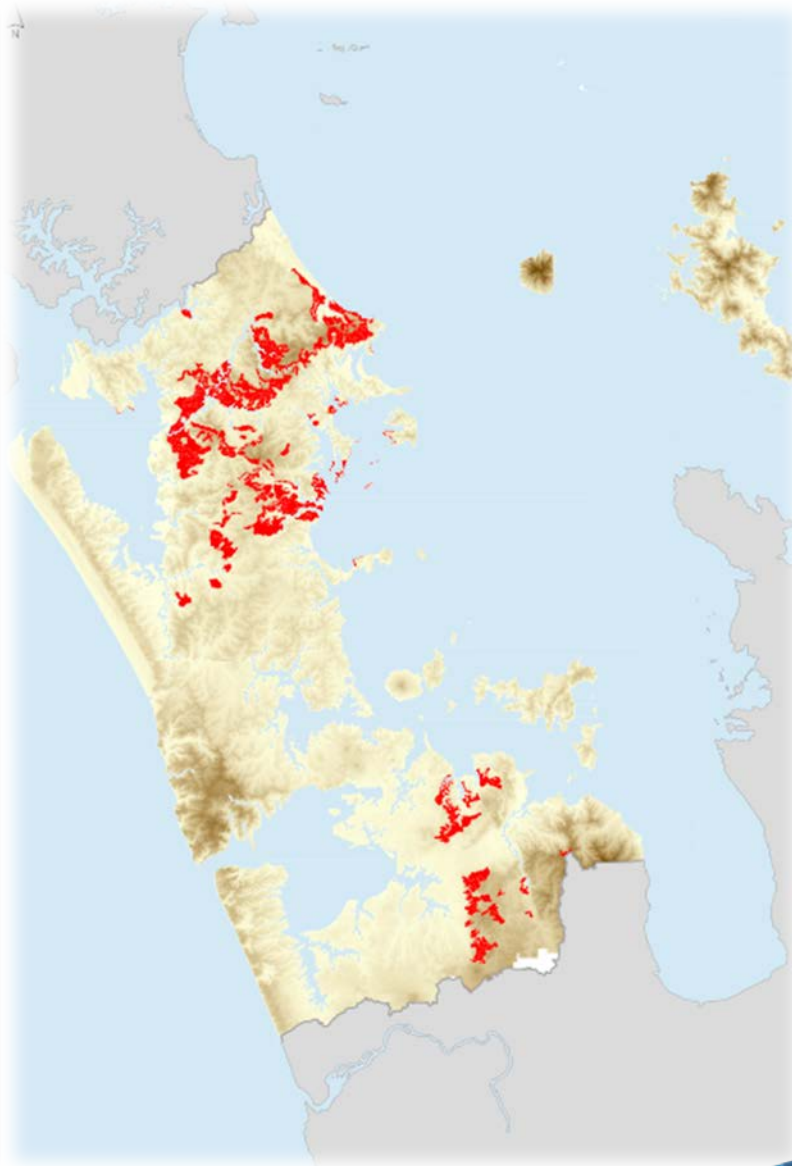


Soil Information Inventory:

Puhioi and related soils

October 2018

Soil Information Inventory 18





Soil Information Inventory 18: Puhoi and related soils

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1 Introduction

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be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports.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

Puhoi and related soils are depicted on the DSIR's published soil maps of North Auckland (1:100,000) as separate series i.e. soils with distinct profiles and parent materials. They are labelled as follows:

PB, PBH	Puhoi clay loam
PBu, PBuH	Puhoi brown clay loam
AN, ANS	Atuanui clay loam

South of Auckland, similar soils are depicted on DSIR's oldest published maps (1: 253,840) as part of the Brookby series:

34a, 34aH	Brookby clay loam
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A recent map of Manukau city (1:20,000) separates the soils into four mapping units that contain spatially associated soil types i.e. soils with differences in texture or other characteristics, assigning alphanumerical labels:

DE1-5 , EE 1-2	Brookby clay loam
DXE1-8, EXE 1	Brookby complex

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:

PB, PBH	Whangaripo family, sibling 16b; or Warkworth family, sibling 10a
PBu, PBuH	Whangaripo family, siblings 16b and 17a; or Warkworth family, sibling 10a
AN, ANS 34a, 34aH	Kaawa family, sibling 8a; or Mataikona family; sibling 29a Bushc family, siblings 18 and 20
DE1	Whangaripo family, siblings 8 and 2
DE2-5	Bushc family, siblings 18 and 20, complexed with other soils
EE1-2	Bushc family, sibling 18, and Part family, un-numbered sibling
DXE 1	Bushc family, sibling 20
DXE2-5	Bushc family, siblings 18 and 20, complexed with other soils
DXE6-8	Whangaripo family, siblings 8 and 2
EXE1	Bushc family, siblings 18 and 20, complexed with other soils

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 soil mappers, any published map polygon labelled as Puhoi or Atuanui series (PB etc.) contains up to four soil types i.e. series divided according to texture. On farm-scale soil maps (1:5,000 - 1: 10,000) they are labelled as:

Pb	Puhoi sandy loam
Py	Puhoi sandy clay loam
Pg	Puhoi clay loam
Pu	Puhoi soils (undifferentiated)
An	Atuanui stony clay loam

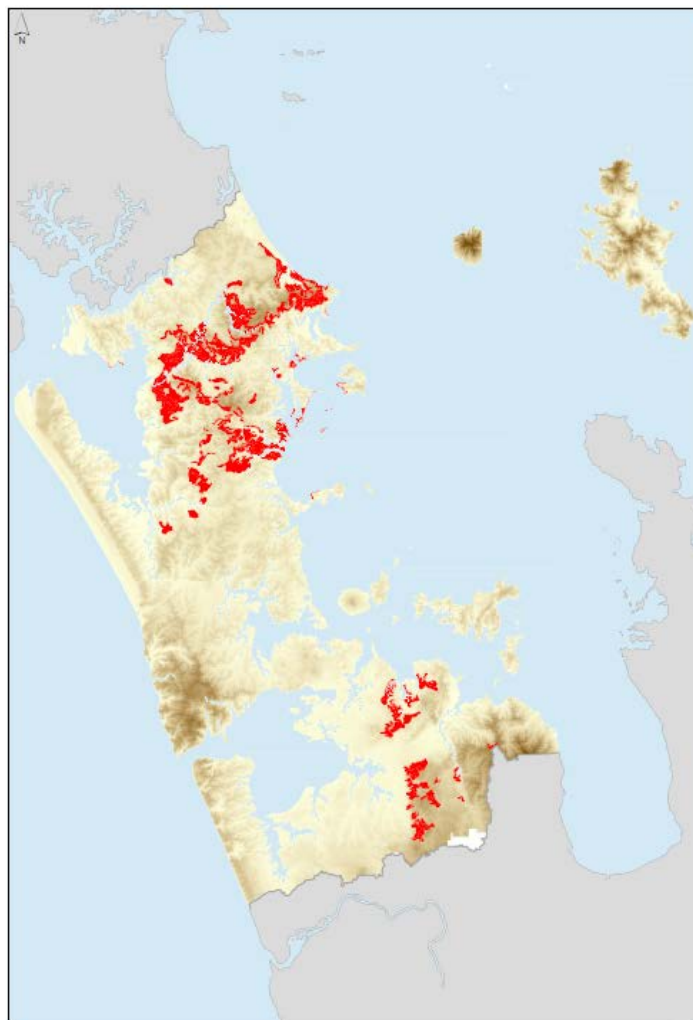
The same types are also mapped at farm scale on large parts of published map polygons labelled Whangaripo hill soil (WRH), Warkworth hill soil (WAH) and Dome Valley hill soil (DVH). Here they are interspersed with smaller patches of Whangaripo clay loam (WR), Warkworth clay loam (WA) or Matakana sandy clay loam (new series previously described as a brown variant of WA).

Puhoi and Atuanui series names have been retained on Auckland Council's farm-scale maps for continuity with published nomenclature, but a local mapper (DLH) considers they are hill and steepland phases respectively, within the Whangaripo, Warkworth and Matakana soil series.

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

Throughout eastern parts of the Auckland region, from its northern boundary at Te Hana, through the urban area to the southern boundary at Ararimu.



Location of Puhoi and related soils

Puhoi and related soils are mapped on 31,900 hectares (8% of Auckland region). About 15,800 hectares (50% of the area mapped) are in productive use as drystock pasture or plantation forest (estimated from overlay of Agribase 2010 on Fundamental Soils Layer). <http://intermaps.arc.govt/AucklandCouncilViewer/>



Puhoi soils develop where sedimentary rock beds are dissected into moderate hillslopes (foreground). They are interspersed by Atuanui soil on steep faces *Photo: D Hicks*

5.1 On what landform

Puhoi soils occur on hillslopes where clayey regolith is weathering from Waitemata Group marine sediments (inter-bedded siltstone, sandstone and tuffaceous sandstone). The soils are found on sites where regolith has been, or is, disturbed by mass movement (slope failure). Atuanui soils are found on the steepest faces where regolith is shallow, with a sharp boundary to unweathered rock which protrudes as outcrops or short bluffs.

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

5.2 How they differ from other soils

Puhoi and Atuanui soils are younger than, so not as weathered as, the Whangaripo and related soils on adjacent undisturbed slopes. Clay content is lower than, and weathered rock fragments more numerous compared with, the disturbed Omu and Te Tio soils which weather from mudstone.

Sourced from:

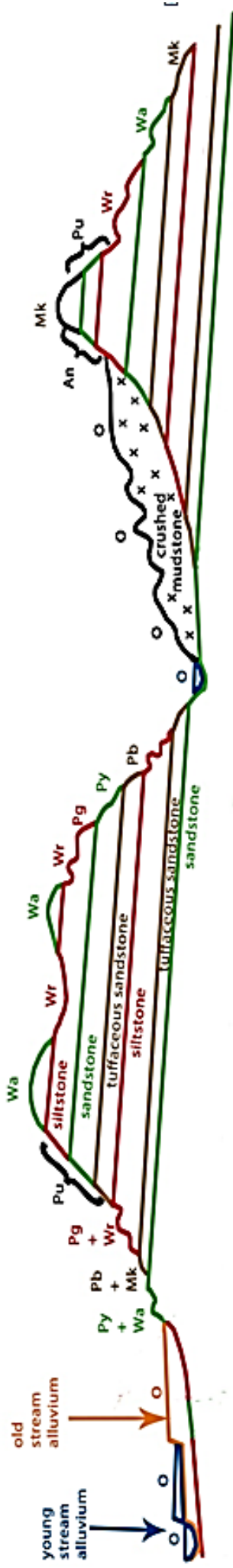
Wilson, A.D. and Cox, J.E., Soils of Rodney County, Unpublished report, Soil Bureau DSIR

6 Classifications

NZ genetic (NZG):	Northern yellow-brown earth
NZ soil (NZSC):	Mottled yellow ultic, acid orthic recent http://intermaps.arc.govt/AucklandCouncilViewer/
Soil Taxonomy (USDA):	Typic ochrept or aquic ochrept http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051544.pdf
World Soils (FAO):	Entisol or leptosol 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 Puhoi and related soils' position in landscape



On very steep faces:
 An Atuanui stony loam
 Pu Puhoi soils - undifferentiated

On steep faces (unstable):
 Pg Puhoi clay loam
 Py Puhoi sandy clay loam
 Pb Puhoi sandy loam

On moderate hillslopes (parts unstable):

Pg+Wr Puhoi clay loam + patches Whangaripo clay loam
 Py+Wa Puhoi sandy clay loam + patches Warkworth clay loam
 Pb+Mk Puhoi sandy loam + patches Matakana sandy clay loam

On rolling lower slopes, upper slopes & ridges (stable):

Wr Whangaripo clay loam
 Wa Warkworth clay loam
 Mk Matakana sandy clay loam

O, O, O Other soils (refer to relevant soil information inventory)

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

7 Soil profile descriptions



Topsoil (Ap and Apg)

Subsoil (Btg)

Parent material (CRg)

Puhoi clay loam Photo: D Hicks

DSIR's type profile is: *Puhoi clay loam*

Horizon	Depth (cm)	Description
Ap	0-13	Dark greyish brown to very dark brown (10YR 4/2–2/2) clay loam; distinct dark reddish brown (5YR 3/3) coatings along root channels; friable (when moist); medium and fine polyhedral structure which breaks to very fine polyhedral structure; wavy boundary.
Apg	13-21	Light brownish grey (2.5Y 6/2), light yellowish brown (2.5Y 6/4) and dark grey (10YR 4/1) clay; distinct brown coatings along root channels; firm when moist; medium to fine polyhedral structure which breaks to very fine; wavy boundary.
Bt(g)1	21-51	Light brownish grey (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) clay; sticky when wet; distinct strong brown (7.5YR 5/8) yellowish red (5YR 5/8) and red (2.5YR 5/8) mottles along soil structural faces and coatings in root channels; coarse to medium polyhedral structure which breaks to fine polyhedral structure; dark greyish brown clay skins along the faces of fissures; indistinct boundary.
Bt(g)2	51-76	Light brownish grey (2.5Y 6/2) clay; sticky when wet; distinct brownish yellow (10YR 6/8) and strong brown (7.5YR 5/8) mottles; medium polyhedral structure which breaks to fine polyhedral; grey clay skins along the faces of fissures; irregular boundary.
CRg	on	Light brownish grey (5Y 7/2) soft (weathered?) sandstone; prominent dark brown (7.5YR 4/4), strong brown (7.5YR 5/8) and dark brown (7.5YR 3/2) mottles



Topsoil (Ap and A/B)

Subsoil (Btg)

Parent material (CRf)

Puhoi sandy clay loam *Photo: D Hicks*

DSIR's mappers recorded Puhoi soils on "weathered grey-brown banded sandstones thinly capped by stronger massive sandstones on the ridges and lower beds of thinly banded hard bluish-grey sandstones, calcareous, in some places (with) glauconite sandstone boulders". A local soil mapper (DLH) comments that the type profile weathers from banded siltstone i.e. siltstone beds interspersed by thin sandstone bands; hard bluish-grey sandstones occur throughout the stratigraphic sequence (not just lower beds) and weather to a different profile, Puhoi sandy clay loam. A provisional profile description is:

Puhoi sandy clay loam

Horizon	Depth (cm)	Description
Ap	0-10	Light grey clay loam; firm consistence; crumbly structure when moist, nutty when dry.
A/B	10-20	Yellow-brown sandy clay loam mixed with light grey clay loam (down cracks); sticky when moist; firm when dry; polyhedral structure.
Bt(g)	20-50	Yellow-brown loamy clay; sticky when moist, firm to very firm when dry; polyhedral to blocky structure; distinct grey clay skins on peds; faint grey mottles within peds.
CR(f)	on	Yellow-brown weathered sandstone with pronounced iron oxide mottles and bands (parallel to bedding); grades to grey sandstone.



Topsoil (Ap)

Subsoil (Bwg)

Parent material (CR)

Puhoi sandy loam Photo D.Hicks

A local soil mapper (DLH) observes that strong massive sandstones weather to yet another profile. There is no description for this soil amongst the DSIR's type profiles, despite its widespread occurrence within areas labelled as Puhoi brown clay loam on published maps. The soil weathers from tuffaceous sandstone beds which form lower slopes as well as ridges in the landscape. Soil texture varies from sandy clay to silty sand. The type profile description for Dome Valley hill soil is a close fit:

Dome Valley hill soil = Puhoi sandy loam

Horizon	Depth (cm)	Description
Ap	0-7	Dark greyish brown (10YR 4/2) clay; friable; medium subrounded polyhedral structure; sharp boundary.
Bw(g)	7-50	Yellowish brown (10YR 5/6) loamy clay with distinct rusty brown and faint grey mottles; friable; coarse prismatic structure breaking down to subrounded polyhedral; diffuse boundary.
CR	on	Brownish yellow (10YR 6/6) loamy clay with prominent rusty brown to pinkish-red mottles (and weathered grit particles); firm packing and loose when dislodged; subrounded polyhedral structure; grading to grey tuffaceous sandstone.



Topsoil (Ap)

Subsoil (Bw)

Parent material (CR)

Atuanui clay loam Photo: D Hicks

Three DSIR descriptions exist for Atuanui clay loam or Atuanui steepland soil, so it is unclear which one is the type profile. The most comprehensive describes skeletal soil on the steepest slopes, except that the boundary between Bw and CR is usually sharp:

Atuanui clay loam

Horizon	Depth (cm)	Description
Ap	0-9	Dark greyish brown (10YR 4/2) clay loam; friable; fine subangular blocky structure; few weathered fragments of parent material; sharp boundary.
Bw	9-44	Yellowish brown (10YR 5/4) gritty and stony clay; friable; sticky when wet; fine subangular blocky structure; contains many fragments of parent material and few soft round manganese concretions; diffuse boundary.
CR	on	Weathered sandstone, siltstone and clays, in places weakly weathered; on large bouldery hard and massive tuffaceous sandstones.

Brookby series

DSIR type profile descriptions for Brookby clay loam (DE or 34a on moderate slopes, EE or 34aH on steep) can be matched with Puhoi clay loam, sandy clay loam or sandy loam. A local mapper (DLH) considers that the Puhoi series name (with appropriate texture description attached) could be adopted when mapping the soils at farm scale south of Auckland. At a few places where soil is so shallow that unweathered rock appears, the Atuanui series name could be used.

Sourced from:

*Sutherland C.F., Cox, J.E. various dates, Type profile descriptions for North Auckland Soil Survey
Purdie, B. et al 1982, Type profile descriptions for Manukau Soil Survey, Unpublished documents,
DSIR Soil Bureau*

8 Properties of typical profile

Properties of typical profiles are best indicated by analysis results for the site where Puhoi clay loam was defined and described. Data for other sites will vary somewhat, particularly where different types within the series are found. Properties of the related Atuanui stony clay loam may differ considerably.

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

An incomplete chemical analysis appears in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 26 (Soils of New Zealand):

Puhoi clay loam

Property	Topsoil	Subsoil	Units
Acidity	5.6-5.8	5.2-5.3	pH
Total carbon	3.0-6.2	0.5-1.3	%
Total nitrogen	0.22-0.51	0.07-0.13	%
Available phosphorus	9	1-2	mg %
P retention	40	42-54	%
Available sulphur	2	2	%
Cation exchange capacity	23.0- 31.2	25.0-28.9	me %
Base saturation	55-56	39-41	%
Calcium	4.6-9.5	1.3-3.2	me %
Magnesium	5.9-9.1	6.6-9.2	me %
Potassium	0.8-1.7	0.4-0.6	me %
Sodium	0.2-0.4	0.4-0.4	me %

Sourced from laboratory analysis SB07652, DSIR Soil Bureau

8.2 Physical

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

An incomplete physical analysis appears in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 26 (Soils of New Zealand):

Puhoi clay loam

Property	Topsoil	Subsoil	Units
Stones	0	0	%
Sand	27	25-26	%
Silt	26	26-28	%
Clay	47	46-49	%
Dry bulk density	0.93	1.18-1.23	g/cm ³
Total porosity	71.6	52.9-53.7	%
Macroporosity	8.7	2.0-5.4	%

Sourced from laboratory analysis SB07652, DSIR Soil Bureau

8.3 Irrigation and drainage

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

An incomplete soil moisture analysis appears in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 26 (Soils of New Zealand), plus estimates from a relevant S-map factsheet.

Puhoi clay loam

Property	Topsoil	Subsoil	Units
Field capacity	67.5	50.0 - 50.7	% w/w
Wilting point	32.7	29.0 - 30.0	% w/w
Plant-available water	32.4	25.2 - 25.5	% w/w
Plant-available water	47	36	mm
Depth to slowly permeable layer	-	0.5-0.8	m
Perm. at slowly permeable layer	-	<4	mm/hr

Sourced from laboratory analysis SB07652, DSIR Soil Bureau, and S-map factsheet, 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.

Puhoi and Atuanui soils have not yet been sampled so there are no comparative analyses of topsoil properties under different uses. Samples for the Whangaripo, Warkworth, and Matakana series provide the closest soil quality data (refer to Soil Information Inventory for Whangaripo and related soils). Puhoi soils and Atuanui soils are younger, have lower clay content, and are less leached, so they may be expected to have higher nutrient status, greater porosity, and better structure. However, their soil quality is limited by shallow topsoil on steep slopes, plus subsoil truncated by erosion (mass movement) where faces are unstable.

Refer to 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 1:50,000 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
Moderate hillslopes, unstable	6e1, 6e19, 6e8,6e19b	6l, 6g+u	Moderate erosion risk (gullies, landslides, slumps)	Semi-improved pasture, woodlots
Steep faces	7e4, 7e1, 7e4b,7e1b	7l, 7u	Severe erosion risk (gullies, landslides, slumps)	Tree plantations, conservation uses
Steep faces, shallow or stony	8e2,8e2	7r	Shallow soil, debris avalanche risk	Conservation uses
Bluffs, gorges, gullies	8s1,8s1	8k	Shallow or no soil, rockfall risk	Conservation uses

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

Horticulture and cropping are not practised. Although the soils' nutrient status and structure can be good, slope (on hill faces) or narrow irregular area (on spurs and ridges) precludes cultivation.

In the 1880s-1890s, some of the settlers north of Auckland attempted dairy farming on Puhoi soils, but quickly found they could not make a living from slopes that were awkward for heavy stock to graze, had low pasture yield and reverted to weeds or scrub. Puhoi soils were back to drystock grazing by the 1940s. This remained their main use 1940s-1960s. The number of drystock farms dropped due to farm amalgamation and forestry conversion, then stabilised in the 1980s. Today drystock farms remain principally where Puhoi and Atuanui soils, are interspersed with hill phases of Whangaripo, Warkworth or Matakana clay loams.

1960s onwards, much hill country with Puhoi or Atuanui soils was bought by forestry companies or partnerships, and planted in radiata pine. Commercial forest plantations are concentrated on the Dome Hills, Moirs Hill, parts of Kaipara Hills, and the hills between Whitford and Clevedon. Drystock farmers also planted some large woodlots on steep faces or gullied basins within their properties. Forestry overtook drystock grazing as the main land use by 1980s.

Few large tracts of uncleared bush remain, notably Mt. Auckland (Atuanui) Scenic Reserve. Small remnants persist on farmland. Extensive scrub reversion occurred 1920s-1940s though is now a rare sight on Puhoi or Atuanui soils because most such areas - in kanuka, tree fern, bracken or gorse - were converted to forest plantation 1960s-1980s. Pockets of reverting scrub continue to appear in the landscape where-ever hill country farmers give up trying to improve pasture on their unstable or steep faces.

Within city and town limits, Puhoi or Atuanui soils are restricted to a few steep escarpments, occupied by lifestyle blocks or public reserves. Developers do not regard them as good prospects for urban subdivision, compared with easier-contour (and more stable) terrain nearby. Since the 1970s, city and district planning schemes have imposed constraints (geotechnical investigation and earthworks guidelines) that normally preclude urban development at such sites.

Sourced from Locker, R.H., 2001, Jade River: a history of settlement on the Mahurangi, Friends of the Mahurangi Inc.

10.1 Typical pasture and tree plantation yields

Pasture	Yield	Units
Improved pasture (dairy)	-	t dm/ha/yr
Improved pasture (drystock)	8.4 (attainable only on ridges and spurs)	t dm/ha/yr
Semi--improved pasture	6.4	t dm/ha/yr
Un-improved pasture	3.6	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

Puhoi and Atuanui soils are of limited use. They sustain few uses other than drystock grazing or commercial forestry. Key issues that arise are:

- Adequate fertilizer to replace grass uptake
- Developing and keeping deep topsoil on slopes
- Pugging in winter and cracking in summer where subsoil is close to surface
- Slips, slumps and gullies in wet weather
- Difficulty forming farm and forest tracks on steep slopes

In these respects, the soils have similar management needs to other immature ultic (clay) soils that have weathered from marine sedimentary rocks, on pockets of steep hill country from Northland through Auckland to the northern Waikato. Tips for managing soil structure and nutrients, and controlling erosion in farmland; also for tree plantation harvest and replanting, are contained in:

- *Soils on hill country* *Soil Information Sheet 14, Auckland Council*
- *Soils on ranges* *Soil Information Sheet 15, Auckland Council*
- *Forest harvest guidelines* *TP223, Auckland Regional Council*
- Code of Practice for Nutrient Management *Fertiliser Association*
http://www.fertiliser.org.nz/site/code_of_practice/default.aspx
- Streamside planting guide *Auckland Council*
- *Native forest restoration guide* *Auckland Council*

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