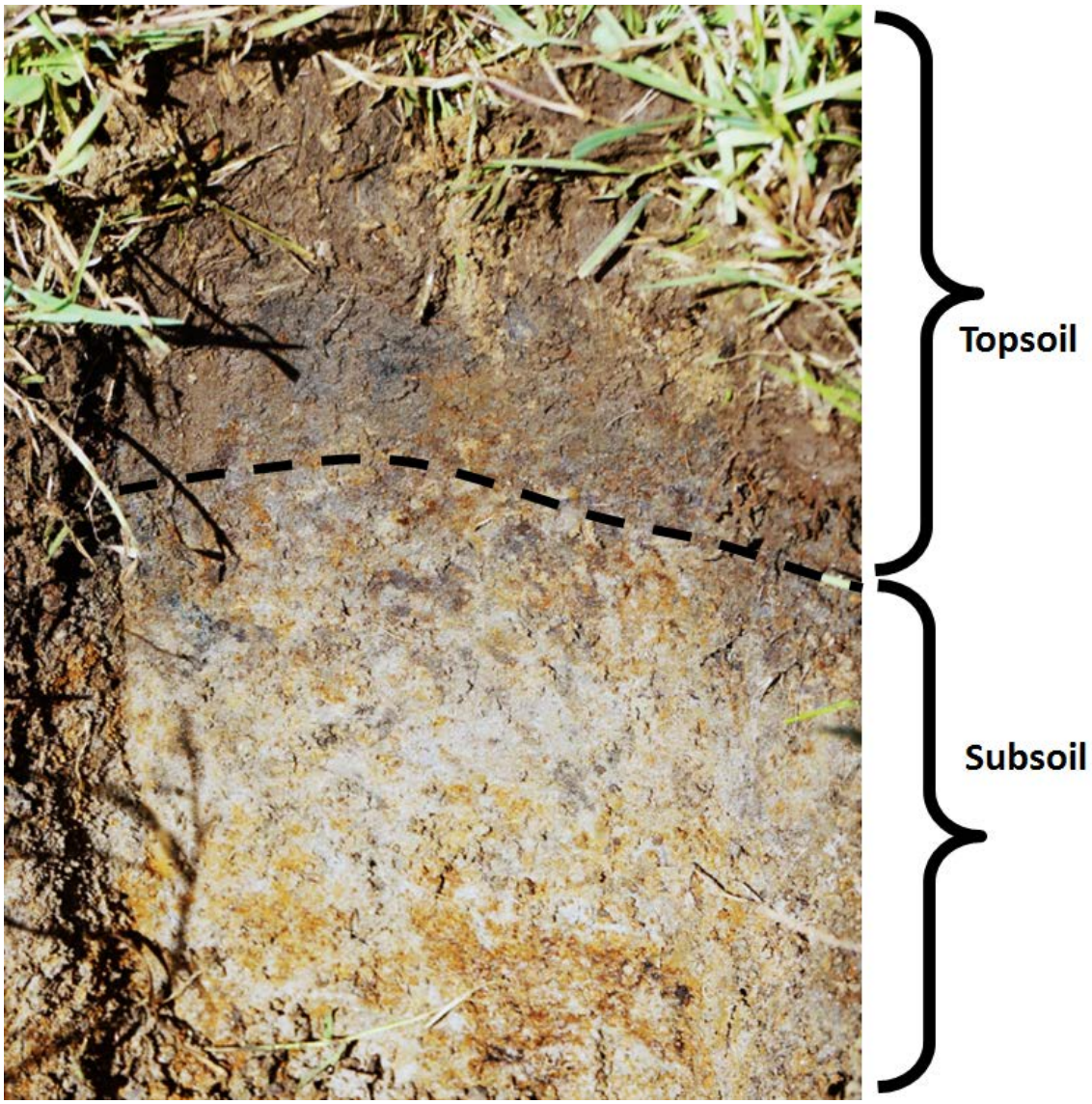


Figure 16. Mottled topsoil and subsoil typical of reductimorphic soil conditions.

3.4 Redox segregations

Redox segregations are mottles or concretions formed as a result of the reduction and solubilisation of iron and/or manganese, their translocation, concentration, and their oxidation and precipitation in the form of oxides (Clayden & Hewitt 1989). They may occur as low or high chroma colours, or both.

3.5 Organic soil material

Organic soil material is soil material dominated by organic matter, excluding fresh litter (L horizons) and living plant material. Organic soil material has 18% or more organic carbon (approximately 30% organic matter) but is defined here using morphology and simple analyses for easier recognition. (For most New Zealand soils, organic carbon may be estimated by total carbon.)

Organic soil material has EITHER

1 All the following:

   a Colour value moist of 3 or less (after exposure to air) and colour value dry of 4 or less, and

   b Deformable failure, and

   c Weight loss of 65% or more by oven-drying a field-saturated sample;

   OR

2 More than 20% (by volume) unrubbed fibre content

   OR

3 More than 35% (by weight) loss on ignition except in materials dominated by allophanic soil material or by limestone.

   OR

4 18% or more total carbon.

Organic soil materials that have accumulated under wet conditions are subdivided into three classes, based on evidence of decomposition (Clayden & Hewitt i989). These classes are used to distinguish soil groups of Organic Soils.

Fibric soil material (Of horizon) consists mainly of well-preserved plant remains that are readily identifiable in terms of botanical origin. The fibre content after rubbing is at least 75% by volume.

Fibres are pieces of plant tissue large enough to be retained on a 100-mesh (0.15 mm) sieve, except for wood fragments that cannot be crushed or shredded in the hand and are larger than 2 cm in the smallest dimension.

Rubbed fibre is the fibre that remains after rubbing a wet sample 10 times between the thumb and forefinger, or kneading a ball in the palm 10 times using firm pressure.

Mesic soil material (Om horizon) consists mainly of partially decomposed plant remains (semi-fibrous peat or hemic soil material) and does not meet the requirements of either fibric soil material or humified soil material.

Humified soil material (Oh horizon) consists of strongly decomposed organic material (humified peat or sapric soil material) with few or no identifiable plant remains other than resistant woody fragments >20 mm that cannot be reduced to fibres by crushing and shredding between the fingers. The fibre content is less than 15% after rubbing.

3.6 Perch-gley features

Perch-gley features are the morphologic indicators of saturation and reducing conditions caused by a water-table perched on a slowly permeable layer within the soil profile.

A horizon with perch-gley features EITHER

- has redox-segregations that occur mainly within peds, or in the case of an apedal soil, mainly within the soil matrix. Macro-void surfaces, either partings or pores, are dominated by greyish colours (moist chroma 2 or less, or moist chroma 3 and value 6 or more). Iron and manganese precipitates occur either adjacent to the greyish void surfaces as a selvedge (edge) or as discrete mottles within the soil mass

OR

- overlies a horizon that is less gleyed (e.g. less redox-segregations) with a matrix that is not dominated by greyish colours.

4 Examples of hydric soil

Wetness can strongly affect the growth and types of plants by limiting the availability of oxygen to roots. The duration and depth to wetness is indicated by accumulation of organic matter and soil colours. Peat indicates permanent wetness, dominant grey colour indicates prolonged wetness, and rust-coloured mottles in normal brown or yellow matrix indicates intermittent wetness. Large areas of Gley and Organic Soils are now drained for farming but the wetness indicators persist as evidence of the former extent of wetlands prior to European settlement. Examples of Gley Soils and Organic Soils are shown in Figures 17 and 18.

4.1 Gley soils

Gley soils are strongly affected by waterlogging and have been bio-chemically reduced.

They have light grey subsoils, usually with reddish brown or brown mottles (Fig. 17). The grey colours usually extend to more than 90 cm depth. Waterlogging occurs in winter and spring, and some soils remain wet all year. The soils occur throughout New Zealand in low parts of the landscape where there are high water tables, or in hill slopes where there are seepages.

Figure 17. Low chroma colours and redox mottles typical of a gley profile form.

Large areas of Gley Soils have been artificially drained to form agricultural land. Drained soils are still regarded as Gley Soils if they have the required colour indicators. They cover 3% of New Zealand.

The rooting depth of Gley Soils may be limited for many plants by oxygen deprivation below the water table. This can be exacerbated by higher bulk density. Trafficability is limited when soils are wet. Drainage is necessary for most agricultural development and when drained the soils can be very productive. Organic matter content is usually high in topsoils.

4.2 Organic soils

Organic Soils are peat soils that are located in wetlands and wet throughout the year. They have formed in the decomposed remains of wetland plants (peat) or forest litter.

Peat or litter has accumulated because decomposition rates of fresh organic matter have been less then accumulation rates in wet anaerobic conditions. Organic Soils have at least 30 cm depth or more of peat compromising the partly decomposed remains of wetland plants (peat), or at least 40 cm depth of forest litter (Fig. 18). Some mineral material may be present but the soil is dominated by organic matter.

Figure 18. Peat soils have at least 30 cm of material within the top 60 cm that contain 18% of more C.

Organic Soils can be highly productive soils when drained and fertilised. However, their use is not likely to be sustainable in the long term because drainage dries out the organic matter. Decomposition rates increase markedly and the soils begin to shrink.

Organic Soils serve as sponges in the landscape, and can hold up to 20 times their weight in water. Organic Soils occur in most parts of New Zealand, or under forests that produce acid litter in areas with high precipitation. They cover 1% of New Zealand.

The soils have very low bulk densities, low bearing strength, high shrinkage potential when dried, very low thermal conductivity, and high total available-water capacity. The soils also have high cation exchange capacities, and in New Zealand are commonly strongly acid. Nutrient deficiencies are common. High carbon/nitrogen ratios indicate slow decomposition rates. Many soil organisms have restricted activity because of anaerobic conditions.

4.3 Other Soils

Hydric soils occur in other soil orders of the New Zealand Soil Classification. They are mainly the result of a slowly permeable or impermeable lower subsoil layer impeding downward drainage of water. This causes the water to perch on the slow permeability layer and saturate the upper soil. These Perch-gley soils occur in most soil orders.

5 Field Identification Procedure and key

Identifying hydric soils in the field requires a spade and/or soil auger, soil colour charts (e.g. Munsell Soil Color Book 2009), the New Zealand Soil Description handbook (Milne et al. 1995), copies of the wetland soil data form (Appendix 2), and a laminated copy of the field identification guide sheet (Appendix 3). Worked examples from field testing the hydric soil tool are provided in Appendix 4, along with a summary of the field trial sites.

Existing soil maps/information may be useful particularly to identify soils that may be difficult to assess. Soils may be difficult to assess if low chroma colours are not due to reductimorphic features and are the result of pale parent materials or highly leached horizons – refer to Section 6.

The steps are:

Landscape assessment

1 Assess the topography. Are you in an area likely to be receiving drainage water from up slope, or on a flat low lying area by a lake, river or the sea? If you are, the soil is likely to be wet at some time of the year.

2 Are there changes in vegetation that indicate a difference in conditions from the immediate higher areas? If so, this may indicate a different soil type.

3 Is it an area with drains and is the surface rough and pugged? If so, the soil is likely to be wet at some time of the year.

Soil assessment

4 Remove any plant litter to expose the soil surface

5 Dig a hole to at least 50 cm depth.

6 While digging observe any changes in colour or layering in the soil. Keep the removed material as intact as possible and do not mix layers or samples.

7 Is water running into the hole? If so, this can indicate hydric soil.

8 Inspect the topsoil carefully for reddish mottles along root channels. These can indicate a hydric soil.

9 Smell the soil. Does it smell of rotten eggs? If so, this can indicate hydric soil.

10 Does the topsoil have black manganese concretions? If present, the soil is likely to be wet at some time of the year.

11 Inspect the subsoil. Is it peaty or mineral soil? If peaty and wet, then it's a hydric soil.

12 If the soil is mineral, is the matrix low chroma and mottled? If these are present within the top 30 cm and the soil is wet, it's a hydric soil.

13 Dig or auger deeper to see if there are any pans or firmer subsoil layers causing perching, or if there is a reductimorphic layer between 30 and 40 cm. These features, if present, are clues to help determine if it is a hydric soil.

Figure 19 below is a simple guide for inspecting the top 30–50 cm of the soil to determine if it has hydric features. Further confirmation of wetness and its duration may be needed before determining whether or not it is a hydric soil. Note that the definition of low chroma colours is divided into 'pale' or 'dark' low chroma colours (Fig. 15).

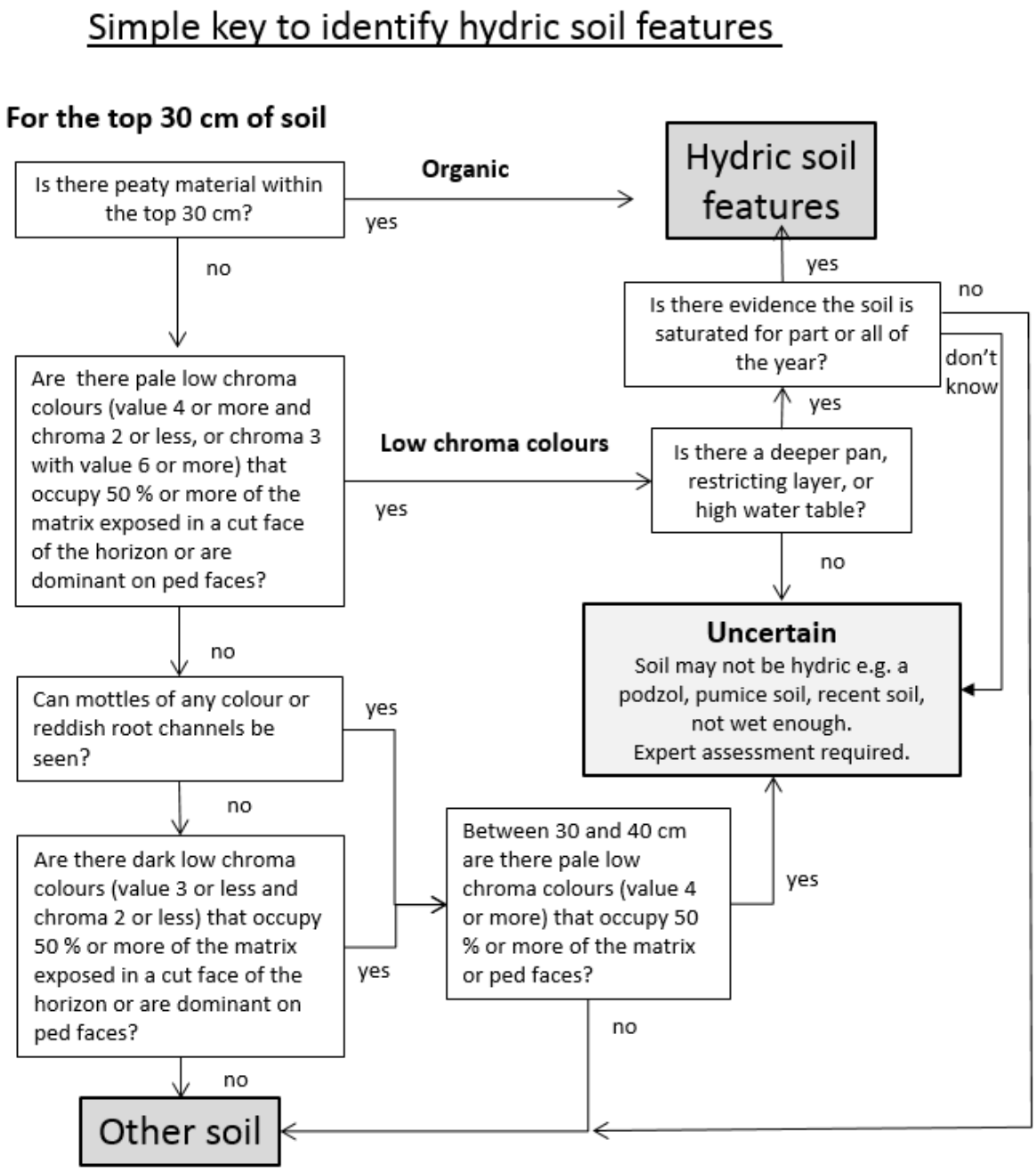


Figure 19. Simple key to identifying hydric soil features.

6 Uncertain Soils

Most hydric soils will be identified by having signs of wetness within their soil profile. These signs include mottles, wet and plastic soil material, and water flowing into the soil pit and pugged ground. However, there are some soils that are not hydric but have colours that could place them in the hydric category. They may not have mottles or other signs of wetness, but they do have low chroma colours and it can be difficult to determine if they are hydric or not.

A pale parent material is one of the main reasons for low chroma colours in non-hydric soils. Another is podzolised soils where bleaching of the soil by acid leaching removes iron, and in some cases, only white silt/sand remains.

6.1 Pale Parent Material

Examples of pale parent material include rocks such as siltstone, sandstone, mudstone, or recent sand and pumice. Younger soils formed from these materials, either in place or redeposited as alluvium, are naturally pale (Fig. 20, a and b). There hasn't been sufficient time for soil forming processes to weather the rock and form high chroma subsoils indicative of better drainage.

These Recent Soils can be found on eroded slopes where the underlying material is exposed, on downslope areas where erosion debris is deposited, or where the material has deposited on alluvial flats. Recent Soils show only incipient marks of soil forming processes. Landscape position can help in determining if these soils are likely to be wet or not.

Figure 20. A. Pale mudstone material. B. Recent Soil developed in pale alluvium.

Pumice is another example of a pale soil parent material that is young and so still retains the light colour of the pumice (Fig. 21). The lumps of pumice when cut through are technically mottles of a lighter colour but they are not formed by reductimorphic soil conditions.

Figure 21. Pumice Soil.

6.2 Podzols and Ultic Soils

Podzols develop under acid vegetation and form quickly in easily leached material such as sand, or over a long time in material such as clay. High rainfall and well drained conditions accelerate the process. Kauri and rimu vegetation types are often associated with Podzols. The humic acids from the forest litter strip clay and iron from the soil and redeposit it lower down in the subsoil. Typical Podzols have a bleached sandy or silty layer (E horizon) over a layer of black often cemented humus stained material (Bh horizon), and/or a reddish Bs horizon (Fig. 22). Some Ultic soils (Densipan Ultic, Albic Ultic) also have bleached E horizons similar to Podzols, but lack the darker coloured podzolic horizons (Bh, Bs) of Podzols (Fig. 23).

The challenge in Podzols and Ultic Soils is to determine if the bleached layer is wet or not. No iron remains for the reductimorphic process to form mottles. There can be a dense layer with depth, but this is no guarantee of wet conditions. In many cases water table measurements will be needed.

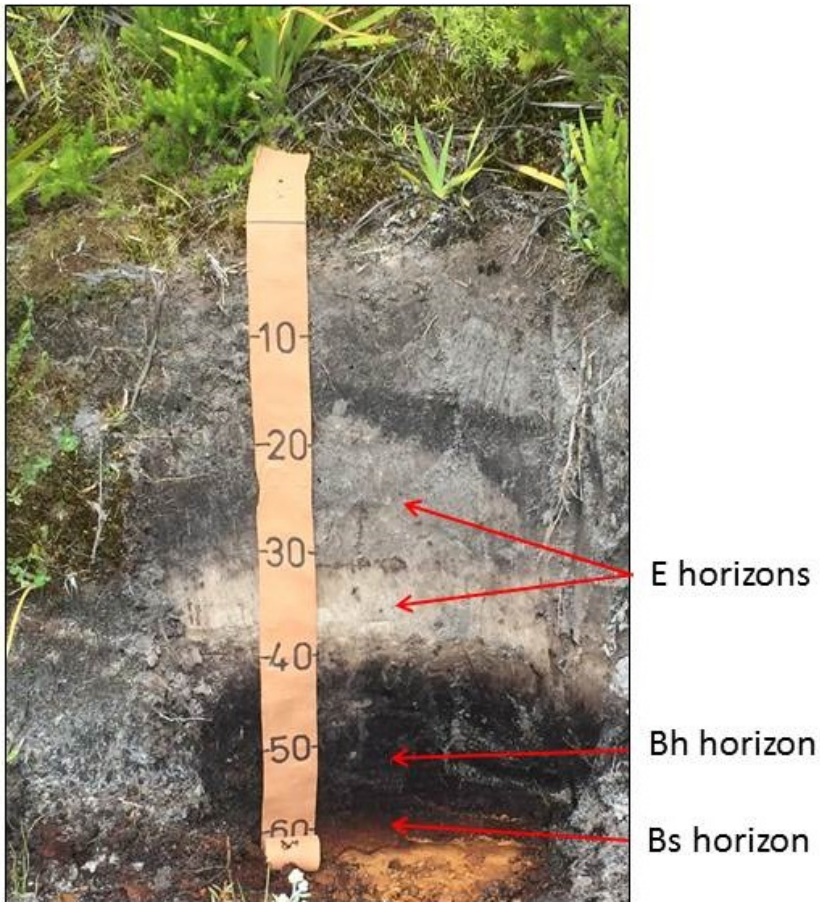


Figure 22. Podzol showing pale E horizons over black Bh horizon over reddish Bs horizon.

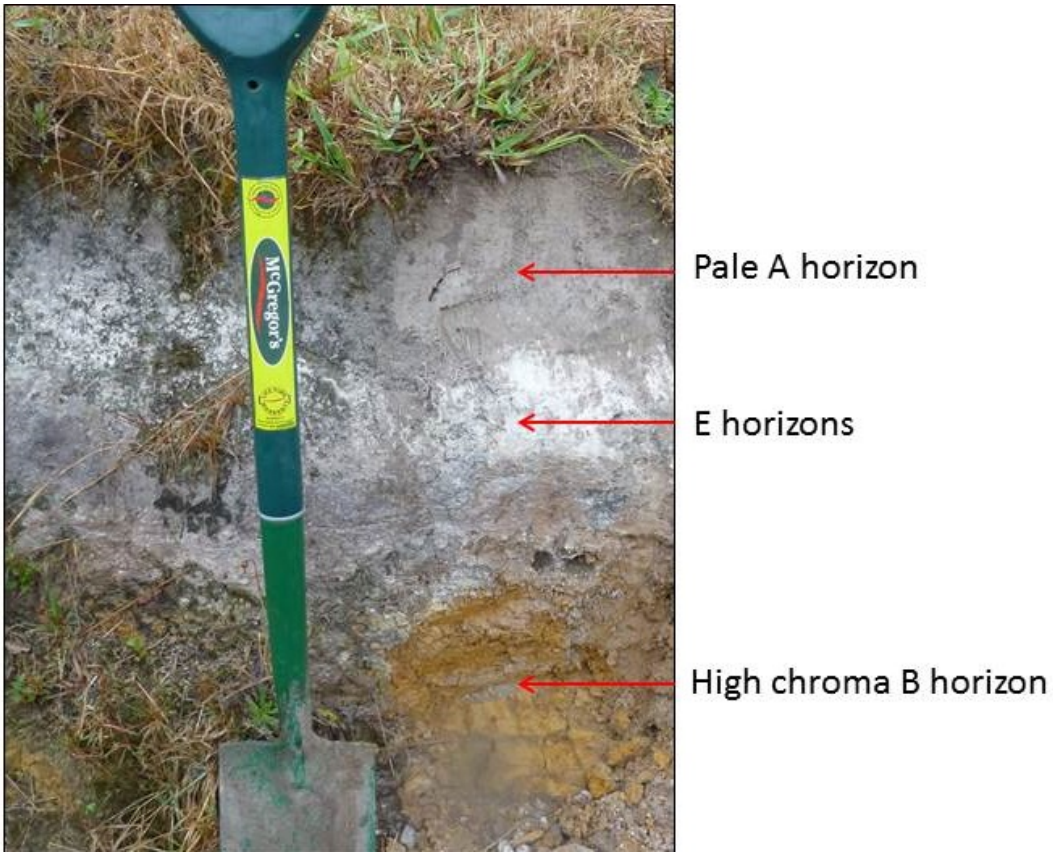


Figure 23. Ultic Soil showing pale A and E horizons over high chroma subsoil.

7 New Zealand hydric soils

The New Zealand Soil Classification groups soil based on common sets of soil characteristics. In the Classification, Gley and Organic Soils are those soil orders that have features that match those of hydric soils. Other soil orders also contain hydric soils but those in the Gley and Organic orders are the most abundant.

Appendix 5 lists the common New Zealand hydric soils based on the NZ Soil Classification and its classification codes. It is a simplified guide to the groups and subgroups within the Gley, Organic and other soil orders that have hydric soils.

8 Limitations

This guide covers the most common forms of hydric soils but saturation does not always result in characteristic peaty or reductimorphic features. Iron accumulation, organic staining and relic soil drainage features can all confuse the inexperienced observer. There are also situations where well-drained soils can look like hydric soils because of pale parent material with weathered reddish gravel fragments.

The greatest source of error could occur where the soils are artificially drained. The colour features of hydric soils can remain but the soil is no longer poorly drained. This can occur in both mineral and organic soils.

Soil colour is just one clue for identifying hydric soils. Not all soils that have pale low chroma colours are hydric. Not all hydric soils (soils formed under wetland conditions) will still be wetland soils, particularly if land has been artificially drained. Wetness needs to be confirmed This can be confirmed by revisiting the site in winter, talking to the land user or measuring the water table.

The drainage class can also change naturally. Some peat soils around the margins of peat bogs in the Waikato have drained naturally as gully systems propagated in sandy alluvium prior to human development, while more recently some land has become poorly drained due to land subsidence after the Canterbury earthquakes.

It is advisable to have some training by a soil expert experienced in mapping soils. In this way identification can be tailored to the location of interest and to local peculiarities in the soils expression of saturated conditions.

9 Conclusions

The effects of prolonged or intermittent saturation at or near the surface alter the soils colours and can form peat or organic rich material. This group of wet soils are collectively known as hydric soils.

Hydric soils can be identified in the field by features such as being in low, poorly drained or very poorly drained landscape positions, changes in vegetation, soft ground, and characteristic colour features of the soil.

The notes in this guide, along with training and practice, should enable non-experts to be able to identify common hydric soils.

10 Acknowledgements

We thank Rob Smith, Trevor James (both Tasman District Council), Lisa Forester (Northland Regional Council), Lois Easton (Gisborne District Council) and Alan Johnstone (Marlborough District Council) for their support in developing the Tools proposal. We also thank the landowners for permission to test the field sampling protocols on private land, and council staff and others for field assistance. Anne Austin edited the report, and Charlie Newling, US Wetlands Training Institute, provided support and advice on adapting the hydric soil tool to New Zealand conditions. Funding was provided by an Envirolink Tools Grant (led by Tasman District Council) and an earlier Envirolink Medium Advice Grant (led by Gisborne District Council) under contract numbers C09X1702 and C09X1328 respectively.

11 References

Clarkson BR 2014. A vegetation tool for wetland delineation in New Zealand. Landcare Research Contract Report 1793. 42 p. Available: http://www.landcareresearch.co.nz/__data/assets/pdf_file/0003/71949/vegetation_tool_wetland_delineation.pdf

Clayden B, Hewitt AE 1989. Horizon notation for New Zealand soils. Division of Land and Soil Sciences Scientific Report 1.

Environmental Laboratory 1987. Corps of Engineers wetlands delineation manual technical report Y-87-1. Vicksburg, MS, US Army Engineer Waterways Experiment Station. 100 p. + appendices.

Federal Register July 13, 1994. Changes in hydric soils of the United States. (Definition of hydric soils). Document No. 94-16835. Washington, DC, Soil Conservation Service.

Hewitt AE 2010. New Zealand Soil classification. 3rd edn. Landcare Research science series No1. Lincoln, New Zealand, Manaaki Whenua Press. 136 p.

Milne JDG, Clayden B, Singleton PL, Wilson AD 1995. Soil description handbook. Rev. edn. Lincoln, New Zealand, Manaaki Whenua Press. 157 p.

Munsell Soil Color Book 2009. Rev. edn. Grand Rapids, MI, X-Rite Inc.

Pierce RJ ed. 2017. Pocket guide to hydric soil field indicators V.8. Glenwood, NM, Wetland Training Institute. 196 p.

US Army Corps of Engineers 2008. Regional supplement to the Corps of Engineers wetland delineation manual: Arid West Region (Version 2.0). ERDC/EL TR-08-28. Vicksburg,

MS, U.S. Army Engineer Research and Development Center, Environmental Laboratory. 133 p.

US Army Corps of Engineers 2010. Regional Supplement to the Corps of Engineers wetland delineation manual: Western Mountains, Valleys, and Coast Region (Version 2.0). ERDC/EL TR-08-28. Vicksburg, MS U.S. Army Engineer Research and Development Center, Environmental Laboratory. 152 p.

12 Glossary

Argillic horizon. A soil layer enriched in clay.

Bh horizon. Dark coloured horizon enriched in organic matter as a result of it leaching from above and depositing as a layer.

Bs horizon. Ochreous horizon enriched in iron and/or aluminium as a result of it leaching from above and depositing as a layer.

Blocky structure. A soil ped that is approximately square in shape.

Calcareous horizon. A soil horizon containing calcium carbonate that can have been formed in the soil or from the material making up the soil.

Colour. Colour is described using a Munsell Soil Colour Book. This book contains pages of colours rather like a paint chart. The soil is matched to the colour, and the colour name and colour code are recorded, e.g. 10YR 8/8 and the colour name is 'Yellow'.

Consistence. A general term for the field-assessed behaviour of soil materials.

Cutanoxidic. Sticky very plastic clayey material with fine soil structure.

Duripan. A layer cemented by silica (duric horizon).

E horizon. A layer leached of organic matter, iron or clay.

Fragipan. A dense compact non-cemented layer with few cracks and few roots.

Humus-pan. A firm layer coloured dark by organic matter.

Indurated. Soil particles held tightly together by cementation or close packing.

Massive: Material having no partings at spacing of less than 200 mm such as some clayey or silty material.

Nodular. An irregular shaped concentration of iron or carbonate.

Ortstein-pan. A firm or strong reddish cemented layer with a sharp upper boundary.

Pedal. Aggregates formed in the soil that are separated from other similar aggregates by an obvious pattern of cracks or partings; or have distinct surfaces over at least one-half of

the aggregate; or have coatings over at least one-half of its surface. They may be an aggregation of smaller peds (aggregates).

Perched. Water that sits on top of an impermeable or slowly permeable soil layer.

Placic horizon. A thin iron pan.

Prismatic soil structure. A soil ped that is taller than it is wide and has a flattish top and bottom.

Redox segregations. Mottles or concretions formed by the reduction of iron and manganese and their precipitation to form oxides. This produces a pattern of high and low chroma colours.

Appendix 1 – Mottle formation and terms

In the presence of oxygen, iron forms iron oxides (Fe^{3+}). These oxides produce the yellowish and reddish soil colour common in many subsoils. In wet conditions air in the soil is replaced by water. Oxygen moves slowly in water and can be depleted by microorganisms and chemical reactions. Under these low oxygen conditions iron is reduced (Fe^{2+}) and is virtually colourless and more soluble. This causes soil colour to be pale. The reduced iron can move in the soil and is either lost in drainage or oxidises in places where air is trapped or enters the soil.

Areas of oxidation and reduction produce a mottled colour pattern of blotches of pale and yellowish and reddish colour (Fig. 24). The more reduced the soil, the greater the predominance of pale low chroma colours. As reducing conditions increase, pale colours become dominant. When this occurs, the term gleyed is often used to describe the soil. In some literature the term 'depleted' is also used to refer to dominantly a pale reduced horizons.

Mottles: Mottling is the name given to spotted or streaked areas of colour (mottles) in soil. Mottling is usually associated with periodic wetting.

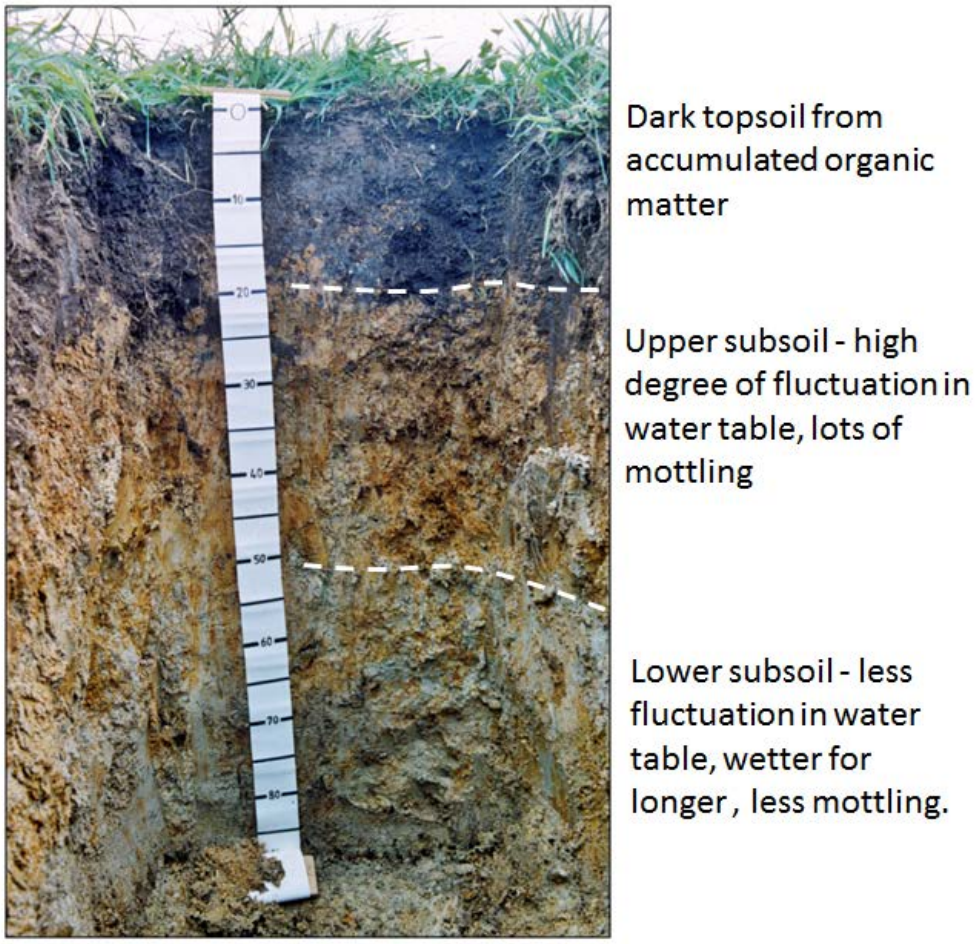


Figure 24. A mottled profile form showing a redox mottled horizon between 20 and 50 cm depth.

Appendix 2: Wetland determination data Form – Soil

WETLAND DETERMINATION DATA FORM – NEW ZEALAND: SOIL

Site: _____ Region: _____ Sampling Point/ID: _____
Owner/address: _____ Land management: _____ Date: _____
NZTM (E): _____ NZTM (N): _____ Datum: WGS84
Landform: _____ Local relief: _____ Slope (°): _____
Drainage: _____ Land cover: _____ Altitude (m): _____
Investigator:_____ Hydrologic features: _____ Photo numbers: _____
Are climatic/hydrologic conditions on the site typical for this time of year? Yes____ No____ If needed, explain in Remarks
Is the soil disturbed or problematic?_____ Are 'normal circumstances' present Yes____ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil
___ Litter
___ Fibric
___Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
___ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:

Remarks:

Hydric soil present? ___ Yes ___ No ___ Uncertain | NZSC Subgroup (if known)_____

Appendix 3: New Zealand Hydric Soils – Field Identification Guide Sheet

Descriptors follow Milne et al. (1995) and Hewitt (2010)

Land Management: Beef cattle, dairy cattle, sheep, forestry, protected area, natural, urban, etc.

Landform *at whole-site scale*: Hill country (steep, gently rolling, etc.), gully, floodplain, valley, terrace, oxbow, old river channel, sand dune, moraine, swamp, bog, fen, etc.

Local Relief *at sampling point/plot scale*: flat, depression, bank, gentle/steep slope/toe slope, etc.

Soil Drainage: W well drained; MW Moderately well drained; I Imperfectly drained; P Poorly drained; VP Very poorly drained

Land Cover *vegetation:* forest, manuka shrubland, exotic grassland, herbaceous freshwater veg, etc.

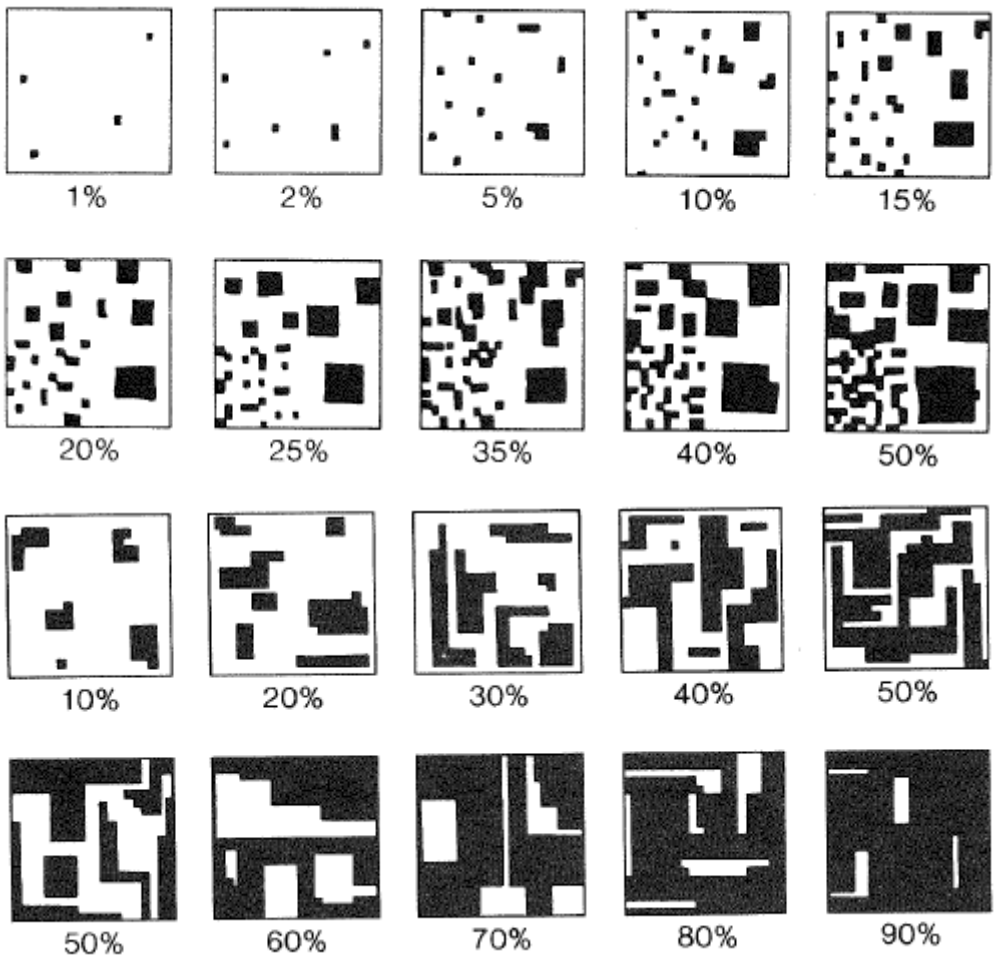
Hydrologic Features *near sampling point:* drain, local ponding, seep, pools, etc.

Is the Site Drained? Looks for drains, diversions, stop banks, etc., which would lower water table

Normal Circumstances: Undisturbed conditions: typical soils and hydrology at the site

Size Classes for mottles: <1 mm, 1–2 mm, 2–6 mm, 6–10 mm, 10–20 mm, 20–60 mm, 60–100 mm, 100–200 mm

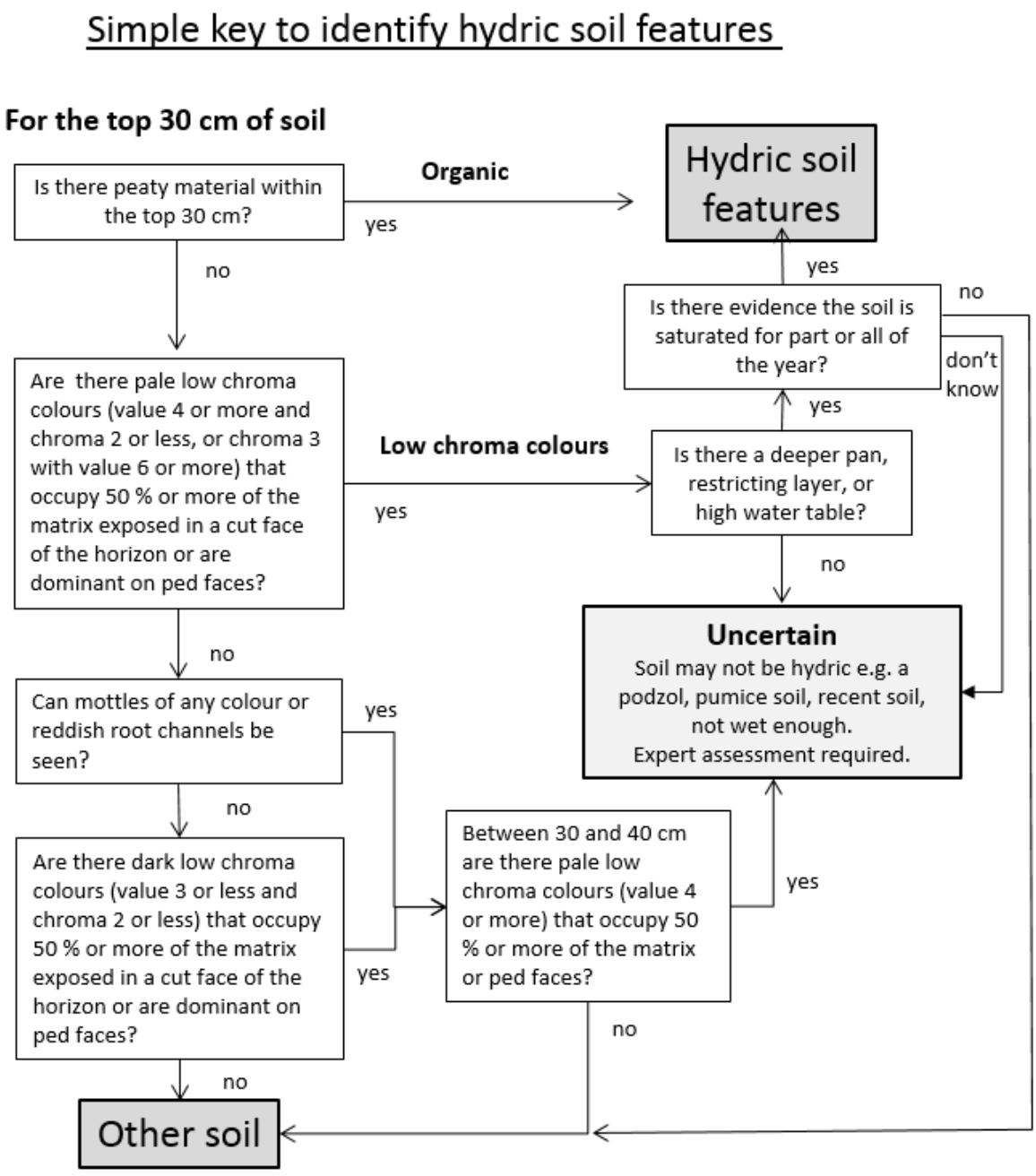
Mottles % area chart



References

Hewitt AE 2010. New Zealand Soil classification. 3rd edn. Landcare Research science series No1. Lincoln, New Zealand, Manaaki Whenua Press. 136 p.

Milne JDG, Clayden B, Singleton PL, Wilson AD 1995. Soil description handbook. Rev. edn. Lincoln, New Zealand, Manaaki Whenua Press. 157 p.



Appendix 4: Field trials

The hydric soil tool, based on the US hydric soil determination protocols (Environment Laboratory 1987; Wetland Training Institute 2017), was developed and trialled in a range of putative wetland and non-wetland situations around New Zealand. The trial sites were selected on the basis of representativeness according to wetland type, land use, landform, slope, vegetation cover and soil wetness.

A description of ten trial sites, together with the field soil data forms are presented below.

1 Fraser Gully (S1, S2)

This is a small sinuous gully system located on a lifestyle farm block under extensive dry stock management. The gully floor is very wet (not sampled), fenced off from stock and overall dominated by exotic grey willow (*Salix cinerea*) which is gradually being removed. The edge of the gully floor outside the fence has a mix of *Carex* sedges, and exotic herbs and grasses, which are occasionally grazed by sheep. This area is wet in winter and dries out occasionally in summer (sampling point S1). A steep bank in pasture grasses rises from the gully floor to a height of about 5 m (sampling point S2). Sampling point S1 was a hydric soil and very close to the wetland margin. The wetland margin coincided with a change in slope/topography from the flat gully floor (wetland) to a relatively steep grassy bank (non-wetland). Sampling point S2 on the grassy bank was not a hydric soil. We also investigated (using an auger) the soils located towards the middle of the gully and these were all Gley, i.e. hydric, soils.

2 Stone Farm (S3–S5)

Stone Farm comprises an intensive dairy farm on mainly flat terraces and floodplains associated with the Waikato River. We tested the soils at two sites with a total of three sampling points. The first site was a grassed paddock. Sampling point S3 was on flat terrain, just inside the putative edge of a wetland as indicated by ponding and wetland vegetation, and S4 was on a very gentle rise a few metres upslope of S3. The prolonged ponding in the lower part of the paddock is unusual and probably a result of the recent very wet growing season (S. Fraser, pers. comm.). We determined S3 to be a hydric soil but not S4. All soils augered within the adjacent ponded area were Gley, i.e. hydric soils. A distinctive iron pan was present about 50 m south of the site adjacent to Te Kowhai Rd (Fig. 25).

The second site was an old former river channel floor bounded by low banks and with drains on both edges of the channel. The topography was flat with local ponding and dominated overall by freshwater herbaceous plants and pasture grasses. Sampling point S5 was determined to be a hydric soil: comprising a gley soil in the upper layers (0–18 cm), overlying an older peaty/organic layer (18–70 cm).

Figure 25. Excavation for a buried power cable reveals the transition from a redox mottled Brown Soil (foreground) to a Gley Soil. Note the summertime water table in the distance and the grey colours mid-photo indicating the extent of the winter time water table. An iron pan was present in the transition zone between Brown and Gley Soils.

3 Mitchel Farm (S6)

This is an intensive dairy farm on flat to gently undulating terraces and floodplains of the Waipa and ancestral Waikato Rivers. The soil sampling site was in a paddock of exotic pasture grasses, located on a slight rise above a lower ponded area dominated by freshwater herbs. Sampling point S6 had a moderately well-drained, non-hydric mineral soil. However, investigations using an auger revealed peaty hydric soils in the flatter ponded area nearby.

4 Waikoha Station (S7–S12)

Waihoka Station is a large extensive dry stock farm on steep hillcountry of the Kapamahunga Ranges forming the divide between the western Hamilton basin and Raglan Harbour. The Kapamahunga Ranges comprise Triassic/Jurassic greywacke overlain by Tertiary mudstone, sandstone and limestone. Small sinuous wetlands are common in this faulted landscape where seepages and drainage patterns are influenced by differing permeability of the various lithologies and mass movement. Two sites were sampled, each with three sampling points. The first site (Fig. 26) was in and around a gently-sloping seep in a gully floor. This comprised relatively flat wet terrain, demarcated by clumps of *Juncus*

rushes, and bounded by high producing pasture grasses on gentle slopes of 5–10°. We sampled downslope along a transect from the pasture on gentle hillslope (S7 – non-hydric soil) to the edge of the exotic grassland (S8 – non-hydric soil), into the rush-dominated wet terrain (S9 – hydric soil). Investigations using an auger revealed the hydric/non-hydric soil boundary coincided with prevalence of rushes in the vegetation, i.e. about 1 m downslope of sampling point S8.

Figure 26. Changes in vegetation correspond to changes from mottled to gley profile form.

The second site (Figs 27 and 28) was a seep 20–30 m wide originating from beneath a limestone outcrop, and flowing into a relatively broad, wet valley floor. We sampled along a short transect from the adjoining hillslope, through the seep margin, to the middle of the seep (Fig. 27). The vegetation of the hillslope was pasture grasses, and the seep was dominated by a variety of freshwater herbs and grasses. Sampling point S10 soil was determined to be non-hydric, site S11 on the seep margin was hydric, and S12 was also hydric. The S11 soil was interesting as although the top 30 cm was hydric, the 30–50 cm horizon revealed a mottled profile form with high chroma colours at depth (Brown Soil). This indicates the wetland had recently 'grown out' over the adjoining hillslopes slopes, probably a result of cattle pugging and trampling.

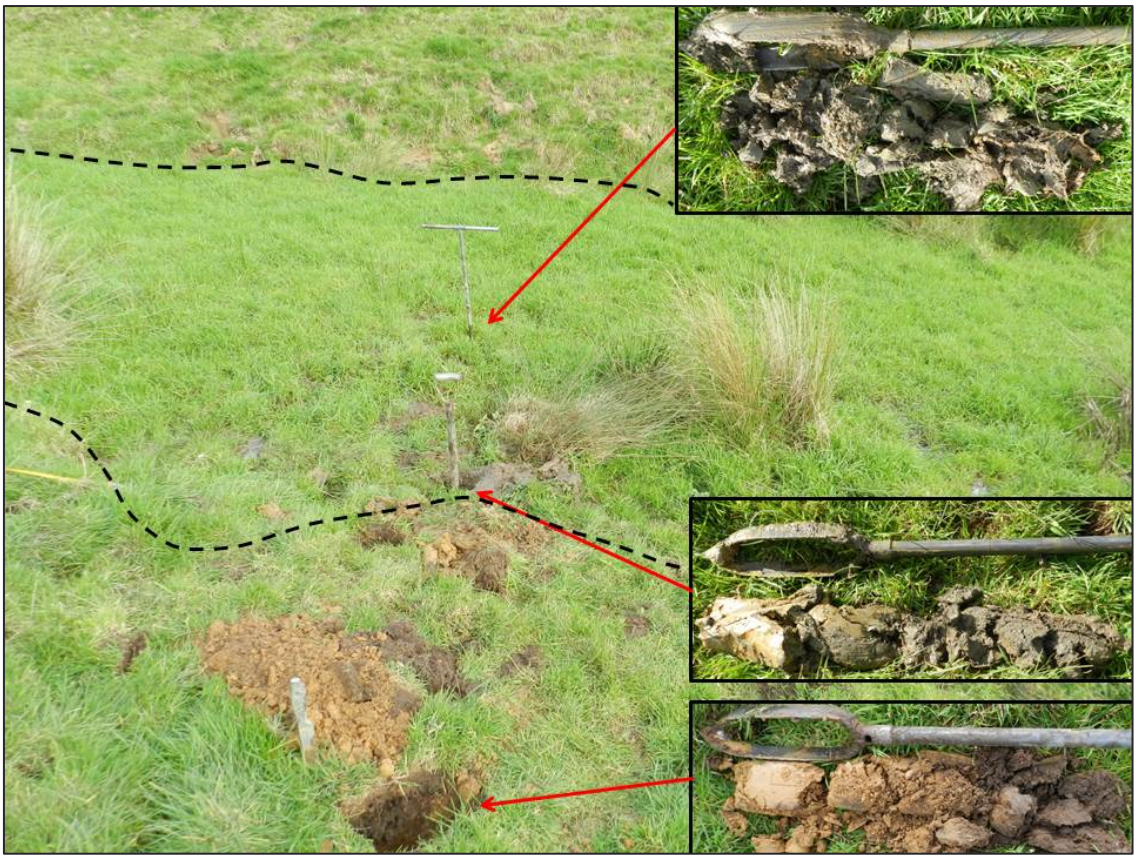


Figure 27. Evidence of a recently expanding wetland seen in the relict mottled profile (at the position of the spade) underlying a recently formed perched gley horizon.

Figure 28. Steepland seepages associated with more permeable limestone overlying less permeable mudstone.

5 Whitehills (W1)

Whitehills is located about 15 km northwest of Kerikeri just off SH10 on a roadside cutting bordered by manuka scrub, typical of gumland in Northland. The soils have developed in siliceous mudstone of the Whangai Formation of late Cretaceous/Paleocene age. These soils are highly weathered and leached Podzols, which have a very firm pan that restricts rooting depth and most likely water infiltration. The profile consists of a shallow greyish brown topsoil over a white E horizon on a very firm pan. As most minerals have leached out of the soil there is no evidence of mottling and while the pale colours are clearly a result of intense leaching, without understanding the hydrology it was not possible to confirm that these soils are hydric. The soil was keyed out to be an Orstein Pan Podzol (Fig. 29).

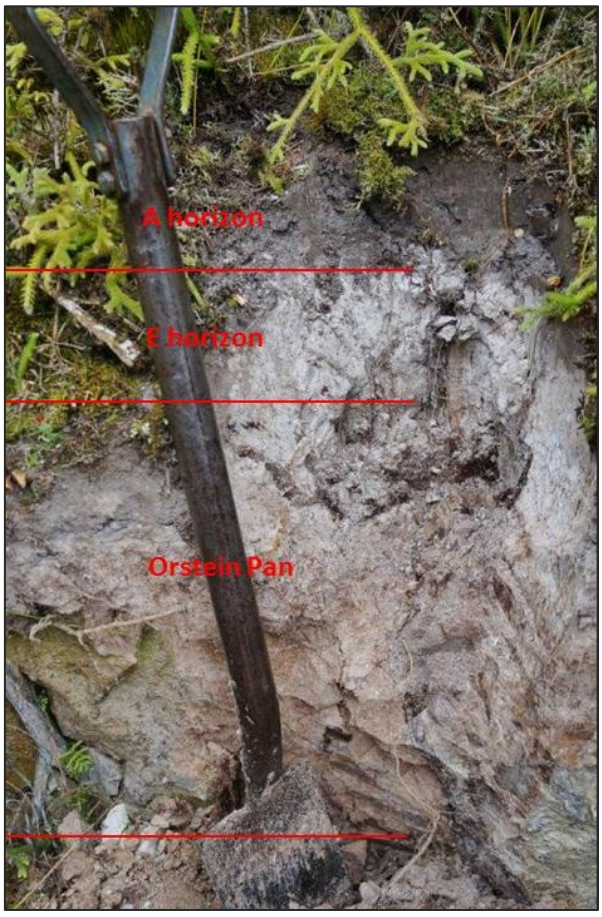


Figure 29. Orstein Pan Podzol.

6 Kerikeri Airport (KA2)

An extensive protected gumland reserve administered by DOC and located adjacent to Kerikeri Airport was investigated. Most of the reserve was relatively dry and dominated by tall manuka, however the site described here was wetter with shorter peatland plants. The underlying geology is mapped as basalt of the Kerikeri Volcanic Group and the site may be part of a depression within a low angle lava flow causing water to pond giving rise to the peatland vegetation. While the soil was described as an Acid Fibric Organic soil, the top 30 cm of the profile did have mineral soil material present also (Fig. 30). This was

possibly due to runoff from adjacent land carrying alluvium into the peatland. This site had a water table close to the soil surface and was clearly a hydric soil (Acid Fibric Organic).

Figure 30. Fibric (fibrous) peat with some mineral material intermixed.

7 Matawhero Loop (M1)

This is a loop of the Waipaoa River, cut off 60-70 years ago as part of the Waipaoa River flood control scheme near Gisborne. Matawhero Loop is a Wildlife Management Reserve owned by Nga Uri o te Kooti. The oxbow area is undergoing restoration with abundant plantings of native species such as kahikatea, cabbage tree and harakeke growing above exotic herbs, rushes and grasses. The oxbow has high water tables with several ponds present, and soils are Typic Recent Gley, i.e. hydric.

8 Jamestown (Jt1)

This site, dominated by tall kānuka and mānuka scrub, was about 3 km west of Collingwood in Golden Bay in the lower Aorere River valley. The soils have formed on Middle Pleistocene aggradation terraces. This land surface predates the last interglacial which has allowed significant time for podzolisation to occur. The profile colours are low chroma; however, evidence of pale uncoated sand grains in topsoil and subsoil are consistent with illuviation and an E horizon, while brighter 7.5YR colours at depth are consistent with a podzolic B horizon. This soil was classified as a Humic Orthic Podzol and no evidence of hydric soil indicators were found.

9 Dobbie (Dob1)

This was a lifestyle block mostly in natural vegetation of manuka and sedges at Puponga near Farewell Spit. The site was on a low hill overlooking Golden Bay. The geology is a complex of Late Cretaceous to Pleistocene sediments including sandstone, siltstone, conglomerate and coal (there were remains of a railway embankment on the property that leads to a disused coal mine further up the valley). The base of the hills is surrounded by

Holocene sediments. The geology on the hills is deeply weathered and soils are predominantly highly leached Podzols. Coarse blocky sub-soil high in clay restricts permeability leading to perch-gley conditions. Due to this slow permeability, hydric features can be observed on hill slopes that would otherwise be expected to be well drained. The highly leached upper profile (A/E horizon) masks the hydric features, although redox mottles are still evident in root channels.

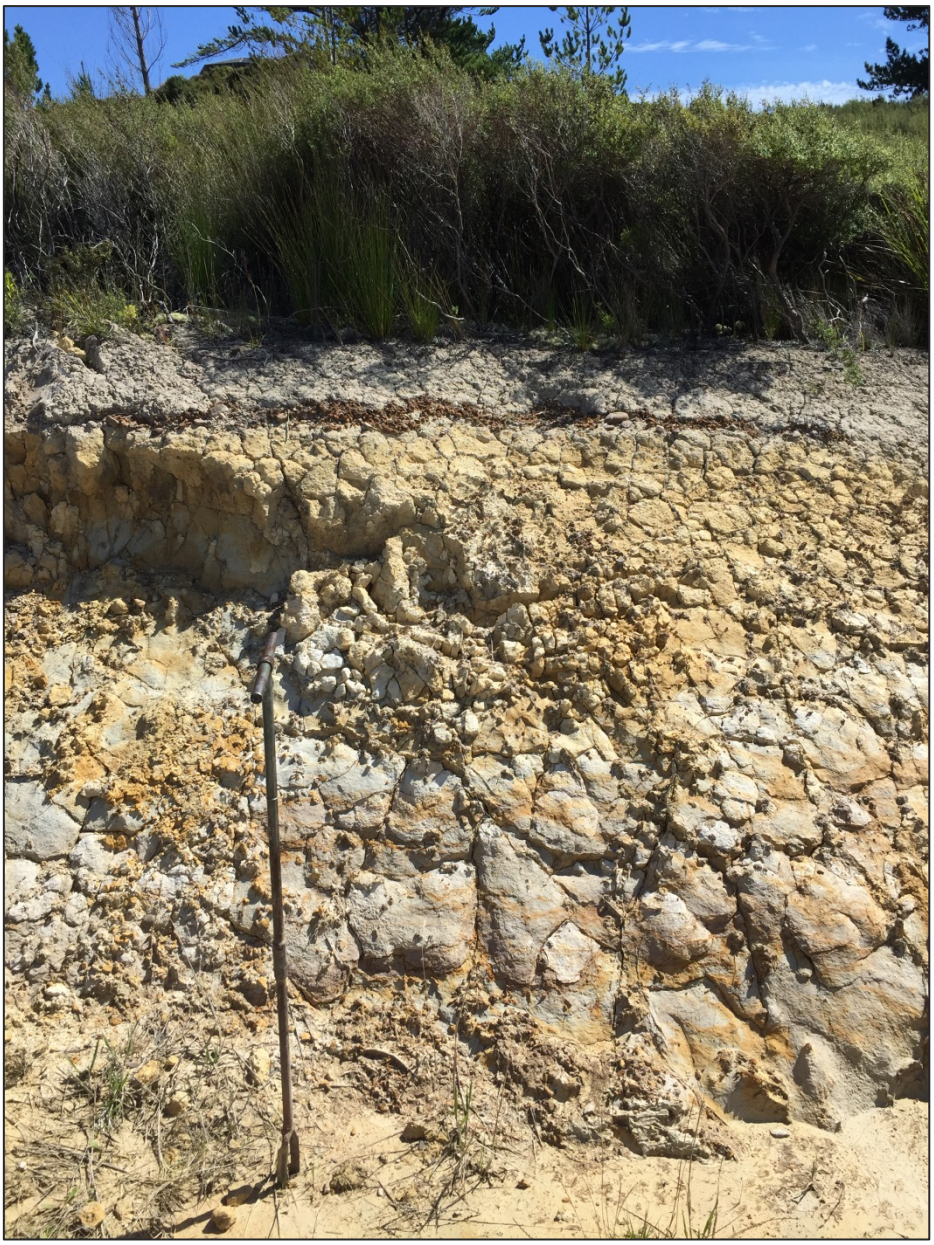


Figure 31. Road cutting near site Dob1 showing perch-gley features due to coarse blocky structured sub-soil. Note iron concretions at base of Bs horizon.

10 Lake Sedgemere, Molesworth Station (S62, S63, S65)

Molesworth Station, administered by DOC, is New Zealand's largest farm (180,000 ha) and is managed by Landcorp Farming Ltd. Lake Sedgemere is on the north-west boundary of the farm adjacent to the Wairau River. There are a series of small lakes and extensive wetlands, both permanent and ephemeral, in this area. The surrounding mountains have been eroded through glaciation and wide valleys in this area consist of glacial gravel deposits. Movement of the Awatere fault during the Quaternary has disrupted local drainage leading to the formation of wetlands and lakes. The Sedgemere area experiences cold winters with high snowfall on surrounding hills, which feed into the wetlands when snow melts in spring. Many of the wetlands around Sedgemere are fed only from snow melt and as this area can have extended dry summers, many wetlands are only wet for short periods each year.

Figure 32. Ephemeral wetland near Lake Sedgemere, Molesworth Station, showing transect from well-drained Brown soils (crowbar, far left), through Mottled Brown on the wetland margin (auger), to poorly drained Gley soil (green spade middle right). This wetland is fed from a small ephemeral stream that originates from gravels at the base of Mt Tarndale.

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Fraser Gully | Region: Waikato (Te Kowhai) | Sampling Point/ID: S1
Owner/address: S Fraser, Fullerton Rd | Land management: Extensive - dry stock | Date: 29/5/17 | Slope (°): 0
Landform: Gully floor | Local relief: Flat | NZTM (E): 1790253
Soil drainage (circle) W MW I P (VP) | Land cover: Herbaceous freshwater vegetation | NZTM (N): 5818936
Investigator: SF, PS | Hydrologic features: Minor pools | Altitude (m): 29

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0–15	10YR 4/2	5YR 4/4	10	2–6mm	Roots, peds	Mineral	Seepage, gully margin
15–30	10YR 3/2					Mineral	
50–60	5BG 4/1					Mineral	Sandy, no structure
							Typic Recent Gley GRT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
✓ Fluid (muck)

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
✓ Depression
___ Flat
___ Valley
✓ Gully
___ Slope

Water table
~1 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

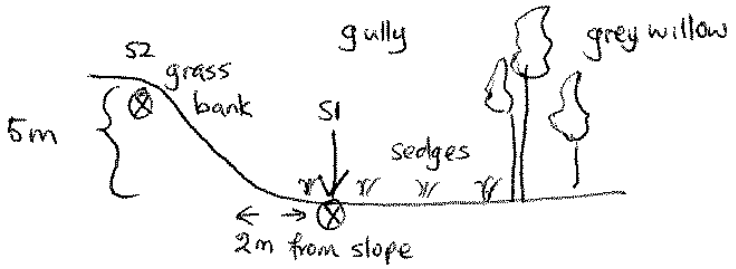
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: On gully floor margin, about 5m from sample point S2 (on grass bank)

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GRT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Fraser Gully | Region: Waikato (Te Kowhai) | Sampling Point/ID: S2
Owner/address: S Fraser, Fullerton Rd | Land management: Extensive-dry stock | Date: 29/5/17 | Slope (°): 10
Landform: Top of bank | Local relief: Gentle slope | NZTM (E): 1790257
Soil drainage (circle) (W) MW I P VP | Land cover: Exotic grassland | NZTM (N): 5818947
Investigator: SF, PS | Hydrologic features: None visible | Altitude (m): 34

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-14	10YR 5/6	10 YR 5/8	1	1-2mm	Within ped	Mineral	
14-30	7.5YR 6/8					Mineral	

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

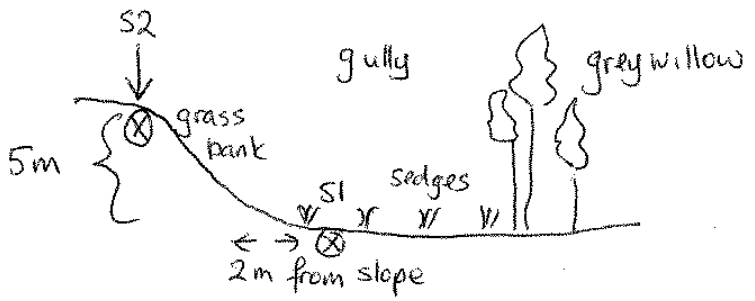
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Mottled orthic brown soil, i.e. not a hydric soil (BOM)
On grass bank, about 5m from sample point S1 (in gully)

Photo numbers: ___

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) BOM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Stone Farm
Owner/address: T. Stone, Te Kowhai Rd
Landform: Floodplain
Soil drainage (circle) W MW I (P) VP
Investigator: SF PS

Region: Waikato (Te Kowhai)
Land management: Intensive - dairy
Local relief: Flat area on edge of ponding
Land cover: Herbac. fw veg/exotic grassld
Hydrologic features: Ponding adjacent

Sampling Point/ID: S3
Date: 29/5/17 Slope (°): 0
NZTM (E): 1793238
NZTM (N): 5820577
Altitude (m): 40

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ✓ No ___
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0-10	10YR 3/2	7.5YR 3/4	10	2-6 mm	Ped face	Mineral	
10-28	10YR 5/3	5YR 4/6	5	<1 mm	Roots	Mineral	
28-30	10YR 6/2	5YR 4/6	10	1-2 mm	Roots	Mineral	
							Iron pan 50 m away
							2m into pond has
							definite hydric soil
							Typic Orthic Gley GOT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
✓ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

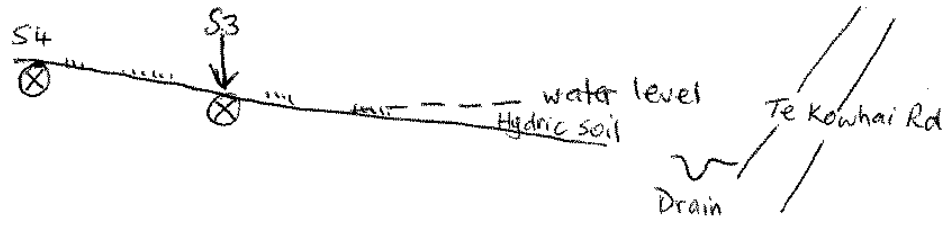
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
✓ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged
✓ Ponding

Sketch of site/soil:



Remarks: Season has been unusually wet (spring + summer)
Grass paddock with flat to undulating topography. Mosaic of hydric and non-hydric soils.
Close to sample point S4 (non-hydric)

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GOT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

: Stone Farm | Region: Waikato (Te Kowhai) | Sampling Point/ID: S4
ner/address: T. Stone, Te Kowhai Rd | Land management: Intensive -dairy | Date: 29/5/17 | Slope (°):
dform: Floodplain | Local relief: Flat - gentle slope | NZTM (E): 1793234
drainage (circle) W MW (I) P VP | Land cover: Exotic grassland | NZTM (N): 5820587
estigator: SF PS | Hydrologic features: Ponding 10m away | Altitude (m): 41

climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ✓ No
ne soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Rema

file description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm defaul

oth	Matrix	Mottles				Material[4]	Comments
)	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
-14	10YR 2/2						
-22	10YR 5/6	5YR 4/6	12	2-6mm	Within ped	Mineral	Moist
-30	10YR 6/6	7.5YR 5/8	25	2-6mm	Roots, ped	Mineral	Moist
							Mottled Orthic Brown

e % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, minera

dric soil indicators:

anic layers
_ Organic soil material (general)
_ Peaty topsoil
_ Peaty subsoil

_ Fibric
_ Mesic
_ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

ıse of wetness

ation
_ Depression
_ Flat
_ Valley
_ Gully
_ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

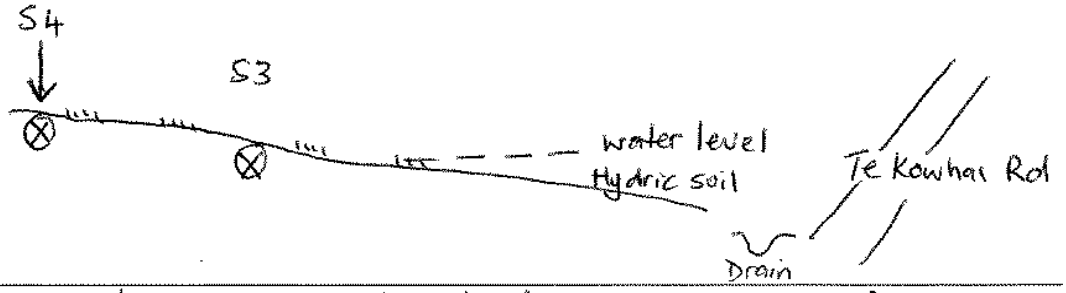
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeabi
___ Argillic layer
___ Depth to restrictive layer (

Surface features
___ Pugged
___ Ponding

tch of site/soil:



narks: Spring + summer season has been unusually wet. Grass paddock with flat to undula
pography. Mosaic of hydric and non-hydric soils. Close to sampling point S3 (hydric

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Stone Farm
Owner/address: T. Stone, Te Kowhai Rd
Landform: Old Waikato River channel
Soil drainage (circle) W MW I (P) VP
Investigator: _____

Region: Waikato (Te Kowhai)
Land management: Intensive - dairy
Local relief: Flat - channel floor
Land cover: Herbac. fw veg/exotic grassld
Hydrologic features: Local ponding, drain

Sampling Point/ID: S5
Date: 29/5/14 Slope (°): 0
NZTM (E): 1793065
NZTM (N): 5820871
Altitude (m): 32

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ✓ No ____
Is the soil disturbed or problematic? _____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0–8	10 YR 3/2	7.5 YR 7/6	10	<1 mm	Roots	Mineral	Humic?
8–16	7.5 YR 4/2	5 YR 3/4	25	2–6 mm	Roots, Ped face	Mineral	
	5Y 7/1	10 YR 6/8	40	2–6 mm	Roots, Ped face	Mineral	
16–18	5 YR 4/4					Mineral	Fe^{3+} accumulation
18–30	10 YR 2/1					Organic	Peat layer
30–70						Organic	
70 +	5 GY 5/1	7.5 YR 6/6	30	10	Within ped	Mineral	
							Mesic Humic Organic OHM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
- ✓ Organic soil material (general)
- ___ Peaty topsoil
- ___ Peaty subsoil

___ Fibric
___ Mesic
✓ Humic

Concretions
- ✓ Iron concretions
- ___ Manganese concretions
- ___ Nodular

Consistence
- ___ Plastic
- ___ Sticky
- ___ Fluid

Colours Profile form either:
- ✓ Gley OR
- ___ Mottled

Horizon
- ✓ Reductimorphic
- ✓ Redox mottled
- ___ Redox segregations
- ___ Perch-gley features

Cause of wetness

Location
- ✓ Depression adj river channel
- ___ Flat
- ___ Valley
- ___ Gully
- ___ Slope

Water table
- 25 Depth to water (cm)
- ✓ High groundwater
- ___ Perched water table
- ___ Seepage
- ___ Tidal

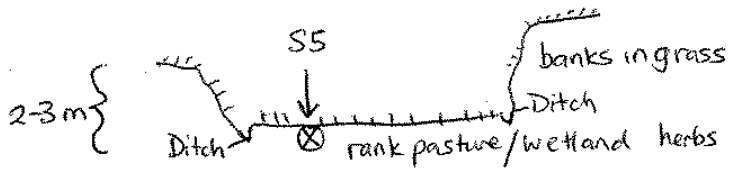
___ Lithic contact

Pans
- ___ Pan (general)
- ___ Humus-pan
- ___ Ironstone-pan
- ___ Densipan
- ___ Duripan
- ___ Fragipan
- ___ Orstein-pan
- ___ Depth to pan (cm)

Layers
- ___ Slow/ restricted permeability
- ___ Argillic layer
- ___ Depth to restrictive layer (cm)

Surface features
- ✓ Pugged
- ✓ Ponding

Sketch of site/soil:



Remarks: Drain 4m away running along margin of channel

Photo numbers: _____

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) OHM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Mitchel Farm
Owner/address: S. Mitchel, Robson Rd
Landform: Floodplain
Soil drainage (circle) W (MW) I P VP
Investigator: _____

Region: Waikato (Whata Whata)
Land management: Intensive - dairy
Local relief: Flat - gently undulating
Land cover: Exotic Pasture
Hydrologic features: Nil

Sampling Point/ID: S6
Date: 29/5/17 Slope (°): 1-2
NZTM (E): 1790999
NZTM (N): 5809756
Altitude (m): 35

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ____ No ✓
Is the soil disturbed or problematic? _____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0–16	10YR 2/2					Mineral	Organic?
16–30+	5YR 3/3					Mineral	
							Humic Orthic Podzol ZOH?

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
___ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

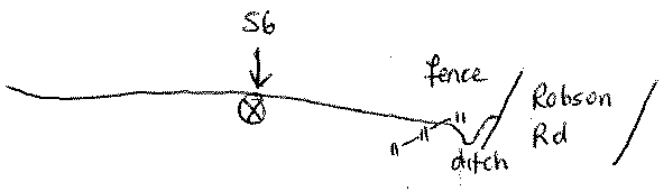
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: ZOH Te Rapa Series?

Photo numbers: _____

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) ZOH ?

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station | Region: Waikato (Te Pahu) | Sampling Point/ID: S7
Owner/address: Waikoha Rd | Land management: Extensive - dry stock | Date: 30/5/17 | Slope (°): 5-10
Landform: Steep hillcountry | Local relief: Gentle slope | NZTM (E): 1784317
Soil drainage (circle) W (MW) I P VP | Land cover: High producing exotic grassland | NZTM (N): 5806086
Investigator: SF | Hydrologic features: Nil | Altitude (m): 233

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ✓ No ___
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-19	10YR 4/3	7.5 YR 5/8	<2	1-2mm	Root channels	Mineral	
19-30	10YR 5/8	2.5 Y 6/3	25	6-10mm	Matrix	Mineral	
							Mottled Orthic Brown BOM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
✓ Plastic
✓ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
<30 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

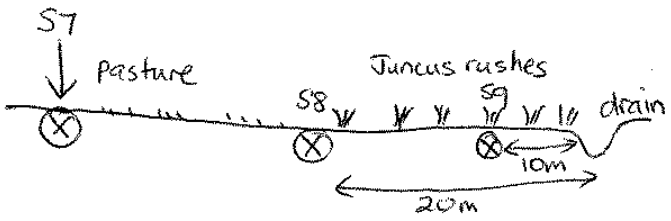
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: High producing pasture species on flat-gently sloping land. Mudstone hillcountry Upslope of wet terrain dominated by rushes (Juncus spp.). Two other sample points nearby: S8 (non-hydric) and S9 (hydric). Both are closer to the drain.

Photo numbers: ___

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) BOM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha station | Region: Waikato (Te Pahu) | Sampling Point/ID: S8
Owner/address: Waikoha Rd | Land management: Extensive - dry stock | Date: 30/5/17 | Slope (°): 5-10
Landform: Steep hillcountry | Local relief: Gentle slope on gully floor | NZTM (E): 1784307
Soil drainage (circle) W MW (I) P VP | Land cover: Exotic grassland | NZTM (N): 8506088
Investigator: SF | Hydrologic features: Near wetland edge | Altitude (m):

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ✓ No ____
Is the soil disturbed or problematic? ____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0–18	10YR 4/3	7.5YR 7/6	<2	2–6 mm	Roots	Mineral	
18–30	7.5YR 5/8	10YR 5/3	30	6–10mm	Within matrix	Mineral	
							Mottled Orthic Brown BOM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
- ___ Organic soil material (general)
- ___ Peaty topsoil
- ___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
- ___ Iron concretions
- ___ Manganese concretions
- ___ Nodular

Consistence
- ___ Plastic
- ___ Sticky
- ___ Fluid

Colours Profile form either:
- ___ Gley OR
- ✓ Mottled

Horizon
- ___ Reductimorphic
- ___ Redox mottled
- ___ Redox segregations
- ___ Perch-gley features

Cause of wetness

Location
- ___ Depression
- ___ Flat
- ___ Valley
- ___ Gully
- ___ Slope

Water table
- <30 Depth to water (cm)
- ___ High groundwater
- ___ Perched water table
- ___ Seepage
- ___ Tidal

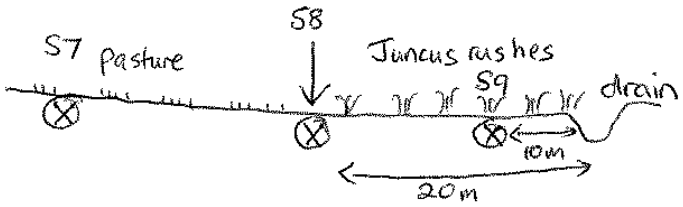
___ Lithic contact

Pans
- ___ Pan (general)
- ___ Humus-pan
- ___ Ironstone-pan
- ___ Densipan
- ___ Duripan
- ___ Fragipan
- ___ Orstein-pan
- ___ Depth to pan (cm)

Layers
- ___ Slow/ restricted permeability
- ___ Argillic layer
- ___ Depth to restrictive layer (cm)

Surface features
- ___ Pugged
- ___ Ponding

Sketch of site/soil:



Remarks: Mudstone steep hillcountry
Right on borderline of wetland. Drain 20m away at bottom of gully depression. Two other sampling points nearby: S7 (non-hydric) upland of S8, and S9 (hydric) into the wetland.
Photo numbers: ____

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) BOM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station
Owner/address: Waikoha Rd
Landform: Steep hillcountry
Soil drainage (circle) W MW I (P) VP
Investigator: SF

Region: Waikato (Te Pahu)
Land management: Extensive - dry stock
Local relief: Very gentle slope
Land cover: Herbaceous freshwater vegetn
Hydrologic features: Seep at head of gully

Sampling Point/ID: S9
Date: 30/5/17 Slope (°): 1-2
NZTM (E): 1784294
NZTM (N): 5806087
Altitude (m): 231

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ✓ No ___
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0-13	10YR 4/2	7.5YR 5/8	15	<1mm	Root	Mineral	
13-25	10YR 5/1	7.5YR 5/8	5	<1mm	Pore, Ped face	Mineral	
25-30	10YR 6/2	7.5YR 6/2	20	10-20mm	Pore	Mineral	Water seepage
-45							
							Typic Orthic Gley GOT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
✓ Plastic
✓ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
-40 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

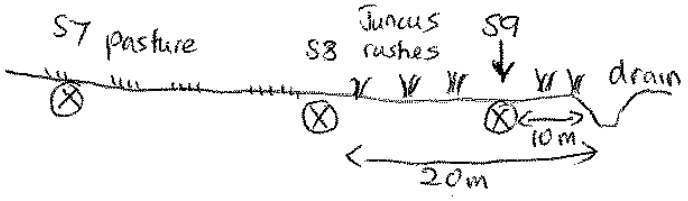
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
✓ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged some
___ Ponding

Sketch of site/soil:



Remarks: Wet at surface; low permeability soils. Water table still rising in hole. Mudstone country. Two other sample points (S7, S8) upland of S9. Both are non-hydric.

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GOT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station
Owner/address: Waikoha Rd
Landform: Steep hillcountry
Soil drainage (circle) W (MW) I P VP
Investigator: SF

Region: Waikato (Te Pahu)
Land management: Extensive - dry stock
Local relief: hillslope - upland margin of gully seep
Land cover: Exotic grassland
Hydrologic features: Nil - seep nearby

Sampling Point/ID: S10
Date: 30/5/17 Slope (°): 15-20
NZTM (E): 1784328
NZTM (N): 5807172
Altitude (m): 228

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-12	10YR 2/2						
12-30	10YR 5/6						
							Red mottles at 50cm depth
							=Mottled orthic brown soil
							BOM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
✓ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

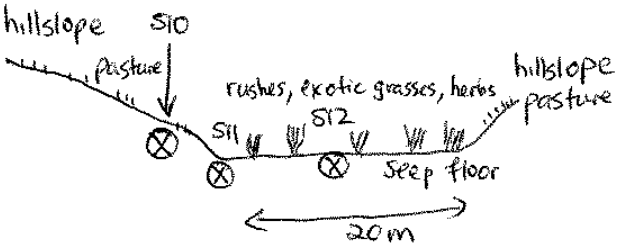
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Mudstone mainly, with limestone outcrops nearby (Tertiary).
Sampling point upslope of two other sampling points in seep wetland: S11 and S12. Both hydric soils.

Photo numbers: ___

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) BOM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station | Region: Waikato (Te Pahu) | Sampling Point/ID: S11
Owner/address: Waikoha Rd | Land management: Extensive - dry stock | Date: 30/5/17 | Slope (°): 5-10
Landform: Steep hillcountry | Local relief: Gentle slope - gully seep | NZTM (E): 1784327
Soil drainage (circle) W MW T (P) VP | Land cover: Herbaceous freshwater veg. | NZTM (N): 5807168
Investigator: SF | Hydrologic features: Inside margin of gullyseep | Altitude (m): 232

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-25	10YR 4/1	10YR 5/8	2	6-10 mm	Roots	Mineral	
25-30	10YR 5/2	10YR 5/6	10	6-10 mm	Roots, pores	Mineral	
30-50	10YR 5/8	10BG 6/2	20	10-20 mm	Pores	Mineral	High chroma colours - intense gleying in mottles
							Mottled fluvial recent
							soil = RFM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
✓ Plastic
✓ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR - upper profile
___ Mottled - below 25-30 cm

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
✓ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
✓ Gully Floor
___ Slope

Water table
-2 Depth to water (cm)
___ High groundwater
✓ Perched water table
✓ Seepage
___ Tidal

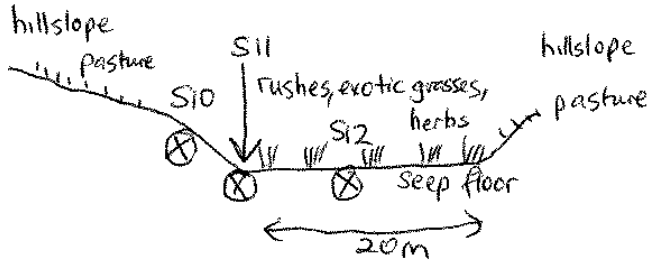
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged
✓ Ponding

Sketch of site/soil:



Remarks: Abrupt boundary from pasture on slope on brown soils to rushes and Glyceria on gley soils. On boundary between wetland and upland. Recently formed wetland at sampling point - wetland 'growing out' caused by cattle. Two other sampling points nearby: S10 upslope (non-hydric) and S12 deeper into seep wetland (hydric)

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) RFM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Waikoha Station
Owner/address: Waikoha Rd
Landform: Steep hillcountry
Soil drainage (circle) W MW I (P) VP
Investigator: SF

Region: Waikato (Te Pahu)
Land management: Extensive - dry stock
Local relief: Flat-gentle slope gully seep
Land cover: Herbaceous freshwater vegetn.
Hydrologic features: In gully seep floor

Sampling Point/ID: S12
Date: 30/5/17 Slope (°): 1-5
NZTM (E): 1784327
NZTM (N): 5807166
Altitude (m): 232

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0-10	10YR 4/2					Mineral	Peaty orthic-gley G-00
10-40	10YR 4/1					Mineral	Fluid Gley Raw WGF
40+	5G 6/1	10YR 5/8	40	10-20mm	Within Ped	Mineral	

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
✓ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
✓ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features Was originally perch-gley

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
✓ Gully Floor
___ Slope

Water table
-2 Depth to water (cm)
___ High groundwater
✓ Perched water table
✓ Seepage
___ Tidal

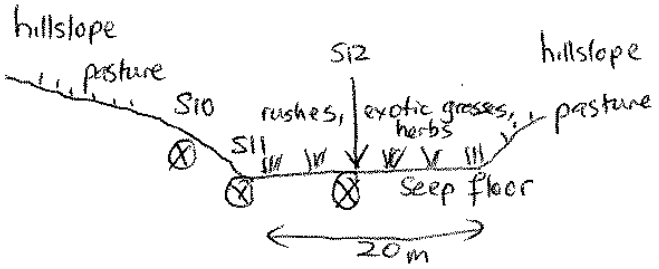
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged
✓ Ponding

Sketch of site/soil:



Remarks: Middle of seep that slopes downhill at 5-10°. Two other sampling points nearby: S11 (hydric) near wetland edge, and S10 (non-hydric), upslope of wetland.

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) G-00 / WGF

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Whitehills | Region: Northland | Sampling Point/ID: W1
Owner/address: Road reserve | Land management: Indigenous cover | Date: 28/11/17 Slope (°): 6-7
Landform: Easy hill country | Local relief: Undulating slope | NZTM (E): 1678549
Soil drainage (circle) W MW I P VP | Land cover: Manuka/Lyc cern. scrub | NZTM (N): 6112978
Investigator: SF PS | Hydrologic features: None | Altitude (m): 224

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ✓ No ____
Is the soil disturbed or problematic? ✓ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0-7	10YR 5/2					Mineral	
7-23	10YR 8/1	5YR 3/4	10	1-2mm	Matrix	Mineral	Many very fine mottles
23-30+	5YR 7/2	5YR 3/4	10	1-2mm	Matrix	Mineral	Many very fine mottles
"		5YR 6/3	50	20-60mm	Ped face	Mineral	Organic coating

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
? Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
? Gley OR E Horizon
___ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
? Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

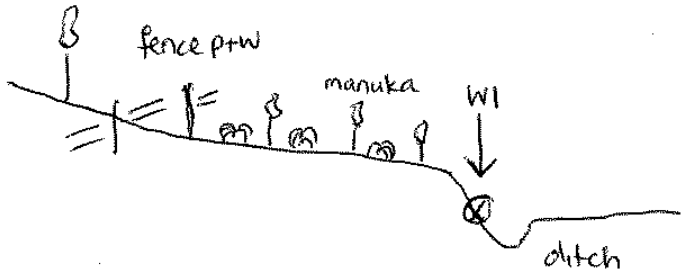
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
✓ Orstein-pan
7 Depth to pan (cm)

Layers
(✓) Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Drain cutting to show soil profile. Problematic soil: Orstein pan podzol ZXQ
Hydrology criterion needs to be applied

Photo numbers: ____ E horizon: Fe is leached so no red mottles obvious

Hydric soil present? ___ Yes ___ No ✓ Uncertain | NZSC Subgroup (if known) ZXQ

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Kerikeri Airport | Region: Northland | Sampling Point/ID: KA2
Owner/address: DOC | Land management: Protected Area | Date: 29/11/17 Slope (°): 0
Landform: Plain | Local relief: Flat | NZTM (E): 1682308
Soil drainage (circle) W MW I P (VP) | Land cover: Manuka/Gledic - Macter shrubld | NZTM (N): 6097584
Investigator: SF PS | Hydrologic features: High water table, pools nearby | Altitude (m): 125

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ____ No ✓
Is the soil disturbed or problematic? ____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
0-30	10YR 4/2					Mineral	Minor component
0-30	10YR 2/1					Organic	Undecomposed plant material = Peat = major component

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
- ✓ Organic soil material (general)
- ___ Peaty topsoil
- ___ Peaty subsoil

- ✓ Fibric
- ___ Mesic
- ___ Humic

Concretions
- ___ Iron concretions
- ___ Manganese concretions
- ___ Nodular

Consistence
- ___ Plastic
- ___ Sticky
- ___ Fluid

Colours Profile form either:
- ___ Gley OR
- ___ Mottled

Horizon
- ___ Reductimorphic
- ___ Redox mottled
- ___ Redox segregations
- ___ Perch-gley features

Cause of wetness

Location
- ___ Depression
- ___ Flat
- ___ Valley
- ___ Gully
- ___ Slope

Water table
- 20 Depth to water (cm)
- ___ High groundwater
- ___ Perched water table
- ___ Seepage
- ___ Tidal

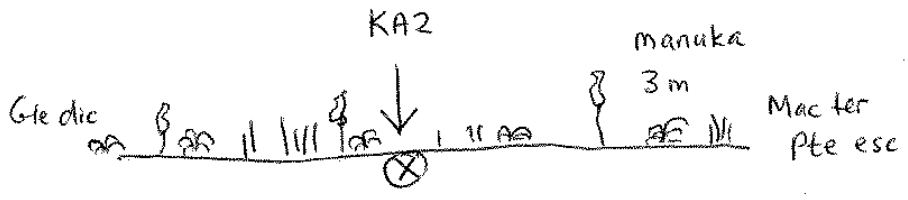
- ___ Lithic contact

Pans
- ___ Pan (general)
- ___ Humus-pan
- ___ Ironstone-pan
- ___ Densipan
- ___ Duripan
- ___ Fragipan
- ___ Orstein-pan
- ___ Depth to pan (cm)

Layers
- ___ Slow/ restricted permeability
- ___ Argillic layer
- ___ Depth to restrictive layer (cm)

Surface features
- ___ Pugged
- ___ Ponding

Sketch of site/soil:



Remarks: Site is a fen wetland

Acid Fibric Organic Soil OFA

Photo numbers: ____

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) OFA

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Matawhero Loop
Owner/address: Nga Uri o te Kooti
Landform: Oxbow
Soil drainage (circle) W MW I P (VP)
Investigator: SF

Region: Gisborne
Land management: Wetland restoration
Local relief: Flat with gentle bank
Land cover: Rank pasture, wetland plantings
Hydrologic features: Local ponding

Sampling Point/ID: M1
Date: 19/10/17 Slope (°): 0
NZTM (E): 2028759
NZTM (N): 5709601
Altitude (m): 1

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
0-3	10YR 2/2					Organic	Peaty
3-25	10YR 5/1	7.5YR 4/4	10	2-6 mm	Root channels	Mineral	
25-30+	10YR 5/1	5.5YR 4/4	20	2-6 mm	Root channels	Mineral	
50+	2.5YR 6/3						Becomes more yellow

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
✓ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
✓ Flat River bed
___ Valley
___ Gully
___ Slope

Water table
0 Depth to water (cm)
✓ High groundwater
___ Perched water table
___ Seepage
___ Tidal

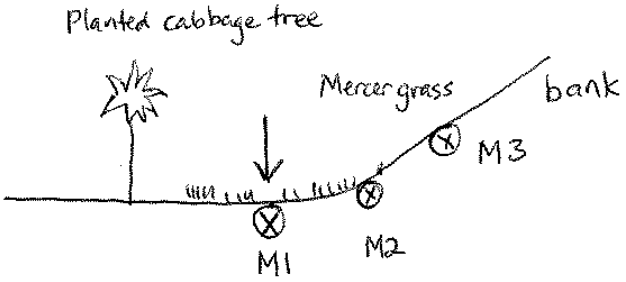
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
✓ Ponding

Sketch of site/soil:



Remarks: Not clear regarding source of water – in close proximity to oxbow pond
Site low in the landscape. Young fluvial parent materials
Typic Recent Gley soil

Photo numbers: ___

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GRT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Matawhero Loop
Owner/address: Nga Uri o te Kooti
Landform: Ox bow
Soil drainage (circle) W MW I (P) VP
Investigator: SF

Region: Gisborne
Land management: Wetland restoration
Local relief: Toe slope of gentle bank
Land cover: Rank pasture, wetland plantings
Hydrologic features: Ponding further away

Sampling Point/ID: M2
Date: 19/10/17 Slope (°): 5
NZTM (E): 2028756
NZTM (N): 5709603
Altitude (m): 1.5

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ____ No ✓
Is the soil disturbed or problematic? ✓ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles % [1]	Mottles Size [2]	Mottles Location [3]	Material [4]	Comments
0–5	10YR 3/1					Organic	Peaty
5–20	2.5Y 4/1	7.5Y 3/3	5	2–6 mm	Ped face	Mineral	
20–30+	10YR 5/1	7.5YR 5/6	35	6–10 mm	Within matrix	Mineral	
							Typic Recent Gley GRT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
✓ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope
✓ River bed edge

Water table
> 40 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

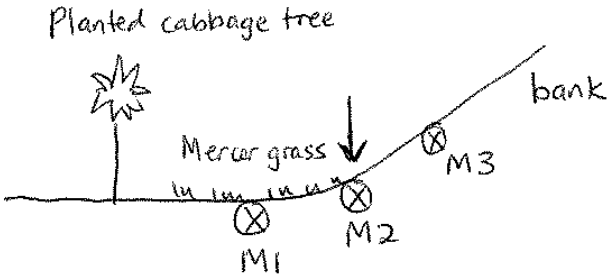
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Toe slope of bank, some gravel – soil is actually fill? from 15 cm down. Pale coloured parent materials

Recent soil: gley features working way down into river silt

Photo numbers: ____

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GRT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Matawhero Loop | Region: Gisborne | Sampling Point/ID: M3
Owner/address: Nga Uri o te Kooti | Land management: Wetland restoration | Date: 19/10/17 | Slope (°): 5
Landform: Oxbow - near top of bank | Local relief: gentle upslope | NZTM (E): 2028756
Soil drainage (circle) W MW (I) P VP | Land cover: Rank pasture | NZTM (N): 5709605
Investigator: SF | Hydrologic features: | Altitude (m): 1.8

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-7	2.5Y 3/2					Mineral	
7-30	2.5Y 5/3	2.5Y 5/1	5-10	6-10mm	Within matrix	Mineral	

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
✓ Slope Gentle

Water table
>60 Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

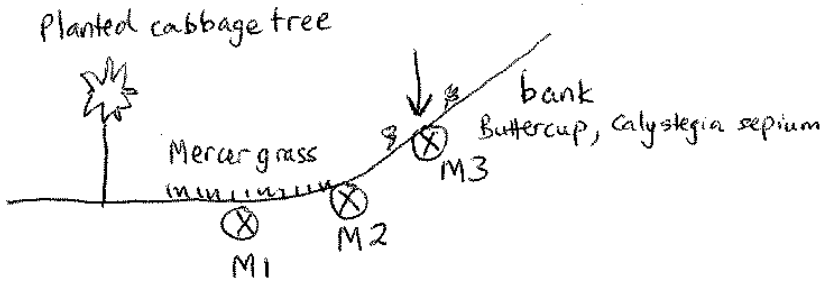
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: M1+M2 = Recent Gley soils - Pale coloured parent materials
Sampling Point M3 - Mottled Fluvial Recent Soil - Mottled profile form RFM

Photo numbers: ___

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) RFM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Jamestown | Region: Tasman | Sampling Point/ID: J+ 1
Owner/address: J. Cassie | Land management: Natural heathland | Date: 22/1/18 | Slope (°): 0
Landform: Terrace | Local relief: Flat | NZTM (E): 1570692
Soil drainage (circle) W MW (I) P VP | Land cover: Kanuka-manuka scrub | NZTM (N): 5496059
Investigator: SF | Hydrologic features: None | Altitude (m): 31

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
0-23	10YR 3/2					Mineral	Topsoil/organic matter
	+ 10YR 8/1					Mineral	Uncoated sand grains
23-32	7.5YR 4/2					Mineral	More uncoated sand grains
32 –	7.5YR 4/3						
							Humic Orthic Podzol ZOH
							Beginning of an orthic podzol

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
___ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

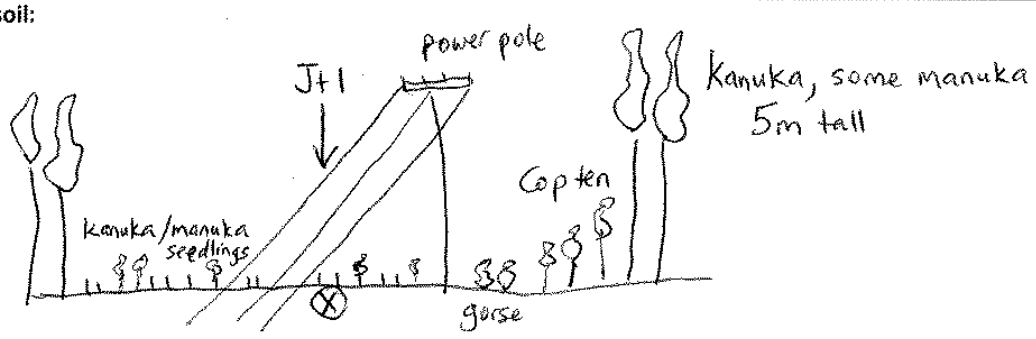
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Below 32cm - gets browner - doesn't suggest groundwater or water perching
Evidence of alluviation/eluviation in the uncoated grain colours
23 – 32cm - weak E horizon, suggests colours due to leaching rather than waterlogging.
Photo numbers: ___ Site undisturbed for c. 40-50 years

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) ZOH

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Dobbie | Region: Tasman | Sampling Point/ID: Dob1
Owner/address: W. Dobbie | Land management: Natural | Date: 23/1/18 | Slope (°): 3-7
Landform: Rounded spur | Local relief: Gently sloping | NZTM (E): 1576955
Soil drainage (circle) W MW I (P) VP | Land cover: Manuka/Lep fil shrubland | NZTM (N): 5514019
Investigator: SF | Hydrologic features: None | Altitude (m): 42

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ____ No ✓
Is the soil disturbed or problematic? ____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	Mottles %[1]	Mottles Size[2]	Mottles Location[3]	Material[4]	Comments
0-25	10YR 5/1	5YR 3/4	5	2-6 mm	Root channels	Mineral	A/E horizon
25-37	5YR 4/6					Mineral	BS sesquioxide (below podzol
	+10YR 5/1						A/E horizon). Chunks of
							red material.
							35-40% iron accumulations
37-	10YR 6/8	10YR 7/1	20	6-10mm	Pore	Mineral	

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
✓ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
✓ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
✓ Redox segregations
✓ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
✓ Perched water table
___ Seepage
___ Tidal

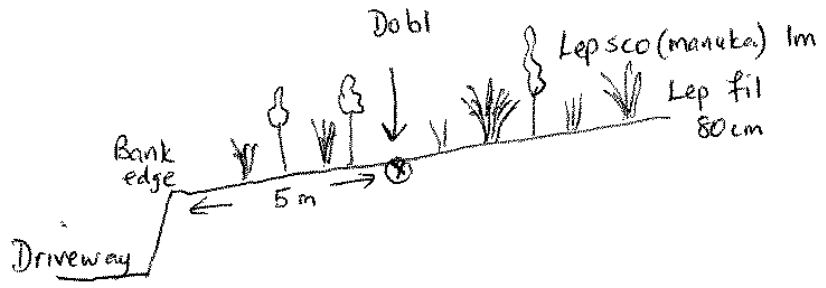
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
✓ Slow/ restricted permeability
___ Argillic layer
37 Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Typic perch: gley podzol ZPT

Photo numbers: ____

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) ZPT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Sedgenere 1 | Region: Marlborough (Molesworth) | Sampling Point/ID: S62
Owner/address: DoC | Land management: Extensive beef | Date: 26/1/18 | Slope (°): 5
Landform: Terrace / fan | Local relief: Hollow | NZTM (E): 2502435
Soil drainage (circle) (W) MW I P VP | Land cover: low producing pasture | NZTM (N): 5896634
Investigator: SF | Hydrologic features: None | Altitude (m): 1016

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ Is the site drained? Yes ____ No ✓
Is the soil disturbed or problematic? ____ Are 'normal circumstances' present Yes ✓ No ____ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
0–10	10YR 3/1						
10–20	10YR 4/4						
20–40	10YR 3/4						

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
___ Mottled

Horizon
___ Reductimorphic
___ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
___ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

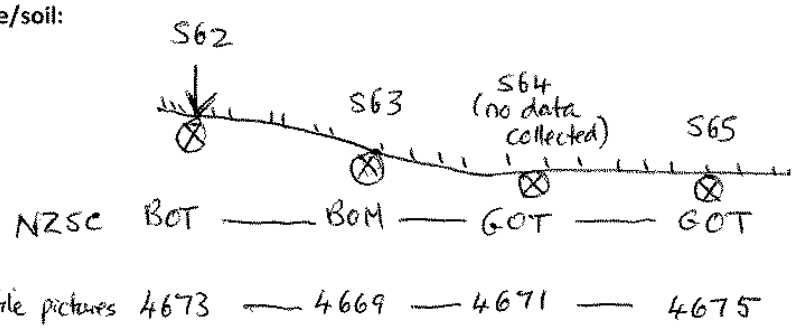
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
___ Ponding

Sketch of site/soil:



Remarks: Moderately-well to well drained. Brown soil. Stony. Rainfall probably c. 1100 mm/yr
Typic Orthic Brown BOT

Photo numbers: ____

Hydric soil present? ___ Yes ✓ No ___ Uncertain | NZSC Subgroup (if known) BOT

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Sedgemere 1
Owner/address: DOC
Landform: Terrace / fan
Soil drainage (circle) W MW (I) P VP
Investigator: SF

Region: Marlborough (Molesworth)
Land management: Extensive beef
Local relief: Hollow
Land cover: Low producing pasture
Hydrologic features: None

Sampling Point/ID: S63
Date: 26/1/18 Slope (°): 3-5
NZTM (E): 2502438
NZTM (N): 5896832
Altitude (m): 1015

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ✓ Are 'normal circumstances' present Yes ___ No ? If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix Colour (moist)	Mottles Colour (moist)	%[1]	Size[2]	Location[3]	Material[4]	Comments
0-10	10YR 3/2	5YR 4/6	10	1-2mm	Root channels	Mineral	0-18 looks like it has
10-18	7.5YR 3/2	5YR 4/6	5	2-6mm	Root channels	Mineral	been pugged
18-32	7.5YR 3/3						
32-	7.5YR 3/3						Stony 20-35%
							Mottled Orthic Brown BoM

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
___ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
✓ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
___ Gley OR
✓ Mottled

Horizon
___ Reductimorphic
✓ Redox mottled
___ Redox segregations
? Perch-gley features

Cause of wetness

Location
✓ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

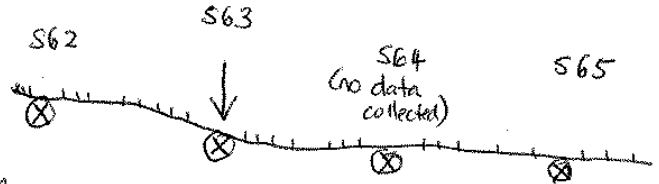
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
✓ Pugged
___ Ponding

Sketch of site/soil:



Profile pictures 4673 — 4669 — 4671 — 4675

Remarks: S63 on wetland margin, top 18cm gley colours and mottles. Suggests seasonal wetness in top layer, but below 18cm looks like a brown soil. S62 - well drained Brown, S65 - poorly-drained Gley soil (also S64 - no soil description data form)

Photo numbers: 4666-70

Hydric soil present? ___ Yes ___ No ✓ Uncertain | NZSC Subgroup (if known) BoM

WETLAND DETERMINATION FORM – NEW ZEALAND: SOIL

Site: Sedgemere 1
Owner/address: DOC
Landform: Terrace / fan
Soil drainage (circle) W MW I P VP
Investigator: SF

Region: Marlborough (Molesworth)
Land management: Extensive beef
Local relief: Hollow
Land cover: Low producing pasture
Hydrologic features: None

Sampling Point/ID: S65
Date: 26/1/18 Slope (°): 0
NZTM (E): 2502449
NZTM (N): 5896822
Altitude (m): 1015

Are climatic/hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ Is the site drained? Yes ___ No ✓
Is the soil disturbed or problematic? ___ Are 'normal circumstances' present Yes ✓ No ___ If needed, explain in Remarks

Profile description: (Describe to the depth needed to document the indicator or confirm absence of indicators, 30 cm default)

Depth (cm)	Matrix	Mottles				Material[4]	Comments
	Colour (moist)	Colour (moist)	%[1]	Size[2]	Location[3]		
0–5	10YR 3/2					Mineral?	Lots of roots/organic matter
5–40	10YR 5/1	2.5Y 5/3	5	6–10	Ped face	Mineral	
							Typic Orthic Gley GOT

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped, along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Organic layers
___ Organic soil material (general)
✓ Peaty topsoil
___ Peaty subsoil

___ Fibric
___ Mesic
___ Humic

Concretions
___ Iron concretions
___ Manganese concretions
___ Nodular

Consistence
___ Plastic
___ Sticky
___ Fluid

Colours Profile form either:
✓ Gley OR
___ Mottled

Horizon
✓ Reductimorphic
✓ Redox mottled
___ Redox segregations
___ Perch-gley features

Cause of wetness

Location
✓ Depression
___ Flat
___ Valley
___ Gully
___ Slope

Water table
___ Depth to water (cm)
___ High groundwater
___ Perched water table
___ Seepage
___ Tidal

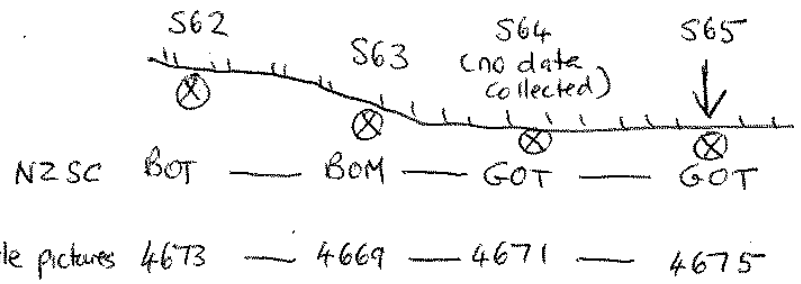
___ Lithic contact

Pans
___ Pan (general)
___ Humus-pan
___ Ironstone-pan
___ Densipan
___ Duripan
___ Fragipan
___ Orstein-pan
___ Depth to pan (cm)

Layers
___ Slow/ restricted permeability
___ Argillic layer
___ Depth to restrictive layer (cm)

Surface features
___ Pugged
✓ Ponding

Sketch of site/soil:



Profile pictures 4673 — 4669 — 4671 — 4675

Remarks: Sampling points S64 & S65 are both Gley and clearly hydric. No soil data description at sampling point S64. Vegetation change between S64 & S65 - See veg. sheets. However both have wetland plants present.

Photo numbers: 4675, 76

Hydric soil present? ✓ Yes ___ No ___ Uncertain | NZSC Subgroup (if known) GOT

Appendix 5: New Zealand hydric soils

Simple guide to Gley soils

Gley Soils are poorly drained and very poorly drained soils. In their undrained state, saturation occurs during prolonged periods, oxygen is limited and reducing conditions occur (typically affecting iron, manganese, nitrates, and sometimes sulphates). Greyish colours are dominant throughout the profile or to a depth of 90 cm or more.

ACCESSORY PROPERTIES OF THE ORDER

i Segregation of iron and manganese oxides. Particles in reduced parts of the soil are not coated by secondary oxides. Redox segregations of iron and manganese oxides, however, are usually present elsewhere in the soil and may occupy large volumes.

ii Commonly formed in alluvial or colluvial parent materials. Soils most frequently occur in relatively low parts of the landscape, in hollows or associated with flushes.

iii Wide range of clay minerals. The clay mineralogy commonly reflects the mineralogy of the ungleyed material from which the soils are derived.

iv Gley Soils cover a wide range of mineralogy classes with Mixed, Illitic, and Smectitic being the most common.

v Poorly or very poorly drained. Topsoils have relatively high levels of organic matter and some are peaty. Subsurface horizons to depth are dominantly grey or bluish grey in colour with strong brown to dark brown redox segregations.

vi High groundwater tables. Most are affected by high groundwater-tables, at least throughout winter months. Soils with slowly permeable layers may also be subject to perching.

vii Shallow potential rooting depth. Potential rooting depth is limited by poor aeration. Even after drainage, root extension may be limited in some horizons.

viii Relatively high bulk densities. Bulk densities are likely to be higher than well drained soils in similar soil materials.

ix Limited trafficability. Trafficability is limited in most soils when wet and pugging damage by stock is likely.

x Response to drainage to drainage. Crops, not adapted to wetness, respond well to drainage.

xi Minimal erosion. Flooding or ponding of water is likely on low-lying sites, especially on floodplains. Deposition of fresh sediment is possible in these sites.

xii Nitrogen requirement. Nitrogen requirements are likely to be higher than for associated well drained soils.

Soil Group	Subgroup	NZSC code
Sulphuric Gley Soils		**GU**
Sulphuric gley soils occur in marine estuarine sites. Ferrous sulphides have oxidised to for sulphuric acid or there are straw yellow (jarosite) mottles.		
Moderately fluid or very fluid and electrical conductivity of 0.8 mS/cm or more.	Fluid-saline sulphuric gley soils	GUFQ
Moderately fluid or very fluid.	Fluid sulphuric gley soils	GUF
Peaty topsoil or buried peat within 60 cm.	Peaty sulphuric gley soils	GUO
Mainly sand in the top 90 cm and electrical conductivity of 0.8 mS/cm or more in the top 60 cm.	Sandy-saline sulphuric gley soils	GUSQ
Other soils	Typic sulphuric gley soils	GUT
Tephric Gley Soils		**GT**
Tephric Gley Soils occur in unconsolidated sediment of volcanic origin including ash, cinders, lapilli, pumice and other pyroclastics.		
Tephric Gley Soils that have a peaty topsoil either at the surface or buried with its upper surface within 60 cm of the soil surface.	Peaty Tephric Gley Soils	GTO
Other soils that have pH of less than 5.5 in some part from the bottom of the topsoil to 60 cm from the soil surface.	Acidic Tephric Gley Soils	GTA
Other soils	Typic Tephric Gley Soils	GTT
Sandy Gley Soils		**GS**
Sandy gley soils occur in sand deposits which are usually Aeolian, but may also be of alluvial origin. Subsoil horizons are sand or loamy sand.		
Peaty topsoil or buried peat within 60 cm.	Peaty sandy gley soils	GSO
Electrical conductivity of 0.8 mS/cm or more within 60 cm of the surface.	Saline sandy gley soils	GSQ
More than 2% concretions in some horizon at 60 cm or less.	Concretionary sandy gley soils	GSC
pH less than 5.5 in some part between the bottom of the topsoil and 60 cm.	Acidic sandy gley soils	GSA
Other soils	Typic sandy gley soils	GST
Oxidic Gley Soils		**GX**
Oxidic gley soils have variable charge and low activity clays dominated by kaolin.		
Oxidic gley soils that have a nodular horizon within 60 cm of the soil surface.	Nodular Oxcidic gley soils	GXN
Other soils	Typic Oxcidic gley soils	GXT

Soil Group	Subgroup	NZSC code
Recent Gley Soils		**GR**
Recent gley soils occur on young land surfaces, usually in fluvial or estuarine sediments. In many sites there is a significant flood risk.		
Peaty topsoil or buried peat within 60 cm.	Peaty recent gley soils	GRO
Are moderately or very fluid within 60 cm of the surface	Fluid recent gley soils	GRF
Electrical conductivity of 0.8 mS/cm or more within 60 cm of the surface.	Saline recent gley soils	GRQ
Calcareous horizon or a shelly layer within 60 cm.	Calcareous Recent gley soils	GRC
pH less than 5.5 in some part between the bottom of the topsoil and 60 cm.	Acid recent gley soils	GRA
Other soils	Typic recent gley soils	GRT
Acid Gley Soils		
Acid gley soils occur on relatively stable land surfaces, and have been subject to a fluctuating groundwater table, or a deep layer of perched water. Plants are susceptible to aluminium toxicity.		
Peaty topsoil or buried peat within 60 cm.	Peaty acid gley soils	GAO
Clayey, moderately or strongly pedal with clay coatings and aggregates 20 mm or less in the majority of the subsoil to 60 cm depth.	Granular acid gley soils	GAG
Subsoil with 10% or more clay or humus coatings and less silt than clay.	Ultic acid gley soils	GAY
A placic (iron pan)horizon and a subsoil horizon with 10% or more dark-coloured coats on aggregates, in pores or on gravel, with moist colour value 4 or less or colour value 5 and chroma 3.	Placic-humose acid gley soils	GAPH
A subsoil horizon with 10% or more dark-coloured coats on aggregates, in pores or on gravel, with moist colour value 4 or less or colour value 5 and chroma 3.	Humose acid gley soils	GAH
Other soils	Typic acid gley soils	GAT
Orthic Gley Soils		**GO**
Orthic gley soils occur on relatively stable land surfaces in sites affected by groundwater. Sediment deposition is unlikely if flooding occurs. They are not strongly acid, sandy or sulphuric and have no Oxcidic horizon.		
Peaty topsoil or buried peat within 60 cm.	Peaty orthic gley soils	GOO
Electrical conductivity of 0.8 mS/cm or more within 60 cm of the surface.	Saline orthic gley soils	GOQ

Soil Group	Subgroup	NZSC code
Calcareous horizon within 60 cm of the surface.	Calcareous orthic gley soils	GOC
Ironstone layer at 90 cm or less from the surface.	Ironstone orthic gley soils	GOI
A subsoil with the major part to 60 cm or to its base (whichever is less) has strong structure, is sticky or very sticky and has pH 5.9 or more.	Melanic orthic gley soils	GOE
Soils with a clay rich argillic horizon.	Argillic orthic gley soils	GOJ
pH less than 5.5 in some part between the bottom of the topsoil and 60 cm.	Acidic orthic gley soils	GOA
Other soils	Typic orthic gley soils	GOT

Simple guide to Organic soils

Organic Soils are soils that occur in the partly decomposed remains of wetland plants (peat) or forest litter. Mineral soil material is commonly present but organic soil material is dominant. The soils occur in sites where rates of organic-matter decomposition are balanced or exceeded by rates of plant biomass production and accumulation.

Organic Soils occur in wetlands in most parts of New Zealand or under forest-produced acid litter in areas with high precipitation.

ACCESSORY PROPERTIES OF THE ORDER

i Low bulk density. Bulk densities are very low, usually in the range of 0.03 to 0.4 mg/m3. Organic Soils may contain up to 70% organic matter. Too few data are yet available to allow mineralogy classes to be stated.

ii High cation exchange capacity. The organic components of Organic Soils have high surface area, and high negative charge that varies markedly with pH. CEC values are very high, mostly ranging from 40 to 170 cmol/kg.

iii High carbon/nitrogen ratios. C /N ratios range from 18 to as high as 70 in unfertilised and uncultivated Organic Soils.

iv Low bearing strength. Construction of buildings or roads requires special foundation design.

v Very low thermal conductivity. Soils warm and cool slowly. Bare soil surfaces, however, have high radiance.

vi High shrinkage potential. The soils shrink markedly upon drying, and loose organic matter due to oxidation. Consequently, following drainage, the classification may change.

vii High total available-water capacity. While total available-water capacity is high, plant-available-water capacity may only be moderate.

viii Common nutrient deficiencies. The major nutrients nitrogen, phosphorus, potassium and sulphur, and the trace elements copper, selenium and molybdenum, are frequently deficient for crops and pasture.

ix Peats are very poorly drained, litters are variable. Organic Soils formed in peats are very poorly drained and those formed from litters may range from well drained to very poorly drained.

Soil Group	**Subgroup**	**NZSC code**
Litter Organic Soils		**OL**
Litter Organic Soils occur under forest beneath a canopy of acid litter or mor-forming species. The organic material is derived predominantly from leaves and twigs and is normally not saturated except for a few days following heavy rain.		
Soils in which a reductimorphic horizon, occurs at less than 30 cm beneath the upper surface of the underlying mineral soil.	Buried-gley Litter Organic Soils	OLBG
Fibric Organic Soils		**OF**
Fibric Organic Soils occur in sites that are saturated to the surface for extended periods (or in sites that have been artificially drained) in which the peat materials are only weakly decomposed. The wetland plant constituents are so little decomposed that their botanic origin may be readily determined and fibres are not destroyed by rubbing.		
Organic fibres, to a depth of 60 cm from the soil surface, or to the base of organic soil material if shallower, are more than 70% *Sphagnum* species.	Sphagnic Fibric Organic Soils	OFS
Soils in which the organic soil material to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.	Acid Fibric Organic Soils	OFA
Other soils	Mellow Fibric Organic Soils	OMF
Mesic Organic Soils		**OM**
Mesic Organic Soils occur in very wet sites (or in sites that have been artificially drained) in which the peat materials are moderately decomposed. The remains of up to two-thirds of the original wetland plants that make up the bulk of the soil are unrecognisable or are largely destroyed by rubbing between the fingers.		
Organic soil material to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.	Acid Mesic Organic Soils	OMA
Other soils	Mellow Mesic organic soils	OMM

Soil Group	Subgroup	NZSC code
Humic Organic Soils		**OH**
Humic Organic Soils occur in very wet sites (or in sites that have been artificially drained). The peat materials are strongly decomposed to the extent that the original wetland plant remains cannot be recognised throughout most of the soil profile.		
Organic soil material to a depth of 60 cm from the soil surface, or to its base if shallower, has pH of 4.5 or less throughout the major part.	Acid Humic Organic Soils	OHA
Other soils	Mellow Humic Organic Soils	OHM

Other soils

Hydric soils occur in other soil orders of the New Zealand Soil Classification. They are mainly the result of a slowly permeable or impermeable lower subsoil layer impeding downward drainage of water. This causes the water to perch on the slow permeability layer and saturate the upper soil. These Perch-gley soils occur in most soil orders.

Allophanic Soils

Soil Group	Subgroup	NZSC code
Perch-gley Allophanic Soils		**LP**
Perch-gley Allophanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by brownish or reddish mottles. The wetness is caused by the perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.		
Perch-gley Allophanic Soils that have an ironstone-pan within 90 cm of the mineral soil surface.	Ironstone Perch-gley Allophanic Soils	LPI
Other soils	Typic Perch-gley Allophanic Soils	LPT
Gley Allophanic Soils		**LG**
Gley Allophanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by brownish or reddish mottles. The wetness is caused by a groundwater-table.		
Gley Allophanic Soils that have peaty topsoil.	Peaty Gley Allophanic Soils	LGO
Other soils	Typic Gley Allophanic Soils	LGT

Granular Soils

Soil Group	Subgroup	NZSC code
Perch-gley Granular Soils		**NP**
Perch-gley Granular Soils occur in sites that are periodically saturated (if undrained). Wetness and associated reducing conditions are indicated by grey colours and reddish mottles. The wetness is caused by perching of water on a clay-enriched slowly permeable layer, although a groundwater-table may also be present.		
Perch-gley Granular Soils that have a cutanoxidic horizon more than 30 cm thick with an upper boundary below 25 cm from the mineral soil surface.	Oxidic Perch-gley Granular Soils	NPX
Other soils that have pH 5.1 or less in some part of the subsoil to 60 cm from the mineral soil surface.	Acidic Perch-gley Granular Soils	NPA
Other soils	Typic Perch-gley Granular Soils	NPT

Melanic Soils

Soil Group	Subgroup	NZSC code
Perch-gley Melanic Soils		**EP**
Perch-gley Melanic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by grey colours in horizons subjacent to the topsoil, and is caused by perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.		
Perch-gley Melanic Soils that have either 1. cracks at least 4 mm wide in some part, either in the subsoil and infilled with topsoil material, or open to a depth of 30 cm or more, from the mineral soil surface, or 2. coefficient of linear expandability of 0.09 or more with moderate or strong, blocky or prismatic soil structure in the major part of the subsoil.	Vertic Perch-gley Melanic Soils	EPV
Other soils with an argillic horizon.	Argillic Perch-gley Melanic Soils	EPJ
Other soils	Typic perch-grey Melanic soils	EPT

Oxcidic Soils

Soil Group	Subgroup	NZSC code
Perch-gley Oxcidic Soils		**XP**
Perch-gley Oxidic Soils occur in sites that are periodically saturated (unless artificially drained). Wetness and associated reducing conditions are indicated by grey colours, and are caused by perching on a slowly permeable layer.		
Perch-gley Oxidic soils that have a nodular layer with an upper boundary within 60 cm of the mineral soil surface.	Nodular Perch-gley Oxidic Soils	XPN
Other soils	Typic Perch-gley Oxidic Soils	XPT

Pallic Soils

Soil Group	Subgroup	NZSC code
Perch-gley Pallic Soils		**PP**
Perch-gley Pallic soils occur in sites that are periodically saturated (if undrained) in winter and spring, but dry out in summer. The wetness and associated reducing conditions are indicated by grey colours on ped surfaces in horizons subjacent to the topsoil. Wetness is caused by perching of water on a slowly permeable subsurface layer, e.g. a fragipan, argillic horizon, duripan, some combination of these horizons or other slowly permeable layer. The reductimorphic horizons are commonly acidic (pH less than 5.5).		
Perch-gley Pallic Soils that have a duripan.	Duric Perch-gley Pallic Soils	PPU
Other soils that have both an argillic horizon and a fragipan.	Argillic-fragic Perch-gley Pallic Soils	PPJX
Other soils that have a fragipan.	Fragic Perch-gley Pallic Soils	PPX
Other soils in which the majority of the gravel is weathered and can easily be broken with a spade, and have an argillic horizon.	Weathered Argillic Perch-gley Pallic Soils	PPWJ
Other soils that have an argillic horizon.	Argillic Perch-gley Pallic Soils	PPJ
Other soils that have a horizon that is cemented to the degree that it is at least weakly indurated, within 90 cm of the mineral soil surface.	Cemented Perch-gley Pallic Soils	PPC
Other soils	Typic Perch-gley Pallic Soils	PPT

Podzol Soils

Soil Group	Subgroup	NZSC code
Perch-gley Podzol Soils		**ZP**
Perch-gley Podzols occur in periodically or predominantly saturated sites (unless artificially drained) in which wetness is indicated by grey colours along with brownish or reddish mottles or peaty topsoils. The wetness is caused by the perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.		
Perch-gley Podzols that have a moderately fluid or very fluid in some part above the podzolic-B horizon.	Fluid Perch-gley Podzols	ZPF
1. an E horizon that (a) has slightly firm or greater moist soil strength, and (b) is apedal massive or has very coarse to coarse prismatic soil structure, and (c) occurs within a layer that is silty through a thickness of at least 15 cm, and 2. a peaty topsoil.	Peaty-silt-mantled Perch-gley Podzols	ZPOZ
Other soils that have an E horizon that has slightly firm or greater moist soil strength, has few cracks or has very coarse to extremely coarse prismatic soil structure, and occurs within a layer that is silty through a thickness of at least 15 cm.	Silt-mantled Perch-gley Podzols	ZPZ
Other soils that have a humus-pan.	Humus-pan Perch-gley Podzols	ZPU
Other soils that have a Bh horizon thicker than 5 cm, and an ortstein horizon.	Humose-ortstein Perch-gley Podzols	ZPHQ
Other soils that have a Bh horizon thicker than 5 cm, and a placic horizon.	Humose-placic Perch-gley Podzols	ZPHP
Other soils that have a Bh horizon thicker than 5 cm.	Humose Perch-gley Podzols	ZPH
Other soils with an ortstein-pan.	Ortstein Perch-gley Podzols	ZPQ
Other soils that have a placic horizon.	Placic Perch-gley Podzols	ZPP
Other soils	Typic Perch-gley Podzols	ZPT
Groundwater-gley podzols		**ZG**
Groundwater-gley Podzols occur in periodically or predominantly saturated sites (unless artificially drained) in which the wetness is indicated by brownish or reddish mottles or peaty topsoils. The wetness is caused by a groundwater-table.		

Soil Group	Subgroup	NZSC code
Groundwater-gley Podzols that have a Bh horizon thicker than 5 cm.	Humose Groundwater-gley Podzols	ZGH
Other soils	Typic Groundwater-gley Podzols	ZGT

Pumice Soils

Soil Group	Subgroup	NZSC code
Perch-gley Pumice Soils		**MP**
Perch-gley Pumice Soils occur in periodically saturated sites (unless artificially drained) in which wetness is indicated by grey colours along with brownish or reddish mottles. The wetness is caused by perching of water on a slowly permeable subsurface layer, although a groundwater-table may also be present.		
Perch-gley Pumice Soils with a duric horizon within 90 cm of the mineral soil surface.	Duric Perch-gley Pumice Soils	MPU
Other soils	Typic Perch-gley Pumice Soils	MPT

Raw Soils

Soil Group	Subgroup	NZSC code
Gley Raw Soils		**WG**
Gley Raw Soils occur in sites that are periodically or permanently flooded. Wetness is expressed in the soil by grey colours with brownish or reddish mottles, by water saturation or is indicated by a chemical test for the presence of reduced iron.		
Moderately or very fluid at some depth less than 30 cm and low pH (more than 4.0 and pH in boiling hydrogen peroxide less than 3.0) within 90 cm.	Fluid-sulphidic Gley Raw soils	WGFU
Other soils that have low pH within 90 cm from the mineral soil surface.	Sulphidic Gley Raw Soils	WGU
Within 30 cm are moderately fluid or very fluid and electrical conductivity of 0.8 mS/cm or more.	Fluid-saline Gley Raw Soils	WGFQ
Other soils that within 30 cm of the mineral soil surface have electrical conductivity of 0.8 mS/cm or more.	Saline Gley Raw Soils	WGQ
Other soils that within 30 cm of the surface have moderately fluid or very fluid fluidity class.	Fluid Gley Raw Soils	WGF

Other soils that have sand or loamy sand texture and that have less than 35% gravel (by volume) in all horizons, from the soil surface to 60 cm depth or more.	Sandy Gley Raw Soils	WGS
Other soils	Typic Gley Raw Soils	WGT

Ultic Soils

Soil Group	**Subgroup**	**NZSC code**
Perch-gley Ultic Soils		**UP**
Perch-gley Ultic Soils have seasonal wetness close to the soil surface, indicated by grey colours in horizons immediately beneath the topsoil. The topsoil is clayey and strongly buffered. The wetness is caused by perching on a clayey slowly permeable layer, although a groundwater table may also occur.		
Soils that have more than 60% sand in the subsoil.	Sandy Perch-gley Ultic Soils	UPS
Other soils that have a reductimorphic horizon with an upper boundary within either 15 cm of the base of the topsoil, or 30 cm of the mineral soil surface.	Typic Perch-gley Ultic Soils	UPT
Densipan Ultic Soils		**UD**
Densipan Ultic Soils have a high density but un-cemented pan at shallow depth which severely limits root penetration and water movement. Surface soil horizons are seasonally wet and the soil is very susceptible to livestock treading damage.		
Soils that have a reductimorphic horizon below the densipan.	Perch-gleyed Densipan Ultic Soils	UDP
Other soils that have a redox-mottled horizon immediately underlying the densipan.	Mottled Densipan Ultic Soils	UDM