SOILS OF MANAWATU COUNTY, NORTH ISLAND, NEW ZEALAND

EXPLANATORY NOTES TO ACCOMPANY
SOIL MAP AND EXTENDED LEGEND

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Part of
NEW ZEALAND SOIL SURVEY REPORT 30
New Zealand Soil Bureau
Department of Scientific and Industrial Research
Wellington, New Zealand 1977

E.C. KEATING, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND - 1977

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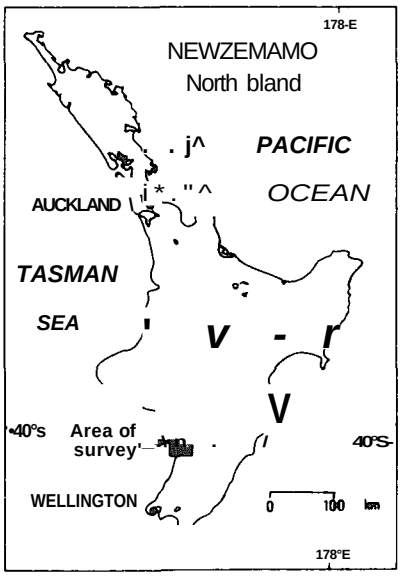
SUMMARY

The soil survey of Manawatu County, Wellington Province, New Zealand covers about 690 km² area comprising three physiographic units: - river flats; terrace land; coastal sand country. The soils of the sand country are mapped in associations because the complex of dunes, sand plains, and peaty swamps are recurrent but cannot be mapped separately at the scale (1:63 360) of mapping used.

Detailed information is given on the soil map and extended legend (in two parts) about the soils, and drainage which is a major limitation to agricultural use on these soils. Classifications of the soils according to their potential for pastoral, cropping, and forestry uses are listed and these can be used for estimating potential productivities of the soils.



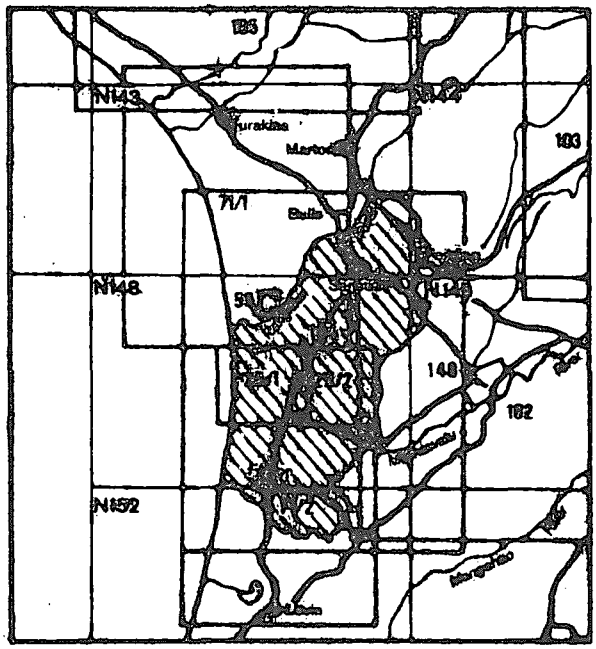


Figure 1. Locality map of Manawatu County and index to published Soil Bureau maps (25/1, 2 - Oroua Downs, 55 - Flock House Farm, 71/1, 2 - Manawatu-Rangitikei sand country, 102 - Kairanga County, 104 - this survey, 105 - part Wanganui County, 148 - Palmerston North City.

INTRODUCTION

Manawatu County is one of the west coast counties of the Wellington Province (Figure 1). It covers about 690 km^2 and comprises three distinct physiographic units: the river flats, the terrace land, and the coastal sand country (Figure 2). The part of the county that consists mainly of sand country has been covered in previous soil maps and bulletins published by Soil Bureau (Cowie and Smith 1958; Cowie, et al. 1967) but it was considered worthwhile to complete and publish a soil map of the whole of the county as a useful addition to the soil survey coverage of the western part of Wellington Province. The soil map and extended legend give detailed information on the soils of the river flats and the terraces within the county and also on drainage which is a major limitation to agricultural use on these soils. It will therefore provide a basis for the investigation of various methods of land drainage. It will also serve as a basis for estimating the potential productivities of the various soils for cropping - a type of land use which is likely to become of increasing importance in the future in this district.

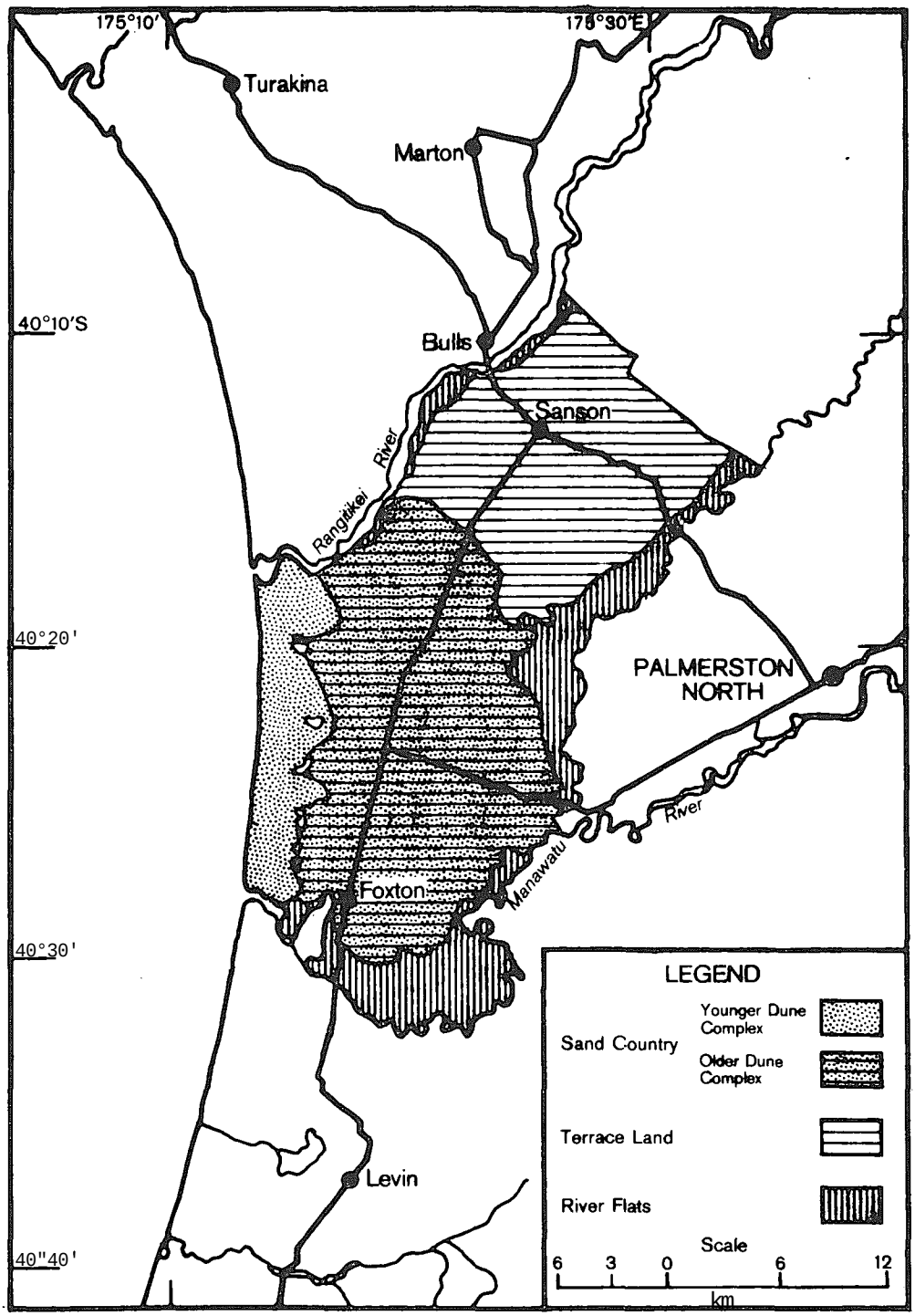


Figure 2. Physiographic map of Manawatu County showing boundaries of sand country, river flats, and terrace land.

PHYSIOGRAPHY AND PARENT MATERIALS

THE RIVER FLATS

The river flats border the Manawatu, Oroua and Pangitikei Rivers which form the southern, eastern and north-western boundaries of the county. The Manawatu and Oroua Rivers have well defined levees which are well drained. Away from the river the levees grade into lower lying, more poorly drained, backswamp areas. These are most extensive along the lower course of the Manawatu River where most of the land is only a metre or so above sea level and the water table is very high. The river flats of the Rangitikei River are of limited area only and are mostly well drained.

The river flats have been built up from alluvium deposited during flooding of the rivers. In some areas flooding has been frequent and severe but, since completion of the Lower Manawatu Flood Control Scheme in 1963, most areas bordering the Manawatu and Oroua Rivers are now free of flooding.

The texture of the alluvium ranges from sand in the frequently flooded berm areas through sand and silt on the levees, to clay on the low-lying backswamps. In the very low-lying parts peaty materials have accumulated.

THE TERRACE LAND

The terrace land occurs in the northern part of the county and includes both river and marine terraces. The lowest and youngest of the river terraces is the Ohakea Terrace (Te Punga 1952) on which Ohakea Aerodrome is situated. This terrace, which ranges in elevation from 30 to 60 m above sea level, has a flattish surface with numerous, small, strongly meandering stream courses. A layer of loess, colluvium and alluvium covers the gravel of this terrace.

The older and higher terraces range in elevation from about 20 m to just under 150 m. Around Rongotea, dissection is slight and only a few narrow and relatively shallow valleys break the terrace surfaces. Northwards in the Mt Stewart - Mt Biggs area, dissection becomes stronger and the landscape consists of a mosaic of flattish and rolling terrace remnants and moderately steep valley sides. These higher terraces are covered with loess which overlies sandstone and gravel of Late Pleistocene age. The loess is generally clay to clay loam in texture but towards the eastern bank of the Rangitikei River it becomes coarser in texture and, locally, thick beds of wind-blown sand occur. These sandy deposits have rolling topography.

THE SAND COUNTRY

The sand country, which occupies almost half of the county and extends up to 20 km inland from the coast, consists of a complex of dunes, sand plains, and peaty swamps. The dunes near the coast are unconsolidated and large areas that have only a scattered plant cover are drifting inland. Further inland, the dunes are more consolidated with a good plant cover. On these there is little wind erosion.

VEGETATION

The vegetation of Manawatu County at the time of European settlement ircluded scrub, fern, forest, and swamp communities (Esler 1964). Scrub and fernland occupied most of the sand country and parts of the terraces. Forest occupied the river flats except the very poorly drained areas, a large part of the terraces, and inland parts of the sand country. Swamp vegetation occurred on the very poorly drained swamps of the Moutoa and Kopane districts and on the peaty swamps of the sand country.

Most of this original vegetation has now been cleared and the land sown to pasture. In the sand country, especially near the coast, large areas of the dunes have been planted in marram grass *(Ammophila arenaria),* tree lupin *(Lupinus arboreus),and* pines (chiefly *Pinus radiata)* . In the swamp land of the Moutua district, extensive areas have been planted in native flax *(Phormiurn tenax).*

CLIMATE

The climate of Manawatu County is mild and subhumid. Annual rainfall is comparatively low compared with other counties of the western part of Wellington Province with mean annual rainfalls ranging from just under 900 mm near the coast to about 1000 mm in the north-east. Rainfall is fairly evenly spread throughout the year, although there is a slight summer minimum. Evaporation and transpiration are greater during the summer because of higher temperatures and, as a result, soils which are not affected by a high water table dry out for two to three months in summer. West to north-west winds prevail and these frequently reach gale force. Mean annual temperature is approximately 12°C.

SOILS

SOIL MAPPING UNITS

The accompanying soil map has been compiled from the "General Survey of the Soils of North Island, New Zealand" (N.Z. Soil Bureau 1954); "Soils and Agriculture of Oroua Downs, Glen Oroua and Taikorea Districts, Manawatu County" (Cowie and Smith 1958); "Soils of the Manawatu-Rangitikei Sand Country" (Cowie et *al.* 1967); from unpublished surveys; and from field work carried out by the writers over several years. Most of these surveys were carried out using aerial mosaics at a scale of 1:15 840 as field sheets, but the scale for publication has been reduced to 1:63 360.

Soil types (Taylor and Pohlen 1970) have been used as the mapping units on the river flats and on the terraces. However, because of the scale of the published map, areas shown as the one soil type may include significant areas of other soil types within the same series or even some areas of a different soil series. In the sand country, the mapping units used are combinations of soil types called soil associations (Cowie et *al.* 1967). These are groupings of geographically associated soils whose differences are related mainly to drainage and topographic position. The mapping units are listed, physiographically, in Table 1.

Table 1 Soil Mapping Units Arranged Physiographically

	Soil Reference Symbol
SOILS OF THE RIVER FLATS	
Rapidly accumulating	
Excessively to moderately well drained	
Rangitikei loamy sand	Rj
Rangitikei sandy loam	R2
Rangitikei fine sandy loam	R,
Imperfectly to very poorly drained	
Parewanui sandy loam	Pa^
Parewanui fine sandy loam	Pa-
Par ewanui silt loam	Pa^
Parewanui heavy silt loam	Pa^

Table 1 - continued

Slowly accumulating	Soil Reference Symbol
Excessively to moderately well drained	
Manawatu sandy loam	M_1
Manawatu fine sandy loam	M_2
Manawatu silt loam	M_3
Imperfectly to very poorly drained	
Kairanga fine sandy loam	K_1
Kairanga silt loam	K_2
Kairanga silt loam on sand	K_3
Kairanga heavy silt loam	K_4
Kairanga peaty silt loam	K_5
Meeanee-Farndon complex	MFc
Opiki silt loam	Op
Makerua peaty silt loam	Mr_1
Makerua peaty loam	Mr_2
Non-accumulating	
Excessively to moderately well drained	
Karapoti black sandy loam	Kt_1
Karapoti black silt loam	Kt_2
Imperfectly to very poorly drained	
Te Arakura silt loam	Te_n
Te Arakura sandy loam	Te_2
SOILS OF THE TERRACE LAND	
Imperfectly to very poorly drained	
Ohakea silt loam	Oh
Tokomaru fine sandy loam	T_1
Tokomaru silt loam	T_2
Tokomaru silt loam, rolling phase	T_2R

Table 1 - continued	Soil Reference Symbol
Soils of the Terrace Land - continued	
Imperfectly to very poorly drained - continued	
Milson silt loam	Mn
Milson silt loam, rolling phase	MnR
Marton silt loam	Ma
Marton silt loam, rolling phase	MaR
Halcombe silt loam	Ha
Halcombe hill soils	HaH
Tokorangi sandy loam	To
Rongotea peaty loam	Ro

SOILS OF THE SAND COUNTRY

Sand plains dominant

Hokio-Waitarere association	H-W
Himatangi-Motuiti association	Hm-Ms
Pukepuke-Motuiti association	P-Ms
Pukepuke-Omanuka association	P-0
Awahou-Foxton association	A-F
Carnarvon black-Foxton association	C-F, C-F*
Carnarvon brown-Foxton association	Cb-F

Dunes dominant

Waitarere-Hokio association	W-H
Motuiti-Himatangi association	Ms-Hm
Foxton-Omanuka association	F-0

Unstabilised sand — **u**

* C-F indicates that clay underlies the soils in parts of the sand plains.

Most of the soils mapped in Manawatu County have been described in other publications and only brief descriptions of the soils are included in these notes and in the extended legend. For a more detailed account of the soils the publications listed in the Bibliography should be consulted.

In these explanatory notes the soils are mainly described according to soil series, which are groupings of soil types with similar profiles but differing in such properties as texture, slope, stoniness, and drainage. Table 2 shows these soil taxonomic units, arranged pedologically.

Table 2 Soil taxonomic units arranged pedologicalTy

	Soil Reference Symbol
YELLOW-GREY EARTHS *(pallic soils)*	
from loess *(pseudomadenti-pallic soils)*	
moderately to strongly gleyed	
-weakly clay-illuvial	
Ohakea series	Oh
-moderately clay-illuvial	
Tokomaru series	T
Halcombe series	Ha
-strongly clay-illuvial	
Milson series	Mn
Marton series	Ma
from wind-blown sand *(voii-pailic soils)*	
weakly gleyed	
-weakly clay-illuvial	
Tokorangi series	To
YELLOW-BROWN SANDS *(subfulvic soils)*	
from wind-blown sand	
non to weakly gleyed (voli-subfulvic and subfulvic soils)	
Motuiti series	Ms
Foxton series	F
Himatangi series	Hm
Awahou series	A
moderately to strongly gleyed (madenti-subfulvic soils)	
Pukepuke series	P
Carnarvon series	.c
GLEY SOILS *(madentic soils)*	
from alluvium	
Te Arakura series	Te

Table 2 - continued	Soil Reference Symbol
ORGANIC SOILS *(platic and luvi-platic soils)*	
from peat *(platic soils)*	
Rongotea series	Ro
Omanuka series	0
from peat and alluvium *(luvi-platic soils)*	
Makerua series	Mr
RECENT SOILS *(luvic and volic soils)*	
from alluvium *(luvic soils)*	
non to weakly gleyed	
-moderately to strongly accumulative	
Rangitikei series	R
-weakly accumulative	
Manawatu series	M
-non-accumulative	
Karapoti series	Kt
from wind-blown sand *(volic soils)*	
non to weakly gleyed	
Waitarere series	W
weakly to strongly gleyed	
Hokio series	H
GLEY RECENT SOILS *(madenti-luvic soils)*	
from alluvium	
moderately to strongly accumulative	
Parewanui series	Pa
weakly accumulative	
Kairanga series	K
Opiki series	Op
SALINE GLEY RECENT SOILS *(saline madenti-luvic soils)*	
from estuarine alluvium	
Meeanee-Farndon complex	M

SOILS OF THE RIVER FLATS

Soils of the river flats include recent *(luvic)* soils, gley recent *(madenti-luvic)* soils, saline gley recent *(saline madenti-luvic)* soils, gley *(madentic)* soils, and organic *(luvi-platic)* soils.

Moderately well to excessive drained recent soils include the Rangitikei, Manawatu and Karapoti series. The Rangitikei series border the rivers on flats which are frequently flooded and which receive regular large additions of fresh alluvium. These soils are sandy and show flood layering. The Manawatu series occur on the levees and flats which are infrequently flooded and only slowly accumulating. They have deep brown to greyish brown A horizons which grade into olive brown subsoils. The Karapoti series occur on the higher parts of the flats and levees of former stream courses which have not been flooded in historic times. They are characterised by black A horizons overlying olive or olive brown slightly firm subsoils which have some faint mottling in the upper part.

Imperfectly to very poorly drained gley recent soils include the Parewanui, Kairanga, and Opiki series. The Parewanui series occur on low-lying flats which are, or have been, frequently flooded and are rapidly accumulating. They have indistinct A horizons with brown mottles, overlying grey or olive grey B horizons with few to many brown mottles. The Kairanga series occur where flooding is less frequent and accumulation slower so that A horizons are darker and more distinct. Opiki series include soils with layers of peat in the subsoil.

Saline gley recent soils (Meeanee-Farndon complex) occur on estuarine areas of the Manawatu and Rangitikei Rivers where flooding by slightly saline water occurs. They are poorly drained and most have clay texture and are slightly saline.

Gley soils (Te Arakura series) are imperfectly to poorly drained soils formed on those parts of the river flats which have been free of flooding and have had only negligible accumulation in historic times. They have greyish brown A horizons overlying olive grey to olive firm B horizons with many to abundant reddish and brownish mottles. In the more poorly drained soils, iron-manganese concretions occur in a layer just below the A horizon. Slight clay accumulation occurs in the B horizon.

Organic soils (Makerua series) are poorly drained and occur in former peat swamps. They consist of over 60 cm of peaty material on grey clay.

Most of the soils of the river flats are well supplied with the major plant nutrients and the two main soil limitations for their intensive use are poor drainage of most of the soils and liability to frequent flooding in some areas. Once drainage can be improved and flooding prevented, these soils are very productive and can be used for cropping, dairying, and fattening stock. The better drained soils such as Manawatu silt loam,

Manawatu sandy loam, Kairanga fine sandy loam and Te Arakura sandy loam could be used for intensive cropping such as market gardens and nurseries. Artificial drainage is necessary on the last two soils if they are to be used for intensive cropping.

SOILS OF THE TERRACE LAND

The soils of the terrace land are mainly yellow-grey earths *(pseudo-madenti-pallic* and *voli-pallic soils)* but also include small areas of organic soils *(platic soils).*

The yellow-grey earths include the Ohakea, Tokomaru, Halcombe, Milson, Marton and Tokorangi series. As a group, these soils are characterised by dark greyish brown to dark grey sandy loam to silt loam A horizons with weakly to moderate developed nut structure and light grey A_2 horizon with iron-manganese concretions. The B horizons are olive grey to olive firm sandy loams to clays with many to abundant brown mottles and moderately to strongly developed blocky structure. In most of the soils a weakly to moderately developed fragipan with horizontal and vertical grey veining occurs below the B horizon. Weak to strong development of clay coatings occurs in the B horizons.

The Ohakea series occur on the low terraces and are formed from loess, colluvium and alluvium. They are imperfectly to poorly drained soils with silt loam A horizons overlying heavy silt loam B horizons. Only weak development of clay coatings occurs in the subsoil and stony gravels are present at 90 to 150 cm from the surface. Near the eastern bank of the Rangitikei River textures of Ohakea soils are sandier and subsoil colours browner.

The Tokomaru series occurs on the intermediate and high terraces bordering the eastern bank of the Rangitikei River and is formed from thick deposits of silty loess. The soils are imperfectly to poorly drained dark greyish brown silt loam and fine sandy loam A horizons and olive grey to grey firm clay loam or sandy clay loam B horizons with many to abundant yellowish brown mottles and moderate development of clay coatings. At about 90 cm from the surface a well developed fragipan with vertical grey veining occurs.

The Milson series occur where the loess is thinner and finer textured, further away from the rivers than the Tokomaru series. Drainage is poor to imperfect and the B horizon consists of olive to olive grey clay loam with many to abundant yellowish brown mottles and moderate to strong development of clay coatings. A moderately well developed fragipan, with vertical grey veining, occurs below the B horizon.

The Marton series occurs on the flat to rolling tops of the dissected high terraces, from thin deposits of fine textured loess. B horizons are light grey to olive clays with strong blocky structure and with strong

development of clay coatings. Weakly to moderately developed fragipans with grey veining occur below the B horizons. Drainage is poor to imperfect.

The Tokorangi series are formed from wind-blown sand deposits which occur on the intermediate and high terraces bordering the eastern bank of the Rangitikei River. Profiles consist of very dark greyish brown sandy loam A horizons on olive to pale olive sandy loam B horizons with firm consistence and many yellowish brown to brown mottles. The C horizon is pale olive brown loamy sand which is firm and massive. Few clay coatings occur on aggregate faces in the B horizon.

The Halcombe series occurs on the rolling to moderately steep sides of the valleys dissecting the terraces. The soils are formed from loess on sandstone and gravels and consist of greyish brown silt loam A horizons on light grey to olive grey firm clay loam B horizons with many to abundant yellowish brown to strong brown mottles and moderate development of clay coatings. Small areas of soils on steep slopes from sandstone and gravels have been included in the Halcombe series. These areas are indicated on the soil map by vertical hatching but have not been separated in the soil legend.

The yellow-grey earths have low values of citric-soluble phosphorus, low to very low values of exchangeable potassium, and low to medium values of exchangeable calcium in the A horizon. Percentage base saturations are medium and increase or remain constant with depth. Exchangeable magnesium is very low but is higher in the subsoil causing a decrease in the calcium to magnesium ratio.

Pasture responses are obtained to phosphate, lime and potash on these soils. Good pastures for fattening or dairying can be maintained with adequate topdressing and tile or mole drainage. Annual cropping in rotation with pasture is also possible.

Organic soils (Rongotea series) are formed in the narrow valleys dissecting the terraces in the Rongtotea district. These soils are formed from peat on colluvium and consist of very dark brown to black peaty loam with many fine reddish yellow mottles on grey to greyish brown clay. Natural drainage is poor.

SOILS OF THE SAND COUNTRY

The soils of the sand country include recent soils from wind-blown sand *(volic soils),* yellow-brown sands *(voli-subfulvic* and *subfulvic soils),* gleyed yellow-brown sands *(madenti-subfulvic soils),* and organic soils *(platic soils).* They have been described in several previous publications (Cowie 1957; Cowie and Smith 1958; Cowie *et al.* 1967; Cowie 1968). This account is restricted to brief descriptions of the soil associations, and their component soils which are set out in Table 3. For more detailed information on individual soil types and phases the above publications should be referred to.

Table 3 Soil Hasten Within Soil Associations of the Sand Country, Manewatu County

Soil Associdtiont (symbol)	Principal Hanbers*			Minor Neater***	
	On Sand Dunes	On Sand Plains	On Peat Swamps	On Sand Dunes	On Sand Plains
Dunes dominant:					
KAITARI:RE-HOKIO (H-Hj	Waitarere sand	Hokio weakly mottled sand Hokio strongly nottled sand Hokio sand Hokio sand, peaty phase			
MOTMTI-HIMATANCI (Ms-lto)	Hotuiti sand	Himatangi weakly mottled sand Hlmatangi sand		Naitarere sand	Pukepuke black sand
FOXTON-OMANUKA (F-O)	Foxton black sand		Omanuka peaty silt loam Omanuka peaty loam	Foxton brown mottled sand	Carnarvon brown sandy loam Pukepuke brown sandy loam
Sand plains doainant: >					
HOKIO-WAITARERE (H-K)	Waitarere sand	Hokio weakly nottled sand Hokio strongly mottled sand Hokio sand Hokio sand, peaty phase			
HIMATANGI-M)TUITI (Hra-Ms)	Hotuiti sand	Himatangi weakly mottled sand Himatangi sand		Naitarere sand	Pukepuke black sand
PUKEPUKE-MDTUITI (P-Hs)	Motuiti sand	Pukepuke black sand Pukepuke black sand with concretions	Omanuka peaty sandy loam Omanuka peaty loam Omanuka peaty sandy loam, shallow phase Omanuka peaty loam, shallow phase	Waitarere sand	Himatangi weakly mottled sand Himatangi sand
PUKEPUKE-OMANUKA (P-O)	Foxton black sand Foxton brown sand	Pukepuke brown sand Pukepuke brown loamy sand Pukepuke brown sandy loam Pukepuke brown sandy loam, peaty phase	Omanuka peaty loam Omanuka peaty silt loam Omanuka peaty loam, shallow phase	Foxton brown mottled sand	Awahou loamy sand Awahou sandy loam
ANAJIOU-FOXTON (A-F)	Foxton black sand	Awahou loamy sand Awahou sandy loam			Carnarvon black sandy loam Carnarvon black loamy sand
CARNARVON BLACK-FOXTON (C-F, C-Ftt)	Foxton black sand	Carnarvon black sandy loam Carnarvon black loamy sand	Omanuka peaty loam Omanuka peaty silt loaa Omanuka peaty loam, shallow phase		Awahou loamy sand Awahou sandy loam
CARNARVON BROWN-FOXTON (Cb-F)	Foxton black sand Foxton brown sand	Carnarvon brown loamy sand Carnarvon brown sandy loam	Omanuka peaty loan Omanuka peaty silt loam Omanuka peaty loam, shallow phase	Foxton brown mottled sand	Awahou loamy sand Awahou sandy loam

t Each association is named after its two most extensive members, the series name of the dominant member appearing first.

• Occupies 10-70\ of area.

'• 0ccupies<10* of area.

ft C-F indicates that clay underlies sand on parts of the sand plains.

Hokio-Waitarere (H-W) and Waitarere-Hokio (W-H) associations

Bordering the coast are the recent soils of these associations in which Waitarere sand occurs on the dunes and Hokio series on the sand plains. In the Hokio-Waitarere (H-W) association Hokio series are dominant whereas in the Waitarere-Hokio (W-H) association Waitarere sand is dominant. The soils of these associations show little profile development and are low in organic matter and nitrogen. Waitarere sand is an excessively drained soil and is very susceptible to wind erosion when its cover is interfered with. Hokio soils range from poorly to somewhat excessively drained, depending on the height of the water table, and can support good pastures if they are not overdrained. Pastures on the somewhat excessively drained soil types (Hokio weakly mottled sand and Hokio strongly mottled sand) dry off in summer but those on the poorly and imperfectly drained units (Hokio sand and Hokio sand, peaty phase) continue to grow through most summers. Farming is possible on the Hokio-Waitarere association although the areas of Waitarere sand should be left in scrub or planted in trees. The Waitarere-Hokio association is best suited for protection and production forests.

Himatangi-Motuiti* (Hm-Ms) and Motuiti-Himatangi (Ms-Hm) associations

These associations include soils of the drier sand plains (Himatangi series) and of the dunes (Motuiti sand) of the weakly consolidated sand country.

The Himatangi soils are somewhat excessively drained and it is difficult to maintain good pastures on them as they dry out in summer. Motuiti sand is somewhat excessively drained and has a topsoil less than 15 cm thick. Pastures dry off severely in summer and the soil is very susceptible to wind erosion once the topsoil is breached by.stock trampling. Areas of the Himatangi-Motuiti association are used mainly as winter run-offs for semi-extensive sheep and cattle farming, and for exotic forest plantations. Motuiti-Himatangi association covers a small area only and is mostly in scrub.

Pukepuke-Motuiti (P-Ms) association

The Pukepuke-Motuiti association includes the soils of the wetter sand plains (Pukepuke black soils), peaty swamps (Omanuka soils), and of the dunes (Motuiti sand) of the weakly consolidated sand country. The Pukepuke

* On previously published maps Motuiti sand was mapped as Foxton dark grey sand. This change has been made as it is now considered that the difference between Foxton dark grey sand and Foxton black sand is more of a series difference than a type difference. As a consequence of this, Himatangi-Foxton association has been changed to Himatangi-Motuiti association; Foxton-Himatangi to Motuiti-Himatangi and Pukepuke-Foxton to Pukepuke-Motuiti associations.

black soils are imperfectly to poorly drained but with shallow drainage to remove surface water, and with phosphate and potash topdressing good pastures can be maintained. Omanuka series are peaty with poor to very poor drainage. Pastures tend to be invaded by rushes and buttercup but provide good summer feed. Motuiti sand, formed on the dunes, is somewhat excessively drained but pastures on it are valuable during winter when surrounding areas are too wet to be grazed.

The Pukepuke-Motuiti association is used mainly for dairying, for which it is well suited. Some market gardening is carried out on the Pukepuke soils.

Pukepuke-Omanuka (P-0) association

The Pukepuke-Omanuka association includes the soils of the wetter sand plains (Pukepuke brown soils), peaty swamps (Omanuka series), and dunes (Foxton series) of the more consolidated sand country. Poor drainage is the limiting factor in the establishment of good pastures on the Pukepuke brown soils and Omanuka soils. High-producing ryegrass-white clover pastures can be maintained with adequate drainage and topdressing with phosphate and potash. These remain green and continue to grow through the summer. Fair pastures of cocksfoot, ryegrass and subterranean clover can be maintained on Foxton black sand and although they dry off in summer, they are valuable for winter grazing when surrounding soils are wet.

The Pukepuke-Omanuka association is used mainly for dairying and fattening sheep although some market gardening is done on the Pukepuke soils. Between Bainesse and Foxton, large areas of this association are only partly developed.

Awahou-Foxton (A-F) association

The Awahou-Foxton association includes the soils of the drier sand plains (Awahou soils) and dunes (Foxton black sand) of the more consolidated sand country. Awahou soils are somewhat excessively drained but fair pastures of cocksfoot, ryegrass and subterranean clover can be maintained with dressings of phosphate, potash and lime. The pastures dry out in summer but not as severely as those on the Himatangi soils. Foxton black sand is a somewhat excessively drained soil with a deep topsoil. Fair pastures of cocksfoot, ryegrass and subterranean clover can be maintained with dressings of phosphate, potash and lime but they dry out badly in summer. The soil is not as susceptible to wind erosion as Motuiti sand because the topsoil is deeper and not so easily breached by stock. The Awahou-Foxton association is used mainly for fattening sheep.

Carnarvon black-Foxton (C-F, C-F) and Carnarvon brown-Foxton (Cb-F) associations

The Carnaron-Foxton associations include the soils of the wetter sand plains (Carnarvon series), peaty swamps (Omanuka series) and dunes (Foxton

series) of the more consolidated sand country. Carnarvon soils are imperfectly and poorly drained, differing from the Pukepuke soils in that they have deeper topsoils and concretions of iron-cemented sand in the subsoil. Good ryegrass-white clover pastures can be maintained with shallow drainage and topdressing with phosphate, potash and lime. Omanuka soils are peaty with poor to very poor drainage. Foxton black sand has somewhat excessive drainage but fair pastures can be maintained by topdre'ssing with phosphate and potash. Pastures on this soil dry out badly in summer.

The Carnarvon-Foxton associations are used mainly for dairying and fattening sheep.

In the Carnarvon black-Foxton association, the soils of the Carnarvon series were formed under scrub vegetation and have black topsoils (Carnarvon black loamy sand and Carnarvon black sandy loam), whereas in the Carnarvon brown-Foxton association, they were formed under forest and have brown topsoils (Carnarvon brown loamy sand and Carnarvon brown sandy loam).

Foxton-Omanuka (F-0) association

The Foxton-Omanuka association includes the soils of the more consolidated dunes (Foxton series), peaty swamps (Omanuka series) and sand plains (Awahou series and Pukepuké brown soils). It covers only a small area within the county and is generally farmed together with the Pukepuke-Omanuka associations.

Chemical properties

The pH of the sand country soils ranges from slightly alkaline to moderately acid with the majority being moderately to slightly acid. Citric-soluble phosphorus ranges from medium to high, exchangeable calcium ranges from low to very high, and potassium is generally low. Pasture responses to phosphate and potash have been obtained on most of the soils in trials laid down by the Ministry of Agriculture and Fisheries. Copper, cobalt and selenium deficiencies in stock have been reported from the sand country soils.

EXTENDED LEGEND

The extended legend accompanying the Soil Map of Manawatu County, North Island, New Zealand (N.Z. Soil Bureau Map 104), summarises the main morphological and environmental properties (Part 1) and agricultural properties (Part 2) of the soil mapping units. Brief explanatory notes are given below.

EXPLANATORY NOTES

1. SOIL REFERENCE SYMBOL

The soil reference symbol is composed of one or two letters of the series name followed, in the symbols of the soils of the river flats and of the terraces, by a subscript indicating types within the series. For the soils of the sand country, no number is given to distinguish types and phases within a series as these are not shown separately on the soil map. The symbols in brackets listed against the soils of the sand country, represent the associations in which the soil is included on the soil map.

Rolling phases are indicated by R and hill soils by H. These letter symbols are consistent with those used on other soil maps of the Manawatu and Wanganui districts.

2. SLOPE, TOPOGRAPHIC POSITION

Slope classes are those of the Land-form Classes of Taylor and Pohlen (1970).

The classes are:

Flat; flat to gently undulating; easy rolling (most slopes under 5^{o}); rolling (most slopes under 12^{o}); moderately steep (most slopes under 23°; many slopes between 12^{o} and 23^{o}); moderately steep to steep (most slopes under 30^{o}; many slopes between 18° and 30^{o}); steep (many slopes between 30^{o} and 38^{o}); very steep (many slopes of 40^{o} and over).

3. BRIEF DESCRIPTION OF REPRESENTATIVE SOIL PROFILE

The descriptions in this column give the main characteristics of modal profiles. Within the area shown as one unit on the soil map some variation may occur in such characteristics as texture, colour and depth of horizons, especially near soil boundaries.

4. OVERALL DRAINAGE (CLASS)

Overall drainage classes are those given in Taylor and Pohlen (1970) and are based on such profile features as background subsoil colours and mottles, and on observations of seasonal changes in soil moisture conditions and water-table heights on sites which have not been artificially drained.

The classes are:

Very poorly drained; poorly drained; imperfectly drained; moderately well drained; well drained; somewhat excessively drained; excessively drained.

5. SOIL CLASSIFICATION Common Name (Technical Name)

Soil classification is according to that given in "Soils of New Zealand" (N.Z. Soil Bureau 1968).

6. SOIL SET (Soil Set Reference No.)

This column gives the name and reference number of the soil set in which the soil is included in the "General Survey of the Soils of North Island, New Zealand" (N.Z. Soil Bureau 1954).

7. NATURAL NUTRIENT STATUS

These ratings are based on levels of phosphorus, calcium and potassium, and of cation-exchange capacities and base saturations of soil samples taken from untopdressed sites. They are given in relative terms of Low, Medium and High.

8. PASTURE RESPONSES TO TOPDRESSING

Information in this column is based on data supplied by officers of the Ministry of Agriculture and Fisheries, from results of field trials, and from observations of farmers on topdressing responses.

9. SOIL LIMITATIONS TO POTENTIAL USES

In these columns the soils have been classified according to their limitations- to potential pastoral (P), cropping (C), and forestry (F) uses.

Soil Limitations to Potential Pastoral Use

This classification generally follows that of Gibbs (1963). The classes which are not represented in Manawatu County are omitted.

CLASS 1 *SoiJti oh itcut and nollinq land with, minimal to blight boil ZÁjniXatioYii> to pabtofial UAZ*

IA *Limitation* oh nwtAizntb: boitb one. dzzp, wzti dJiainzd, with low to modzhatz fizqaiAzmznti, h*[Qfl] *h&*[c]*&*[J]*&sers*

Rangitikei fine sandy loam
Manawatu sandy loam
Manawatu fine sandy loam
Manawatu silt loam
Karapoti black sandy loam
Karapoti black silt loam

TOTAL AREA: *1 545 ka*

78 *Imítation* to dA.aina.QZ and nutniznt A*

Parewanui sandy loam
Parewanui fine sandy loam
Parewanui silt loam
Parewanui heavy silt loam
Kairanga fine sandy loam
Kairanga silt loam
Kairanga silt loam on sand
Kairanga heavy silt loam
Kairanga peaty silt loam
Meanee-Farndon complex
Opiki silt loam
Makerua peaty silt loam
Makerua peaty loam
Te Arakura silt loam
Te Arakura sandy loam
Hokio sand
Hokio sand, peaty phase
Pukepuke black sand
Piikepuke black sand with concretions
Pukepuke brown loamy sand
Pukepuke brown sandy loam
Pukepuke brown sandy loam, peaty phase
Carnarvon black sandy loam
Carnarvon black loamy sand
Carnarvon brown loamy sand
Carnarvon brown sandy loam
Omanuka peaty sandy loam
Omanuka peaty sandy loam, shallow phase
Omanuka peaty loam
Omanuka peaty loam, shallow phase
Omanuka peaty silt loam
Ohakea silt loam
Tokomaru fine sandy loam
Tokomaru silt loam

Tokoraaru silt loam, rolling phase
Milson silt loam
Milson silt loam, rolling phase
Marton silt loam
Marton silt loam, rolling phase
Halcombe silt loam
Tokorangi sandy loam
Rongotea peaty loam

TOTAL AREA:* *45 145 ha*

CLASS 2 *SolIU, O& &lat and lotting land utiXh modvuvtz &olt UmitatioYU> to paAtoial* o6e.

2A *Limitation* oh inAu^idznt moiAtuJie. and, to a. lu>i>QJi axtznt, nuuOiie.nti>*

Hokio weakly mottled sand
Hokio strongly mottled sand
Himatangi weakly mottled sand
Himatangi sand
Awahou loamy sand
Awahou sandy loam
Pukepuke brown sand
Motuiti sand
Foxton black sand
Foxton brown sand
Foxton brown mottled sand
Rangitikei loamy sand
Rangitikei sandy loam

TOTAL AREA: *14* 275 *ha*

CLASS 3 *SoW>* 0$ *filat and itolSULng land with* •ievete *toll JUmltatLovib to paAtonaZ UML*

3E *LJjruAationb o£ 6ie.que.nt d/iyneAA, and &uAc.ojpti.bWUty to uiind erosion*

Waitarere sand
Unstabilised sand

TOTAL AREA: 3 695 *ha*

* In calculating the areas of the different classes for pastoral use, the soil associations of the sand country have been treated as one unit and their area has been allotted to the class to which the dominant member belongs.

CLASS 4 SOAJU o{, hilly and stze.p land mXh slight to modeAate, soil UmiXatlons to pastoAal use.

4A Limitations o{> nutAlznts

Halcombe hill soils

TOTAL AREA: *4 030 ha*

This classification for potential pastoral use shows that 68% of the soils of Manawatu County (46 700 ha) have only minimal to slight limitations for pastoral use (Class 1) and that the main limitation is one of drainage. On most of the soils this can be corrected by conventional drainage methods with tiles, moles or open ditches. However on some of the more low-lying soils such as Opiki series, Makerua series, Parewanui silt loam, Parewanui heavy silt loam, Kairanga peaty silt loam (totalling 3 800 ha) additional pumping may be required for satisfactory drainage.

Soils of Class 2A are suitable for pastoral farming using suitable techniques of dryland farming or supplementary irrigation, but they may be better used for commercial exotic forestry as this has been shown to give a better economic return than farming (Chisholm 1963).

Soils of Class 3E are not suitable for pastoral farming and would be best used for exotic forestry to prevent encroachment of sand drifts on to inland farming areas.

Soil Limitations to Cropping

This classification of soils according to limitations to cropping is after Cutler (1968) and is for cash crops. The classes which are not represented in Manawatu County are omitted.

CLASS 1 SolU> oh ilat and easy totting land utiXh minimal to Alight soil lúrUXatlons to cAop production

1A Sollb uiiXh only minimal limitations and moi>t suitable, {on. Intensive. cAopplng. Thzy have. i>any loam to silt loam tzx.tan.es iMlth pliable. subsoils and aAe. uod&L to modoAatoZy W2IZ dAalnnd. GinUiaJULy they have. mod&Aatz to high levdU, ofa the. majoA plant nuJJu.e.ntt>. S\xppleme.ntxxAy inAlgatlon may be *Ae.qvJjie, d{, OA some. cAops In summeA. Thexj can* be. o4ed *&OA Intensive. CAopplng such as maAkeX. gaAde.ns, nuAseAles and oAchaAds uiheAe. cultivation Is caAAlzd out thAough most ofi the. yeaA. Topsoll stAuctuAe. deXeAloAatzs howevaAik*

continuous chopping and tkuz i>oitt> need *to* be *peAiodicatty ndhtud in pas tune., on cov&i cn.op& nze.d to* be *gn.own*

Rangitikei fine sandy loam
Manawatu sandy loam
Manawatu fine sandy loam
Manawatu silt loam
Karapoti black sandy loam
Karapoti black silt loam

TOTAL AREA: I 645 *ha*

1C SOAJU> In which impnA^e.ct on. poon. dAainage. is tho. main limitation and which n.&quin.e. anti&idaJl dnainagz on. water-tablz control bn^on.<L they can be *cAoppzd 6ucceA& &utly.* Even *with d/iainagz, cultivation i& di^icult duAing winteA and Apning, and woX condition* would adveAboJLy a^zct •i>u6ce.ptibl<i cH.op&. Thu t>oil£> an.z mo&tly Auitablz ion. continuous annual chopping but wJJk puniodic no^ts in pastxxAz.*

Parewanui sandy loam
Parewanui fine sandy loam
Parewanui silt loam
Kairanga fine sandy loam
Kairanga silt loam
Kairanga silt loam on sand
Kairanga peaty silt loam
Opiki silt loam
Meeanee-Farndon complex
Makerua peaty silt loam
Makerua peaty loam
Te Arakura silt loam
Te Arakura sandy loam
Hokio sand
Hokio sand, peaty phase
Pukepuke black sand
Pukepuke black sand with concretions
Pukepuke brown loamy sand
Pukepuke brown sandy loam
Pukepuke brown sandy loam, peaty phase
Carnarvon black sandy loam
Carnarvon black loamy sand
Carnarvon brown loamy sand
Carnarvon brown sandy loam

TOTAL AREA:* *21 625 ha*

* In calculating the area of the classes, a deduction of 25% has been made in the Himatangi-Motuiti, Pukepuke-Motuiti, Pukepuke-Omanuka, Awahou-Foxton, Carnarvon black-Foxton and Carnarvon brown-Foxton associations to allow for the area of Foxton soils within these associations.

CLASS 2 SoiU oh hloJt and lotting tand with modznatz 6oiZ timXationA to cAop pnoduction: 6oit limitation anz handzn to connzct than thot>z oh Clan 1 and thz nangz oh cnopi that can* be *gnown ii> mom timitzd*

Ik Soiti> with limitation oh in&uhhidznt moiAtunz: AjittlgatJLon would bz tizquitzd ho*[1]* -t^e *production oh mo6t- cAop&, and wind zfio&ion ´u> tikzty with mopping*

Himatangi weakly mottled sand
Himatangi sand
Pukepuke brown sand
Awahou loamy sand
Awahou sandy loam

TOTAL AREA: 9 3?5 *ha*

2B *Soitt> w-Lth timXationi, oh Impzdzd dnainagz and with hzavy tzxtusizd i>u.bt>OAM>. Tkz pzulod vohzn ouJLtAvatJuon can* be *cawlzd oat XM timitzd,* even *with aAtlhicJjoJL dtialnagz, and cAopi an.z tizA&CLctzd to annual mop* £>uch at, cznzaJU, -in flotation uj-ith paAtuJiz. Majox. nutnJiznt IZVZZA OJIZ mainty mzdiim to low but <in &omz oh tkz &OJJU may* be *high.*

Parewanui heavy silt loam
Kairanga heavy silt loam
Ohakea silt loam
Tokomaru fine sandy loam
Tokomaru silt loam
Tokomaru silt loam, rolling phase
Milson silt loam
Milson silt loam, rolling phase
Marton silt loam
Marton silt loam, rolling phase
Halcombe silt loam
Tokorangi sandy loam

TOTAL AREA: *U 640 ha*

CLASS 3 SoiZi, oh h&rt [an]d lotting tand wiXh 4eveAe *boil tinuXationb to cAop production. Thz&z ioiti an.z gznoAatty uniuitablz h[ofl] crop production ai> thzin. timiXationA anz vzry dihhicult on. impossible to connzct.*

3A *Soitb with timitationA oh ihatlownzAA on bandy tzxtusiz, with 4>zniouA moiAtunz dzhidzncy, on tiabtz to* £teo.ue>tt j$£ood<.ng. *Many oh thz hoiti> would* be *Aubjzct to izvznz wind znobion ih cultivatzd.*

Rangitikei loamy sand
Rangitikei sandy loam
Motuiti sand
Foxton black sand

Foxton brown sand
Foxton brown mottled sand
Waitarere sand
Unstabilised sand
Hokio weakly mottled sand
Hokio strongly mottled sand

TOTAL AREA: *12 &55 ha*

38 *SoiZb oh wtt low-lying land with* *>Z\JQAQ. lir/ilbat lonA oh poon to vnny pool. dn. ainagz which is di^icuJUt to correct*

Rongotea peaty loam
Omanuka peaty sandy loam
Omanuka peaty sandy loam, shallow phase
Omanuka peaty loam
Omanuka peaty loam, shallow phase
Omanuka peaty silt loam

TOTAL AREA: 655 *ha*

CLASS 4 SoilA oh hitly and ktzap land with AeveAe. timLtationA oh ilope. and gunzfwJLly unsuitable. Ion. cAop production

Halcombehill soils

TOTAL AREA: 4 030 ha

Soil Limitations to Forestry

The classification of soil limitations to forestry follows that given by Cutler (1968) and is for commercial forestry and farm woodlots, generally with exotic species. The classes which are not represented in Manawatu County are omitted.

CLASS 1 *Soitt> oh hlat, KoVLẃig and hilly land with minimal to blight toil linuXatioYiA to hoiutsiy: theAn 6oili>* OK<L *suitable for &u&tain&d yield oh a widz va/iiety oh trees*

7 A *Soil* w-Lth minimal limitation* to forestry*

Rangitikei fine sandy loam
Manawatu sandy loam
Manawatu fine sandy loam
Manawatu silt loam
Karapoti black sandy loam
Karapoti black silt loam

TOTAL AREA: *1 645 ha*

IB SoilA with Alight lonίXatsionA o{, toil dx.ai.na.QQ. which may limit the. eAtabliAhme.nt ofa borne. Ape.ci.QA

Parewanui fine sandy loam
Kairanga fine sandy loam

TOTAL AREA: 2 230 *ha*

CLASS 2 *SoilA* Q$ *^lat, flatting and hilly land wiXh modenate. toil limiJja&Lovu> to lon.QMtn.y- the. Kongo, ofi Ape.ci.eA which can* be *QUOUM. on the. &OUJ> ofa thiA cla66 i& moio, h.oJ>tAi.cto.d than, in C&u>& 1, but vo<Lth bixitablo. bpo.ci-OM* (e.g. *Pinus radiata) growth mxtoA OAZ modojuxto.*

ZA *Soil* wi£h LmiAjotlonk ofi inAu66i.cie.nt moiAtuAe. and a i>ub6oil pan fieMt/victA.ng Hoot devoJiopmo.nt*

Halcombe hill soils

TOTAL AREA: 4 030 *ha.*

28 *Soiti, with LmiXationA o£ 6urmoA droughtiness*

Motuiti sand
Foxton black sand
Foxton brown sand
Foxton brown mottled sand
Hokio weakly mottled sand
Hokio strongly mottled sand
Himatangi weakly mottled sand
Himatangi sand
Pukepuke brown sand
Awahou loamy sand
Awahou sandy loam

TOTAL AREA: *7 7 660 ha*

CLASS 3 *SoilA ofi filat, rolling and hltZy land with i>e.\)QA.e. i>oil UjnUationA to ioh.eAtn.y- tho. choice ofa &pe.ciej> which can* be *giown AucceAAfiully on the. AOULA o^ thiA claAb iA veny n.QMtnJ.ctzd and thzy one. g^nenally not AUAstable. ^OK. cormeAci.al {oneAtx.y*

3A *SoilA with LLmitatlonA oi i.nAu6ii.cX.e.nt moiAtuno. and pob&ible. damage, by i>alt 6pnay on. by pizquznt 6loodi.ng*

Waitarere sand
Unstabilised sand*
Rangitikei loamy sand
Rangitikei sandy loam

TOTAL AREA: *4 505 ha*

* In areas of unstabilised sand which are sheltered from salt spray or where a seaward protective screen of trees has been planted, suitability and growth of trees may approach that on soils of Class 2B.

3C *Soil* uiiAh poo ft dh.aina.qn and o&tzn uiith buhboiZ panA which fivAtAJfjt fiioot devpJLonmznt*

Parewanui sandy loam
Parewanui silt loam
Parewanui heavy silt loam
Kairanga silt loam
Kairanga silt loam on sand
Kairanga heavy silt loam
Kairanga peaty silt loam
Meeanee-Farndon complex
Opiki silt loam
Makerua peaty silt loam
Makerua peaty loam
Te Arakura silt loam
Te Arakura sandy loam
Ohakea silt loam
Tokomaru fine sandy loam
Tokomaru silt loam
Tokomaru silt loam, rolling phase
Milson silt loam
Milson silt loam, rolling phase
Marton silt loam
Marton silt loam, rolling phase
Halcombe silt loam
Tokorangi sandy loam
Rongotea peaty loam
Hokio sand
Hokio sand, peaty phase
Pukepuke black sand
Pukepuke black sand with concretions
Pukepuke brown loamy sand
Pukepuke brown sandy loam
Pukepuke brown sandy loam, peaty phase
Carnarvon black sandy loam
Carnarvon black loamy sand
Carnarvon brown loamy sand
Carnarvon brown sandy loam
Omanuka peaty sandy loam
Omanuka peaty sandy loam, shallow phase
Omanuka peaty loam
Omanuka peaty loam, shallow phase
Omanuka peaty silt loam

TOTAL AREA: *3S 690 ha*

This classification shows that the area of soils with minimal or slight limitations to forestry is limited in Manawatu County. It is unlikely that they will be used for this purpose as they also have high potentials for cropping and for pastoral use.

Soils with moderate limitations are more extensive and mainly include the somewhat excessively and excessively draining soils of the sand country. Although the choice of species is restricted on these soils, growth of such species as *Pinus radiata* is moderate, and because these soils have low to moderate potentials for cropping and pastoral uses, they offer the greatest scope for commercial forestry in Manawatu County.

Soils of Class 3A are rather marginal for commercial forestry because of their droughtiness and exposure to salt-laden winds. However they also have very severe limitations for pastoral use or for cropping, and they would be best used for protection forestry to achieve stabilisation of the coastal sands and to protect inland farmed areas from encroachment of sand. Once a seaward protective belt of trees is established there is some scope for production forestry along the inland border of these soils.

Soils of Class 3C are considered unsuitable for commercial forestry because of serious soil limitations such as wet winter conditions, compact subsoils limiting root development, and summer droughtiness. Some tree species would be able to tolerate these conditions but, as these soils have a high to moderate potential for pastoral use or for cropping, they are unlikely to be used for forestry.

10. SOIL EROSION

Soil erosion is given according to its severity and type under pastoral use. With soils that may be used for cropping, the potential erosion under this use is also given. Degree of erosion is given in relative terms of nil, slight, moderate, severe, very severe.

11. AREAS OF SOIL MAPPING UNITS

Areas of the soil types and soil associations shown on the soil map of Manawatu County are as follows:

	Area hectares
Rangitikei loamy sand	610
Rangitikei sandy loam	240
Rangitikei fine sandy loam	185
Parewanui sandy loam	250
Parewanui fine sandy loam	650
Parewanui silt loam	515
Parewanui heavy silt loam	285
Manawatu sandy loam	535
Manawatu fine sandy loam	355
Manawatu silt loam	265
Kairanga fine sandy loam	1585
Kairanga silt loam	1355
Kairanga silt loam on sand	515
Kairanga heavy silt loam	310

Kairanga peaty silt loam	1080
Meeanee-Farndon complex	710
Opiki silt loam	115
Makerua peaty silt loam	1595
Makerua peaty loam	220
Karapoti black sandy loam	260
Karapoti black silt loam	45
Te Arakura silt loam	75
Te Arakura sandy loam	720
Ohakea silt loam	6265
Tokomaru fine sandy loam) Tokomaru silt loam)	4865
Tokomaru silt loam, rolling phase	435
Milson silt loam	970
Milson silt loam, rolling phase	2355
Marton silt loam	1635
Marton silt loam, rolling phase	315
Halcombe silt loam	1130
Halcombe hill soils	4030
Tokorangi sandy loam	85
Rongotea peaty loam	250
Hokio-Waitarere association *	3255
Himatangi-Motuiti association *	6910
Pukepuke-Motuiti association *	6130
Pukepuke-Omanuka association *	4635
Awahou-Foxton association *	2265
Carnarvon black-Foxton association *	4810
Carnarvon brown-Foxton association *	1215
Waitarere-Hokio association *	855
Motuiti-Himatangi association *	105
Foxton-Omanuka association *	905
Unstabilised sand	2840
TOTAL AREA:	68 735 ha

These areas (given to nearest 5 ha) were calculated by planimeter measurements and are approximate only.

* Areas of soils of the sand country are not estimated separately but are included in the associations.

BIBLIOGRAPHY

CHISHOLM, A.H. 1963:
An economic comparison of forestry and agriculture.
Discussion Paper No. 30. Department of Agricultural Economics and Farm Management, Massey University, Palmerston North, New Zealand. 153 p.

COWIE, J.D. 1957:
The soils of the Manawatu Sand Country.
Proceedings 5th N.Z. Ecological Society Conference: 17-88.

COWIE, J.D. 1963:
Dune-building phases in the Manawatu District, New Zealand.
N.Z. Journal of Geology and Geophysics 6: 268-80.

COWIE, J.D. 1964a:
Aokautere ash in the Manawatu District, New Zealand.
N.Z. Journal of Geology and Geophysics 7: 67-11.

COWIE, J.D. 1964b:
Loess in the Manawatu District, New Zealand.
N.Z. Journal of Geology and Geophysics 7: 389-96.

COWIE, J.D. 1968:
Pedology of soils from wind-blown sand in the Manawatu District.
N.Z. Journal of Science 11: 459-87.

COWIE, J.D.; FITZGERALD, P.; OWERS, W. 1967:
Soils of the Manawatu-Rangitikei Sand Country.
N.Z. Soil Bureau Bulletin 29: 58 p.

COWIE, J.D'.; KEAR, B.S. ; ORBELL, G.E.; BLAKEMORE, L.C. (in press) :
Soils and agriculture of Kairanga County.
N.Z. Soil Bureau Bulletin 33.

COWIE, J.D.; SMITH,B.A.J. 1958:
Soils and agriculture of the Oroua Downs, Glen Oroua and Taikorea Districts, Manawatu County.
N.Z. Soil Bureau Bulletin 16: 55 p.

CUTLER, E.J.B. 1968:
Soils of the Otago Region.
N.Z. Soil Bureau Publication 351 (reprinted from pp. 35-51 National Resources Survey, Part V - Otago Region, compiled by Town and Country Planning Branch, Ministry of Works).

ESLER, A.E. 1964:
The vegetation of Early Manawatu. pp. 39-44 in "Introducing Manawatu". B.G.R. Saunders and A.G. Anderson (Editors), Department of Geography, Massey University of Manawatu, Palmerston North.

GIBBS, H.S. 1963:
Soils of New Zealand and their limitations for pastoral use. *Proceedings N.Z. Institute of Agricultural Science 9:* 63-79.

N.Z. SOIL BUREAU 1954:
General survey of the soils of North Island, New Zealand. *N.Z. Soil Bureau Bulletin 5 (n.s.):* 286 p.

N.Z. SOIL BUREAU 1968:
Soils of New Zealand, Parts 1, 2 and 3. *N.Z. Soil Bureau Bulletin 26 (1, 2, 3).*

TAYLOR, N.H.; POHLEN, I.J. 1970:
Soil survey method. *N.Z. Soil Bureau Bulletin 25:* 242 p.

TE PUNGA, M.T. 1952:
The geology of the Rangitikei Valley. *N.Z. Geological Survey Memoir 8:* 44 p.

This txtended Legend accompanies:

N.Z. Soil Bureau dap 104 — *Soi£ Map oi MonatW-tu County, Noith l&land. Heu> Zealand*

*ExjplanaXoAy Note** I - 6 — *Lúted on pp. 21 -2* .ot

So-ct& Oj *MaruuoaAu County, Noxth litand,* New Zealand

VoJiX **Oj ff.Z. Soil Survey *Report 30***

E.C. KEATIKG, GO^RMKENT PRIHTER, HELLINSTON, NEW ZEALAND - 1977

EXTENDED LEGEND OF SOIL MAP OF MANAWATU COUNTY, NORTH ISLAND, NEW ZEALAND

PART 2
SUMMARY OF SOME AGRICULTURAL PROPERTIES OF SOIL MAPPING UNITS

J.D. COWIE & W C. R1JKSE
Palmerston North

Part of

NEW ZEALAND SOIL SURVEY REPORT 30

New Zealand Soil Bureau
Department of Scientific and Industrial Research,
Wellington, New Zealand 1977

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[6]
SOILS OF THE RIVER FLATS						
- Rapidly accumulating						
Rl	Rangitikei loamy sand	Medium to low	Grazing	Grazing	Frequent flooding, dries out in summer	No information
R2	Rangitikei sandy loam	Medium	Grazing	Fattening, grazing	Frequent flooding, dries out slightly in summer	No information
R3	Rangitikei fine sandy loam	High to medium	Fattening, dairy-ing, grazing	Fattening, dairying, breeding, cropping if protected from flooding	Frequent flooding, dries out slightly in summer	No information
Pal	Parewanui sandy loam	Medium to high	Dairying, fattening	Dairying, fattening	Frequent flooding if not protected by stopbanks, dries out in summer	Phosphate - slight

Son Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion [10]	Supplementary Notes	Area of Soil topping Unit [u] (hectares)	Soil Reference Symbol
2A	3A	3A	Moderate river-bank erosion	Small areas along Manawatu, Rangitikei and Oroua Rivers. Some areas near the rivers have shallow profiles over gravels and stones.	610	Rl
2A	3A	3A	Moderate river-bank erosion	Small areas along Manawatu, Rangitikei and Oroua Rivers. Some areas show mottling in subsoil and are moderately well drained.	240	R2
1A	1A	1A	Moderate river-bank erosion	Small areas along Manawatu, Rangitikei and Oroua Rivers. Some show mottling in subsoil and are moderately well drained.	185	R3
IB	1C	3C	Slight river-bank erosion, slight wind erosion if cultivated	Moderate areas along the Oroua River, south of the Glen Oroua district.	250	Pal

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
Pa2	Parewanui fine sandy loam	High	Dairying, fattening, cropping	Cropping, dairying, fattening	Imperfect drainage, frequent flooding if not protected by stop-banks.	Phosphate - slight Lime - good
Pa3	Parewanui silt loam	High	Dairying, fattening, cropping	Cropping, dairying, fattening	Poor drainage, frequently flooded if not protected by stop banks, winter pugging.	Phosphate - slight Lime - slight
Pa4	Parewanui heavy silt loam	High	Fattening, dairying	Dairying, fattening, cropping	Drainage, frequently flooded if not protected by stopbanks, winter pugging.	Phosphate - slight Lime - slight

Soil Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit [1J] (hectares)	Soil Reference Symbol
IB	1C	IB	Slight river-bank erosion	Small areas in Moutoa District and along Oroua River.	650	Pa2
IB	1C	3C	Slight river-bank erosion	Moderately extensive in Moutoa district.	515	Pa3
IB	2B	3C	Slight river-bank erosion	Small areas in Moutoa district. Buried topsoils which have strong nut structures occur frequently.	285	Pa4

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
- Slowly accumulating						
Ml	Manawatu sandy loam	High	Dairying, fattening	Market gardening, nurseries, cropping, fattening, dairying	Dries out slightly in summer, topsoil structure deteriorates if frequently cultivated.	Phosphate - slight
M2	Manawatu fine sandy loam	High	Dairying, fattening, cropping	Market gardening, nurseries, cropping, fattening, dairying	Dries out slightly in summer, topsoil structure deteriorates if frequently cultivated.	Phosphate - slight
M3	Manawatu silt loam	High	Dairying, fattening, cropping	Market gardening, nurseries, cropping, dairying, fattening	Dries out slightly in summer.	Phosphate - slight
Kl	Kairanga fine sandy loam	High	Dairying, fattening	Market gardening, nurseries, cropping fattening	Requires some drainage.	Phosphate - slight Lime - good

Soil Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
1A	1A	1A	Slight river-bank erosion, slight wind erosion if cultivated	Small areas along Rangitikei, Oroua and Manawatu Rivers.	535	Ml
1A	1A	1A	Nil	Small areas along Rangitikei, Oroua and Manawatu Rivers.	355	M2
1A	1A	1A	Nil	Small areas along Manawatu, Rangitikei and Oroua Rivers. Includes small areas which are moderately well drained with yellowish brown mottles in subsoils.	265	M3
IB	1C	IB	Nil	Extensive along Manawatu and Oroua Rivers and levees of small streams.	1585	Kl

"Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
K2	Kairanga silt loam	High	Fattening, dairying, cropping	Fattening, dairying, cropping	Winter pugging, requires drainage.	Phosphate - slight Lime - good
K3	Kairanga silt loam on sand	High	Fattening, dairying, cropping	Fattening, cropping, dairying	Winter pugging, requires drainage.	Phosphate - slight Lime - good
K4	Kairanga heavy silt loam	High	Fattening, dairying	Fattening, dairying	Poor drainage, severe winter pugging,	Phosphate - slight Lime - good

Soil Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IIB	1C	3C	Nil	Extensive along Manawatu and Oroua Rivers.	1355	K2
IIB	1C	3C	Nil	Small areas between dunes and Oroua River and north of Moutoa district.	515	K3
IIB	2B	3C	Nil	Moderate areas in Moutoa and Glen Oroua districts.	310	K4

son Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
K5	Kairanga peaty silt loam	High	Fattening, cropping, dairying	Fattening, dairying, cropping	Drainage, slight summer droughtiness (often because of overdrainage).	Phosphate - good Lime - good
MFc	Meeanee-Farndon complex	High	Fattening, dairying	Dairying, fattening, cropping of salt-tolerant crops	Poor drainage, local salinity, danger of flooding.	Phosphate - slight
Op	Opiki silt loam	High	Fattening, cropping, dairying	Fattening, dairying, cropping	Drainage, slight summer droughtiness.	Phosphate - slight Lime - good

Soil Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	1C	3C	Nil	Small areas in Moutoa and Kopane districts. Profiles are transitional to Makerua peaty loam and Opiki silt loam.	1080	K5
18	1C	3C	Nil	Saline mud flats at mouths of Manawatu and Rangitikei Rivers. Soil textures range from sandy loam to clay loam.	710	MFc
IB	1C	3C	Nil	Small area in Kopane district. Peaty horizons in soil profiles are variable in depth. Tree stumps common throughout soil profiles.	115	Op

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
Mrl	Makerua peaty silt loam	High	Flax growing, fattening, dairying	Fattening, dairying, cropping, flax growing	Drainage	Phosphate - good Lime - good
Mr2	Makerua peaty loam	High	Flax growing, fattening	Fattening, cropping, flax growing	Drainage	Phosphate - good Lime - good
- Non-accumulating						
Ktl	Karapoti black sandy loam	Medium	Dairying, fattening	Market gardening, cropping, fattening, dairying	Dries out slightly in summer, A horizon structure deteriorates under continuous cultivation.	Phosphate - good Lime - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IIB	1C	3C	Nil	Large, area in Moutoa district. Many logs occur directly beneath the peaty horizons.	159S	Mrl
IIB	1C	3C	Nil	Small areas in Moutoa district, Many logs occur in the peaty horizons.	220	Mr2
1A	1A	1A	Slight wind erosion if cultivated	Small areas along Rangitikei and Oroua Rivers.	260	Ktl

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Problems	Pasture Responses to Topdressing[8]
Kt2	Karapoti black silt loam	Medium	Dairying, fattening	Market gardening, cropping, dairying, fattening	Dries out slightly in summer	Phosphate - good Lime - good
Tel	Te Arakura silt loam	Medium	Dairying, fattening, some cropping	Fattening, dairying, cropping	Drainage	Phosphate - good Lime - good Potash - ?

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
1A	1A	1A	Nil	Small areas about Awahuri. Some Karapoti black sandy loam is included. Depth of A horizon ranges from 20 to 30 cm.	45	Kt2
IB	1C	3C	Nil	Small areas on river flats between Kopane and Awahuri.	75	Tel

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments^ Extensive Lar se	Pasture Responses to Topdressing[8]
Te2	Te Arakura sandy loam	Medium	Dairying, fattening, some cropping	Fattening, dairying, cropping	Drainage^	Phosphate - good Lime - good Potash - ?

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IIB	iic	3C	Nil	Moderate areas on river flats between Kopane and Awahuri.	720	Te2

.Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
SOILS OF THE TERRACE LAND						
Oh	Ohakea silt loam	Medium	Fattening, dairying, limited cropping	Fattening, dairying, cropping	Drainage, dries out in summer.	Phosphate - good Lime - good Potash - ?
Tl	Tokomaru fine sandy loam	Medium	Fattening, dairying, cropping	Fattening, dairying, cropping	Drainage, dries out in summer.	Phosphate - good Lime - good Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	2B	3C	Nil	Extensive areas in Ohakea and Fielding districts. Includes Ohakea fine sandy loam, which has similar profile characteristics but sandier textures. Deep profiles show some vertical grey veining in lowest horizons.	6265	Oh
IB	2B	3C	Nil	Small areas near the sand country boundary, have sandier soil profiles and fewer iron and manganese concretions than Tokomaru silt loam.	(see T2)	Tl

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
T2 and T2R	Tokomaru silt loam and Tokomaru silt loam, rolling phase	Medium	Fattening, dairying, limited cropping	Fattening, dairying, cropping	Drainage, dries out in summer.	Phosphate - good Lime - good Potash - good
Mn and MnR	Milson silt loam and Milson silt loam, rolling phase	Medium	Fattening, dairying, cropping	Fattening, dairying, cropping	Drainage, dries out in summer.	Phosphate - good Lime - good Potash - good

Stfil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	2B	3C	Sheet erosion on the rolling phase if frequently cultivated	Extensive in Rongotea district. Rolling phase has similar profiles, but topsoils are shallower. Near Rongotea sandier profiles occur near the edges of dissected terraces.	4865 (in cluding 2,145 T1);	T2 and T2R
IB	2B	3C	Slight sheet erosion on rolling phase if frequently cultivated	Extensive areas north of Awahuri and around Sanson. The rolling phase has similar profiles to those of Milson silt loam.	970; 2355	Mn and MnR

Soil Reference Symbol*	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
Ma and MaR	Marton silt loam and Marton silt loam, rolling phase	Medium	Fattening, dairying, cropping	Fattening, cropping, dairying	Drainage, dries out in summer.	Phosphate - good Lime - good Potash - good
Ha	Halcombe silt loam	Medium	Fattening, dairying, cropping	Fattening, dairying, cropping	Drainage, dries out in summer.	Phosphate - good Lime - ? Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	2B	3C	Slight sheet erosion on rolling phase if frequently cultivated	Extensive areas around Mount Stewart and Mount Biggs.	1635; 315	Ma and MaR
IB	2B	3C	Slight sheet erosion on rolling phase if frequently cultivated	Extensive west of Fielding. Some sandier profiles occur with fine sandy loam A horizons and sandy clay loan subsoils.	1130	Ha

Soil Reference Symbol*	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
HaH	Halcombe hill soils	Medium	Fattening, store sheep	Fattening	Slope	Phosphate-good Potash - good Lime - ?
To	Tokorangi sandy loam	Medium	Fattening, dairying	Fattening, dairying	Dries out in summer	Lime - good Phosphate - good

Soil Limitations for Potential Use [9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion [10]	Supplementary Notes	Area of Soil Mapping Unit [11] (hectares)	Soil Reference Symbol
4A	4	2A	Slight slip erosion	Extensive west of Fielding and in Mount Stewart and Mount Biggs areas. Includes small areas of soils on steep slopes with sandier profiles.	4030	HaH
IIB	2B	3C	Slight wind erosion if cultivated	Small areas along eastern bank of Rangitikei River.	85	To

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
Ro	Rongotea sandy loam	High	Fattening, dairying	Fattening, dairying, limited cropping	Drainage	Phosphate - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	ic	3C	Nil	Small areas in Rongotea district.	250	Ro

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
SOILS OF THE SAND COUNTRY						
W (W-H) (H-W)	Waitarere sand	Low	Not utilised, forestry-	Protection and production forestry	Lack of consolidation and liability to wind erosion, excessive drainage$_t$	No information
Ms (Ms-Hm) (Hm-Ms) (P-Ms)	Motuiti sand	Low	Rough grazing, some forestry	Forestry, pasture, light grazing	Droughtiness, wind erosion, difficulty of ploughing.	Potash - good Phosphate - good
F (F-O) CP-O) (A-F) (C-F) (C-F)* (Cb-F)	Foxton black sand	Low	Rough grazing, some forestry	Pasture, light grazing for dairy cattle and sheep, forestry	Droughtiness, difficulty of ploughing.	Phosphate - good Potash - good
F (F-O) (Cb-F) (P-0)	Foxton brown sand	Low	Rough grazing, some forestry	Pasture, light grazing for dairy cattle and sheep	Droughtiness, difficulty of ploughing.	Phosphate - good Potash - good

* C-F clay underlies sand on parts of the sand plains

Soii Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
3E	3A	2B	Severe wind erosion	Occurs in Hokio-Waitarere (H-W) and in Waitarere-Hokio (W-H) associations.	*	W
2A	3A	2B	Moderate wind erosion	Occurs in Motuiti-Himatangi (Ms-Hm), Himatangi-Motuiti (Hm-Ms), and Pukepuke-Motuiti (P-Ms) associations. Livestock responses to Cu, Co and Se.	*	Ms
2A	3A	2B	Slight wind erosion	Occurs in Pukepuke-Omanuka (P-0), Awahou-Foxton (A-F), Carnarvon black-Foxton (C-F, C-F), Carnarvon brown-Foxton (Cb-F) and Foxton-Omanuka (F-0) associations. Livestock responses to Cu and Se.	*	F
2A	3A	2B	Slight wind erosion	Occurs in Pukepuke-Omanuka (P-0), and Carnarvon brown-Foxton (Cb-F) associations. Livestock responses to Cu and Se.	*	F

Soil Reference Symbol*	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
F (Cb-F) **(P-0)**	Foxton brown mottled sand	Low	Rough grazing, some dairying	Pasture, light grazing for dairy cattle and sheep, forestry	Droughtiness,	Phosphate - good Potash - good
H (H-W) (W-H)	Hokio weakly mottled sand. and Hokio strongly mottled sand	Low	Fattening, dairying, forestry	Forestry, pasture, light grazing	Droughtiness, erosion.	Phosphate - good Potash - good
H (H-W) (W-H)	Hokio sand	Medium	Dairying, fattening	Dairying, fattening	Surface water in winter, encroachment by drifting sand.	Phosphate - good Potash - good
H (H-W) (W-H)	Hokio sand, peaty phase	Medium	Dairying, fattening, forestry	Dairying, fattening	Surface water in winter, encroachment by drifting sand.	Phosphate - good Potash - good

"Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
2A	3A	2B	Slight wind erosion	Occurs in Carnarvon brown-Foxton (Cb-F), Pukepuke-Omanuka (P-O), and Foxton-Omanuka (F-O) associations. Livestock responses to Cu and Se.	*	F
2A	3A	2B	Slight wind erosion; severe wind erosion if cultivated	Occurs in Hokio-Waitarere (H-W) and in Waitarere-Hokio (W-H) associations; gravels underlie sand in a small area south of Tangimoana. Livestock responses to Cu and Se.	*	H
IB	1C	3C	Slight wind erosion if cultivated	Mapped in Hokio-Waitarere (H-W) and in Waitarere-Hokio (W-H) associations. Livestock responses to Cu and Se.	*	H
IB	1C	3C	Nil	Occurs in Hokio-Waitarere (H-W) and in Waitarere-Hokio (W-H) associations. Livestock responses to Cu and Se.	*	H

Soil Reference Symbol[1]	Soil Name	Nat. Status	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[2]
Hm (Hm-Ms) (Ms-Hm)	Himatangi weakly mottled sand	Medium	Winter grazing, fattening, some forestry, dairying	Forestry, fattening, winter grazing	Droughtiness, erosion.	Phosphate - good Potash - good
Hm (Hm-Ms) (Ms-Hm)	Himatangi sand	Low to medium	Winter grazing, fattening, dairying	Forestry, fattening, winter grazing	Droughtiness,	Phosphate - good Potash - good
P (P-Ms)	Pukepuke black sand	Medium	Dairying, fattening, market gardening, cropping	Dairying, fattening, cropping, market gardening	Drainage, surface water in winter.	Phosphate - good Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
2A	2A	2B	Slight to moderate wind erosion; severe wind erosion if cultivated	Occurs in Himatangi-Motuiti (Hm-Ms) and Motuiti-Himatangi (Ms-Hm) associations; in some areas the depth of A horizon is less than 15 cm. Livestock responses to Cu and Se.	*	Hm
2A	2A	2B	Slight wind erosion; severe wind erosion if cultivated	Occurs in Himatangi-Motuiti (Hm-Ms) and Motuiti-Himatangi (Ms-Hm) associations. In some areas the depth of A horizon is less than 15 cm. Livestock responses to Cu, Co and Se.	*	Hm
IB	1C	3C	Slight wind erosion if cultivated	Mapped in Pukepuke-Motuiti (P-Ms) association. Livestock responses to Cu and Se.	*	P

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
P (P-Ms)	Pukepuke black sand with concretions	Medium	Dairying, fattening	Dairying, fattening, cropping	Drainage, surface water in winter,	Phosphate - good Potash - good
P (P-O)	Pukepuke brown sand	Medium	Dairying, fattening	Dairying, fattening, forestry	Droughtiness,	Phosphate - good Potash - good
P (P-0)	Pukepuke brown loamy sand	Medium	Dairying, fattening	Dairying, fattening, cropping	Surface water in winter.	Phosphate - good Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	1C	3C	Slight wind erosion if cultivated.	Mapped in Pukepuke-Motuiti (P-Ms) association. Livestock responses to Cu and Se.	*	P
IB	2A	2B	Moderate wind erosion if cultivated	Mapped in Pukepuke-Omanuka (P-0) association. Livestock responses to Cu and Se.	*	P
IB	1C	3C	Slight wind erosion if cultivated	Mapped in Pukepuke-Omanuka (P-0) association. Livestock responses to Cu and Se.	*	P

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
P (P-O)	Pukepuke brown sandy loam and Pukepuke brown sandy loam, peaty phase	Medium	Dairying, fattening	Dairying, fattening, cropping	Drainage, surface water in winter and spring,	Phosphate - good Potash - good
A (A-F)	Awahou loamy sand and Awahou sandy loam	Low to medium	Fattening, some dairying	Fattening, dairying, forestry	Surface water in winter.	Phosphate - good Potash - good

•Son Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion	Supplementary Notes[10]	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	1C	3C	Slight wind erosion if cultivated	Mapped in Pukepuke-Omanuka (P-O) association. The peaty phase has peaty sandy loam topsoils. On low mounds the concretions form a vesicular pan in the topsoil and such areas dry out quickly in summer. Livestock responses to Cu and Se.	*	P
2A	2A	2B	Moderate wind erosion if cultivated	Mapped in Awahou-Foxton (A-F) association. Livestock responses to Cu and Se.	*	A

Soil Reference Symbol*	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
C (C-F) (C-F)	Carnarvon black sandy loam and Carnarvon black loamy sand	Medium	Dairying, fattening	Fattening, dairying, cropping	Surface water in winter.	Phosphate - good Potash - good
Cb (Cb-F)	Carnarvon brown loamy sand	Medium	Dairying, fattening	Dairying, fattening, cropping	Surface water in winter.	Phosphate - good Potash - good
Cb (Cb-F)	Carnarvon brown sandy loam	Medium	Dairying, fattening	Dairying, fattening, cropping	Drainage.	Phosphate - good Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class)	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares)	Soil Reference Symbol
IB	1C	3C	Slight wind erosion if cultivated	Mapped in Carnarvon black-Foxton (C-F) association. In places are underlain by clay loam within 25 cm of the surface. Livestock responses to Cu and Se.	*	C
IB	1C	3C	Slight wind erosion if cultivated	Occurs in Carnarvon brown-Foxton (Cb-F) association. Livestock responses to Cu and Se.	*	Cb
IB	1C	3C	Nil	Occurs in Carnarvon brown-Foxton (Cb-F) association. Livestock responses to Cu and Se.	*	Cb

Soil Reference Symbol[1]	Soil Name	Natural Nutrient Status[7]	Present Land Use	Potential Land Use	Impediments to Extensive Land Use	Pasture Responses to Topdressing[8]
0 (P-Ms)	Omanuka peaty sandy loam	Medium	Dairying, flax growing, much in scrub or flax	Reserves for wild life, dairying, fattening	Drainage, artificial drainage difficult-	Phosphate - good Potash - good
0 (P-Ms) (P-0) (F-O) (C-F)(C-F) (Cb-F)	Omanuka peaty loam and Omanuka peaty silt loam	Medium	Much in scrub and flax, some rough grazing	Reserves for wild life, dairying, fattening	Drainage, artificial drainage difficult.	Phosphate - good Potash - good
0 (P-Ms) (P-0) (C-F)(C-F) (Cb-F)	Omanuka peaty sandy loam, shallow phase and Omanuka peaty loam, shallow phase	Medium	Rough grazing	Dairying, fattening	Drainage.	Phosphate - good Potash - good

Soil Limitations for Potential Use[9] Pastoral (Class)	Cropping (Class)	Forestry (Class	Soil Erosion[10]	Supplementary Notes	Area of Soil Mapping Unit[11] (hectares	Soil Reference Symbol
IIB	3B	3C	Nil	Occurs in Pukepuke-Motuiti (P-Ms) association. Livestock responses to Cu and Se.	*	0
IIB	3B	3C	Nil	Mapped in Pukepuke-Motuiti (P-Ms), Pukepuke-Omanuka (P-O), Carnarvon black-Foxton (C-F), Carnarvon brown-Foxton (Cb-F), and Foxton-Omanuka (F-O) associations. Livestock responses to Cu and Se.	*	0
IIB	3B	3C	Nil	Mapped in Pukepuke-Motuiti (P-Ms), Pukepuke-Omanuka (P-O), Carnarvon black-Foxton (C-F), and Carnarvon brown-Foxton (Cb-F) associations. Livestock responses to Cu and Se.	*	0

* see p. 32 explanatory notes

This Extended Legend accompanies:

N.Z. Soil Bureau Map 104 — *Soil Map of, Manawata County, NoJtfh IAland, New Zealand*

*Explanatory Note** I, 7-7 7 — *ti&te.d on pp. 21-32* -in *Soils* 0(5 *Manauoatu County, HonJth Island, New Zealand*

Part of ***N.Z. Soil Survey Report 30***

E.C. KEATING, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND - 1977

EXTENDED LEGEND OF SOIL MAP OF MANAWATU COUNTY, NORTH ISLAND, NEW ZEALAND

PART 1
SUMMARY OF SOIL PROPERTIES OF SOIL MAPPING UNITS

J.D. COWIE S W.C. RIJKSE
Palmerston North

Part of

NEW ZEALAND SOIL SURVEY REPORT 30

New Zealand Soil Bureau
Department of Scientific and Industrial Research,
Wellington, New Zealand 1977

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
SOILS OF THE RIVER FLATS				
- Rapidly accumulating				
Rl	Rangitikei loamy sand	River alluvium	Flat, low river flats bordering rivers	0 - 8 cm greyish brown loamy sand; loose; single grain, on grey sand or gravel.
R2	Rangitikei sandy loam	River alluvium	Flat, low river flats bordering rivers	0 - 8 cm greyish brown sandy loam; friable; weak nut structure, on grey loamy sand and sand.
R3	Rangitikei fine sandy loam	River alluvium	Flat, low river flats bordering rivers	0 - 20 cm dark greyish brown fine sandy loam; very friable; weak nut structure, on olive grey fine sand.
Pal	Parewanui sandy loam	River alluvium	Flat, low-lying river basin	0 - 10 cm dark greyish brown sandy loam to loamy sand; very friable; weak nut structure, 10 - 48 cm olive to olive grey sand; loose; single grain; many coarse yellowish brown mottles, on olive grey sand; loose; single grain; few yellowish brown mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)[4]	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs on frequently flooded river flats. Sandy soil with shallow A horizon, on sand or gravel. Differs from Rangitikei sandy loam in having coarse textures and shallow soil profiles.	Excessively and somewhat excessively drained	Rapidly accumulating recent soil (very weakly enleached strongly accumulative luvic soil)	Tukituki soils (lc)	Rl
Occurs on frequently flooded river flats. Sandy soil with shallow A horizon. Differs from Manawatu soil in having shallower and less well defined A horizon and no B horizon.	Somewhat excessively drained	Rapidly accumulating recent soil (very weakly enleached strongly accumulative luvic soil)	Tukituki and Esk soils (lc and lb)	R2
Occurs on frequently flooded river flats. Has deeper and finer textured A horizon than Rangitikei sandy loam.	Well drained	Moderately accumulating recent soil (moderately accumulative very weakly enleached luvic soil)	Manawatu soils (1)	R3
Occurs on parts of frequently flooded river basins. Has poorly defined, often shallow A horizon and sandy texture. Differs from Parewanui fine sandy loam in its coarser texture, and from Rangitikei sandy loam in having poorer drainage, and mottles.	Imperfectly drained	Rapidly accumulating gley recent soil (strongly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	Pal

Soil-Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Pa2	Parewanui fine sandy loam	River alluvium	Flat, low-lying river basin	0 - 18 cm olive grey fine sandy loam; many fine yellowish brown mottles; friable; weak nut structure, 18 - 56 cm olive grey fine loamy sand; abundant yellowish brown mottles; friable; weak blocky structure, on grey fine sand; firm; massive; many brown mottles.
Pa3	Parewanui silt loam	River alluvium	Flat, low-lying river basin	0 - 23 cm olive grey silt loam; friable; nut structure; abundant reddish brown mottles, 23 - 36 cm dark grey silt loam; friable; strong nut structure; abundant reddish brown mottles, on grey clay; sticky, slightly plastic; weak blocky structure; many yellowish brown mottles.
Pa4	Parewanui heavy silt loam	River alluvium	Flat, low-lying river basin	0 - 25 cm dark greyish brown heavy silt loam; friable; moderate nut structure; abundant fine yellowish brown mottles; 25 - 58 cm greyish brown clay; firm; weak nut structure; abundant yellowish brown mottles, on grey clay loam; sticky, plastic; weak blocky structure; many yellowish brown mottles.

distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occurs on slightly higher parts of frequently flooded river basins. Has poorly defined A horizon and sandy texture. Differs from Parewanui silt loam in its slightly higher position and sandier textures, and from Rangitikei fine sandy loam in having poorer drainage, and mottles.	Imperfectly drained	Rapidly accumulating gley recent soil (strongly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	Pa2
Occurs on low-lying frequently flooded river basins. Has poorly defined A horizon with reddish brown mottles on grey mottled clay; buried horizons common in the Moutoa area. Differs from Parewanui fine sandy loam in being poorly drained and heavy textured.	Poorly drained	Rapidly accumulating gley recent soil (strongly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	Pa3
Occurs on low-lying parts of frequently flooded river basins. Has poorly defined heavy silt loam to silty clay loam A horizon on grey mottled clay. Differs from Parewanui silt loam in being more poorly drained and heavy textured.	Poorly drained	Rapidly accumulating gley recent soil (strongly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2 and 2a)	Pa4

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
_ Slowly accumulating				
Ml	Manawatu sandy loam	River alluvium	Flat, river levees	0 - 20 cm very dark greyish brown sandy loam; friable; weak nut structure, 20 - 48 cm pale olive brown loamy sand; friable; weak nut structure, on olive sand; loose; single grain.
M2	Manawatu fine sandy loam	River alluvium	Flat, river levees	0 - 25 cm dark greyish brown fine sandy loam; friable; moderate nut structure, 25 - 43 cm olive brown fine sandy loam; firm; weak nut structure, on olive brown fine sand; firm; massive.
M3	Manawatu silt loam	River alluvium	Flat, river levees	0 - 23 cm brown silt loam; friable; moderate nut structure, 23 - 74 cm pale olive brown silt loam; firm; moderate nut structure, on pale olive brown fine sandy loam; firm; massive.
Kl	Kairanga fine sandy loam	River alluvium	Flat, higher parts of river basins and lower parts of levees	0 - 20 cm dark greyish brown fine sandy loam; friable; moderate nut structure; 20 - 41 cm grey fine sandy loam; slightly firm; moderate nut structure; many yellowish brown mottles, on grey fine loamy sand; firm; massive; many yellowish brown mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)[4]	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs on infrequently flooded river levees. Has brownish sandy loam A horizon, on olive brown loamy sand B horizon. Differs from Rangitikei series in having deeper and better defined A horizon and B horizon.	Somewhat excessively drained to well drained	Slowly accumulating recent soil (weakly accumulative weakly enleached luvic soil)	Manawatu soils (1)	Ml
Occurs on infrequently flooded river flats. Differs from Manawatu sandy loam in having finer textures.	Well drained	Slowly accumulating recent soil (weakly accumulative weakly enleached luvic soil)	Manawatu soils (1)	M2
Occurs on infrequently flooded river flats. Texture is silt loam on fine sandy loam. Differs from Manawatu fine sandy loam in having finer textures.	Well drained	Slowly accumulating recent soil (weakly accumulative weakly enleached luvic soil)	Manawatu soils (1)	M3
Occurs on transitional areas between river basins and levees. Has fine sandy loam texture and grey to olive grey subsoil with brown mottles. Differs from Manawatu series in having poorer drainage with grey subsoils and mottles, and differs from Parewanui series in having a better defined A horizon.	Imperfectly drained	Slowly accumulating gley recent soil (weakly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	Kl

Soil "Reference Symbol *	Soil Name	Parent. Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
K2	Kairanga silt loam	River alluvium	Flat, low-lying river basin	0 - 18 cm dark greyish brown silt loam; friable; moderate nut structure; reddish mottles along root channels, 18 - 33 cm grey clay loam to heavy silt loam; firm; weak nut structure; many yellowish brown mottles, on grey clay to clay loam; firm; weak blocky structure; many yellowish brown mottles.
K3	Kairanga silt loam on sand	River alluvium	Flat, low-lying river basin near sand dunes	0 - 18 cm very dark brown silt loam; friable; moderate nut structure, 18 - 33 cm grey clay loam; firm; weak blocky structure; yellowish brown mottles along root channels, on grey sand; firm; massive; abundant yellowish brown mottles.
K4	Kairanga heavy silt loam	River alluvium	Flat, low-lying river basins	0 - 18 cm dark greyish brown heavy silt loam; friable; moderate nut structure; reddish brown mottles along root channels, 18 - 38 cm light grey clay loam; firm; moderate blocky structure; many yellowish brown mottles, on bluish grey clay; firm; weak blocky structure; abundant yellowish brown mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs on infrequently flooded river basins. Has silt loam A horizon, on grey heavy silt loam to clay subsoil with brown mottles. Differs from Kairanga fine sandy loam in having poorer drainage and heavier textures and from Parewanui silt loam in having darker coloured and better defined A horizon.	Poorly drained	Slowly accumulating gley recent soil (weakly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	K2
Occurs on infrequently flooded river basins near sand country. Similar to Kairanga silt loam but medium textured sand occurs at 25 to 50 cm depth.	Poorly drained	Slowly accumulating gley recent soil (weakly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2)	K3
Occurs on low-lying parts of infrequently flooded river basins. Has heavy silt loam to clay loam A horizon with brown mottles, on grey to bluish grey clay with brown mottles. Has poorer drainage and heavier texture than Kairanga silt loam.	Poorly to very poorly drained	Slowly accumulating gley recent soil (weakly accumulative weakly enleached madenti-luvic soil)	Kairanga soils (2 and 2a)	K4

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
K5	Kairanga peaty silt loam	River alluvium and peat	Flat, low-lying river basins	0 - 15 cm dark brown peaty silt loam to silt loam; friable; moderate to strong granular and nut structure, 15 - 38 cm very dark greyish brown peaty silt loam; friable; moderate nut structure; pockets of greyish brown silt loam, on grey silty clay; firm; weak coarse blocky structure.
MFc	Meeanee-Farndon complex	Estuarine alluvium	Flat, low-lying flats at river mouths	0 - 15 cm brownish grey silt loam; friable; weak nut structure; yellowish brown mottles along root channels, 15 - 36 cm grey heavy silt loam; firm; weak blocky structure; many fine reddish brown mottles, on grey clay loam; firm; weak blocky structure; many fine reddish brown mottles.
Op	Opiki silt loam	River alluvium and peat	Flat, very low-lying river basins	0 - 25 cm grey silt loam; friable; moderate granular structure; peaty in places; reddish brown mottles along root channels, 25 - 53 cm very dark brown peaty loam; friable; weak nut structure; abundant reddish brown mottles, on bluish grey clay.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)"	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol *
Occurs on low-lying parts of infrequently flooded river basins. Has brown slightly peaty A horizon with granular structure, on grey to greyish brown clay to silty clay. Differs from Kairanga silt loam in having a slightly peaty A horizon and stronger developed structures in the upper horizons.	Very poorly to poorly drained	Slowly accumulating gley -recent soil (weakly accumula-tive weakly enleached madenti-luvic soil)	Opiki soils (2b)	K5
Occurs in estuarine areas. Has silt loam **A horizon grading down** to mottled clay **loam; slightly** to moderately saline.	Poorly drained	Weakly accumulating saline gley recent soils (weakly accumulative saline madenti-luvic soils)	Meeanee-Farndon soils (111)	MFc
Occurs on low-lying parts of infrequently flooded river basins around peaty swamps. Has silt loam A horizon, on bluish grey clay w^th layers of peaty loam. Distinguished from Kairanga soils by presence of peaty layers.	Very poorly to poorly drained	Slowly accumulating gley recent soil (weakly accumulative weakly enleached madenti-luvic soil)	Opiki soils (2b)	Op

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Mrl	Makerua peaty silt loam	Peat and river alluvium	Flat, very low-lying swamps	0 - 8 cm very dark greyish brown peaty silt loam; friable; moderate granular structure; many reddish brown mottles along root channels, 8 - 66 cm dark brown peaty silt loam; friable; moderate granular structure, on very dark greyish brown silty clay loam; firm; weak blocky structure.
Mr2	Makerua peaty loam	Peat and river alluvium	Flat, very low-lying swamps	0 - 3 cm peaty turf, 3 - 46 cm dark reddish brown peaty loam; friable; weak crumb structure, 46 - 69 cm very dark greyish brown peaty silt loam; friable; moderate nut structure; few dark yellowish brown mottles, on dark greyish brown silty clay; very sticky, very plastic; weak coarse blocky structure; abundant dark yellowish brown mottles.
	Non-accumulating			
Ktl	Karapoti black sandy loam	River alluvium	Flat, levees of former stream and river courses	0 - 30 cm black to very dark brown sandy loam; friable; moderate nut structure, 30 - 64 cm olive to pale olive loamy sand; friable; weak blocky structure; few reddish brown mottles, on pale olive sand; firm; massive.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs in low-lying infrequently flooded swamps. Has more than 50 cm of peaty silt loam on brown silty clay loam or silty clay.	Very poorly to poorly drained	Organic soil (weakly enleached luvi-platic soil)	Makerua soils (107)	Mrl
Occurs in low-lying infrequently flooded swamps. Has more than 50 cm of peaty loam on dark greyish brown silty clay and has higher organic matter content than Makerua peaty silt loam.	Very poorly to poorly drained	Organic soil (weakly enleached luvi-platic soil)	Makerua soils (107)	Mr2
Occurs on levees of former stream and river courses now above flood level. Has deep black to very dark brown, sandy loam A horizon, on pale olive loamy sand to sand with mottles in the upper part. Differs from Manawatu series in having darker coloured A horizon and mottled subsurface horizons.	Somewhat excessively drained	Non-accumulating recent soil (weakly enleached non-accumulative luvic soil)	Manawatu soils (1)	Ktl

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Kt2	Karapoti black silt loam	River alluvium	Flat, levees of former stream and river courses	0 - 30 cm very dark grey to black silt loam; friable; strong nut structure, 30 - 80 cm light olive brown fine loamy sand; slightly firm; weak nut structure; few grey and yellowish brown mottles, on olive grey fine loamy sand; slightly firm; massive; many fine yellowish brown mottles along root channels.
Tel	Te Arakura silt loam	River alluvium	Flat, low-lying areas	0 - 18 cm greyish brown silt loam; friable; weak nut structure, 18 - 43 cm olive sandy clay loam; many reddish brown mottles; friable; moderate nut structure; many concretions, 43 - 63 cm olive grey sandy clay loam; abundant reddish brown and strong brown mottles; firm; weak blocky structure, on olive grey sandy clay loam; many strong brown and yellowish brown mottles; firm; weak blocky structure; some black manganese concretions.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[x]
Occurs on levees of former stream and river courses now above flood level. Differs from Karapoti sandy loam in having silt loam A horizon and fine sandy loam B horizon.	Well drained	Non-accumulating recent soil (weakly enleached non-accumulative recent soil)	Manawatu soils (1)	Kt2
Occurs on low-lying river flats now free of flooding. Has greyish brown silt loam A horizon overlying olive grey sandy clay loam with reddish brown mottles and some concretions beneath the A horizon. Differs from Te Arakura sandy loam in being poorly drained and heavy textured and from Kairanga silt loam in being non-accumulating and having concretions in the subsoil.	Poorly drained	Gley soil (weakly enleached madentic soil)	Kairanga soils (2)	Tel

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Te2	Te Arakura sandy loam	River alluvium	Flat, transitional areas between old river levees and lower lying flats	0 - 23 cm very dark grey sandy loam; friable; moderate nut structure, 23 - 43 cm olive grey sandy loam; abundant reddish brown mottles; friable; weak blocky structure; iron concretions in upper part of horizon, on olive grey loamy sand; many strong brown and yellowish brown mottles; firm; weak blocky structure.

Bistinguishing Features of Soil and Environment	Overall Drainage (Class)[4]	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[7]
Occurs on transitional areas between old river levees and lower lying flats. Has sandy loam to fine sandy loam A horizon on olive grey sandy loam to loamy sand with reddish brown slightly hard mottles. Differs from Kairanga fine sandy loam being non-accumulating and having slightly hard mottles.	Imperfectly drained	Gley soil Cweakly enleached -madentic soil)	Kairanga soils (2)	Te2

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
SOILS OF THE TERRACE LAND				
Oh	Ohakea silt loam	Colluvium, loess and alluvium	Flat, low terrace	0 - 20 cm dark greyish brown silt loam; friable; moderate nut structure; few yellowish brown mottles, 20 - 46 cm light yellowish grey heavy silt loam; coBipact; weak blocky structure; many yellowish brown mottles; some iron and manganese concretions, on grey sandy clay loam; hard; weak to moderate blocky structure; many yellowish brown mottles.
Tl	Tokomaru fine sandy loam	Loess overlying wind-blown sand	Flat, high terrace	0 - 18 cm dark greyish brown fine sandy loam; friable; weak nut structure, 18 - 28 cm light grey sandy clay loam; friable; moderate blocky structure; many yellowish brown mottles; few black concretions, 28 - 48 cm grey sandy clay loam; compact; massive; abundant yellowish brown and strong brown mottles, on brown sand; firm; massive.

{distinguishing Features of Soil and Environment	Overall Drainage (Class)"	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs on low terraces. Has greyish brown silt loam A horizon on yellowish grey to olive grey compact heavy silt loam to sandy clay loam with yellowish brown mottles and concretions. Greywacke gravels occur below 120 cm. Differs from Tokomaru silt loam in having less well developed profile with no fragipan, little or no ganimation and gravels below 120 cm depth.	Imperfectly and poorly drained	Moderately to strongly gleyed ye How-grey earth (weakly clay illuvial weakly enleached pseudomadenti-pallic soil)	Ohakea soils (12)	Oh
Similar to Tokomaru silt loam, but textures are sandier and the lower subsoil is brown sand.	Imperfectly drained	Moderately to strongly gleyed yellow-grey earth (moderately clay illuvial weakly enleached pseudomadenti-pallic soil)	Tokomaru soils (13)	Tl

Soil-Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
T2 and T2R	Tokomaru silt loam and Tokomaru silt loam, rolling phase	Loess	Flat and rolling, high terrace slightly dissected in places	0 - 18 cm dark greyish brown silt loam; friable; weak nut structure; many yellowish red mottles in lower part, 18 - 36 cm light grey heavy silt loam; friable; weak nut structure; many yellowish red mottles; many dusky red concretions, 36 - 66 cm light olive grey clay loam; firm; weak blocky structure; many strong brown mottles; weakly developed clay coating^ 66 - 96 cm light olive brown sandy clay loam; very firm; massive; many light olive grey mottles; few vertical grey veins, on pale olive fine sandy loam; firm; weak blocky structure; abundant yellowish red mottles.
Mn and MnR	Milson silt loam and Milson silt loam, rolling phase	Loess	Flat to rolling disse ted terrace	0 - 18 cm dark greyish brown silt loam; friable; moderate nut structure, 18 - 43 cm light olive grey silt loam; firm; weak blocky structure; many yellowish brown mottles £ concretions, 43 - 69 cm olive clay loam; firm; moderate blocky structure; abundant strong brown and yellowish brown mottles; moderately developed clay coatings, on olive and pale olive clay loam; very firm; moderate prismatic structure; abundant yellowish brown mottles; vertical grey veins; moderate clay coatings.

•distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occur on intermediate terraces. Have silt loam A horizons on grey to olive clay loam subsoil with strong brown mottles and clay coatings in lower part. A fragipan with grey veining occurs at about 75 cm depth. Differ from Ohakea silt loam in having more developed profile with clay coatings, fragipan, and grey veining.	Poorly and imperfectly drained	Moderately to strongly gleyed ..yeHow-grey earths (moderately clay llluvial weakly enleached pseudomadenti-pallic soils)	Tokomaru soils (13)	T2 and T2R
Occur on intermediate terraces. Have silt loam A horizons on olive to olive grey clay loam with yellowish brown mottles and clay coatings. A fragipan with grey veining occurs at about 75 cm. Differ from Tokomaru silt loam in having greater development of clay coatings and is considered intermediate between Tokomaru silt loam and Marton silt loam.	Poorly and imperfectly drained	Strongly gleyed yellow-grey earths (moderately to strongly clay illuvial weakly enleached pseudomadenti-pallic soils)	Milson soils (13a)	Mn and MnR

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Ma and MaR	Marton silt loam and Marton silt loam, rolling phase	Loess	Flat to rolling, dissected high terrace	0 - 20 cm dark greyish brown silt loam; friable; moderate nut structure, 20 - 43 cm light grey clay; firm; moderate blocky structure; many strong brown mottles; many iron concretions; well developed clay coatings, on olive clay; firm; moderate blocky; many pale olive and yellowish brown mottles; many clay coatingsi vertical grey veins at lower depths.
Ha	Halcombe silt loam	Loess and sandstone	Rolling, valley sides	0 - 20 cm greyish brown silt loam; friable; weak nut structure, 20 - 30 cm greyish brown clay loam; firm; moderate blocky structure; few yellowish brown mottles, on light grey clay loam; compact; weak to moderate blocky structure; abundant yellowish brown and strong brown mottles.

Bistinguishing Features of Soil and Environment	Overall Drainage (Class)[4]	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[7]
Occur on flattish to undulating surfaces of high terraces. Have silt loam A horizons on light grey to olive clay subsoil with yellowish brown mottles, well developed clay coatings, and moderately to strongly developed blocky structure. Differ from Tokomaru silt loam and Milson silt loam in having heavier textured subsoil with greater development of clay coatings and more well developed blocky structure.	Poorly and imperfectly drained	Strongly gleyed yellow-grey earths (strongly clay illuvial weakly enleached pseudomadenti-pallic soils)	Marton soils (13c)	Ma and MaR
Occurs on rolling valley sides and is formed from loess on sandstone. Has greyish brown silt loam A horizon on greyish brown and light grey clay loam with a few mottles which passes down to compact light grey clay loam with many mottles. Differs from Tokomaru, Milson and Marton soils in having slightly browner subsurface horizon and less well developed profile.	Moderately well to imperfectly drained	Moderately gleyed yellow-grey earth (moderately clay illuvial weakly enleached pseudomadenti-pallic soils)	Halcombe soils (13b)	Ha

Soil Reference Symbol*	Soil Name	Parent Material	Slope[2], Topographical Position	Brief Description of Representative Soil Profile[3]
HaH	Halcombe hill soils	Sandstone, greywacke gravels and loess	Moderately steep and moderately steep to steep, valley sides	0 - 18 cm dark greyish brown fine sandy loam; friable; weak nut structure, 18 - 30 cm light yellowish brown fine sandy loam; friable; weak blocky structure; many strong brown mottles, 30 - 61 cm light olive grey heavy silt loam; compact; weak blocky structure; many yellowish brown and strong brown mottles, on light olive grey fine sandy loam; compact; massive; many yellowish brown mottles.
To	Tokorangi sandy loam	Wind-blown sand	Easy rolling to rolling old river sand dunes	0 - 20 cm very dark greyish brown sandy loam; very friable; weak nut structure, 20 - 76 cm olive to pale olive sandy loam; firm; weak blocky structure; many strong brown mottles; weakly developed clay coatings, on pale olive brown loamy sand; firm; massive; few light grey mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)[4]	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occur on moderately steep sides of valleys dissecting the terraces. Have fine sandy loam A horizons on light olive grey compact heavy silt loam with brown mottles.	Moderately well drained	Weakly to moderately gleyed yellow-grey earths (weakly clay illuvial weakly enleached pseudomadenti-pallic soils)	Halcombe hill soils (13b H)	HaH
Occurs on old dunes formed from wind-blown sand from braided courses of rivers. Has very dark greyish brown sandy loam A horizon and olive to pale olive firm subsoil with indistinct clay coatings and many mottles. Differs from Tokomaru silt loam in having coarser texture and less weakly developed profile.	Moderately well drained	Weakly gleyed weakly clay illuvial yellow-grey earth (weakly gleyed weakly clay illuvial weakly enleached voli-pallic soil)	Tokomaru and Kiwitea soils (13 and 76a)	To

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Ro	Rongotea peaty loam	Peat and colluvium	Flat, floors of valleys dissecting terraces	0 - 23 cm very dark brown peaty loam; very friable; moderate nut structure; many reddish yellow mottles, 23 - 33 cm dark brown peaty silt loam; friable; moderate nut structure; abundant yellowish brown mottles, 33 - 84 cm olive brown clay loam; friable; moderate blocky structure; many strong brown mottles, on grey clay; firm; massive.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)"	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occurs on floors of valleys; dissecting terraces. Consists of more than 30 cm friable peaty loam on grey clay.	Poorly drained	Organic soil (very weakly /- enleached platic soil)	Included in Tokomaru soils (13)	Ro

son Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
SOILS OF THE SAND COUNTRY				
W (W-H) (H-W)	Waitarere sand	Wind-blown sand	Rolling, dunes	0 - 1 cm dark greyish brown and light grey sand; loose; single grain, 1 - 15 cm grey sand; loose; single grain, on grey sand; only slightly firm; single grain.
Ms (Ms-Hm) (Hm-Ms) (P-Ms)	Motuiti sand	Wind-blown sand	Rolling, dunes	0 - 10 cm very dark grey to black sand; very friable; moderate granular structure, 10 - 20 cm light yellowish brown sand; loose; single grain, on olive grey sand; loose; single grain
F (F-O) (P-O) (A-F) (C-F) (C-F) * (Cb-F)	Foxton black sand	Wind-blown sand	Rolling, dunes	0 - 25 cm black sand; very friable; moderate granular structure, 25 - 46 cm yellowish brown sand; friable; weak nut structure, on olive brown sand; loose; single grain.
F[1] (F-0) (Cb-F) (P-01	Foxton brown sand	Wind-blown sand	Rolling, dunes	0 - 23 cm very dark greyish brown sand; very friable; weak coarse nut structure, 23 - 38 cm olive brown sand; slightly firm; single grain, on olive grey to olive sand; slightly firm; single grain.

* C-F clay underlies sand on parts of the sand plains

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occurs on recently stabilised dunes. Has shallow A horizon on loose grey sand.	Excessively drained	Recent soil (very weakly enleached volic soil')	Loose sand dunes	W (W-H) (H-W)
Occurs on less consolidated dunes of the inland parts of the sand country. Has shallow (less than 10 cm) very dark grey to black A horizon on light yellowish brown and olive grey loose sand. Differs from Waitarere sand in having deeper A horizon and browner subsoil.	Somewhat excessively drained	Yellow-brown sand (very weakly enleached voli-subfulvic soil)	Patea soils (23)	Ms (Ms-Hm) (Hm-Ms) (P -Ms)
Occurs on more consolidated dunes of the sand country. Has deep black A horizon over yellowish brown subsoil. Has deeper A and B horizons than Motuiti sand.	Somewhat excessively drained	Yellow-brown sand (weakly enleached subfulvic soil)	Patea soils (23)	F (F-0) (P-O) (A-F) (C-F) (C-F) (Cb-F)
Occurs on more consolidated dunes of the sand country, which were formerly under forest. Similar to Foxton black sand but has browner A horizon.	Somewhat excessively drained	Yellow-brown sand (weakly enleached subfulvic soil)	Patea soils (23)	F (F-0) (Cb-F) (P-0)

son Reference Symbol[x]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
F (Cb-F) (P-O)	Foxton brown mottled sand	Wind-blown sand	Easy rolling, dunes	0 - 28 cm very dark brown sand; very friable; weak nut structure, 28 - 48 cm yellowish brown sand; slightly firm; single grain, on greyish yellow sand; slightly firm; single grain; many faint dark red mottles.
H (H-W) (W-H)	Hokio weakly mottled sand, and Hokio strongly mottled sand	Wind-blown sand	Flat, higher parts of sand plains	0 - 8 cm very dark brown sand; loose; single grain, 8 - 28 cm light grey sand; loose; single grain, on grey sand; slightly firm; single grain; few to many yellowish brown mottles.
H (H-W) (W-H)	Hokio sand	Wind-blown sand	Flat, low-lying sand plains	0 - 5 cm very dark brown sand; very friable; single grain, 5 - 15 cm dark grey sand; firm; single grain; few yellowish brown mottles, on dark grey sand; firm; single grain; many reddish brown mottles, which become less abundant with depth.
H (H-W). (W-H)	Hokio sand, peaty phase	Peat on wind-blown sand	Flat, very low-lying sand plains	0 - 8 cm very dark brown peaty sand; on bluish grey sand; firm; single grain; few dark red mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)[1]*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[7]
Occurs on easy rolling dunes. Has similar profile to Foxton brown sand but has mottles in the subsoil.	Somewhat excessively drained	Yellow-brown sand (weakly enleached subfulvic soil)	Patea soils (23)	F (Cb-F) (P-O)
Occur on the higher parts of the unconsolidated sand plains. Have shallow very dark brown A horizons on grey loose sand with few to many mottles. The underlying sand becomes firmer with depth and mottles increase in abundance.	Somewhat excessively drained	Weakly gleyed recent soil (very weakly enleached weakly gleyed volic soil)	Not separated	H (H-W) (W-H)
Occurs on lower parts of unconsolidated sand plains. Has shallow A horizon on dark grey firm sand with few mottles which become less abundant with depth. Differs from Hokio weakly mottled sand and Hokio strongly mottled sand in having poorer drainage, and firmer and darker coloured subsoil in which mottling decreases with depth.	Imperfectly drained	Moderately gleyed recent soil (very weakly enleached moderately gleyed volic soil)	Not separated	H (H-W) (W-H)
Occurs on very low-lying parts of unconsolidated sand plains. Has shallow peaty A horizon on bluish grey firm sand with a few mottles. Differs from Hokio sand in having poorer drainage and peaty A horizon.	Poorly drained	Strongly gleyed recent soil (very weakly enleached moderately gleyed volic soil)	Not separated	H (H-W) (W-H)

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
Hm (Hm-Ms) (Ms-Hm)	Himatangi weakly mottled sand	Wind-blown sand	Flat, higher parts of sand plains	0 - 18 cm black sand; very friable; weak nut structure, 18 - 28 cm light olive brown sand; loose; single grain, on light grey sand; slightly firm; single grain; few yellowish red mottles becoming more abundant with depth.
Hm (Hm-Ms) (Ms-Hm)	Himatangi sand	Wind-blown sand	Flat, medium to high parts of sand plains	0 - 20 cm black sand; very friable; weak medium nut structure, 20 - 36 cm grey sand; loose; single grain; few yellowish brown mottles, on^ grey sand; firm; single grain; many yellowish red and dark reddish brown mottles.
P (P-Ms)	Pukepuke black sand	Wind-blown sand	Flat, low-lying parts of sand plains	0 - 20 cm black to dark brown sand; very friable; moderate nut structure; many fine dark reddish brown mottles in lower part of horizon, on dark grey sand; firm; single grain; many reddish brown mottles decreasing in number with depth.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)[1]*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occurs on higher parts of sand plains. Has black to very dark brown sand A horizon, on light olive to olive grey loose sand with a few mottles. The mottles increase with depth and sand becomes firm. Differs from Hokio weakly mottled sand in having deeper A horizon.	Somewhat excessively drained	Weakly gleyed yellow-brown sand (weakly enleached weakly gleyed subfulvic soil)	Whananaki soils (23b)	Hm (Hm-Ms) (Ms-Hm)
Similar to Himatangi weakly mottled sand but has few mottles in B horizon and many mottles in C horizon. Topsoils are from 15 to 25 cm in depth.	Somewhat excessively drained	Weakly gleyed yellow-brown sand (weakly enleached weakly gleyed subfulvic soil)	Whananaki soils (23b)	Hm (Hm-Ms) (Ms-Hm)
Occurs in lower parts of the sand plains. Has a deep, black A horizon with few reddish brown mottles, on dark grey firm sand with abundant mottles which decrease in number with depth. Differs from Himatangi sand in having poorer drainage, more mottles, and generally darker and firmer subsoil.	Imperfectly drained	Gleyed yellow-brown sand (weakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	P (P-Ms)

Soil Reference Symbol *	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
p (P-Ms)	Pukepuke black sand with concretions	Wind-blown sand	Flat, very low-lying parts of sand plains	0 - 20 cm black to very dark brown sand; very friable; weak nut structure; few dark red mottles; few to many iron and manganese concretions, 20 - 28 cm very dark grey loamy sand; very friable; very weak nut structure; few dark red mottles and iron concretions, 28 - 41 cm dark grey sand; firm; single grain; many dark red mottles, on bluish grey sand; firm; single grain; few yellowish red mottles decreasing with depth.
P (P-O)	Pukepuke brown sand	Wind-blown sand	Flat, higher parts of older sand plains	0 - 20 cm very dark brown sand; very friable; very weak nut structure, on yellowish brown sand; slightly firm; single grain; many yellowish brown mottles increasing with depth.
P (P-Q)	Pukepuke brown loamy sand	Wind-blown sand	Flat, low-lying older sand plains	0 - 20 cm dark greyish brown loamy sand; very friable; weak nut structure; few dark red mottles in lower part of horizon, on grey sand; firm; single grain; many yellowish brown mottles increasing with depth.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[7]
Occurs on low-lying parts of sand plains. Similar to Pukepuke black sand but has poorer drainage, fine concretions in A and B horizons, and bluish grey subsoil.	Poorly drained	Gleyed yellow-brown sand Cweakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	P, (P-Ms)
Occurs on high parts of more consolidated sand plains. Has very dark brown sand A horizon on yellowish brown sand with mottles increasing with depth. Differs from Himatangi sand in having browner A and B horizons and from Pukepuke black sand in having better drainage and browner A horizon.	Somewhat excessively drained	Gleyed yellow-brown sand (weakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	P (P-O)
Occurs on lower parts of more consolidated sand .plains. Has dark greyish brown loamy sand A horizon with a few mottles, on grey firm sand with many mottles. Differs from PukepuKe brown sand in having poorer drainage, mottles in the A horizon, and grey subsoil.	Imperfectly drained	Gleyed yellow-brown sand (weakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	P (P-0)

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
P (P-O)	Pukepuke brown sandy loam and Pukepuke brown sandy loam, peaty phase	Wind-blown sand	Flat, very low-lying older sand plains	0 - 25 cm very dark reddish brown sandy loam; friable; strong nut structure; many dark red and grey mottles; abundant iron and manganese concretions, 25 - 36 cm dark grey sandy loam; very friable; weak nut structure; many dark reddish brown mottles; few small iron concretions, on grey sand; firm; single grain; few dark reddish brown mottles.
A (A-F)	Awahou loamy sand and Awahou sandy loam	Wind-blown sand	Flat, higher parts of older sand plains	0 - 25 cm black to very dark brown loamy sand to sandy loam; very friable; weak nut structure, 25 - 33 cm brownish yellow sand; very slightly firm; single grain, on grey sand; slightly firm; single grain; many hard almost concretionary yellowish brown mottles.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)"	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occur on very low-lying parts of more consolidated sand plains. Have very dark reddish brown sandy loam to peaty sandy loam A horizons with concretions, on grey firm sand with mottles. Differs from Pukepuke brown loamy sand in being poorly drained and having reddish brown or peaty topsoils with concretions.	Poorly and very poorly drained	Gleyed yellow-brown sands (weakly enleached madenti-subfulvic soils)	Whananaki soils (23b)	P (P-0)
Occur on higher parts of more consolidated older sand plains. Have deep, black A horizons, on brownish yellow sand which grades down to grey sand with hard mottles. Differ from Pukepuke and Carnarvon soils by being in a higher topographical position and having more excessive drainage, and from Himatangi sails by having more developed profiles with deeper A horizons and having large hardened mottles in the subsoil.	Somewhat excessively drained	Weakly gleyed yellow-brown sands (strongly enleached weakly gleyed subfulvic soils)	Whananaki soils (23b)	A (A-F)

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
C (C-F) (C-FD)	Carnavon black sandy-loam and Carnavon black loamy sand	Wind-blown sand	Flat, low-lying older sand plains	0 - 25 cm black sandy loam or loamy sand; very friable; moderate granular and weak nut structure; few reddish mottles in lower part of horizon, 25 - 43 cm brownish yellow sand; firm; single grain; abundant reddish mottles; some iron-cemented sand concretions, on dark grey sand; firm; single grain; many large concretions decreasing with depth.
Cb (Cb-F)	Carnavon brown loamy sand	Wind-blown sand	Flat, low-lying older sand plains	0 - 23 cm dark greyish brown loamy sand; very friable; weak nut structure; many fine dark red mottles, 23 - 53 cm grey sand; firm; single grain; many concretions of iron-cemented sand many yellowish brown mottles, on grey sand; firm; single grain; many yellowish brown mottles; few concretions.
Cb (Cb-F)	Carnavon brown sandy loam	Wind-blown sand	Flat, very low-lying older sand plains	0 - 23 cm very dark brownish grey sandy loam; very friable; weak nut structure; many fine dark red mottles, on grey sand; firm; single grain; many dark red and yellowish brown mottles; many concretions of iron-cemented sand.

Distinguishing Features of Soil and Environment	Overall Drainage (Class)"	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol*
Occur on low-lying parts of the older sand plains. Have deep, black A horizons, on brownish yellow and dark grey sand with many large iron-cemented sand concretions. Differs from Awahou soils in being poorly drained with greyer subsoils. Differs from Pukepuke soils in having large concretions in the subsoil.	Imperfectly drained	Gleyed yellow-brown sands (weakly enleached madenti-subfulvic soils)	Whananaki soils (23b)	C (C-F) (C-F)
Occurs on low-lying parts of older sand plains. Has deep, dark greyish brown loamy sand A horizon with many fine mottles, on grey firm sand with many mottles and concretions decreasing with depth. Differs from Carnavon black loamy sand in having browner A horizon and more concretions and mottles in the subsoil.	Imperfectly drained	Gleyed yellow-brown sand (weakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	Cb (Cb-F)
Occurs on low-lying parts of older sand plains. Similar to Carnavon brown loamy sand, but has sandy loam A horizon and is poorly drained.	Poorly drained	Gleyed yellow-brown sand (weakly enleached madenti-subfulvic soil)	Whananaki soils (23b)	Cb (Cb-F)

Soil Reference Symbol[1]	Soil Name	Parent Material	Slope[2], Topographic Position	Brief Description of Representative Soil Profile[3]
0 (P-Ms)	Omanuka peaty sandy loam	Peat and wind-blown sand	Hat, peaty swamps	0 - 46 cm black peaty sandy loam; few to many plant remains; many dark red mottles in upper 8 cm, oil bluish grey sand; slightly firm; single grain.
0 (P-Ms) (P-0) (F-0) (C-F) (C-F) (Cb-F)	Omanuka peaty loam and Omanuka peaty silt loam	Peat and wind-blown sand	Flat, peaty swamps	0 - 10 cm black peaty loam; few plant remains; few large reddish brown mottles, 10 - 61 cm black mellow peaty loam; some thin layers of partially decomposed plant remains, on bluish grey sand; firm; single grain,
0 (P-Ms) (P-O) (C-F) (C-F) (Cb-F)	Omanuka peaty sandy loam, shallow phase and Omanuka peaty loam, shallow phase	Peat and wind-blown sand	Flat, borders of peaty swamp	0 - 25 cm dark brown to black peaty sandy loam to peaty loam, on dark grey sand; firm; single grain; very dark red mottles decreasing with depth,

Distinguishing Features of Soil and Environment	Overall Drainage (Class)*	Soil Classification Common Name (Technical Name)[5]	Soil Set (Soil Set Reference No.)[6]	Soil Reference Symbol[1]
Occurs in peaty swamps in low-lying areas of sand plains. Has 45 to 90 cm peaty sandy loam with a few mottles, overlying bluish grey sand. Differs from Pukepuke brown sandy loam, peaty phase in having deeper peaty horizon.	Very poorly drained	Organic soil (weakly enleached platic soil)	Whananaki soils (23b)	0 (P-Ms)
Occur in peaty swamps in low-lying areas of older sand plains. Have 45 to 90 cm of peaty loam to peaty silt loam with few mottles on bluish grey sand. Differ from Omanuka peaty sandy loam in having finer topsoil texture.	Very poorly drained	Organic soils (weakly enleached platic soils)	Whananaki soils (23b)	0 (P-Ms) (P-O) (F-O) (C-F) (C-F) (Cb-F)
Occur on borders of peaty swamps. Similar to Omanuka peaty sandy loam and Omanuka peaty loam but the peaty horizon is less than 45 cm in depth.	Poorly drained	Organic soils (weakly enleached platic soils)	Whananaki soils (23b)	0 (P-Ms) (P-O) (C-F) (C-F) (Cb-F)

N.Z. Soil Bureau Map 104.
To accompany N.Z. Soil Survey Report 30.

SOIL MAP OF MANAWATU COUNTY, NORTH ISLAND, NEW ZEALAND

LAND USE
CAPABILITY SURVEY

WATER & SOIL DIVISION
MINISTRY OF WOiiKS
PRIVATE BAG
PALMERSTON NORTH

Magnetic Declination
1975
20° 19'
Annual Increase + 5'

Locality Map and Index to N.Z.M.S. 1 Sheets and Soil Bureau Maps (25/1, 25/2 — Oroua Downs;-55——Flock-House Farm; 71/1, 71/2— Manawatu — Rangitikei Sand Country; 102-Kairanga County; 103-Pohangina County; 104—This Survey; 105—Part Wanganui County).

NEW ZEALAND
North Island
PACIFIC OCEAN
AUCKLAND
TASMAN SEA
WELLINGTON
40°S
178°E
0 Miles 100
0 100 km
Scale 1:12 000 000

R. B. MILLER
DIRECTOR

Base data from the Department of Lands and Survey.
Soil Survey by J.D. Cowie and W.C. Rijkse, Soil Bureau,
Department of Scientific and Industrial Research, PalmVrston North, 1969-70.

Bibliographic Reference
COWIE, J. D.; RIJKSE, W. C. 1976.
Soil map of Manawatu County, North Island, New Zealand.
Scale 1:63,360 (1 inch to 1 Mile) *N. Z. Soil Bureau Map 104.*

Published by the Department of Scientific and Industrial Research, Wellington, 1976.

REFERENCE

Railway		Stream	
Road		Shingle Beds	
Transmission Line		Soil Boundary	P–Ms
Trig Station	△	Holding Boundary	
Stopbank		County Boundary	

AREAL SCALE

400 Acres in units of 80 Acres
(1 Acre= 0-4047 Hectares,
80 Acres=32 Hectares)

Scale 1:63 360 (1 inch to 1 mile)

Chains 80 40 0 1 2 3 4 5 Miles
Feet 10,000 5,000 0 10,000 20,000 Feet
Metres 1,000 0 1 2 3 4 5 6 7 8 Kilometres

PHYSIOGRAPHIC LEGEND OF SOILS

SOILS OF THE RIVER FLATS

Rapidly accumulating

Excessively to moderately well drained

- Rangitikei loamy sand — R 1
- Rangitikei sandy loam — R 2
- Rangitikei fine sandy loam — R 3

Imperfectly to very poorly drained

- Parewanui sandy loam — Pa 1
- Parewanui fine sandy loam — Pa 2
- Parewanui silt loam — Pa 3
- Parewanui heavy silt loam — Pa 4

Slowly accumulating

Excessively to moderately well drained

- Manawatu sandy loam — M 1
- Manawatu fine sandy loam — M 2
- Manawatu silt loam — M 3

Imperfectly to very poorly drained

- Kairanga fine sandy loam — K 1
- Kairanga silt loam — K 2
- Kairanga silt loam on sand — K 3
- Kairanga heavy silt loam — K 4
- Kairanga peaty silt loam — K 5
- Meeanee—Farndon complex — MFc
- Opiki silt loam — Op
- Makrua-peaty-silt loam — C Mr
- Makerua peaty loam — Mr

Non—accumulating

Excessively to moderately well drained

- Karapoti black sandy loam — ?Kt 1 / ?Kt 2
- Karapoti black silt loam

Imperfectly to very poorly drained

- Te Arakura silt loam — Te 1
- Te Arakura sandy loam — Te 2

SOILS OF THE TERRACE LAND

Imperfectly to very poorly drained

- Ohakea silt loam — Oh
- Tokomaru fine sandy loam — T 1
- Tokomaru silt loam — T 2
- Tokomaru silt loam, rolling phase — T 2R
- Milson silt loam — Mn
- Milson silt loam , rolling phase — MnR
- Marton silt loam — Ma
- Marton silt loam, rolling phase — MaR
- Halcombe silt loam — Ha
- Halcombe hill soils — HaH
- Tokorangi sandy loam — To
- Rongotea peaty loam — Ro

SOILS OF THE SAND COUNTRY

Sand plains dominant

- Hokio—Waitarere association — W-H
- Himatangi—Motuiti association — Hm-Mn
- Pukepuke—Motuiti association — P-Ms
- Pukepuke—Omanuka association — P-O
- Awahou—Foxton association — A-F
- Carnarvon black —Foxton association — C-F
- Carnarvon brown—Foxton association — C-F*

* indicates that clay underlies the soils in parts of the sand pjains -

Dunes dominant

- Waitarere—Hokio association — W-H
- Motuiti—Himatangi association — Mn-Hm
- Foxton—Omanuka association — F-O
- Unstabilised sand — V

PEDOLOGICAL LEGEND OF SOILS

YELLOW-GREY EARTHS (**pallic** soils)

—from loess (pseudomadenti—pallic soils)

—moderately to strongly gleyed

weakly clay illuvial

- Ohakea series — Oh

moderately clay illuvial

- Tokomaru series — T
- Halcombe Series — Ha

strongly clay illuvial

- Milson series — Mn
- Marton series — Ma

—from wind—blown sand (voli—pallic soils)

—weakly gleyed

weakly clay illuvial
- Tokorangi series — hv/X

YELLOW-BROWN SANDS (subfulvic soils)

—from wind—blown sand

—nontcrweakly-gleyed-(voli—subfulvic and-subfulvicrsoils)

- Motuiti series — Mn
- Foxton series — F
- Himatangi series — Hm
- Awahou series — A

—moderately to strongly gleyed (madenti—subfulvic soils)

- Pukepuke series — P
- Carnarvon series — C

GLEY SOILS (madentic soils)

—from alluvium

- Te Arakura series — Te

ORGANIC SOILS (platic and luvi-platic soils)

—from peat (platic soils)

- Rongotea series — Ro
- Omanuka series — O

—from peat and alluvium (luvi—platic soils)

- Makerua series — Mr

RECENT SOILS (luvic and volic soils)

—from alluvium (luvic soils)

—non to weakly gleyed

moderately to strongly accumulative

- Rangitikei series — R

weakly accumulative

- Manawatu series — M

non—accumulative

- Karapoti series — Kt

—from wind—blown sand (volic soils)

—non to weakly gleyed

- Waitarere series — W

—weakly to strongly gleyed

- Hokio series — H

GLEY RECENT SOILS (madenti-luvic soils)

—from alluvium

moderately to strongly accumulative

- Parewanui series — Pa

weakly accumulative

- Kairanga series — K
- Opiki series — Op

SALINE GLEY RECENT SOILS (saline madenti-luvic soils)

—from estuarine alluvium

- Meeanee—Farndon complex — MFc

Drawn by K. Roberts
A.R. Shearer,Government Printer, Wellington, New Zealand
F. J. Tindall, Chief Cartographer