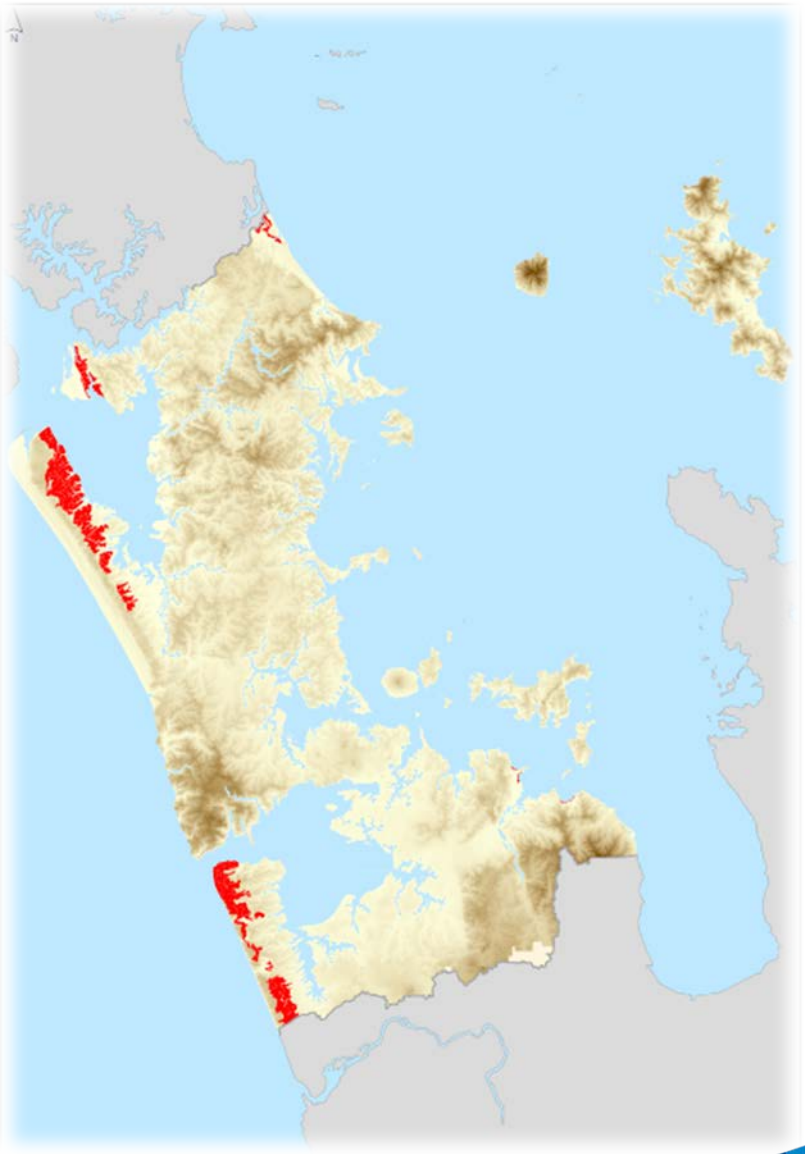
Soil Information Inventory:

Red Hill and related soils

October 2018 Soil Information Inventory 21



RIMU Research and Evaluation Unit

Auckland Council
Te Kaunihera o Tamaki Makaurau

Soil Information Inventory 21:

Red Hill and related soils

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Auckland Council
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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be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports.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), old sand soils are depicted as two separate series i.e. soils with distinct profiles and parent materials. They are divided into five types i.e. soils with differences in texture or other characteristics:

HO, HOH	Houhora sand and sandy loam
RLa, RLaH	Red Hill sand
RL, RLH	Red Hill sandy loam
RLl, RLlH	Red Hill sandy clay loam

On DSIR's oldest maps of South Auckland (1:253,840) similar soils are depicted as a single series divided into two types:

24a, 24aH	Red Hill sand and sandy loam

The same series appears on a map of intermediate age covering part of Franklin district (1:63, 360) labelled as:

Rh	Red Hill sandy loam

A recent map of Manukau city (1:20,000) separates the soil as two mapping units that contain spatially associated soil types, assigning an alphanumeric label:

AB3	Red Hill sandy loam with Marsden sand
AB5	Red hill sandy loam

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*

On maps north of Auckland, the differentiation of old sand soils into different series relates to mineral composition which changes geographically. On eastern parts of the South Kaipara peninsula from South Head to Shelly Beach, sand is mostly siliceous (quartz) with low ferromagnesian (ironsand) content, and old sand soil is mapped as Houhora series. Along centre of the peninsula from South Head to west

of Shelly Beach, the proportions reverse. Old ironsand soil is mapped as Red Hill series here, and throughout the old dunefield from west of Shelly Beach to Waimauku. From Manukau Heads south to Port Waikato, ironsand climbs from 50% to 80% by weight, in soils also mapped as Red Hill series.

Sand soils inland from east coast beaches are siliceous, though the proportion of quartz drops from close to 100% at Mangawhai to about 40% at Orere Point. Areas of old sand soil here are labelled as Red Hill sandy loam, which is anomalous given their low ironsand content.

On the South Kaipara peninsula there is a problem with the published maps' separation of Red Hill series into three types, Red Hill sand, Red Hill sandy loam, and Red Hill sandy clay loam. When investigated at farm scale, extensive areas labelled as Red Hill sandy clay loam turn out to be a mosaic of loam, clay loam, sandy loam or sand, in places thick; at others a thin veneer over older buried soils which protrude on hillslopes. Areas labelled Red Hill sand or sandy loam on the Awhitu peninsula are a similar mosaic. Here the loam and clay loam variants appear identical to old ash soils, mapped to the east as Pollok clay loam (80, 80H) or Matakawau clay loam (86, 86H).

3 Online maps

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

HO, HOH	No family name or sibling number assigned
RLa, RLaH	No family name or sibling number assigned
RL, RLH	No family name or sibling number assigned
RLl, RLlH	No family name or sibling number assigned
24a, 24aH	No family name or sibling number assigned
Rh	Wiku family, sibling 10
AB3	Koputaroa family, sibling 4
AB5	Fitz family, sibling 1

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

When investigated in the field by local mappers, published map polygons labelled Houhora or Red Hill series are differentiated into six soil types, depending on the soils' mineral composition, texture, and whether they are deep or veneers over older buried soils. On farm-scale maps (1:5,000-1: 10,000), the soils are labelled as:

Ho	Houhora sand or sandy loam
Ho'/Tt	Houhora sand or sandy loam (shallow) over Tangitiki soil
Rl	Red Hill sand or sandy loam
Rl'/Tt or Hr	Red Hill sand or sandy loam (shallow) over Tangitiki or Horea soil
Rli	Red Hill loam or clay loam (deep)
Rli'/Tt or Hr	Red Hill loam or clay loam (shallow) over Tangitiki or Horea soil

South of Auckland, when farm mapping/identifying soils for sampling, the same labels are applied.

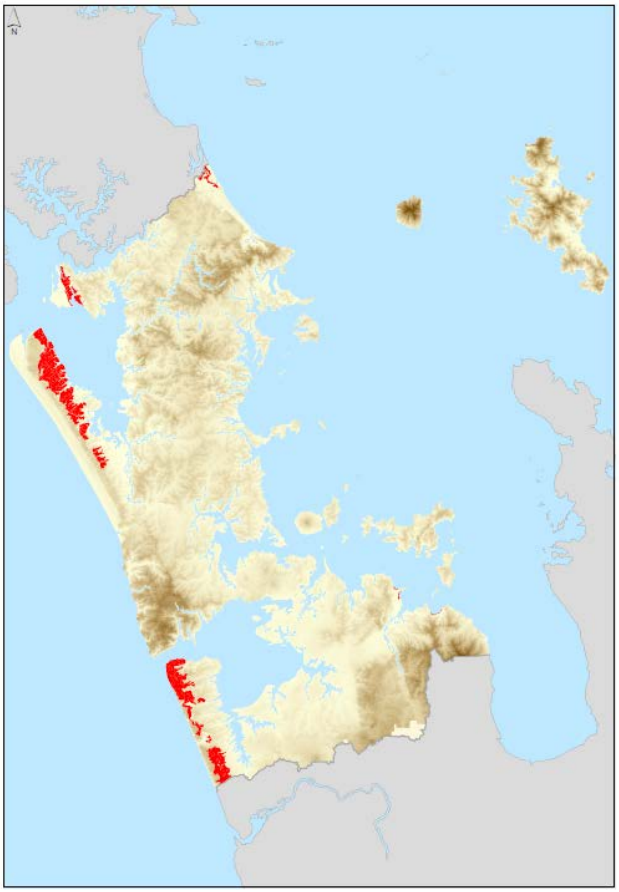
Red Hill loam and clay loam are so different from Red Hill sand or sandy loam that they will be described separately in conjunction with Pollok and Matakawau soils. Refer to Soil Information Inventory for Matakawau and related soils (yet to be prepared) for a description of their properties and use.

Local series names for Red Hill and related soils have been 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 central parts of the South Kaipara peninsula and Awhitu peninsula, also near tip of Okahukura peninsula. Locally along the region's north-east coast from Mangawhai to Pakiri, then as small patches behind east coast beaches from Omaha (south of Cape Rodney) to Tanewhanewha (south of Orere Point). Likewise, as small patches, behind north or east-facing beaches on Waiheke and Great Barrier Islands.



Location of Red Hill and related soils

Red Hill and related soils are mapped on 13,500 hectares (3% of Auckland region). About 10,000 hectares (75% of the area mapped) are in agricultural use as dairy or drystock pasture. A further 650 hectares are in farm woodlots or forest plantations (estimated from overlay of Agribase 2010 on Fundamental Soils Layer). *http://intermaps.arc.govt/AucklandCouncilViewer/*

Red Hill sand and sandy loam are on elevated rolling terrain – old vegetated dunefields – above Horea sandy clay on steep gully sides (cut through an older buried dunefield) at Awhitu. Parore sand and peaty sand are on the alluvial flat in the valley bottom. *Photo: P. Singleton*

5.1 On what landform

Red Hill and related soils occur on fixed dunefields where forest cover succeeded natural colonisation by coastal grasses or scrub, prior to human settlement. Within the Karioitahi Group of windblown sand deposits, they are the second-youngest formations, more than 10,000 years old and less than 80,000, interpreted by geologists as having moved inland at several times when falling sea level exposed coastal sediment during the last Ice Age. The early part of this period (between 80,000 and 50,000 years ago) coincided with last of the Hamilton Ash showers from rhyolitic eruptions in the central North Island. More ash fell during substantial eruptions about 30,000 years ago (Rotoehu) and 22,000 years ago (Kawakawa). Where ash fell onto mobile dunes it was mixed, creating a loamy sand which develops red-brown colour on weathering. Where ash fell onto fixed dunes or wet flats between moving dune ridges, it was preserved as a loamy or clay loam layer that also develops red-brown colour on weathering, over coarser-textured grey-brown or yellow-brown sand.

Patches of mixed forest (totara, rimu, broadleaved species notably taraire, occasional tanekaha and kauri) remain on Houhora and Red Hill soils. Timber buried in sand or in the peat of inter-dune swamps, carbon-dated to ages between a few thousand and fifty thousand-plus years, indicates a long period of forest cover

interspersed by occasional dune advances. But when European settlers arrived, the soils were mostly vegetated by kanuka scrub. This pattern, combined with charred timber and charcoal, suggests repeated burning during the Polynesian period.

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
Hicks, D.L., 1977, Pp 48 -52 in Soil Groups of New Zealand Part 1: Yellow-Brown Sands, New Zealand Society of Soil Science

5.2 How they differ from other soils

Characteristic features of Houhora, Red Hill and related soils are well-developed sandy loam topsoil with moderate organic content and with low packing strength which can become microfine single grained (powdery) when dry, above weathered silty sand subsoil, compact but loose-structured, grading to unweathered sand (parent material) one to two metres down. Topsoil and subsoil are free-draining, though contain enough silt (from weathering of sand or mixture with volcanic ash) to retain some moisture, reducing drought stress. The silty sand subsoil, cohesive when moist and compact when dry, protects underlying sand from wind-blow; though topsoil may be removed by wind-blow or sheetwash, leaving exposed subsoil "scalds" where vegetation cover is breached, with shallow "veneers" of wind-blown or water-washed sand to leeward.

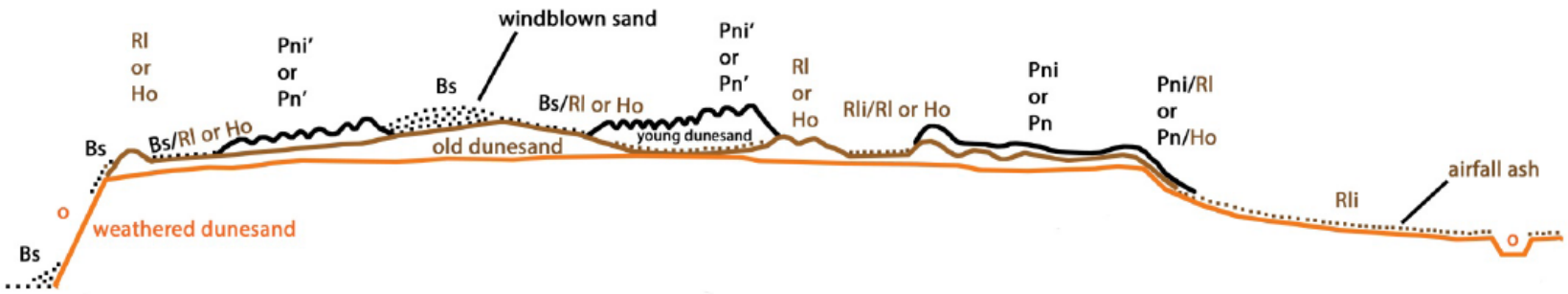
Sourced from:
Cox, J.E. 1977 Northland Peninsula, Pp 18-47 in Soil Groups of New Zealand Part 1: Yellow Brown Sands, New Zealand Society of Soil Science
Wilson, A.D. and Mc Donald, W. 1984, Soils of Northland: Pinaki and Ruakaka suite District Office Report KK4, Soil Bureau DSIR

6 Classification

NZ genetic (NZG):	Yellow-brown sand
NZ soil (NZSC):	Typic sandy brown, typic orthic brown *http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx*
Soil Taxonomy (USDA):	Psammentic hapludult *http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051544.pdf*
World Soils (FAO):	Arenosol *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 Red Hill and related soils' position in landscape



	South Auckland		North Auckland	
On windblown sand dunes: (bare)	Bs	Bare sand	Bs	Bare sand
On young unstable dunesand: (re-vegetating)	Pni'	Pinaki ironsand (incipient topsoil)	Pn'	Pinaki sand (incipient topsoil)
	Pni	Pinaki ironsand (well-developed topsoil)	Pn	Pinaki sand (well-developed topsoil)
On old stable dunesand: (vegetated)	Rl	Red Hill sand or sandy loam	Ho	Houhora sand or sandy loam
On old airfall ash: (over old stable dunesand)	Rli	Red Hill loam or clay loam	Rli	Red Hill loam or clay loam
Old weathered dunesand: (inter-bedded with coastal and estuarine sediment)	O	Other soils	O	Other soils

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

7 Soil profile descriptions

Houhora sand and sandy loam *Photo: N Watson*

The DSIR's type profile description for Houhora sand was originally labelled Houhora sand plus Houhora sandy loam. It comes from a Northland site where the parent material's mineral composition is mixed; a third is silica, a third is ironsand, a third is other minerals. This is also typical of Houhora sand from about halfway up the South Kaipara peninsula:

Horizon	Depth (cm)	Description
Ah	0-8	Very dark grey brown (10YR 4/2-3/2) sand; compound structures of weakly and moderately developed extremely fine and very fine polyhedral structure and single grain; friable; contains numerous scrub roots; sharp boundary.
A/B	8-16	Yellowish brown to pale brown intermingled with dark grey brown (10YR 5/4-6/3 + 4/2) sand; very friable to loose; very weakly developed extremely fine polyhedral and single grain structures; contains numerous scrub roots; diffuse boundary.
B	16-29	Brownish yellow (10YR 6/6) sand; friable; slightly compact and massive in place; weakly developed very fine and extremely fine polyhedral structure; slight staining of dark brown on the faces of some of the aggregates; contains numerous scrub roots; diffuse boundary.
2B	29-80	Strong brown (7.5YR 5/6) sandy clay loam; friable; more compact in place and massive, very weakly developed fine and medium polyhedral structures; contains numerous scrub roots; diffuse boundary.
2Cu	80-100	Brownish yellow (10YR 6/6) sand; massive in place, slightly compacted, becomes loose and readily breaks to single grain when disturbed.

A local soil mapper (DLH) who has seen the type profile site comments that Houhora sand's subsoil resembles the B horizon though is normally thicker (30 to 60 cm) grading to parent sand. The 2B horizon at this site appears to be the buried Houhora sandy loam. Its "sandy clay" texture is atypical of either soil type, and may be due to sand weathering in the presence of buried organic matter.

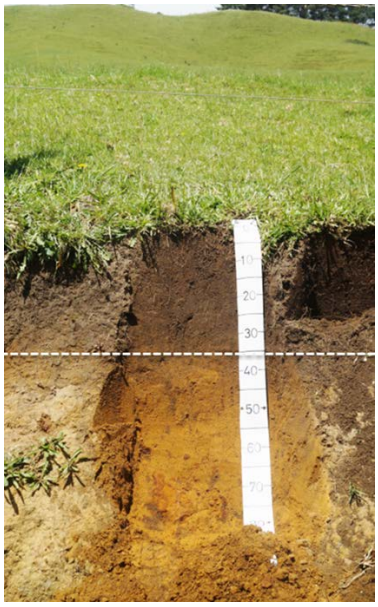
Red Hill sand *Photo: D. Hicks*

The type profile description (from Northland) is:

Red Hill sand

Horizon	Depth (cm)	Description
Ah	0-13	Very dark brown (10YR 3/8) sandy loam or sand; friable; weakly and some moderately developed fine and very fine polyhedral and single grain structure; abundant scrub roots; sharp boundary.
B1	13-48	Strong brown (7.5YR 5/6) sandy clay loam; massive in place breaking to weakly to moderately developed fine, some medium and very fine polyhedral structure; friable; medium packing; abundant scrub roots; diffuse boundary.
B2	48-88	Yellowish red (5YR 5/6) loamy clay; massive in place breaking to weakly developed fine and medium polyhedral structure, breaks down readily to extremely fine polyhedral or single grain structure when disturbed; slightly sticky when wet; high packing; abundant roots; irregular boundary.
Cu	on	Olive brown (2.5Y 4/4) slightly consolidated sand, crushes under firm pressure to sand.

Red Hill sand's A horizon is shallower than 13 centimetres in many places. It appears to be a new topsoil forming where the original topsoil of Red Hill sandy loam (see below) has been eroded from rolling slopes, leaving subsoil exposed.



Red Hill sandy loam *Photo: P. Singleton*

Another type profile description (from South Kaipara peninsula) corresponds with undisturbed Red Hill soil:

Red Hill sandy loam

Horizon	Depth (cm)	Description
Ap	0-18	Very dark grey (10YR 3/2) sandy loam; friable; moderately developed fine extremely fine polyhedral structure; abundant grass roots; diffuse boundary.
A/B	18-26	Dark brown (7.5YR 4/4) loamy clay; massive in place breaking to moderately developed fine and very fine polyhedral structure; high packing but friable in the hand; abundant grass roots; the upper half of this horizon is intermingled with the A horizon; diffuse boundary.
B1	26-39	Reddish brown (5YR 4/4) loamy clay; firm, more tightly packed in place and very hard to dig; massive like but with a weakly developed fine and very fine polyhedral with tendency to blocky structure contains numerous grass roots all penetrating the soil aggregates; diffuse boundary.
B2	39-59	Reddish brown (5YR 4/4) loamy clay; moderately developed medium and fine polyhedral breaking down to very fine blocky structure, very high packing and very weakly indurated; many pores; abundant grass roots; diffuse boundary.
C	59-92	Reddish brown-dark reddish brown (5YR 4/4 - 3/4) clay; strongly developed medium and fine polyhedral structure breaking to very fine blocky structure, disintegrates readily when disturbed; very high packing; many pores; many grass roots.
Cu	on	Weathered sands

Red Hill sandy clay loam and Red Hill loam

For profile descriptions of these soil types, refer to the Soil Information Inventories for Tangitiki, Matakawau and related soils (yet to be prepared).

Sourced from:
Sutherland C.F., Cox, J.E., various dates, Type profile descriptions for North Auckland Soil Survey, Unpublished documents, Soil Bureau, DSIR
Orbell, G.E., 1977, Soils of part Franklin County, Soil Bureau Report 33, DSIR

8 Properties of typical profile

Properties of typical profiles are best indicated by analysis results for the type profiles i.e. sites where Red Hill and Houhora series were 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 for either soil appears in the online version of National Soils Database (NSD). The following analyses appear in Soil Bureau laboratory records.

Houhora sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Acidity	6.4	5.9-6.0	pH
Total carbon	2.0	-	%
Total nitrogen	-	-	%
Available phosphorus	-	-	mg %
P retention	-	-	%
Available sulphur	-	-	%
Cation exchange capacity	7.0	5.3-5.5	me %
Base saturation	23	9-13	%
Calcium	1.3	0.4-0.5	me %
Magnesium	-	-	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB7290, DSIR Soil Bureau

Red Hill sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Acidity	5.2-5.2	5.3-5.5	pH
Total carbon	2.8-4.5	0.3-1.3	%
Total nitrogen	0.18-0.33	0.02-0.09	%
Available phosphorus	5-12	1-6	mg %
P retention	37-43	23-51	%
Available sulphur	15-23	28-35	%
Cation exchange capacity	11.9-16.7	4.1-9.2	me %
Base saturation	24-45	21-22	%
Calcium	2.1-5.2	0.4-1.3	me %
Magnesium	0.6-1.7	0.4-0.4	me %
Potassium	0.1-0.6	<0.1	me %
Sodium	0.1-0.1	0.1-0.3	me %

Sourced from laboratory analysis SB8262, DSIR Soil Bureau

8.2 Physical

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

No physical analysis appears in the online version of National Soils Database (NSD). The following data are sourced from old Soil Bureau laboratory records, plus some estimates from Fundamental Soils Layer (FSL).

Houhora sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand	8.5	83-88	%
Silt	8	7-12	%
Clay	7	5-9	%
Dry bulk density	-	-	g/cm³
Total porosity	-	-	%
Macroporosity	7.5-25.0	-	%

Sourced from laboratory analysis SB07290, DSIR Soil Bureau, and FSL table, Landcare Research

Red Hill sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand	76	69-75	%
Silt	14	3-15	%
Clay	10	16-24	%
Dry bulk density	-	-	g/cm³
Total porosity	-	-	%
Macroporosity	5.0-14.9	-	%

Sourced from laboratory analysis SB07145, DSIR Soil Bureau, and FSL table, Landcare Research

8.3 Irrigation and drainage

http://irrigationefficiency.co.nz/assets/Uploads/Farmers-Guide.pdf

No soil moisture analysis appears in the online version of National Soils Database (NSD). The following estimates are sourced from Fundamental Soils Layer (FSL).

Houhora sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Field capacity			% w/w
Wilting point			% w/w
Plant-available water			% w/w
Plant-available water	25-99	30-45	mm
Depth to slowly permeable layer		1.20-1.49	m
Perm. at slowly permeable layer		<4	mm/hr

Sourced from FSL table, Landcare Research

Red Hill sand/sandy clay loam

Property	Topsoil	Subsoil	Units
Field capacity	-	-	% w/w
Wilting point	-	-	% w/w
Plant-available water	-	-	% w/w
Plant-available water	25-99	40-50	mm
Depth to slowly permeable layer	-	1.20-1.49	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. Red Hill and related soils have been sampled at six sites in the Auckland region, corresponding to the main land uses which are dairy pasture, drystock pasture and forest plantation.

Land use:		**Natural cover**	**Pasture**		**Forest**		
Types:		**Bush**	**Dairy**	**Drystock**	**Young**	**Mature**	**Recently planted**
Sample Number:		**99/3**	**98/13**	**98/9**	**98/10**	**98/11**	**98/12**
Acidity	pH	5.6	5.5	5.6	5.3	4.9	5.5
Total carbon	%	9.3	7.1	6.6	5.3	11.0	9.4
Total nitrogen	%	0.44	0.65	0.67	0.49	0.76	0.86
Available nitrogen	ug/ cm^3	107	106	175	60	81	109
Available phosphorus	ug/cm^3	2	15	22	17	7?	9
Cation exchange capacity	cmol/cm^3	24.8	24.6	22.9	13.8	21.5	19.6
Base saturation	%	43	42	53	40	39	47
Calcium	cmol/ cm^3	5.9	7.2	6.8	2.6	3.6	5.2
Magnesium	cmol/ cm^3	3.6	1.9	3.0	1.5	2.7	2.6
Potassium	cmol/ cm^3	0.6	0.7	2.2	0.6	0.9	1.2
Sodium	cmol/ cm^3	0.4	0.4	0.2	0.8	1.1	0.2
Bulk density	t/ m^3	0.65	0.94	1.01	0.76	0.91	0.54
Particle density	t/ m^3	2.43	2.43	2.61	2.63	2.57	2.42
Aggregate stability	mm mwd	2.55	2.56	2.33	2.55	2.10	2.59
Total porosity	%	73	61	61	71	65	74
Macroporosity	%	31	12	6	35	18	23
Total available water	%	20	20	29	16	20	24
Readily available water	%	7	6	12	10	12	10

Sourced from Sparling, G. et al, various dates, 500 Soils Project, Landcare Research Reports to Auckland Council Soil Quality of Dairy Sites in the Auckland Region in 2009), Soil Quality of Drystock Sites in the Auckland Region in 2010, Soil Quality of Plantation Forestry Sites in the Auckland Region in 2011

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
Undulating to rolling hollows	3e5, 3e6	3x+d	Moderate windblow and sheetwash risk (if cultivated)	Tree and vine crops, rotational cropping, intensive dairy or drystock grazing
Strongly rolling hollows	4e9,4e6	4x+d	Severe windblow and sheetwash risk (if cultivated)	Tree and vine crops, occasional cropping, intensive dairy or drystock grazing
Strongly rolling dune ridges	-,-	5x+s	Slight windblow and sheetwash risk (if pasture breached)	Intensive dairy or drystock grazing, tree plantations
Moderate dune ridges	6e6,6e15	6x+g	Moderate windblow and sheetwash risk (if pasture breached)	Dairy runoff or drystock grazing, tree plantations

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

Red Hill and Houhora soils contain enough silt in their topsoils to be cultivated, though are free-draining, and mostly on rolling terrain. For these reasons they do not appear to have been favoured by early Maori as sites for growing kumara or other crops, except in undulating dune hollows (which remain moist in summer). Original vegetation was mixed forest. After arrival of Polynesians, forest cover was widely disturbed by burning or by migration of dunes from the unstable Pinaki dunefield to windward. By time of European settlement, the Red Hill and Houhora soils were a mosaic of forest remnants, kanuka scrub regrowth, and bare subsoil “scalds” interspersed by shallow sand “veneers” where Pinaki dunes had migrated across their surface.

Pasture establishment was difficult on bare scalds interspersed by shallow sand. These windward areas usually became infested with an assortment of exotic scrubby weeds such as gorse and pampas interspersed with native scrub. Wildling trees - pine, gum and wattle - often established and grew well in the scrub. Farmers started felling the trees for firewood or farm timber. By the 1950s, they were re-planting with timber trees at a close spacing. Today such areas are mostly farm woodlots. Where settlers cleared bush or scrub from intact Red Hill and Houhora soils, there was enough topsoil for grass to grow well. So, they were able to establish large drystock farms the length of the Awhitu and South Kaipara peninsulas; also, small dairy farms, though dairy production is limited by the soils’ free drainage (which depresses pasture growth from summer to autumn).

Commercial grain or fodder cropping has never been practised on these soils. Most paddocks are too rolling to cultivate. Where undulating enough to plough, sandy texture and free drainage would cause uneven strike and poor yield. Nevertheless, grain and greenfeed crops are sown in course of pasture renewal, for on-farm consumption by stock.

In recent years, some landowners have realised that the free-draining, sandy soils have potential for tree horticulture. Quite a range of trees has been planted experimentally to see what will grow. As yet avocados and macadamias are the only species to be established commercially, at a few sites on the Awhitu, South Kaipara and Okahukura peninsulas. A growing area of orchards on Houhora and Red Hill soils in Northland, indicates that there is scope for expansion on the same soils here.

Sourced from:
Aspin, W. (ed), 1998, Heads, Harbour and Hills, Awhitu History Book Society Inc.
Dixon, P., 2004, Backbreak Peninsula, Awhitu History Book Society Inc.

10.1 Typical crop, pasture, and tree plantation yields

Crop	Yield	Units
Maize	Up to 25	t/ha
Forage brassica	Up to 8	t/ha
Forage turnips	?	t/ha

Source: local growers

Pasture	Yield	Units
Improved pasture (dairy)	>9.3	t dm/ha/yr
Improved pasture (drystock)	9.3	t dm/ha/yr
Semi-improved pasture	7.4	t dm/ha/yr
Un-improved pasture	4.7	t dm/ha/yr

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

Timber	Yield	Units
Radiata pine (clearwood regime)	?	t/ha
Radiata pine (unpruned pulpwood)	?	t/ha
Macrocarpa cypress (woodlot)	?	t/ha
Eucalypt (woodlot)	?	t/ha
Acacia (woodlot)	?	t/ha

Source: FRI trials cited by SCION website; various papers in NZ Journal of Forestry or NZ Farm Forestry

11 Information about soil management

Red Hill and Houhora soils are not as versatile as their better-structured variants (Red Hill sandy clay loam or loam, Matakawau clay loam) which have a distinct layer of volcanic ash topsoil over windblown sand subsoil. The sands/sandy loams' light texture, free drainage and rolling contour render them unsuitable for commercial vegetable, grain or fodder cropping (though grain or greenfeed crops may be sown when pasture is renewed). Nonetheless they have sufficient silt in their topsoil (from several thousand years' weathering beneath forest cover) to be at low risk of wind erosion and retain enough moisture to grow good grass or trees.
Management issues that may arise are:

- Adequate fertilizer to replace grass uptake
- Minimum tillage or direct-drilling in preference to cultivation, if cropped
- Grazing control to maintain dense sward in pasture
- Irrigation where possible to maintain summer-autumn grass growth
- Stock water supply (there are few surface streams or springs)
- Temporary ground cover after felling timber trees

Tips for managing soil structure and nutrients, for controlling erosion, and for applying irrigation water or effluent, are contained in:

- *Old sand soils* *Soil Information Sheet 8, Auckland Council*
- *Code of Practice for Nutrient Management* *Fertiliser Association*
  http://www.fertiliser.org.nz/site/code_of_practice/default.aspx
- *A guide to managing farm dairy effluent (Auckland)* *Dairy NZ*
  http://www.dairynz.co.nz/media/880785/auckland_guide_to_managing_farm_dairy_effluent.pdf
- *Streamside planting guide* *Auckland Council*
- *Native forest restoration guide* *Auckland Council*
- *Forest harvest guidelines* *TP223, Auckland Regional Council*
- *Establishing permanent tree cover on sand country Information leaflet* *Awhitu Landcare Group*
- *Pasture management on sand country Information leaflet* *Awhitu Landcare Group*

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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