Soils of McRae Trust Farm

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Contents

Summary

Project and client

Landcare Research was contracted by the McRae Trust to prepare a soil map of the McRae Trust Farm (614 ha), Frasertown, at an approximate scale of 1:10 000. Preparation of the soil map forms part of a larger project, funded by the Sustainable Farming Fund, administered by the Ministry of Agriculture and Forestry. After completion of the soil map, a land-use capability survey of the farm will be made, and these maps will contribute to the establishment of land management units, with a view to exploring both present and potential alternative land uses. Extension of the findings to farmers throughout the wider community is considered important by the funding provider and the McRae Trust.

Objectives

- Complete a survey of soils and prepare a soil map of the McRae Trust farm, Frasertown, at an approximate scale of 1:10 000.
- Prepare a report to describe the soils mapped.

Methods

- Soil survey followed standard procedures outlined in Milne et al. (1995)
- Soil map unit boundary and mapping unit data were put into the GIS and a soil map produced at an approximate scale of 1:10 000.

Results

The farm is divided into four major landforms and associated soils:

- Low river terraces and fans, on north-western margin along the Wairoa River and southern margin along the Kauhauroa Stream, where soils are developed from alluvium from sedimentary rocks and tephra. Poorly drained Gley Soils (Awamate soils) dominate, but there are well-drained Recent Soils (Waihirere soils). A very small area has moderately well-drained Waipaoa soils developed from Cyclone Bola (1988) sediments.
- Intermediate gently sloping terraces, abutting hills along the north-western margin. The gentle slopes have encouraged the survival of airfall tephra, giving coarse sandy Pumice Soils (Mohaka soils) from Taupo and Waimihia tephra, overlying older undifferentiated weathered tephra and loessic material. These soils are poorly drained due to perching of water over slowly permeable layers.
- Hill country. This lies mostly on the southern margin, and rises from the river flats of the Kauhauroa Stream. As much as 1 m depth of tephra remains on the easier hill country slopes, and Pumice Soils (Gisborne soils) are recorded here, but in other areas most of the tephra has been removed to give Pallic Soils (Pouawa and Pakarae) from siltstone. A veneer of Taupo tephra remains in topsoils of the Pallic Soils.
- Steepland. Half the farm is steep and seriously affected by landslide erosion. Soils are developed on siltstone, rather than tephra. Soils are highly variable over short distances (with eroded/uneroded soils in close proximity), but are broadly similar over the whole terrain, being mainly Recent Soils from siltstone (Mahoenui shallow phase, steepland soils) or siltstone with a veneer of Taupo tephra (Hangaroa steepland soils).

1. Introduction

Landcare Research was contracted by the McRae Trust to prepare a soil map of the 614 ha McRae Trust Farm (Fig. 1), Frasertown, at an approximate scale of 1:10 000.

Preparation of the soil map forms part of a larger project, funded by the Sustainable Farming Fund (and administered by the Ministry of Agriculture and Forestry). After completion of the soil map, a land-use capability survey of the farm will be made, and a map that defines land management units will follow this. This will explore both present and potential alternative uses. Extension of the findings to farmers throughout the wider community is considered important by the funding provider and the McRae Trust. The Trust is keen to raise the profile of soils among farmers of the district, and it plans to hold field days to explain soils on the Trust farm as revealed by the present soil survey.

Previously, soil information was taken from a soil map of part Tiniroto–Wairoa area produced at a scale of 1:100 000 (Rijkse 1978) and from the accompanying report (Rijkse 1979). In accordance with the general scale of this soil information, just four soil map units (at the series level) covers the area of the Trust farm, and modal profile descriptions for these were taken well away form the farm. It was clear to the Trust that farm-specific soils information was required, and for this to be delivered at a scale suitable to meet the detailed farm planning aims of the larger project.

2. Objectives

- Complete a survey of soils and prepare a soil map of the McRae Trust Farm, Frasertown, at an approximate scale of 1:10 000.
- Prepare a report describing the soils mapped.

3. Methods

- Landforms were identified in the field and by reference to stereo-pairs of aerial photographs.
- Soil profiles were described in each of the landforms, and access to the profiles was gained by digging a 40x40 cm hole to at least 70 cm depth. Track and road-cut banks were used for checking, rather than for making descriptions.
- Soil profile descriptions were compared with previously described and mapped soils from Rijkse (1978, 1979) and with likely candidate soil sets from New Zealand Soil Bureau (1954). Soil names from these existing information sources were chosen.
- Soil map units were defined according to their expression in the farm property.
- A small number of tests were carried out to confirm technical soil classifications according to the New Zealand Soil Classification (Hewitt 1998). These were pH in water (to identify possible acidic soil subgroups), and particle-size distribution of topsoils (to identify vitric soil material and to confirm field determinations of topsoil texture).
- Soil map unit boundaries were identified by viewing stereo-pairs of aerial photographs of the farm and by reference to detailed field notes and soil profile descriptions. The boundaries

were transferred from the aerial photographs by eye to a 1:5000 scale photo-base map and then georeferenced (in ARCGIS) to the New Zealand Map Grid, to create a transformed aerial photograph base map.

- Soil map unit boundary and map unit data were put into a GIS and a soil map produced at an approximate scale of 1:10 000.

4. Results

4.1 Location

The McRae Trust farm lies between Highway 36 and Mangapoike Road about 500 m from Frasertown, northern Hawke's Bay (see location map). The 614 ha farm has river flats and easy sloping intermediate terraces, but about 80% of it comprises moderately steep to steep hill country that rises from the river flats at 20 m a.s.l. to 230 m a.s.l. The Wairoa River forms the north-western boundary and the southern boundary follows the Kauhauroa Stream.

4.2 Climate

Mean annual rainfall at Frasertown is 1450 mm, and while there are frequent summer dry spells and rare droughts, rainfall is reasonably well spread throughout the year. The high probability of receiving high intensity rainstorms causes concern, given the moderately steep to steep and erosion-prone nature of the farm. Mean annual air temperature ranges from summer highs about 19^o to a winter lows at about 9^o. Twenty-one ground frosts occur during the year, and most occur during the months of May through to September.

4.3 Landform and parent material

Landform

Parent materials of soils are divided into alluvium, tephra and siltstone. Each is associated with, but not necessarily exclusive to, one of four broad landforms where certain soils are anticipated:

Low river terraces and fans: This is low country along the north-western margins beside the Wairoa River, and along the southern margin beside the Kauhauroa Stream, forming wide floodplain surfaces. Merging with these are low-angle fans (at about 3^o of slope) that emerge subtly from first or second-order hill country and steepland stream valleys.

Intermediate gently sloping terraces: Best examples are the 'bull' paddocks along the north-western margin and can be seen clearly from the 'beef units lane'. Gently inclined terrace surfaces (at 3^o) have encouraged the survival of airfall tephra.

Hill country: This occurs mainly on the southern margin, and rises toward the steepland from the river flats of the Kauhauroa Stream. Most slopes are between 16^o and 25^o. Some slopes are stable and carry at least 1 m depth of tephra deposits over siltstone (seen best in the 'point' paddock area of the farm). In other areas, tephra deposits have been removed by erosion, and soils are developed from siltstone. A shallow veneer of Taupo ash and lapilli may remain, but only where slopes have not experienced landslides.

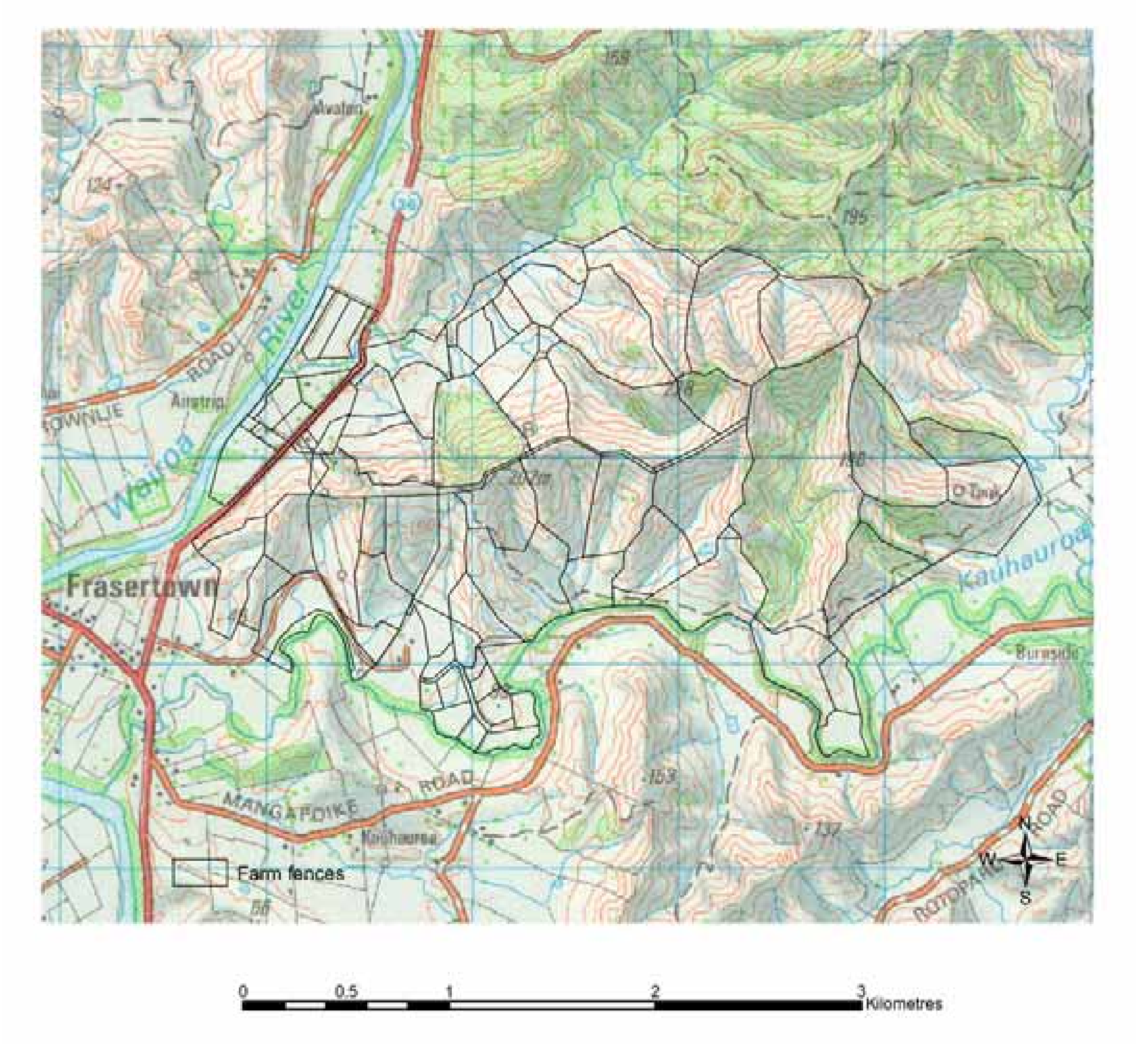

Fig. 1. McRae Trust Farm

Steepland: About half of the farm comprises steep and very steep slopes (slopes > 25°) and most of this is seriously affected by past landslide-producing storms. Because the tephra has been removed, most soils are developed from the underlying siltstone. Soils are highly variable over short distances because of intricate patterns of dissection and erosion, but are broadly consistent over the entire steepland landform unit. The steepland is so affected by landslides, an eroded phase of the Mahoenui steepland soil was required.

Parent material

Alluvium: Alluvium is derived from the erosion of soil and rock material from more elevated parts of the catchments. It is derived from sedimentary rock (mainly siltstone) and pumiceous tephra. The alluvium occurs on the wider river flats on the northwest border (Wairoa River floodplain) of the farm and along the southern border (Kauhauroa Stream), in narrower valleys of smaller streams in hill country and steepland, and on gently sloping fans. Most alluvium is very silty (topsoils usually contain about 60% silt), but is sandier on levees near the present day stream/river courses.

Tephra: Tephra deposits from the Taupo and Rotorua regions fell over the entire area as 'airfall tephra'. Erosion subsequently removed most of it from the hill country and steepland, leaving just the easiest hill slopes and terraces with the original deposits. Two important tephra beds are Taupo Pumice Formation (1850 years old) and Waimihia Formation (3280 years old). The Waimihia beds are underlain by older tephras such as the Rotoma (8530 years old) and Waiohau (11850 years old), but these remain undifferentiated in this survey. Loess (wind-blown silts) occurs with these older tephra, but is likewise undifferentiated.

Taupo Pumice materials are recognised in topsoil horizons on the farm as a few, fine, pale yellow soft gravels in a silty matrix, blackening soil colours and weakening the soil structure. Waimihia material comprises the highly distinctive loose, uniform, rounded, strongly coloured (usually brownish yellow) pumice gravel in subsoils. Waimihia components can be mixed together with the younger Taupo material in topsoils. The tephra generally results in slightly more coarsely textured topsoils than subsoils, but both parts of soil profiles are predominantly silty.

Siltstone: Grey, massive siltstone forms the parent material for most hill country and steepland soils. In the "Geology of the Raukumara area" (Mazengarb & Speden 2000) this material is described as "undifferentiated fossiliferous mudstone and tuffaceous sandstone", of young age in geological time (early to late Pliocene, or 5.3 to 1.8 million years old). The siltstone beds (no tuffaceous sandstone seen) appear to dip gently away to the southeast, giving exposure to the older (early Pliocene) siltstone in most of the steepland paddocks north of 'ridgetop track', and the younger (late Pliocene) material south of ridgetop track. The attitude of 'scamperdown 3' reflects a dip angle there of about 8^{o}. There is a prominent thin band of Tahaenui Limestone (described by Mazengarb & Speden as "sandy, shelly limestone and calcareous sandstone") about two-thirds of the way upslope in the steepland paddocks north of ridgetop track. The calcareous sandstone (no shelly limestone seen) was judged to have a very local impact on soil properties at the mapping scale (that is, influences not seen beyond the immediate environs of the outcropping rock).

4.4 Soil legends

Soils arranged physiographically

Soils of the low river terraces and fans

Rapidly accumulating

Ya	Waipaoa sandy loam
Yaf	Waipaoa sandy loam, raw variant

Slowly accumulating, non-gleyed

Yh	Waihirere silt loam

Slowly accumulating, gleyed

Aw	Awamate silt loam
Awg	Awamate silt loam, fan variant

Soil of the intermediate terraces

Mo	Mohaka loamy sand

Soils of the hill country

Gi	Gisborne loamy sand
GiH	Gisborne loamy sand, hill soil
PwH	Pouawa silt loam, hill soil
PcH	Pakarae silt loam, hill soil
PcH*	Pakarae complex

Soils of the steepland

HaS	Hangaroa silt loam, steepland soil
MeSe	Mahoenui silt loam, shallow phase, steepland soil

Soils arranged pedologically

Raw Soils

Fluvial Raw Soils

Yaf	Waipaoa sandy loam, raw variant

Recent Soils

Fluvial Recent Soils

Ya	Waipaoa sandy loam
Yh	Waihirere silt loam

Orthic Recent Soils

HaS	Hangaroa silt loam, steepland soil
MeSe	Mahoenui silt loam, shallow phase, steepland soil

Gley Soils

Recent Gley Soils

Aw	Awamate silt loam
Awg	Awamate silt loam, fan variant

Orthic Gley Soils

PcH*	Pakarae complex

Pumice Soils

Perch-gley Pumice Soils

Mo	Mohaka loamy sand

Orthic Pumice Soils

Gi	Gisborne loamy sand
GiH	Gisborne loamy sand, hill soil

Pallic Soils

Immature Pallic Soils

PwH	Pouawa silt loam, hill soil
PcH	Pakarae silt loam, hill soil

4.5 Soil distribution

Soil areas summary table

Table 1 lists the soil map units and the areas covered.

Table 1 Soil map units and areas

Soil map units	Area of map unit (ha)	Area of map unit (%)	Area of dom. soil (ha)	Area of dom. soil (%)
Ya	6	1.0	8	1.3
Ya+Yh	2	0.3		
Yaf+PwH	4	0.7	4	0.7
Yh	24	3.9	24	3.9
Aw	28	4.5	33	5.4
Aw+Yh	6	0.9		
Awg	16	2.6	16	2.6
Mo	29	4.8	33	5.4
Mo+PwH	4	0.6		
Gi	8	1.3	12	1.9
Gi+Awg	2	0.3		
Gi+GiH	2	0.3		
GiH	16	2.5	66	10.8
GiH+Gi	4	0.6		
GiH+PwH	47	7.6		
PwH	45	7.4	53	8.6
PwH+GiH	4	0.7		
PwH+Mo	2	0.3		
PwH+Yh	2	0.3		
PcH	40	6.5	40	6.5
PcH*	14	2.3	14	2.3
MeSe	4	0.6	310	50.6
MeSe+HaS	307	49.9		
Pond	1	0.1	1	0.1
Total	614	100.0	614	100.0

Soils of the farm in summary

Half the farm comprises Mahoenui and Hangaroa steepland soils developed from massive siltstone, with a significant veneer of Taupo tephra in Hangaroa topsoils. Mahoenui soils occur where landslides have substantially affected the land surface (an eroded phase of this soil was required), while Hangaroa soils occur on the relatively stable ridges and spurs. Included are unnamed Rocky Raw Soils developed on landslide scars, and as much as 25% of the land surface is likely to have these. While a certain amount of erosion event-resistance has been built into the landscape by successive storms since deforestation (scar surfaces are unlikely to eroded further) there is considerable opportunity for further soil loss.

Hill country around the margins of the steepland is evenly divided between slopes that have retained a significant thickness of tephra (Gisborne soils—11%) and slopes where tephra is largely absent (Pouawa and Pakarae soils—15%) except for a veneer of Taupo tephra. Pouawa soils are best considered hill country versions of both Hangaroa and Mahoenui steepland soils, while

Pakarae soils are recorded in the more slumpy/flowy siltstone terrain. The three hill country soils are well drained (except for flow debris in Pakarae soil) and provide opportunities for intensification of hill country farming. Gisborne soils provide the most favourable land. An advantage of Gisborne soils is that they offer easily manageable slopes with soils that are well drained and able to withstand animal hoof pressures better than most other more poorly drained soils. They are least affected by past erosion. Phosphate fixation is high in the Gisborne soils due to the mixing of Waimihia tephra (with very high P-fixation properties) and Taupo tephra (low P-fixation). Gisborne soils require different fertilization management from the other soils and this may involve different types of fertilizer, different application rates and schedules.

A sloping south-facing elevated platform in the central hill and steeplands has the Pakarae soil complex. These easier slopes promised much in terms of land-use intensification, but the scope for development is hampered by poor soil drainage. The complex recognises that most of its area has poorly drained soils from soft mudstone, but there are mini-hillocks (remnants) of soils from tephra with slightly better drainage.

Mohaka soils are recorded on the intermediate terraces of the ‘bull’ paddocks and in ‘scamperdown 3’. These are important soils for the mainly hill and steepland farm (covering 33 ha, 5%), largely because they are easily accessible and have slopes less than about 8^{o}. They remain limited by poor soil drainage. Poor drainage results from perching of groundwater on a pan deep in the subsoil, which lies on slowly permeable siltstone bedrock. Effective drainage seems infeasible, given the intrinsic nature of these causes. Use of cut-off drains at the intersections of the terraces with the adjacent hilly land may be locally beneficial. The full impact of poor drainage is, however, somewhat mitigated by sandy soil texture, tephric-composition, and well-developed and rather deep topsoil, giving a measure of resistance and resilience from soil compaction effects from heavy stock.

Soils of the low river terraces and fans along southern and north-western margins of the farm offer an obvious physiographic contrast to the central hills and steepland. There are opportunities for productivity gains on this accessible and favourably sloping land. Waihirere soils are the most versatile, being well-drained soils from alluvium and Waimihia tephra. They are able to sustain heavy hoof traffic and cultivation for cropping if soils are not too wet or too dry. They cover just 24 ha (4% of the farm). Other soils of the low river terraces and fans (Awamate silt loams and a fan variant) are poorly drained, and cover most of these low surfaces (50 ha, 8% of the farm). Waipaoa soils (well drained, with a few topographic lows imperfectly drained) covers just 8 ha in the south-western corner, where March 1988 Cyclone Bola sediments are preserved. Sustainable productivity gains over the lowland may come predominantly from drainage improvements to Awamate soils (and the Awamate fan variant).

In summary, the best opportunities for fastest and sustainable productivity gains will come from the best soils, and these are Gisborne and Waihirere soils. In the longer term, sustainable land-use intensification (development without harming environmental values) will come from the low river terraces if effective drainage can be achieved on Awamate soils. Mohaka soils could be improved by drainage, but the scope for this appears to be limited by their intrinsic properties.

5. Conclusions

- Half the farm comprises Mahoenui and Hangaroa steepland soils developed from massive siltstone, with a significant veneer of Taupo tephra in Hangaroa topsoils. Past and likely future storm-driven landsliding provides natural limitations for the use-potential of this land, even though some event-resistance has been built by successive storms.

- Hill country around the margins of the steepland is divided between slopes that have retained a significant thickness of tephra (Gisborne soils—11% of the farm) and slopes where tephra is largely absent (Pouawa and Pakarae soils—15%) except for a veneer of Taupo tephra in these latter two soils. Gisborne soils offer immediate and sustainable opportunities for productivity gains.

- Mohaka soils are recorded on the intermediate terraces of the 'bull' paddocks and in 'scamperdown 3'. These are important soils for the mainly hill and steepland farm (covering 33 ha, 5%) largely because they are easily accessible and have slopes less than about 8^{o}. However, they remain somewhat limited by having poor soil drainage, and this condition may be difficult to remedy due to the presence of slowly permeable layers deep in the subsoils. The full impact of poor drainage is mitigated to some extent by sandy soil texture, tephric-composition, and well-developed and rather deep topsoil, giving a measure of resistance and resilience from soil compaction effects from heavy stock.

- The well-drained soils (Waihirere silt loams) of the low river terraces and fans along southern and north-western margins of the farm provide early and sustainable opportunities for productivity gains, although they cover just 24 ha (4% of the farm). Other soils of the low river terraces and fans (Awamate silt loams and a fan variant) are poorly drained, and these cover most of these low surfaces (50 ha, 8% of the farm). Sustainable productivity gains here will come mainly from making improvements to drainage.

6. Acknowledgements

Peter Manson (Hawkes Bay Regional Council) facilitated this project on behalf of the Trust and provided the local organisation required to make the fieldwork run smoothly. Fenton Wilson (project leader for the McRae Trust) and Peter Manson assisted in the field. Farm manager Ray Aires provided useful insights into the soils and their management history.

Landcare Research colleagues are thanked for their contributions: Wim Rijkse for early discussions about likely soil units, Malcolm McLeod for peer review, Anne Austin for editing, and Jemma Callaghan for formatting. Gareth Salt tested selected samples in the laboratory. Sarah Pitcher-Campbell provided GIS services, including map production, with helpful advice from Peter Newsome and Janice Willoughby.

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8. Appendices

Appendix 1 Abundance and size classes used in soil profile descriptions

Table 1 For mottles, macrofabric terms (such as describing the nature of aggregated material), and roots

Size class (mm)		**Abundance class**	
extremely fine	1–2	very few	<2%
very fine	2–6	few	2–10%
fine	6–10	common	10–25%
medium	10–20	many	25–50%
coarse	20–60	abundant	50–75%
very coarse	60–100	profuse	>75%

Table 2 For gravels (primary particles with a diameter >2 mm)

Size class (mm)		**Abundance class**	
fine gravel	2–6	non-gravelly	<1%
medium gravel	6–20	very slightly gravelly	1–5%
coarse gravel	20–60	slightly gravelly	5–15%
very coarse gravel	60–200	moderately gravelly	15–35%
		very gravelly	35–70%
		extremely gravelly	>70%

Table 3 Degree of pedality

Degree of pedality class	**Percentage material comprising peds**
weakly	15–25%
moderately	25–75%
strongly	>75%

Appendix 2 Soil profile descriptions

Pedons considered to be representative of the key soils in the major landforms were selected for detailed field description. Eight of the 13 soil taxonomic units have been previously described from other locations in the area (Rijkse 1979) but are re-presented here in modified form to reflect the specific nature of soil individuals on the farm. Differences for the eight are considered to be within the expected range of variation for the series.

Soil classifications according to the New Zealand Soil Classification (Hewitt 1998) are presented for each soil (Order, Group, Subgroup), and these are extended down to the fourth level of the classification to give the soilform (Clayden & Webb 1994). Descriptions follow standard practice according to the 'Soil Description Handbook' (Milne et al. 1995). Tables in Appendix 1 give abundance and size classes.

Soil:	**Waipaoa sandy loam (Ya)**
Derivation	Waipaoa soils (Ya) (Rijkse 1979)
Classification:	Typic Fluvial Recent Soil (RFT); stoneless soils, quartzo-feldspathic; layered sandy/silty; rapid
Location:	Bottom Flat, south-western end. E. 2892839; N. 6239844
Landform/slope:	Low river terraces (lowest parts), slope 1^{o} (at site), 0–2^{o} (typical for soil)
Drainage:	Well
Vegetation:	Improved pasture
Parent Material:	Alluvium from sedimentary rocks and tephra.

Representative profile:

Ap	0–23 cm	brown (10YR 5/3) and light olive brown (2.5Y 5/4) sandy loam; non-sticky; non-plastic; peds very weak with brittle fracture; strongly pedal; many very fine and fine polyhedral (nutty) peds and common medium polyhedral peds; common extremely fine roots; abrupt wavy boundary; (March 1998, Cyclone Bola sediments),
C	23–36 cm	light yellowish brown (10YR 6/4) sand; non-sticky; loose particle packing; peds very weak and friable; weakly pedal; few fine polyhedral peds (nutty); few microfine roots; abrupt wavy boundary; (Cyclone Bola sediments),
bApg	36–76 cm	dark brown (10YR 3/3) to light olive brown (2.5Y 5/4) silt loam; few extremely fine distinct strong brown (7.5YR 4/6) mottles; slightly sticky; slightly plastic; strongly pedal; peds weak with brittle failure; few microfine roots; abrupt wavy boundary; (pre-Bola topsoil, formed in sediments from the 1938 Anzac Day Storm?),
bC	76–110 cm	light olive brown (2.5Y 5/4) sand; non-sticky; non-plastic; peds very weak with brittle failure; loose particle packing; moderately pedal; few fine polyhedral (nutty) peds; no roots; abrupt wavy boundary; (sediments from the 1938 Anzac Day storm?),
2bAp	110 on	dark brown (10 YR 3/3) and light olive brown (2.5Y 5/4) silt loam; slightly sticky; slightly plastic; peds weak with brittle failure; strongly pedal; no

roots; (pre-1938 Anzac Day Storm topsoil?).

Soil: **Waipaoa sandy loam, raw variant (Yaf)**
Derivation New
Classification: Fluvial Raw Soil (WF); stoneless soils, quartzo-feldspathic; layered sandy/silty; rapid
Location: Along the Wairoa River banks
Landform/slope: River bank, 18^o (at site), 15–25^o (typical for soil)
Drainage: Well
Vegetation: Exotic weeds and trees, rank pasture grasses
Parent Material: Alluvium from sedimentary rocks and minor tephra.

Representative profile:

Notes: No representative profile was investigated, but auger inspections reveal fluvial features, a weakly developed and largely apedal A horizon and no B horizon. The soil comprises grey fine sandy material draped onto the Wairoa river banks as lag deposits from high river stages. Upper banks show more soil development (longer time intervals between sedimentation episodes).

Significant associated soils are Pouawa silt loams where lag deposits have not settled, and soils here are developed from siltstone.

Soil: **Waihirere silt loam (Yh)**
Derivation Waihirere soils (Yh) (Rijkse 1979)
Classification: Weathered Fluvial Recent Soil (RFW); tephric, rhyolitic; sandy; rapid
Location: Pear Tree, ≈150 m diagonally from the entrance gate. E. 2893393; N. 6240671
Landform/slope: River terrace leveé (very low amplitude hummocky), slope 1^o (at site), 0–2^o (typical for soil)
Drainage: Well
Vegetation: Improved pasture
Parent Material: Alluvium from sedimentary rocks and rhyolitic tephra (Waimihia lapilli).

Representative profile:

Ap 0–18 cm dark greyish brown (10YR 4/2) silt loam; non-sticky; moderately plastic; peds weak with semi-deformable failure; strongly pedal; many coarse and common medium, fine and very fine polyhedral (nutty) peds; about 1% fine, fresh and rounded gravels (Taupo lapilli); common extremely fine roots; non-reactive to reactive-Al test; abrupt wavy boundary,

Bw 18–40 cm brownish yellow (10YR 6/6) silt loam; non-sticky; moderately plastic; peds weak with semi-deformable failure; strongly pedal; many coarse and common medium fine and very fine polyhedral (nutty) peds; about 1% fine, fresh and rounded gravels (Taupo lapilli); common extremely fine roots; non-reactive to reactive-Al test; abrupt wavy boundary,

2Bw2 40–65 cm brownish yellow (10YR 6/8) sand; non-sticky; non-plastic; non-cohesive, particle packing loose; single grain apedal; >70% fine pumice gravels (Waimihia lapilli); sesquioxide stains on lapilli; strongly reactive to reactive-

Al test; distinct wavy boundary,

2Bw3	65 cm–on	light yellowish brown (10YR 6/4) sand; non-sticky; non-plastic; non-cohesive, particle packing loose; single grain apedal; >70% fine pumice gravels (Waimihia lapilli); sesquioxide stains on lapilli; moderately reactive to reactive-Al test.

Notes: There is variation in the depth of alluvial material over the Waimihia lapilli (from about 40 cm to 103 cm), although 40 cm to 60 cm is normal for these soils. Topsoil textures are usually silt loams, but in a few places loamy silts are found (reflecting that clay percentage has fallen below 19%). Topsoil colours can be darker (e.g., 10YR3/2), and Waimihia lapilli can be either lighter yellowish brown (10YR6/4) or darker brown (10YR5/4), and in a few places, 2.5Y hues are found. Some pedons are somewhat less free draining below about 60 cm depth, with the occurrence of paler colours and ochreous mottles, but an imperfectly drained subsoil phase was not warranted.

Soil:	**Awamate silt loam (Aw)**
Derivation	Awamate soils (Aw) (Rijkse 1979)
Classification:	Typic Orthic Gley Soil (GOT); stoneless soils, quartzo-feldspathic; silty; slow
Location:	Camerons, 10 m from road (across abandoned shallow stream channel). E. 2893081; N. 6239226
Landform/slope:	River terrace (lower parts), slope 0^o (at site), $0–2^o$ (typical for soil)
Drainage:	Poor
Vegetation:	Improved pasture
Parent Material:	Alluvium from sedimentary rocks and rhyolitic tephra (mainly Waimihia lapilli and ash).

Representative profile:

Apg	0–20 cm	dark greyish brown (10YR 4/2) silt loam; few very fine distinct brown to dark brown (7.5YR 4/4) mottles along root channels; slightly sticky; slightly plastic; soil strength slightly firm; peds weak with semi-deformable failure; strongly pedal; common coarse and medium polyhedral (nutty) peds and many fine and very fine polyhedral peds; common extremely fine roots; indistinct wavy boundary,
Bg	20–90 cm	light brownish grey (2.5Y 6/2) and brown (2.5Y 6/4) silt loam; common very fine faint brownish yellow (10YR 6/6) mottles; slightly sticky; slightly to moderately plastic; soil strength slightly firm; peds weak with semi-deformable failure; strongly pedal; common coarse polyhedral (nutty) peds, many medium polyhedral peds and common fine and very fine polyhedral peds; few extremely fine roots; distinct wavy boundary,
2Bw	90 cm–on	brownish yellow (10YR 6/6) sand; non-sticky; non-plastic; non-cohesive, loose; single grain apedal; >70% fine pumice gravels (Waimihia lapilli), sesquioxide stains on the pumice lapilli; no roots; very weakly reactive to reactive-Al test.

Notes: Considerable local variation is found. Some pedons comprise greater depths of silty material over Waimihia lapilli. Others occur on mini-hillocks, and might not have a reductimorphic horizon. These would be better classified as Mottled Fluvial Recent Soils (as undifferentiated inclusions within Awamate silt loams).

Soil:	**Awamate silt loam, fan variant (Awg)**
Derivation	New
Classification:	Typic Orthic Gley Soil (GOT); stoneless soils, quartzo-feldspathic; silty; slow
Location:	Triangle, 20 m diagonally from gate into paddock, 20 m from main road. E. 1893235; N. 6240141
Landform/slope:	Low-angle fan, slope 4^{o} (at site), 1–4^{o} (typical for soil)
Drainage:	Poor
Vegetation:	Improved pasture
Parent Material:	Alluvium from sedimentary rocks and rhyolitic tephra (Waimihia lapilli and ash)

Representative profile:

Apg	0–31 cm	dark greyish brown (10YR 4/2) silt loam; few very fine faint strong brown (7.5YR 5/8) mottles; slightly sticky; slightly plastic; peds weak with semi-deformable failure; strongly pedal; few coarse polyhedral (nutty) peds, common medium polyhedral peds, many fine and many very fine polyhedral peds; many extremely fine roots; indistinct wavy boundary,
Bg1	31–90 cm	light brownish grey (2.5Y 6/2) silt loam; common very fine distinct brownish yellow (10YR 6/8) mottles, very few very fine distinct strong brown (7.5YR 4/6) mottles; slightly sticky; slightly plastic; peds weak with semi-deformable failure; strongly pedal; common coarse polyhedral (nutty) peds, many medium polyhedral peds, common fine and common very fine polyhedral peds; roots absent; very slightly gravelly, fine, fresh, rounded and sesquioxide stained (Waimihia lapilli); diffuse wavy boundary,
Bg2	90–120 cm	light brownish grey (2.5Y 6/2) silt loam; common fine prominent brownish yellow (10YR 6/8) and few very fine prominent strong brown (7.5YR 4/6) mottles; slightly sticky; slightly plastic; peds weak with semi-deformable failure; strongly pedal; common coarse polyhedral (nutty) peds, many medium polyhedral peds and common fine and very fine polyhedral peds; roots absent; slightly gravelly, fine, fresh, rounded and sesquioxide stained (Waimihia lapilli); diffuse wavy boundary,
Cg	120 cm–on	light brownish grey (2.5Y 6/2) silt loam; common fine prominent brownish yellow (10YR 6/8) and few very fine prominent strong brown (7.5YR 4/6) mottles; slightly sticky; slightly plastic; slightly gravelly, fine, fresh, rounded and sesquioxide stained (Waimihia lapilli); macrofabric not assessed as material augered only.

Notes: This soil is more consistently and strongly gleyed than Awamate silt loam. It reflects the more proximal parent material strongly (eroded from nearby hillslopes), and most of this is from siltstone. The fan variant is less strongly influenced by Waimihia tephric materials, and layers of these materials are absent in the first 100 cm depth in profiles (they might remain unobserved deeper in the profiles). Topsoils are generally deeper than Awamate silt loams. The variant is more difficult to manage for drainage than Awamate silt loam because it lies adjacent to hillslopes and receives runoff water.

Soil:	**Mohaka loamy sand (Mo)**
Derivation	Mohaka soils (Mo) (Rijkse 1979)
Classification:	Typic Perch-gley Pumice Soils (MPT); tephric, rhyolitic; sandy/silty; rapid/slow
Location:	Bu 1, lower part. E. 2893968; N. 6240553
Landform/slope:	Intermediate gently sloping terraces, slope 3^o (at site), 2–6^o (typical for soil)
Drainage:	Poor
Vegetation:	Improved pasture
Parent Material:	Airfall ryholitic tephra (Taupo ash and lapilli, Waimihia lapilli and ash, older weathered tephra and loess).

Representative profile:

Ap	0–16 cm	very dark brown (10YR 2/2) loamy sand; non-sticky; non-plastic; peds very weak with very friable failure; strongly pedal; many fine polyhedral (nutty) peds and abundant very fine polyhedral peds; many very fine roots; very slightly gravelly, fine, fresh rounded pumice (Taupo lapilli); non-reactive to reactive-Al test; abrupt wavy boundary,
Bw	16–26 cm	yellowish brown (10YR 5/8) and light reddish brown (5YR 6/4) loamy sand; few extremely fine distinct dark red (2.5YR 3/6) and few very fine faint yellowish red (5YR 5/8) mottles; non-sticky; non-plastic; peds very weak with very friable failure; loose particle packing; weakly pedal; few fine polyhedral (nutty) peds; common very fine roots; non-gravelly; moderately to strongly reactive to reactive-Al test; abrupt wavy boundary; (Waimihia ash),
Bg	26–39 cm	light brownish grey (2.5Y 6/2) sand; common very fine distinct dark red (2.5YR 3/6) and yellowish red (5YR 5/8) mottles; non-sticky; non-plastic; peds very weak with very friable failure; loose particle packing; weakly pedal; few fine polyhedral (nutty) peds; few very fine roots; non-gravelly; non-reactive to reactive-Al test (as are all underlying horizons); abrupt wavy boundary; (Waimihia ash),
Cg	39–76 cm	light grey (10YR 7/2) sand; few very fine faint to distinct brownish yellow (10YR 6/8) and few very fine distinct yellowish red (10YR 5/8) mottles; non-sticky; non-plastic; loose particle packing; single grain apedal; roots absent; distinct wavy boundary; (Waimihia ash),
2Btg	76–100 cm	light grey (10YR 7/2) and light yellowish brown (10YR 6/4) sandy clay loam; common fine distinct brownish yellow (10YR 6/8) and few very fine faint light reddish brown (2.5YR 6/4) mottles; slightly sticky; slightly plastic; very weakly indurated; massive apedal; clay coats suspected but difficult to detect as material was excavated in massive clods; distinct wavy boundary; (older weathered tephra and loess and pan-forming),
3Bw	100–112 cm	strong brown (7.5YR 5/8) silt loam; slightly sticky; slightly plastic; peds with friable failure; firm to auger; macrofabric not assessed as material augered only; (parent material is siltstone),

R	112 cm–on	grey (2.5Y 5/0) silt loam; slightly sticky; slightly plastic; firm to auger; macrofabric not assessed as material augered only (auger depth 120 cm); (slightly weathered siltstone).

Notes: Mohaka soils occur on the distinctive inclined intermediate terraces seen best in the 'bull' paddocks. They extend (and become narrower) into the adjacent hill and steepland where they become steeper (up to about 6°). Internal drainage becomes more impeded (worse) closer to the hills. Water is perched in the strongly gleyed subsoil layers. The main cause of this perching is the presence of slightly weathered, very slowly permeable siltstone at shallow depth. There is just 100 cm or so of sandy tephric material over the siltstone. The 2Btg horizon corresponds to the pan as reported in Rijkse (1979), and this material also contributes to poor subsoil drainage. While topsoil textures are mainly loamy sands, and are notably coarse when compared with the predominant silty textures of the farm property, a small increase in clay content to just 10–12% will give sandy loam textures (observed where terraces merge into hill country slopes).

Soil:	**Gisborne loamy sand (Gi)**
Derivation	Gisborne soils (Gi) (Rijkse 1979)
Classification:	Allophanic Orthic Pumice Soil (MOL); tephric, rhyolitic; sandy; rapid
Location:	Not described, but best examples in paddocks 1,2,12,13 in the new blocks
Landform/slope:	Undulating to rolling 4–15° (typical for soil)
Drainage:	Well
Vegetation:	Improved pasture
Parent Material:	Taupo and Waimihia ash and lapilli on older weathered rhyolitic tephra and loess on siltstone.

Representative profile:

Notes: No representative profile was selected for description, but pedons are similar to the profile described for the Gisborne hill soil (below). Auger inspections of the Gisborne rolling phase reveal slightly deeper topsoils over the mixed AB horizon (many more than 20 cm), and greater depths to the massive older weathered sandy tephric material.

Soil:	**Gisborne loamy sand, hill soil (GiH)**
Derivation	Gisborne hill soils (GiH) (Rijkse 1979)
Classification:	Allophanic Orthic Pumice Soil (MOL); tephric, rhyolitic; sandy; rapid
Location:	Paddock No. 8 in the new blocks, 20 m beside track cut into hillslope. E. 2894050; N. 6238800
Landform/slope:	Hillslope, slope 22° (at site), 16–25° (typical for soil)
Drainage:	Well
Vegetation:	Improved pasture
Parent Material:	Taupo and Waimihia ash and lapilli on older weathered rhyolitic tephra and loess on siltstone.

Representative profile:

Ap	0–16 cm	very dark brown (10YR 2/2) loamy sand; non-sticky; non-plastic; peds very weak with very friable failure; strongly pedal; common fine polyhedral (nutty) peds and abundant very fine polyhedral peds; many extremely fine roots; very slightly gravelly, fine, fresh and rounded (Taupo lapilli); moderately reactive to reactive-Al test; distinct wavy boundary,
AB	16–28 cm	very dark brown (10YR 2/2) and yellowish brown (10YR 5/8) loamy sand (50/50 mixed material from A and B horizons); non-sticky; non-plastic; peds very weak with very friable failure; strongly pedal; common fine polyhedral (nutty) peds and abundant very fine polyhedral peds; many extremely fine roots; very slightly gravelly, fine, both fresh and sesquioxide-stained, rounded (Taupo and Waimihia lapilli); strongly reactive to reactive-Al test; distinct wavy boundary,
2Bw1	28–50 cm	yellowish brown (10YR 5/8) and brownish yellow (10YR 6/4) sand; non-sticky; non-plastic; particle packing loose; peds very weak with very friable failure; moderately pedal; many fine polyhedral (nutty) peds and abundant very fine polyhedral peds; common extremely fine roots; very slightly gravelly, fine, sesquioxide-stained, rounded (Waimihia lapilli); strongly reactive to reactive-Al test; distinct wavy boundary,
3Bw2	50 cm–on	brownish yellow (10YR 6/4–6/6) loamy sand; non-sticky; non-plastic; peds weak with very friable failure; moderately pedal; many fine polyhedral (nutty) peds and abundant very fine polyhedral peds; non-reactive to reactive-Al test.

Notes: Gisborne loamy sands are very easy to predict in the landscape because they occupy the obviously stable hillslopes. Also, where subsoils are exposed by stock camps or farm track cuttings, the strong yellowish brown colour of the Waimihia material is evident from a distance. While topsoil textures are mainly loamy sands, and are notably coarse when compared with the predominant silty textures of the farm property, a small increase in clay content to just 10–12% will give sandy loam textures.

Soil:	**Pouawa silt loam, hill soil (PwH)**
Derivation:	Pouawa silt loam, hill soil (25bH) (NZ Soil Bureau 1954)
Classification:	Typic Immature Pallic Soil (PIT); moderately deep soils on rock, soft mudstone; sandy over skeletal; rapid
Location:	Western margin of Pylon, in cut bank beside track. E. 2893237; N. 6239595
Landform/slope:	Hillslope, slope 16^{o} (at site), 16–25^{o} (typical for soil)
Drainage:	Well
Vegetation:	Unimproved pasture
Parent Material:	Siltstone with veneer of Taupo ash and lapilli.

Representative profile:

Ap	0–20 cm	black (10YR 2/1) silt loam; non-sticky; non-plastic; peds very weak with very friable failure; strongly pedal; few fine polyhedral (nutty) peds and abundant very fine polyhedral peds; many extremely fine roots; very slightly gravelly,

fine, fresh and rounded (Taupo lapilli); indistinct wavy boundary,

AB	20–24 cm	black (10YR 2/1) and light yellowish brown (10YR 6/4) silt loam (50/50 mixed material from A and B horizons); slightly sticky; moderately plastic; peds weak with friable failure and other peds firm with semi-deformable failure; strongly pedal; few medium polyhedral (nutty) peds, common fine polyhedral peds and many very fine polyhedral peds; common extremely fine roots; slightly gravelly, fine, fresh, rounded (Taupo lapilli) and medium, moderately weathered, angular, siltstone; distinct wavy boundary,
Bw	24–34 cm	light yellowish brown (10YR 6/4–2.5Y 6/4) silt loam; slightly sticky; moderately plastic; peds weak with semi-deformable failure; moderately pedal; few medium polyhedral (nutty) peds, many fine and many very fine polyhedral peds; common extremely fine roots; very gravelly (40%), coarse, medium to fine, moderately weathered, angular siltstone; distinct wavy boundary,
C	34 cm–on	light yellowish brown (10YR 6/4–2.5Y 6/4) silt loam; slightly sticky; slightly plastic; peds weak with semi-deformable failure; weakly/moderately pedal; few medium polyhedral (nutty) peds, few fine and few very fine polyhedral peds; common extremely fine roots; extremely gravelly (83%), coarse, medium to fine, moderately weathered and fresh, angular siltstone.

Notes: Pouawa silt loams are essentially hilly versions of Hangaroa (with Taupo tephra) and Mahoenui (Taupo tephra absent) steepland soils, with slopes generally less than 26^{o} in the former soil terrain and greater than 25^{o} in the latter. About 10% of Pouawa map unit areas have been stripped of soil material to leave Raw Soils on landslide sites (soil material here comprises 3–10 cm (usually around 5 cm) of immature topsoil on insitu rock). The steepland soil terrain, by contrast, has more than 40% area affected by landslides.

Soil:	**Pakarae complex (PcH*)**
Derivation:	Pakarae complex, hill soil (29dH) (NZ Soil Bureau 1954)
Classification:	Typic Orthic Gley Soil (GOT); stoneless soils; silty; slow
Location:	Upper Hill end, paddock 3. E. 2893766; N. 6239809
Landform/slope:	Hillslope, slope 12^{o} (at site), 8–15^{o} (typical for soil)
Drainage:	Poor
Vegetation:	Unimproved pasture grasses, sedges, rushes
Parent Material:	Siltstone with veneer of Taupo ash and lapilli.

Representative profile 1:

Ap	0–14 cm	dark greyish brown (2.5Y 4/2) silt loam; common fine faint light brownish grey (2.5Y 6/2) mottle and few extremely fine distinct dark yellowish brown (10YR 4/6) mottles; slightly sticky; slightly plastic; peds slightly firm with semi-deformable failure; strongly pedal; common coarse, medium and fine polyhedral (nutty) peds; common extremely fine roots; distinct wavy boundary,
Bg1	14–30 cm	light brownish grey (2.5Y 6/2) silt loam; many fine prominent yellowish brown (10YR 5/8) mottles; slightly sticky; moderately plastic; peds weak with semi-deformable failure; strongly pedal; few medium polyhedral (nutty) peds, common fine polyhedral peds and many very fine polyhedral peds; few extremely fine roots; 2 cm thickness of very dark grey (10YR 3/1) carbon-rich

material at base (not present in all places); distinct wavy boundary,

Bg2	30–47 cm	light brownish grey (2.5Y 6/2) silt loam; many fine prominent yellowish brown (10YR 5/8) mottles; slightly sticky; moderately plastic; peds weak with semi-deformable failure; strongly pedal; few medium polyhedral (nutty) peds, common fine polyhedral peds and many very fine polyhedral peds (macrofabric assessed with difficulty due to the soil mass being very wet); roots absent; distinct wavy boundary,
R	47 cm–on	grey (10YR 5/1) silty clay; light olive brown (2.5Y 5/4) staining; very sticky; very plastic; massive apedal; moderately weathered and fresh, crumbly (soft) siltstone–higher content of clay than is normal for the siltstone formation underlying the farm.

Representative profile 2: (brief description, small hillock at E. 2893734; N. 6239778, slope 10^o)

Ap	0–17 cm	dark yellowish brown (10YR 3/4) silt loam; non-sticky; non-plastic; many extremely fine roots; very slightly gravelly, fine, fresh and rounded (Taupo lapilli); distinct wavy boundary,
Bw	17–38 cm	brownish yellow (10YR 6/6) loamy sand; non-sticky; non-plastic; common extremely fine roots; very slightly gravelly, fine, rounded, sesquioxide-stained (Waimihia lapilli); distinct wavy boundary,
Bg	38–90 cm	light brownish grey (2.5Y 6/2) silt loam; common very fine and fine brownish yellow (10YR 6/6) mottles; slightly sticky; moderately plastic; roots absent; distinct wavy boundary,
C	90 cm–on	pale olive (5Y 6/3) silty clay; few fine distinct brownish yellow (10YR 6/6) and common fine distinct strong brown (7.5YR 5/8) mottles; highly altered crumbly (soft) siltstone–higher content of clay than is normal for the siltstone formation underlying the farm.

Notes: The Pakarae complex occurs in Hill End on a very large, distinctive east-facing slumped block, dipping at an average angle of about 10^o. At lowest elevations the dipping surface is cut by gullies where Pakarae silt loam, hill soils occur. The dominant part of the complex supports the poorly drained Typic Orthic Gley Soil described in representative profile 1. Abundant sedges and rushes testify to the poor drainage conditions. The second (representative profile 2) and subdominant part (estimated to cover 15–25% of the area) is a better-drained soil (although still imperfect) on very low amplitude hillocks within the slumped structure. This soil has retained some influences of tephra (Taupo and Waimihia) in upper horizons, but comprises weathered siltstone (similar to the dominant profile) in lower horizons. There is no obvious indication of recent mass slope failures (no tension cracks, etc.), but the landform suggests that creeping styles of movement might occur.

Soil:	**Pakarae silt loam, hill soil (PcH)**
Derivation:	Pakarae hill soils (PcH) (Rikse 1979)
Classification:	Typic Immature Pallic Soil (PIT); moderately deep soils on rock, soft mudstone; sandy over skeletal; rapid
Location:	Scamperdown 3 and 4 paddocks
Landform/slope:	Hillslopes, 16–25^o (typical for soil)

Drainage: Well and imperfectly
Vegetation: Unimproved pasture
Parent Material: Siltstone with veneer of Taupo ash and lapilli.

Notes: No description is available for this soil, but it is described in Rijkse 1979. Pakarae silt loams are similar in morphology to Pouawa silt loams, but the former are recorded on slopes that are more disturbed by landslides. Characteristically, flowy (poorly drained) debris from these landslides remain in storage on lower slopes. While landslides occur in Pouawa terrain, they tend to be more discrete, and without the slumpy/flowy materials on lower slopes. The cause of the difference is speculative without proper investigation, but it may be related to the siltstone under Pakarae soils being softer and weaker (similar idea as that used to explain the Pakarae complex landform) and/or with a higher clay content.

The tephra-rich profile described in Rijkse (1979), is very rare in Pakarae terrain on the farm. Most tephra has been removed by erosion, and remains on spur slopes only. For management purposes, Pakarae soil is best treated as a soil developed directly from soft siltstone, with a patchy veneer of Taupo tephra, no Waimihia material and no older weathered tephra.

Soil: **Hangaroa silt loam, steepland soil (HaS)**
Derivation: Hangaroa steepland soils (HaS) (Rijkse 1979)
Classification: Weathered Orthic Recent Soil (ROW); paralithic soils, soft mudstone; silty over skeletal; rapid
Location: Winiatas 1, Ridge Lane. E. 2894279; N. 6239971
Landform/slope: Steepland, slope 33^{o} (at site), 27–35^{o} (typical for soil)
Drainage: Well
Vegetation: Unimproved pasture
Parent Material: Siltstone with veneer of Taupo ash and lapilli (and Waimihia ash).

Representative profile:

Ap 0–17 cm very dark greyish brown (10YR 3/2) and black (10YR 2/1) silt loam; slightly sticky; slightly plastic; peds slightly firm with semi-deformable failure and few peds weak with friable failure; strongly pedal; few medium polyhedral (nutty) peds, common fine polyhedral peds and many very fine polyhedral peds; common very fine roots; very slightly gravelly, fine and medium, fresh, sub-rounded pumice (Taupo lapilli) and fine to medium slightly weathered, sub-rounded and angular siltstone; abrupt wavy boundary (high amplitude wavy–Ap horizon depths vary over short distances for 9 cm depth to 24 cm),

Bw 17–47 cm yellowish brown (10YR 5/6) silt loam; few very dark greyish brown (10YR 3/2) occlusions of topsoil in upper parts; peds weak with friable failure; moderately pedal; few medium polyhedral (nutty) peds, common fine very fine polyhedral peds; common very fine roots; very gravelly (42%), coarse, medium and fine, slightly weathered, angular siltstone; diffuse wavy boundary,

C 47 cm–on yellowish brown (10YR 5/6) silt loam; slightly sticky; moderately plastic; peds weak with friable failure; slightly pedal; few fine and very fine polyhedral (nutty) peds; few fine roots; extremely gravelly (84%), coarse, medium to fine, moderately weathered, angular siltstone.

Notes: Hangaroa soils form the subdominant part of a double taxa soil map unit (MeSe+HaS). Hangaroa soils occur on ridges and spurs, extending downslope to where slopes become highly disturbed by past landslide activity. This more eroded terrain lying between landslide sites is dominated by the Mahoenui silt loam, shallow phase, steepland soil. An approximate ratio of Mahoenui to Hangaroa is 60/40. The two soils are inseparable at the mapping scale. The only

significant difference between the two is that Hangaroa topsoils are strongly influenced by Taupo ash and lapilli (and possibly some Waimihia ash), giving topsoils a darker, sandier (although still basically silty), more friable feel and less well-developed pedality. The main inclusion in the MeSe+HaS map unit are Rocky Raw Soils on landslides scars, and a representative description for these is given in the Mahoenui soil description.

Soil:	**Mahoenui silt loam, shallow phase, steepland soil (MeSe)**
Derivation:	Mahoenui steepland soils (MeS) (Rijkse 1979)
Classification:	Weathered Orthic Recent Soil (ROW); paralithic soils, soft mudstone; silty over skeletal; rapid.
Location:	Grants. E. 2894872; N. 6240724
Landform/slope:	Steepland, slope 35^{o} (at site), 33–45^{o} (typical for soil)
Drainage:	Well
Vegetation:	Unimproved pasture
Parent Material:	Siltstone.

Representative profile 1:

Ap	0–8 cm	very dark brown (10YR 2/2) silt loam; slightly sticky; slightly plastic; peds slightly firm with semi-deformable failure and peds very weak with friable failure; strongly pedal; few medium polyhedral (nutty) peds, common fine polyhedral peds and many very fine polyhedral peds; common very fine roots; very slightly gravelly, fine and medium, fresh, sub-rounded pumice (Taupo lapilli) and fine to medium slightly weathered, sub-rounded and angular siltstone; abrupt wavy boundary,
AB	8–15 cm	light grey (10YR 7/2) and very dark greyish brown (10YR 3/2) silt loam (50/50 mixed A and B horizon materials); peds weak with friable failure; moderately pedal; few medium polyhedral (nutty) peds, common fine very fine polyhedral peds; common very fine roots; moderately gravelly (20%), coarse, medium and fine, slightly weathered, angular siltstone; diffuse wavy boundary,
C	15–32 cm	light grey (10YR 7/2) and light yellowish brown (10YR 6/4) silt loam; slightly sticky; moderately plastic; peds firm and very firm with brittle failure; slightly pedal; few fine and very fine polyhedral (nutty) peds; apedal material massive; few fine roots; very gravelly (65%), coarse, medium to fine, moderately weathered, angular siltstone,
R	32 cm–on	light yellowish brown (10YR 6/4) slightly to moderately weathered siltstone; common fine to very fine brownish yellow (10YR 6/6) mottles.

Representative profile 2: (the main included and unnamed soil. This particular site is most likely of March 1988 Cyclone Bola age)

Soil:	**Unnamed Rocky Raw Soil,** recognised as an inclusion in the map unit MeSe+HaS
Derivation:	New

Classification:	Rocky Raw Soil (WX); lithic soils, soft mudstone; silty; rapid
Location:	Face. E. 2894266; N. 6240210
Landform/slope:	Steepland, slope 35^{o} (at site), 33–45^{o} (typical for soil)
Drainage:	Well
Vegetation:	20–60% vegetated by unimproved pasture grasses
Parent Material:	Siltstone.

Ap	0–5 cm	very dark brown (10YR 2/2) silt loam; slightly sticky; slightly plastic; peds slightly firm with semi-deformable failure and peds very weak with friable failure; weakly pedal; few medium, fine and very fine polyhedral (nutty) peds, common very fine roots; sharp smooth boundary,
R	5 cm–on	light yellowish brown (10YR 6/4) slightly weathered massive siltstone rock; slip plane of landslide (scar-covered by uneven pockets of soil material, but mostly no thicker than 3–5 cm).