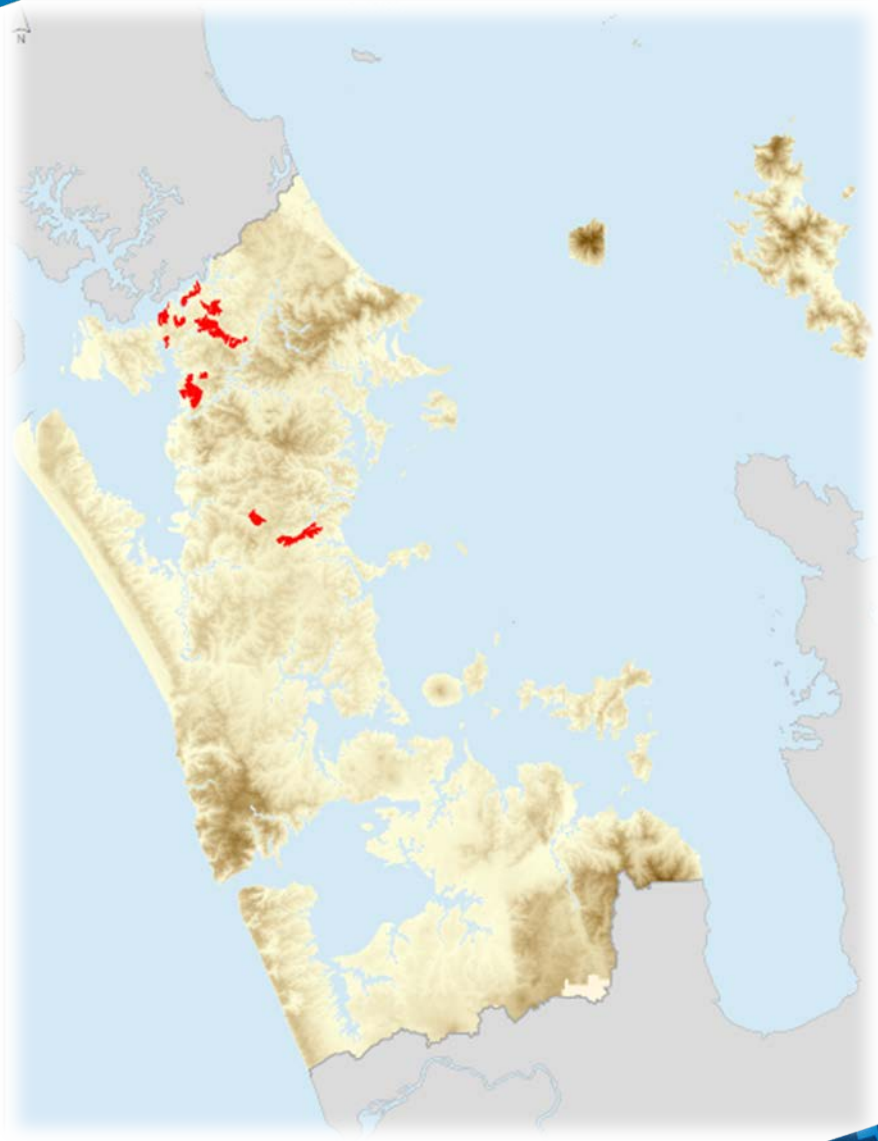
Soil Information Inventory:

Omu and related soils

October 2018 Soil Information Inventory 12



RIMU Research and Evaluation Unit

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Soil Information Inventory 12:

Omu and related soils

Compiled from published and unpublished sources by:

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be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports.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

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

OM, OMH	Omu clay loam
TF, TFH	Te Tio clay loam

These labels usually appear singly. A few map polygons are labelled with the combination OM + AP (Aponga clay loam) or TFH + OAH (Okaka silty clay loam), or rarely OM + YK (Waikare silt loam or silty clay). For information about these, refer to Soil Information Inventories for Aponga and related soils, or Waikare and related soils.

Similar soils do not appear on DSIR's maps of South Auckland, where mudstone parent material is absent.

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

3 Online maps

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

OM, OMH	Whangaripo family, sibling 18a
TF, TFH	No family or sibling assigned

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 OM etc. contains several soil types i.e. series divided according to texture or other characteristics. On farm-scale soil maps (1:5,000 - 1: 10,000) the main ones are:

Om	Omu clay
Tf	Te Tio stony clay loam

Published map polygons labelled as hill phases of Aponga (APH) or Okaka (OAH), if on unstable or steep ground, turn out to contain a mosaic of Aponga with Omu, or Okaka with Te Tio. Patches of Omu and Te Tio soil are differentiated where farm map scale permits; where not, farm-scale maps are labelled with the combinations Ap + Om or Oa + Tf.

Waikare soils are associated with Omu and Te Tio soils almost everywhere on farms, regardless of whether the published DSIR map labels indicate their presence. On farm maps they are differentiated where-ever scale permits, and labelled as:

Yk	Waikare clay loam or clay
Ykc	Waikare silty clay loam (colluvial variant)

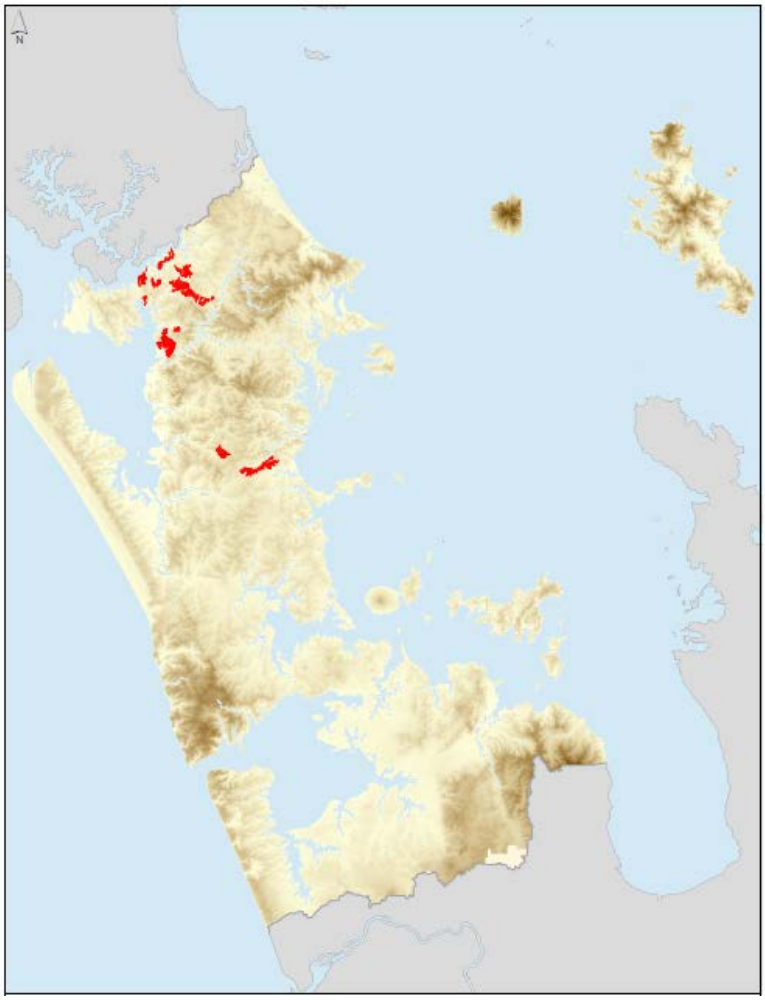
The two are so different, that they are described in a separate soil information inventory.

On some farms, bands of other soil run through polygons labelled OM, TF etc. on DSIR's maps. Similar soils in Northland are labelled Autea clay loam (AU, AUH) and White Cone steepland soil (WCS). As yet they have not been recorded on any of Auckland Council's farm-scale maps.

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

As pockets from Dairy Flat north to Kaipara Flats; extensively from north side of the Hoteo river mouth to the Auckland region's boundary at Te Hana.



Location of Omu and related soils

Omu and related soils are mapped on 6,000 hectares (1.5% of Auckland region). About 3,500 (58% of the area mapped) are in productive use for dairy or drystock grazing and forestry (estimated from overlay of Agribase 2010 on Fundamental Soils Layer). *http://intermaps.arc.govt/AucklandCouncilViewer/*

Omu clay is an incipient soil on earthflows and gullies in hummocky slump debris (background) cf. Aponga clay loam, a well-developed soil on inactive slump terrain (foreground) *Photo: D. Hicks*

5.1 On what landform

On unstable ground within rolling downland formed from siliceous or calcareous mudstone. The rocks are marine sediments deposited from end of the Cretaceous period (70 million years ago) through early epochs of the Tertiary period (up till 25 million years ago). These geological formations comprise the Northland Allochthon, emplaced over younger siltstone, sandstone or volcanic rocks of the Waitemata Group by sea-floor landslides during the Miocene epoch (between 25 and 8 million years ago). They alternate from intact blocks rafted in the landslides, through rock with shattered but visible bedding, to crushed rock without visible structure. The allochthon has been eroded away from high ground, where resistant Waitemata Group rocks outcrop as moderate to steep hill country, but survives as a mantle over low-lying parts of North Auckland's landscape.

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

Omu clay is associated with active or recently active slumps in clay weathering from crushed siliceous or calcareous mudstone. Te Tio stony clay loam is found on moderate to steep slump headscarps, or on steep faces where these rocks are close to the surface, shattered to intact. What both soils have in common, is sites disturbed by a natural erosion process - slumping - on crushed or shattered rock of fine-grained texture. They have the same clay-rich texture as Okaka or Aponga soils on surrounding ground that is stable or has healed, but the profiles of Omu and Te Tio soil are truncated, with incipient topsoil re-forming over disturbed subsoil.

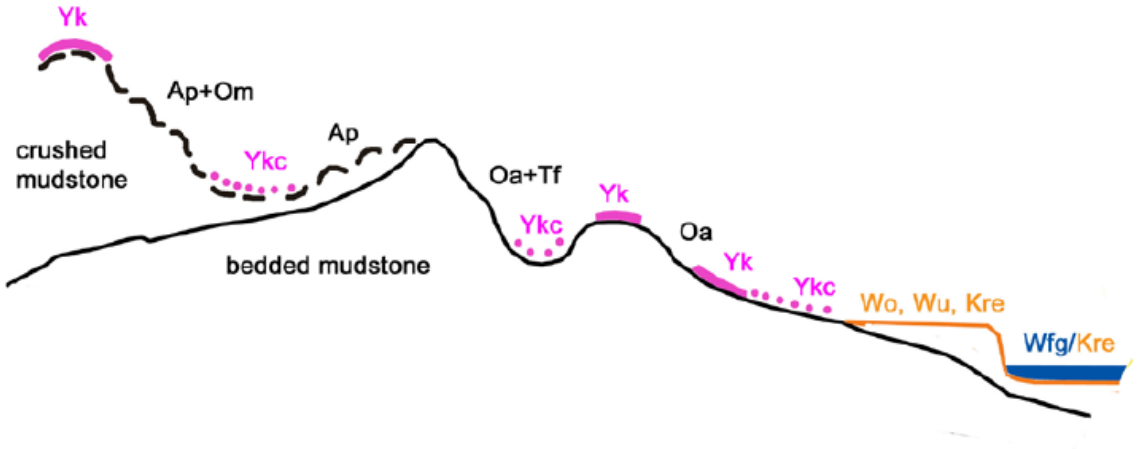
Sourced from: Wilson, A.D. and Cox, J.E., Soils of Rodney County, Unpublished report, Soil Bureau DSIR

6 Classifications

NZ genetic (NZG):	Northern yellow-brown earth
NZ soil (NZSC):	Typic perch-gley ultic or typic yellow ultic *http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx*
Soil Taxonomy (USDA):	Aquept or 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 NZ genetic classification dating from 1930s with the NZ 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 Omu and related soils' positions in landscape.



On bedded mudstone:
Oa Okaka silty clay loam or clay
Tf Te Tio stony clay loam

On crushed mudstone:
Ap Aponga clay loam or clay
Om Omu clay

On clay weathered from mudstone:
Yk Waikare clay loam or clay
Ykc Waikare silty clay loam (colluvial variant)

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

7 Soil profile descriptions

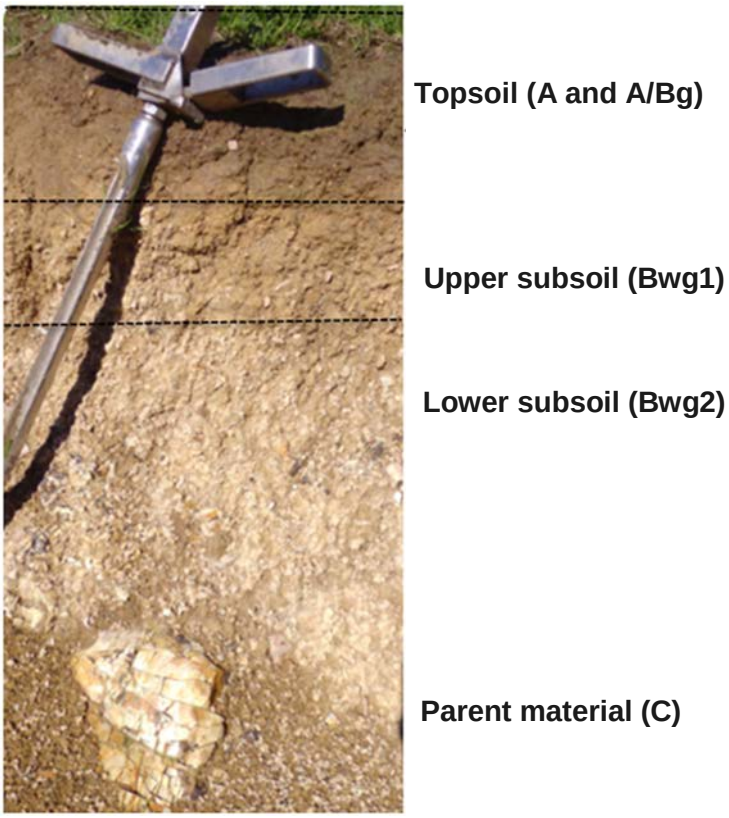
Omu clay *Photo: D Hicks*

DSIR's type profile is labelled Omu clay loam:
Omu clay loam = Omu clay

Horizon	Depth (cm)	Description
A	0-4	Very dark greyish brown (10YR 3/2) silty clay loam; friable when moist; finepolyhedral structure when dry breaking to very fine; distinct irregular boundary.
A/B(f)	4-7	Yellowish brown (10YR 5/3-5/4) silty clay; few reddish yellow (7.5YR 5/6) mottles; very dark grey (10YR 3/1) subrounded inclusions of topsoil decreasing to the base; friable when moist; medium subangular polyhedral structure breaking to fine polyhedral and blocky structure; indistinct irregular boundary.
Bw(f) 1	7-13	Intermingled light yellowish brown (10YR 6/4); strong brown (7.5YR 5/6) and light brownish grey (10YR 6/2) clay, abundant strong brown (7.5YR 5/8) mottles; sticky when wet, firm when dry; medium blocky polyhedral structure; many subrounded inclusions of topsoil; indistinct smooth boundary.
Bw(f) 2	13-25	Pale brown (10YR 6/3) silty clay; profuse yellowish red (5YR 5/8) to strong brown (7.5YR 5/6) mottles following surfaces of aggregates; firm when dry; medium blocky structure breaking to fine and very fine blocky; diffuse smooth boundary.
C(g)	On	White (10YR 8/2) to pale grey (5Y 7/1) silty clay; profuse brownish yellow (10YR 6/8) to yellowish red (5YR 4/8) distinct mottles; sticky and plastic when wet; firm when dry; coarse polyhedral structure breaking to medium polyhedral; many vertical worm burrows.

Attached site notes describe Omu clay loam as formed from “claystone (Onerahi Formation) ... strongly rolling”. Other details given are that “on knolls and sloping ridges the profiles are well drained ... with fainter mottling in the upper B ... here the topsoil is even thinner being frequently about 1 to 2 in”; “in the concave sites ... the profiles are very grey in the subsoil and dark brown soft manganese (*possibly iron oxide? -DLH*) concretions are abundant”; “Omu and Waiotira soils quite commonly occur intermingled”; and “boulders of indurated yellowish-brown claystone with ... ramifying quartz veins occur on the slopes”.

A local soil mapper (DLH) considers the type profile is a reasonably good description of Omu clay, with proviso that it omits subsoil consistence (sticky) and structure (massive) when wet. Site notes fail to mention that topsoil truncation on “knolls and sloping ridges” is disturbance by slumps or secondary earthflows in slump debris. Weathered rock is rarely visible in or beneath the C horizon - just residual corestones if silicified.



Te Tio stony clay loam *Photo: D Hicks*

DSIR’s unpublished description includes two type profiles. The first is labelled as Te Tio clay loam, and is described as the modal (most widespread) profile:

Te Tio clay loam = Te Tio stony clay loam

Horizon	Depth (cm)	Description
A	0-4	Brown (10YR 5/2) silty clay; firm when dry, friable when moist; fine to medium polyhedral structure which breaks to very fine; dark grey staining on the faces of aggregates; contains a few fine particles of parent material; sharp wavy boundary.
A/B(g)	4-8	Intermingled light brownish grey (2.5Y 6/2) greyish brown (2.5Y 5/2) and light grey (2.5Y 7/2) clay; few distinct brown mottles; firm when dry; medium and coarse polyhedral structure which breaks to fine and very fine polyhedral; contains few fragments of parent material; indistinct boundary.
Bw(g) 1	8-16	Light grey (2.5Y 7/2-6/2) clay; abundant distinct yellow and brown mottles; very firm when dry, and sticky when wet; medium and coarse polyhedral structure which breaks to fine and very fine polyhedral structure; contains common fragments of parent material; indistinct boundary.
Bw(g) 2	16-24	Light grey (2.5Y 7/2-6/2) clay; many distinct yellow and brown mottles; firm to very firm when dry and sticky when wet; medium and coarse polyhedral structure which breaks to fine polyhedral; contains many fragments of parent material; irregular distinct boundary.
C	on	Shalely mudstone and claystone, or a matrix of parent material and clay.

Attached site notes describe Te Tio clay loam as occurring on “deeply weathered shalely mudstones and partly silicified claystones ... mainly rolling ... slumped areas”. The type profile notes “a feature of this soil type ... is parent material through the profile and that the average depth is 24 - 30 inches” i.e. shallow.

A local soil mapper (DLH) considers the modal type profile a good description, except that subsoil texture is better described as stony clay loam. Site notes give the impression that Te Tio soil is found on rolling slumped areas, but it is on strongly rolling, moderate, and occasionally steep slopes - areas that haven’t slumped - within slump terrain.

A second type profile, described on “strongly gleyed wet lateral seepage areas ... at lower levels of the easier ... slopes”, is completely different. It is either an un-named soil, or possibly the footslope (perch-gley) phase of Waikare clay (though DSIR mappers do not identify it as such). On slump terrain in the Auckland region, patches of Waikare clay are common on footslopes, in association with Omu, Aponga, Okaka and Te Tio soils.

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

8 Properties of typical profile

The properties of typical profiles are best indicated by analysis results for the type profiles i.e. sites where Omu and Te Tio soils were defined and described. Data for any other sites will vary from the type profiles, though not greatly. Properties of the related Autea and White Cone soils (in Northland) may differ considerably.

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

No chemical analysis for either soil appears in the on-line version of National Soil Database (NSD). The following analyses appear in Soil Bureau Bulletin 5 (General Survey of the Soils of North Island).

Omu clay loam or clay

Property	Topsoil	Subsoil	Units
Acidity	5.0	5.2	pH
Total carbon	5.3	-	%
Total nitrogen	0.33	-	%
Available phosphorus	0.005	0.003	%
P retention	-	-	%
Available sulphur	-	-	ug/g
Cation exchange capacity	26.3	24.2	me %
Base saturation	45	22	%
Calcium	6.2	2.7	me %
Magnesium	4.6	2.6	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB0709, DSIR Soil Bureau

Te Tio clay loam or stony clay loam

Property	Topsoil	Subsoil	Units
Acidity	5.6	5.3	pH
Total carbon	4.4	-	%
Total nitrogen	0.23	-	%
Available phosphorus	0.014	0.004	%
P retention	-	-	%
Available sulphur	-	-	%

Cation exchange capacity	15.9	9.7	me %
Base saturation	60	64	%
Calcium	6.3	3.2	me %
Magnesium	3.2	3.6	me %
Potassium	-	-	me %
Sodium	-	-	me %

Sourced from laboratory analysis SB1472, DSIR Soil Bureau

8.2 Physical

No physical analysis for either soil appears in the on-line version of NSD. The following estimates are sourced from Fundamental Soils Layer (FSL) and the relevant S-map factsheet.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/home/?cid=nrcs141p2_018993

Omu clay loam or clay

Property	Topsoil	Subsoil	Units
Stones	0-4	-	%
Sand	2-8	2-5	%
Silt	58-61	58-60	%
Clay	31-40	35-40	%
Dry bulk density	1.08	1.54	g/cm³
Total porosity	-	-	%
Macroporosity	0-9.9	-	%

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

Te Tio clay loam or stony clay loam

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

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

8.3 Irrigation and drainage

No soil moisture analysis for either soil appears in the on-line version of NSD. The following estimates are sourced from FSL and the relevant S-map factsheet.

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

Omu clay loam or clay

Property	Topsoil	Subsoil	Units
Field capacity	37	36	% w/w
Wilting point	19	21	% w/w
Plant-available water	-	-	% v/v
Plant-available water	52	45	mm
Depth to slowly permeable layer	-	0.6-1.49	m
Perm. at slowly permeable layer	-	<4	mm/hr

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

Te Tio clay loam or stony clay loam

Property	Topsoil	Subsoil	Units
Field capacity	-	-	% w/w
Wilting point	-	-	% w/w
Plant-available water	-	-	% v/v
Plant-available water	25 - 99	-	mm
Depth to slowly permeable layer	-	0.6-1.49	m
Perm. at slowly permeable layer	-	<4	mm/hr

Sourced from FSL table 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.

Neither Omu nor Te Tio soil has yet been sampled for soil quality in the Auckland region. No horticulture and little cropping is practiced on the soils. Omu clay is used for dairying and drystock farming, so consideration could be given to sampling these uses in a future year. Apart from limited areas of drystock pasture, Te Tio stony clay loam has been planted in woodlots, reverted to scrub, or remains in bush.

500 Soils Project samples for Aponga series (refer to relevant soil information inventory) provide the closest soil quality data to Omu clay. Omu clay being a young soil, it may be expected to have higher nutrient status but poorer structure and drainage. Its soil quality is also limited by shallow topsoil, plus subsoil disturbed by erosion (mass movement).

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 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 strongly rolling slump basins	6e12	6g+u	Inactive slumps and earthflows	Semi-improved pasture with soil conservation plantings
Undulating to strongly rolling slump basins	7e2	7g+u	Active slumps and earthflows	Soil conservation plantings, woodlots
Moderate headscarps and slopes	6e7	6l	Reveg slips and gullies	Semi-improved pasture with soil conservation plantings
Steep faces	7e2b	7l	Active slips and gullies	Woodlots, conservation uses
Very steep faces including rock outcrops	8e2, 8s1	7r, 8k	Debris avalanches, rockfalls	Conservation uses (scrub reversion, bush retention)

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

It is unknown whether settlers attempted horticulture or grain cropping on Omu clay when first clearing scrub or bush from their land 1850s-1860s. If so, they would have rapidly discovered that its structure and drainage properties are completely unsuitable. Forage crops were - and still are - sown in course of pasture renewal, but strike and yield are patchy at best.
Dairy farms were established on Omu clay, but have long since converted to drystock, except where patches are present within paddocks that are mainly Aponga clay loam. Omu clay pugs badly in winter and spring. It stays moist longer into summer, but pasture yield becomes depressed by late summer - early autumn drought. Slumps or secondary earthflows in slump debris disrupt fences, water supply pipes and dairy races. For all these reasons, it is a difficult soil to graze intensively. Soil conservation tree plantings, runoff diversion, and on occasion subsoil drainage, are essential to stabilise it. The soil supports grazing by lighter stock provided it is spelled when wet, so drystock grazing has become the largest use by area.
Small farm woodlots are common. They have usually been established for soil conservation as much as timber production, where pasture has been disrupted by slumps, or by secondary earthflows and gullies in slump debris.
No extensive tracts of uncleared bush remain, nor are there many intact bush patches within the farms. However, a feature of the landscape is scattered remnant bush trees within grazed paddocks, particularly kahikatea groves on wet footslopes. Scrub patches reverted on unstable land after initial bush clearance, becoming widespread by 1910s - 1940s, but almost entirely disappeared due to woodlot conversion 1950s onwards.
Te Tio stony clay loam, on steep faces with outcrops of intact to shattered rock, is rarely used for commercial forestry or farm woodlots. A few patches remain in semi- or un-improved drystock pasture, but most have reverted to scrub or remain in bush.

Sourced from Anonymous, 1962, Albertland: the first hundred years, Albertland and District Museum

10.1 Typical pasture and timber yields

Pasture	Yield	Units
Improved pasture (dairy)	-	t dm/ha/yr
Improved pasture (drystock)	9.7-10.4 (attainable only on ridges and spurs)	t dm/ha/yr
Semi--improved pasture	5.8-6.3	t dm/ha/yr
Un-improved pasture	3.6-3.9	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	?	t/ha
Acacia (woodlot)	?	t/ha

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

11 Information about soil management

Omu and Te Tio soils are of limited use. They are unsuitable for any kind of crop. Where mudstone downlands or hills are occupied by dairy and drystock farms, these two soils are the least productive parts of paddocks, as pasture yields remain depressed by the after-effects of instability.

Issues that may arise when managing the soils under pasture are:

- Controlling any gullies or earthflows in old slump debris
- Restoring topsoil
- Building enough structure and fertility for improved pasture to persist

If in farm woodlots, the soil management issues are:

- Diverting runoff from harvest tracks and landings
- Prompt re-planting, before the roots of harvested trees decay

Omu and Te Tio soils have greater management needs than the other immature ultic (clay) soils that have weathered from more stable marine sedimentary rocks. Pasture or woodlots can be sustained on Omu clay only if soil conservation techniques are applied. Te Tio stony clay loam is so shallow and unstable, that neither pasture nor woodlots are likely to be sustained as a profitable land use.

Tips for managing soil structure and nutrients and controlling erosion in farmland; also for tree plantation harvest and re-planting, are contained in:

- *Soils on hill country* *Soil Information Sheet 14, Auckland Council*
- *Soils on steep ranges* *Soil Information Sheet 15, Auckland Council*
- *Code of Practice for Nutrient Management Fertiliser Association*
  Code of Practice for Nutrient Management
- *Forest harvest guidelines* *TP223, Auckland Regional Council*
- *Poplars* *Soil Conservation Leaflet, Auckland Regional Council*
- *Willows* *Soil Conservation Leaflet, Auckland Regional Council*
- *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**

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