WW1&2 consent application

Appendix B

Soil type assessment of soils at Woldwide 1 & 2 dairy farms

Introduction

The soil assessment was carried out by Mr. John Scandrett at Woldwide 1&2 dairy farms in 2017. Mr. Scandrett is a farm consultant experienced in all aspects of sheep and beef management and agricultural engineering including drainage, effluent management, irrigation and machinery management and water scheme design.

Mr. Scandrett holds a Bachelor of Agricultural Science degree with honours. Practical experience gained since receiving his qualification in 1981 includes the digging of hundreds if not thousands of holes for soil profile assessment for farm management and drainage reasons. This includes checking the soil profile to determine if it is true to type and its physical properties, including drainage status and properties. Mr. Scandrett worked closely with the late Bill Risk, soil scientist between 2008 and 2012 who assessed the physical properties of in excess of 300 subsoil samples on his behalf.

The investigation of the spatial variation in soil properties at the property was undertaken because Mr. de Wolde believed the soil and description provided in Topoclimate did not accurately portray the soil types and boundaries at the property.

Mr de Wolde's description of the soil properties was in line with Mr Scandrett's knowledge of the soils in the area, which in that area, are largely considered to be free draining. Topoclimate has most of the area mapped as primarily a Braxton soil, which is a poorly drained soil. Mr de Wolde confirmed that most of the property doesn't have tile drains installed and is free draining. Only a few paddocks in the south west corner of the property have tile drains installed.

The free draining soil that Topoclimate has mapped along the eastern boundary of the property is the Glenelg soil. This is described in the Topoclimate data sheets as stony in both the topsoil and subsoil. Mr de Wolde's experience was the topsoil was largely stone free and the subsoil, while varying in depth to gravel, was also largely stone free, such that the profile was typically stone free to a depth of up to 0.5 m or more.

Prior to Topoclimate remapping the soils in the area covered by the farm, the Soil Bureau Division of the DSIR had mapped the soils as being of the Drummond type, as reported in Soil Bureau Bulletin 27, General Survey of the Soils of South Island, New Zealand, 1968.

The Drummond soil is described as a silt loam soil, 0.5 m deep overlaying sandy gravels in Soil Bureau Bulletin 27. This description was a good fit with Mr de Wolde's local knowledge of the property.

Further, a study of the Topoclimate soil map for the farm area shows that no test pits were excavated on either Woldwide one or two to confirm soil types. Presumably mapping was based on auger holes and an assessment of the topography.

Method

Mr de Wolde provided farm maps showing the paddock boundaries for Woldwide 1 and 2 and on these he marked in the soil boundaries based on his farming experience of the land. This includes where tile drains are located, the location of heavy versus free draining soils, areas sensitive to dry spells/drought etc.

Mr. Scandrett researched soil information available for the area using:

- Soil Map of The South Island New Zealand sheet 12;
- General Survey of the Soils of South Island New Zealand, Soil Bureau Bulletin 27, which gave descriptions of Drummond, Glenelg and Makarewa soils; and
- Soil technical data sheets from Topoclimate for Braxton, Drummond, Glenelg and Pukemutu soils.

Mr. Scandrett carried out an on-site investigation in February 2017. See the Appendix for location of test holes. Mr. de Wolde's revised soil boundary was used as a guide to the digging of 28 test holes.

The aim of digging the test holes was to confirm the actual soil type at each point, how it compared to Mr de Wolde's assessment and if the Topoclimate soil boundary was correctly located.

For each test hole, the soil profile was inspected and characterised compared to Topoclimate. A spear was also used to check for soil depth to gravel in the vicinity of the test hole. This confirmed whether the points at which test holes were dug were representative for the area.

Results

See the Appendix for revised soil maps based on Mr. Scandrett's investigation of soils, including the digging and inspection of 28 test holes.

The following is a report on the soil investigation at Woldwide 1.

Woldwide One Soils

The following photographs and comments refer to various paddocks across Woldwide One using paddock numbers provided on a farm plan as at January 2017, which is appended.

Holes were dug on the 7 February 2017 to check the depth of topsoil, stone content and drainage properties. The topsoil and subsoil were checked for texture using field methods and for the drainage properties mottling was taken as an indication of impeded drainage.

The profile at each site was compared to the Topoclimate South soil map to determine if the soils were true to type as described in the Topoclimate soil information sheets.

It was found the Topoclimate map was not particularly accurate with actual soil profiles generally better than stated by Topoclimate.

Two test holes in paddock 23 plus checking with a spear indicated the soil profile was not a Glenelg or Braxton as Topoclimate indicated, but a Drummond soil type. Two test holes in paddock 24 indicated the soil was free draining and had a stone free topsoil overlying a stoney subsoil. This soil was mapped as a Braxton on Topoclimate, but in reality is a Glenelg – Drummond intergrade.

The test holes in paddock 21 indicated an intergrade soil with the Drummond type tending towards the Braxton soil type in the subsoil. The holes were excavated in the vicinity of the soil boundary Mr de Wolde had indicated between Braxton and Drummond soils and the soil profile appearance supports this observation.

Paddocks 3 and 5 to 14 on Woldwide one were considered to be typical of the Braxton or Pukemutu type based on Mr de Wolde's experience and 5 test holes were dug to check the soil profile.

The Braxton and Pukemutu soils are less extensive than shown in Topoclimate. The Glenelg soil is also less extensive than Topoclimate suggests.

Prior to Topoclimate maps being produced most of the block was depicted as being of the Drummond soil type in DSIR Soil Bureau Bulletin 27. Makarewa soils were shown to cover the west end of the farm. Makarewa soils are inherently poorly drained. Topoclimate has redefined the area covered by the Makarewa type as being a Braxton or Pukemutu soil type, both of which are poorly drained. Topoclimate has also extended the area of poorly drained soil to cover approximately 90% of Woldwide One.

Based on field work at the Woldwide 1 property, Mr. Scandrett concluded that shallow to moderately deep Drummond soils cover much of the area shown as the Braxton type, other than for the west end of the property.

Paddock 23

Topoclimate suggests a Glenelg soil type for this area. However, there was no stone in the topsoil and there was a well-developed subsoil. The subsoil was free draining with no mottling to the bottom of the subsoil level at 0.5 m. This profile is more characteristic of a Drummond soil type. The sample site was on a broad ridge. The paddock had recently been cultivated and the profile was reported as being uniform to plough depth across it, i.e. no stones in the topsoil.

Paddock 24

Topoclimate suggests a Braxton soil type for this paddock. There was 250 mm depth of soil overlying stone. The profile was better than a typical Glenelg soil which has stone throughout all horizons. The south west corner where this hole was dug is the lightest part of the paddock according to Mr de Wolde.

Paddock 21

Topoclimate suggests Braxton and Pukemutu soil types cover this area. The profile was 250 mm depth of topsoil, no mottles present, well-structured, overlying a heavier textured subsoil. There were some mottles present in the subsoil and no stone with 0.5 m of the surface. This profile is tending towards the Braxton soil type. The sample site was in a slight but distinct hollow and would be expected to have a wetter profile compared to the higher adjoining ground.

Paddock 7

Topoclimate suggests Braxton and Pukemutu soil types cover this area. The topsoil depth was 200 mm, overlying a 50 mm thick intergrade layer between the topsoil and subsoil overlying a heavy and mottled subsoil. This profile showed poorer drainage than the profile in paddock 21 and is more characteristic of a Braxton soil type.

Woldwide One Ltd

1354 Hundred Line Rd, Dunearn 9783

LEGEND

Quarry/Gravel Pit	Shed
Creak/Duck Ponds	Public Road
Trees	Slurry Pit
Flood Bank	Tanker Track
Pilones/Powerline	Cow Yards
Effluent Paddocks	Waste Area
Houses	Bridge/Culvert
Water Bore	HNSO Chemical Storage
Under Pass	Fuel Tank
OFFAL Pit	Water Trough

Woldwide Two Soils

The following photographs and comments refer to various paddocks across Woldwide Two and the support block on the north side of SH96, now incorporated into Woldwide Two. A farm plan is appended.

Holes were dug to check the depth of topsoil, stone content and drainage properties. The topsoil and subsoil were checked for their texture using field methods and their drainage properties with mottling taken as an indication of impeded drainage.

The profile at each site was compared to the Topoclimate South soil map to determine if the soils were true to type as described in the Topoclimate soil information sheets.

Paddock 10 had a well structured, well drained topsoil overlying a well structured subsoil with no indication of impeded drainage until 0.5 m depth where some mottles occurred. Topoclimate maps this paddock as being of the Braxton type where as it is more characteristic of the Drummond type.

Two paddocks to the west of paddock 10 paddock 8 had the properties of an intergrade between Drummond and Braxton soils.

Four paddocks to the north of paddock 8 is paddock 16 which was mapped by Topoclimate as being predominantly of the Braxton soil type. Five test holes in this paddock revealed that the soil is typical of a shallow Drummond soil.

To the north of SH96 test holes in paddock Marcel 1, SH2 and SH1 indicated a Drummond soil or the shallow variant of it. Topoclimate mapped the area as being of the Braxton type. To the east and far north of this block Topoclimate has mapped the soils as being of the Glenelg type. Test holes in paddock 12 confirm that the profile is stoney in all horizons, typical of a Glenelg soil.

WOLDWIDE 2

Paddock 10

Topoclimate suggests Braxton and Pukemutu soil types cover this area. The topsoil was well structured with no mottles to a depth of 250 mm, overlying a well structured subsoil. Mottles didn't occur in the subsoil until 0.5 m depth. This soil is more characteristic of the Drummond soil type.

Paddock 8, East side

Topoclimate suggests Braxton and Pukemutu soil types cover this area. The topsoil was 200 mm deep and free of mottles. The subsoil had increasing mottling with depth, and was heavily mottled at 450 mm depth. Braxton soils are mottled in all horizons, this soil was representative of an intergrade between Braxton and Drummond soils.

Paddock 16

Topoclimate suggests Braxton and Pukemutu soils cover this area. Several holes were checked in this paddock. In a shallow hollow running through the paddock there was faint mottling in the topsoil tending to heavy mottling at 0.5 m deep in the subsoil. The majority of the paddock is a broad ridge with 250 mm depth of topsoil, no mottling, over a subsoil with variable stone content. Mottles were absent from the subsoil. This soil is not of the Braxton type but more like a shallow Drummond soil or Drummond Glenelg intergrade.

Support Block, to be part of Woldwide Two
Paddock SH2

Topoclimate suggests Braxton and Pukemutu soils. This paddock has a shallow hollow running through it. In the hollow the profile was mottled in all horizons. The paddock had been used for wintering stock and was showing signs of soil compaction. The profile in this hollow was characteristic of the Braxton type. Holes either side of the hollow showed a much lighter and better drained profile.

Paddock SH1

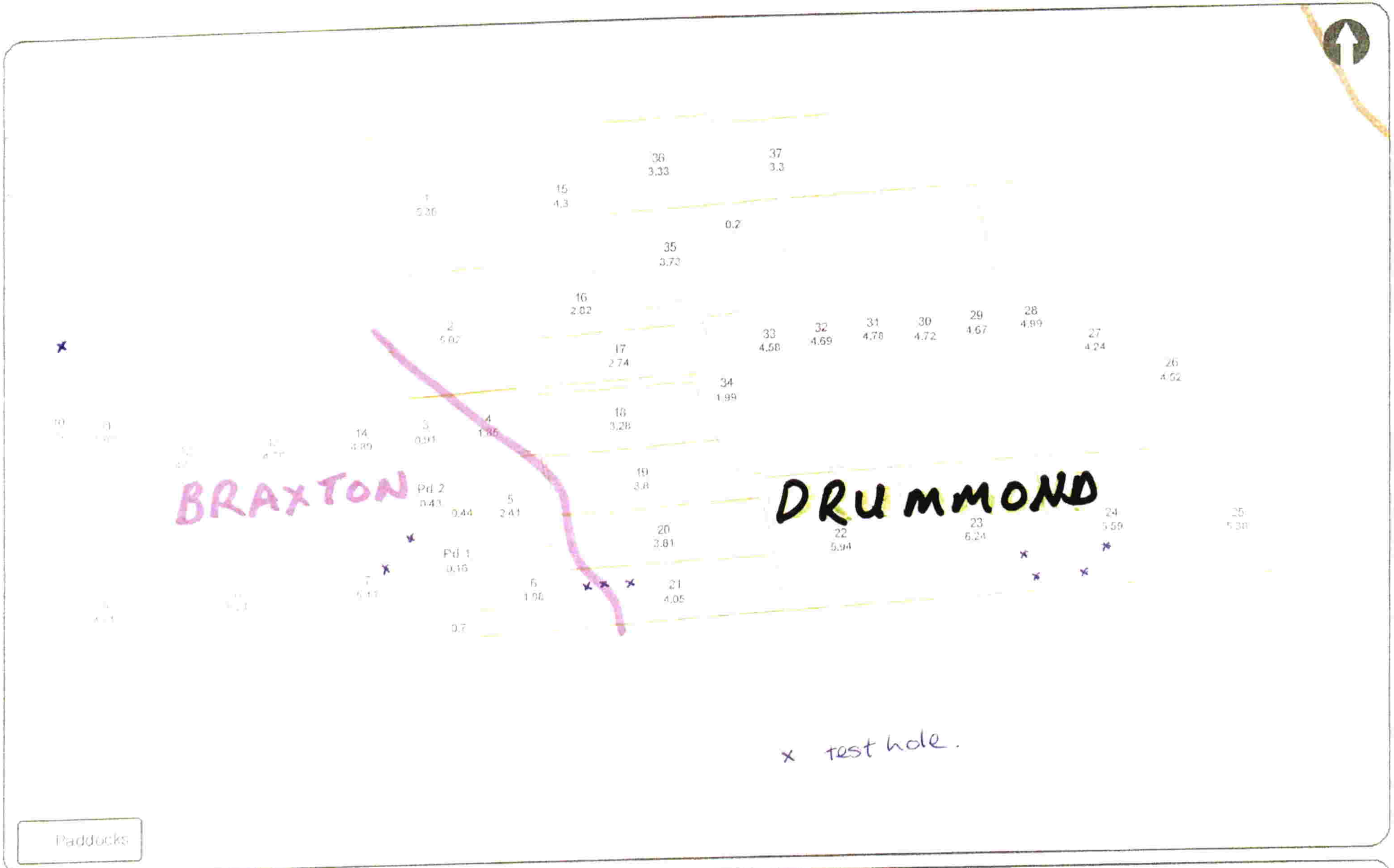
Topoclimate suggests Braxton and Pukemutu soil types. The profile was free draining with an absence of mottles in the topsoil and subsoil. The topsoil was 250 mm deep to a stoney subsoil. This profile is similar to that observed in paddock 16 and is not of the Braxton type.

Paddock 12

Topoclimate suggests Glenelg soils. This paddock had been cultivated and was in winter crop. The profile was stoney in all horizons, typical of the Glenelg soil type.

Appendix

Appendix

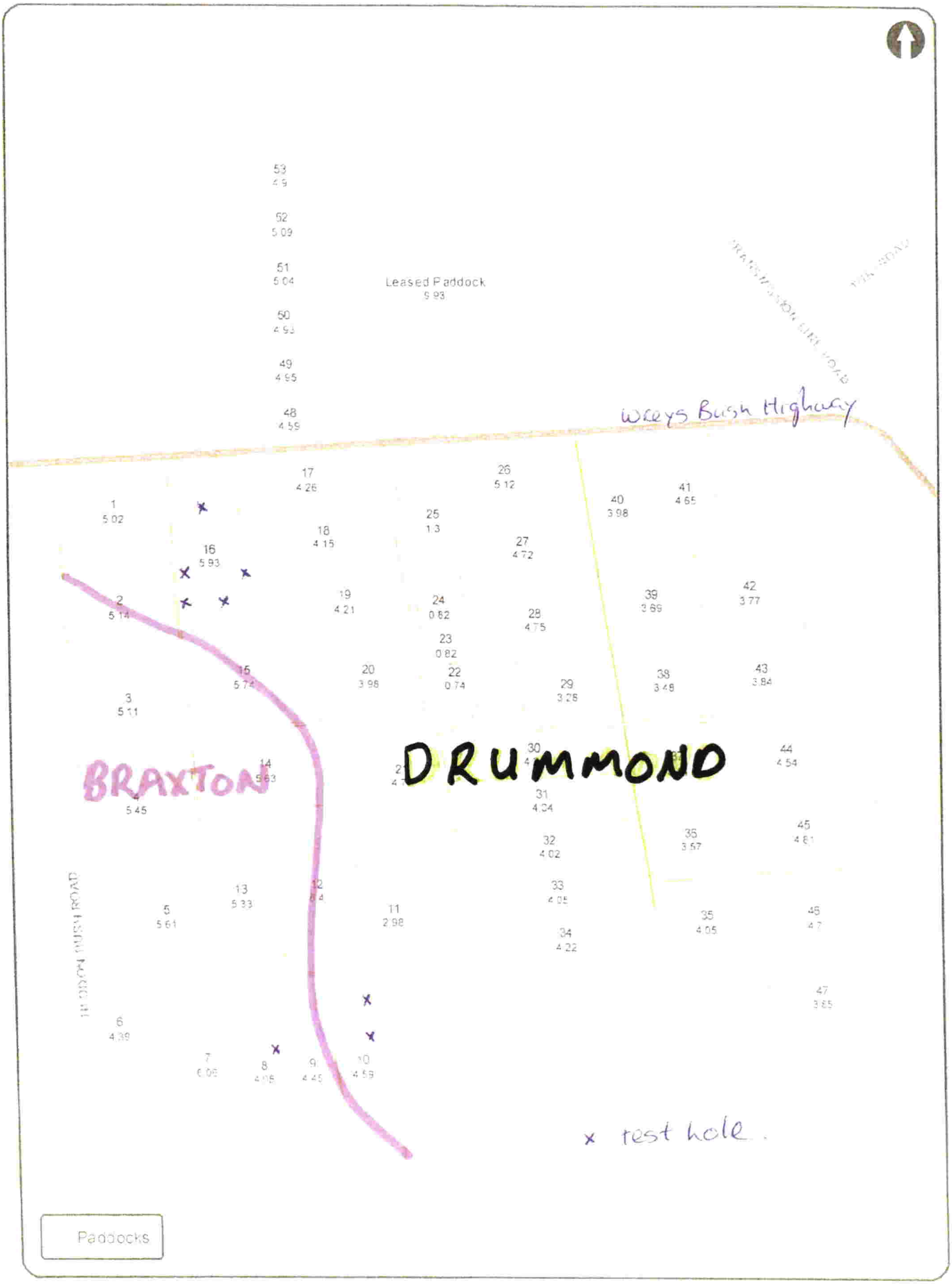


My Ravensdown Smart Maps

Woldwide One Ltd

0 55 110 220 330 440 Metres

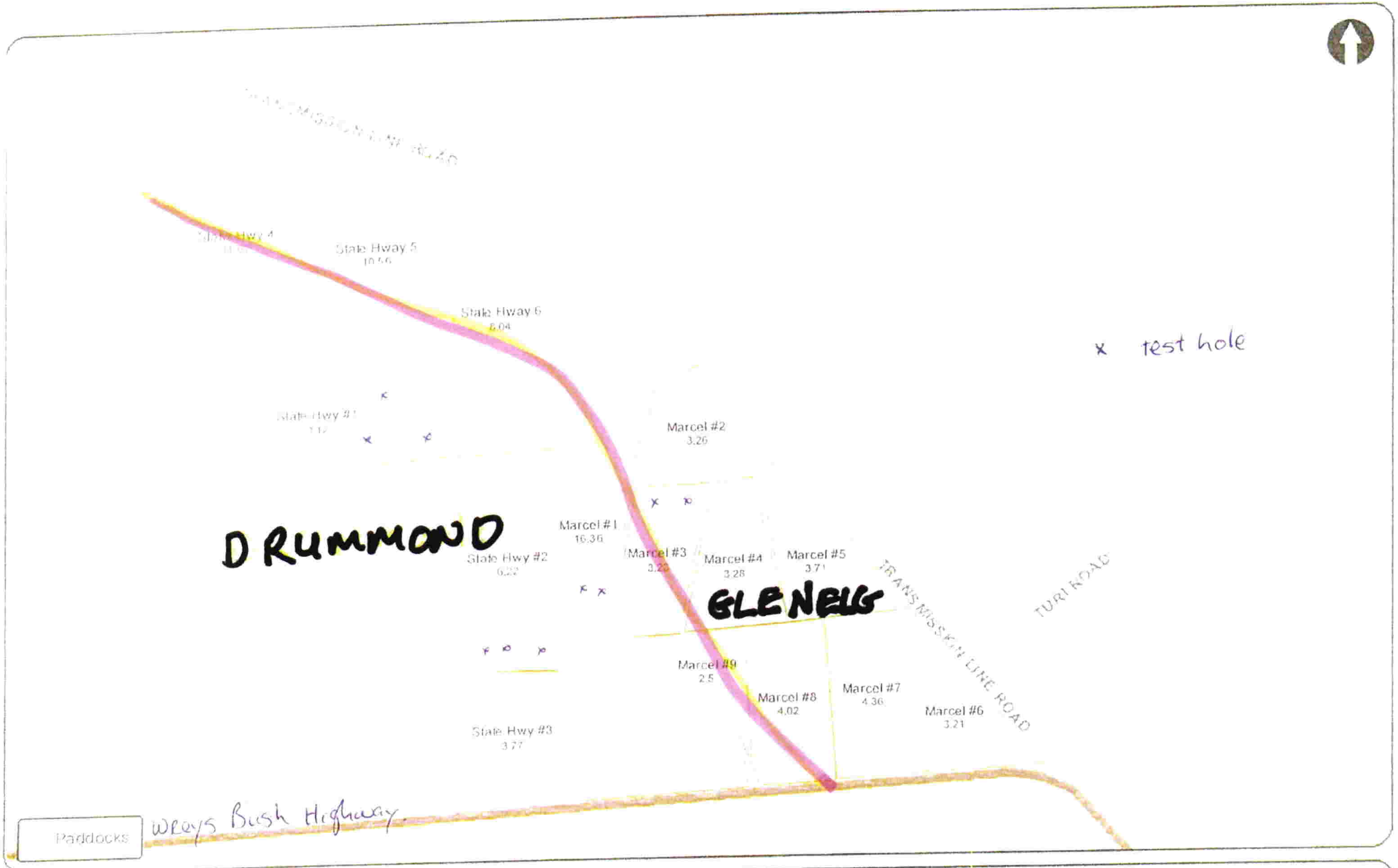
ravensdown



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Woldwide Two

ravensdown



My Ravensdown Smart Maps

Highway 96 Support / Worldwide Two.

0 55 110 220 330 440 Metres

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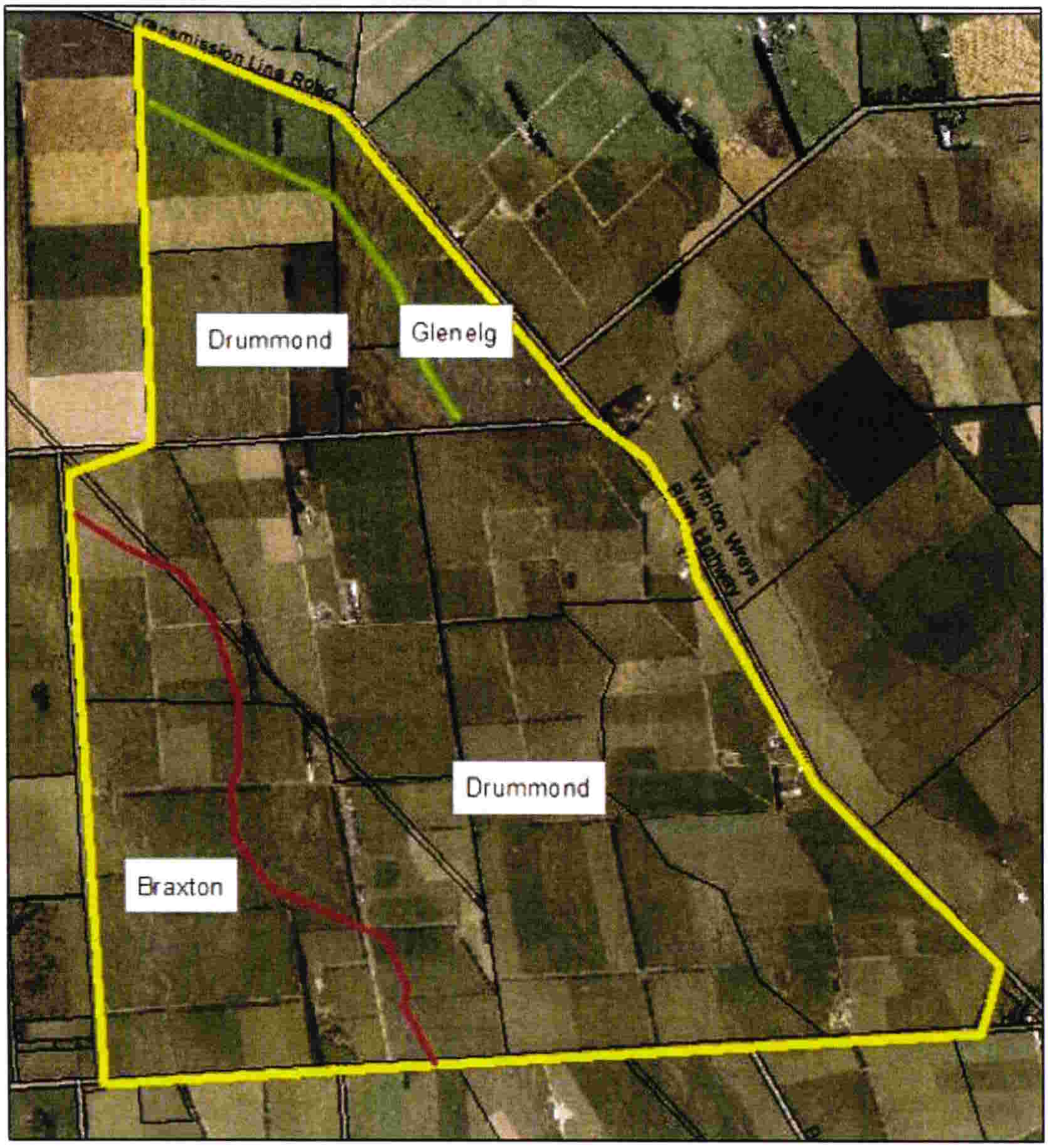


Transmission Line Road
Drummond
Glenelg
Winton Wreys Bush Highway
Drummond
Braxton

Investigation of cracking soils: Heddon Bush, January 2018.
Michael Killick, Technical Specialist (Soils and Groundwater Quantity)

On January 30, 2018, I visited dairy farms of the Woldwide group with the owner, Abe de Wolde, in the area of Heddon Bush, to see if we could observe soil cracking as is described for the Central Plains physiographic unit. We looked at a paddock ('Site 1') on the corner of Hundred Line Road and Drummond Heddon Bush Road which in the Topoclimate survey is mapped as Braxton + Pukemutu soils. There were noticeable cracks in the soil at this site, 3-10mm wide, less than 150mm long, 5-10m apart. It was not clear how many cracks might be hidden by pasture, but there were areas of sparse pasture which had no cracks.

A shallow hole (~15cm deep) at the site showed the soil was friable with many small to medium well-formed peds. A creek on the west side of the paddock which is a small tributary of Middle Creek was dry at the culvert where the bed was a metre or so below ground level. Site 1 was described by Abe as wet in winter with areas of standing water, the effects of which could still be observed in the dry conditions of our visit (re-sowing with new pasture had been prevented in one place due to previous muddy conditions). See figures 1-5.

Figure 1. Cracked soil at Site 1.

Figure 2. Uncracked soil at Site 1.

Figure 3. Creek bed at Site 1.

Figure 4. Site 1 locations.


Figure 5. Soil at Site 1.

We also looked at a site ('Site 2') on the north side of Hundred Line Rd mapped as Glenelg soils. This soil did not appear cracked although the soil surface was disrupted by the remains of past pugging so it was not easy to observe. A hole dug to about 15cm depth at this site brought up a number of stones supporting the mapped classification as Glenelg soil.

We walked a transect of approximately 50m at a third site ('Site 3', Figure 7) mapped as Glenelg + Drummond soils (close to the boundary of Braxton + Pukemutu soils). Cracks in this soil were observed at a density of at least one in the region of each stride i.e. $1/m^2$. The cracks were smaller than at Site 1, 2-4mm wide and less than 100mm long (see Figure 6). A hole dug to about 15cm depth at this site brought up two large stones (~90mm) and a number of small stones. A steel ruler was inserted easily into a crack to a depth of ~20cm, but could be inserted with similar ease to similar depth in soil without cracks at the site. (The depth of the cracks could not otherwise be ascertained as it was not visible from the surface and the soil structure and cracks collapsed easily with digging.)

Figure 6. Cracking at Site 3. These cracks do not show up well in the photo because of their smaller size and the high contrast shadows but were easily visible at the time.

A fourth site ('Site 4') on Braxton + Pukemutu soils with heavier pasture cover than sites 1 and 3 showed no cracking although the soil surface was difficult to see beneath the pasture. Large cracks would have been visible if a reasonable number had been there, but possibly smaller cracks such as those at Site 3 might have been present but not seen.

A site mapped as Tuatapere soils on Bayswater Road showed cracking at similar or somewhat greater density than Site 3 and the cracks were a similar or somewhat smaller size. There were frequent small stones on the surface of this soil. Tuatapere soil is described

Figure 7. Site 3 location.

as having stones at greater than 45cm depth, but it is contiguous in this area with stonier soils (Waiau and Glenelg) and may also have been modified by cultivation at some point.

Following the field observations on 30 January, sustained rainfall occurred on the properties and across the region beginning late January 31 and continuing through February 1. At Site 1 further observations were made by Abe to see how it responded to rainfall. At the location described above which was muddy in winter (i.e. where re-sowing had been prevented) no surface ponding occurred after 30mm rainfall or after 60mm rainfall. As this location was a slight depression, prone to ponding in winter, it is not thought that the rainfall was shed in runoff.

At the Environment Southland site, Central Plains Aquifer at Heddon Bush, about 2.7 km from Site 1, rise in the groundwater level in the 6m deep bore occurred within 12 hours of the onset of rainfall. The location of this site is mapped as Braxton and Pukemutu soils but it was found at installation to be stony, so the site description was changed to Glenelg soils. Earlier, lesser rainfall events in January had little effect on groundwater level. See Figure 8.

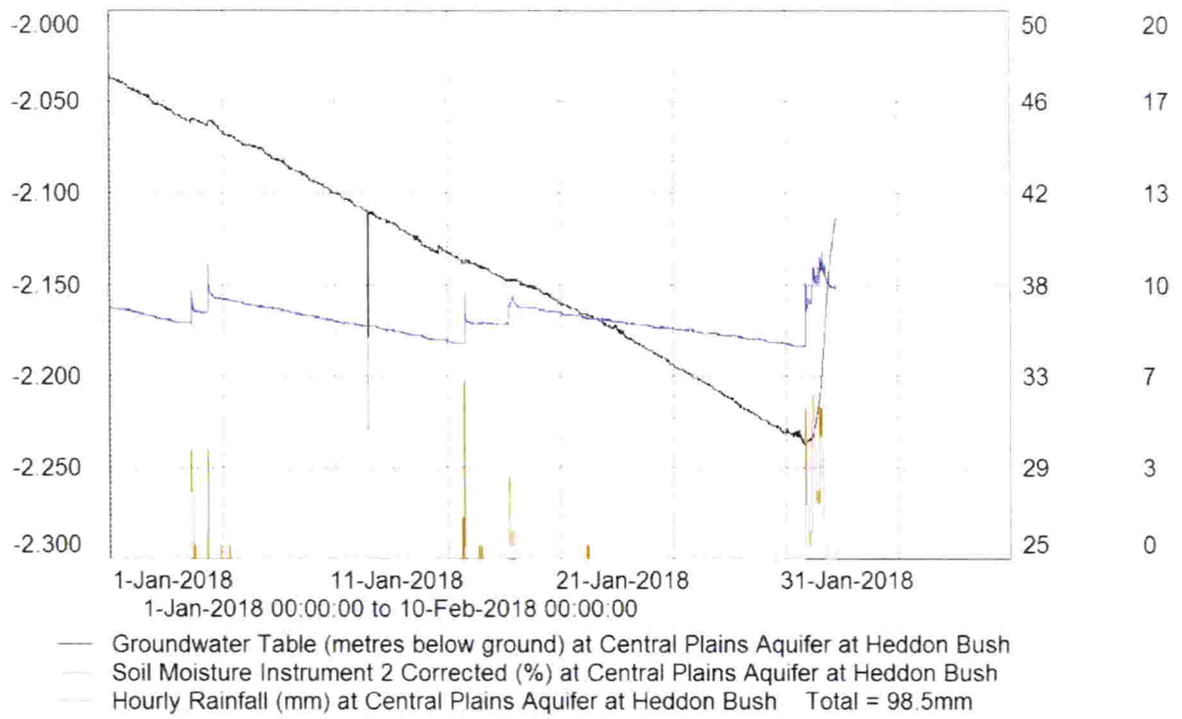


Figure 8. Groundwater level, soil moisture and rainfall at the Environment Southland Heddon Bush monitoring site.

Discussion

All the soils observed were dry and pasture was stressed and sparse to varying degrees. Some soils mapped as Braxton + Pukemutu showed cracks, while other soils with this mapped description did not. Likewise, some stony soils (mapped as Glenelg and Tuatapere) in the area were cracked and some not. It is not surprising that some stony soils were cracked as the fine matrix material in these soils is sourced from the same mafic parent materials in the Takitimu Mountains as the Braxton and Pukemutu soils, and so may also contain clays prone to shrink-swell behaviour. Cracking in stony soils may, however, have drawn less attention in studies of soil behaviour as it would not greatly alter the soil properties from those they are already thought to possess i.e. free drainage with risk of nutrient leaching.

The largest cracks seen were ~10mm wide. Most were 2-5mm wide. As discussed above, some Braxton/Pukemutu soils or variants were not cracked. Glenelg soils at the nearby Environment Southland monitoring site (Central Plains Aquifer at Heddon Bush) had volumetric soil moisture <35% throughout December 2017-January 2018 and <30% for two weeks prior to the observations[1] (and were not visibly cracked). Soil moisture at comparable sustained, low levels was last recorded at the Heddon Bush site in January-February 2008 which was recognized as a drought year. Soil temperature in the two weeks prior to the current observations was 18-27°C. In these conditions further drying of the soil occurs only slowly as the residual moisture is tightly held in fine pores, hence it would take a significant

[1] These soil moisture figures are the average of two calibrated soil moisture sensors at the Heddon Bush site. Calibration is against periodic neutron probe measurements.

continuation or intensification of the conditions then current to make the soils significantly drier with whatever structural changes might accompany that.

It seems reasonable to conclude that the occurrence of very large cracks such as feature in some anecdotes about the soils (e.g. 'to reach your arm into') would now be rare in the soils observed for this investigation, and might not occur. Continued development or changes in management of the soils e.g. the ongoing effects of drainage, or conversion from sheep to dairy, may have influenced the historical pattern of soil behaviour. Or it may be that occurrences of Braxton soils other than those described here, crack more.

The strong, friable structure of the Braxton/Pukemutu soils observed raises the prospect that they may behave as free draining soils when very dry, with or without visible cracking. This behaviour of the dry soils with regard to drainage, and the effects of cracks where present, has not been quantified, but is described in the literature relating to the Central Plains physiographic zone (see following link).

http://eswaterandland.datacomsphere.com.au/southland-science/physiographic-zones/physiographics-and-farm-management

The potential for Braxton and related soils to crack when dry – as was observed for some soils in the investigation described above - has perhaps attracted more attention than the general capacity of these soils for 'bi-modal' transport of leachate and contaminants, as described in the physiographic zone technical sheet, via more general structural changes which may include visible cracking. Understanding the transition from the 'summer soil' to the 'winter soil' – when wetting of dry soils occurs - could help further explain nutrient loss processes in the Central Plains physiographic unit where the observations described above were made.

During the investigation there was some discussion of the possible influence of different pasture conditions, or variations in soil type, on the prevalence or absence of cracking. Some soils in the area are thought to have been mapped previously as Makarewa soils (now Braxton). The distinction between these soils apparently relates to the geomorphic setting with Braxton soils on terraces and Makarewa soils on flood plains (because of this, Makarewa soils may also be younger). It was seen, however, that cracking could occur in a variety of soils in the area. Further investigations could shed light on the influence of pasture condition, soil type and moisture content on the drainage capacities of soils and thresholds of dryness and rainfall associated with deep drainage.

Further pictures of soil cracks follow, at the risk of emphasizing these at the expense of areas where cracks were few or absent. As there are not many pictures of the cracks, however, they are included here for interest.


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
1 2 3 4 5 6 7 8

See points 33-39 : Findings by Mr John Scandrett Regarding soil cracking

A HEARING BEFORE

ENVIRONMENT SOUTHLAND

Under An application under the Resource Management Act
APP-20171445

Applicant **WOLDWIDE ONE LIMITED**
ABE AND ANITA DE WOLDE

BRIEF OF EVIDENCE OF JOHN SCANDRETT

20 March 2018

29 To better understand the soil types and soil boundaries on Woldwide One and Two I made an inspection of the property on the 7 February 2017 and checked the soil profile in numerous paddocks. Comments and photographs and a farm map showing paddock numbers are appended.

30 My investigation showed much of the middle of Woldwide One had a soil profile better described as a Drummond soil than Braxton or Pukemutu or Glenelg.

31 Further evidence of this can be obtained from looking at the drainage map supplied in the FEMP page 5, which shows open drains, tile drains and critical source areas. There are no known tile drains east of the tanker track to the Woldwide One dairy shed. Tile drains are only found in the south west corner of the farm which is correctly mapped as Braxton and Pukemutu soil. Drummond soils are free draining and would not normally have tile drainage installed.

32 As a consequence of this inspection the map of soil boundaries and soil types was redrawn and submitted with the consent application, section 6.2, Soil Types. These findings are important as the Council's information is that 90% of the property is on poorly drained soil.

Soil Drainage Properties and Potential for Cracking

33 My experience is that silt loam soils that have dried out such that the soil moisture content is close to wilting point may exhibit cracking but the degree and size of surface cracking is highly related to the soil cover. A well established pasture with good grass content is unlikely to show large soil cracks, i.e. no greater than 1 – 2 mm in breadth and of limited depth. That is because grass, particular ryegrass has a strong fibrous root system which provides significant soil strength and controls shrinkage.

34 By comparison soils with a sparse cover or newly establishing pasture will be much more prone to significant shrinkage cracks which could easily be 5mm wide or more.

35 These points are illustrated in the following photographs taken on the 5 December 2017.

36 The first is on a well-established pasture on a Drummond soil type on Woldwide One.

The second is on a newly establishing pasture on a Braxton soil type.

37 A knowledge of these properties can be incorporated into good farm management practices in regard to residual pasture length after grazing and effluent application. Effluent should not be applied to soil which exhibits severe cracking. Effluent receiving paddocks could be selected based on better pasture cover and a visual inspection to ensure minimal cracking. Limiting the depth of application will also reduce any potential risk of contaminants being lost below the root zone.

38 I have also frequently observed an increase in macroporosity in soils that approach wilting point at least in the topsoil, as subsequent pasture growth after the dry period stabilises the increased porosity in the profile. Therefore natural drainage properties are enhanced.

39 It is also my experience that dry soils have a significant ability to retain rainfall and drainage doesn't occur until the soil moisture content is at or above field capacity. The exception would be prolonged or high intensity rainfall which leads to soil surface ponding and by pass flow down the soil profile. Southland generally receives low intensity rainfall so a combination of free draining soil and a limited area of soil prone to cracking and a low incidence of high intensity rainfall should lower the risk of contaminant risk for this property

Soil Properties and Effluent Application and Storage

40 The Massey University Dairy Effluent Storage Calculator (DESC) categorises soils as being either high risk or low risk when it comes to effluent application.

41 The low risk soils, which are free draining, don't have the large continuous vertical macropores down the soil profile that are common to high risk soils. It is these large macropores that are created through either artificial drainage processes or natural processes, particularly changes in soil moisture content, that allow approx 90 % of the drainage water that passes down the profile to drop below the root zone.

42 Low risk soils exhibit what is termed by soil scientists as matrix flow, or piston flow when liquid is applied to them. The liquid moves uniformly down the profile displacing the moisture already in the profile. For this reason having a soil moisture deficit greater than the effluent irrigation depth is less crucial. Consequently there are more irrigation days available with low risk soils and less effluent storage is needed compared to high risk soils.

43 The risks of applying dairy shed effluent to land with a travelling irrigator are therefore lower when applying to low risk soils compared to high risk soils. Limiting the application depth to a maximum depth of 10 mm also helps control any potential loss of contaminants below the root zone. The travelling irrigator on Woldwide One has been checked in March 2018 and was found to have an average application depth across its wetted diameter of 6.2mm. This relatively low depth of application allows a reduced risk of loss of contaminants from the root zone, especially at higher soil moisture contents.

44 The availability of the wintering barn allows manure from the cows to be collected and applied to the land uniformly at a later date when there is active pasture growth. This greatly reduces the risk of nutrients being lost below the root zone. The even application from a slurry tanker is in contrast to how cows deposit dung and urine in a very patchy manner when grazing pasture or winter crop.

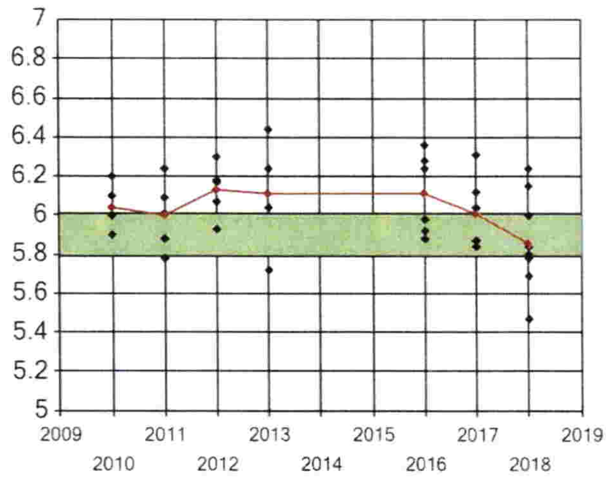
45 Mr de Wolde uses a trailing shoe slurry tanker which is used to take effluent from the storage pond and apply it to land at low depths. The actual depth of application is controlled by the

WOL dairy unit / WW1.

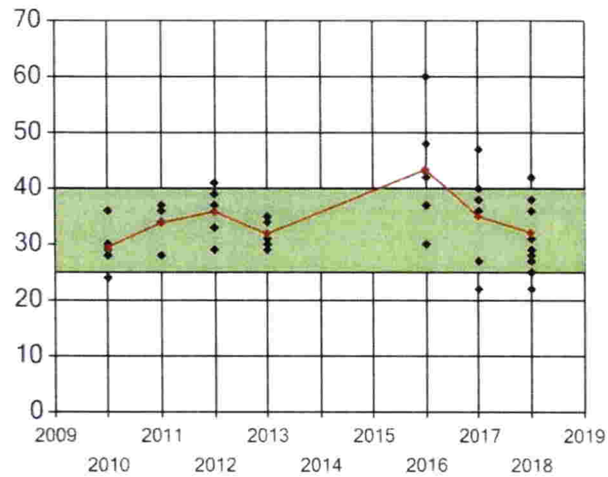
Soil Fertility Trends

Farm

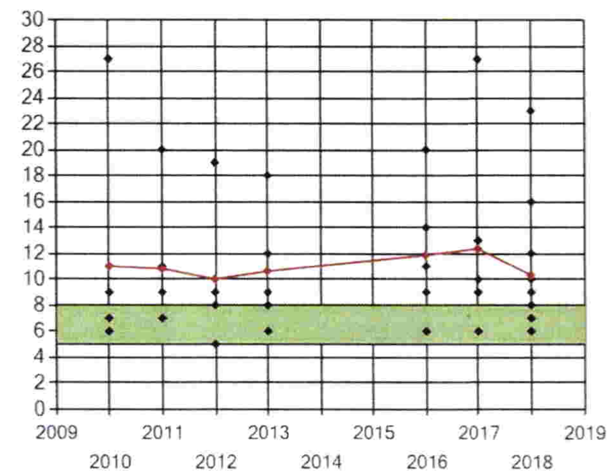
pH



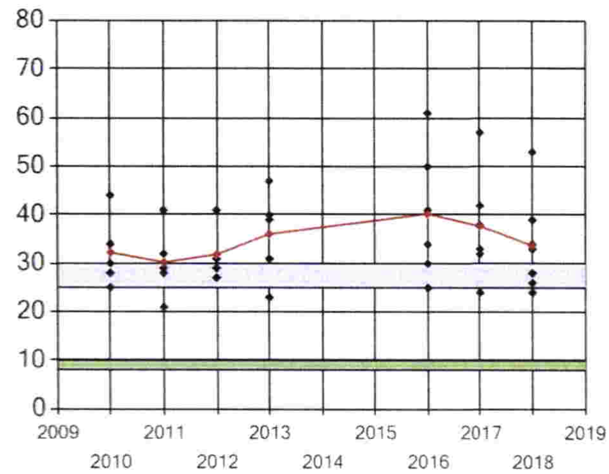
Olsen P



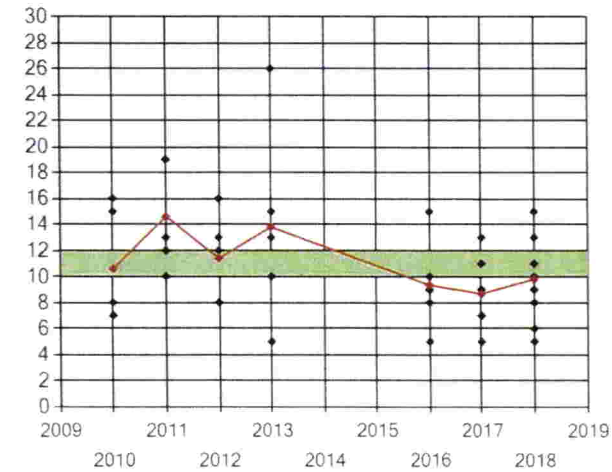
Potassium



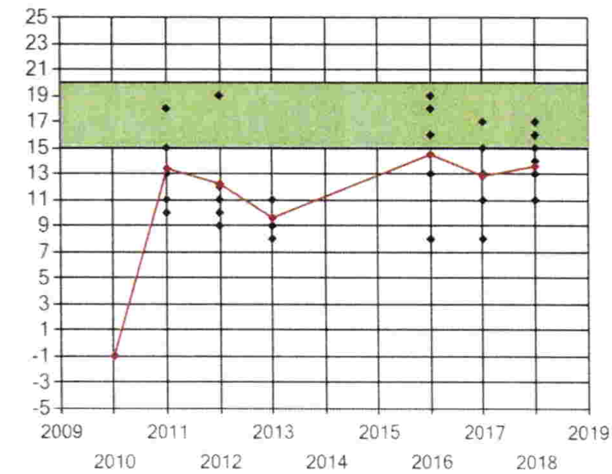
Magnesium



Sulphate S



Organic S



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Woldwide 1 Olsen P

0 60 120 240 360 480 Metres

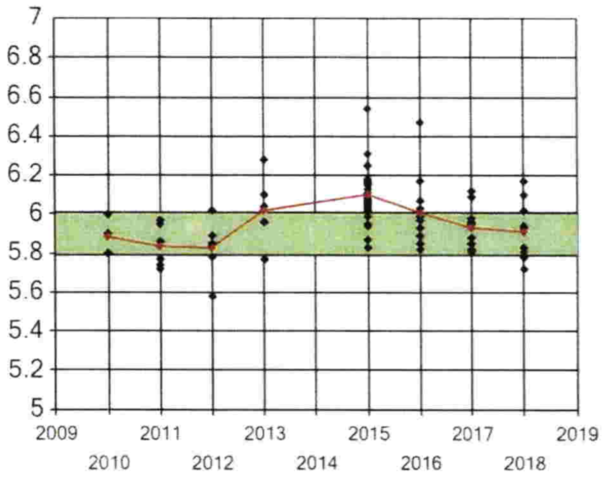
ravensdown

WTL dairy unit | WW2.

Soil Fertility Trends

Farm

pH



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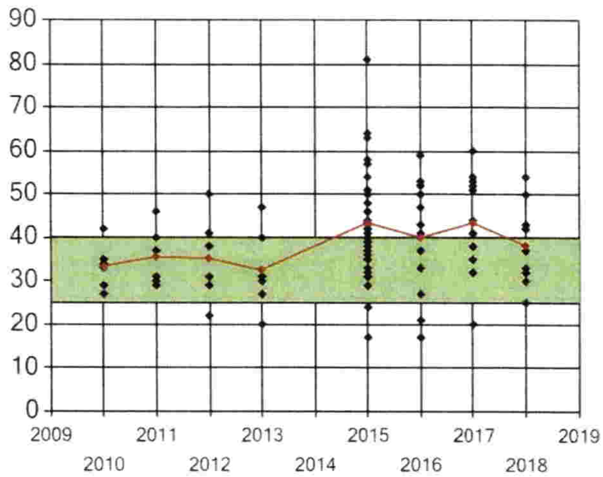
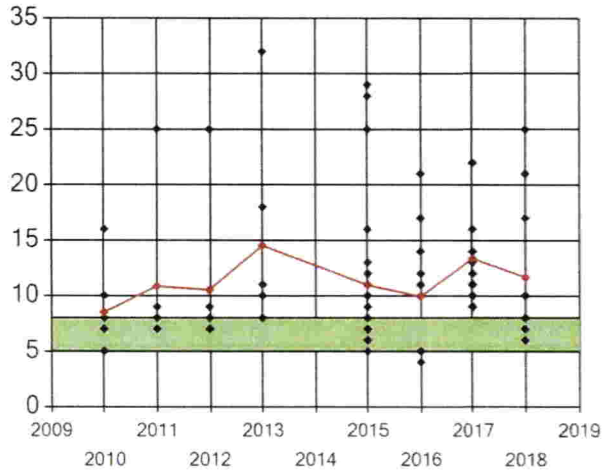


Potassium



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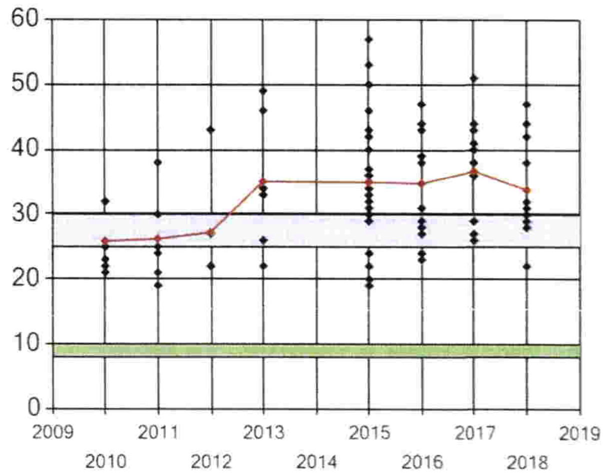
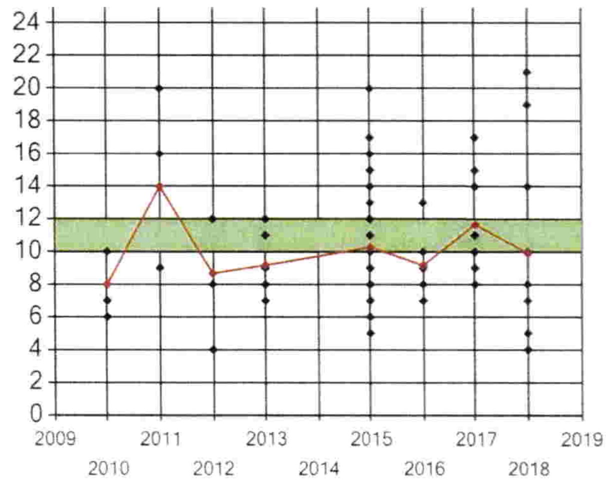
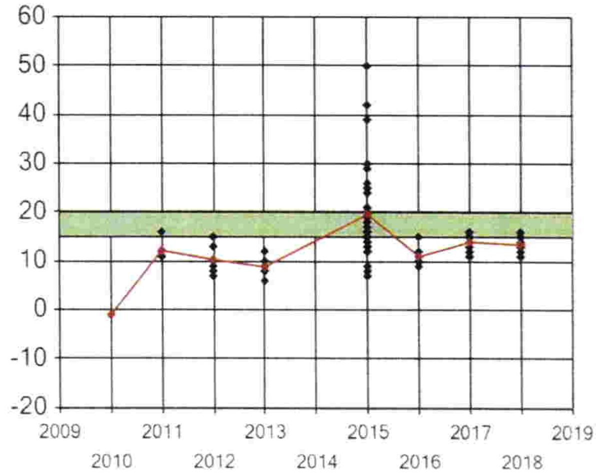


Sulphate S



Organic S



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Woldwide two Olsen P

0 62.5 125 250 375 500 Metres

ravensdown

Agronomy Plan

Horner 2018/2019

for WOLDWIDE FARM LTD

Prepared by Senior Agri Manager

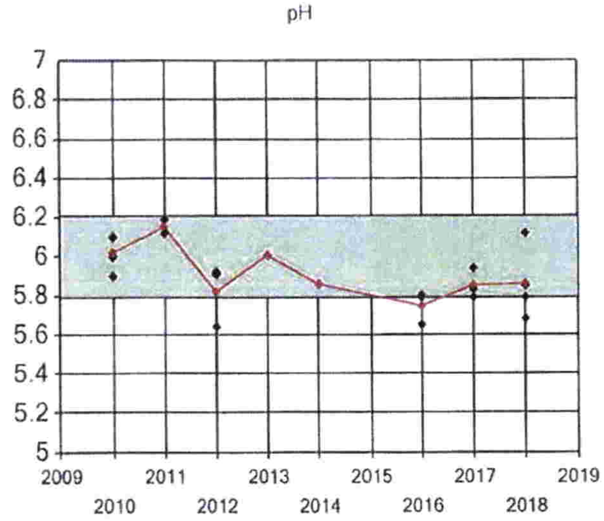
Kieran Anderson

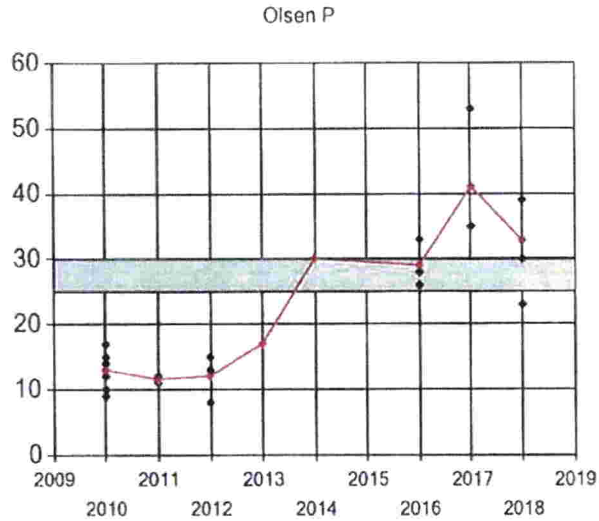
15/07/2018

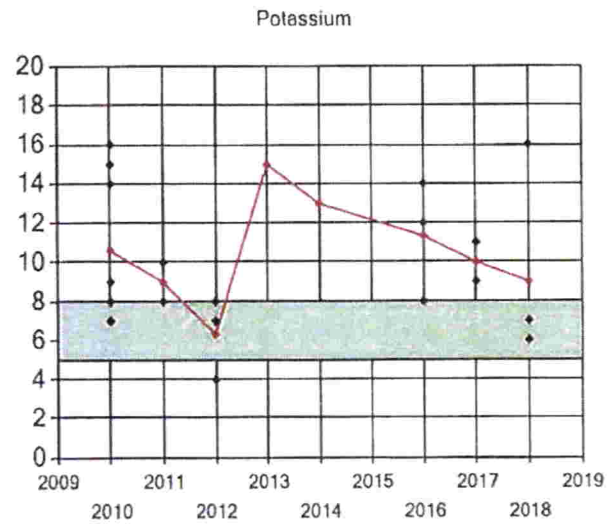
Customer Number: 60842383

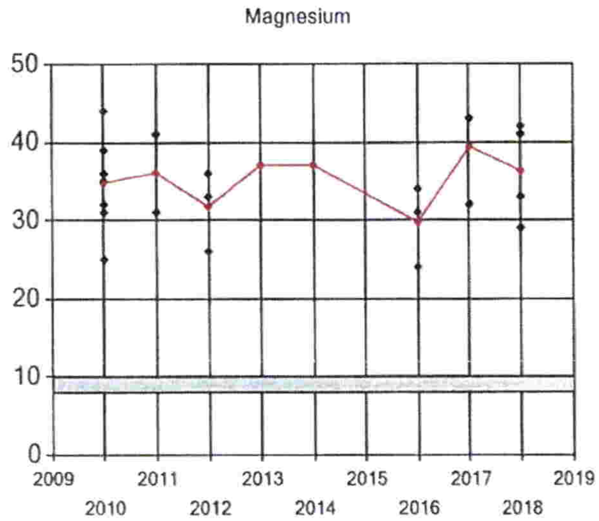
Soil Fertility Trends

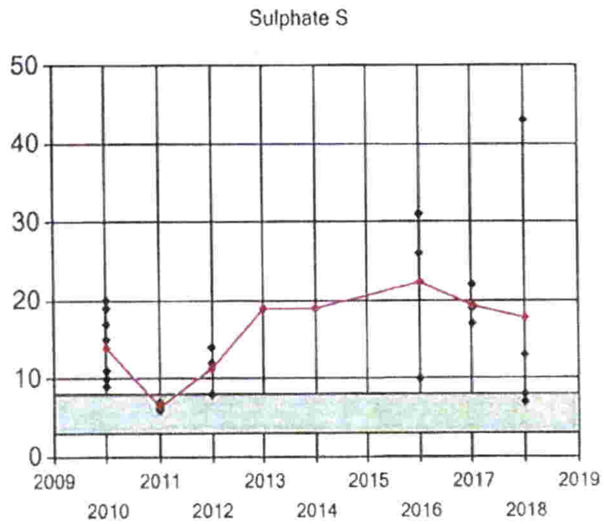
Horner Block

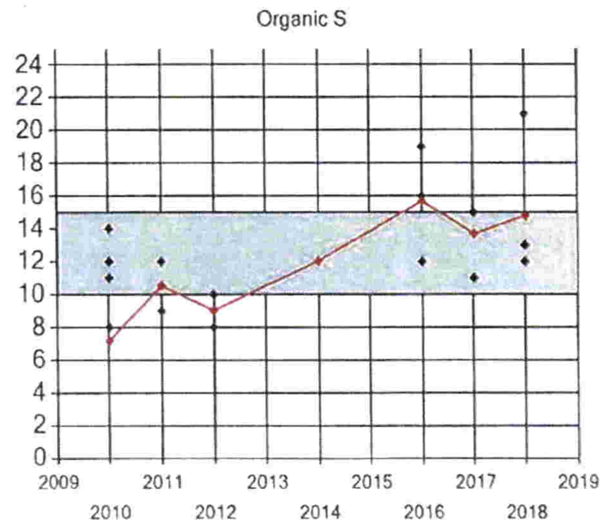


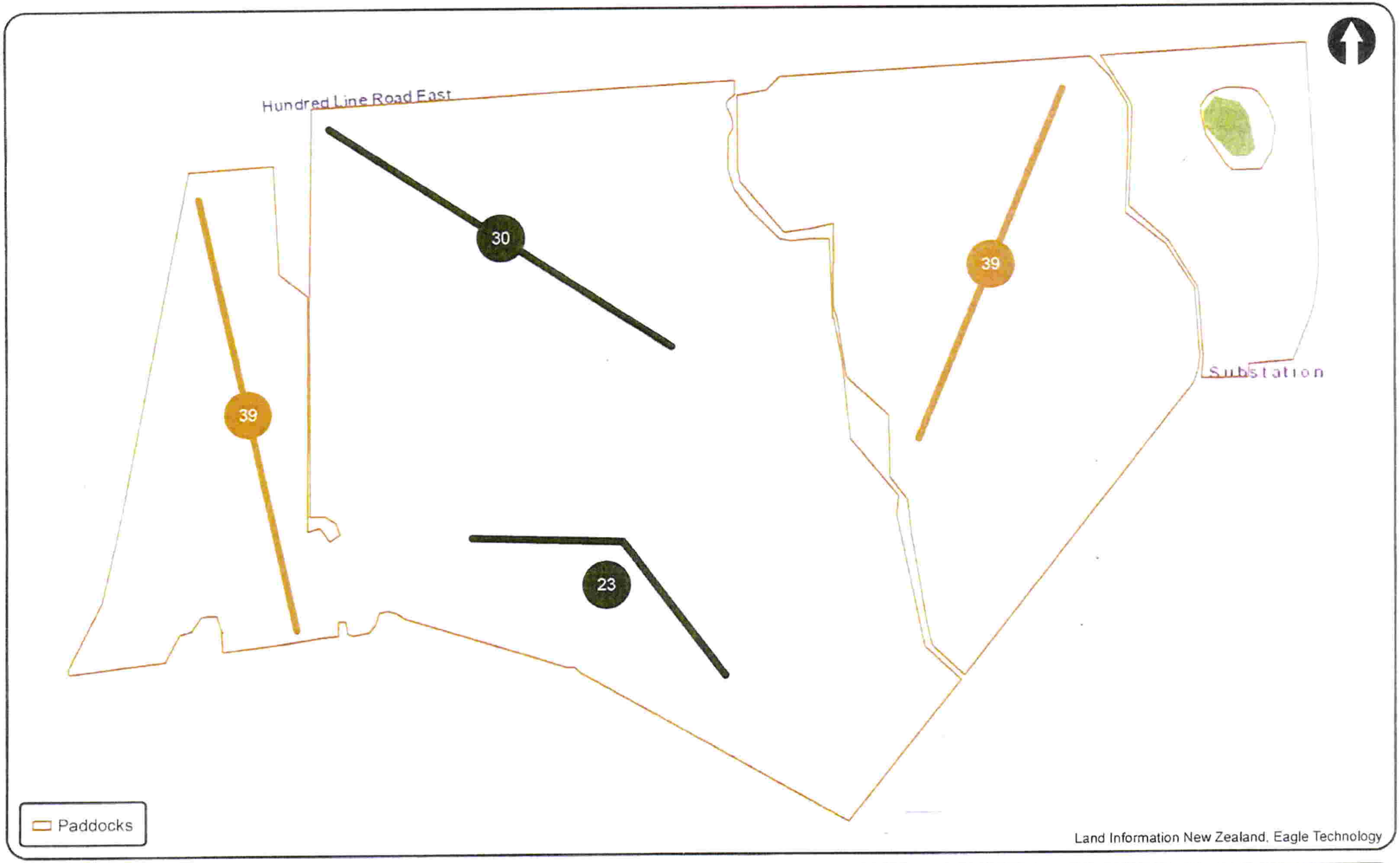












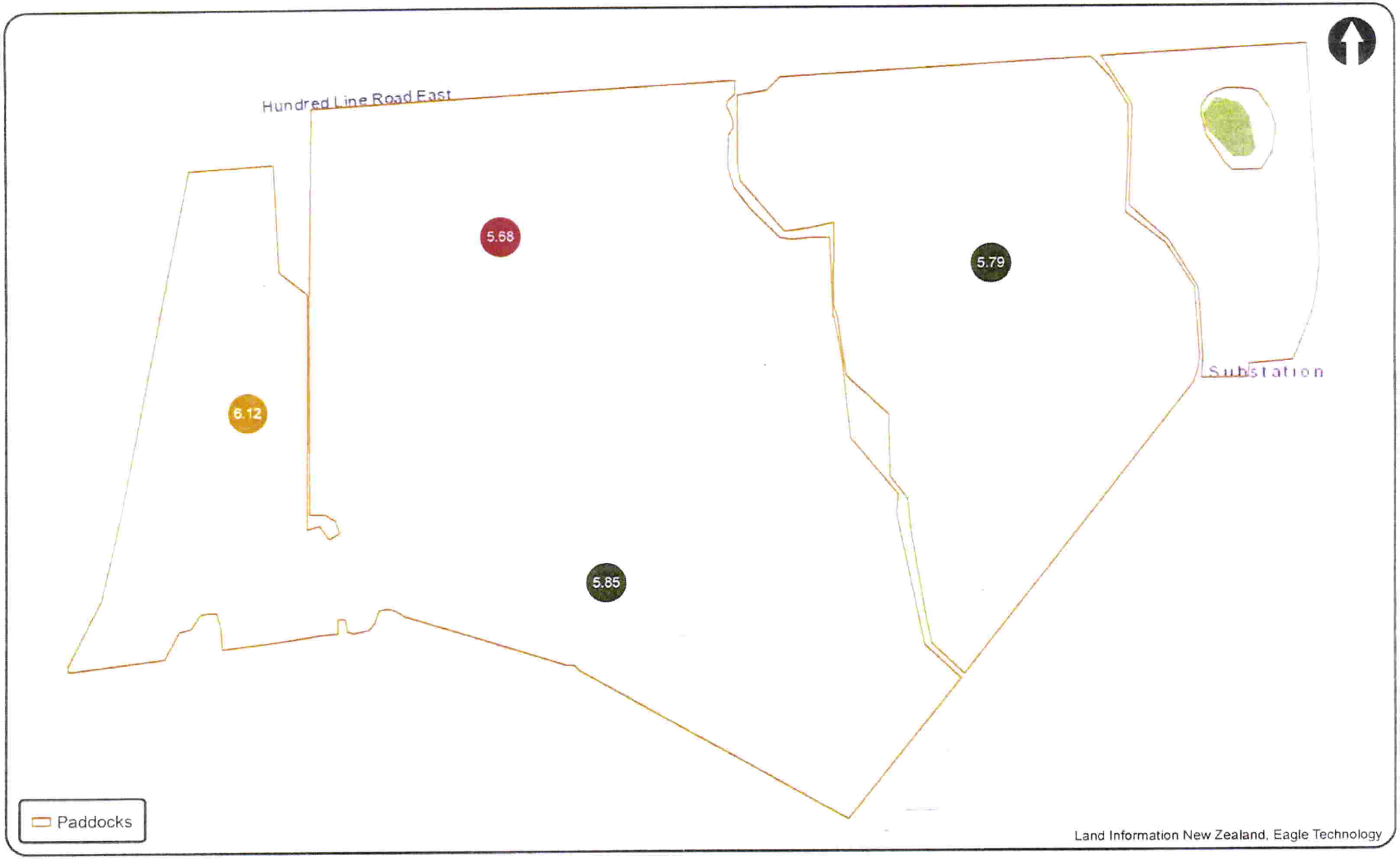
My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Horner Olsen P

0 50 100 200 300 400 Metres

ravensdown

15 July 2016



My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Horner pH

0 50 100 200 300 400 Metres

ravensdown

15 July 2016

My Ravensdown Smart Maps
www.myravensdown.co.nz
Note: Areas are in hectares

Horner K

0 50 100 200 300 400 Metres

ravensdown

15 July 2018