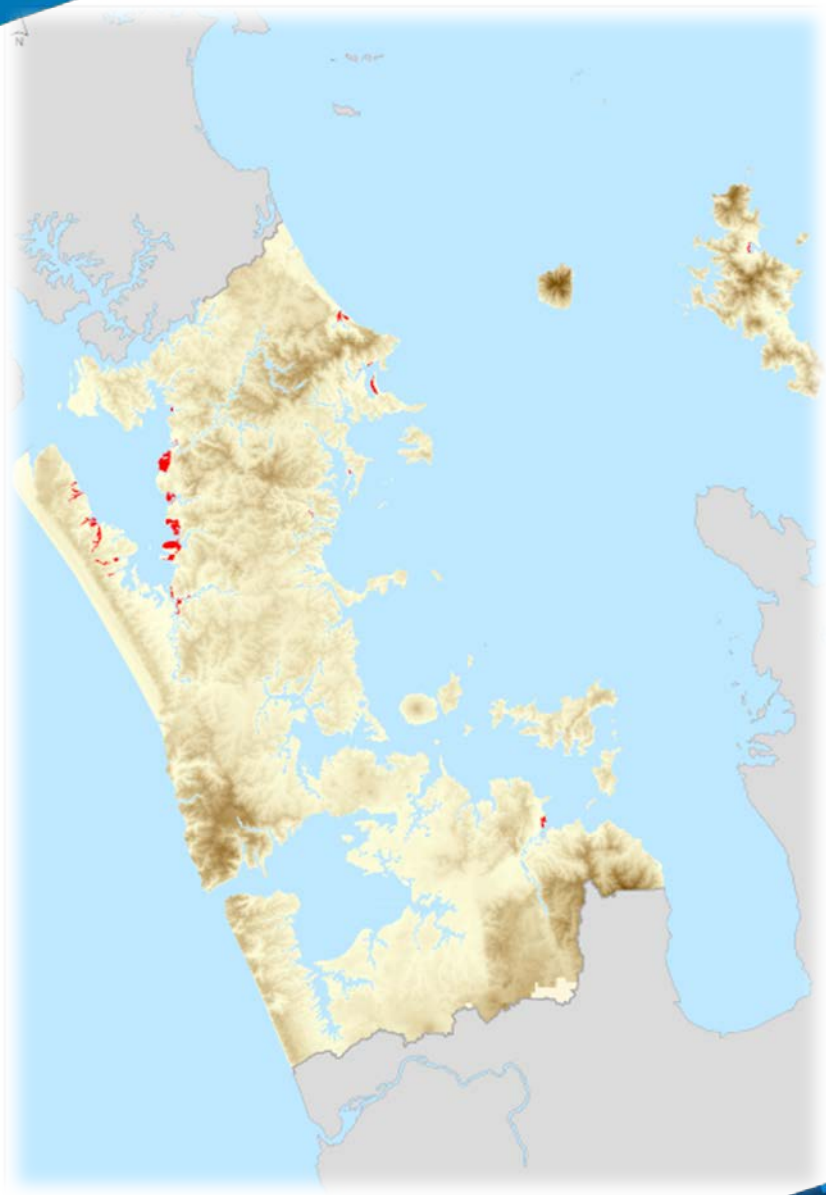
Soil Information Inventory:

Takahiwai and related soils

October 2018 Soil Information Inventory 22



RIMU Research and Evaluation Unit

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Soil Information Inventory 22:

Takahiwai and related soils

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Table of contents

1 Introduction

With Auckland's expected growth from 1.7 to 2.0 million people in the next 30 years (The Auckland Plan 2050) and a goal to double New Zealand's agricultural exports by 2025 (Ministry for Primary Industries), an understanding of Auckland's soil resources is essential for planning urban growth, and sustaining if not expanding rural production, while managing the impacts of both on our region's environment.

Existing information on Auckland's soils is difficult to assess and interpret. Electronic versions of soil maps are available on research institute websites. Some have been uploaded into Auckland Council's geographic information system (GIS, GeoMaps) for use by council staff and for public viewing. However, the GIS maps and their attached attribute lists cannot be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports. Many of these documents are now hard to find.

Auckland Council has undertaken to compile old information for the region's main soils into single documents called soil information inventories (SIIs). These may be viewed on Knowledge Auckland, www.knowledgeauckland.org.nz council's research and technical publications website, downloaded and printed. It is expected that there will be gaps in each inventory. The gaps will be filled as new information becomes available. Each inventory is a repository for information old and new and will be a "living document".

Their intent is to:

- ease access to soil information
- enable better understanding of the soils' properties
- enhance public awareness about the location of productive or problematical soils
- improve awareness of the soils' potential and limitations, amongst consultants and planners
- help council staff provide better advice, and make more informed decisions.

Our role has been document compilers, not authors. We have selected information which appears useful for landowners, farm, forest, environmental or planning consultants, and the council staff who deal with them. While we regard the selected information as reliable, responsibility for accuracy of contents rests with the organisations which originally collected and published the maps or documents which we cite. Auckland Council makes the information available on the Knowledge Auckland website with this understanding.

Acknowledgments are due principally to old soil surveyors of the DSIR's Soil Bureau, who collected most of the information reproduced here, notably Charles Sutherland, Charles Wright, Norman Taylor, Edward Cox, and Gary Orbell.

Assistance from Mandy Holt (cross-section), Tyana Rowe-Kurene, Tony Edhouse and Linda Wallis (document editing and layout), Fiona Curran-Cournane (internal publication referee) and Malcolm McLeod (external publication referee) is also acknowledged.

Michael Martindale, Douglas Hicks and Peter Singleton
June 2016, October 2018

2 Published maps

On DSIR's published soil maps of North Auckland (1:100,000), raw soils on estuarine flats - still inundated by spring tides except where stop-banked and reclaimed - are depicted as one series i.e. soil with distinct profile and parent material. They are divided into four types i.e. soils with different textures:

TCa	Takahiwai sand
TC	Takahiwai clay
TCya	Takahiwai peaty sand
TCy	Takahiwai peaty clay loam

On DSIR's oldest maps of South Auckland (1:253,840), similar soils are depicted as three series:

111c	Takahiwai clay
111b	Waitakaruru clay
6	Miranda shelly clay
6a	Miranda shelly sand

An additional type appears on a map of intermediate age covering part of Franklin district (1:63,360):

Tk	Takahiwai silt loam

There is a problem with this map's labelling of Takahiwai as silt loam. A local soil mapper (DLH) considers polygons labelled Tk on the Manukau harbour's shores rarely have loamy texture, and would be better described as clay, silty clay, sandy clay or shelly clay.

A more recent map of Manukau city (1:20,000) separates the soils into seven mapping units, containing spatially associated soil types. The following alphanumeric labels are assigned:

AAA1	Takahiwai clay (raw)
AAB5	Waitakaruru clay
AAB6	Waitakaruru clay
AAB7	Takahiwai sandy clay
AAB8	Takahiwai clay
AB1	Miranda shelly clay
AB2	Miranda shelly sand

Sourced from:
Soil maps of Maungaturoto-Kaipara area; Mangawhai-Warkworth area;
Helensville-Waitakere area; Whangaparaoa-Auckland area
NZ Soil Bureau maps 189, 190, 220, 221
Soil map of the North Island, sheets 2 and 3 (Auckland and Waikato)
NZ Soil Bureau maps 11/2, 11/3
Soil map of part Franklin county *NZ Soil Bureau map 149/1*
Soil map of Manukau City *NZ Soil Bureau map unpublished*

3 Online maps

Landcare Research's online soil map (S-map, 1:50,000) re-names and re-labels the soils as follows:

TC etc.	Temuka family, sibling 55
111c, etc.	No family name or sibling number assigned
Tk	Ahuriri family, sibling 3
AAA1	Takahiwai family, sibling 2
AAB5	Takahiwai family, sibling 6
AAB6	Takahiwai family, sibling 6
AAB7	Nixon family, sibling 3
AAB8	Marti family, sibling 2
AB1	Shelly family, sibling 3
AB2	Fere family, sibling 8

Reasons for the basis of S-map can be found in the S-map database manual. The names and numbers were assigned by computer-matching local soil properties with different soils in other parts of the country.

Sourced from S-map Online – Home http://smap.landcareresearch.co.nz/home

4 Farm-scale maps

North of Auckland, any published map polygon labelled TCa etc. turns out to be a mosaic of TCa plus other soil types when investigated in the field by local mappers. On farm-scale soil maps (1:5,000 - 1: 10,000) they are labelled as:

Tca	Takahiwai sand or sandy clay
Tc	Takahiwai clay
Tcya	Takahiwai peaty sand
Tcy	Takahiwai peaty clay loam

South of Auckland, no field investigation of published map polygons labelled 111c, Tk, AAA1 etc has been undertaken by local mappers. In event of future mapping or sampling at farm scale, a local soil mapper (DLH) recommends using North Auckland or Waikato labels that correspond to Manukau labels, as follows:

Wra	Waitakaruru (Takahiwai) sand or sandy clay
Wr	Waitakaruru (Takahiwai) clay
Wrya	Waitakaruru (Takahiwai) peaty sand
Wry	Waitakaruru (Takahiwai) peaty clay loam
Mia	Miranda shelly sand
Mi	Miranda shelly clay

Local series names for Takahiwai and related soils are retained on Auckland Council's farm-scale maps for continuity with published nomenclature.

Sourced from 1995-2015 farm-scale maps and soil notes prepared for private landowners, Auckland Regional Council or Auckland Council

5 Where the soils occur

Extensively along estuaries of the Kaipara harbour. As narrow strips along estuaries of the Manukau and Waitemata harbours. As patches on the shores of east coast estuaries from Mangawhai to Okura; also, the Tamaki, Whitford and Wairoa estuaries. South of Orere point, as a thin strip along the Firth of Thames coast.

Location of Takahiwai and related soils

Takahiwai and related soils are mapped on 2,500 hectares (less than 1% of Auckland region). About 2,000 hectares (80% of the area mapped) are in agricultural use, as dairy or drystock pasture (estimated from overlay of Agribase 2010 on Fundamental Soils Layer). Additional areas of Takahiwai and related soils around the shores of Manukau and Waitemata harbours, also on east coast estuaries, do not appear in FSL.
http://intermaps.arc.govt/AucklandCouncilViewer/

5.1 On what landform

In their natural state, Takahiwai and related soils occur where sedimentation has raised the landward margins of estuary mudflats, sandbanks or shellbeds, above level of all but the highest tides or storm surges. Salicornia, wiwi sedge, salt-tolerant grasses, and shrubs such as pohuehue and shore ribbonwood, replace mangrove swamps (which grow on regularly inundated flats). With root penetration and decay of organic matter, shallow topsoil starts to form.

Similar soils develop where stopbanks have been constructed across estuary flats. Here the tide is kept out by one-way valves at drain outlets. Sown pasture replaces salt-tolerant plants except on drain banks or in depressions, where saltwater seepage enables them to persist.

Sourced from:

Edbrooke, S. W., 2001, Geology of the Auckland Area, Institute of Geological and Nuclear Sciences 1: 250,000 map 3 and accompanying bulletin

Molloy, L., 1987, Soils in the New Zealand Landscape, New Zealand Society of Soil Science

Outside the stopbank, raw Takahiwai soils are sparsely vegetated by mangroves and salt marsh. Inside, the same soils support pasture. Near Tauhoa Creek on Kaipara Harbour *Photo: D. Hicks*

5.2 How they differ from other soils

Key features of Takahiwai and related soils are incipient or shallow topsoil, blocky or prismatic upper subsoil (where drained), and structureless wet lower subsoil. In their natural state both topsoil and subsoil are saline, with encrusted salt visible at the surface. After reclamation, salinity declines, but percolating rainwater and penetrating air react with sulphur compounds in the drained topsoil and upper subsoil. Resultant acid-sulphate weathering perpetuates poor subsoil structure and causes hydrogen sulphide emission, sometimes to a degree that depresses plant growth.

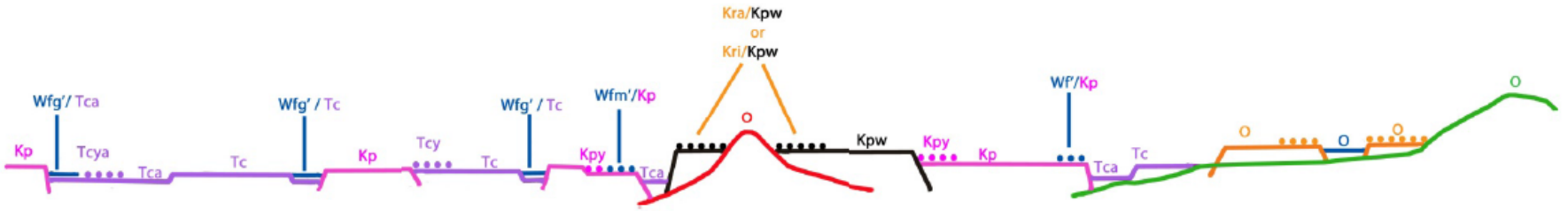
Sourced from:
Wilson, A.D. and Cox, J.E. Soils of Rodney County. Unpublished report, Soil Bureau DSIR
Dent, D.G. 1978 Pp44-60 in Soil Groups of New Zealand Part 3: Gley Soils. New Zealand Society of Soil Science

6 Classifications

NZ genetic (NZG):	Saline gley
NZ soil (NZSC):	Gley raw, recent or sulphuric gley, melanic orthic gley, orthic melanic or sandy recent *http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx*
Soil Taxonomy (USDA):	Sulphic hydraquent or typic sulfaquept *http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051544.pdf*
World Soils (FAO):	Acid-sulphate gleysol *http://www.fao.org/3/a-i3794e.pdf*

DSIR replaced the New Zealand genetic classification dating from 1930s with the New Zealand soil classification in 1990s. DSIR's soil scientists considered that Soil Taxonomy did not work well in New Zealand, nor did World Soils. Soil Taxonomy and World Soils remain internationally accepted classifications.

Cross section showing Takahiwai and related soils' position in the landscape



On fresh estuary alluvium:

Tca Takahiwai sandy clay
Tcya Takahiwai peaty sandy clay
Tc Takahiwai clay
Tcy Takahiwai peaty clay

Wfg'/Tc etc Whakapara sandy or silty clay (shallow) over Takahiwai soils

On young estuary alluvium:

Kp Kaipara clay or clay loam
Kpy Kaipara peaty clay loam

Wf'/Kp } Whakapara sandy silt loam or silty clay
Wfm'/Kp } loam (shallow) over Kaipara soils

On old estuary alluvium

Kpw Kaipara clay or clay loam (weathered)

Kra'/Kpw } Kara sandy loam or silt loam (shallow) over
Kri'/Kpw } Kaipara clay or clay loam (weathered)

On stream alluvium:

O, O Other soils

On clay weathered from rock:

O, O Other soils

Soil type labels on the cross-section are sourced from Auckland Council's farm-scale maps.

7 Soil profile descriptions

DSIR's Soil Bureau appears not to have prepared a type profile for the modal (most widespread) type, Takahiwai clay. Bulletin 5 (General Survey of the Soils of North Island) contains the following brief description:

Takahiwai clay

Horizon	Depth (cm)	Description
A	0-10	Dark grey-brown clay
C	10-45	Grey-brown flecked clay
	on	Bluish clay

Soil Groups of New Zealand Part 3: Gley Soils contains four profile descriptions for Takahiwai clay, on sites ranging from regularly inundated mangrove swamp to reclaimed pasture. Their wording is too complex to be used for practical recognition of Takahiwai clay in the field. A local mapper (DLH) has prepared abbreviated versions of two (KII and OVI):

Takahiwai clay without topsoil *Photo: D Hicks*

Takahiwai clay (without topsoil) on regularly inundated mudflat in mangrove swamp (KII)

Horizon	Depth (cm)	Description
Ctgg	0-3	Olive brown (2.5Y 4/3) silty clay; faint diffuse dark greenish grey (5G 4/1) mottles; fine platy structure with vertical fissures; continuous thick (2-3mm) dark brown (7.5YR 4/4) clay coatings on ped faces; few very fine soft rounded black nodules; few fine roots but common mangrove pneumatophores; abrupt boundary.
Cgg	3-11	Green grey (5G 5/1) silty clay; distinct light olive brown (2.5Y 5/4) mottles; medium platy structure, fissured to medium blocky; fine dendritic pores (root channels?); common small soft rounded dark brown (7.5YR 4/4) nodules; frequent fine fibrous roots, common woody lateral roots bearing pneumatophores; abrupt boundary.
Crg1	11-56	Dark blue grey (5B 4/1) silty clay with prominent red brown (5YR 4/4) and distinct pale olive (5Y 5/4) mottles; coarse prismatic structure; many fine to coarse vertical tubular pores; thick-walled (up to 8mm) dark red brown iron oxide pipes around medium and coarse pores; common fine to coarse roots; diffuse boundary.
Crg2	56-80	Dark blue grey (5B 4/1) silty clay loam; massive; many fine to coarse dendritic pores (root channels?) commonly occupied by partly decomposed roots and black fluid mud, few live roots; sharp boundary.
2Crg	80-200+	Dark blue grey (5B 4/1) loamy sand; firm but fluid when disturbed; massive single grained; abundant shells between 120cm and 150cm, common shells below 150cm.

Takahiwai clay with incipient topsoil *Photo: D. Hicks*

Takahiwai clay (with incipient topsoil) on reclaimed mudflat in pasture (OVI)

Horizon	Depth (cm)	Description
Of	0-10	Dark brown (7.5YR 3/3) fibrous peat mixed with dark grey-brown (10YR 3/2) silty clay; distinct dark yellow-brown (10YR 4/4) mottles; friable; subrounded structure; mixed with clods of unaltered subsoil; abrupt boundary.
Ctrj	10-75	Grey (7.5YR 5/1) silty clay; pale yellow (5Y 8/4), and below 40 cm, dark green-grey (5BG 3/1) mottles; very coarse prismatic structure, fissures filled with topsoil; many fine pores (root channels?) with partly decomposed roots; ped faces and pores have jarosite clay coats, commonly with brown (7.5YR 5/6) to red (2.5YR 4/2) iron oxide clay coats superimposed, coarse pores are loosely filled with powdery jarosite and root remains; distinct boundary.
Ctrgj	75-146	Blueish grey (5B 5/1) silty clay with faint black mottles; very coarse prismatic structure; many fine to coarse pores (root channels?) and coarse vertical tubular pores, commonly with partly decomposed roots in situ, encased in iron oxide pipes up to 8mm diameter; ped faces carry continuous brown (10YR 4/3) iron oxide clay coatings and patchy jarosite clay coatings; diffuse boundary.
Crg	146-220+	Blueish grey (5B 5/1) silty clay; massive; many medium and coarse root channels occupied by partly decomposed roots.

Takahiwai peaty clay *Photo: D. Hicks*

No type profile exists under this name, but a soil labelled as Takahiwai silt loam in Soil Report 33 (Soils of part Franklin County) appears to be decomposed peat over silt and clay. Its type profile is:
Takahiwai silt loam = Takahiwai peaty clay

Horizon	Depth (cm)	Description
A1	0-5	Dark reddish brown peaty silt loam; friable; very weakly developed fine subrounded polyhedral structure; distinct wavy boundary.
A2	5-20	Black silt loam; slightly firm; moderately developed medium blocky structure; distinct boundary.
Cr1	20-45	Grey silt loam; firm; weakly developed medium prismatic structure; many distinct yellowish red mottles; diffuse boundary.
Cr2	on	Grey clay; firm; strongly developed medium prismatic structure; many distinct yellowish red mottles.

The A2 horizon is not always present. It develops where the A1 decomposes beneath established pasture.

Takahiwai peaty sand over sandy clay *Photo: A. Thompson*

There is no type profile for Takahiwai sand. The closest unpublished type profile, re-labelled by hand as Takahiwai peaty sand, is atypical:

Takahiwai sand and peaty sand

Horizon	Depth (cm)	Description
Ap	0-14	Very dark grey to black (10YR 3/1-2/1) peaty sand; very friable, low packing in place; single grain structure; contains numerous grass roots; sharp boundary.
Cr1	14-20	Dark grey (10YR 4/1) peat stained sand; medium packing in place, loose when disturbed; single grain structure; many grass roots; diffuse boundary.
Cr2	20-50	Dark grey brown (10YR 4/2) slightly peat stained sand; low packing in place; very friable; single grain structure; common grass roots; diffuse boundary.
2Cr	50-70	Very dark brown (10YR 2/2) peat stained loamy sand; few faint fine grey mottling in the lower part of the horizon; medium packing in place, friable; single grain structure; common grass roots; sharp boundary.
3Crg	on	Dark olive grey (5Y 3/2) sand; compact in place but very friable when disturbed; single grain structure; contains some partly decomposed roots. This horizon would be moist to wet most of the year, and during the winter periods the water table would rise to the top of this horizon.

A local soil mapper (DLH) comments that around the southern Kaipara, such deep Cr1 and Cr2 horizons are rare. Typically, the Ap horizon overlies a thin Cr, on top of a Crg which is sandy clay, (see photo).

Sourced from:
Dent, D.G. 1978, Pp 44-60 in Soil Groups of New Zealand Part 3: Gley Soils, New Zealand Society of Soil Science
Orbell G.E., 1977, Soils of part Franklin County, Report 33, DSIR Soil Bureau
Sutherland, C.F., Cox, J.E, Type profile descriptions for North Auckland Soil Survey, Unpublished document, DSIR Soil Bureau

8 Properties of typical profile

Properties of typical profiles are best indicated by analysis results for the type profile i.e. sites where Takahiwai series was defined and described. Data for other sites will vary somewhat, particularly where different types within the series are found.

8.1 Chemical http://soils.tfrec.wsu.edu/mg/chemical.htm

No chemical analysis appears in the online version of National Soils Database (NSD). The following data are sourced from Dent 1978, plus an old Soil Bureau laboratory record.

Takahiwai clay (with incipient topsoil)

Property	Topsoil	Subsoil	Units
Acidity	6.7-7.0	6.9-8.0	pH
Total carbon	9.4-9.5	0.8-6.5	%
Total nitrogen	0.58-0.72	0.04-0.37	%
Available phosphorus	-	-	%
P retention	70-90	20-40	%
Available sulphur	0.39-0.52	0.58-4.93	ug/g
Cation exchange capacity	42.0-42.1	-	me %
Base saturation	-	-	%
Calcium	-	-	me %
Magnesium	-	-	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis Rv, DSIR Soil Bureau

Takahiwai clay (with developing topsoil)

Property	Topsoil	Subsoil	Units
Acidity	6.0-6.5	5.9-7.0	pH
Total carbon	3.1-12.8	0.7-4.1	%
Total nitrogen	0.27-0.88	0.05-0.29	%
Available phosphorus	-	-	%
P retention	50-50	20-51	%
Available sulphur	0.19-0.37	0.20-3.68	ug/g
Cation exchange capacity	38.5-54.1	7.5-37.1	me %
Base saturation	-	-	%
Calcium	7.1-11.6	6.0-7.9	me %
Magnesium	16.2-21.5	13.5-15.6	me %
Potassium	1.8-2.0	1.3-1.4	me %
Sodium	13.1-19.3	12.2-15.8	me %

Sourced from laboratory analysis SB08267, DSIR Soil Bureau

Takahiwai sand and peaty sand. No laboratory analyses in NSD, Bulletin 5 or Dent 1978.

8.2 Physical

http://soils.tfrec.wsu.edu/mg/chemical.htm

No physical analysis appears in the online version of NSD. The following data are sourced from Dent 1978, plus estimates from the Fundamental Soils Layer (FSL).

Takahiwai clay (with incipient topsoil)

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand			%
Silt			%
Clay			%
Dry bulk density	0.40	0.45-0.76	g/cm³
Total porosity	82.1	75.1-89.4	%
Macroporosity	0-9.9	0-9.9	%

Sourced from FSL table, Landcare Research, and laboratory analysis Rv, DSIR Soil Bureau

Takahiwai clay (with developing topsoil)

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand			%
Silt			%
Clay			%
Dry bulk density	0.59-0.75	0.37-0.52	g/cm³
Total porosity	69.7-78.6	78.6-85.0	%
Macroporosity	0-9.9	0-9.9	%

Sourced from FSL table, Landcare Research, and laboratory analysis Riv, DSIR Soil Bureau

Takahiwai peaty (silt loam over) clay

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand			%
Silt			%
Clay			%
Dry bulk density			g/cm³
Total porosity			%
Macroporosity	0-9.9	0-9.9	%

Sourced from FSL table, Landcare Research

Takahiwai sand and peaty sand

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand			%
Silt			%
Clay			%
Dry bulk density			g/cm³
Total porosity			%
Macroporosity	0-9.9	0-9.9	%

Sourced from FSL table, Landcare Research

8.3 Irrigation and drainage

No soil moisture analysis appears in the online version of NSD. The following estimates are sourced from FSL:
http://irrigationefficiency.co.nz/assets/Uploads/Farmers-Guide.pdf

Takahiwai clay (with incipient topsoil)

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	0-24		mm
Depth to slowly permeable layer		0.45-0.89	m
Perm. at slowly permeable layer		<4	mm/hr

Takahiwai clay (with developing topsoil)

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	0-24		mm
Depth to slowly permeable layer		0.45-0.89	m
Perm. at slowly permeable layer		<4	mm/hr

Sourced from FSL table and S-map factsheet, Landcare Research

Takahiwai peaty (silt loam over) clay

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	0-49		mm
Depth to slowly permeable layer		0-0.59	m
Perm. at slowly permeable layer		<4	mm/hr

Sourced from FSL table, Landcare Research

Takahiwai sand and peaty sand

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	0-49		mm
Depth to slowly permeable layer		0-0.59	m
Perm. at slowly permeable layer		<4	mm/hr

Sourced from FSL table, Landcare Research

8.4 Topsoil properties under different uses

Local management practices affect the properties of soil, so the history of land use needs to be considered. For many Auckland soils, an indication is provided by soil test results collected by Auckland Council from sites known to have been under the same use long-term. These sites are being re-sampled at five to ten year intervals to detect any trends. Takahiwai and related soils have not yet been sampled for soil quality in the Auckland region. 500 Soils Project samples for Kaipara clay (refer to Soil Information Inventory for Kaipara and related soils) provide the closest soil quality data. Takahiwai clay being raw or recent, it may be expected to have higher nutrient status (from saline incursion) but lower carbon and nitrogen content (incipient topsoil) and poorer structure (affected by salt and sulphur). Low plant-available water (in incipient topsoil) is unlikely to limit plant growth because the topsoil rarely dries out; salt is more likely to be a constraint.

Sourced from Sparling, G. et al, various dates, 500 Soils Project, Landcare Research Reports to Auckland Council

9 Land use capability

Land use capability is a classification of land according to properties that determine its capacity for sustained primary production. Classes 1 to 4 are arable, classes 5 to 8 non-arable. Class 1 is versatile i.e. capable of many uses, with negligible limitations to any use. Class 8 is land with extreme limitations that preclude productive use.
http://www.landcareresearch.co.nz/publications/books/luc

Three factors - geology, soil and slope - are considered when assigning land use capability classes. Another two - erosion and vegetation - may be recorded but rarely affect the decision. On regional-scale maps, notably the 1: 50,000 New Zealand Land Resource Inventory (NZLRI), limitations to use are indicated by four subclasses, c (climate), w (wetness), s (soil) or e (erosion). Unit numbers (1, 1b etc.) are used as labels for areas of land (map polygons) with the same geology, soil and slope, which are considered to have similar productive potential and management needs. General descriptions of productive potential and management needs are attached to NZLRI unit numbers.

NZLRI sub-classes and unit numbers were used for farm-scale land use capability maps (1:5,000 - 1: 10,000) prepared by Auckland Regional Authority or Auckland Regional Council between 1979 and 2010. On farm-scale soil maps prepared for Auckland Council since 2011, the four sub-classes are now replaced by twenty specific limitations. NZLRI unit numbers and their attached general descriptions are replaced by farm-specific tables.

Landform	NZLRI	Farm	Main limitation	Sustainable uses
Poorly drained estuary flats	3w3, 3wlb	3a+e	High water table after rain; poor structure	Occasional fodder crops; improved pasture
Seasonally wet estuary flats	4w2, 4wlb	4a+e	High water table through winter and spring; poor structure	Improved pasture (if better-drained)
Semi-drained mud flats	-	5a	Saltwater incursion during storm surges	Semi-improved pasture
Mudflats	6w2, 6wlb	6a	Saltwater incursion during spring tides	Un-improved pasture; ecological restoration to salt marsh
Mudflats	7w3, 7wlb	7a	Saltwater incursion every high tide	Ecological restoration to mangrove swamp
Semi-drained sandbanks and shellbeds	-	5a+r	Saltwater incursion during storm surges	Semi-improved pasture
Sandbanks and shellbeds	6s2	6a+r	Saltwater incursion during spring tides	Un-improved pasture; ecological restoration
Sandbanks and shellbeds	-	7a+r	Saltwater incursion every high tide	Ecological restoration

Sourced from: Harmsworth, G.R. 1996, Land use capability classification of the Northland region, Publication 9, Landcare Research; Anonymous 1979, NZLRI Waikato region land use capability extended legend, Water and Soil Division, MWD; Jessen, M.R. 1984, Additions to NZLRI Waikato Region land use capability extended legend, Water and Soil Division, MWD; Hicks, D. and Vujcich, V. 2017, Farm-scale land use capability classification for Auckland. Auckland Council Technical Report TR2017/016.

10 Past and present land uses

Takahiwai and related soils' poor structure, residual salinity and high water table precluded cultivation for the crops favoured by Maori i.e. kumara, yam, taro. Flax may have been harvested from clumps at the margins of saltmarsh, but they would have been too sparse to supply any quantity.

During the early days of settlement along harbours and estuaries - when farm fences were absent or few - European colonists noticed that their sheep and cattle preferred browsing the shore-line, where they could feed on a mix of saltmarsh vegetation and self-sown grass when drought stressed pasture on high ground. This observation would have sown the idea of establishing good pasture by reclaiming estuary flats that were already dry through most of the tidal cycle. When the first reclamations were attempted is not known, but through the 1920s - 1960s quite several Kaipara farmers obtained licenses from the Marine Department constructing long stop-banks and extensive drains. Small-scale reclamations also occurred along the little east coast estuaries from Pakiri to Wairoa. Large-scale reclamation was not attempted on the Manukau or Waitemata harbours, except for wharves and landfills close to the city of Auckland. Although quite a proportion of reclamations failed - still visible as breached stopbanks and silted drains running through mangrove swamps - the successes account for most of the 2,000 hectares presently farmed on Takahiwai and related soils.

The soils' poor structure, high water table and residual salinity preclude commercial grain or fodder crops. Nonetheless paddocks are cultivated when sowing pasture and an initial fodder crop may be sown as part of the pasture mix.

Farmers can establish improved pasture only where drainage is optimal. Most of the pasture remains semi-improved species interspersed with rush and sedge. Where saline incursion still occurs, rush and sedge remain amongst a ground cover of salt-tolerant grasses and herbs. Paddocks are generally used for summer grazing; a time of year when they are firm enough to be grazed by stock. The high water table ensures that at onset of winter rainfall, topsoil saturates. Currently, most farmers shift their stock onto different soils, in paddocks on higher ground.

Trees - whether fruit-bearing, timber or shelter - can grow on Takahiwai and related soils once drained, but do not thrive. The shallow-rooted trees are frequently toppled by gales.

Sourced from:
Ryburn, W.R. (1999) "Tall Spars, Steamers and Gum: A History of the Kaipara from Early European Settlement, 1854-1947" Kaipara Publications,
And D. Hicks personal observations.

10.1 Typical crop and pasture yields

Crop	Yield	Units
Maize	?	t/ha
Sorghum	?	t/ha
Forage brassica	?	t/ha

Source: local growers

No long-term pasture yield trials have been conducted on Takahiwai and related soils. The following estimates were made by scaling down dry matter yield (for changes in pasture composition) from an improved pasture trial on the closest soil, Kaipara clay.

Pasture	Yield	Units
Improved pasture (dairy)	11.9	t dm/ha/yr
Improved pasture (drystock)	8.9	t dm/ha/yr
Semi--improved pasture	7.1	t dm/ha/yr
Un-improved pasture	4.5	t dm/ha/yr

Source: MAF and Dexcel trials cited in Lincoln Farm Technical Manual 2008; various papers in NZ Journal of Agricultural Research

11 Information about soil management

Takahiwai and related soils are of limited use. Poor structure, residual salinity, high water table and occasional to frequent flooding constrain them to a single use - livestock grazing - and that only from summer to autumn. Issues arise if they are grazed at other times of year:

- Poor pasture composition and yield (where poorly drained)
- Pugging by stock (if grazed when wet)
- Sediment entry into, nutrient loss towards, and faecal contamination of, drains

So how the soils are managed impacts on water quality of estuaries as well as on farm production. Tips for drainage, grazing management, improving soil structure, also for controlling sediment, nutrient and faecal matter losses, are contained in:

- *Low flats with estuarine soil* *Soil Information Sheet 3, Auckland Council*
- *Code of Practice for Nutrient Management* *Fertiliser Association*
  (Code of Practice for Nutrient Management)
- *Riparian zone management: strategy guideline and planting guide*
  TP148, Auckland Regional Council
- *Drainage construction and maintenance:*
  TP10, Auckland Regional Council
- *A guide to managing farm dairy effluent (Auckland)* *Dairy NZ*
- *Soil structural breakdown and compaction in New Zealand soils*
  Technical Paper 95/5, MAF Policy
  http://maxa.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/land-management/soil-structure/soilcomp.htm

Find out more: phone 09 301 0101, email rimu@aucklandcouncil.govt.nz or visit aucklandcouncil.govt.nz **and knowledgeauckland.org.nz**

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