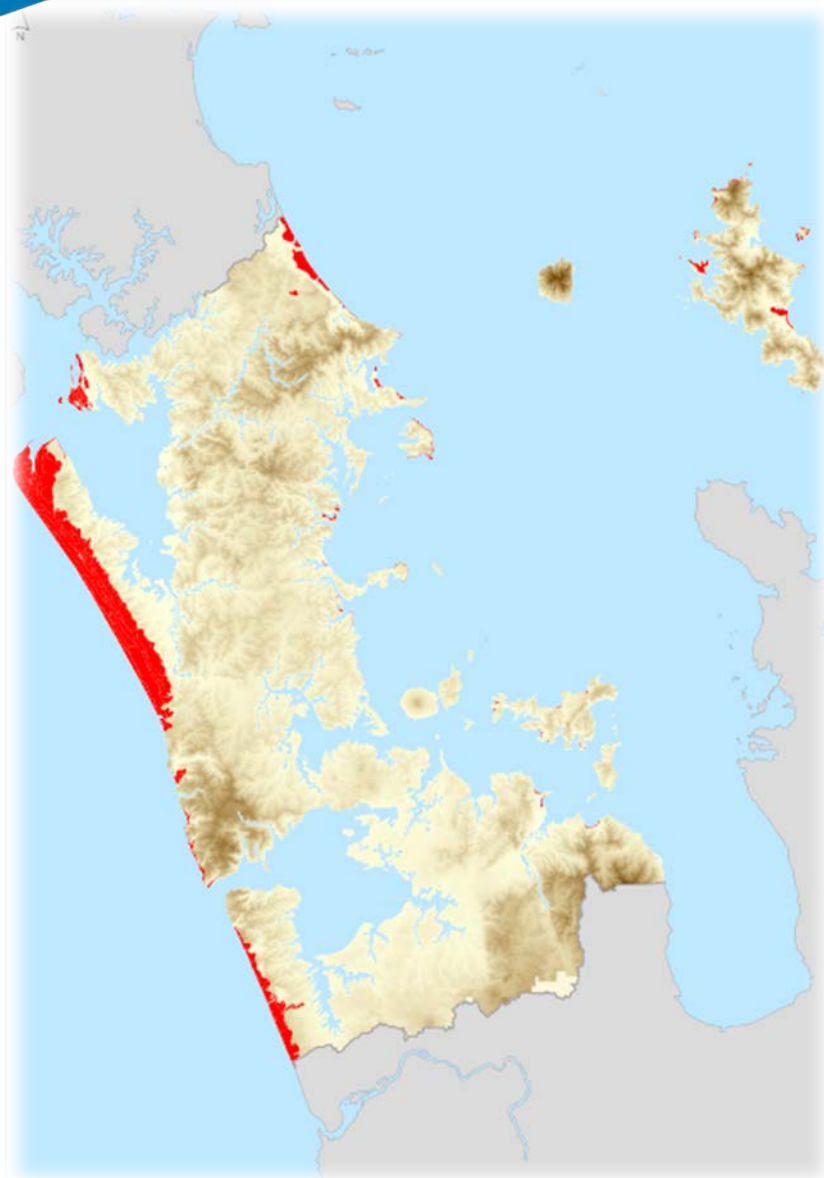


Soil Information Inventory:

Pinaki and related soils

October 2018

Soil Information Inventory 17





Soil Information Inventory 17: Pinaki and related soils

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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be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports.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

DSIR's soil maps of North Auckland (1:100,000) show extensive areas of bare sand dunes behind beaches. Farther inland, the maps show young sand soils on vegetated dunes near the west coast as a single series i.e. soil with distinct profile and parent materials or as a separate series on the east. The series are labelled as:

BS	Bare sand
PN, PNH	Pinaki sand
WD	Whananaki sand
MD	Marsden sand

On DSIR's oldest maps of South Auckland (1:253,840), similar soils are depicted with different labels:

SDH	Sand hills
23a, 23aH	Pinaki sand

They do not appear on a map of intermediate age covering an inland part of Franklin district (1:63,360).

A recent map of Manukau city (1:20,000) separates small areas of young sand soil on its east coast into two mapping units that contain spatially associated soil types i.e. soils with differences in texture or other characteristics, assigning alphanumeric labels:

AB3	Red Hill sandy loam with Marsden sand
AB4	Whananaki sand

A problem with depiction of young sand soils on all the maps is that areas labelled bare sand were stabilised from the 1920s onwards by planting a sequence of marram grass, lupins, and pine trees. At date of field sheet compilation (1937-1952), they were a mosaic of young vegetation interspersed by yet unplanted dunefields. Nowadays (2015) few unplanted dunes remain, although new sand-blows open here and there within plantations. On most land behind the beaches, incipient soils are now forming beneath vegetation which has been established for anything from 50 to 90 years.

Another problem is that the mineralogy of young sand soils (whether mapped as bare sand or as Pinaki series) changes geographically. At Kaipara South Head the soils are mostly siliceous (quartz) with low ferromagnesian (ironsand) content. Moving south through the dunes behind Muriwai and other west coast beaches,

proportions gradually reverse. From Manukau Heads south to Port Waikato, ironsand climbs from 50% to 80% by weight. 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. These differences affect ease (or difficulty) of revegetation and have a bearing on whether the revegetated land can be sustained in trees or pasture. Areas where ironsand or silica content exceeds 80% are actual or potential open-cast mine sites.

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

149/1

NZ Soil Bureau map

Soil map of Manukau City

unpublished

NZ Soil Bureau map,

3 Online maps

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

BS	No family name or sibling number assigned
PN, PNH	No family name or sibling number assigned
WD	Fere family, sibling 41
SDH	No family name or sibling number assigned
23a, 23aH	No family name or sibling number assigned
AB3	Koputaroa family, sibling 4
AB4	Tidl family, sibling 2, complexed with other soils
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

North of Auckland, any published map polygon labelled as Pinaki (PN) or related series turns out to be a mosaic of Pinaki plus other soil types – old sand soils such as Houhora or Red Hill series - when investigated in the field by local soil mappers. On farm-scale soil maps (1:5,000 - 1:10,000) the young sand soils are labelled as:

Bs	Bare sand
Pn'	Pinaki sand (incipient topsoil)
Pn	Pinaki sand (distinct topsoil)
Wd	Whananaki sand

Marsden sand (MD) has not yet been mapped at farm scale. It is mostly on flats behind or between foredunes (see Soil Information Inventory for Parore and related soils). Where on foredunes or blow-outs from foredunes, a local mapper (DLH) recommends recording it as: Md' Marsden sand (incipient topsoil).

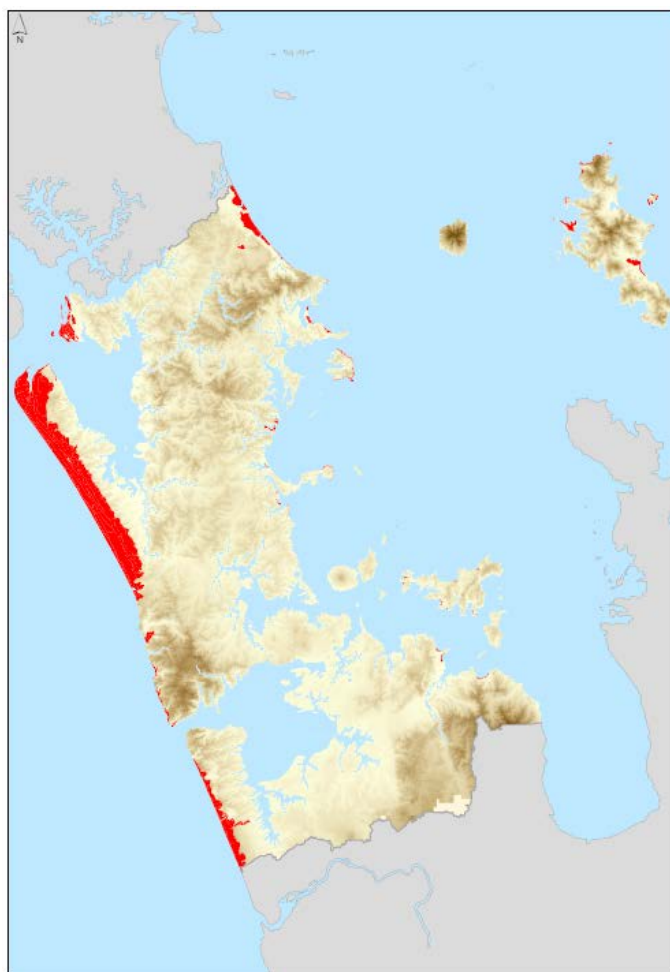
South of Auckland, the same labels are applied when farm mapping or identifying soil for sampling. Ironsand variants here (presently denoted by bracketed comments in map keys) may be labelled Bsi, Pni' or Pni on future maps.

Local series names for Pinaki 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 western halves of the South Kaipara peninsula and Awhitu peninsula, also on tip of Okahukura peninsula. Locally behind Waitakere beaches between Bethells and Whatipu. Along the region's north-east coast from Mangawhai to Pakiri. Just as thin strips, behind east coast beaches from Omaha (south of Cape Rodney) to Tanewhanewha (south of Orere Point). Also, as thin strips, behind north or east-facing beaches on Waiheke and Great Barrier Islands.



Location of Pinaki and related soils

Pinaki and related soils are mapped on 18,700 hectares (4% of Auckland region). About 6,300 hectares (34% of the area mapped) are in agricultural use and about 10,000 (53%) are in forest plantation (estimated from overlay of AgriBase 2010 on Fundamental Soils Layer). <http://intermaps.arc.govt/AucklandCouncilViewer/>



Pinaki sand (grey) on a recent dunefield naturally colonized by scrub prior to pasture conversion, overlies Horea sandy clay (brown) exposed in stream gullies cut through an older buried dunefield at Awhitu *Photo: D Hicks*

5.1 On what landform

Bare sand corresponds to either foredunes immediately behind beaches (where vegetation is too sparse for soil to develop), or mobile dunes migrating inland from the foredunes, or sandblows farther inland (where cover has been breached on vegetated dunes).

Incipient topsoil phases of Pinaki, Whananaki or Marsden sand develop on dunes and sandblows fixed by vegetation recently i.e. since about 1920. Well-developed phases of Pinaki, Whananaki or Marsden sand occur on dunefields fixed through natural colonisation by coastal grasses or scrub, prior to human settlement.

Within the Karioitahi Group of windblown sand deposits, they are the youngest formations, less than 10,000 years old (and mostly less than 2,000). When European settlers arrived, the well-developed Pinaki, Whananaki or Marsden soils were vegetated by coastal scrub such as flax and taupata, interspersed with patches of light coastal forest, either pohutukawa or kanuka. Other forest species were not present. This pattern, combined with charcoal and widespread umu, 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 young sand soils are incipient or thin topsoil with low organic content and loose structure, above slightly weathered sand. Time beneath stabilising vegetation has been insufficient for a subsoil to develop. Topsoil and parent material are excessively free-draining, so vegetation has difficulty re-establishing if depleted by drought stress, saltburn, grazing animals or fire. Absence of a weathered (silty or clayey) subsoil renders the underlying sand susceptible to wind-blow. In all these respects, Pinaki and related soils strongly differ from older sand soils such as Houhora or Red Hill.

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 Classifications

NZ genetic (NZG): Yellow-brown sand

NZ soil (NZSC): Typic sandy raw, typic sandy recent, typic sandy brown
http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx

Soil Taxonomy (USDA): Typic udipsamment or quartzipsamment
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.

7 Soil profile descriptions



Topsoil (AC)

Parent material (Cu)

Pinaki sand (incipient topsoil) Photo: D Hicks

DSIR appears not to have prepared a type profile for raw Pinaki sand. A brief description is attached to one of the DSIR's type profiles for well-developed Pinaki sand:

Pinaki sand (incipient topsoil)

Horizon	Depth (cm)	Description
AC	0-5	Missing
Cu	5-274	Dark olive grey (5Y 3/2) sand; loose; single grained; many fine roots of the pines (to a depth of 3 metres).



Topsoil (Ap and AC)

Subsoil (Cu)

Pinaki sand (well-developed topsoil) Photo: D Hicks

DSIR's unpublished type profiles contain three for Pinaki sand with well-developed topsoil. The first (in Northland) is on siliceous parent material:

Pinaki sand (silica variant)

Horizon	Depth (cm)	Description
Ap	0-13	Very dark grey brown (10YR 3/2) sand; very friable; single grain structure moderately coherent because of the humus and abundance of grass roots; diffuse boundary.
AC	13-23	Very dark grey brown (2.5Y 3/2) sand; very friable; single grain structure only slightly coherent due to the numerous roots and some humus; diffuse boundary.
Cu	23-120+	Light yellowish brown (10YR 6/4) sand (tinted grey to pale brown) very friable and loose; single grain structure; contains many grass roots to a depth of 120 cm.

The second (South Kaipara peninsula) is on iron sand:

Pinaki sand (ironsand variant)

Horizon	Depth (cm)	Description
Ap1	0-13	Very dark brown-black (10YR 2/2-2/1) fine sand; loose; very weakly developed extremely fine subangular polyhedral structure; contains abundant fine grass roots; sharp boundary.
Ap2	13-23	Dark brown (7.5YR 3/2) fine sand; loose; very weakly developed extremely fine subangular polyhedral structure; contains abundant fine grass roots; diffuse boundary.
Cu1	23-38	Dark grey brown (10YR 4/2) medium sand; loose; single grained; contains many fine grass roots; diffuse boundary.
Cu2	on	Light olive brown (2.5Y 5/4) medium sand; loose; single grained; contains common finer grass roots to a depth of 180 cm; sands moister with increasing depth.

A third type profile is from a South Kaipara site where the parent material's mineral composition is mixed:

Pinaki sand (mixed variant)

Horizon	Depth (cm)	Description
Ap1	0-13	Very dark brown-black (10YR 2/2-2/1) fine sand; loose; very weakly developed extremely fine subangular polyhedral structure; contains abundant fine grass roots; sharp boundary.
Ap2	13-28	Very dark grey brown (10YR 3/2) fine sand; loose; very weakly developed extremely fine subangular polyhedral structure; contains many fine grass roots; diffuse boundary.
Cu	on	Light olive brown (2.5Y 5/4) medium sand; loose; single grained; contains common fine grass roots to a depth of 180 cm; sands moister with increasing depth.

It is the west coast equivalent of Whananaki sand (see next profile). Whananaki sand is mapped on foredunes or blow-outs from foredunes, behind most of Auckland's east coast beaches. Between Pakiri and Mangawhai, Marsden sand is mapped where the same landforms derive from silica sand.



Topsoil (AC)

Parent material (Cu)

Whananaki sand Photo: D Hicks

Whananaki sand

Horizon	Depth (cm)	Description
Ap1	0-13	Very dark grey (10YR 3/1) sand; friable; single grain structure with some very weakly developed very fine subrounded polyhedral structure and worm casts; abundant grass roots; diffuse boundary.
AC	13-51	Dark grey (10YR 4/1) sand; loose; single grain structure; contains few broken shells and abundant grass roots; sharp boundary.
Cu	51-66	Light brown grey (10YR 6/2) sand; loose; single grain structure; contains many grass roots; diffuse boundary.
2C	on	Light yellowish brown (10YR 6/4) sand; firm in place; single grain structure; contains few fine grass roots.

Another type profile is given, for a shallow variant with AC and Cu horizons reversed, over black peaty sand. It is probably water-washed or wind-blown Whananaki sand, on top of a buried Marsden peaty sand.

Sourced from:

Sutherland C.F., Cox, J.E., various dates, Type profile descriptions for North Auckland Soil Survey, Unpublished documents, Soil Bureau, DSIR

Gibbs, H. (ed), 1954, General Survey of Soils of North Island, Soil Bureau Bulletin 5, DSIR

8 Properties of typical profile

Properties of typical profiles are best indicated by analysis results for the type profiles i.e. sites where Pinaki and Whananaki 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/mq/chemical.htm>

No chemical analyses for Pinaki or Whananaki sand appear in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 5.

Pinaki Sand

Property	Topsoil	Subsoil	Units
Acidity	6.5	-	pH
Total carbon	3.6	-	%
Total nitrogen	0.21	-	%
Available phosphorus	0.013	-	%
P retention	-	-	%
Available sulphur	-	-	%
Cation exchange capacity	11.5	-	me %
Base saturation	53	-	%
Calcium	3.9	-	me %
Magnesium	1.7	-	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB00867, DSIR Soil Bureau

Whananaki sand

Property	Topsoil	Subsoil	Units
Acidity	6.1	6.3	pH
Total carbon	2.8	-	%
Total nitrogen	0.23	-	%
Available phosphorus	0.020	0.026	%
P retention	-	-	%
Available sulphur	-	-	%
Cation exchange	10.7	8.1	me %

capacity			
Base saturation	63	56	%
Calcium	5.6	3.6	me %
Magnesium	1.2	0.6	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB0B554, DSIR Soil Bureau

8.2 Physical

<http://soils.tfrec.wsu.edu/mq/chemical.htm>

No physical analyses for Pinaki or related soils appear in the online version of NSD. Soil physical data are not tabulated in Soil Bureau Bulletin 5. The following data are sourced from an old Soil Bureau laboratory record, plus some estimates from Fundamental Soils Layer (FSL).

Pinaki Sand

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand	28	9.9	%
Silt	1	<1	%
Clay	1	<1	%
Dry bulk density	-	-	g/cm ³
Total porosity	-	-	%
Macroporosity	5.0-7.4	-	%

Sourced from laboratory analysis SB07144, DSIR Soil Bureau, and FSL table, Landcare Research

Whananaki Sand

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand	-	-	%
Silt	-	-	%
Clay	-	-	%
Dry bulk density	-	-	g/cm ³
Total porosity	-	-	%
Macroporosity	10-25	-	%

Sourced from 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 FSL plus data cited by Wilson and Mc Donald 1987.

Pinaki Sand

Property	Topsoil	Subsoil	Units
Field capacity	-	-	% w/w
Wilting point	-	-	% w/w
Plant-available water	-	-	% w/w
Plant-available water	25-74	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

Whananaki sand

Property	Topsoil	Subsoil	Units
Field capacity	-	-	% w/w
Wilting point	-	-	% w/w
Plant-available water	-	-	% w/w
Plant-available water	25-49	40-60	mm
Depth to slowly permeable layer	-	0.60-1.19	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. Pinaki and related soils have been sampled at six sites in the Auckland region, corresponding to the main land uses which are pastoral farming and forestry, together with a control site under natural vegetation.

Soil information inventory 17: Pinaki and related soils

Land use:		Natural cover	Drystock pasture		Forest plantation		
Types		Scrub	Conventional	Organic	Mature	Scrub	Replanted
Sample Number:		99/15	99/13	99/14	99/21	99/22	99/23
Acidity	pH	5.3	6.1	5.5	5.7	6.1	5.9
Total carbon	%	3.9	4.3	2.9	4.2	0.5	0.9
Total nitrogen	%	0.2	0.2	0.3	0.3	<0.1	<0.1
Available nitrogen	ug/ cm ³	63	80	52	55	-	9
Available phosphorus	ug/cm ³	5.5	16	17	5	13	6
Cation exchange capacity	cmol/cm ³	14.5	11.3	13.4	11.8	5.4	4.9
Base saturation	%	41	74	43	61	68	60
Calcium	cmol/ cm ³	3.0	6.7	4.5	4.5	2.3	1.4
Magnesium	cmol/ cm ³	2.5	1.3	1.1	2.3	1.1	1.3
Potassium	cmol/ cm ³	0.3	0.3	0.1	0.2	0.2	0.2
Sodium	cmol/ cm ³	0.2	0.1	0.1	0.2	0.1	0.1
Bulk density	t/ m ³	0.99	0.88	1.17	0.89	1.44	1.02
Particle density	t/ m ³	2.58	2.51	2.59	2.57	2.85	2.71
Aggregate stability	mm mwd	2.42	2.17	1.79	-	-	-
Total porosity	%	62	65	54	66	50	63
Macroporosity	%	27	22	15	28	32	43
Total available water	%	15	25	16	16	4	10
Readily available water	%	8	10	9	7	3	3

Sourced from:

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

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
Vegetated, undulating to rolling sand flats	-, -	5d	Slight windblow risk	Drystock grazing, plantation forestry
Vegetated, strongly rolling sand flats	6e15,6s1	6d	Moderate windblow risk	Drystock grazing, plantation forestry
Re-vegetating or reactivating (inland) dunes	7e10,7e7	7d	Moderate to severe windblow risk	Plantation forestry
Re-activating or bare (coastal) dunes	8e1,8e4	8d	Severe to extreme windblow risk	Conservation (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

Pinaki and related soils although sandy and warm are excessively free-draining, so were not cropped by Maori, but their scrubby coastal vegetation was extensively disturbed by fires. By the time of European settlement, the scrub was interspersed by extensive sand dunes. Settlers' clearance of the scrub and attempts to sow pasture for grazing caused farther expansion of bare sand. Stabilisation commenced in the 1890s, becoming widespread in the period between 1920 and 1960. A sequence of marram grass, then tree lupin, followed by either pasture oversowing or pine plantation, transformed the landscape of both peninsulas.

Where the Pinaki soil was brought into pasture, it supported drystock farms. Pasture growth was insufficient for dairying, though where dairy farms were established on adjacent moisture-retentive soils such as Houhora or Red Hill sandy loam, any Pinaki soil in coastal paddocks was utilised as winter runoff for dry cows. It remains susceptible to sand-blow if pasture is depleted by drought, saltburn, and fire or over-grazing. Most local farmers have learned to control grazing out of necessity. They formerly retained tree lupins as a protective canopy over pasture, but stands almost disappeared when blight spread through them in the early 1990s, causing many small sand-blows to open. Farmers still routinely revegetate sandblows by spelling, marram planting and oversowing pasture species. In recent decades some have initiated native scrub plantings on particularly exposed sites close to the coast, which they permanently retire from stock.

Forest plantations became, and remain, the largest land use on Pinaki and Whananaki soils. Between 1920 and 1960 the Forest Service planted 12,500 hectares of pine in Woodhill Forest on the South Kaipara, about 3,000 hectares in Maioro Forest at Waikato Heads on southern end of the Awhitu Peninsula, and about 800 hectares in Te Arai Forest south of Mangawhai. Cutting rights were sold to private forestry companies in the 1980s, and land ownership at all the forests was transferred from the Crown back to traditional Maori owners between 1990 and 2014.

The other significant use of Pinaki soil is opencast mining for ironsand 1.5-3.0 million tonnes a year have been extracted from Maioro since 1965, to supply New Zealand Steel's foundry at Glenbrook. Workings are back-filled with silica sand (separated from titanomagnetite ore), stabilised with marram grass, then re-planted in pines.

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 pasture and tree plantation yields

Pasture	Yield	Units
Improved pasture (dairy)	-	t dm/ha/yr
Improved pasture (drystock)	8.4	t dm/ha/yr
Semi-improved pasture	6.7	t dm/ha/yr
Un-improved pasture	4.2	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 on SCION website; various papers in NZ Journal of Forestry and NZ Farm Forestry

11 Information about soil management

Pinaki and related soils are not versatile. Their uses are restricted to drystock grazing, plantation forestry and mining where ironsand content is high enough. Under any of these uses, they require careful management to avoid initiating sand-blows that may migrate across vegetation - and better soils - to landward.

Management issues that may arise are:

- Fertilising adequately to replace grass uptake
- Maintaining dense sward in grazed pasture
- Establishing temporary ground cover on felled forest compartments
- Promptly stabilising any sand-blows before they develop into mobile dunes
- Restoring native coastal vegetation on sand cliffs and foredunes behind beaches

So how these soils are managed, impacts on quality of the Auckland region's environment, as well as on farm production. Tips for managing soil structure and nutrients, for controlling erosion, and for revegetating bare sand, are contained in:

- *Young sand soils* *Soil Information Sheet 7, Auckland Council*
- *Code of Practice for Nutrient Management* *Fertiliser Association*
http://www.fertiliser.org.nz/site/code_of_practice/default.aspx
- *Riparian zone management: strategy guideline and planting guide*
TP148, Auckland Regional Council
- *Forest harvest guidelines* *TP223, Auckland Regional Council*
- *Stabilising sandblows* *Information leaflet, Awhitu Landcare Group*
- *Protecting vegetation on cliffs* *Information leaflet, Awhitu Landcare Group*
- *Establishing permanent tree cover on sand country* *Information leaflet, Awhitu Landcare Group*
- *Pasture management on sand country* *Information leaflet, Awhitu Landcare Group*
- *A comparison of techniques for pasture re-establishment on sandblows* *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