Cover Note:

These slides were put together for a Northland Branch NZGS presentation on 02/06/2020. The information included in the slides does not standalone without some explanation. Please view the presentation recording on the NZGS website for the full context.

Sources of figures/pictures in the presentation are not fully acknowledged.
Historic aerial photos were sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0.
A number of aerial photos and property boundaries were sourced from https://data.linz.govt.nz/and licensed by LINZ CC-BY 4.0, typically Northland 0.4m Rural Aerial Photos (2014-2016) and NZ Parcel Boundaries Wireframe layers were used.
Geological maps where sourced from https://maps.gns.cri.nz/ and licenced by GNS CC-BY.
Free software for stereo pair red/blue anaglyphs can be found here: http://stereo.jpn.org/eng/stphmkr/index.html
QGIS was used for terrain models and compiling figures/maps. This is open source and can be downloaded here: https://qgis.org/en/site/forusers/download.html
A number of Google Earth images are used.
Borehole data has been obtained from the NZ Geotechnical Database for some of the sites: https://www.nzgd.org.nz/
Details of Landslip 2 were obtained from an Auckland Council Property File.

Hopefully you find the presentation useful.
David Buxton
David@northlandgeotech.co.nz

Landslips in Northland
Observations from Select Case Studies

David Buxton – Northland Geotechnical Specialists

Landslip Sources

- Work history
- GNS database
- Geological maps
- Observations of road slips
- Review of aerial photos
- NZ Geotech database
- Discussions with others

The information discussed is public, although not always readily available. Traditionally individual landslips are not published and for most engineers there is no easy/accessible way to find out about many landslips. Hopefully this can change in the future.

Disclaimer

1) This presentation is to learn from not to criticise.
2) I do provide my honest thoughts were I see due
3) Please don’t take my honesty as individual criticism.
4) I’m also part of the learning.

There is time for questions following my presentation.

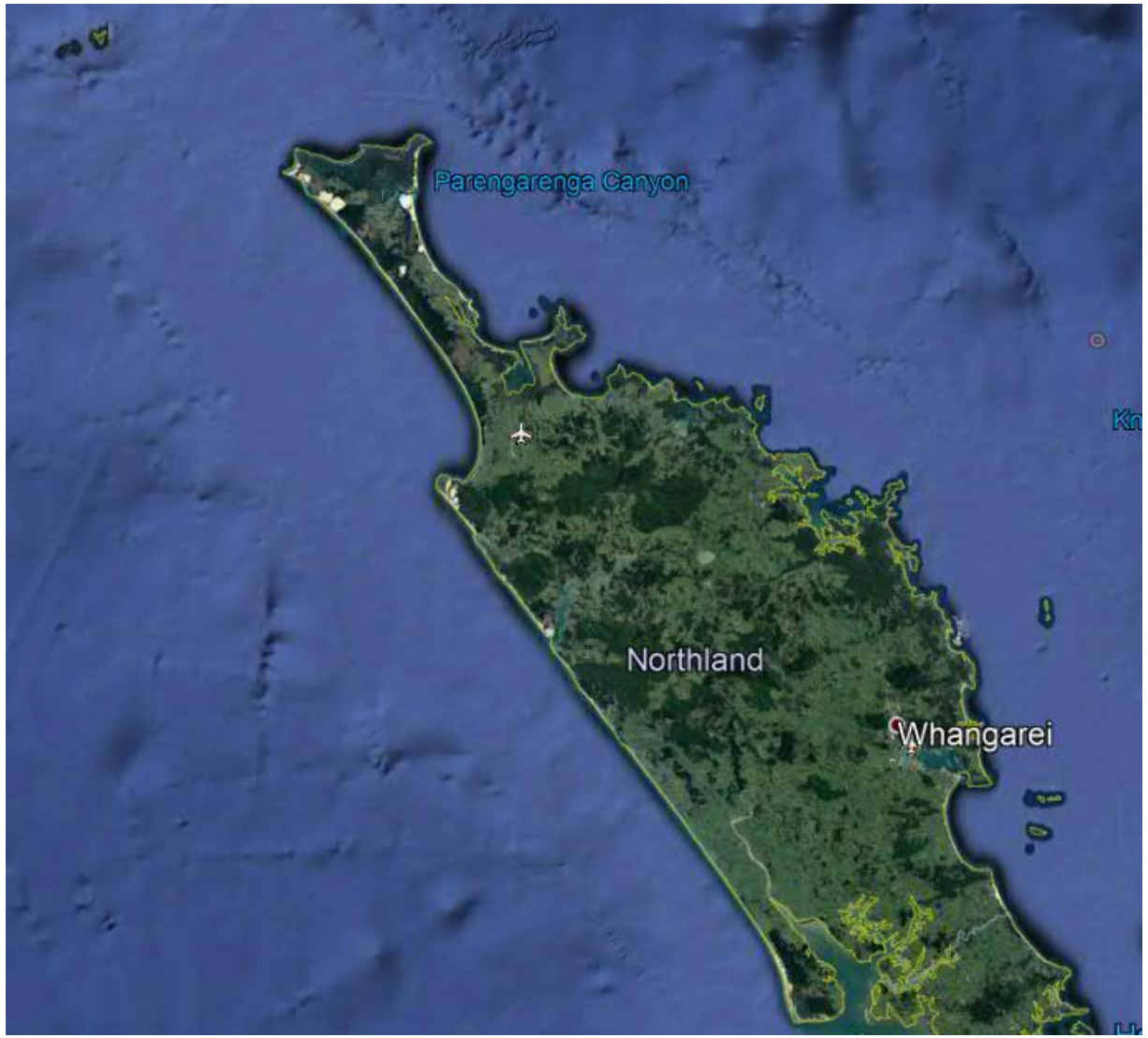
My Personal Introduction

Dad

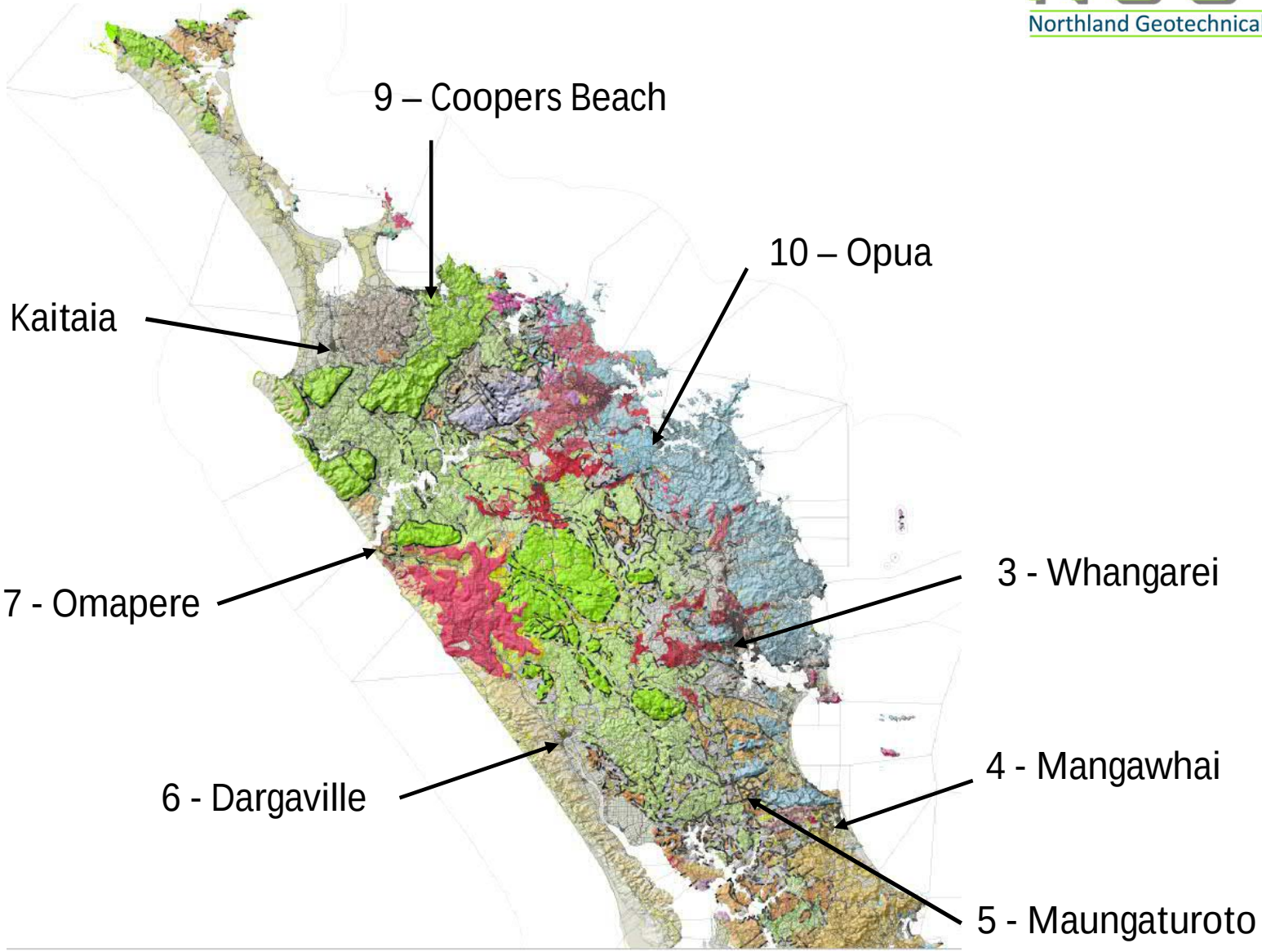
6 year old me

NGS
Northland Geotechnical Specialists

Northland



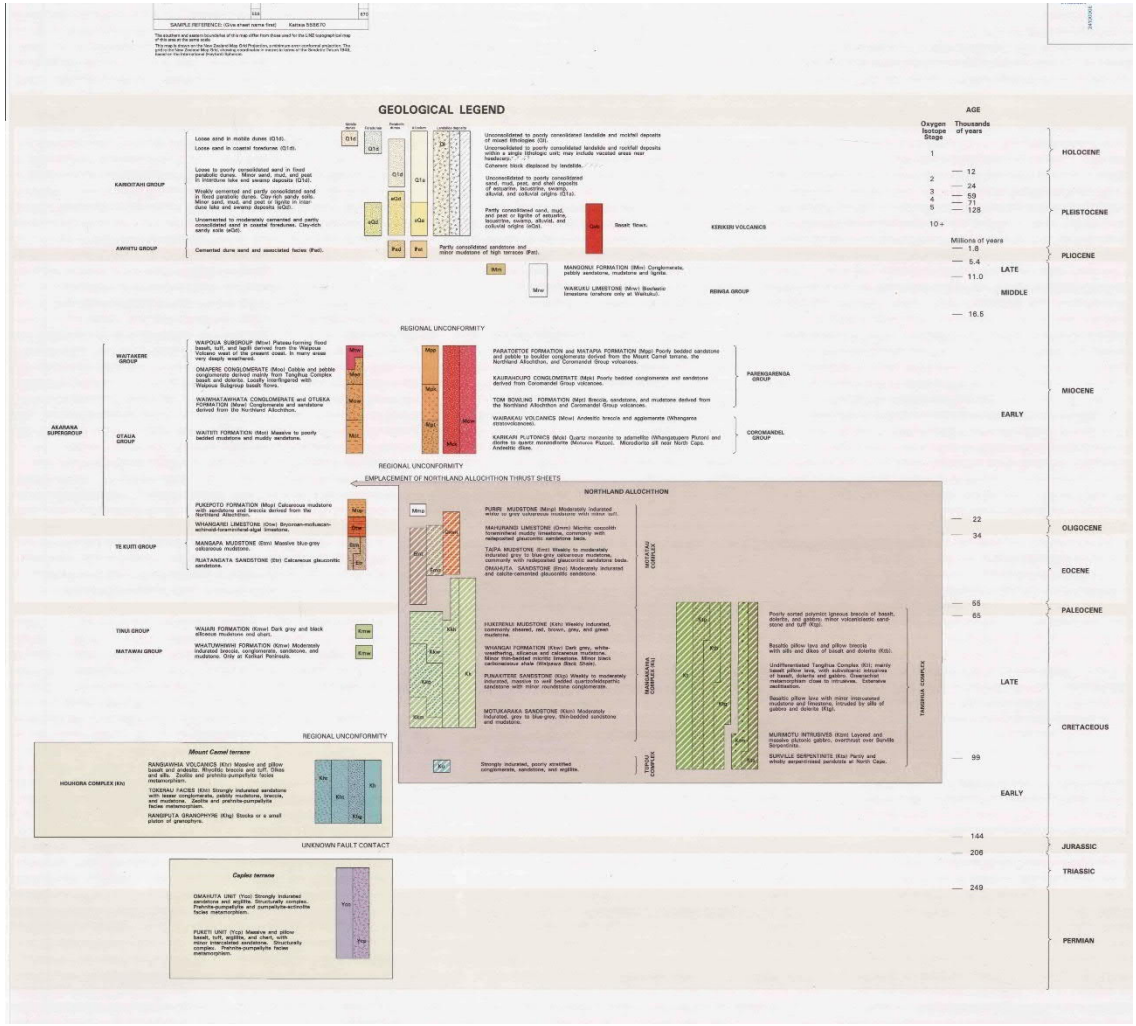
Northland

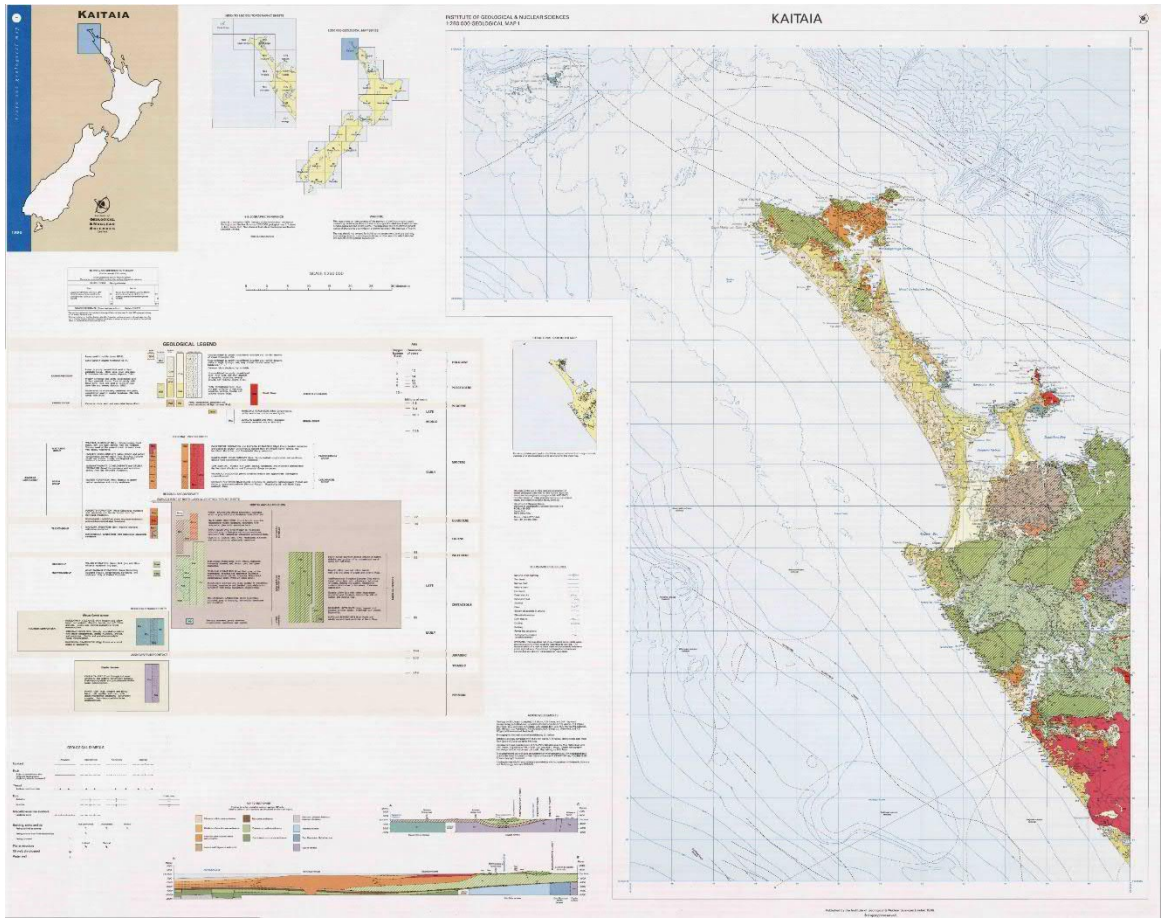


Map source:
NZ 8m DEM from LINZ
Qmap from GNS
Property Boundaries from LINZ
CC BY 4.0
Map generated in QGIS

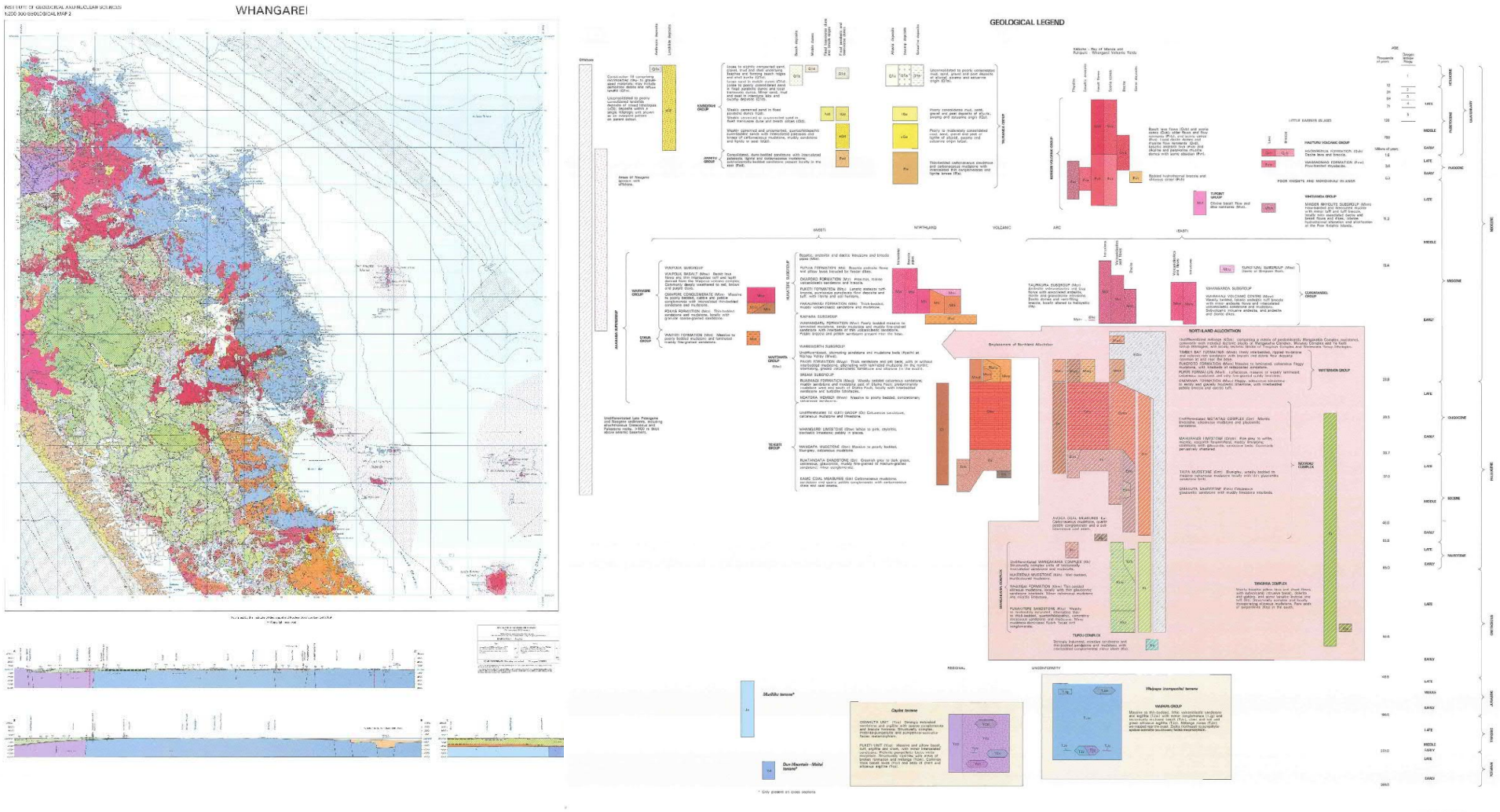
Landslips 1 & 2 are in Auckland but relevant to Northland.

Qmap - Kaitaia





Qmap - Whangarei



Landslip 1 - My Professional Introduction

Figure 2. House site in Lingham Crescent, Torbay where a home damaged by slow movement (700 mm on 30 July 2008) of a creeping landslide was evacuated and later demolished. Site evidence suggests the landslide is an old feature that was active before the site was developed, and reactivated by the prolonged rainfall in July 2008. *[GNS Photo: GTH-0429].*

Figure 4. View of house foundations (left) after the most severely damaged house in Lingham Crescent (above) was demolished. The concrete driveway seen here has slid 100 mm towards the road as a result of the landslide movement. *[Photo S Nelis]*

Engineers keep watch on North Shore slip

News > National

A "creeping" landslip on Auckland's North Shore is under close scrutiny from engineers today as it threatens to take out more houses.

One house in the East Coast Bays suburb of Torbay has been written off and two others were damaged by the slip yesterday as ground sodden by days of heavy rain gave way.

The slip had been "slowly creeping" for several days, said North Shore City Council spokesman, Blair Harkness today.

Yesterday the ground in Lingham Cres gave way, leaving one house twisted on its cracked foundation and another two badly damaged.

As emergency services feared the slip could spread, 12 more houses were evacuated and it may be days before the residents were are allowed to return civil defence officers said.

A large slip has caused the evacuation of more than a dozen homes on Auckland's North Shore

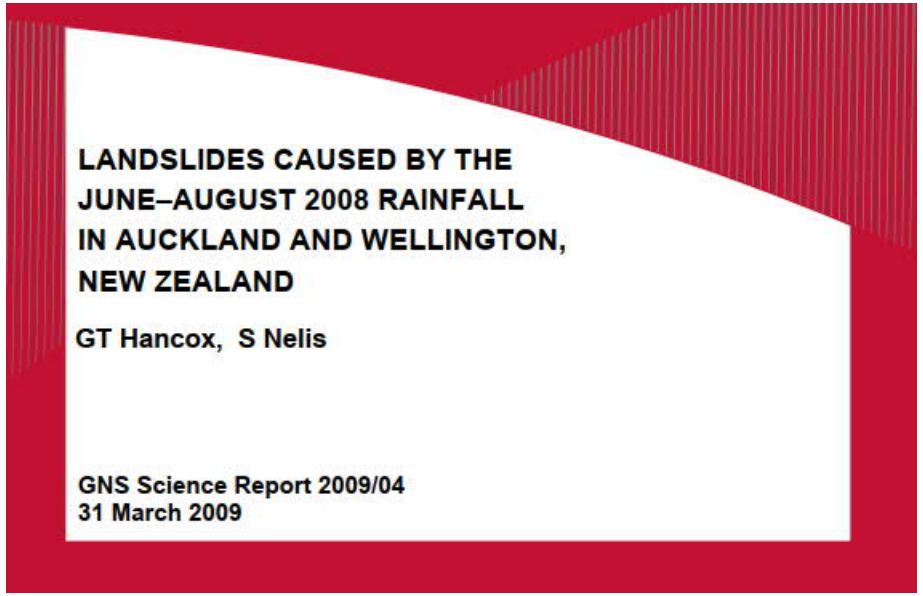
An Earthquake Commission engineer was due back on the site today to assess the damage to the houses and the likelihood of further erosion of the slope.

The ground movement left a 12m split in the ground and residents were given a few minutes to gather important items and leave.

Everyone cooperated with civil defence officers to get out of their homes, David Keay, from North Shore City Civil Defence, said.

Lingham Crescent - 2008

https://static.geonet.org.nz/info/reports/landslide/SR_2009-004.pdf
Landslides caused by the June-August 2008 rainfall in Auckland & Wellington - GNS

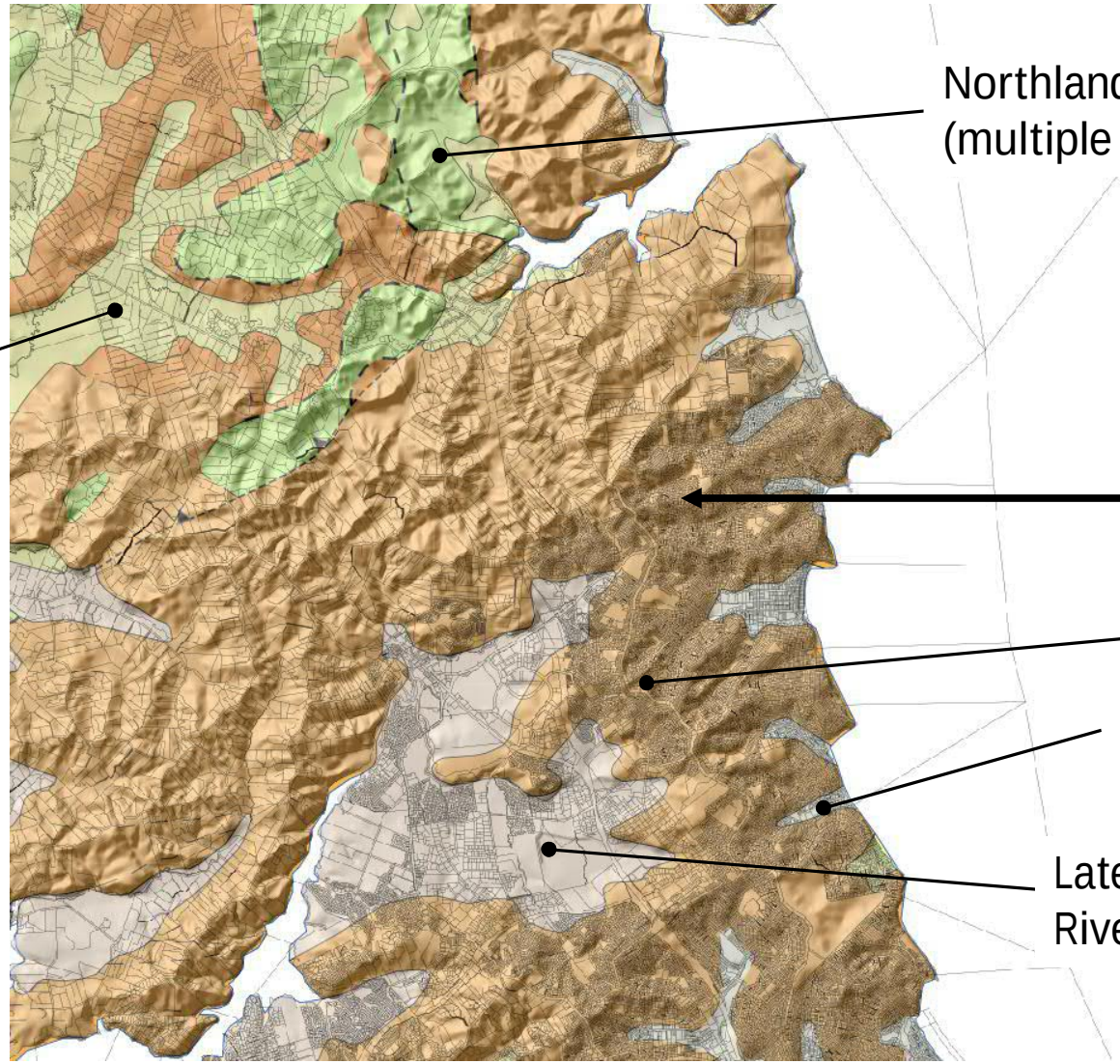


The landslide that occurred in Lingham Crescent in Torbay was a deep-seated earth slide. Significant slide movements occurred on 30th July 2008 following a sustained period of heavy rainfall over two weeks. GNS Science staff (S Nelis and S McColl) inspected the site on 1st September 2008, after the most severely damaged house had been demolished and removed (Figure 2). The landslide is thought to be a reactivation of an older feature that was most likely active before the site was developed. Geomorphic evidence for this being a reactivated old landslide includes existing scarps 200-500 mm in height running through the back of the property (Figure 3).

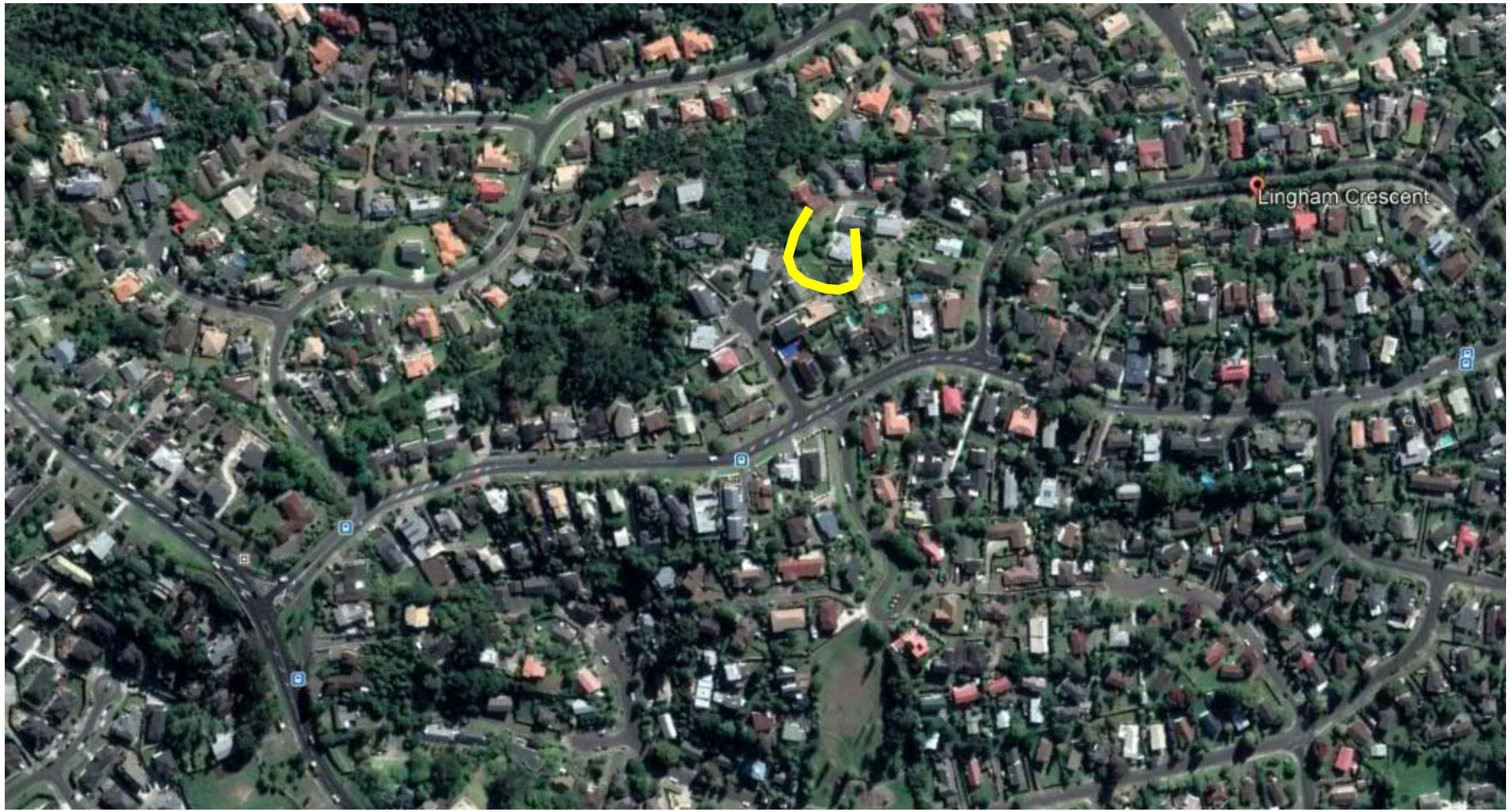
(2) Although the recent landsides at Torbay, Glenfield, and Huia were clearly related to greater-than-normal rainfall, in these cases, however the underlying cause appears to have resulted from, or be associated with, development and building on old landslides (as at Torbay) or on previously unstable land that has undergone major alterations to the ground surface profiles, without due recognition or allowance for the underlying instability.

More reports at
https://www.geonet.org.nz/landslide/reports

Lingham Crescent - 2008

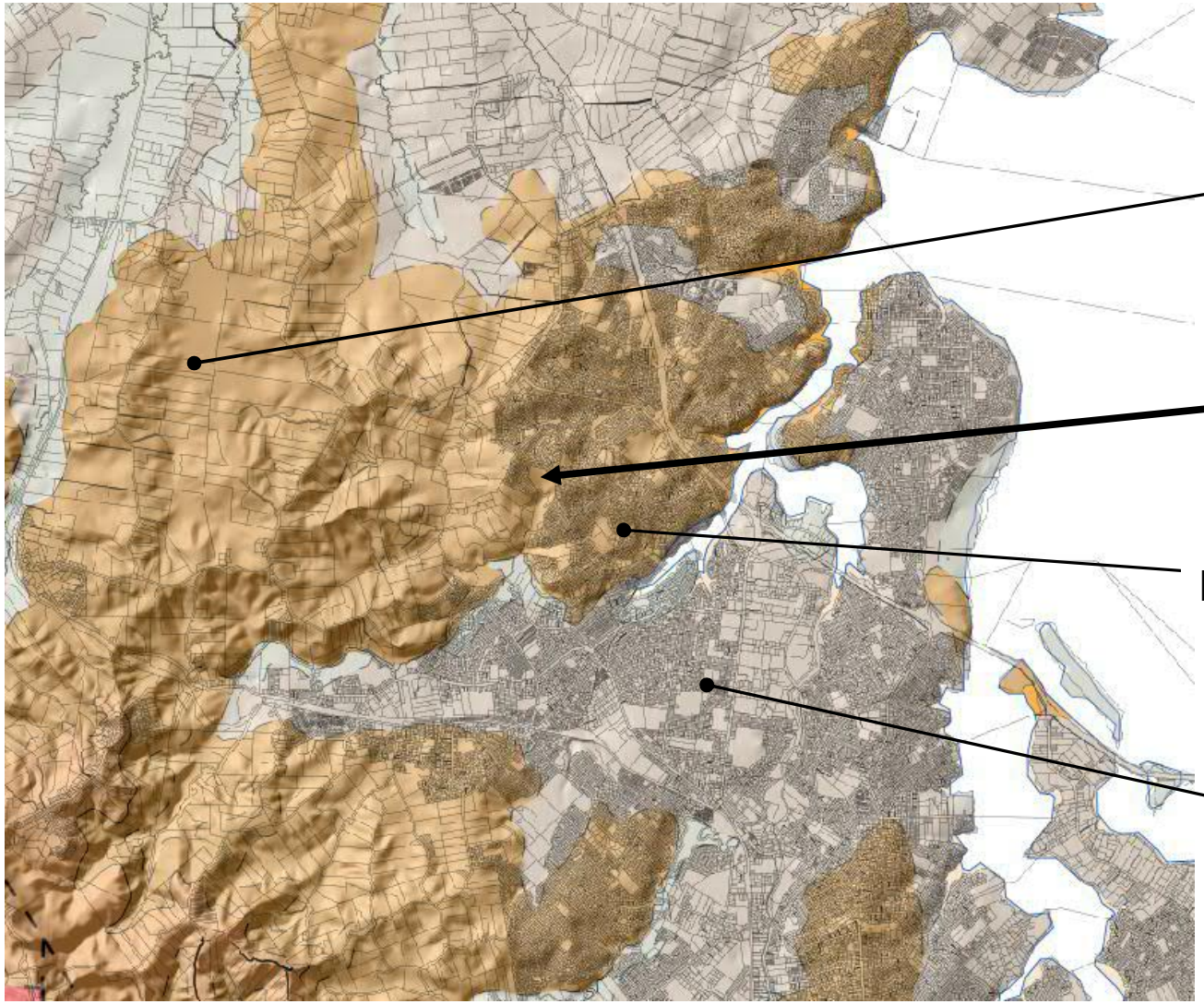


Lingham Crescent - 2008



Lingham Crescent - 2008

Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015



Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

Northland Geotechnical Specialists

From a paper presented at the 2001 NZGS Conference….

Land Development Zones for Structure Plans

S. C. Tilsley
Beca Carter Hollings and Ferner Ltd

A. L. Williams
Beca Carter Hollings and Ferner Ltd

D. V. Toan
Beca Carter Hollings and Ferner Ltd

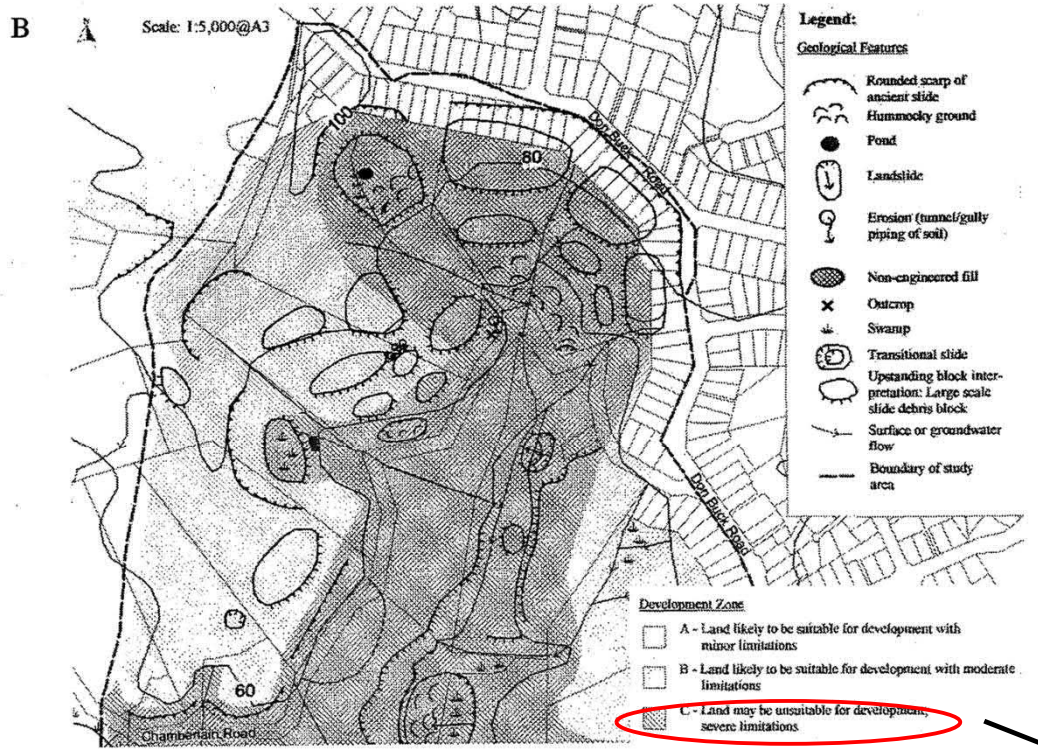


Figure 1. Extracts from slope grade and lithologic map (A) and observed slope movements overlain on resultant slope instability hazard map (B).

Hazard zoning was based on a 1:5,000 regional scale mapping and the project was for Auckland Council planning purposes.

Land may be unsuitable for development, severe limitations

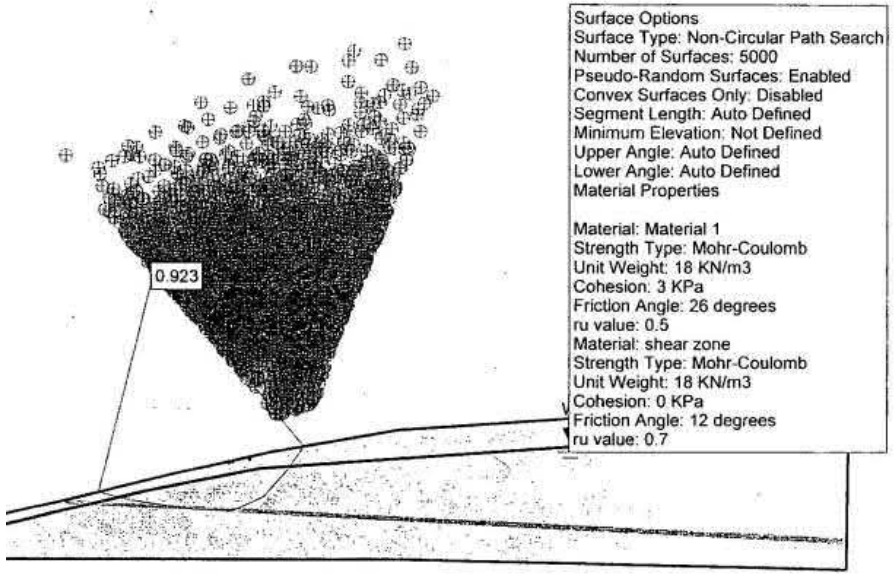
Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

RE: SLIP REMEDIATION WORKS

41-49 CHAMBERLAIN ROAD, MASSEY

Soil Parameters

Soil Type	Effective Cohesion on the Failure Plane c' (kPa)	Effective Angle of Internal Friction Φ'(°)	Unit Weight γ (kN/m³)
Engineered Fill	7	28	18
Alluvial Deposits	2	26	18
Shear zone (rupture surface)	0	12	18



Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

Photo 5 - Toe of slip in drain CD3 – up to 20mm displacement with the top layer overriding the base layer

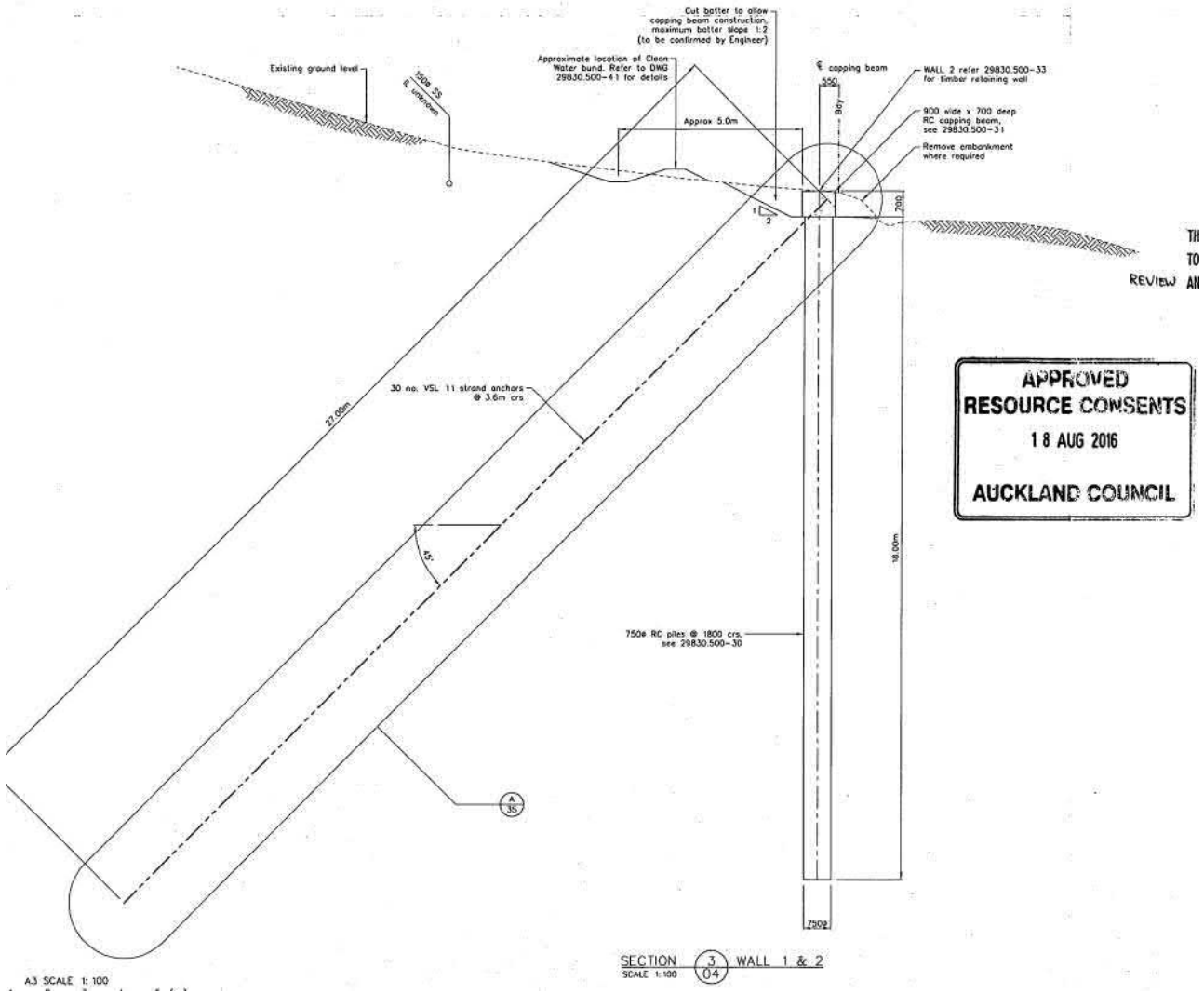
Photo 8 - Up to 75mm of displacement observed on side of drain CD3

Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

Table 7-2: Soil design parameter values

	Weathered ECBF	Shear surface zone (at 13.5m depth)	ECBF rock
Unit Weight, (kN/m³)	18	18	22
Cohesion, c' (kPa)	5	5	10
Friction angle, φ' (°)	26	26	30
Anisotropic dip angle range (°)	N/A	2 to 12	N/A
Anisotropic cohesion, c' (kPa)	N/A	0	N/A
Anisotropic friction angle, φ (°)	N/A	13	N/A
Young Modulus, E (GPa)	20	20	150

Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015



Don Buck Landslide Remediation

Design Report

Date
July 2016

Table 7-2: Soil design parameter values

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Landslip 2a & 2b - Don Buck Road, Massey – 2007 & 2015

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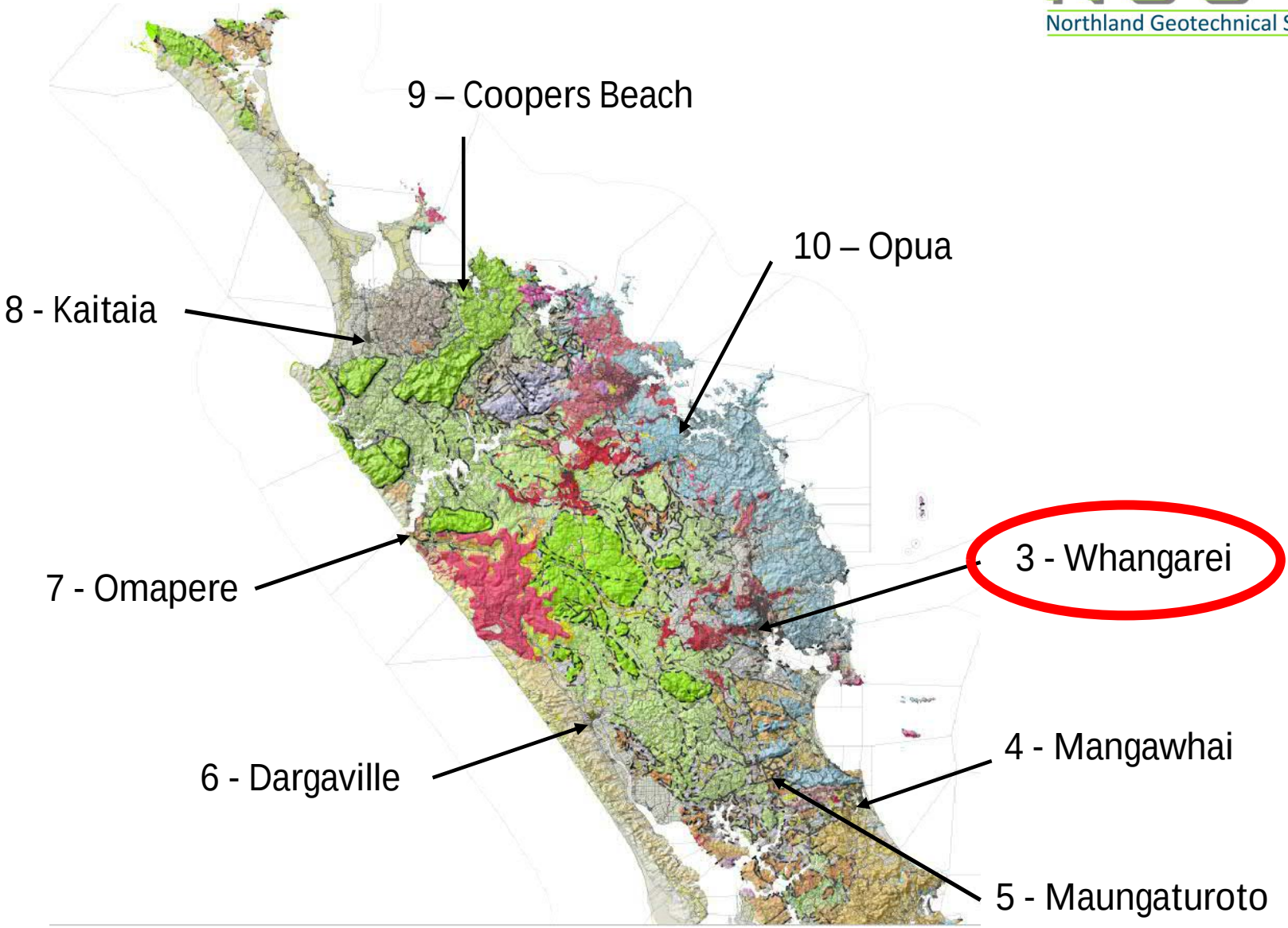
Northland


9 – Coopers Beach
10 – Opua
8 - Kaitaia
7 - Omapere
3 - Whangarei
6 - Dargaville
4 - Mangawhai
5 - Maungaturoto

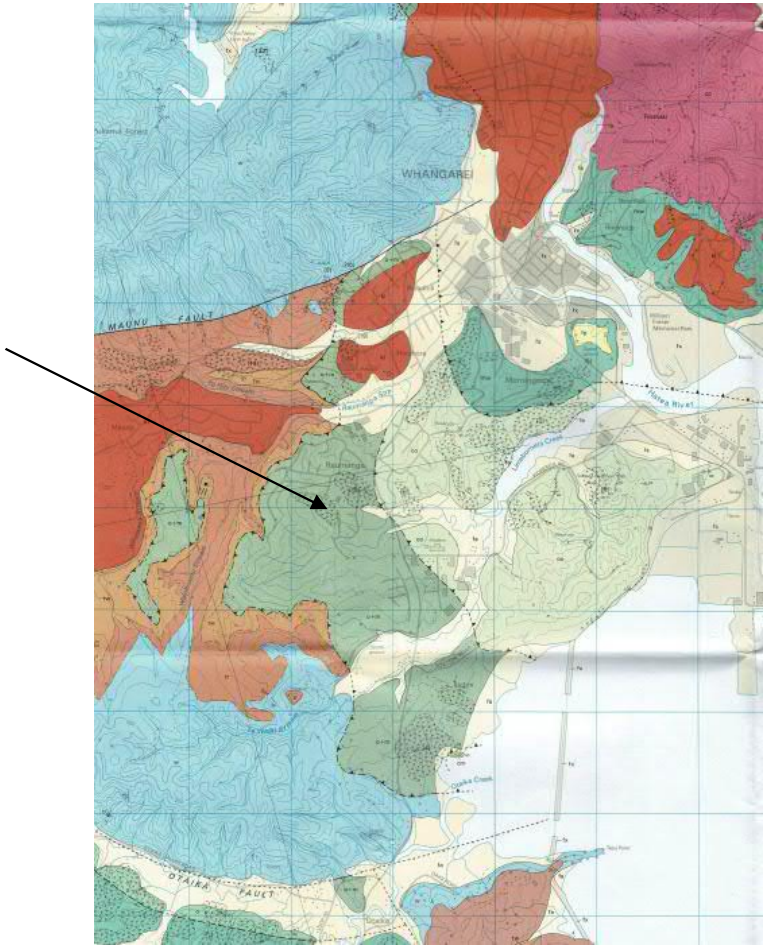
Landslip 3 – Isola St Whangarei

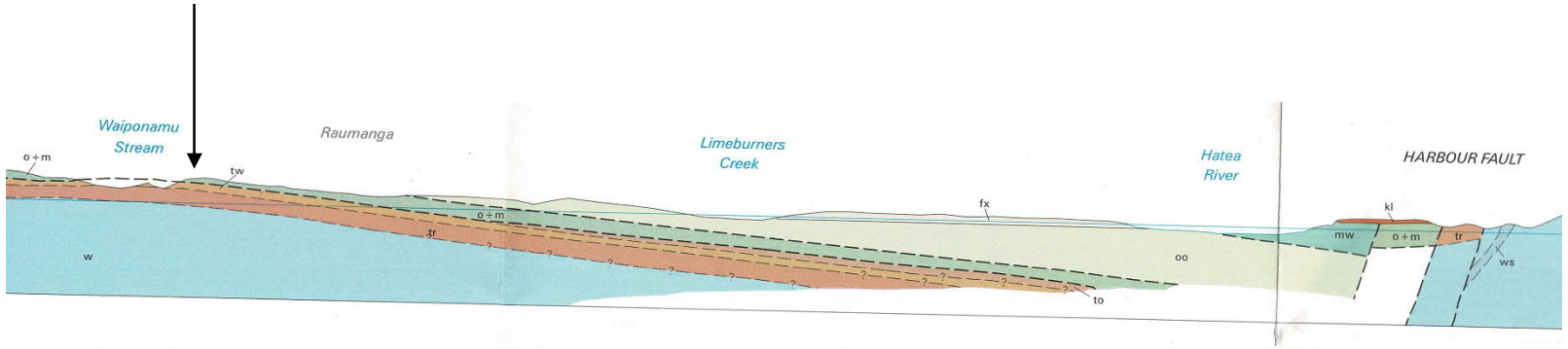
Movement in this area has been known since 1970's when the houses were developed and movement in the backyard of 4 adjacent properties occurred. One of the properties was recently again for sale, having again been purchased by an unsuspecting person. Could it have been identified in advance if it was a new development?

Landslip 3 – Isola St Whangarei

Northland Geotechnical Specialists

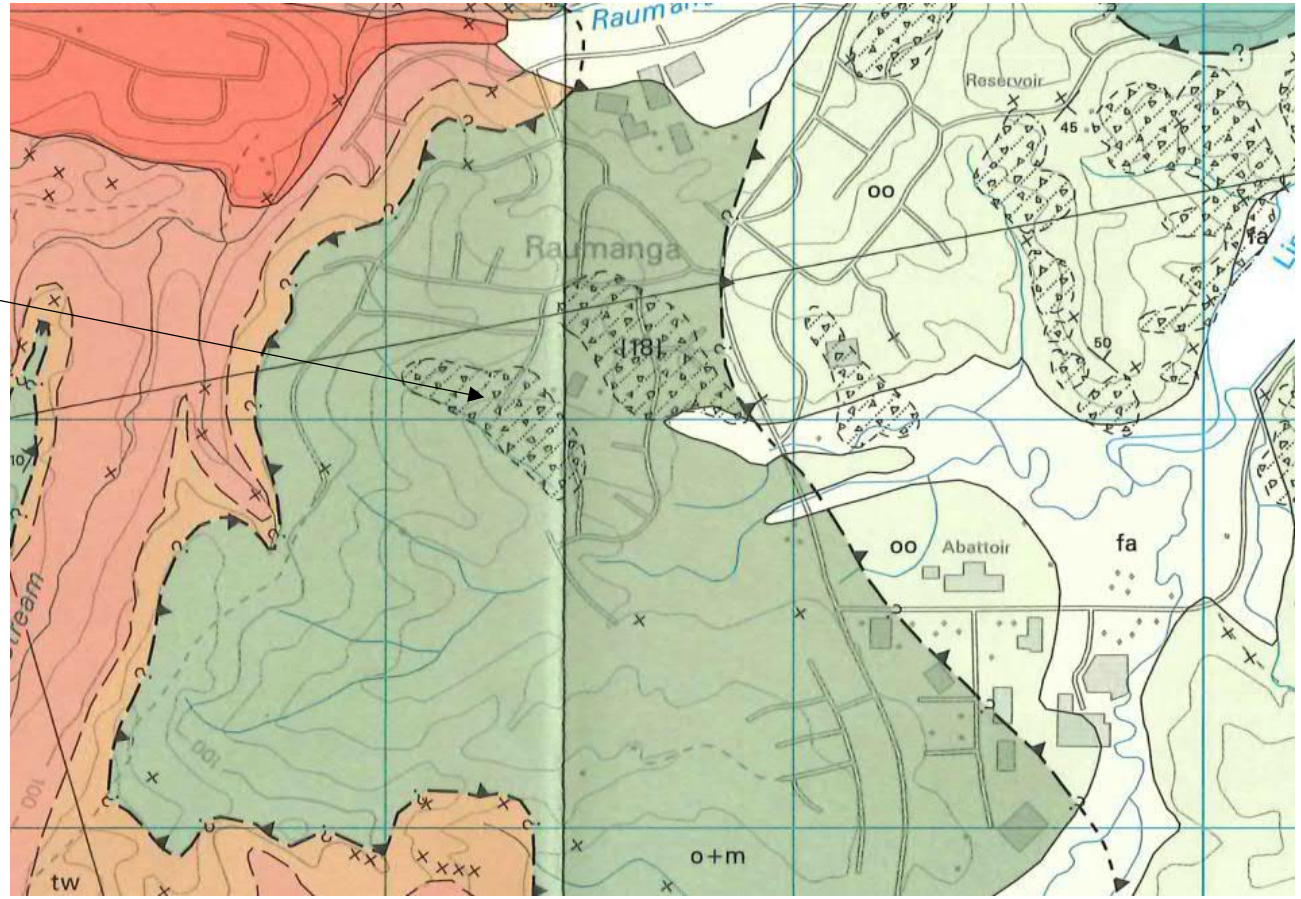
Method 1 – Geological Map – 1:25,000 Scale – Geology of the Whangarei Urban Area 2003 – Regional Geology





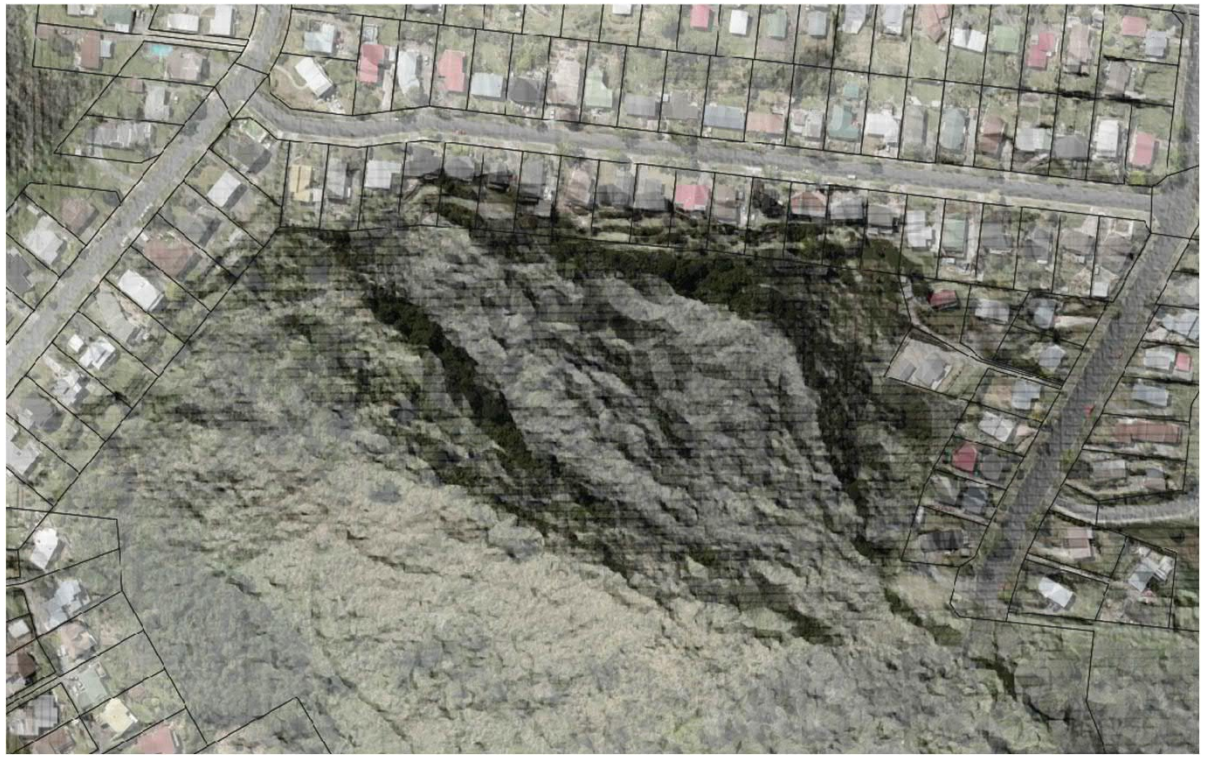
Landslip 3 – Isola St Whangarei

Geological Map – 1:25,000 Scale – Geology of the Whangarei Urban Area 2003 – Mapped Landslide



Landslip 3 – Isola St Whangarei

Use the LiDAR data – All of Northland imminent. Images below created in QGIS which is open source & free!



Whangarei: Some History

EG 229

WHANGAREI CITY CORPORATION, ENGINEERING
GEOLOGICAL MAPPING FOR URBAN DEVELOPMENT

I.R. Brown
October 1975

ENGINEERING GEOLOGY SECTION

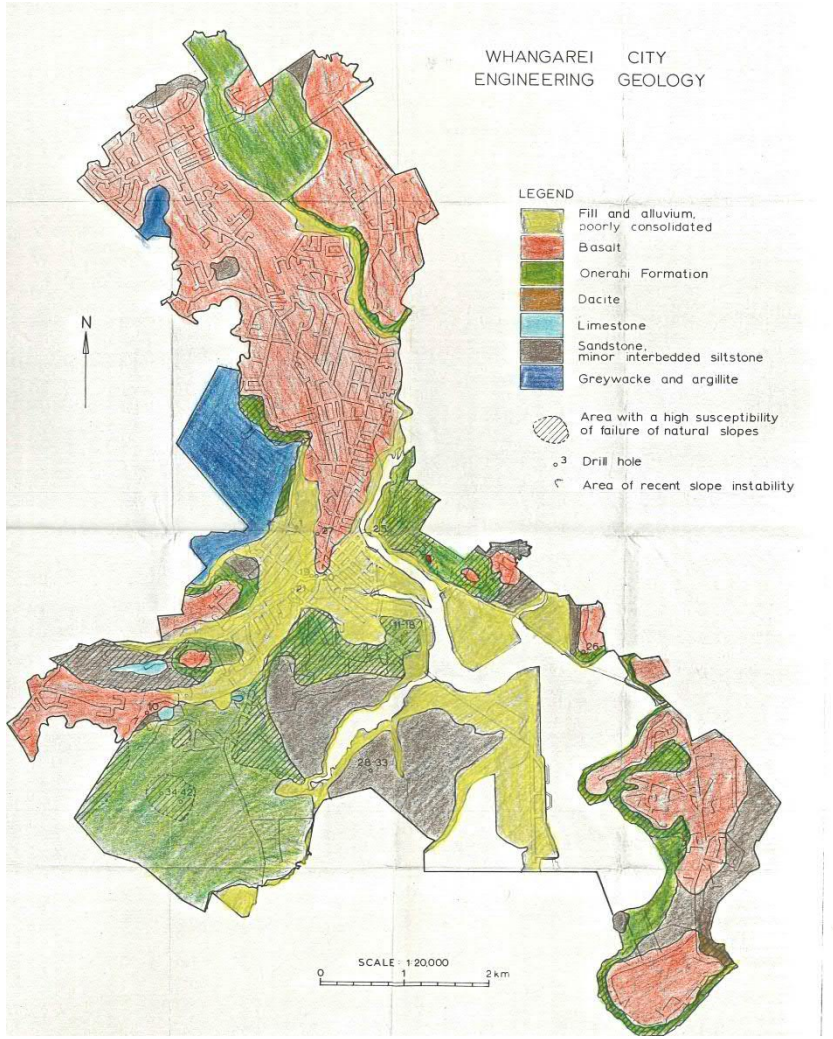
NEW ZEALAND GEOLOGICAL SURVEY

LOWER HUTT

R. P. Suggate
Director

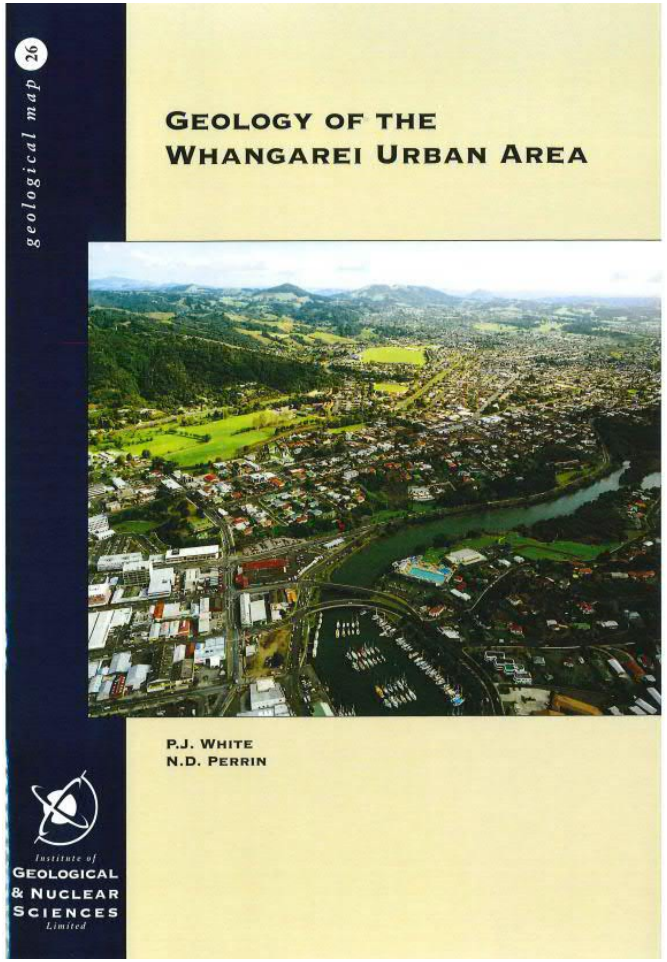
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Refer to this report as:
N.Z GEOLOGICAL SURVEY UNPUBLISHED
ENGINEERING GEOLOGY REPORT EG229



Whangarei: Sudden Street Endings & Vacant Land a Warning?

Whangarei: Sudden Street Endings & Vacant Land a Warning?



GEOLOGICAL HAZARDS

LANDSLIDES AND SLUMPING

Most natural slopes developed on soft rocks in the Whangarei area exhibit an undulating hummocky surface that is characteristic of soil creep and surficial slumping (Fig. 18). Landslides in the map area have been mapped from aerial photographs and field mapping. The positions of features and landslides discussed below are indicated on the accompanying map by numbers in square brackets.

Whangai Formation mudstone (mw) is very susceptible to instability, even on gentle slopes of less than 10°, and in most cases the steeper slopes can be considered to consist of a complex of creeping landslides, for example in the Otaika area [1]. These slides are probably in the order of 5 m deep, but are possibly up to 20 m deep in places. The tendency of these rocks to slump arises from their generally clay-rich composition and the intense tectonic shearing within them. Instability is also widespread in areas of Omahuta sandstone (oo), particularly beside Limeburners Creek [2]. Mahurangi limestone (om) is comparatively strong and areas of limestone are less prone to slumping and more resistant to erosion. The large mass at Portland forms Tikorangi Hill which rises above the surrounding mudstones (Fig. 9).

In general, areas with a slope greater than 15° and underlain by Late Cretaceous and Tertiary soft rocks of the Northland Allochthon (except Mahurangi limestone) are considered to have a high risk of failure (Brown 1975). This includes parts of Raumanga, Kioreroa, Morningside and Riverside, and much of the land south of Otaika Fault.

Several deep-seated, ancient, large landslides have been identified in areas underlain by Whangai Formation mudstone or Omahuta sandstone. Some have apparently not moved for a long period, but others are obviously active, or at least partially active. A very large landslide at the Onerahi end of Riverside Drive, north of Sherwood Rise [3], shows no signs of recent activity, but a slide of similar size north of Otaika Creek [4] is probably creeping at present and the hummocky nature of the ground suggests relatively recent, large-scale movement.

A failure of the old railway cutting in Whangai mudstone at Morningside [5] in the 1940s was subsequently stabilised by cutting back to 20°. Nearby, a large area of hummocky ground was formerly visible on the north-facing slope of Morningside [6]; the area is now covered with houses. Extensive ancient landslides on the west-facing slopes of Morningside [7] are also developed in sheared Whangai mudstone, but have apparently been inactive for a long time. The old slide in the area of the sewage treatment plant also seems to be inactive [8].

Both old slope failures and recent movement affecting houses and streets are present to the north of the hospital on Maunu Road [9], and sheet piling and rebuilding of the street was necessary in Glendale Road [10]. These areas are also underlain by Whangai mudstone, as are the large areas of sliding near Colenso Street, Kamo [11], which show recent creeping movement.

In many cases, it is apparent that vegetation has a significant effect on the shallow, creeping slides in Whangai mudstone and Omahuta sandstone. Deforestation results in significant activation soon afterwards, but the level of activity in many places has declined since the 1940s, probably as the slopes have readjusted to a semi-stable lower angle under pasture than they had under forest. Any further modification of the landscape and drainage needs to make provision for possible instability.

Areas of soft rock beneath hard, permeable units (e.g. basalt and limestone) are subject to both oversteepening of natural slopes and saturation by groundwater, and are thus particularly unstable (Brown 1975). Such areas include most of the waterfront around Onerahi peninsula, where two recently active areas are apparent - one adjacent to Johnson Street [12], and the other near the intersection of Hill Street and Church Street [13], at the east end of the airport runway. Similar failures are present at the margins of the Tikipunga plateau and in parts of Maunu. West of Whangarei Hospital, large blocks of Whangarei Limestone are being rafted north down slope, by creep in underlying Ruatangata Sandstone [14].

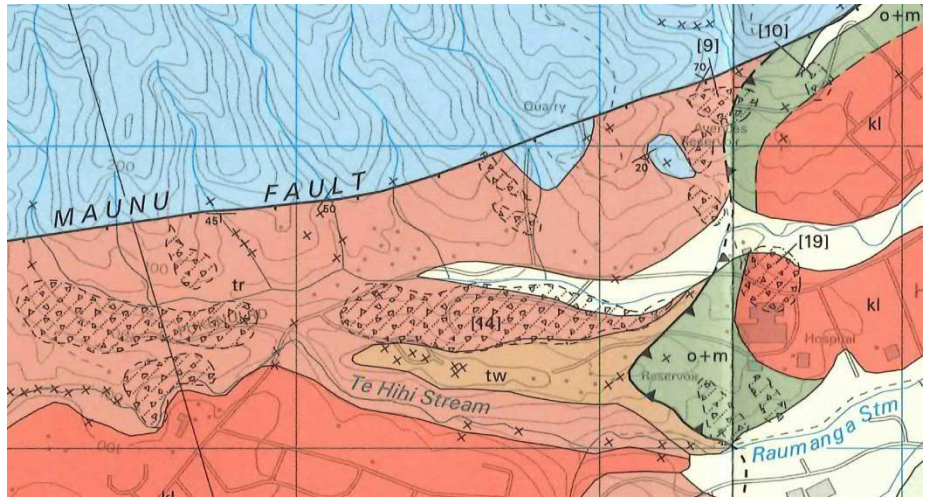
Three large, ancient slides between State Highway 1 and Vinegar Hill Road at the northern margin of the area mapped [15, 16 and 17] are at least partially active, with large-scale, deep-seated creeping modes of failure. It appears that failure of the underlying weak rocks has resulted in failure of the edge of a basalt flow. The most easterly of these three slides [17], on the Mangakino Stream, contains large semi-intact blocks of basalt.

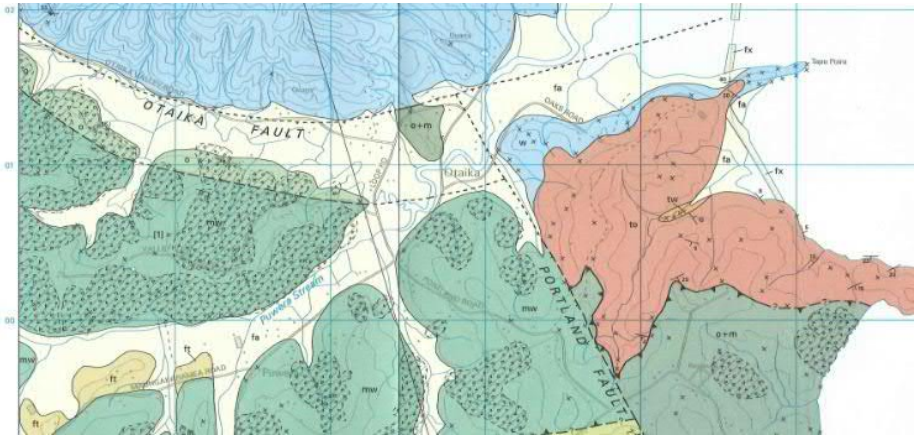
Deeper-seated gradual movement may occur on the thrust contact at the base of the Northland Allochthon where this dips in the same direction as the ground surface (e.g. Raumunga, and beneath Whangarei Hospital [19]). Such movement may disrupt underground services and cause gradual displacement of building foundations, but is unlikely to have catastrophic effects unless major excavations are undertaken down slope.

The deeply weathered or hydrothermally altered zones in Parahaki Rhyolite (cp) and Maungarei Dacite (km) are slightly susceptible to landsliding, but these are usually regolith failures of no more than 2 m depth, incorporating topsoil and weathered colluvium sliding on the clayey interface with the underlying weathered bedrock. Shallow regolith failures in pasture adjacent to Parakiore [20] cover a few hundred square metres and are still active. Gully erosion is also a feature on Parakiore, but the regeneration of scrub in this area in the last 30 years has inhibited further erosion. There are, however, two examples of large, ancient slides on the northwest slopes of Parahaki above Whareora Road [21].

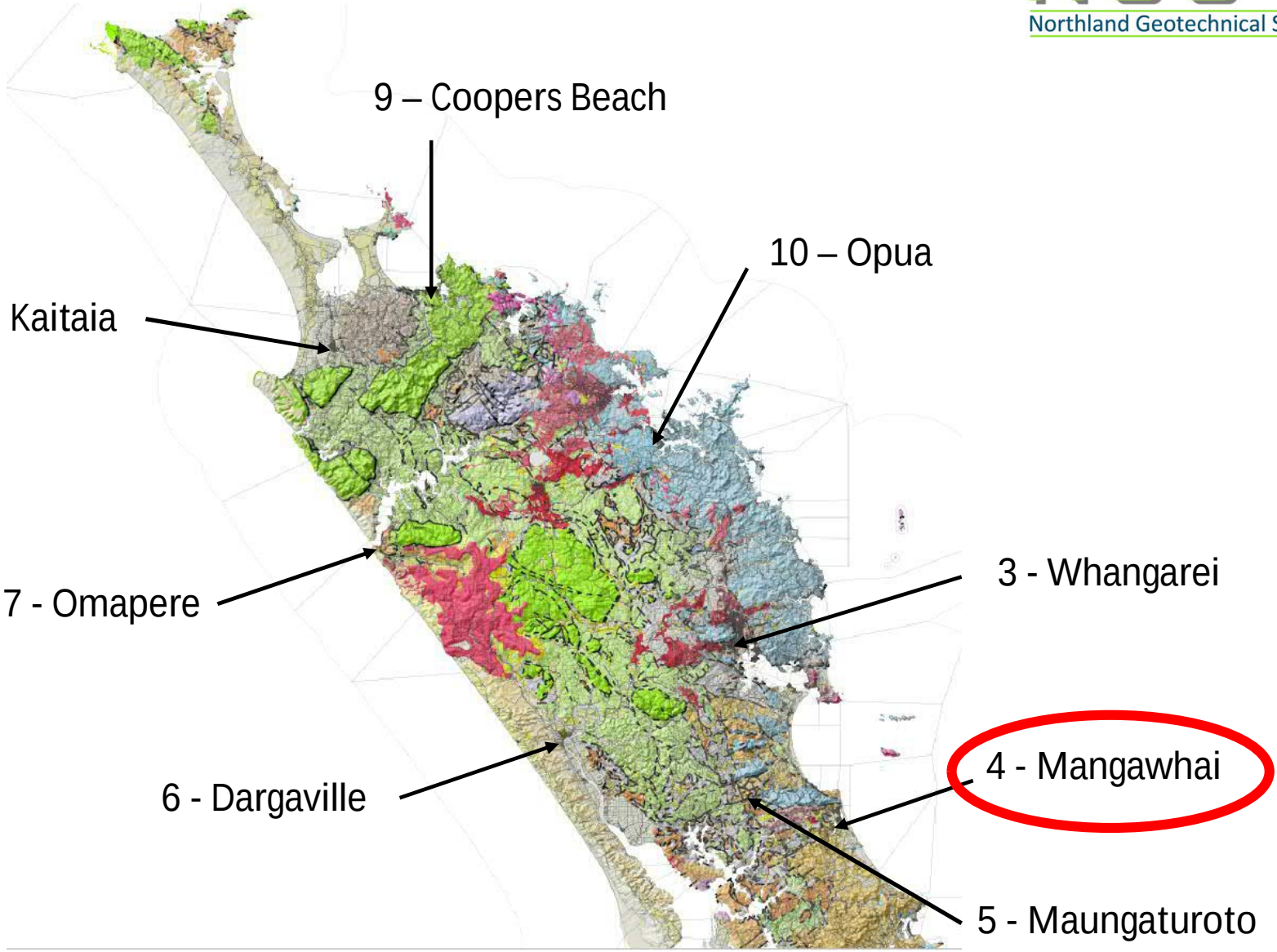
Te Kuiti Group rocks other than Ruatangata Sandstone (tr) are generally not susceptible to landsliding. In places, Ruatangata Sandstone stands in steep bluffs, but some minor landslides are present where it is weathered. It is very variable in strength.

24





Northland


9 – Coopers Beach
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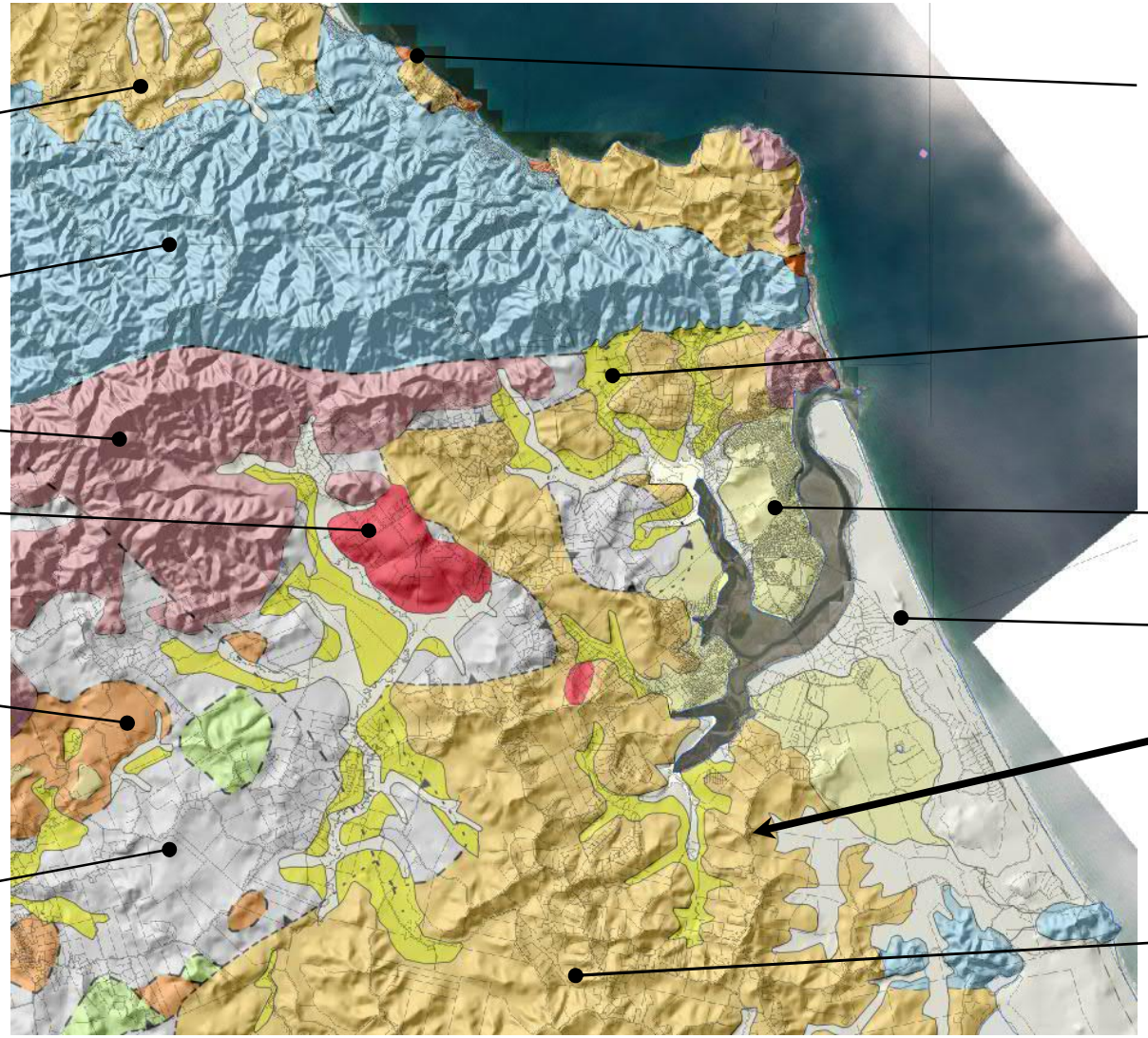
5 - Maungaturoto

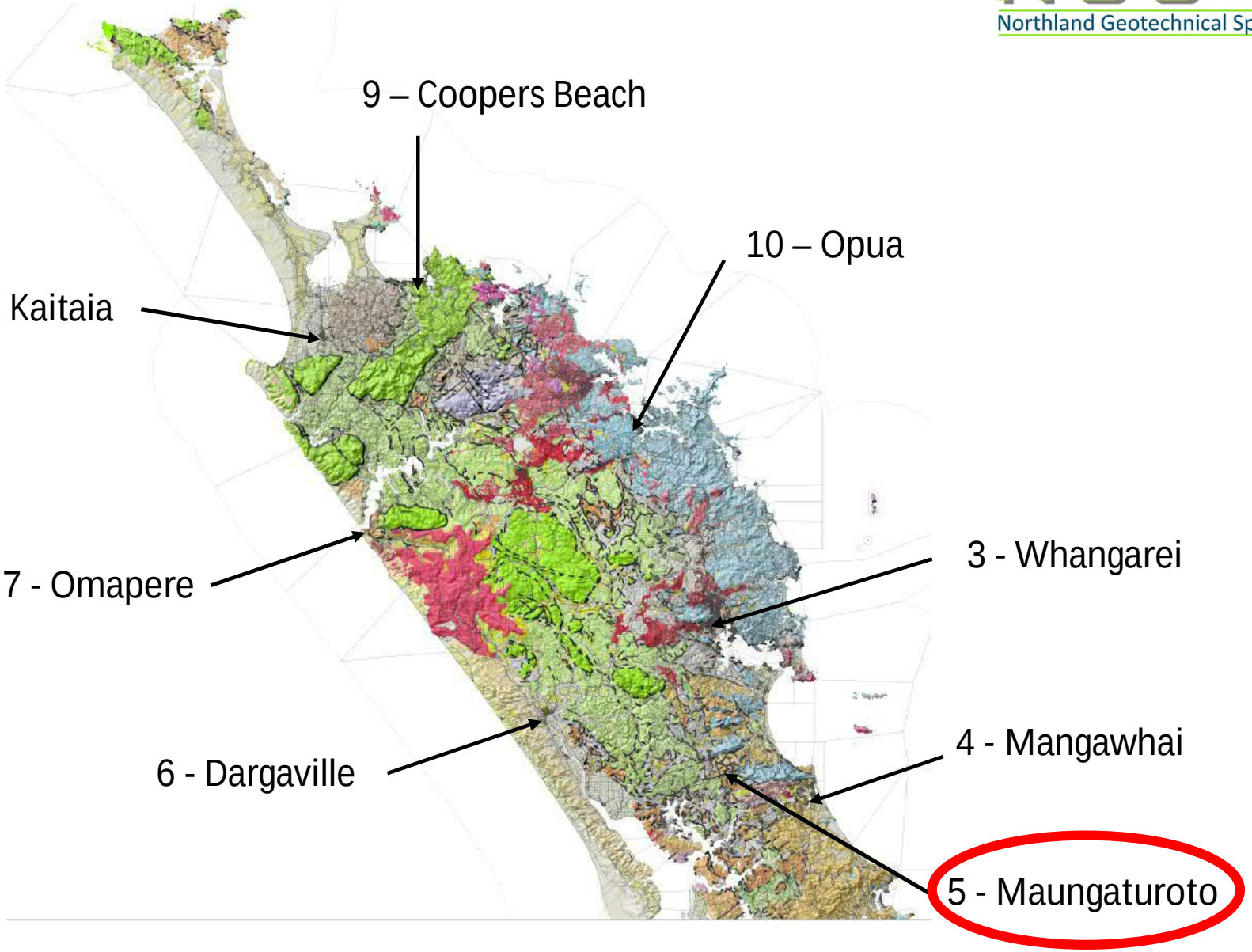
4 - Mangawhai


Whangarei Limestone
Rurangi Formation
Waipapa Group
Early-Mid Pliestocene Alluvium
Dacite
Basalt
Late Pliestocene Dunes
Holocene Dunes
Mahurangi Limestone
Landslip 4
Melange of Northland Allochthon
Pakiri Formation

4 - Mangawhai

The LiDAR contours indicate a 9m fall over 45m horizontal distance between the headscarp and toe – an average of 1V:5H or 11°, indicating a very low strength failure plane must exist.

Northland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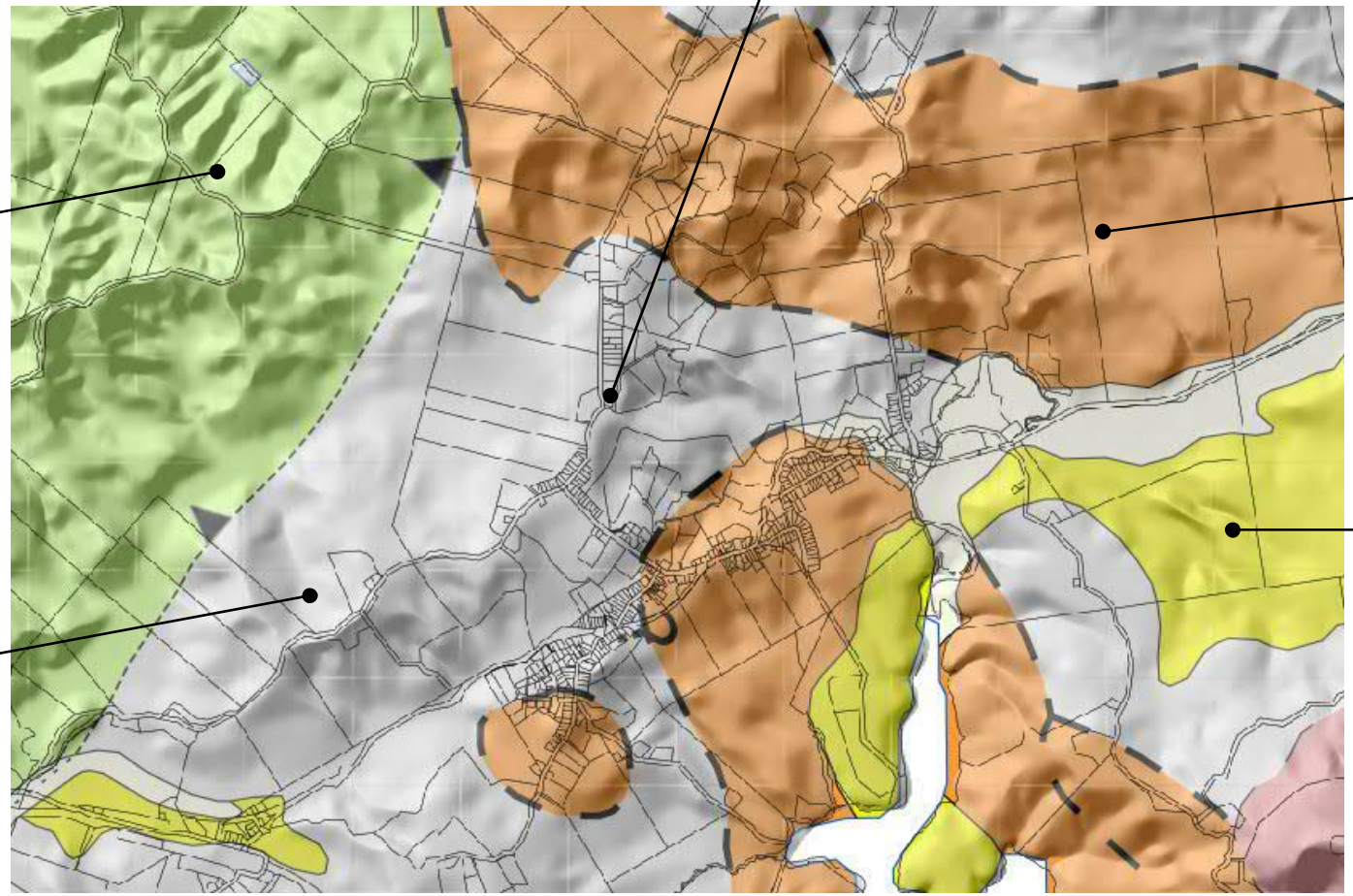
5 - Maungaturoto

Landslip Case Study

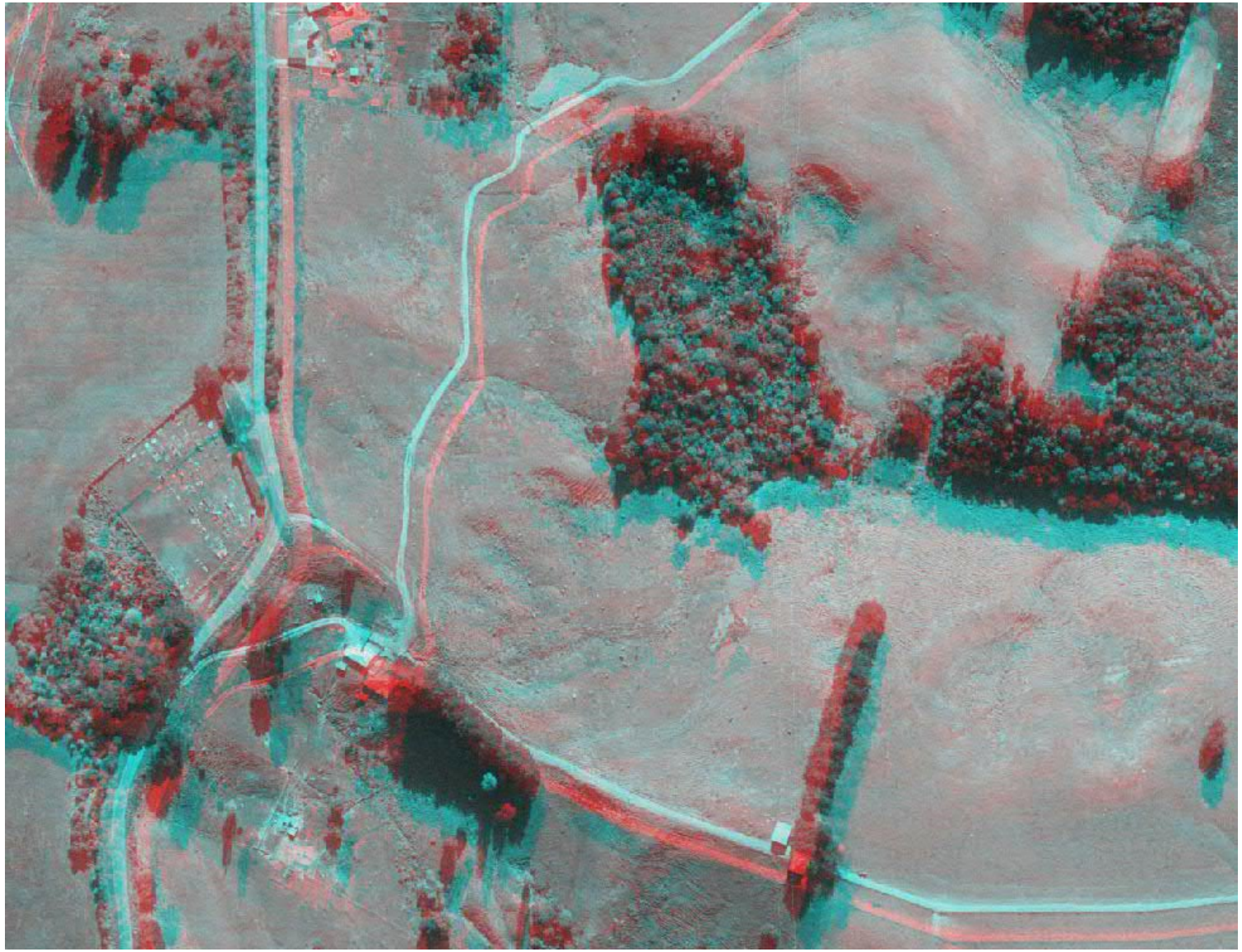


5 - Maungaturoto

5 - Maungaturoto

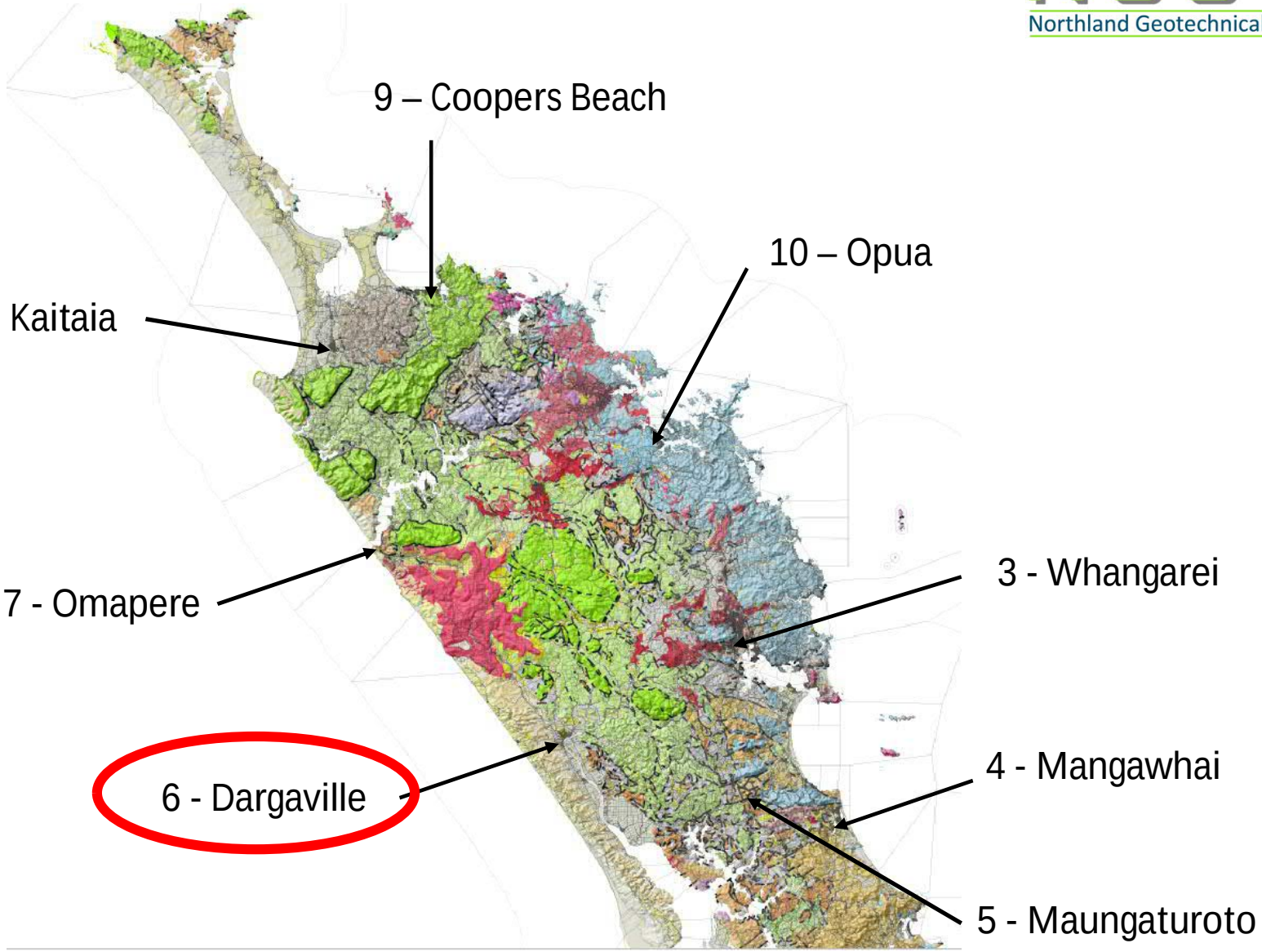
5 - Maungaturoto

5 - Maungaturoto



5 - Maungaturoto

Northland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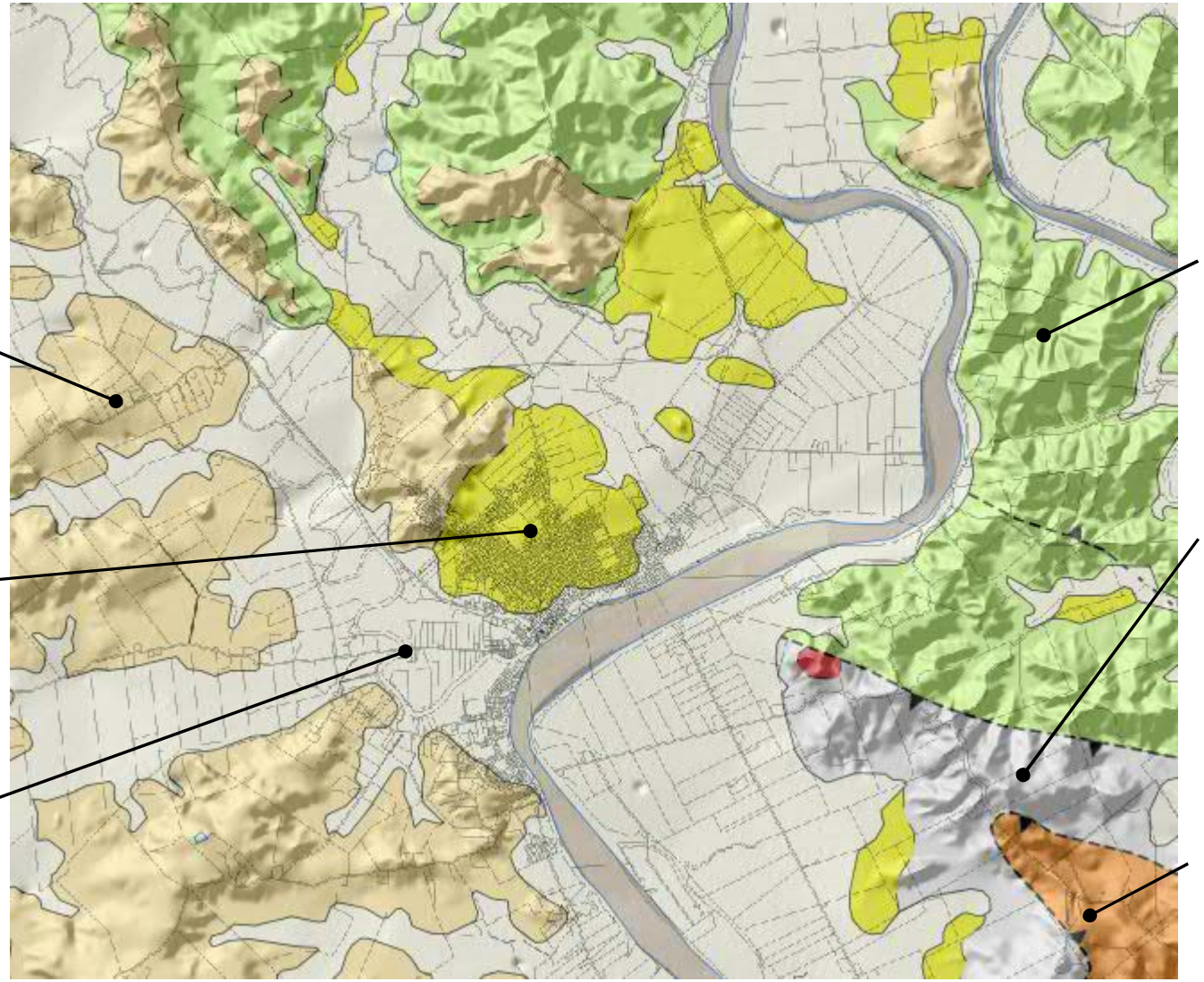
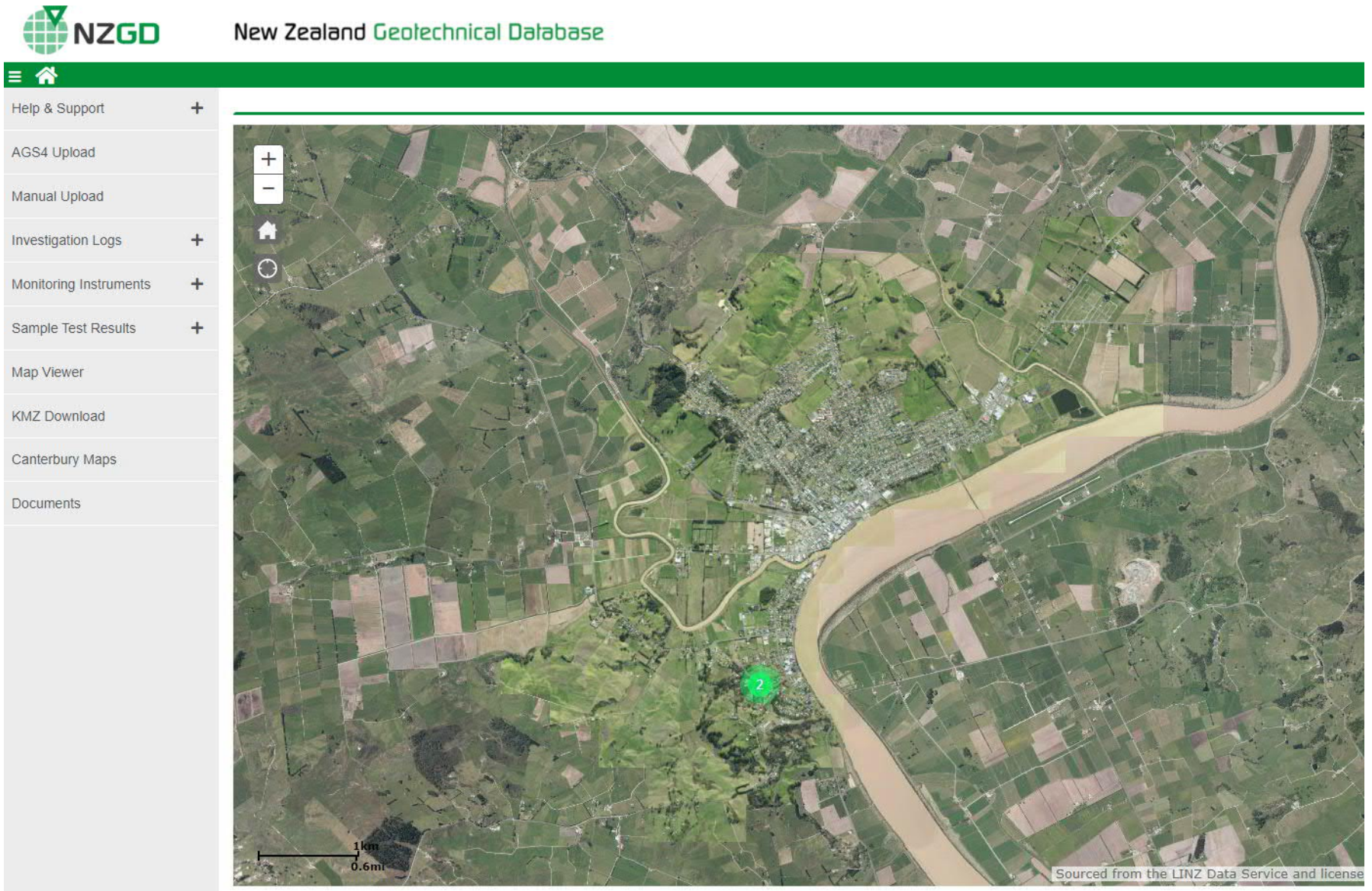
10 – Opua
8 - Kaitaia
7 - Omapere
3 - Whangarei
6 - Dargaville
4 - Mangawhai
5 - Maungaturoto

6 - Dargaville



6 - Dargaville

NGS
Northland Geotechnical Specialists



6 - Dargaville

6 - Dargaville

NZGD ID: BH_116179

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH1
Hole Location: Concrete Driveway
SHEET 1 OF 5

PROJECT: EQC-Colville Road 52 | LOCATION: 52 Colville Road, Dargaville | JOB No: 25062

CO-ORDINATES mN mE | DRILL TYPE: Tractor JD07 | HOLE STARTED: 13/11/07

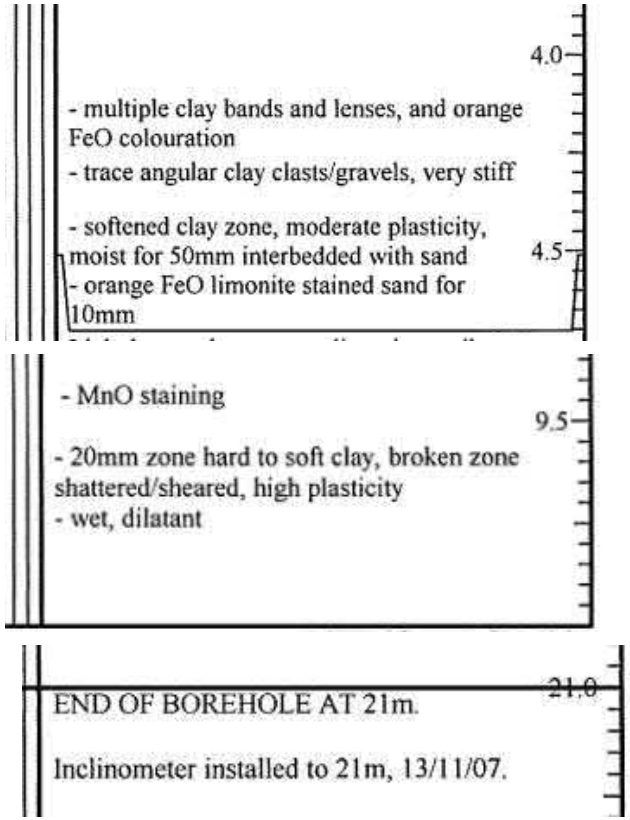
R.L. m | DRILL METHOD: OB/HQ Rotary | HOLE FINISHED: 13/11/07

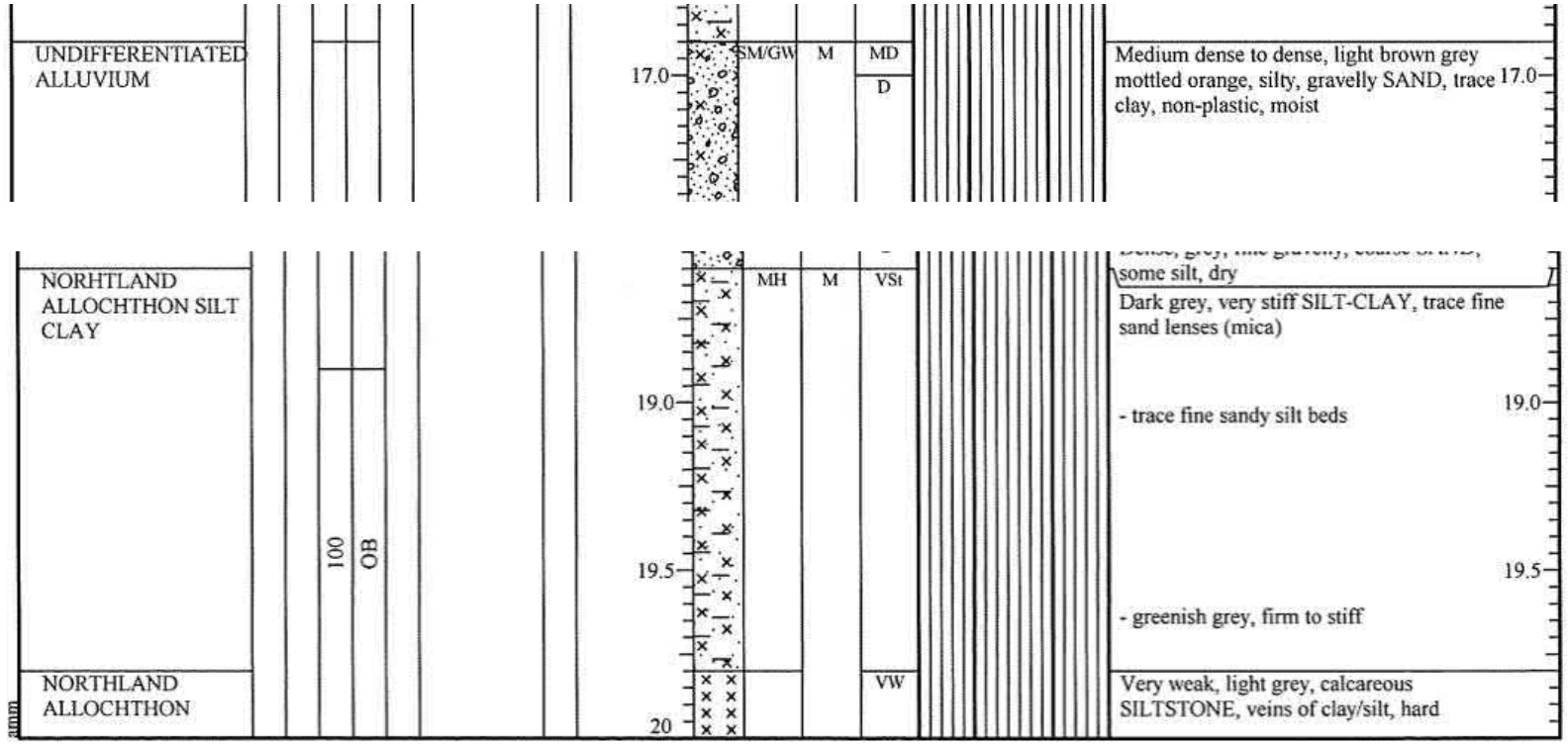
DATUM | DRILL FLUID: Water | DRILLED BY: DCN Drilling Ltd | LOGGED BY: CMW/RAM CHECKED:

GEOLOGICAL | ENGINEERING DESCRIPTION

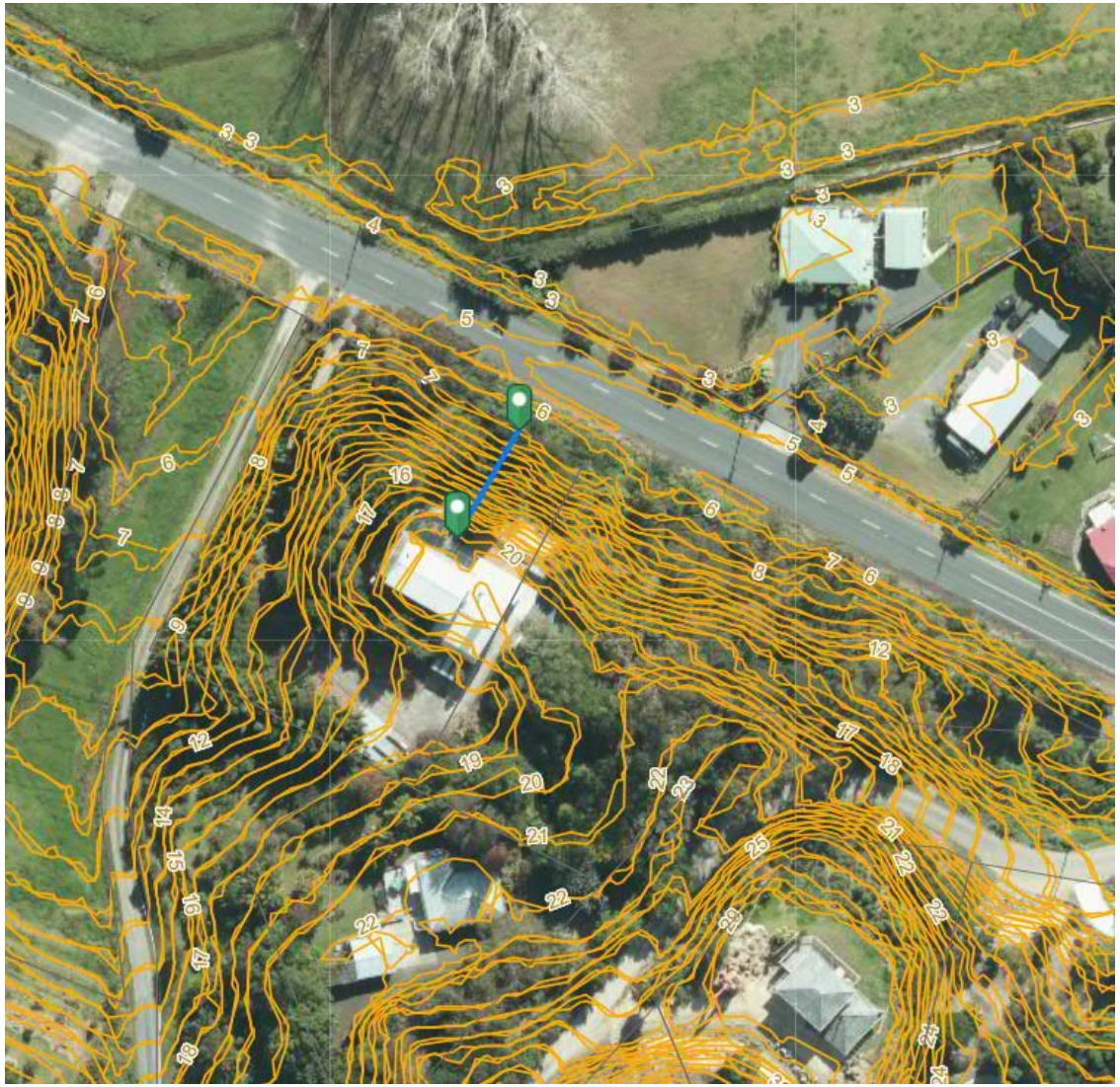
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
FILL			80	OB	1.5m casing						MH	M	S				CONCRETE, 100mm, non-reinforced Soft silty CLAY, some sand, some angular gravels, brown mottled yellow/light brown, moderate plasticity
OLD TOPSOIL ORGANIC FILL									0.5		MH	W	VS				- wood fragments, very soft, dark brown, organic SILT, trace clay, no plasticity, trace fine sand 0.5 - brown mottled light brown, clayey SILT, trace fine sand, trace organics, moderately plastic.
HIGH LEVEL COASTAL SANDS			90	OB					1.0			S W					1.0 Very soft, sandy SILT, some clay (dilatent), slight plasticity, light whitish grey orange mottles

6 - Dargaville

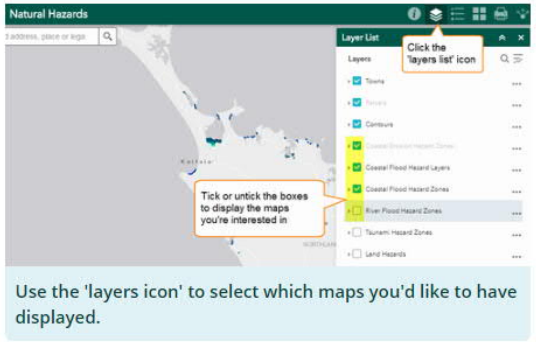




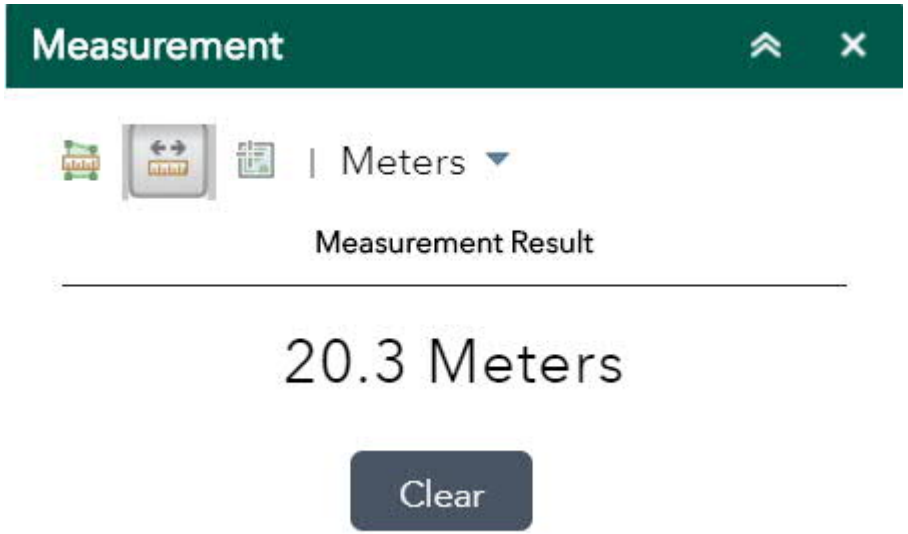
6 - Dargaville



Open the Flood and Coastal Hazards (Natural Hazards) maps

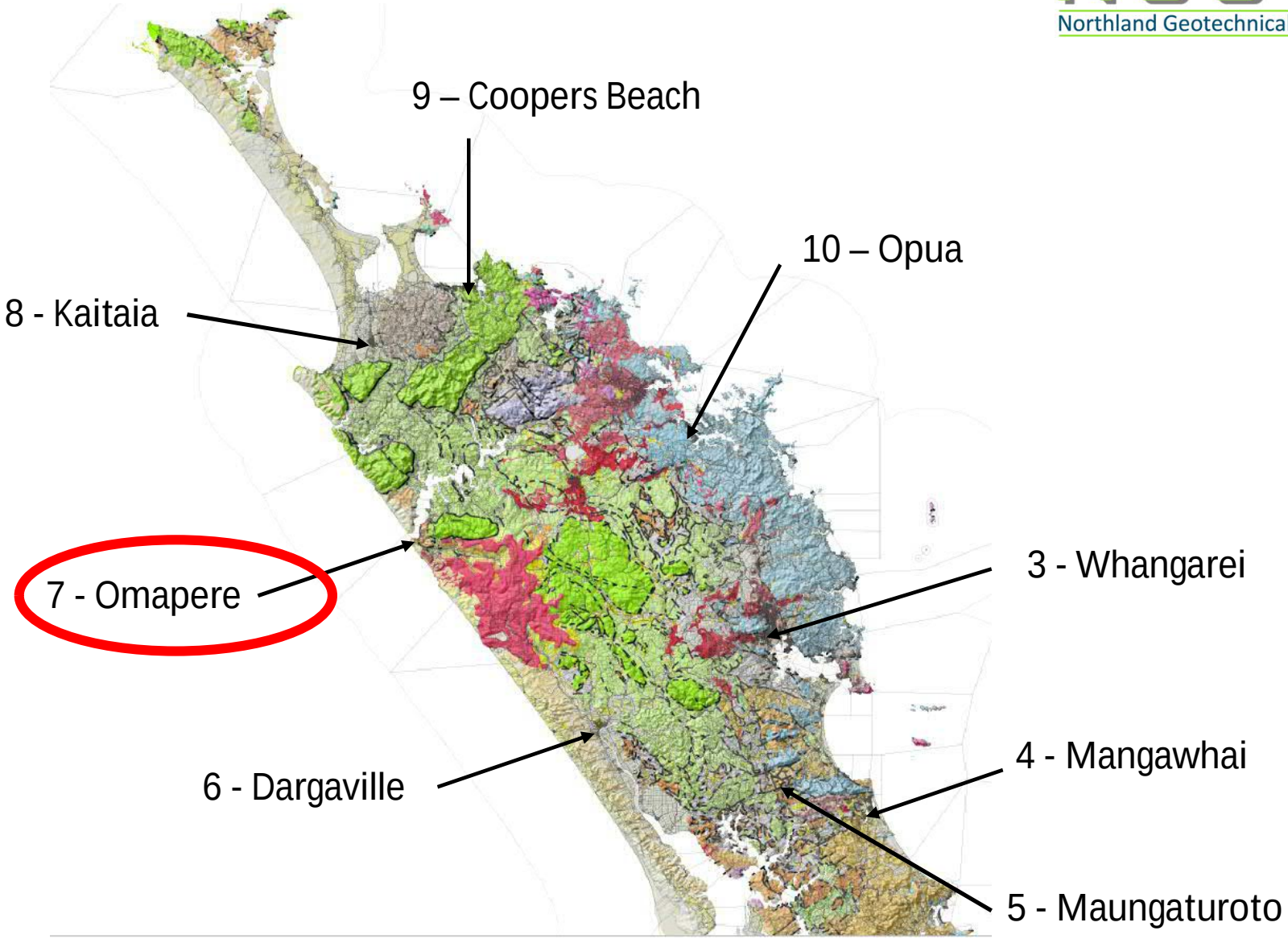


Use the 'layers icon' to select which maps you'd like to have displayed.



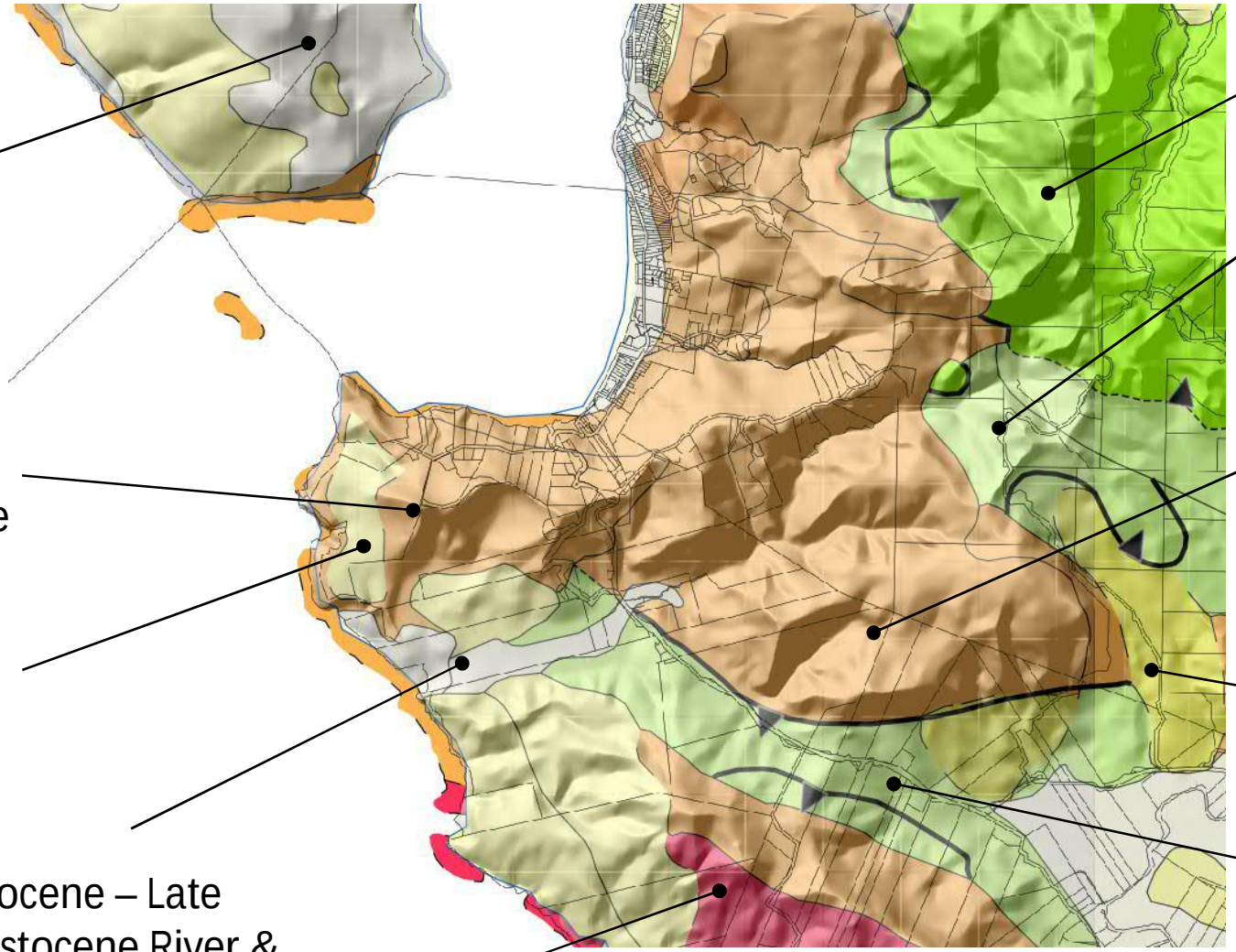
13m rise over 20m = 33° (1V:1.5H)

Northland


9 – Coopers Beach
10 – Opua
8 - Kaitaia
7 - Omapere
3 - Whangarei
6 - Dargaville
4 - Mangawhai
5 - Maungaturoto

7 - Omapere – Signal Station Road

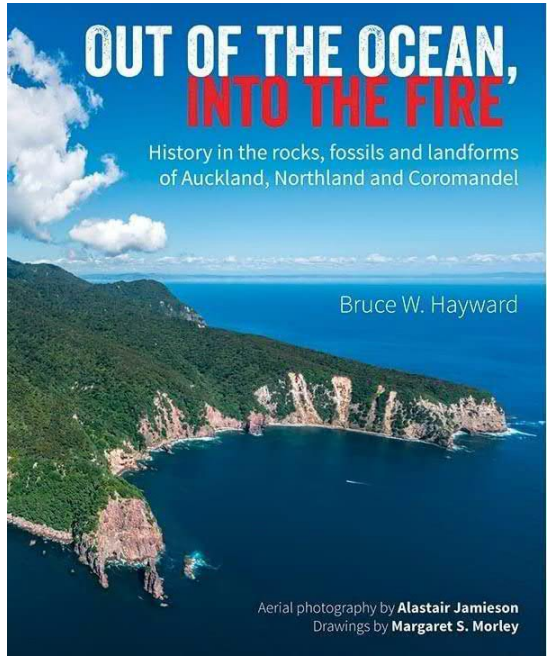
7 - Omapere – Signal Station Road

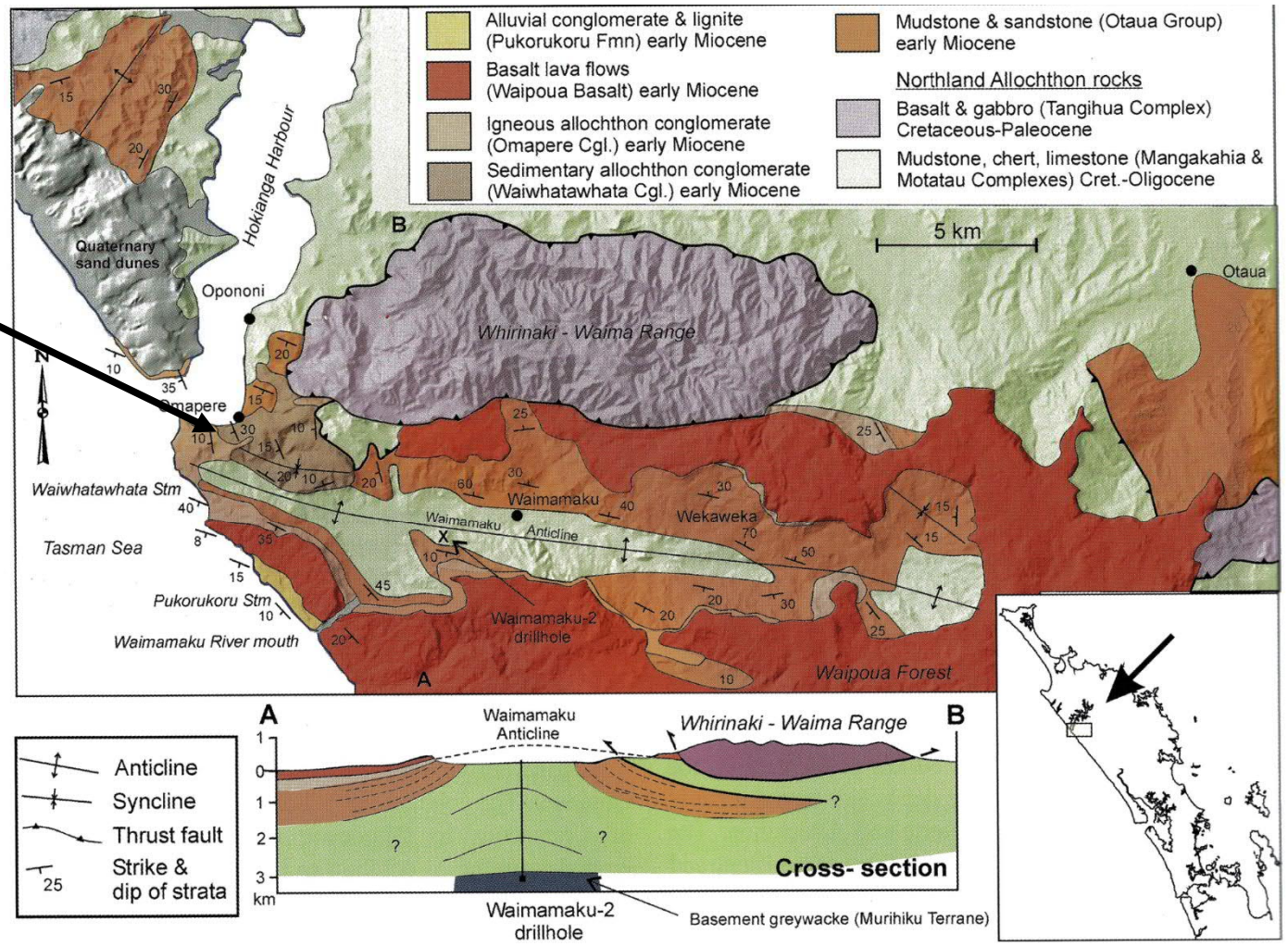


7 - Omapere – Signal Station Road

Location of interest

Figure from “Out of the Ocean, into the Fire”, Bruce W. Hayward, 2017





5.71 Geological map showing the surface distribution and structure of the Early Miocene Hokianga Basin rocks and their relationship to the underlying and sometimes overthrust Northland Allochthon rocks. A north-south cross-section of the inferred subsurface geology is shown (A-B). Modified from Hayward (1993) and Evans (1994).

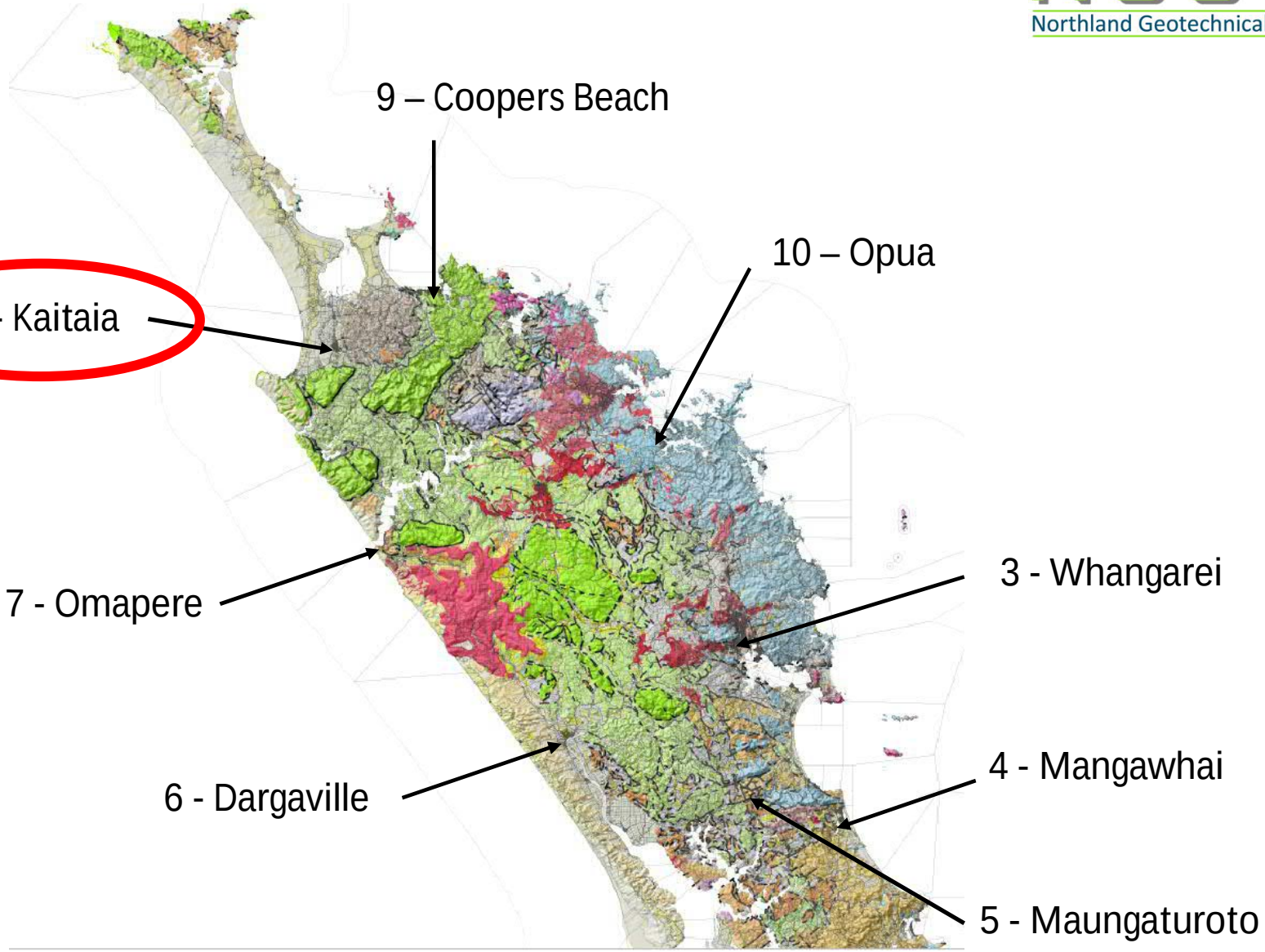
7 - Omapere – Signal Station Road

7 - Omapere – Signal Station Road

7 - Omapere – Signal Station Road

7 - Omapere – Signal Station Road

Northland


9 – Coopers Beach
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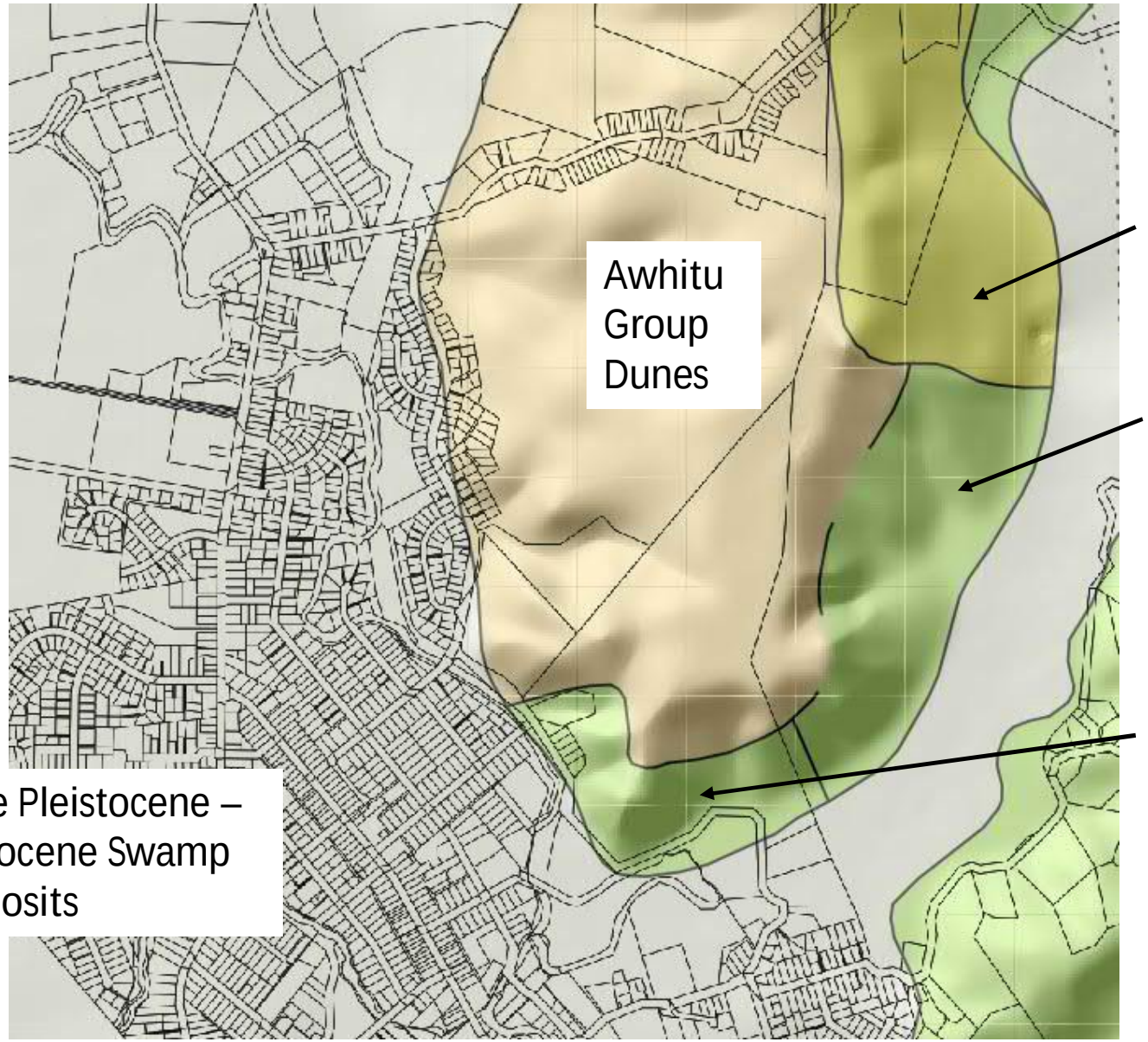
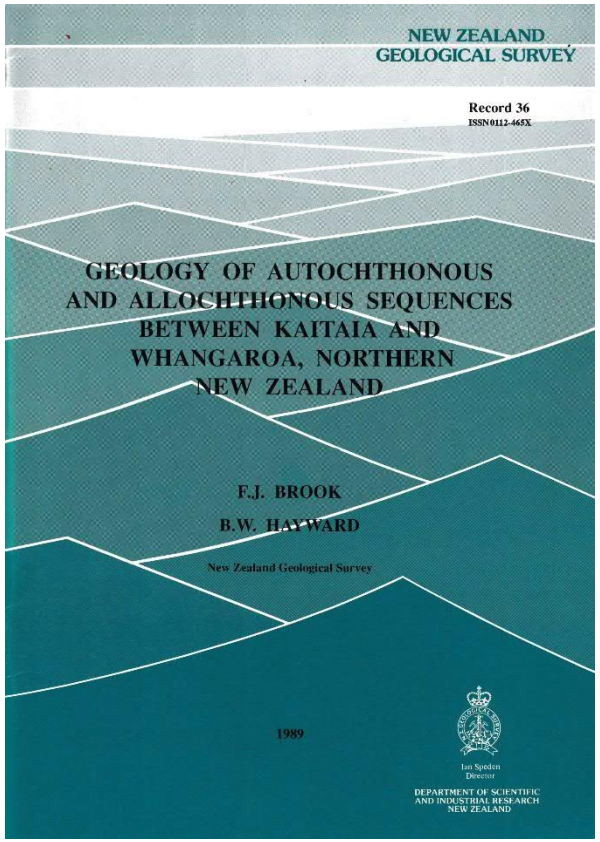
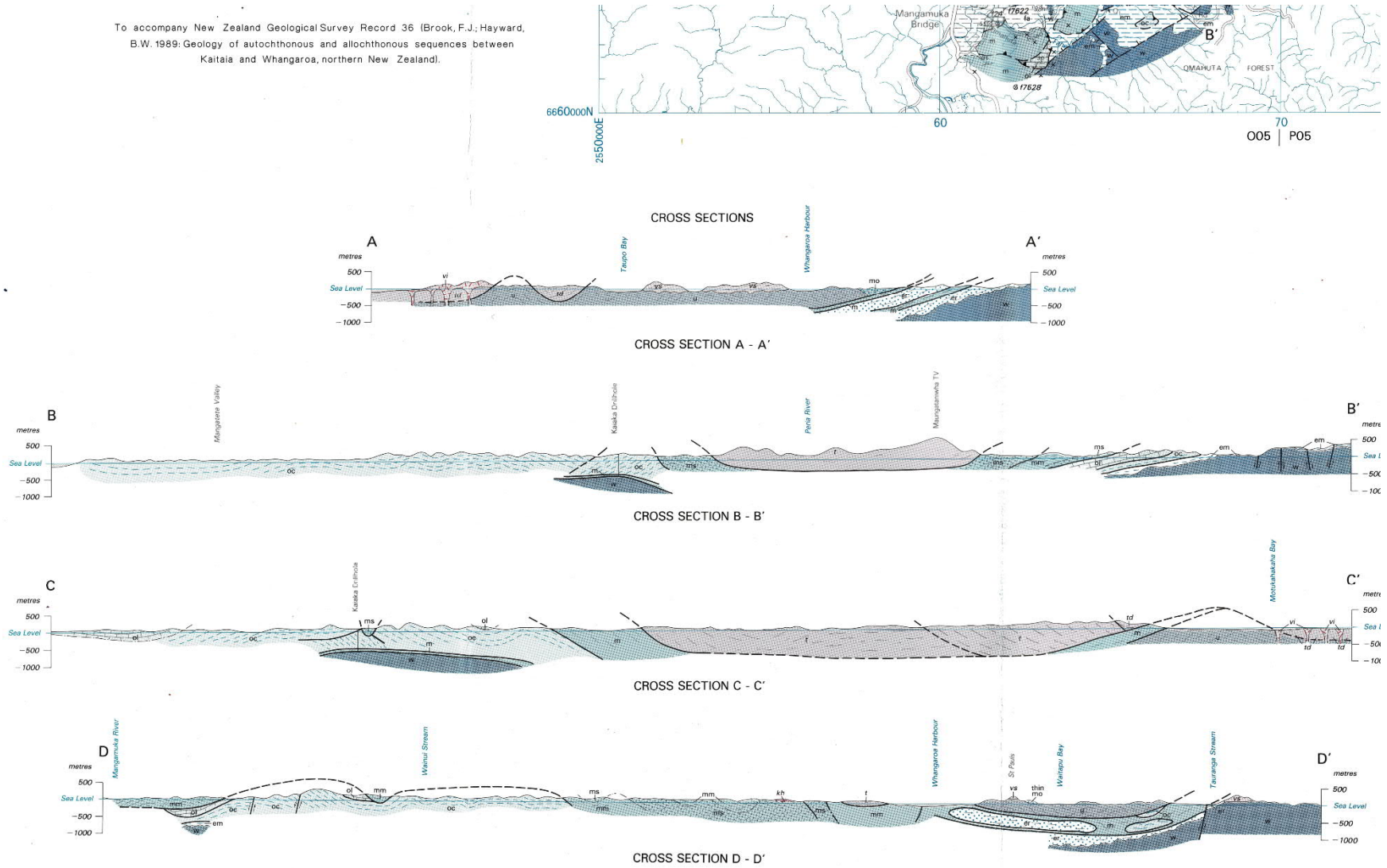
8 - Kaitaia

A 1:100,000 scale Kaitaia-Whangaroa map from DSIR 1989 is available. It was produced during efforts to “unravel” the Northland Allochthon. It maps the Allochthon and dunes as part of the Motatau Complex



8 - Kaitaia


NEW ZEALAND
GEOLOGICAL SURVEY
Record 36
ISSN 0112-465X
GEOLOGY OF AUTOCHTHONOUS AND ALLOCHTHONOUS SEQUENCES BETWEEN KAITAIA AND WHANGAROA, NORTHERN NEW ZEALAND
F.J. BROOK
B.W. HAYWARD
New Zealand Geological Survey
1989
Ian Speden
Director
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
NEW ZEALAND


To accompany New Zealand Geological Survey Record 36 (Brook, F.J.; Hayward, B.W. 1989: Geology of autochthonous and allochthonous sequences between Kaitaia and Whangaroa, northern New Zealand).
Mangamuka Bridge
B'
OMAHUTA FOREST
f7622
f7628
6660000N
2550000E
60
70
O05 | P05
CROSS SECTIONS
A
A'
metres
500
Sea Level
−500
−1000
Taupo Bay
Whangaroa Harbour
CROSS SECTION A - A'
B
B'
Mangatara Valley
Kaaika Drillhole
Pera River
Maungatamawha TV
CROSS SECTION B - B'
C
C'
Kaaika Drillhole
Motukahakaha Bay
CROSS SECTION C - C'
D
D'
Mangamuka River
Waihui Stream
Whangaroa Harbour
St Pauls
Waitapu Bay
Tauranga Stream
CROSS SECTION D - D'

8 - Kaitaia

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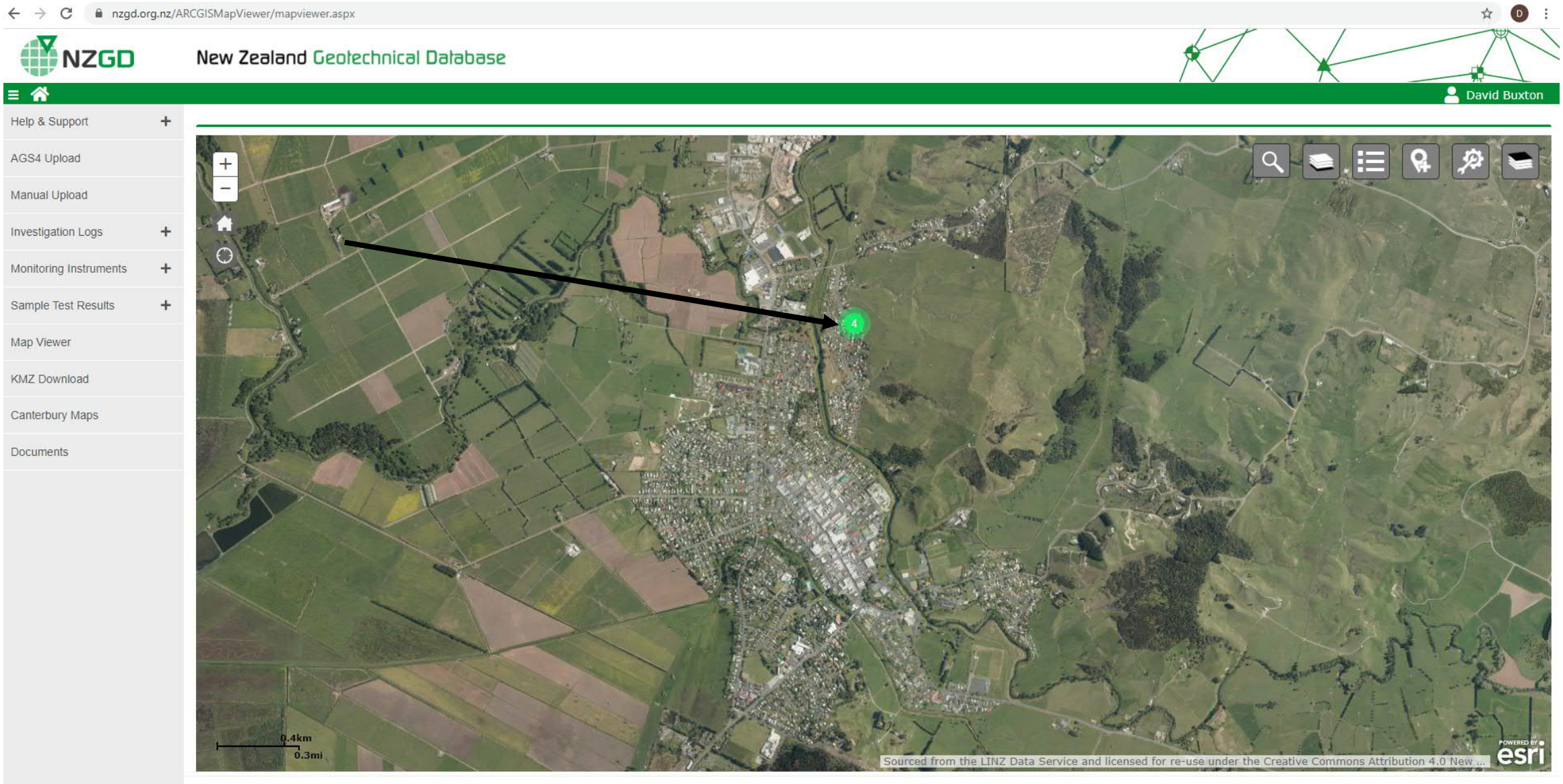

8 - Kaitaia

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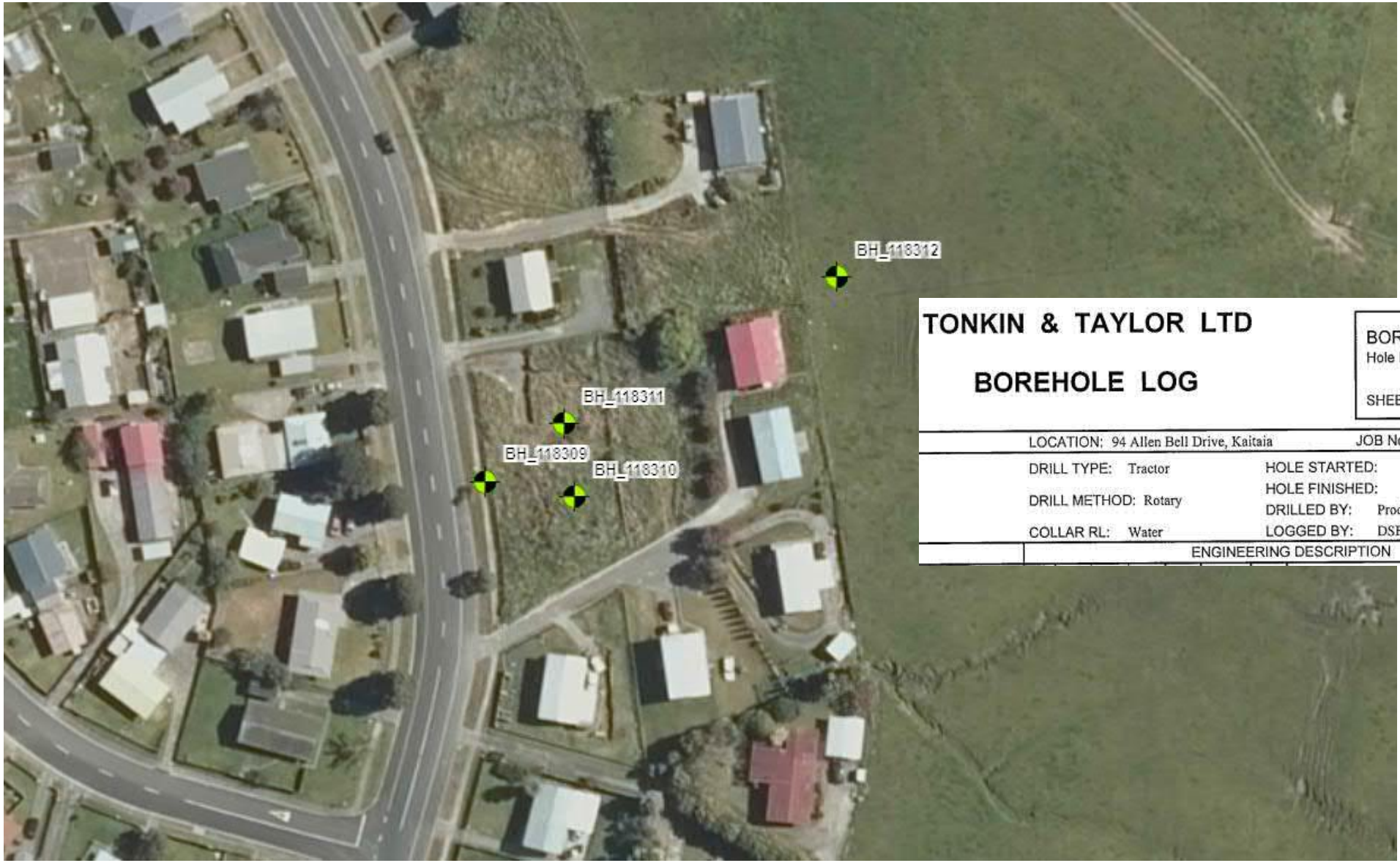

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH5
Hole Location: Paddock- headscarp
SHEET 1 OF 3

LOCATION: 94 Allen Bell Drive, Kaitaia		JOB No:	17600.001
DRILL TYPE: Tractor		HOLE STARTED:	20/2/07
DRILL METHOD: Rotary		HOLE FINISHED:	21/2/07
		DRILLED BY:	Prodrill
COLLAR RL: Water		LOGGED BY: DSBB	CHECKED: CMW

ENGINEERING DESCRIPTION

8 - Kaitaia


© 2020 Google
Image © 2020 CNES / Airbus
Imagery Date: 4/1/2


Image © 2020 Maxar Technologies
Imagery Date

8 - Kaitaia

NZGD ID: BH_118312

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH5
Hole Location: Paddock- headscarp
SHEET 1 OF 3

PROJECT: Geotechnical Investigation
LOCATION: 94 Allen Bell Drive, Kaitaia
JOB No: 17600.001
CO-ORDINATES mN mE
DRILL TYPE: Tractor
HOLE STARTED: 20/2/07
DRILL METHOD: Rotary
HOLE FINISHED: 21/2/07
R.L. m
DATUM
DRILLED BY: Prodrill
COLLAR RL: Water
LOGGED BY: DSBB CHECKED: CMW

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	DEPTH (m)	R.L. (m)	TESTS	CORE RECOVERY	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION / ROCK DESCRIPTION
COLLUVIUM	0			70% OB	OL	D	F	TOPSOIL, dark brown, organic, sandy silt.
					MH	M	St	Clayey SILT, orange/brown, with organics, dark brown mottles.
LANDSLIP DEBRIS	1			60% OB	MH	M	F/St	SILT CLAY, light brown orange, minor organics, moderately plastic, firm to stiff.
			1.5m on 20/02/2007				S	-light whitish grey with orange speckles, minor organics, soft.
	2		1 2 2 N=4	100% SPT				
				100% OB			F/St	-becoming light grey with orange speckles, 20mm thick, clay gouge. -clay gouge 30mm thick, light grey, dark grey mottles. -disturbed sandy silt clay, with blocks of extremely weak sandstone, greyish orange mottles.
LANDSLIP DEBRIS Shear zone- 2.8m to 4.0m 3.4 Shear Surface 40° backscarp	3		3 5 7 N=12	100% SPT				
NORTHLAND ALLOCHTHON							ExW	SILTSTONE/SANDSTONE, highly disturbed, blocky, disaggregates easily, grey, iron oxide staining. -light orange silt/clay mottles.
	4			70% OB	MH	D	St/VSt	SILT CLAY, grey, with siltstone/sandstone clasts, stiff to very stiff, some disturbance, occasional light brown mottles.
NORTHLAND ALLOCHTHON	5				MH	D	St/VSt	SILT CLAY, grey, with siltstone/sandstone clasts, stiff to very stiff, some disturbance,

BORELOG_TT 17600.001.GPJ 16/4/07

NZGD ID: BH_118312

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH5
Hole Location: Paddock- headscarp
SHEET 2 OF 3

PROJECT: Geotechnical Investigation
LOCATION: 94 Allen Bell Drive, Kaitaia
JOB No: 17600.001
CO-ORDINATES mN mE
DRILL TYPE: Tractor
HOLE STARTED: 20/2/07
DRILL METHOD: Rotary
HOLE FINISHED: 21/2/07
R.L. m
DATUM
DRILLED BY: Prodrill
COLLAR RL: Water
LOGGED BY: DSBB CHECKED: CMW

GEOLOGICAL / ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	DEPTH (m)	R.L. (m)	CORE RECOVERY	METHOD	SOIL DESCRIPTION / ROCK DESCRIPTION
	6		77% OB		occasional light brown mottles.
			50% HQTT		Fine SANDSTONE, light grey, very weak band 80mm within highly sheared siltstone/mudstone, extremely weak, disaggregates easily into fine gravel sized blocks.
	7		19% HQTT		NO RECOVERY. Lost core, re-drilled, limited core recovered cuttings appear to be similar to above.
Box 2	8		0% HQTT		NO RECOVERY.
	9		67% HQTT		SILTSTONE/MUDSTONE, highly sheared, in a silt clay matrix, dark grey, light grey mottled, polished surfaces.
					150mm thick highly fractured fine well cemented SANDSTONE, grey.
					As at 9.0m, blocky sandstone inclusions.
NORTHLAND ALLOCHTHON	10		100% HQTT		SILTSTONE/MUDSTONE, highly sheared, in a silt clay matrix, dark grey, light grey mottled, polished surfaces.
					-70mm thick blocky fine SANDSTONE,

BORELOG_TT 17600.001.GPJ 16/4/07

NZGD ID: BH_118312

Geotechnical Specialists

8 - Kaitaia


1364/9
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A/15
3675
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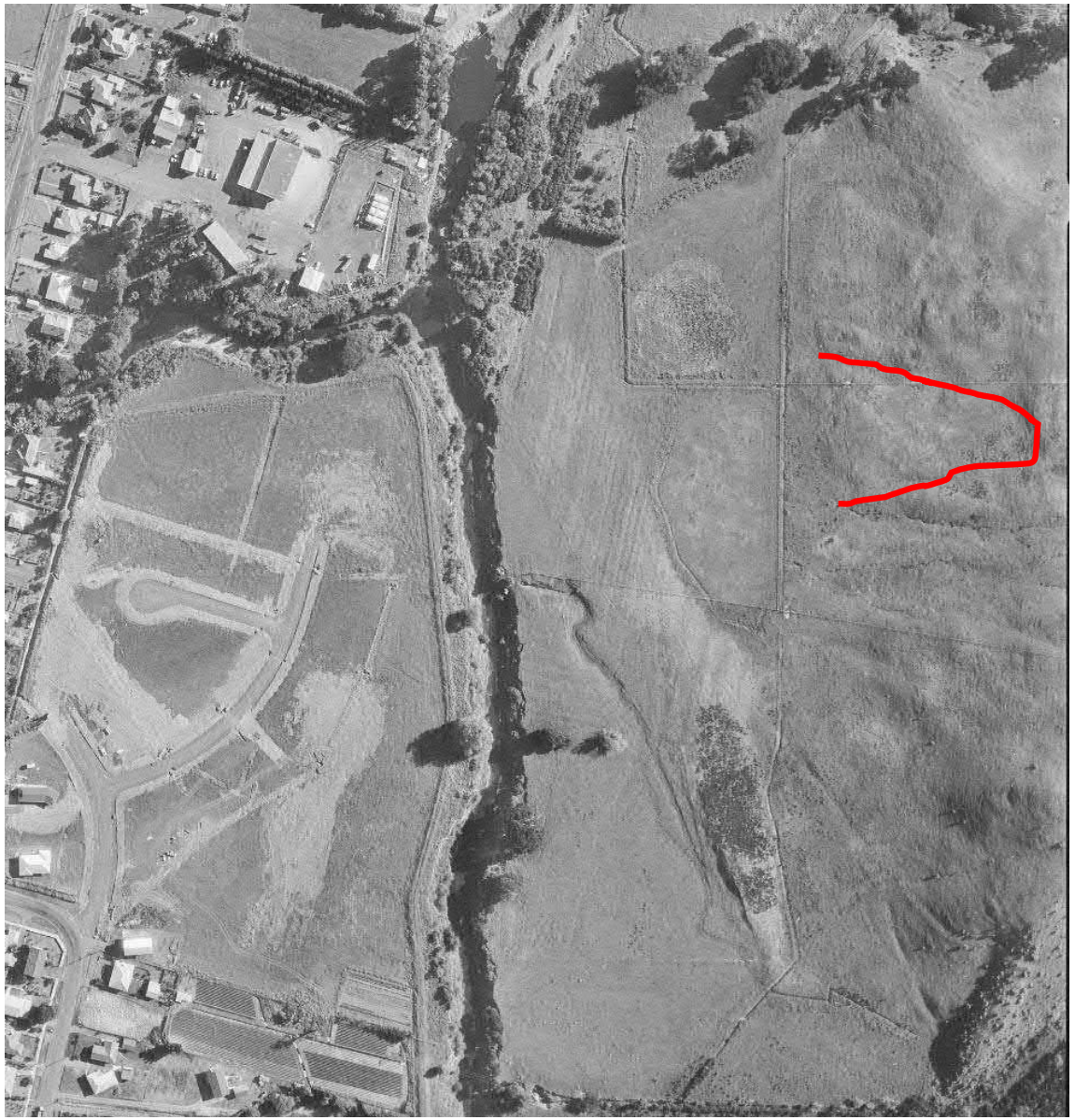
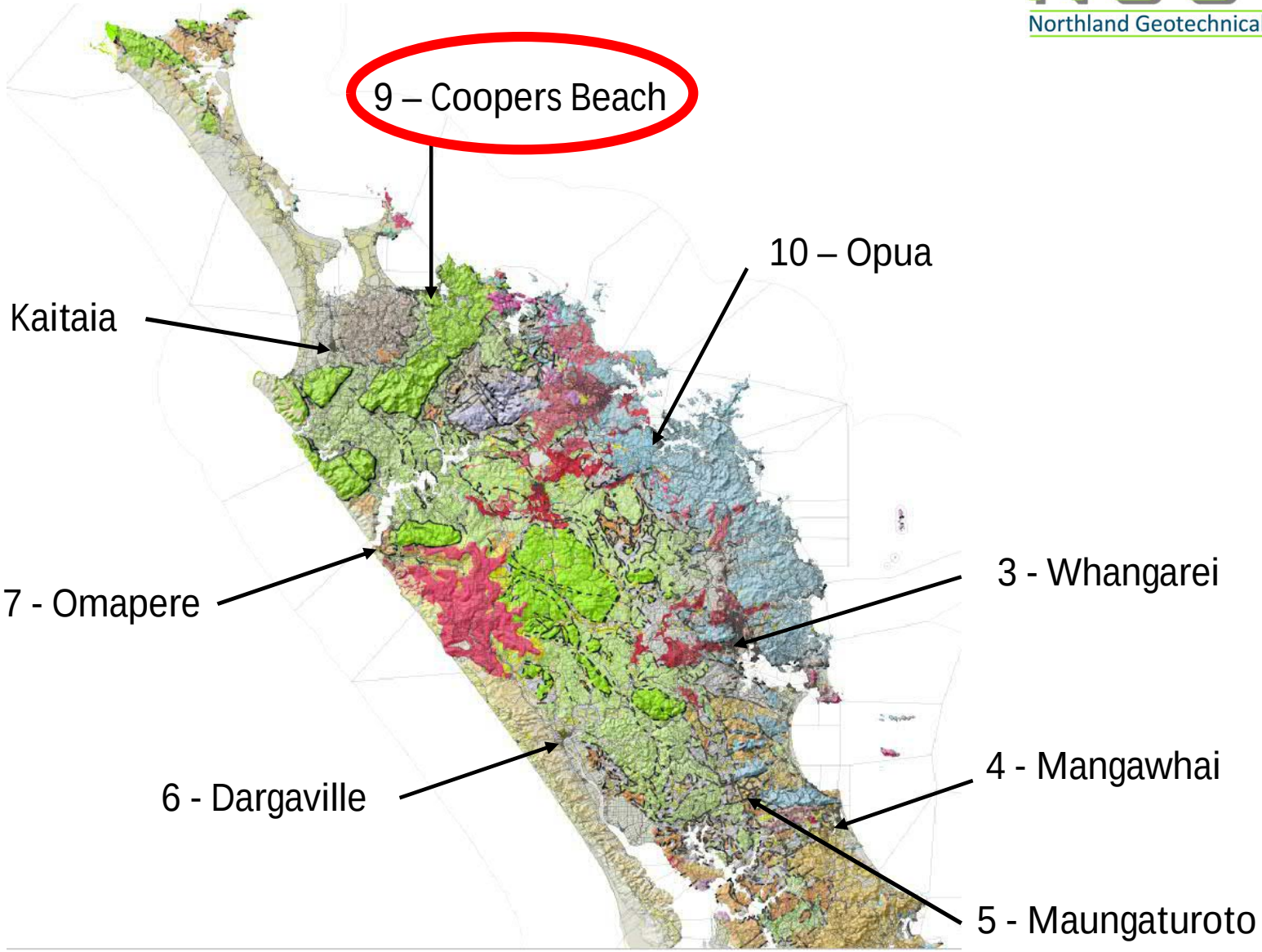
8 - Kaitaia



Northland


9 – Coopers Beach
10 – Opua
8 - Kaitaia
7 - Omapere
3 - Whangarei
6 - Dargaville
4 - Mangawhai
5 - Maungaturoto

9 - Coopers Beach

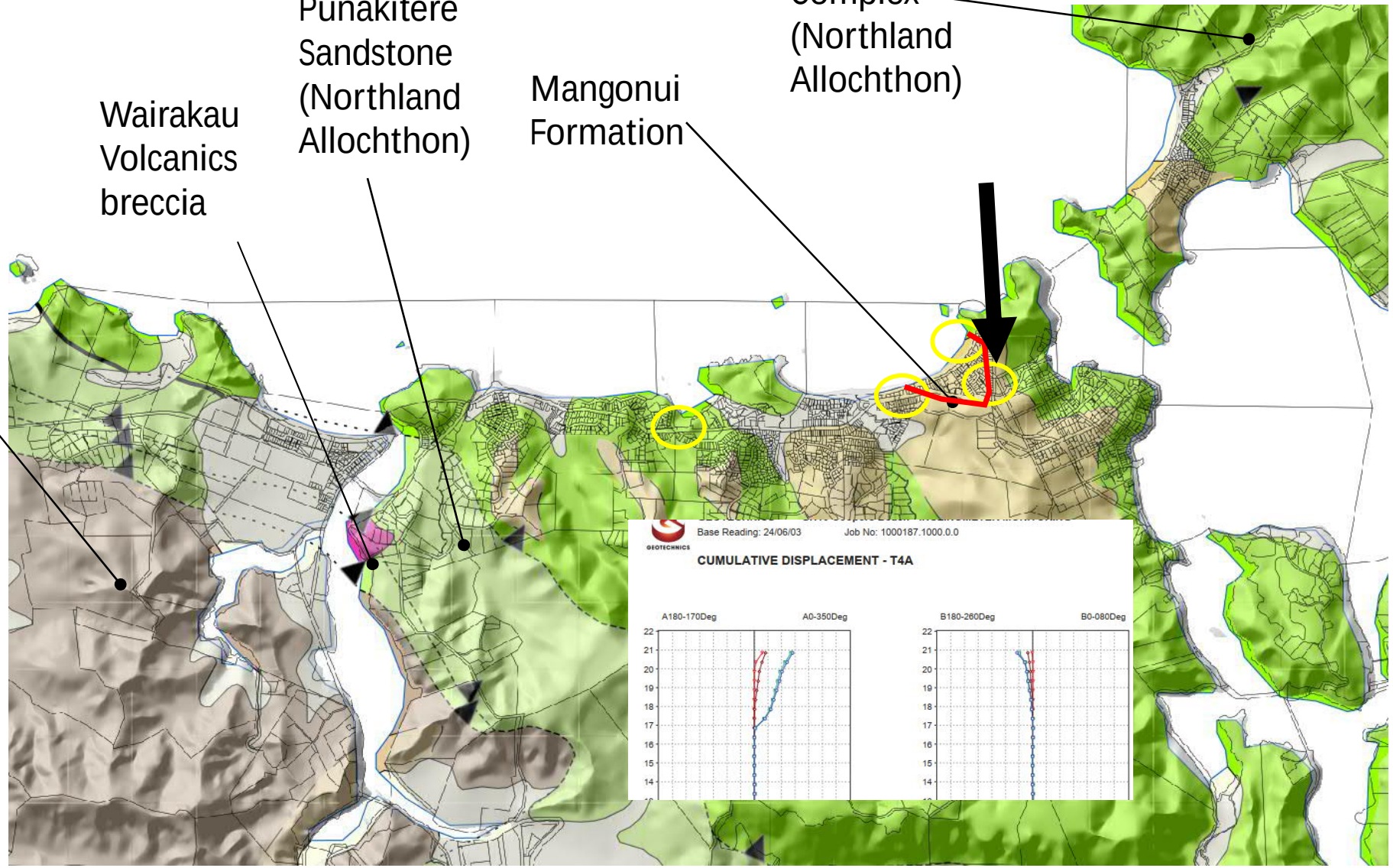
Tangihua Complex (Northland Allochthon)

Punakitere Sandstone (Northland Allochthon)

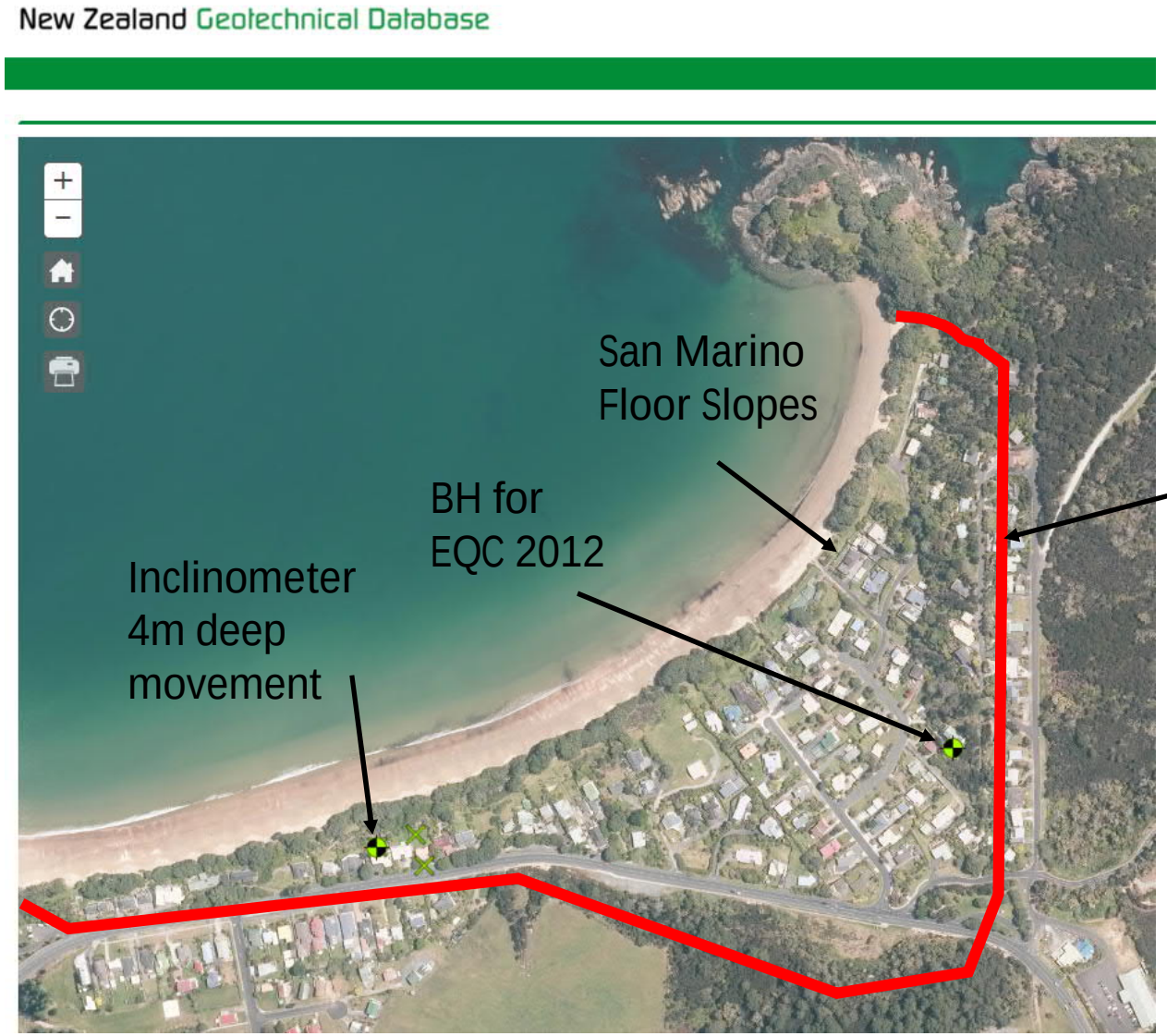
Mangonui Formation

Wairakau Volcanics breccia

Taipa Mudstone (Northland Allochthon)



9 - Coopers Beach



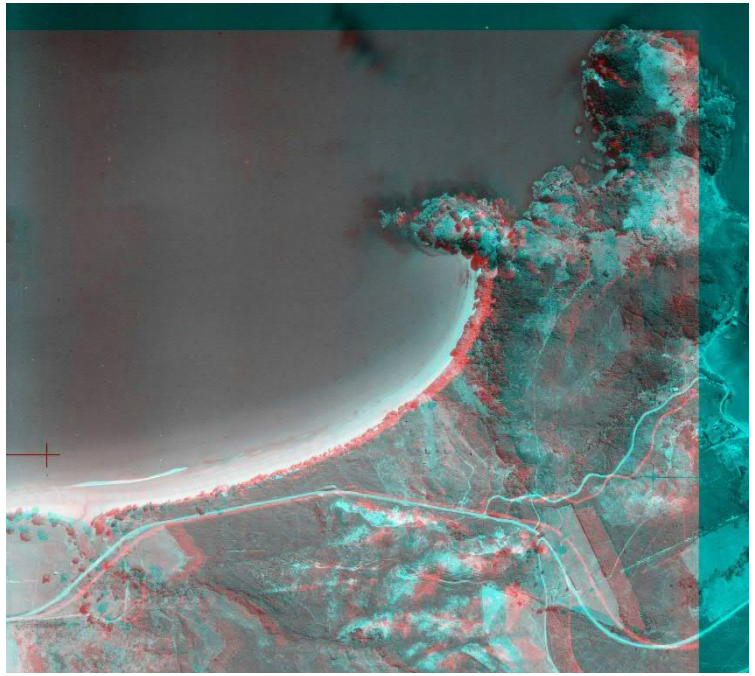
Coopers Beach Landslip as suggested by T+T, review by GNS – report available.

9 - Coopers Beach

Aerials Reviewed from:
1948
1970
1972
1976
1977
1981

1966 photos have good resolution but no overlap.

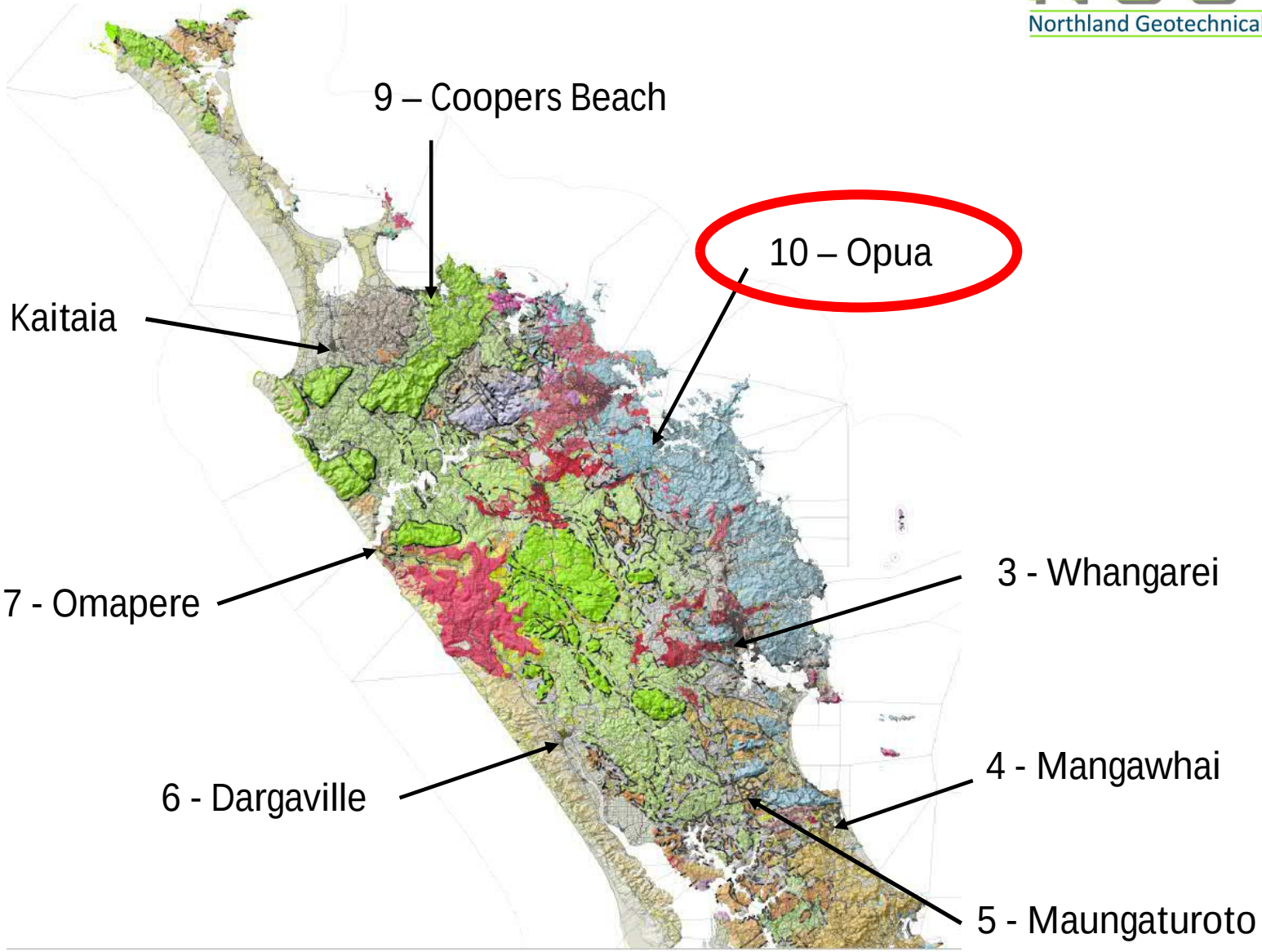
1948 Aerials provide the best viewing and are used for mapping of landslip scarp features.



9 -Coopers Beach

Possible landslip scarp features to East of Coopers Beach

Northland


9 – Coopers Beach
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3 - Whangarei
6 - Dargaville
4 - Mangawhai
5 - Maungaturoto

10 - Opua – Hihitahi Rise

Landslide and legal loophole strand families

13 May, 2012 5:30am

7 minutes to read

Leonie Brittain, husband Chris and son, Ja
Commission says they cannot build on. Ph

Herald on Sunday

As Is Where Is

A large four bedroom plus office home on a corner site in Te Haumi. Large family bathroom and master en-suite. Open plan kitchen and dining stepping down to a lower level lounge. Single garage.
The total home is in need of an internal and external make over. However, 230 square metres is a lot of home. There is a letter on file from the FNDC, which any intending purchaser should view, regarding the property. This is all reflected in the asking price.

FEATURES

Secure Parking

The subdivision where the Brittain family were to build their dream home is sliding down the hill, and nobody will accept responsibility. Their battle with bureaucracy reveals thousands of families could be equally vulnerable when they try to fulfil the Kiwi dream: building homes for their families. *Susan Edmunds* reports.

nzherald.co.nz/residential-property/news/article.cfm?c_id=76&objectid=10805458

Slow-moving slip forces people out of Paihia homes

Josh Fagan · 10:51, Feb 26 2015

Council: slip is private matter for insurers

05:00, Aug 07 2014

Property Snapshot

4 2 1

Property Type:
House

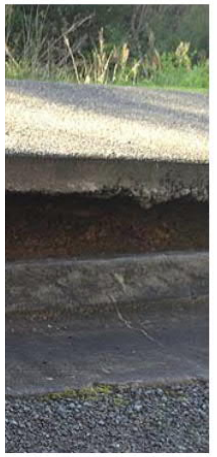
Land Area:
702 m²

House Size:
230.00 m²

Print Brochure

Send to friend

Notify me of updates to this property



seated landslip.

showed that the
d, rock mass failure
that cannot be economically stabilised by individual landowners.

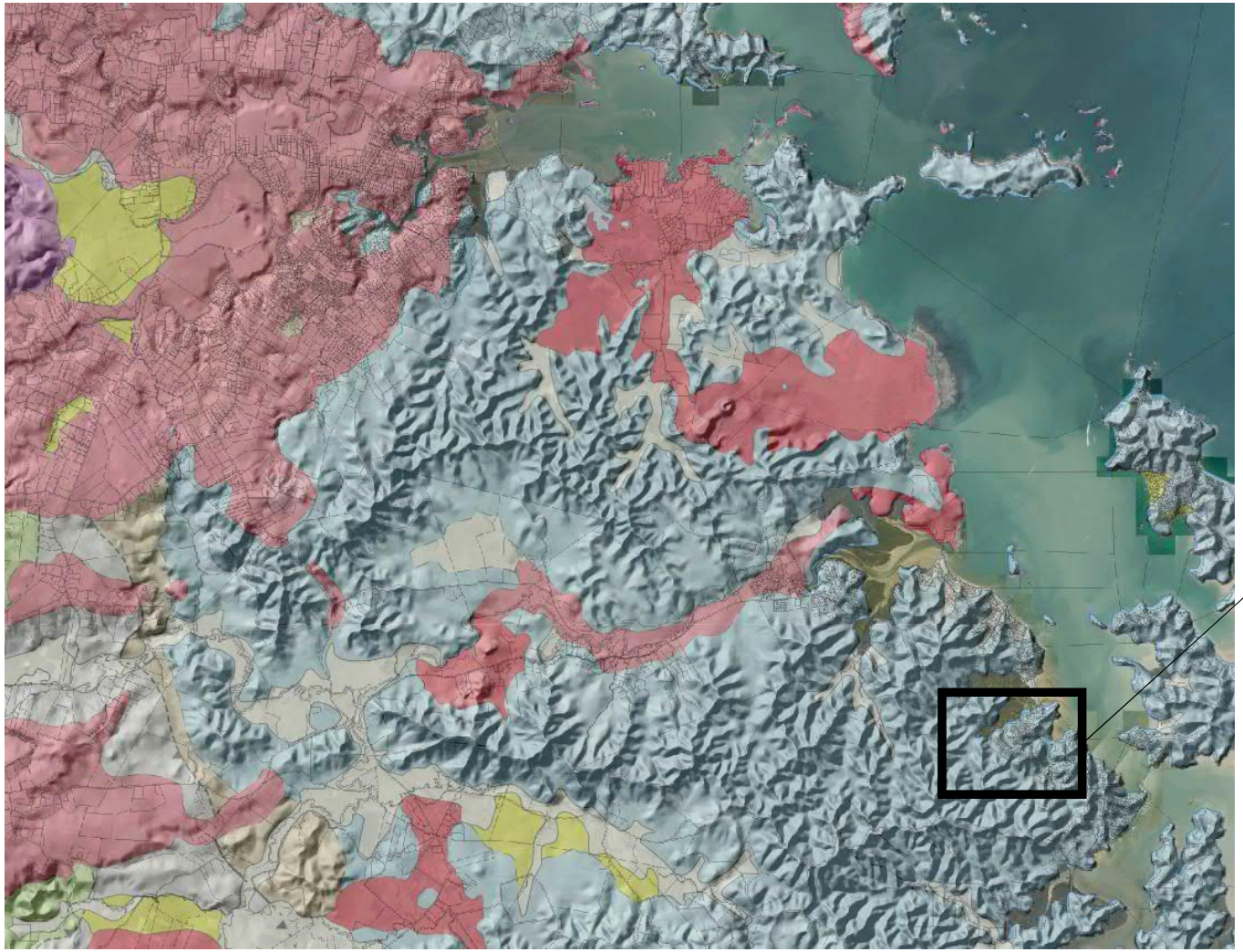
The advice given to EQC in 2005 was to write all the properties off.

Rogers says the problem has the potential to grow larger.

A 50m borehole, properly logged, and with downhole defect orientation equipment, will be needed to get to the bottom of it, he says.

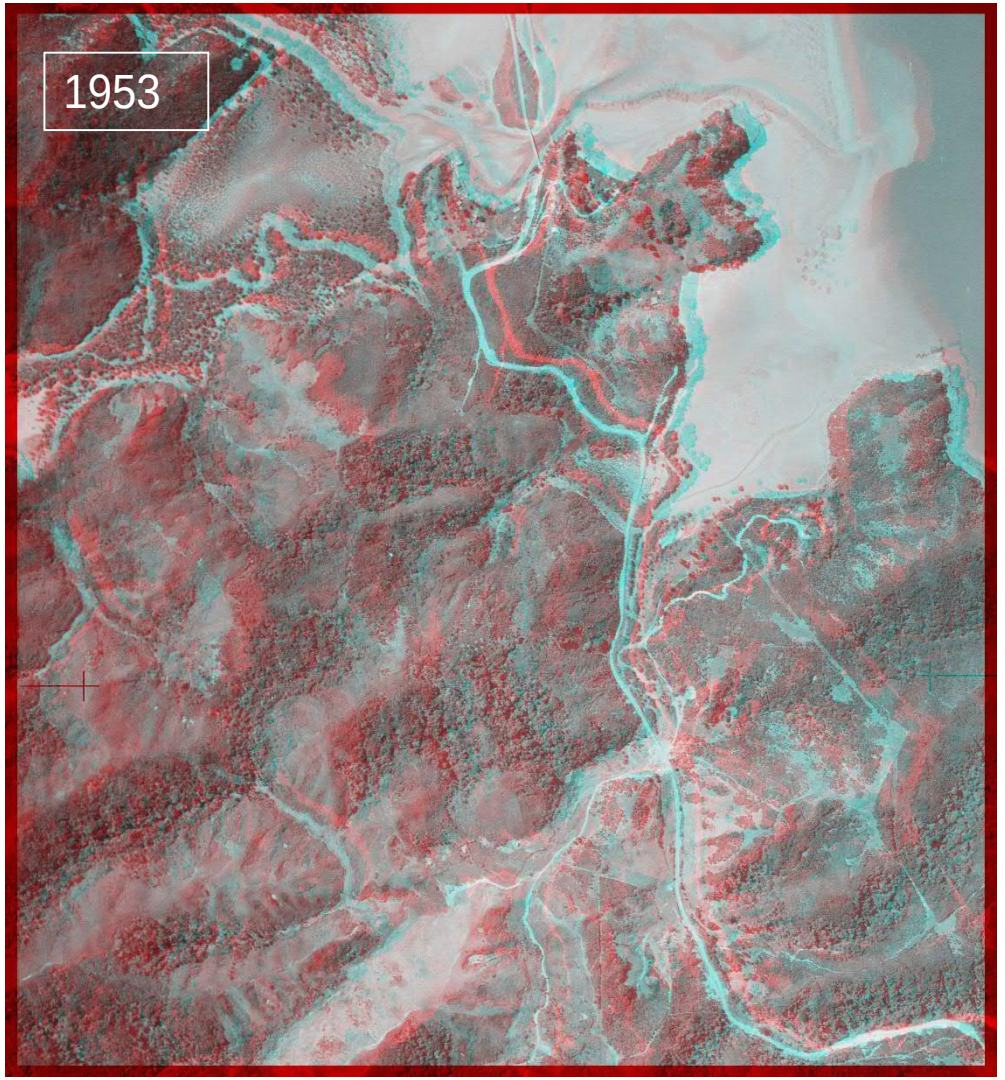
stuff.co.nz/auckland/local-news/northland/bay-chronicle/10354308/Council-slip-is-private-matter-for-insurers

10 - Opua – Hihitahi Rise

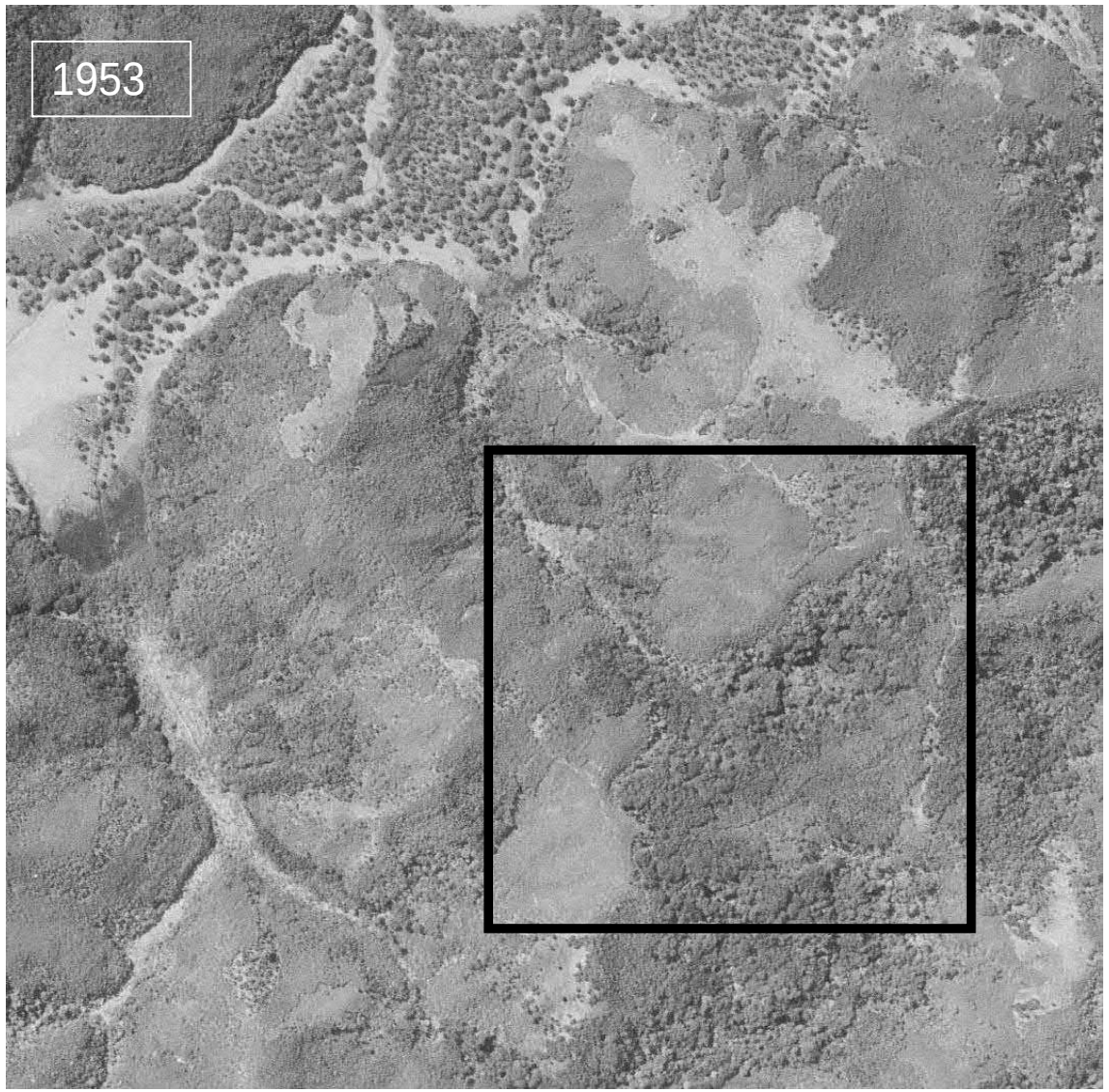


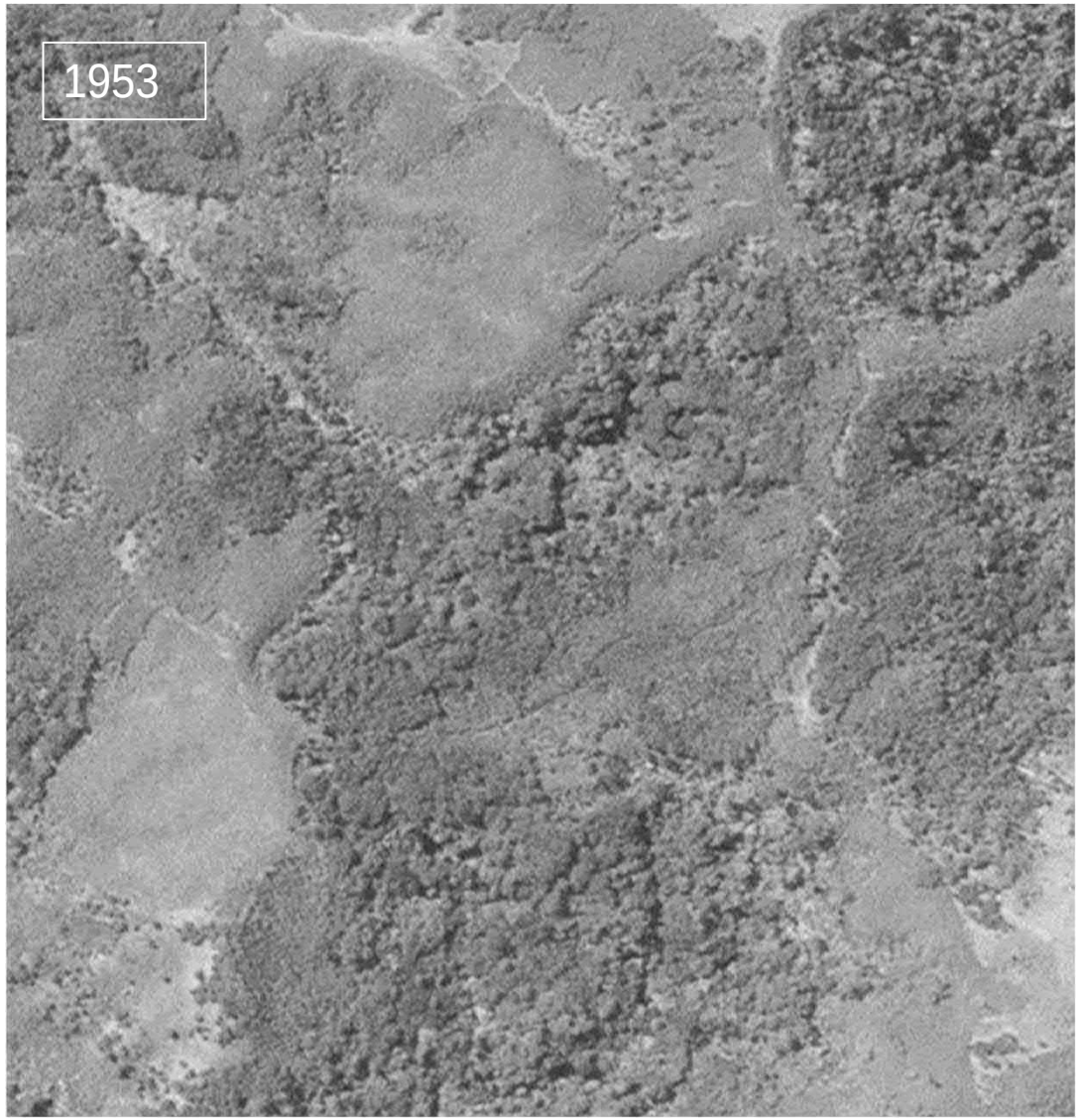
10 - Opua – Hihitahi Rise

As red-blue anagram

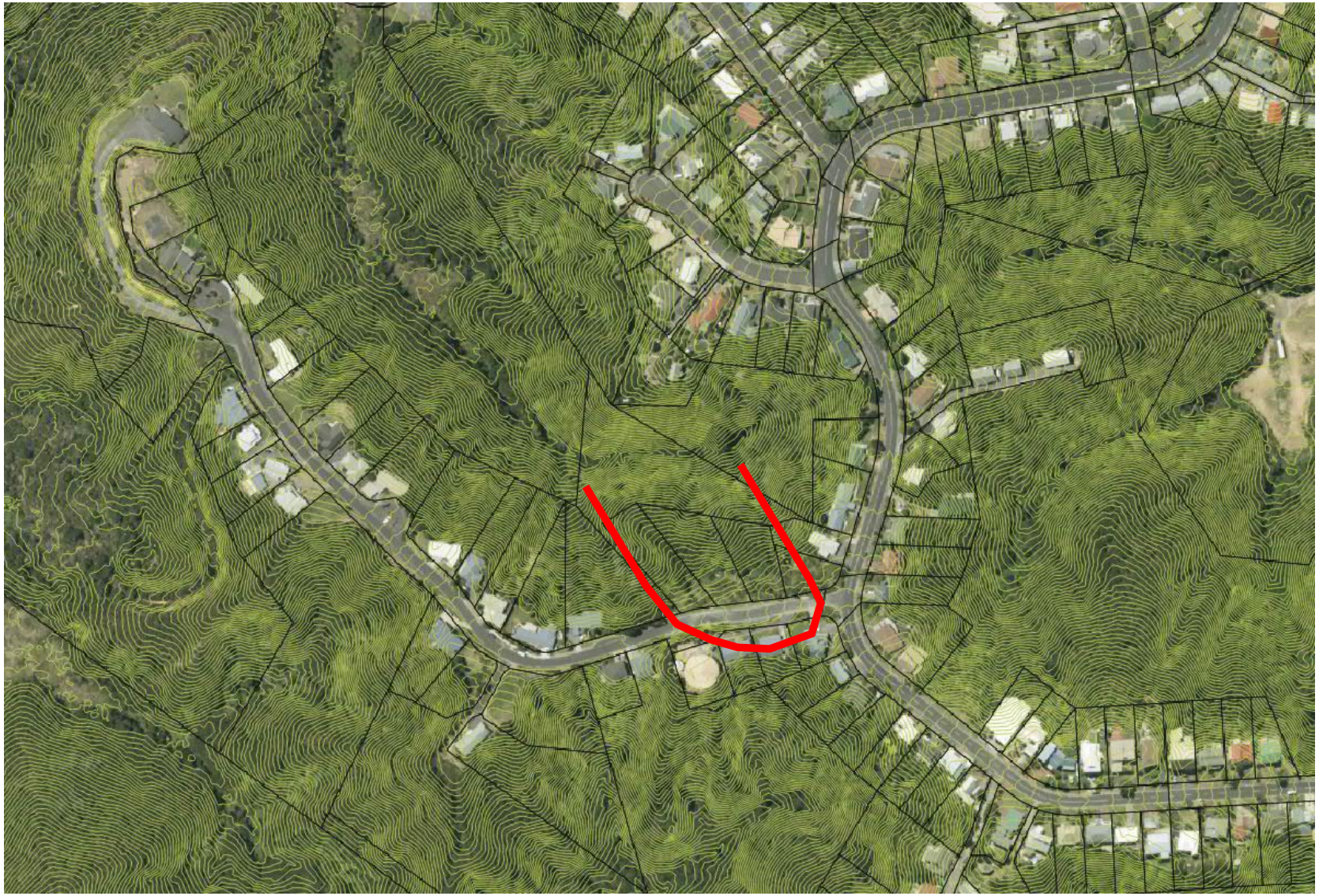


10 - Opua – Hihitahi Rise

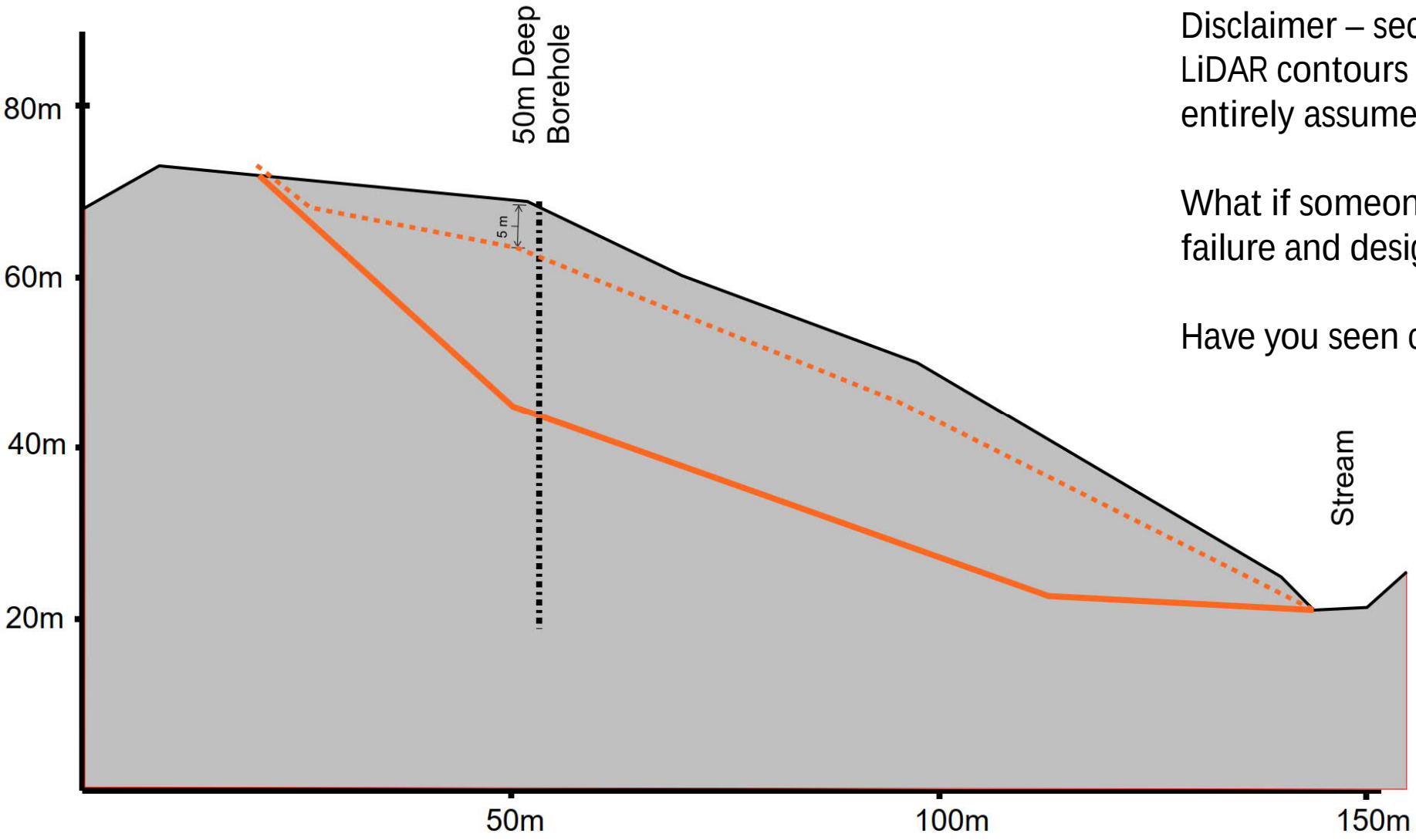




10 - Opua – Hihitahi Rise



10 - Opua – Hihitahi Rise



Disclaimer – section is indicative only. LiDAR contours but slip surface etc. entirely assumed.

What if someone had assumed shallow failure and designed remediation?

Have you seen cantilever walls fail?

10 - Opua – Hihitahi Rise

QGIS

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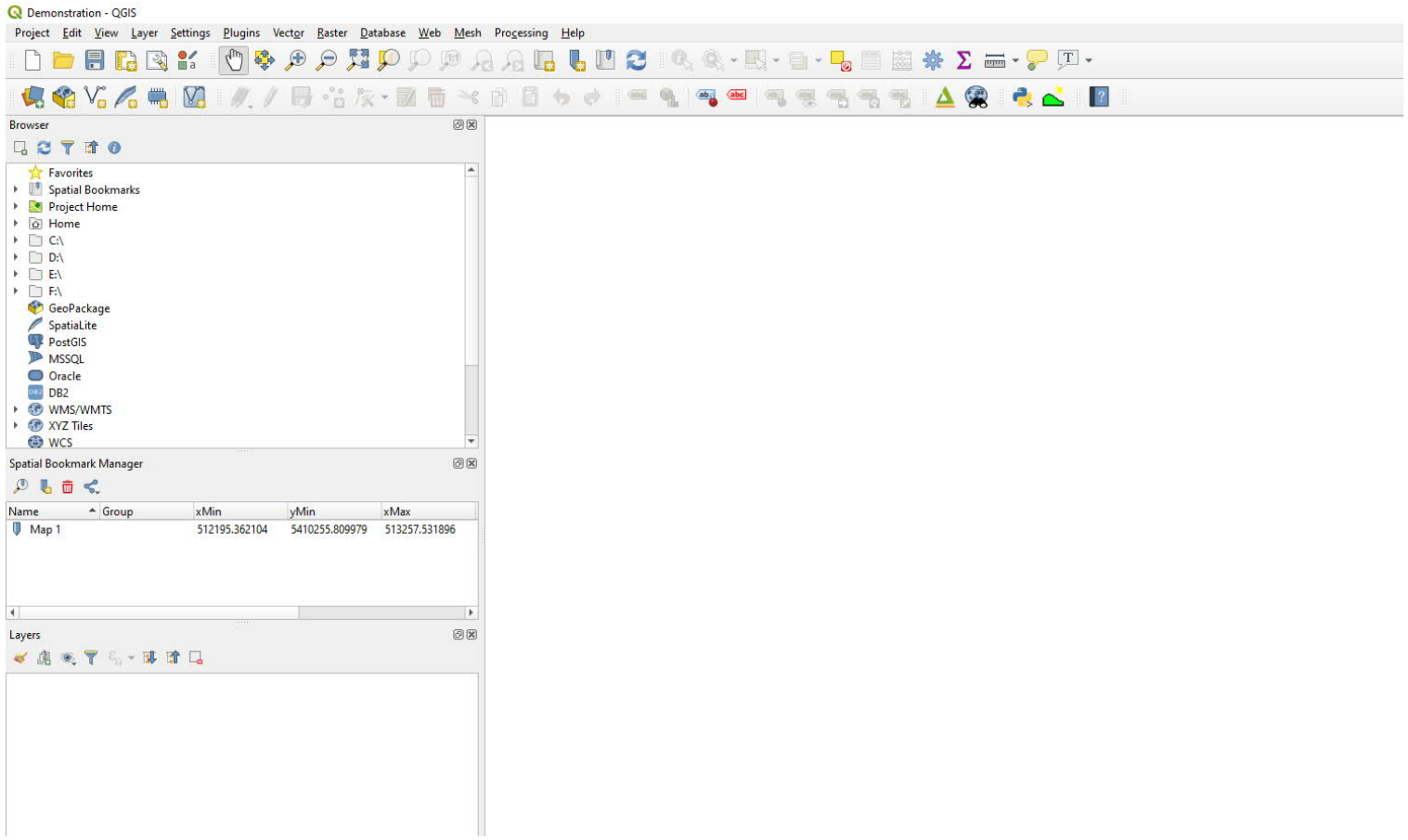

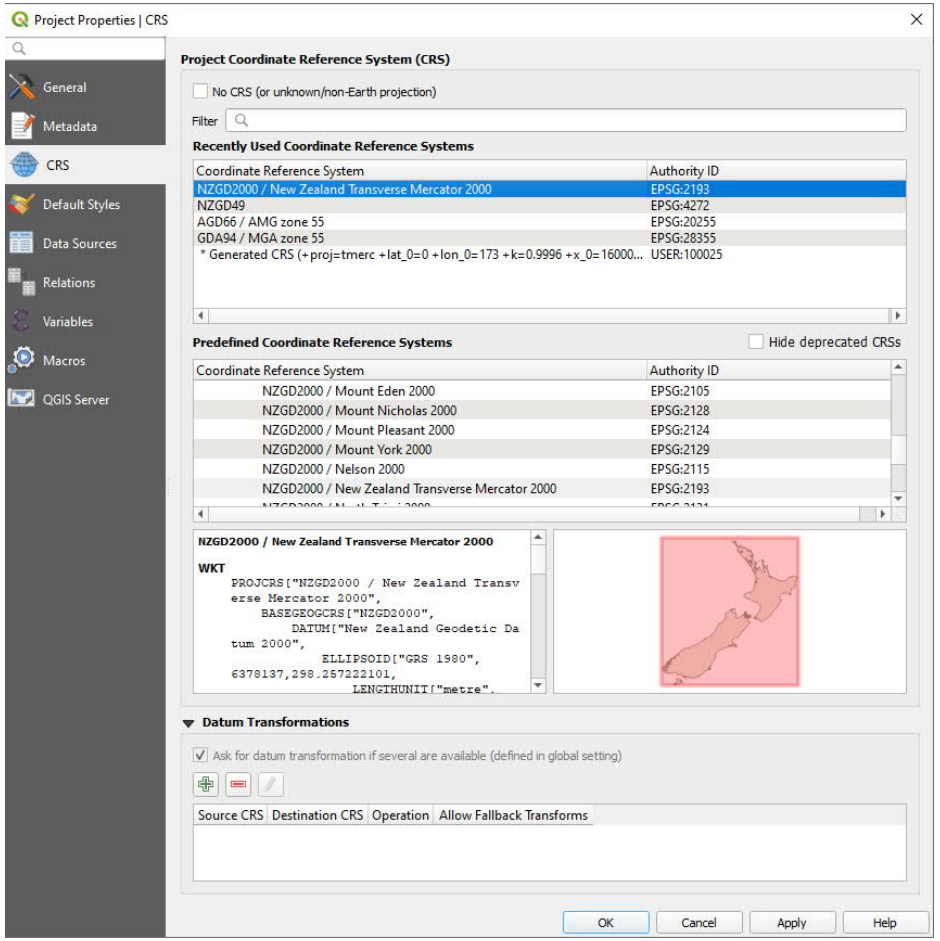

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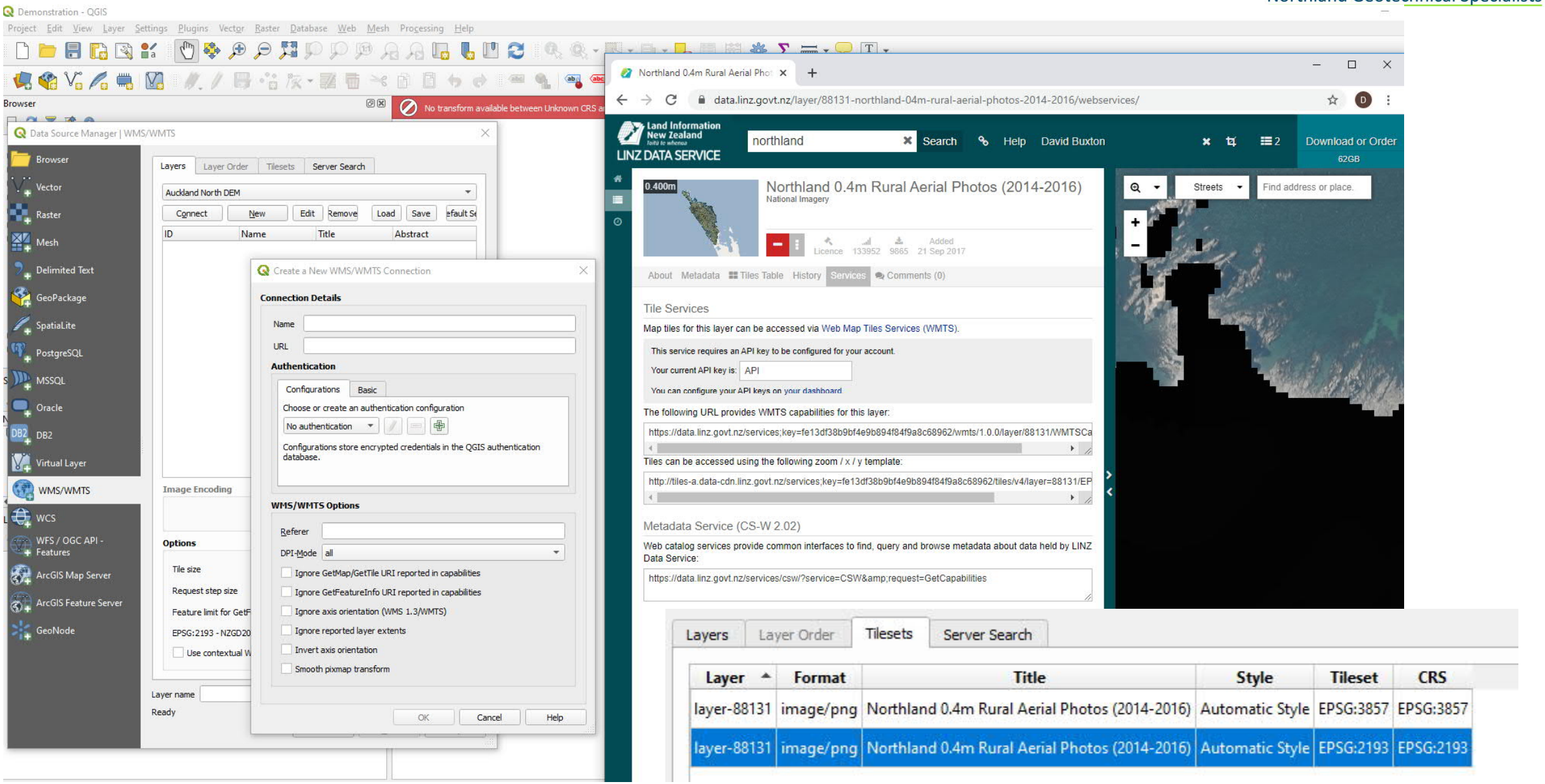
Demonstration - QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Mesh Processing Help
Browser
Data Source Manager | WMS/WMTS
Browser
Vector
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Delimited Text
GeoPackage
SpatiaLite
PostgreSQL
MSSQL
Oracle
DB2
Virtual Layer
WMS/WMTS
WCS
WFS / OGC API - Features
ArcGIS Map Server
ArcGIS Feature Server
GeoNode
Layers
Layer Order
Tilesets
Server Search
Auckland North DEM
Connect
New
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Remove
Load
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ID
Name
Title
Abstract
Image Encoding
Options
Tile size
Request step size
Feature limit for GetF
EPSG:2193 - NZGD20
Use contextual W
Layer name
Ready
Create a New WMS/WMTS Connection
Connection Details
Name
URL
Authentication
Configurations
Basic
Choose or create an authentication configuration
No authentication
Configurations store encrypted credentials in the QGIS authentication database.
WMS/WMTS Options
Referer
DPI-Mode
all
Ignore GetMap/GetTile URI reported in capabilities
Ignore GetFeatureInfo URI reported in capabilities
Ignore axis orientation (WMS 1.3/WMTS)
Ignore reported layer extents
Invert axis orientation
Smooth pixmap transform
OK
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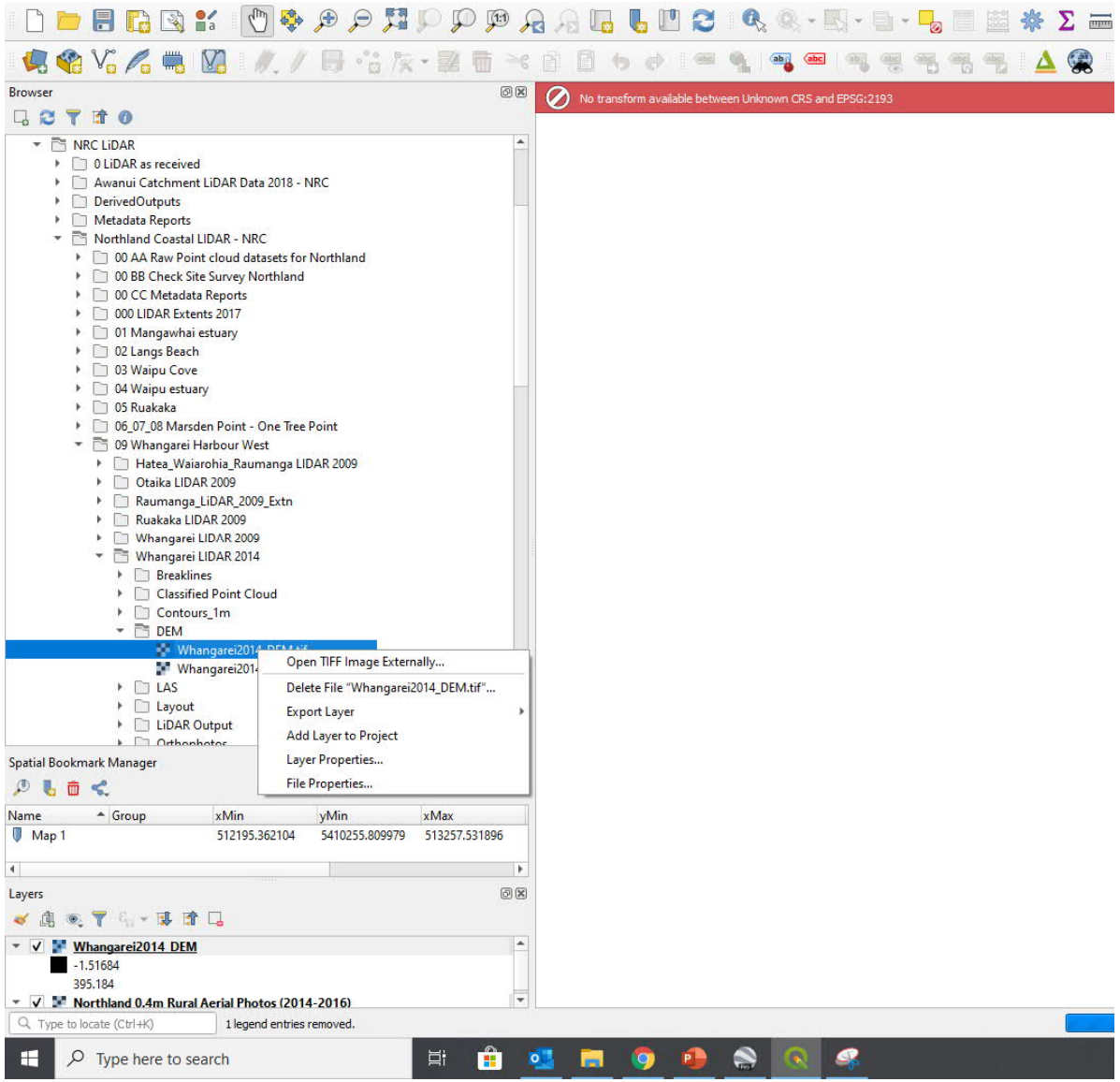
Help
Northland 0.4m Rural Aerial Pho
data.linz.govt.nz/layer/88131-northland-04m-rural-aerial-photos-2014-2016/webservices/
Land Information New Zealand
LINZ DATA SERVICE
northland
Search
Help
David Buxton
Download or Order
62GB
0.400m
Northland 0.4m Rural Aerial Photos (2014-2016)
National Imagery
Licence
133952
9865
Added
21 Sep 2017
About
Metadata
Tiles Table
History
Services
Comments (0)
Tile Services
Map tiles for this layer can be accessed via Web Map Tiles Services (WMTS).
This service requires an API key to be configured for your account.
Your current API key is:
API
You can configure your API keys on your dashboard.
The following URL provides WMTS capabilities for this layer:
https://data.linz.govt.nz/services;key=fe13df38b9bf4e9b894f84f9a8c68962/wmts/1.0.0/layer/88131/WMTSCa
Tiles can be accessed using the following zoom / x / y template:
http://tiles-a.data-cdn.linz.govt.nz/services;key=fe13df38b9bf4e9b894f84f9a8c68962/tiles/v4/layer=88131/EP
Metadata Service (CS-W 2.02)
Web catalog services provide common interfaces to find, query and browse metadata about data held by LINZ Data Service:
https://data.linz.govt.nz/services/csw/?service=CSW&request=GetCapabilities
Streets
Find address or place.
Layers
Layer Order
Tilesets
Server Search
Layer
Format
Title
Style
Tileset
CRS
layer-88131
image/png
Northland 0.4m Rural Aerial Photos (2014-2016)
Automatic Style
EPSG:3857
EPSG:3857
layer-88131
image/png
Northland 0.4m Rural Aerial Photos (2014-2016)
Automatic Style
EPSG:2193
EPSG:2193

QGIS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NRC LiDAR
0 LiDAR as received
Awanui Catchment LiDAR Data 2018 - NRC
DerivedOutputs
Metadata Reports
Northland Coastal LIDAR - NRC
00 AA Raw Point cloud datasets for Northland
00 BB Check Site Survey Northland
00 CC Metadata Reports
000 LIDAR Extents 2017
01 Mangawhai estuary
02 Langs Beach
03 Waipu Cove
04 Waipu estuary
05 Ruakaka
06_07_08 Marsden Point - One Tree Point
09 Whangarei Harbour West
Hatea_Waiarohia_Raumanga LIDAR 2009
Otaika LIDAR 2009
Raumanga_LiDAR_2009_Extn
Ruakaka LIDAR 2009
Whangarei LIDAR 2009
Whangarei LIDAR 2014
Breaklines
Classified Point Cloud
Contours_1m
DEM
Whangarei2014_DEM.tif
Whangarei201
LAS
Layout
LiDAR Output
Orthophotos
Open TIFF Image Externally...
Delete File "Whangarei2014_DEM.tif"...
Export Layer
Add Layer to Project
Layer Properties...
File Properties...
Spatial Bookmark Manager
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Group
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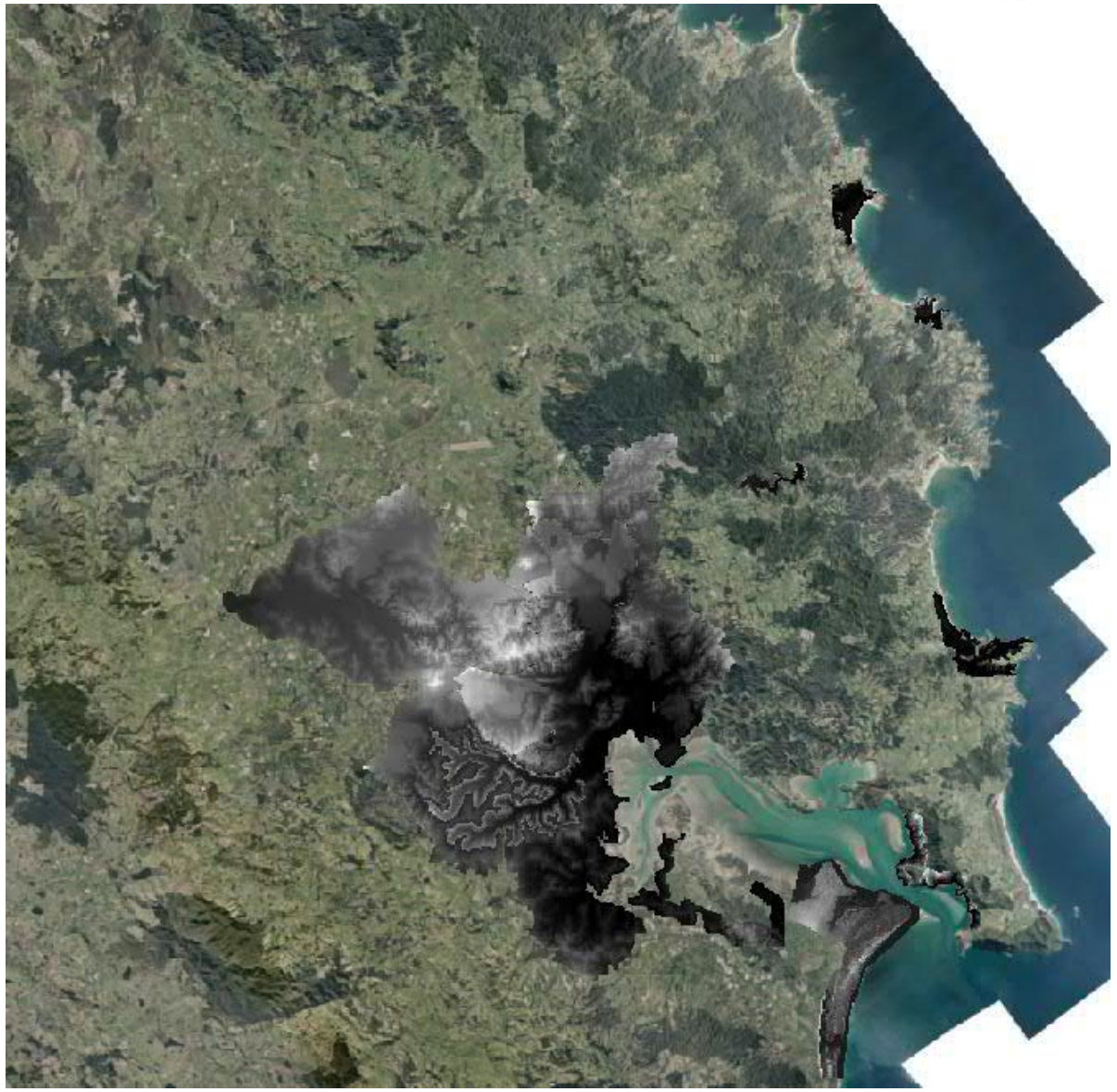
yMin
xMax
Map 1
512195.362104
5410255.809979
513257.531896
Layers
Whangarei2014_DEM
-1.51684
395.184
Northland 0.4m Rural Aerial Photos (2014-2016)
Type to locate (Ctrl+K)
1 legend entries removed.
Type here to search



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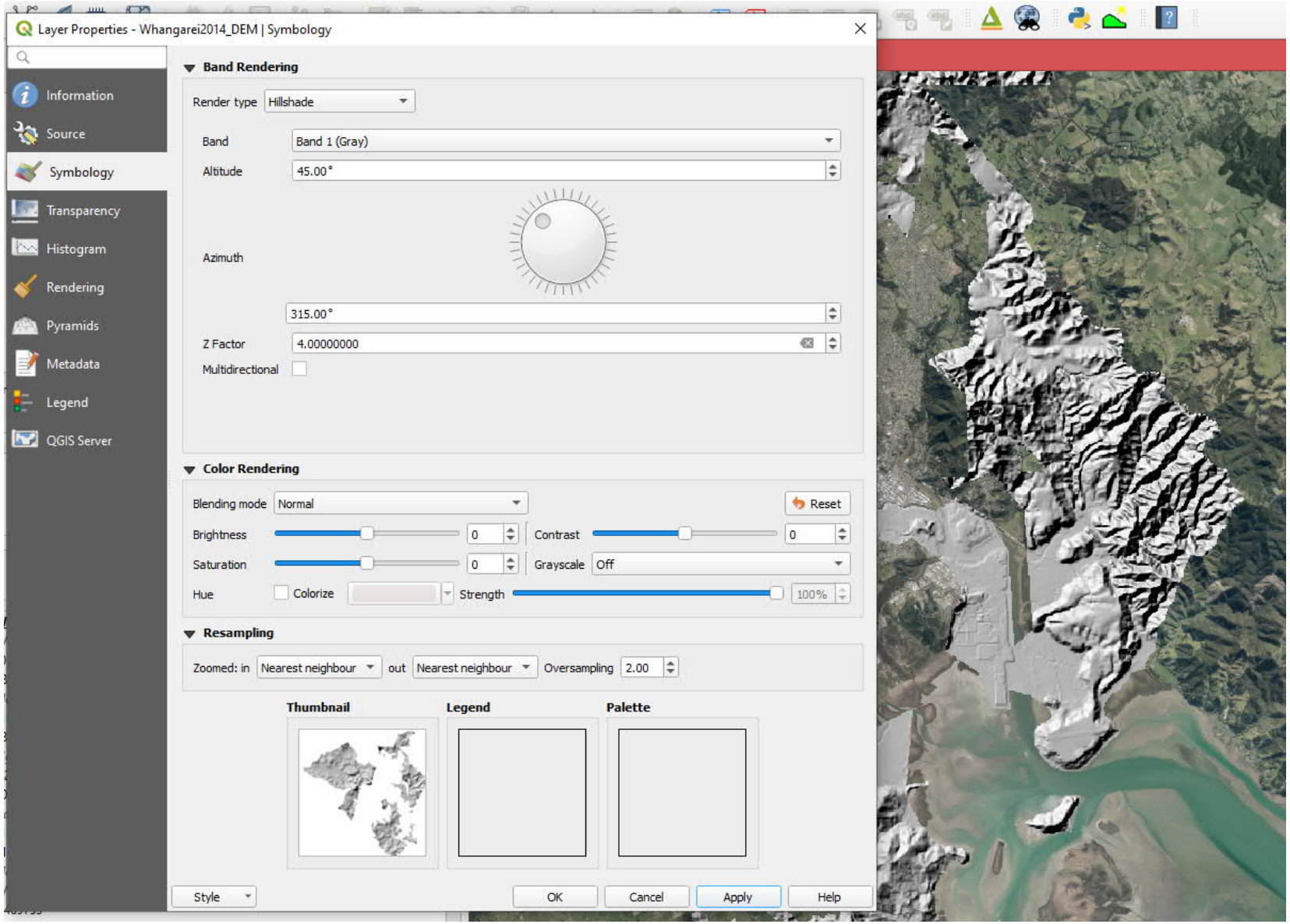
Layer Properties - Whangarei2014_DEM | Symbology
Information
Source
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Transparency
Histogram
Rendering
Pyramids
Metadata
Legend
QGIS Server
Band Rendering
Render type
Hillshade
Band
Band 1 (Gray)
Altitude
45.00°
Azimuth
315.00°
Z Factor
4.00000000
Multidirectional
Color Rendering
Blending mode
Normal
Reset
Brightness
Contrast
Saturation
Grayscale
Off
Hue
Colorize
Strength
100%
Resampling
Zoomed: in
Nearest neighbour
out
Nearest neighbour
Oversampling
2.00
Thumbnail
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Style
OK
Cancel
Apply
Help

QGIS

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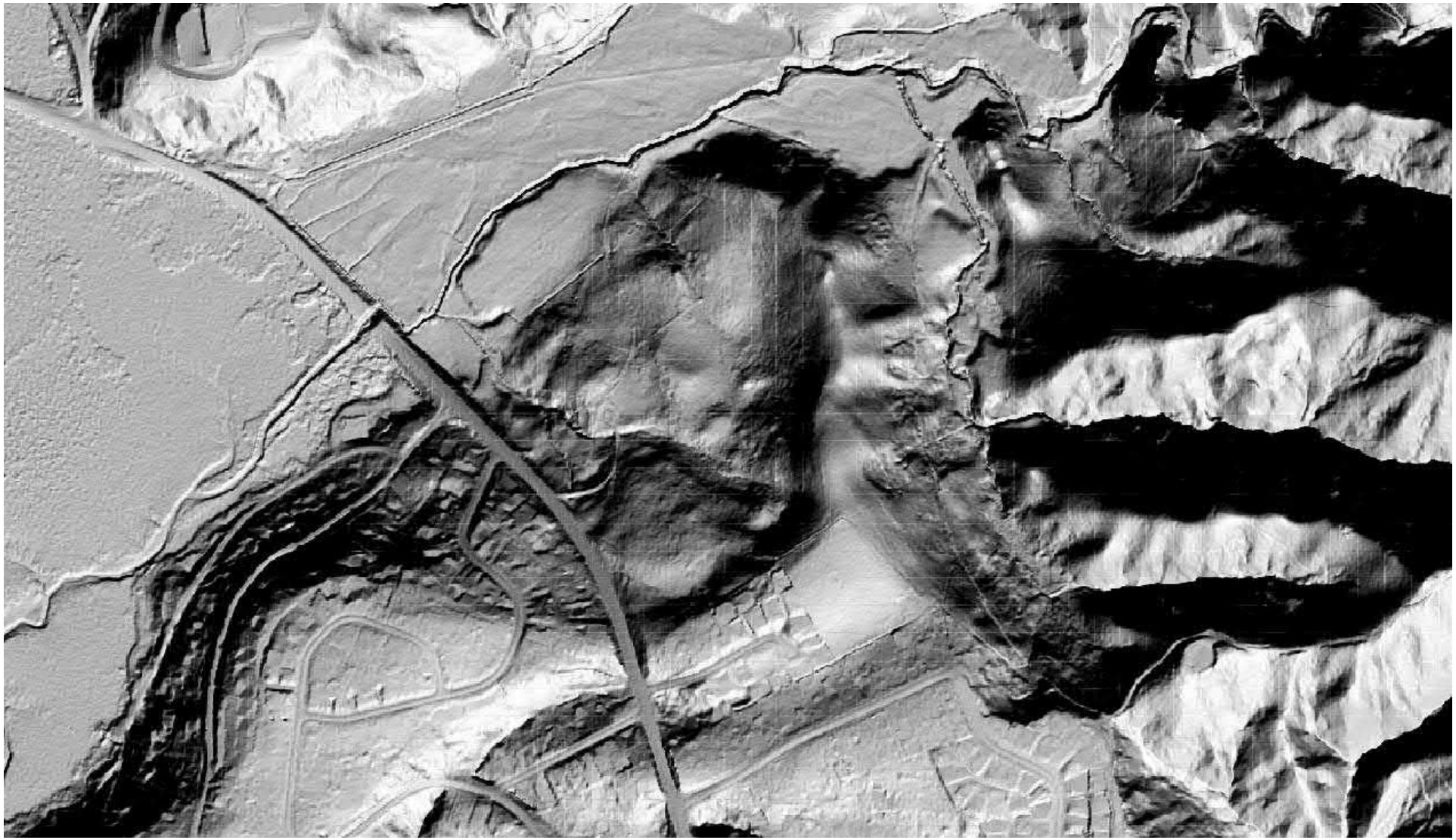

QGIS

QGIS

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Stereo Pairs

- I hope that everyone looking at landslips has used a Stereoscope. Looking at aerial photos in 2D is not a suitable substitute.

- Credit to NRC for helping set up Retrolens and ensuring all the photos are available. I think we are still missing the WDC aerials from hazard zoning – something to follow up.

- Once upon a time to look at smaller scale features you needed to order enlargements. Just getting copies of the photos could be hard/expensive. Photocopier enlargements were a cheap substitute and getting a pick of years was uncommon.

- We can view onscreen with freeware. You just need a pair of these ←

StereoPhoto Maker

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http://stereo.jpn.org/eng/stphmkr/index.html

StereoPhoto Maker

Crop both pairs to the area of interest

StereoPhoto Maker

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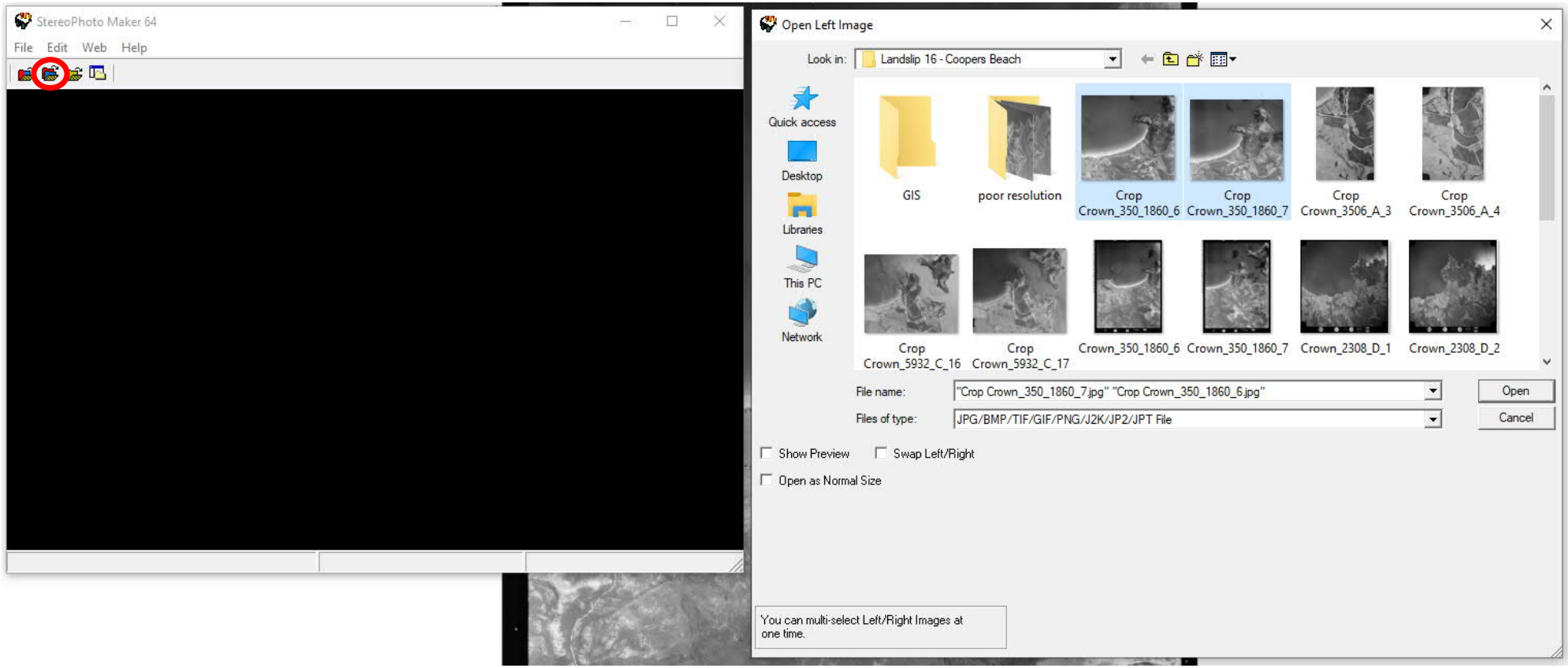
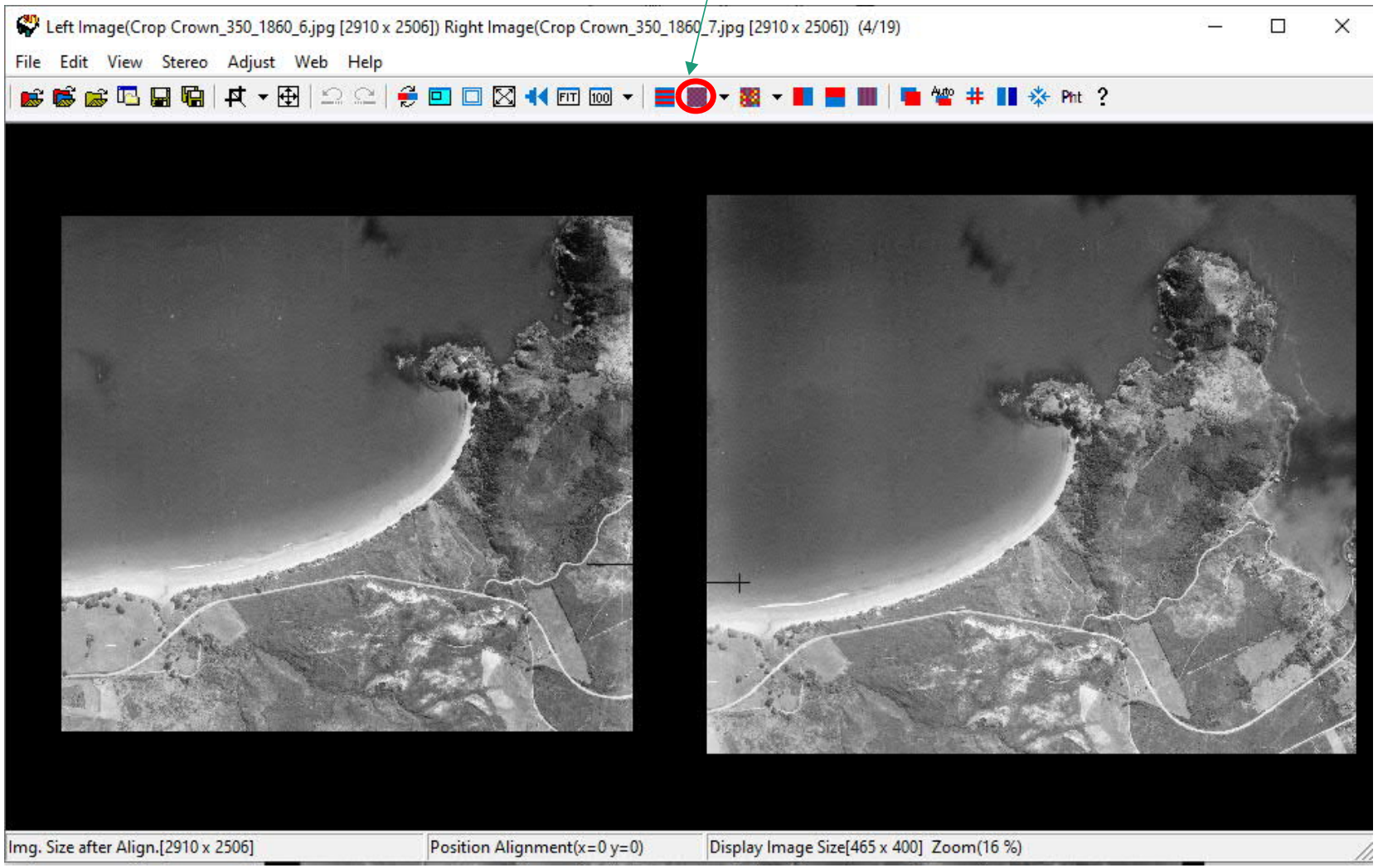
Open pair:



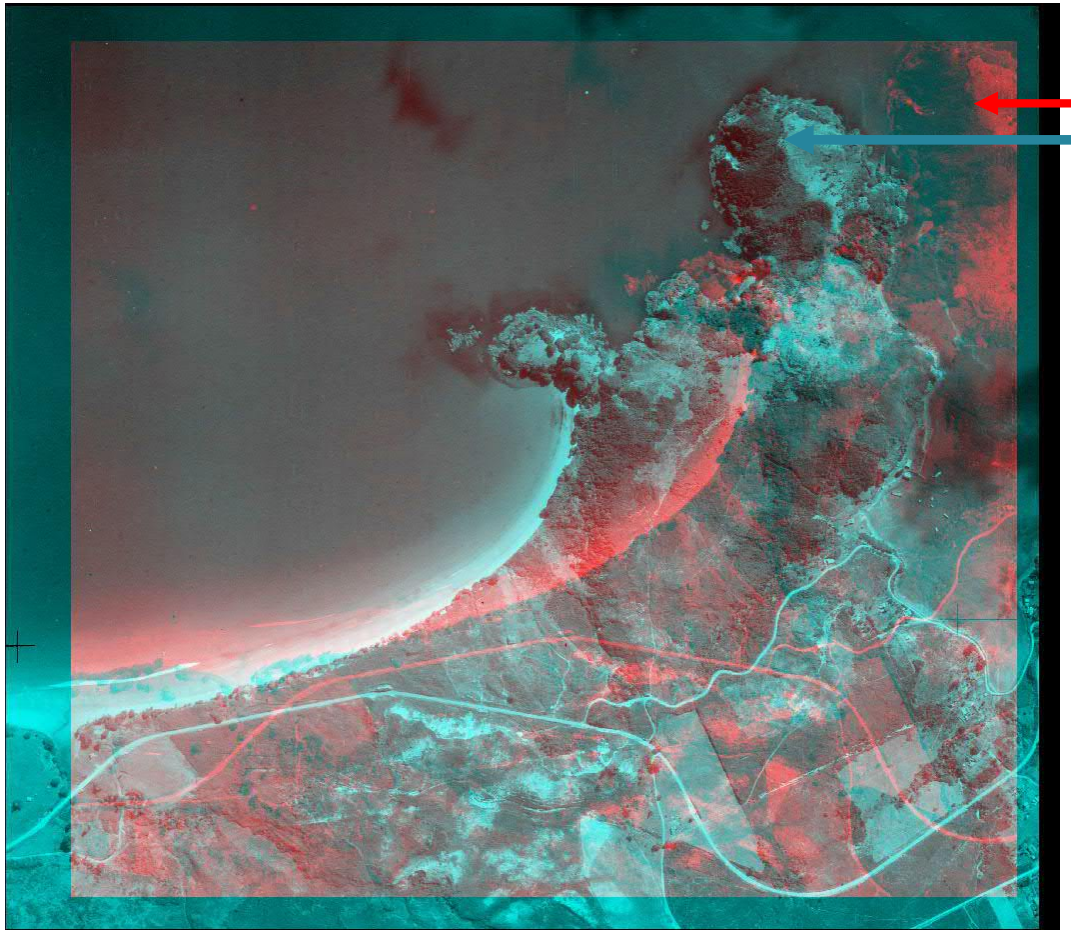
StereoPhoto Maker

Open pair:



StereoPhoto Maker

Put on glasses – use arrows to adjust image alignment to suit your eyes (adjustment often needed after zooming). You can pan and zoom with ease.



Overlay of red/blue layers need aligned to suit your eyes.

StereoPhoto Maker

My recommendation – historic stereo pair photo viewing for all sites. It is free and available for all. Even with LiDAR DEM models it is still the best for a good portion of sites.

Hazard Zoning Comments

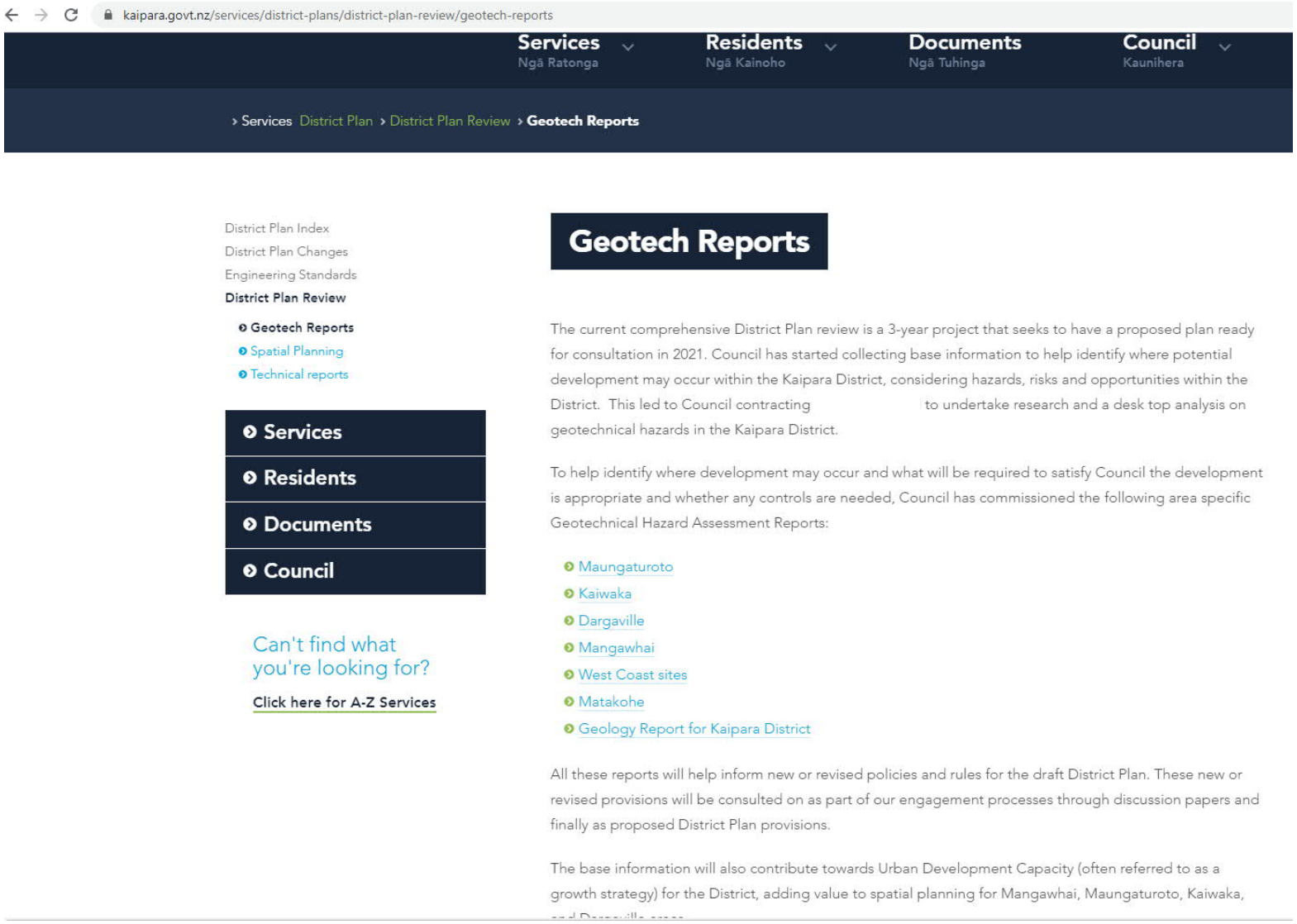
- WDC hazard zoning is very good.
- It was completed from geomorphology with a detailed understanding of the geology.
- Quite a bit of time was spent in the field to validate the results.
- High risk Northland Allochthon is a different mechanism (usually) to high risk Greywacke – but don't ignore the high risk zoning.
- The mapping clearly follows geomorphic features (i.e. landslip scarps)
- Be very careful with less rigorous hazard mapping. Why:

Hazard Zoning Comments

KDC hazard zoning:

Not clear how geomorphology is captured in the mapping other than a yes/no layer that doesn't appear to have a logical way of inter-relating to hazard zoning.

Slope stability hazard zoning by slope angle.



Hazard Zoning

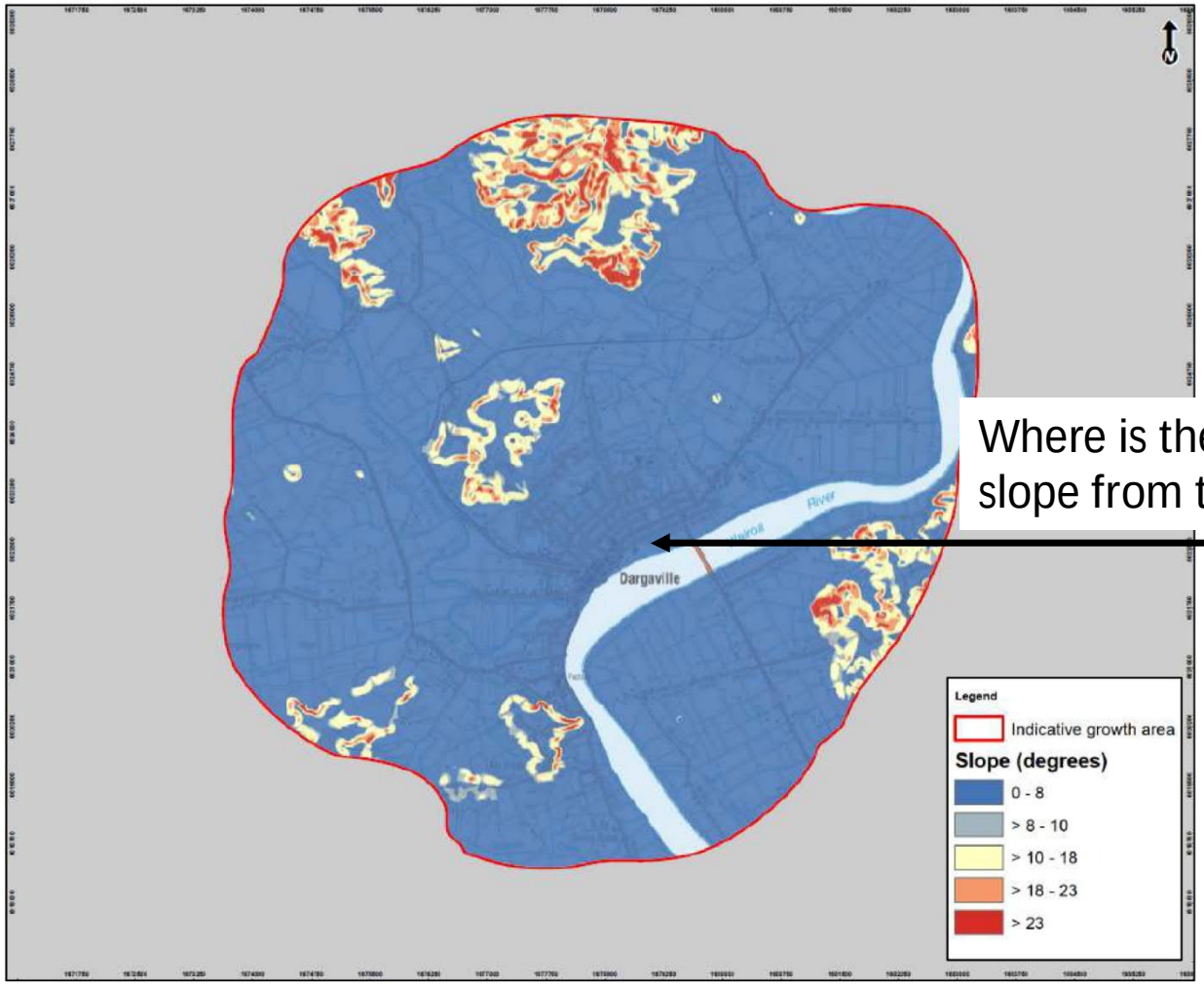
Geotechnical Assessment

Dargaville

Kaipara District

NGS Northland Geotechnical Specialists

Figure 4: Topographic Slope Angles

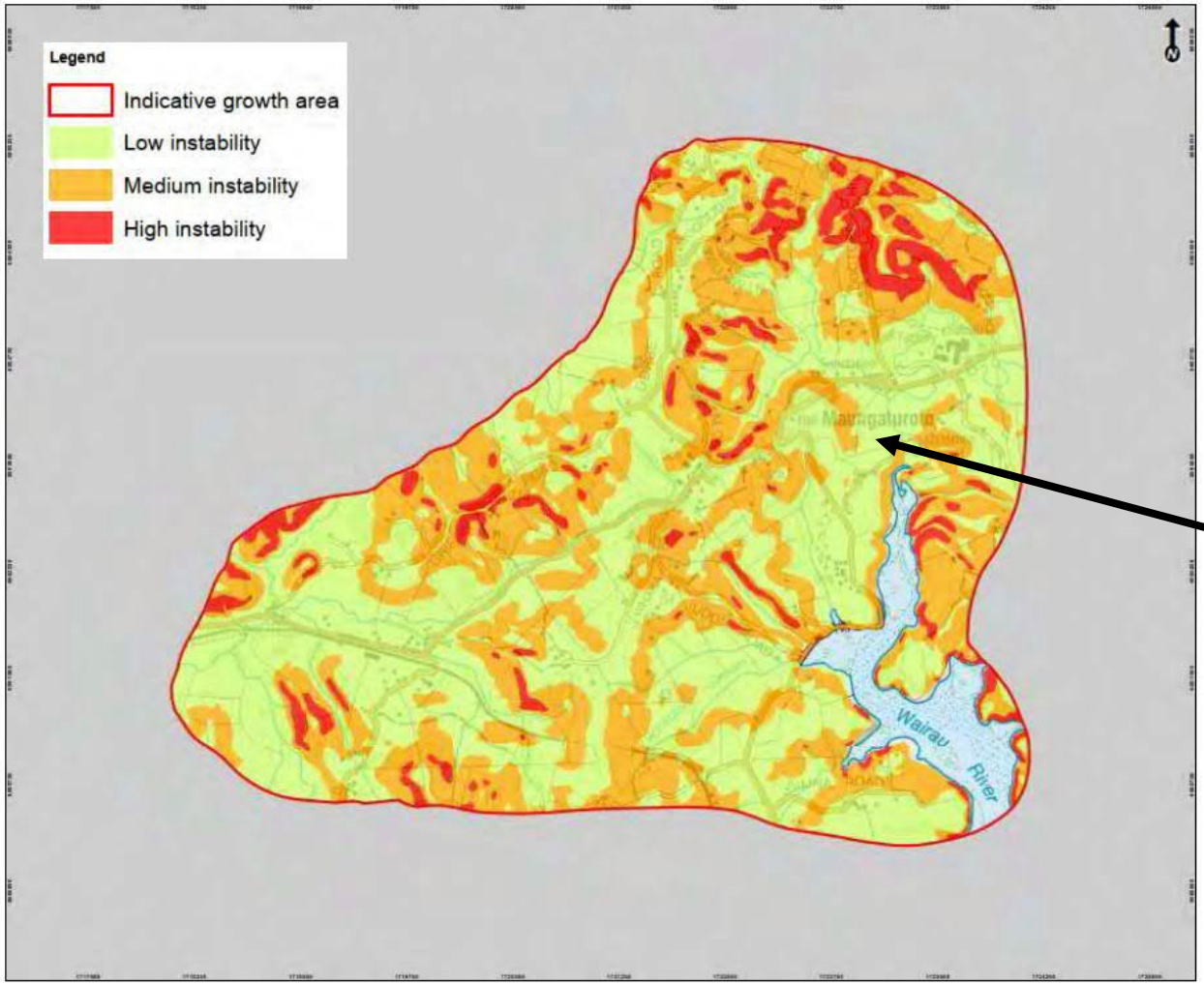


Where is the 12m high 25° slope from the LiDAR?

Hazard Zoning

Northland Geotechnical Specialists

Figure 8: Slope Instability Potential



Geotechnical Assessment

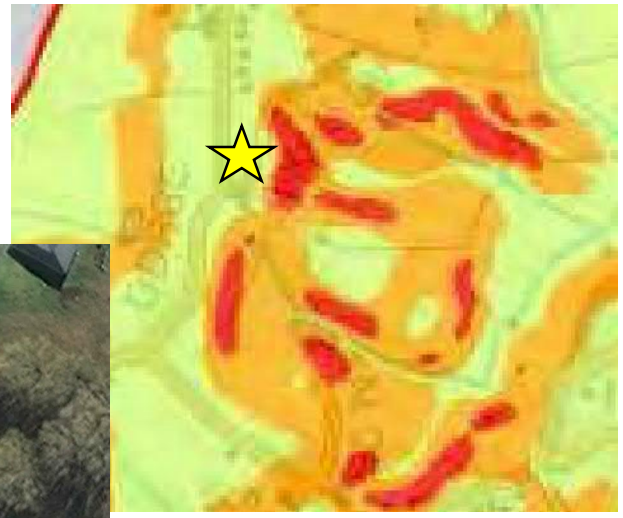
Maungaturoto

Kaipara District

Maungaturoto and surrounds was a high risk area with lots of actual landslips last time I drove through??
I see very little red and scarce orange, hmmm.

Hazard Zoning

Lets check out Landslip 5:



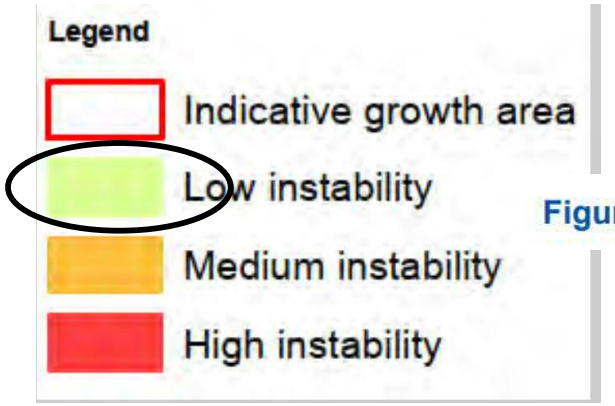
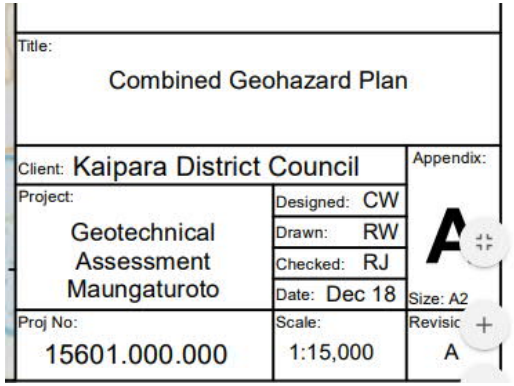


Figure 8: Slope Instability Potential



Unfortunately not the excellence we saw with Landslip 2 Zoning

Hazard Zoning

The KDC reports do have disclaimers but it does rely on the user to both read the report and be able to understand the disclaimers.

My personal view is that the public should be able to take such a report at face value without having to read in detail to identify the disclaimers

The reports (text) do in general identify the hazards.

In my opinion the slope angle thresholds are unconservative. They are of concern as others will it is likely they will be referenced and relied on in the future by some.

Based on slope angle alone the maps will always be insensitive to actual landslip features.

Table 2: Slope Instability Profile

Geologic Unit	Slope Instability Potential based on Slope Profile Ranges		
	Low	Medium	High
Tauranga Group Alluvium	<10°	10-23°	>23°
Kariotahi Group dunes	<14°	14-26°	>26°
Kerikeri Volcanic Group	<18°	18-45°	>45°
Taikura Subgroup	<18°	18-45°	>45°
Waitemata Group (includes Pakiri Formation and Ruarangi Formation)	<14°	14-26°	>26°
Northland Allochthon (includes Undifferentiated Mélange, Mahurangi Limestone, Whangai Formation)	<8°	8-18°	>18°
Whangarei Limestone	<8°	8-18°	>18°
Waipapa Group	<18°	18-45°	>45°

Landslip 4 in Pakiri Formation on 11° Slope!!!

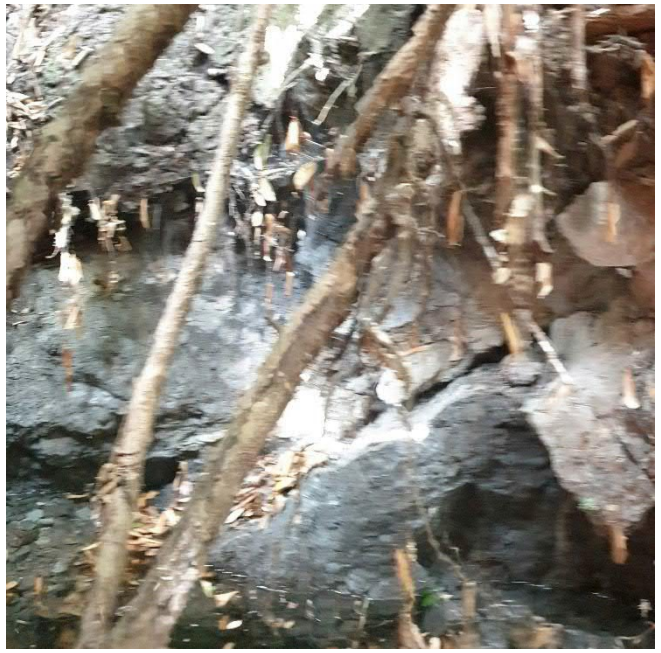
Many Allochthon Units are too weak to stand this steep

??????

The slope profile ranges have been applied to the LiDAR contour and elevation data to generate the Slope Instability Potential plan presented in Figure 8. It is important to note that the "Low Instability Potential" category does not imply that instability will not occur on these slopes, particularly where underlain by Northland Allochthon strata. Rather, some of the slopes may have historically failed, which has resulted in the flatter slope angles observed today. Changes to the equilibrium of a slope through some combination of land modification earthworks, fill or building loading, or introduction of water, can trigger reactivation of previous landslides on any slope.

Pictures of Northland Allochthon

For those who have not had the chance to dig and drill into it



Landslips in Northland. Observations from select case studies

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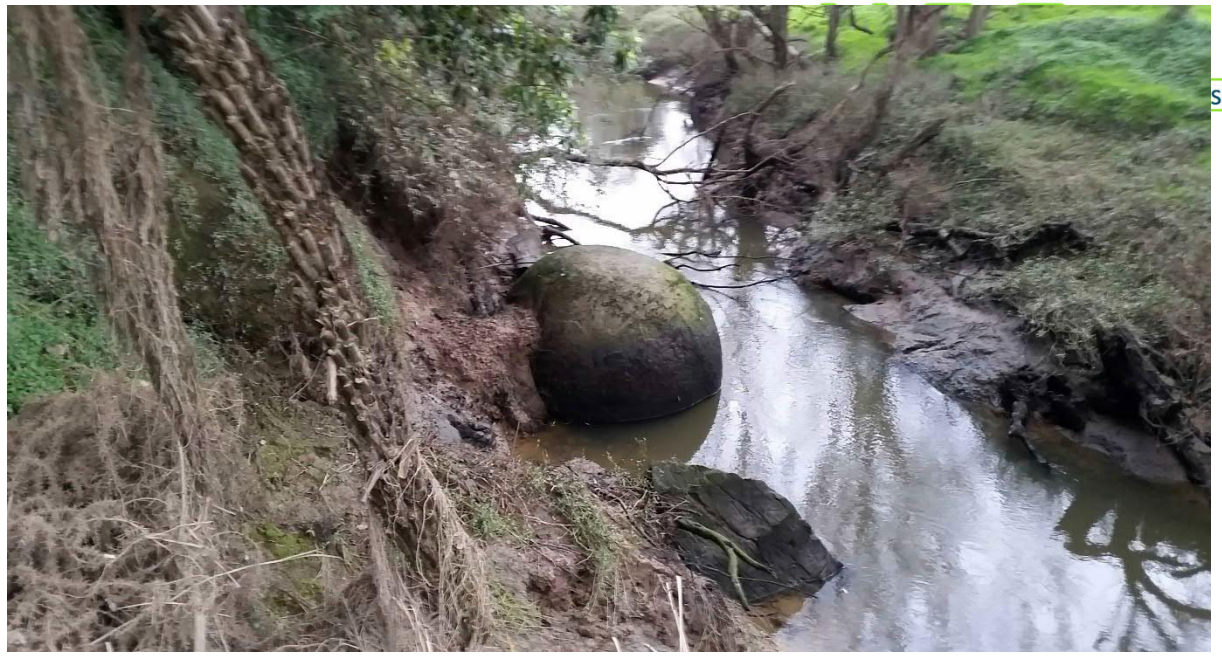
Landslips in Northland. Observations from select case studies



Landslips in Northland. Observations from select case studies

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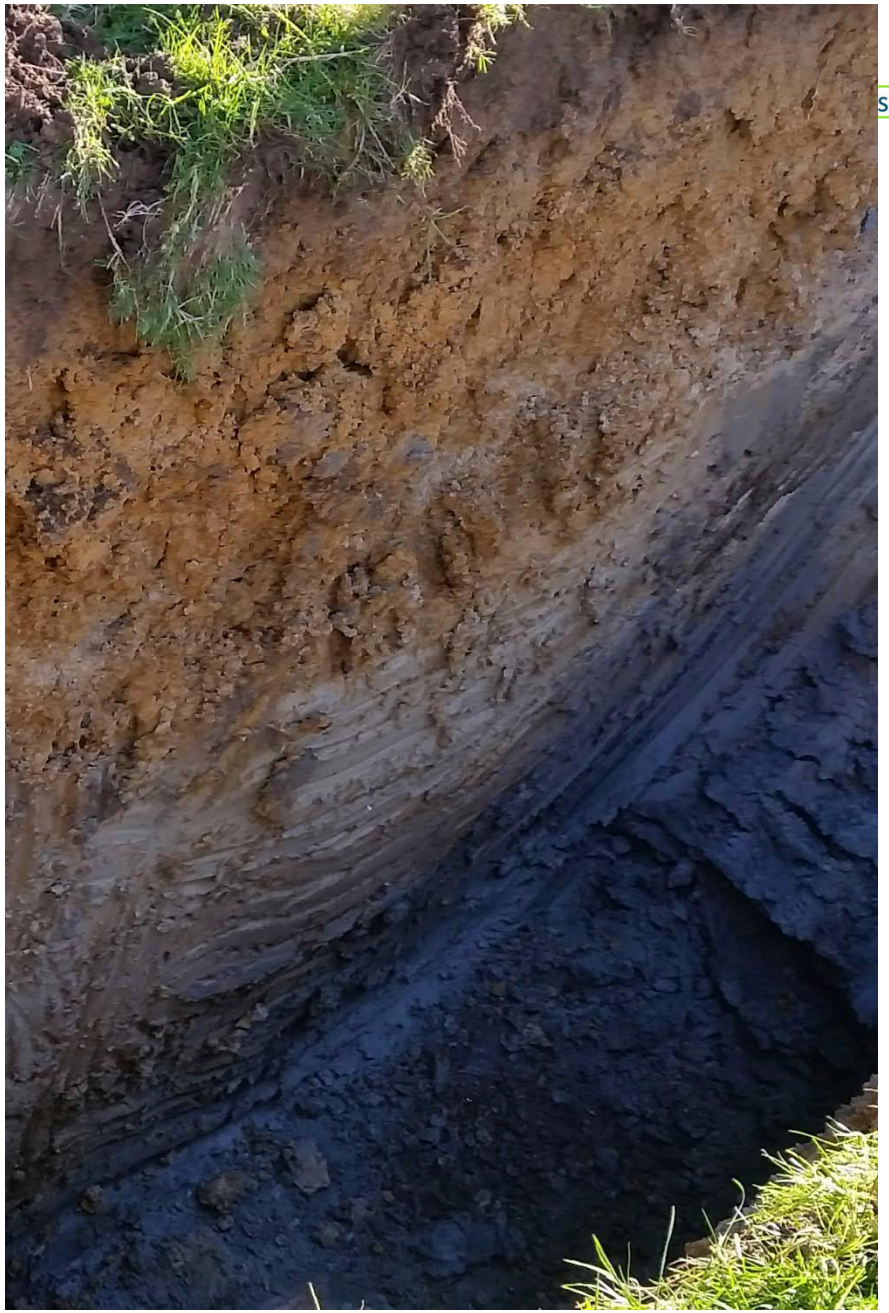
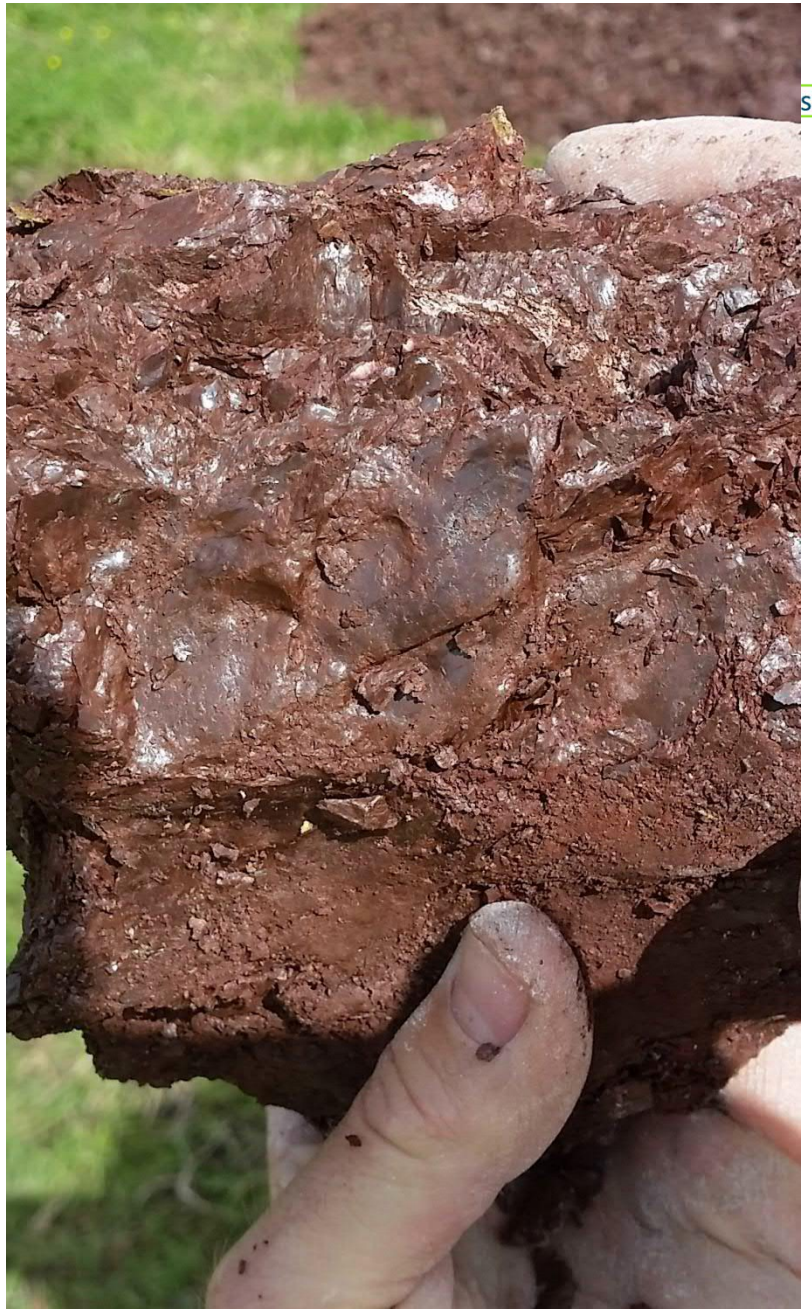
Landslips in Northland. Observations from select case studies



Landslips in Northland. Observations from select case studies



Landslips in Northland. Observations from select case studies

Landslips in Northland. Observations from select case studies

10 Minute Challenge for any site?

- Google Earth
- Geological Map
- Google Street View
- DEM Terrain Model?
- Aerial photo review (maybe 30min)

Do this at the start so you know the range of possible issues, scope the site right, tell the client right from the start.

Our decision making is human – if we put ourselves in bad situations we make bad decisions.

Being “helpful” by ignoring the issues hurts our clients in the long term.

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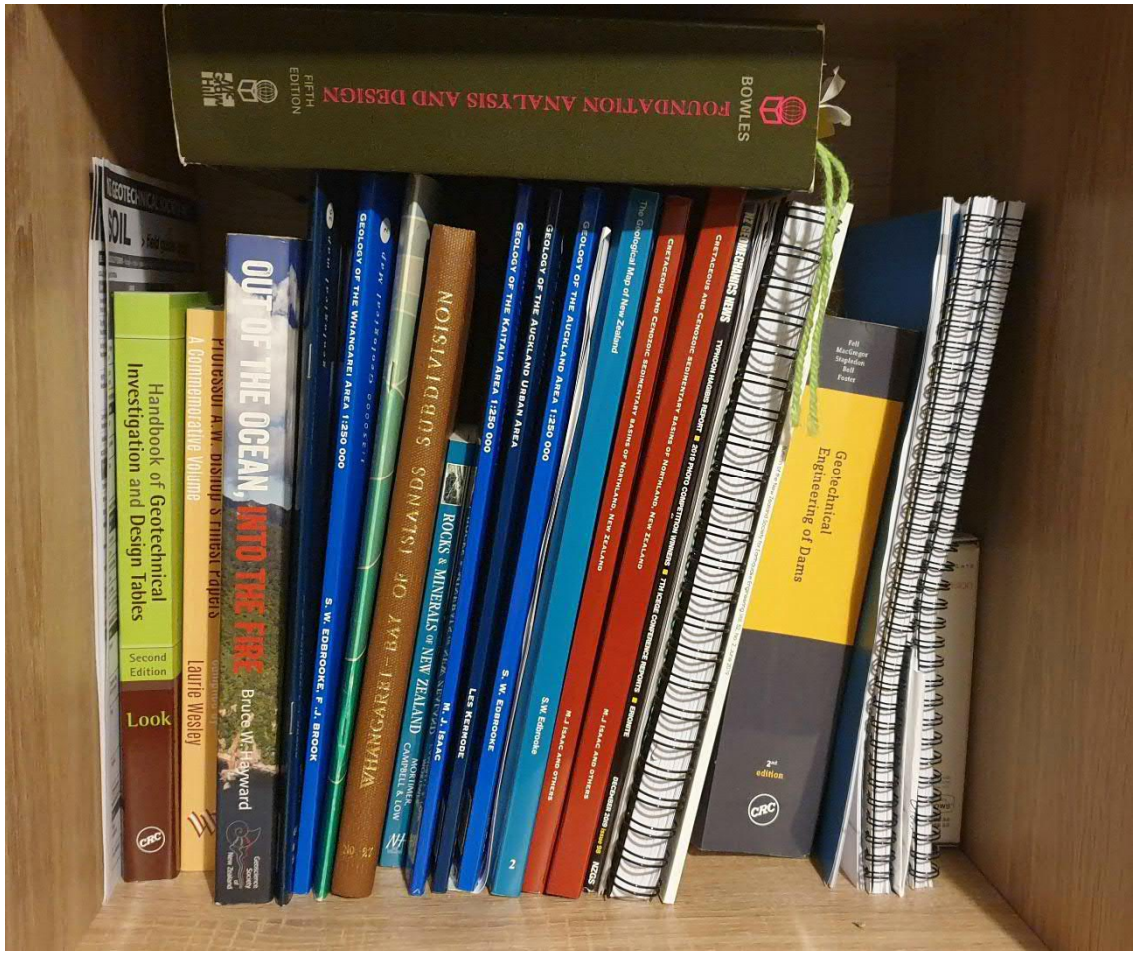
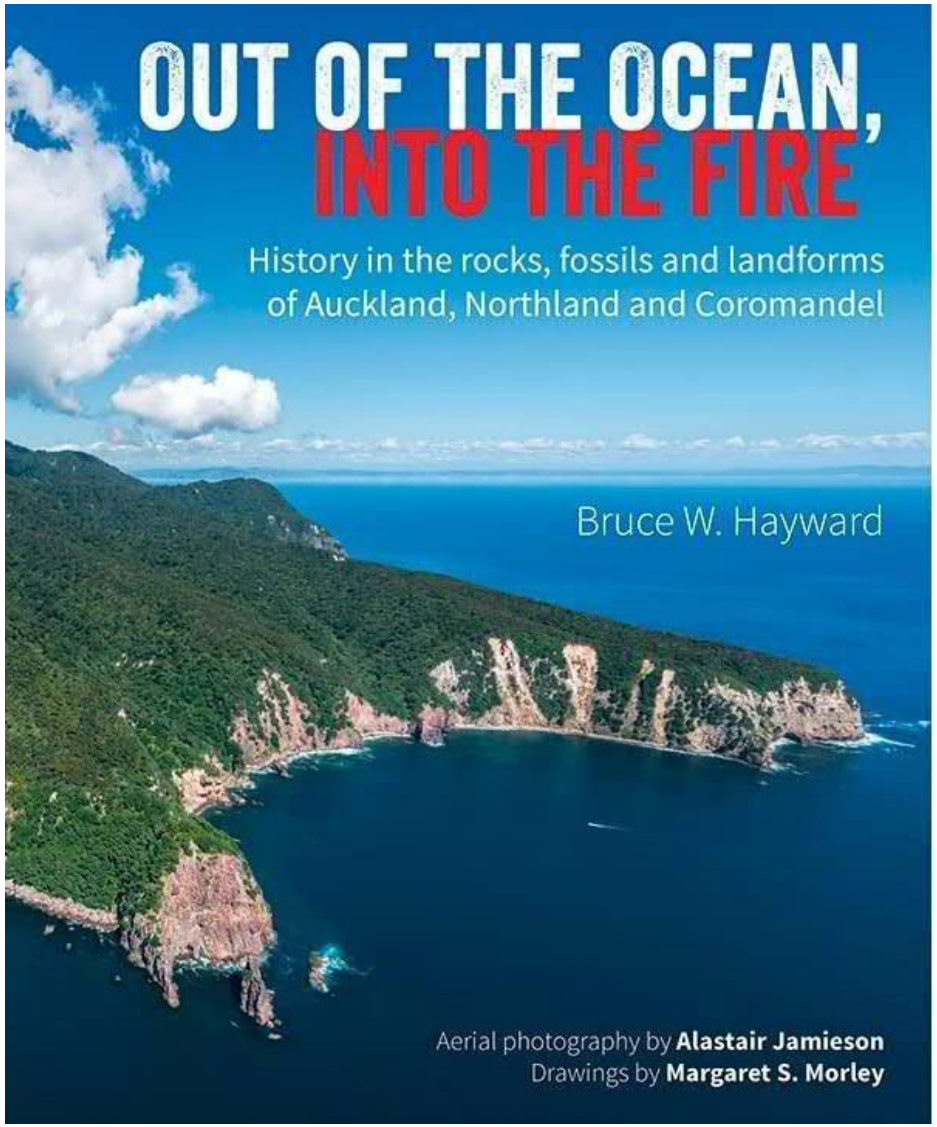
Other References





Conclusions

- Hopefully the presentation will aid your work.
- We need to identify and address the geomorphological features.
- Anyone signing a Geotech report in Northland needs to make sure they can identify the geomorphic features and ensure they have confidence in the staff who completed the onsite fieldwork.
- These are difficult sites. We should not rely on a single person's judgement. We should welcome peer review and will all benefit from it.
- Landslips happen – remember the people. I have met many. Young families, elderly, people doing well, people with life struggles. Regardless, landslips take more than just a financial toll on these people.
- People trust us. We need to do a good job and be honest.
- Our understanding is always incomplete. There needs to be a level of robustness/margin for error in our work as we will usually be wrong to some extent.
- Being a Geotech in Northland does sometimes involve giving bad news – a site not suitable to subdivide or a site not suitable to build on. We have to be prepared to have these discussions and reach these conclusions.

Questions & Acknowledgements