Before the Selwyn District Council

under: the Resource Management Act 1991

in the matter of: Proposed Private Plan Change 69 to the Operative District Plan: Lincoln South

and: **Rolleston Industrial Developments Limited**
Applicant

Evidence of Katherine McCusker (Versatile soils)

Dated: 4 November 2021

Reference: JM Appleyard (jo.appleyard@chapmantripp.com)
LMN Forrester (lucy.forrester@chapmantripp.com)

chapmantripp.com
T +64 4 499 5999
F +64 4 472 7111

PO Box 993
Wellington 6140
New Zealand

Auckland
Wellington
Christchurch

chapman tripp

STATEMENT OF EVIDENCE OF KATHERINE MCCUSKER
INTRODUCTION

1 My full name is Katherine Ann McCusker.

2 I am a Farm Environment Consultant with Pattle Delamore Partners Limited.

3 I hold a Bachelor of Agricultural Science degree and I am a member of the New Zealand Institute of Primary Management. I completed the Massey University Advanced Sustainable Nutrient Management course in 2015. I have over thirty years' experience as a farm consultant and farm environment consultant, much of this has been in the Selwyn Te Waihora catchment of Canterbury. Prior to my employment at PDP, I was employed by DairyNZ as an environmental change specialist for three years and by The Agribusiness Group for five years, both roles were based in Lincoln. I have worked with farmers in the Selwyn District for nearly 30 years.

4 I have particular experience in improving farm productivity while mitigating the environmental effects that can arise from that land-use change. This includes helping farmers manage poorly drained soils to reduce nutrient loss and sediment run off and improving farm sustainability.

5 I am familiar with the plan change application (PC69) by Rolleston Industrial Developments Limited (*the Applicant*) to rezone approximately 190 hectares of land on Springs Road, Lincoln to enable approximately 2,000 residential sites and three small commercial zones. I provide the following statement of evidence on the quality of the soils for agricultural production at the PC69 site.

CODE OF CONDUCT

6 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 7 of the Environment Court Practice Note 2014. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

7 My evidence relates to:

7.1 The quality of soils for agricultural production at the proposed Lincoln South Development; and

7.2 The areas of Highly Productive Soils within the Selwyn - Waihora catchment.

8 In preparing my evidence, I have reviewed and considered the following:

8.1 Information on the quality of the soils for agricultural production, as determined from:

(a) Soil types based on Landcare Research S-map database
(b) Soil information provided by an electromagnetic (EM) survey
(c) Auger and soil inspection
(d) Land Use Compatibility (LUC) mapping

These sources provide very comprehensive information on the soils, particularly in relation to the quality of the soils for agricultural production.

8.2 In addition, I visited the site on 13 May, and met with the Greenslade family who own the majority of the 190 ha proposed site. During this visit I undertook field observations of the site.

EVIDENCE

Soils within the subject property

9 I was engaged by Rolleston Industrial Developments Ltd to prepare a report relating to the productivity of the soils contained on this site. I attach this report at **Appendix 1**. My evidence remains the same as this report, with my key findings summarised in the following paragraphs

10 Detailed soil information for the property has been determined using an electro-magnetic (EM) survey carried out by Agri-Optics (now Vantage NZ) on 18-19 July 2014. It provides information for 79% (152 ha) of the property at 1491 Springs Road (the PC69 site). An EM survey measures and maps the variability in apparent electrical conductivity within the soil profile using sensors. The readings use GPS to an accuracy of 2 cm[1] and provide comprehensive data on the soil characteristics, including soil texture and moisture.

11 The remainder of the soils on the property (21%, 38 ha) have been assessed using S-Map and a visual/physical inspection using a soil auger taken by Arron Stafford in 2014, as part of a Lincoln University

[1] Vantage EM surveying fact sheet. Note Vantage was formerly Agri-Optics who provided the EM mapping.

research project. During the auger and soil inspection mapping, coarse distinct soil mottles were identified in a number of samples and these provide additional evidence that the soils are regularly waterlogged.

12 EM and physical mapping show the area of Templeton soil as 4.6 ha, 2% of the property, which is the better soil for agricultural production. S-map shows 11 ha of Templeton soils, however approximately 5 ha of this has been disturbed by quarrying. The remaining 98% of the soils at the property are imperfectly or poorly drained. The most detailed mapping shows that 83.1 ha (43%) has poorly drained soils that are vulnerable to waterlogging and has severe limitation for agricultural production and 105.3 ha (55%) is likely to be Wakanui soil that is imperfectly drained and with areas of wet or waterlogged soil, when surveyed in July 2014, providing limitations for agricultural use.

13 Land Use Capability (LUC) classifications of the PC69 land are based on the New Zealand land Resource Inventory (NZLRI) (Ministry of Works and Development 1979) land resource database. The LUC maps show that the property is good multiple-use land (i.e. LUC Classes 1-3). However, all the LUC classifications on this property have a dominant limitation of wetness.

14 The Land Use Capability mapping uses the Fundamental Soil Layers (FSL), derived from the New Zealand Land Resource Inventory (NZLRI), whereas the more modern S-map provides more detailed information on water holding capacity of soils and drainage classes and some of the soil boundaries were recently updated. A 2020 comparison of S-map information with the older fundamental soil layers showed the area of highly productive land in the Canterbury region derived from the two data sources differs by 116,912 ha [2]. This is due to more accurate differentiation and determination of soil characteristics such as soil texture, drainage, permeability, depth to slow layers, rooting depth, and topsoil stoniness in S-map. This comparison showed there were differences between FSL and S-Map in the drainage class for most of the area between Lincoln and Te Waihora, where this site is located.

15 In my opinion, the LUC mapping is likely to be the least accurate source of soil information, particularly as this farm has detailed soil information provided by EM mapping, auger and visual observations.

16 The farm environment plan for the PC69 property and my discussions with Mr and Mrs Greenslade who farm the property, confirm that they actively manage and mitigate issues that arise from farming poorly

[2] Lilburne L.R., Guo J., Barringer J., Lynn I., Webb T., Hainsworth S., Teixeira E., Metherell A., 2020. Comparison of S-map soil information with the older fundamental soil layers: implications for modelling. In: Nutrient Management in Farmed Landscapes.

drained soils that are vulnerable to phosphorus leaching and runoff, sediment loss and compaction. Figure 2B of my report attached as **Appendix 1** shows the areas identified as poorly drained soils. Mr and Mrs Greenslade confirmed to me that these areas are very rarely cultivated, so are not suitable for crops and the soils must be carefully managed for dairy farming due to the wetness. This careful management involves use of direct drilling in dry periods to avoid soil compaction and no winter crops are grown to avoid the risk of pugging.

17 The current farming operation creates a risk of sediment, faecal coliforms and phosphorus runoff to the drains and creeks that flow into the Ararири/LII River, which has poor water quality and flows into Te Waihora (Lake Ellesmere). This property is located within the Selwyn Te Waihora Phosphorus zone[3], so needs to manage soil Olsen P, and phosphate fertiliser use to reduce phosphorus runoff and leaching.

Soils within the Selwyn Waihora catchment

18 As noted above, only about 4.6 ha (2%) of the property's soils are classified as having medium soil water holding capacity, are moderately well drained and are suitable for multiple land uses. These better soils occupy a very small part of the proposed development area.

19 The most versatile soils in the Selwyn Te Waihora catchment are those that are classified as deep soils (1% of the catchment soils), followed by soils that have a medium water holding capacity and are moderately well drained. These soils are suitable for multiple land uses with very few limitations. There are approximately 95,690 ha (34%) of these medium soils in the catchment. The property has 4.6 ha of soils that are in this category, which is equivalent to 0.005% of medium soils in the Selwyn Te Waihora catchment. Figure 3 of my report shows a map of these areas.

RESPONSE TO SUBMITTERS

20 Many of the submitters are concerned about the loss of Highly Productive land that would occur if Plan Change 69 rezoned land from Rural (Outer Plains) to Living Z, Living X (Lincoln) and Business 1. In general, I agree that the loss of Highly Productive land is a concern. Those submissions reference the relevance of the proposed National Policy Statement on Highly Productive Land (pNPS-HPL). The submitters have based their concerns on the Selwyn District Council's Baseline Assessment (DW015) and the Land Use Capability maps of the area. Based on this assessment, 34 ha of the land is Class 1 land. However, the more detailed information that is available from EM

[3] As defined in the Canterbury Land and Water Regional Plan.

mapping, S-map and physical inspection shows that this site has only 4.6 ha of highly productive land that is not limited by poor or imperfectly drained soils. I consider that PC69 would represent a minor loss of the overall Class 1 and Class 2 versatile soil resource.

21 As noted earlier in my evidence, both the Selwyn District Council's Baseline Assessment (DW015) and the Land Use Capability are based on the NZLRI Fundamental soil layer database. The more modern S-Map has comprehensive data available for the Selwyn district at a 1:10,000 scale compared with the NZLRI that was compiled at a scale of 1:63,360 and 1:50,000 scale. A comparison of S-Map and the Fundamental soil layers by Lilburne et al, 2020 showed forty percent of the area in common between the two data sets has different drainage classes assigned and, in my opinion, this has occurred on the PC69 property. Therefore, the areas of soils described in my evidence provide a more accurate assessment of the soils that would be affected by this proposed plan change.

COMMENTS ON THE SECTION 42A REPORT

22 I have read the s42A report. With regard to paragraph 64, I agree that the soils within PC69 area are heavier and poorly drained compared with other areas containing Class 1 and 2 soils around Lincoln, including those to the northwest that have been recently developed for residential purposes. In general, I agree with the section on versatile soils in the section 42A report. The Officer has commented that PC69 would represent a moderate loss of the overall Class 1 and Class 2 versatile soils around Lincoln. However, that statement fails to acknowledge the difference in productive land use options arising from the drainage limitations. As noted earlier in my evidence, there is only 4.6 ha of highly productive land and the loss of that land from agricultural development is of a minor scale for the Lincoln area.

CONCLUSION

23 The area of Templeton soil that is the better soil for agricultural production is 4.6 ha (2%) of the soils. The remaining 189 ha (98% of the property) are imperfectly or poorly drained soils. The imperfectly or poorly drained nature of these soils provides limitations for agricultural use.

24 There are approximately 95,690 ha of soils suitable for multiple land uses in the Selwyn Te Waihora sub region. The 4.6 ha of medium soils in the proposed development only represents 0.005% of these soils.

Dated: 4 November 2021

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Katherine McCusker

APPENDIX 1

SOIL CONSIDERATIONS – LINCOLN SOUTH DEVELOPMENT

1.0 INTRODUCTION

Pattle Delamore Partners (PDP) have been engaged by Rolleston Industrial Developments Ltd to provide a report outlining the quality of soils for agricultural production at the proposed Lincoln South Development. The land is located at 1491 Springs Road, south of Lincoln township, upgradient of Te Waihora / Lake Ellesmere, as shown in Figure 1 attached to this letter. The majority of the 193 ha property is currently owned by John and Leslie Greenslade and is run as "The Springs" dairy farm, with some intensive winter feed crops.

PDP (Katherine McCusker) visited the site on 13 May 2021 and met with John and Leslie Greenslade and their son and made some soil observations.

2.0 QUALITY OF SOILS FOR AGRICULTURAL PRODUCTION

2.1 Soil Mapping

For the majority of the proposed Lincoln South development, there are four different sources of information available on the quality of the soils for agricultural production. These sources are:

- Soil types based on the Landcare Research S-map database
- Soil information provided by an electromagnetic (EM) survey
- Auger and soil inspection
- Land use capability (LUC) mapping

These sources provide very comprehensive information on the soils and the information is summarised below.

2.1.1 Soil Types based on Landcare S-map Database

The Landcare Research S-map database is a digital soil spatial information system for New Zealand. S-map data includes fundamental soil property data (e.g. depth, stoniness, clay and sand content) created from field observations and expert knowledge, as well as derived soil data based on models, at a 1 to 10,000 scale. S-map shows that the property has the following soil types:

- 69 ha: Flaxton_4a.1 (50%) and Temuka_18a.1 (50%)
- 87 ha: Wakanui_1a.1 (80%) and Wakanui_3a.1 (20%)
- 26 ha: Taitapu_20a.1 (50%), Waimairi_16.1 (25%) and Taitapu_16a.1 (25%)
- 9 ha: Templeton_4a.1 (50%), Temp_3a.1 (30%) and Temp_2a.1 (20%)
- 2 ha: Templeton_2a.1 (60%), Eyre_1a.1 (30%) and Eyre_3a.1 (10%).

A map of these soils is shown in Figure 2A attached and their details are summarised in Table 1, later in this letter.

2.1.2 Soil Information Provided by Conducting an EM Survey

Detailed soil information is available for 79% (152 ha) of the property at 1491 Springs Road. This data was determined using an EM survey by Agri-Optics (now Vantage NZ) . An EM survey measures and maps the variability in apparent electrical conductivity within the soil profile through the use of sensors. The readings use GPS to an accuracy of 2 cm[4] and provide comprehensive data on the soil characteristics. The measured conductivity can then be linked to different soil characteristics, such as stone and clay content, for zoning differing management zones. The data was used to make two highly detailed maps of soil variability at
0-50 cm and 0-125 cm depth.

Image A, below, shows the variability of available water (wetness) in the top 0-50 cm of the soil profile as found by the EM survey conducted by Agri Optics Ltd on 18-19 July 2014. Areas in red on this map are lower EM conductivity areas, with lower available water, at the time of surveying. Areas in blue are areas of higher EM conductivity, with higher available water by comparison, at the time of surveying.

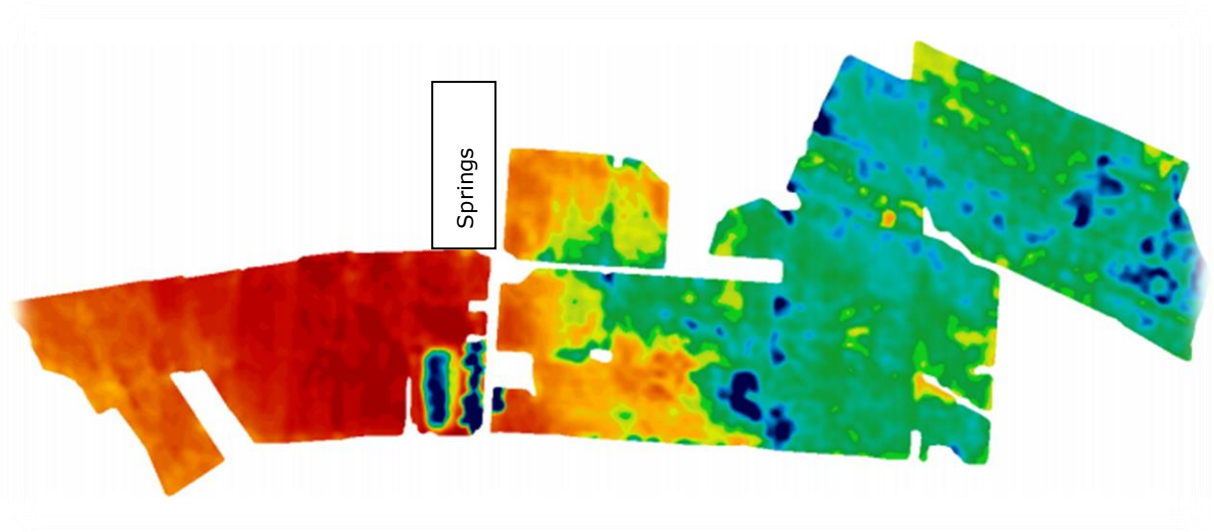


Image A: EM survey of the 0 – 50 cm soil profile

Image B, below, shows the variability in the soil profile from 0-125 cm. These measurements were taken simultaneously with the 0-50 cm measurements. Areas in red on the map are lower EM conductivity areas, typically with a higher gravel and lower water content than the blue areas (higher EM conductivity). It shows that the sub soil (areas below 50 cm deep) is wetter than the top soil in the blocks east of Springs Road. It also shows a block west of Springs Road at the bottom of the map where the soil has been disturbed (quarried and filled with a different soil) shown as very dark blue (wet) and surrounded by red (drier) soil. This block is 5 ha. This is significant in that this disturbed

[4] Vantage EM surveying fact sheet. Note Vantage was formerly Agri-Optics who provided the EM mapping.

soil site is on approximately half the area identified in S-map as Templeton soil (i.e. the better agricultural soil).

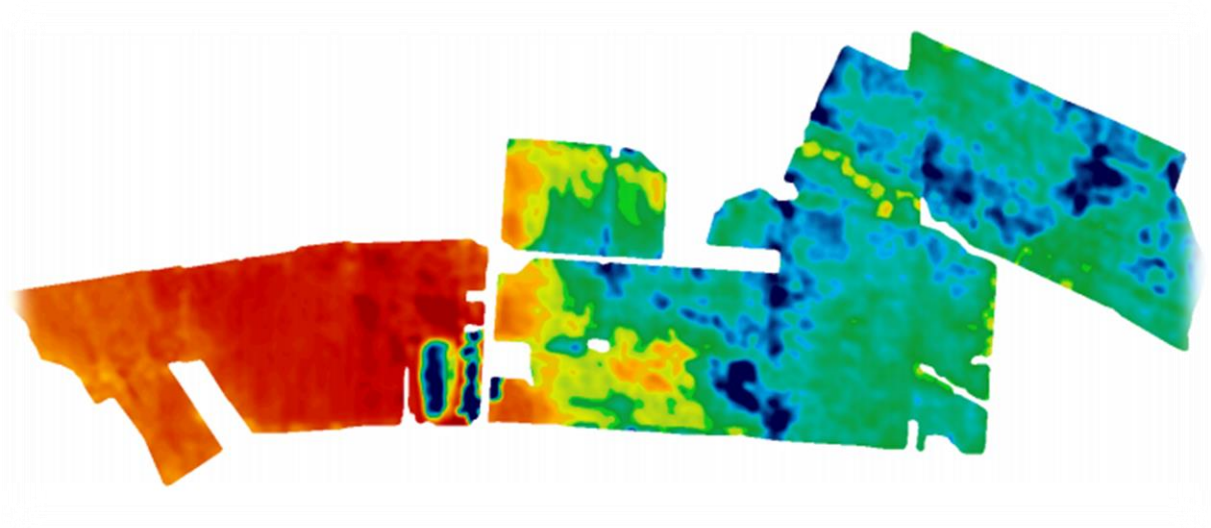


Image B: EM survey of the 0 – 125 cm soil profile

2.1.3 Auger and Soil Inspection to provide a Soil Map

Additional information on this property has also been collected using core samples taken from eight sites across the property, using a visual/physical "auger and soil inspection" approach. Auger samples were taken down to about 1 m depth, in an 80 m grid across the property to create a detailed, farm specific soil map, to align and compare with the EM soil survey maps. During the auger and soil inspection mapping, coarse distinct soil mottles were identified in a number of samples and these provide additional evidence that the soils are regularly waterlogged.

This detailed information was provided by Aaron Stafford as part of a Lincoln University research project. The map developed from the auger and soil inspection combined with the EM survey is provided as Figure 3, attached to this letter. Note PDP have updated the soil names to align with the current S-map naming, as Manaaki Whenua Landcare Research have updated soils since Aaron Stafford developed the map in 2014.

There are differences between S-map and the EM mapping/physical mapping of the boundaries of the soils, particularly between the boundary of the Flaxton/Temuka and the Taitapu/Waimairi soils. However, all these soils are gley soils that are poorly drained and affected by waterlogging. The difference between these soils is the amount of water they hold, shown in the profile available water (PAW), which ranges from high at 98 mm to very high at 175 mm. The most detailed mapping shows that 84 ha (44%) of the farm has poorly drained soils, vulnerable to waterlogging and with severe limitations for agricultural production.

In addition, 105 ha (54%) is likely to be Wakanui soil that is imperfectly drained and has areas of wet or waterlogged soil when surveyed in July 2014, which has limitations for

agricultural use. The remaining 4 ha (2%) of the farm has Templeton soils, which are suitable for multiple uses.

Further details on the soil properties and the impacts on farm management are given in Table 1 below, based on information contained in the Landcare Research S-map database and the on-farm mapping.

Table 1: Soil Characteristics					
Soil Name	**Soil Drainage**	**Soil Properties**	**Soil Management**	**S-map area of soil (ha)**	**EM/ physical mapping (ha)**
Flaxton _4a.1 (50%), Temuka_18a.1 (50%)	Poorly drained (blue on Figure 2B)	Gley soils are strongly affected by waterlogging, have light grey subsoils, and usually have reddish brown or brown mottles.	Poorly drained, Water logging vulnerability – high, Moderate risk of P runoff to surface water, N leaching vulnerability – very low, High structural vulnerability – prone to compaction by vehicles and stock.	69 ha	44.2 ha
		Waterlogging occurs in winter and spring, and some soils remain wet all year.	High profile available water (Flaxton 105 mm, Temuka 98 mm) to 60 cm		
Taitapu_20a.1, (50%), Waimairi_16.1 (25%), Taitapu_16a.1 (25%)	Poorly drained (blue on Figure 2B)	Gley soils are strongly affected by waterlogging, have been chemically reduced, have light grey subsoils, and usually have reddish brown or brown mottles. Waterlogging occurs in winter and spring.	Poorly drained with very high vulnerability of water logging, and high soil water holding capacity. These soils have a high structural vulnerability, very low N leaching potential	26 ha	38.9 ha
			Moderate risk of phosphorus runoff to surface water.		
			Very high profile available water (PAW) (Taitapu 139 mm, Waimairi 175 mm) to 60 cm		
Wakanui_1a.1 (80%),	Heavy (green on	A mottled pallic soil, have pale coloured subsoils, due to low	Imperfectly drained, N leaching vulnerability low, No significant	87 ha	105.3 ha[2]

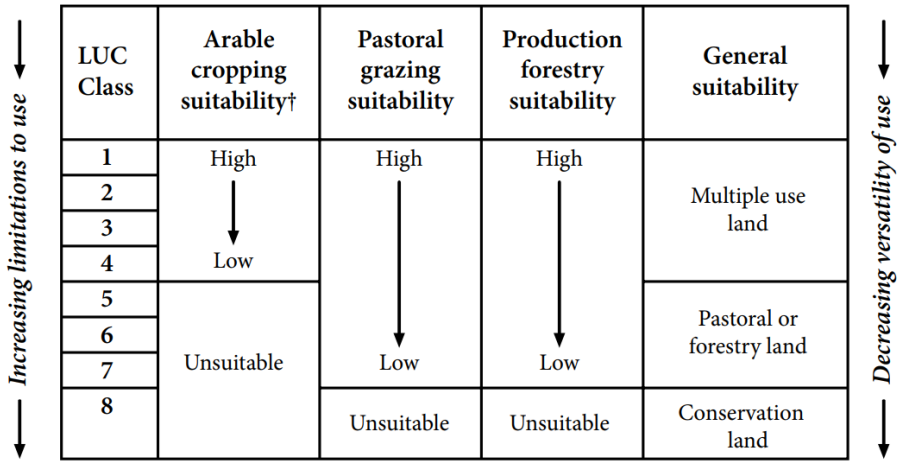
Table 1: Soil Characteristics					
Soil Name	**Soil Drainage**	**Soil Properties**	**Soil Management**	**S-map area of soil (ha)**	**EM/ physical mapping (ha)**
Wakanui_3a.1 (20%)	Figure 2B)	contents of iron oxides, have weak soil structure and high density in subsurface horizons. Pallic soils tend to be dry in summer and wet in winter.	pathways for P loss, High water logging vulnerability. High structural vulnerability – prone to compaction by vehicles, cultivation and stock		
Templeton_4a.1 (50%), Temp_3a.1 (30%), Temp_2a.1 (20%) and Templeton_2a.1 (60%), Eyre_1a.1 (30%), Eyre_3a.1 (10%)	Medium (orange on Figure 2B)	Moderately deep and well drained with moderate vulnerability of water logging in non-irrigated conditions, and has moderate to high soil water holding capacity.	Moderate risk of P runoff to surface water, N leaching vulnerability – very low, suitable for cropping	11 ha[3]	4.6 ha

Notes:

1. *Sources: S-map soil reports, Manaaki Whenua Landcare Research and EM and auger and physical soil inspection reports from Aaron Stafford. Only 164 ha was EM mapped.*
2. *Only 64.2 ha mapped but most of the 41 ha of unmapped soil is likely to be Wakanui.*
3. *Approx. 5 ha is now disturbed land, with approximately 6 ha remaining.*

2.1.4 Land Use Capability

The Land Resource Inventory (NZLRI) Land Use Capability (LUC) rates the ability to sustain agricultural production based on the assessment of soils, climate, the effects of past land use and the potential for erosion. There are eight classes, with LUC Class 1 being the best and LUC Class 8 being the worst, as shown in the diagram below[5] (Lynn et al., 2009).



The area of the plan change request is comprised of LUC class 1, 2 and 3 soils, as shown in Figure 4 attached to this letter. LUC shows the dominant limitation as a sub class. All areas on this property have wetness (w) as the dominant subclass, resulting from poor drainage or a high water table or from a frequent overflow from streams, which limits production. The soil type is one of the factors considered in the assessment of LUC. Under this assessment, the property has a mix of LUC rates with the property classed as having:

- LUC 1w1 – 34 ha – Most versatile multiple-use land, minimal limitations, highly suitable for cropping; dominant limitation is wetness;
- LUC 2w1 – 116 ha – Very good multiple-use land, slight limitations, suitable for cropping; dominant limitation is wetness;
- LUC 3w1 – 45 ha – Moderate limitations, suitable for restricted crop types and intensity of cultivation; dominant limitation is wetness.

There are differences for this property between the S-map soil boundaries and the boundaries of the LUC Class 1, 2 and 3. This is because the Land Use Capability mapping uses the Fundamental Soil Layers (FSL), derived from the New Zealand Land Resource Inventory (NZLRI), whereas the more modern S-map provides more detailed information on water holding capacity of soils and drainage classes and some of the soil boundaries

[5] Lynn et al. 2009. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3rd ed. GNS Science. 163p.

were recently updated. A 2020 comparison of S-map information with the older fundamental soil layers showed the area of highly productive land in the Canterbury region derived from the two data sources differs by 116,912 ha [6]. This is due to more accurate differentiation and determination of soil characteristics such as soil texture, drainage, permeability, depth to slow layers, rooting depth, and topsoil stoniness in S-map.

2.2 Management of Soils and Nutrients on the Property

The Flaxton/Temuka, Taitapu/Waimairi and Wakanui soils are all poorly drained or imperfectly soils and are prone to waterlogging, particularly in winter and spring. Untimely cultivation or grazing when these soils are wet can give rise to a rapid and marked loss of soil structure and can result in soil compaction, so these soils must be carefully managed to avoid damage. The current property owner has confirmed that they avoid cultivating much of the property to the east of Springs Road due to wetness and the risk of damaging the soils. All pasture renewal on this block is done by direct drilling during dry periods to avoid compaction or other problems. No winter feed crops are grown due to pugging risk. The soils on the western block are easier to manage and have less limitations.

The most productive soil on the property is 4 ha of the Templeton soil, based on the EM mapping. The Templeton topsoil is a fine sandy loam and is stoneless. The subsoil is a sandy loam with a few small greywacke stones, with a very gravelly layer extending continuously to 100 cm. The plant rooting depth extends beyond 1 m, making it suitable for cropping, with some limitations due to wetness.

The farm environment plan for The Springs Dairy Farm, provided by The AgriBusiness Group, indicates the way in which the farmer must actively manage and mitigate issues that arise from farming poorly drained soils that are vulnerable to phosphorus leaching and runoff, sediment loss and compaction.

This property is identified in the farm environment plan as being located within the Selwyn Te Waihora Phosphorus zone[7], so needs to manage soil Olsen P, and phosphate fertiliser use to reduce phosphorus runoff and leaching to Te Waihora/Lake Ellesmere and the loss of sediment from winter grazing. There is also a risk of sediment and phosphorus runoff to the drains and creeks that drain into the Ararīri/LII River, which has poor water quality due to high levels of suspended sediment, nutrients (phosphorus) and faecal coliforms. This sub-catchment feeds into Te Waihora and has special significance to Ngāi Tahu as a tribal taonga representing a major mahinga kai. A change of land use to urban has the potential to reduce the risk of sediment and phosphorus loss from grazing and fertiliser applications. With the current land use of dairy farming there

[6] Lilburne, et al. 2020. Comparison of S-map soil information with the older fundamental soil layers: implications for modelling

[7] As defined in the Canterbury Land and Water Regional Plan.

is also a risk of ruminant faecal coliform entering the water bodies from runoff from tracks and dairy effluent applications.

Current land use on the property is dairy farming and surrounding land use is urban, lifestyle blocks, grazing and dairying. There is very limited arable or horticultural land use in the Arariri/LII River sub-catchment that this property is located in.

3.0 Area of Highly Productive Soils within the Selwyn - Waihora Catchment

The Selwyn – Waihora Zone in the Canterbury Water Management Strategy stretches from Te Waihora up to Springfield and the Rakaia to the Waimakariri Rivers, it excludes the hill and high country areas of the Selwyn District. The majority of the LUC NZLRI classes 1 – 3 productive soils, in the Selwyn District, are in the Selwyn – Waihora zone. The soils of this area is shown in Figure 3, attached to this report, and their details are summarised in Table 2.

The most versatile soils in the Selwyn - Waihora are those that are classified as deep soils (1% of the catchment soils), followed by soils that have a medium water holding capacity and are moderately well drained. These soils are suitable for multiple land uses with very few limitations. There are approximately 95,690 ha (34%) of these medium soils in the catchment. The property has 4 ha of soils that are in this category, which is equivalent to 0.004% of medium soils in the Selwyn Te Waihora catchment.

Table 2: Selwyn Te Waihora catchment soils				
Soil classification	**Catchment soil area (ha)**	**Percentage of the catchment**	**Soil area on property (ha)**	**Percentage of property**
Deep	3,686	1%		
Heavy	31,278	11%	105.3	55%
Light	58,097	21%		
Medium	95,691	34%	4.6	2%
Poorly drained	32,074	11%	83.1	43%
Poorly drained, light	10,229	4%		
Very light	19,481	7%		
Extremely light	7,590	3%		
Unknown	23,318	8%		

Notes:

1. *Source S-map, Manaaki Whenua Landcare Research and EM mapping.*
2. *Unknown is disturbed land.*

4.0 SUMMARY

For the majority of the proposed Lincoln South development, there are four different sources of information available on the quality of the soils for agricultural production. There sources are:

- Soil types based on Landcare Research S-map database
- Soil information provided by an EM survey
- Auger and soil inspection
- LUC mapping

These sources provide very comprehensive information on the soils and the information about the quality of the soils for agricultural production. EM/physical mapping shows the area of Templeton dominant soil that is the better soil for agricultural production is 4.6 ha (2%) of the soils. The remaining soils (98% of the property) are imperfectly or poorly drained. The most detailed mapping shows that 83.1 ha (43%) of the farm has poorly drained soils that are vulnerable to waterlogging and has severe limitation for agricultural production and 105.3 ha (55%) is likely to be Wakanui soil that is imperfectly drained and with areas of wet or waterlogged soil, when surveyed in July 2014, providing limitations for agricultural use.

All the LUC classifications on this property have a dominant limitation of wetness. Even though the LUC mapping indicates that the property is good multiple-use land (i.e. LUC Classes 1-3), as this farm has detailed soil information provided by EM mapping, auger and visual observations, the LUC mapping is likely to be the least accurate source of soil information.

The farm environment plan for the property and discussions with the farmers confirm that they actively manage and mitigate issues that arise from farming poorly drained soils that are vulnerable to phosphorus leaching and runoff, sediment loss and compaction. They confirmed that the areas identified as poorly drained soils are very rarely cultivated, so are not suitable for crops and they have to be carefully managed for dairy farming due to the wetness.

The current farming operation creates a risk of sediment, faecal coliforms and phosphorus runoff to the drains and creeks that flow into the Arariri/LII River, which has poor water quality.

Approximately 4.6 ha (2%) of the property's soils are classified as having medium soil water holding capacity, moderately well drained and are suitable for multiple land uses. These better soils occupy a very small part of the proposed development area. There are approximately 95,690 ha of these medium soils in the catchment, and therefore, the 4.6 ha of medium soils in the development only represents 0.005% of the medium soils in the Selwyn Te Waihora catchment.

5.0 REFERENCES

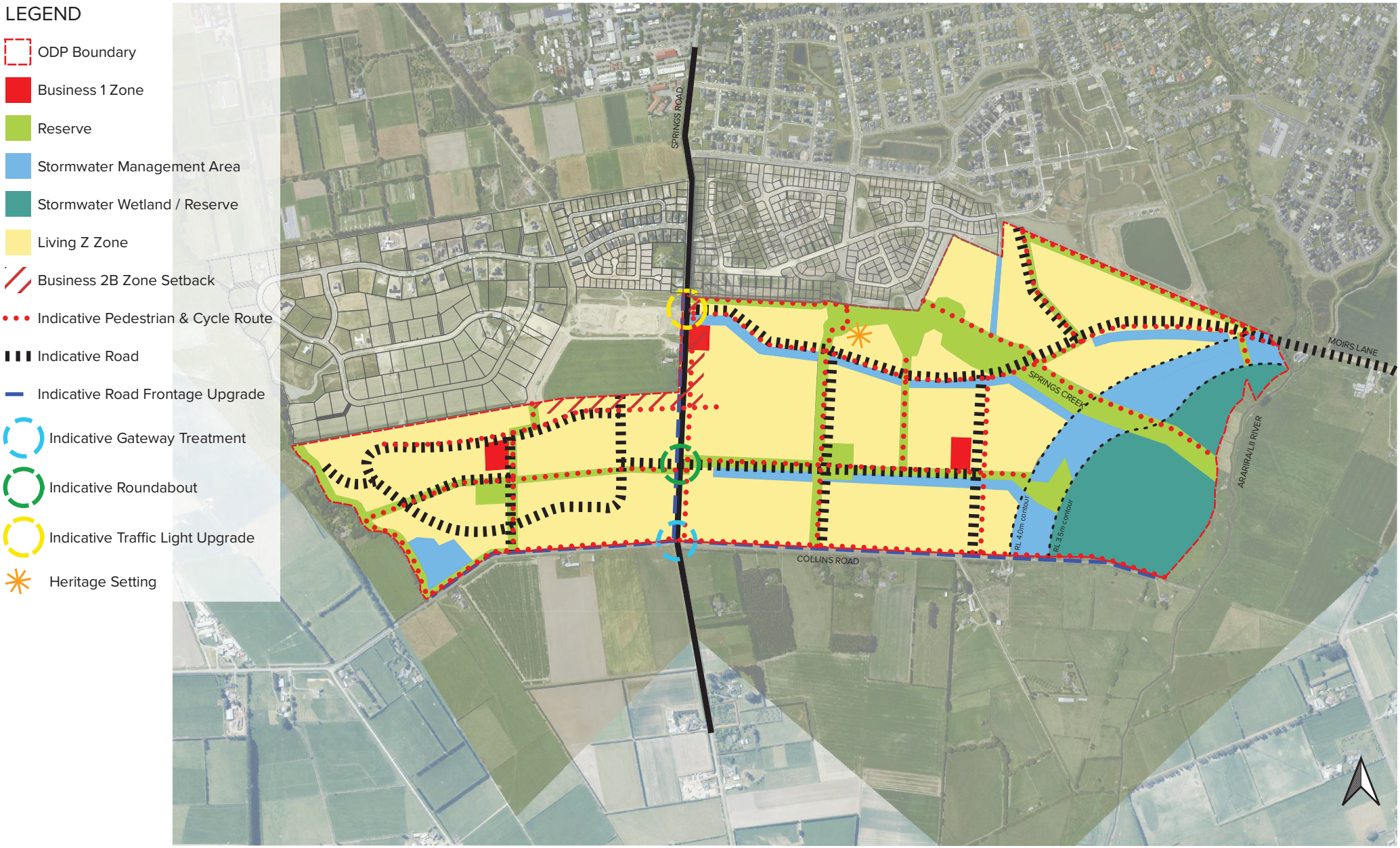
Lilburne, L., Guo, J., Barringer, J., Lynn, I., Webb, T., Hainsworth, S., Teixeira, E., Metherell, A. 2020. Comparison of S-map soil information with the older fundamental soil layers: implications for modelling. Paper_Lilburne_2020.pdf (massey.ac.nz).

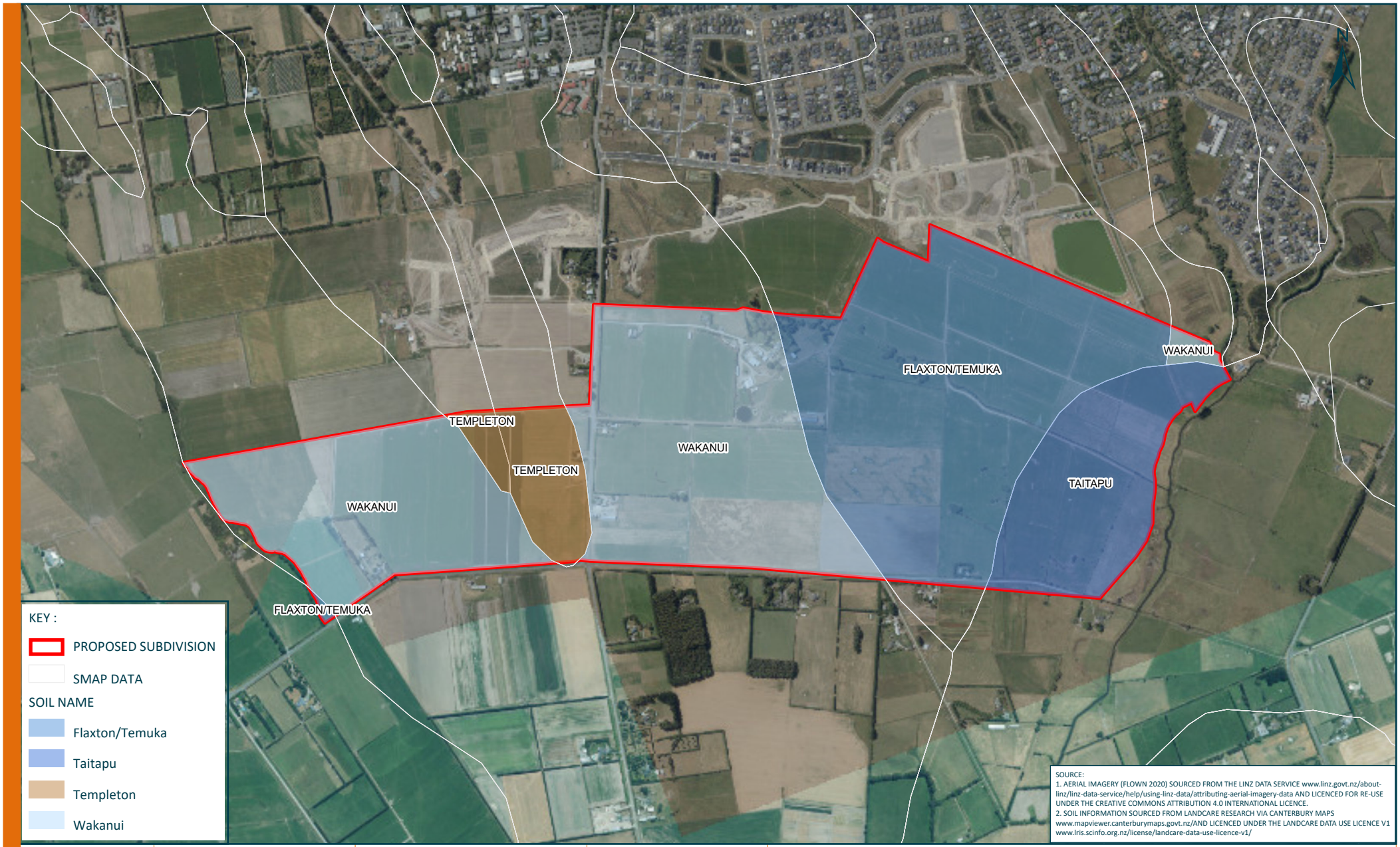
Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land

3rd ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163p.

Vantage New Zealand. 2021. EM soil surveying. Retrieved from https://www.vantage-nz.com/portfolio/em-soil-surveying/.

OUTLINE DEVELOPMENT PLAN (ODP) - LINCOLN SOUTH





0 250 500
METRES

SCALE : 1:15,000 (A4)

NO.	REVISION	DATE	BY
A	ISSUED	MAY 21	MR

ROLLESTON INDUSTRIAL DEVELOPMENTS LTD

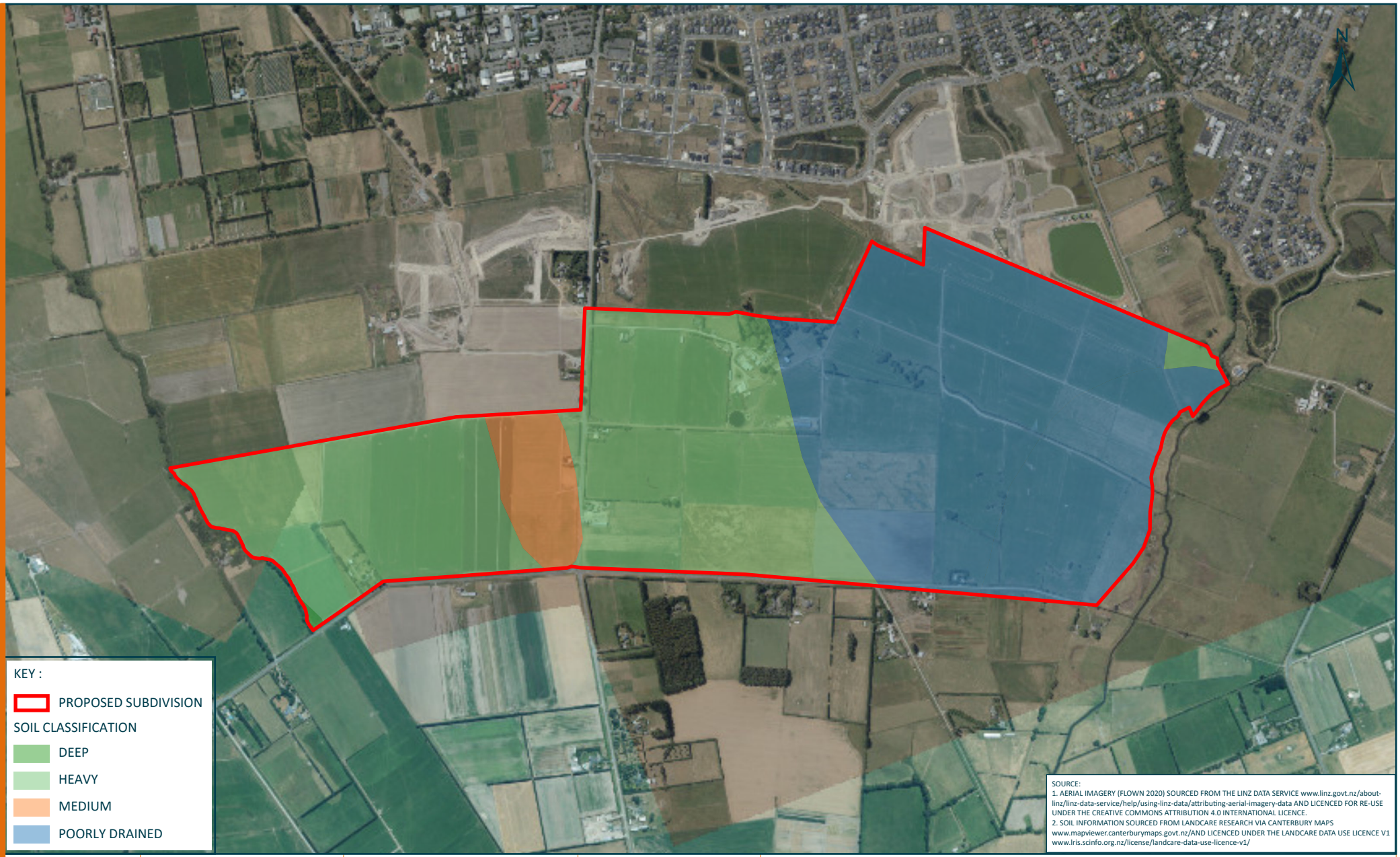
FIGURE

FIGURE 2A: SMAP SOIL DATA

PROJECT

LINCOLN SOUTH DEVELOPMENT

C04369500.aprx - C04369500_A4L_FIGURE_2B



0 250 500
METRES

SCALE : 1:15,000 (A4)

NO.	REVISION	DATE	BY
A	ISSUED	MAY 21	MR

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FIGURE

FIGURE 2B: SOIL DRAINAGE

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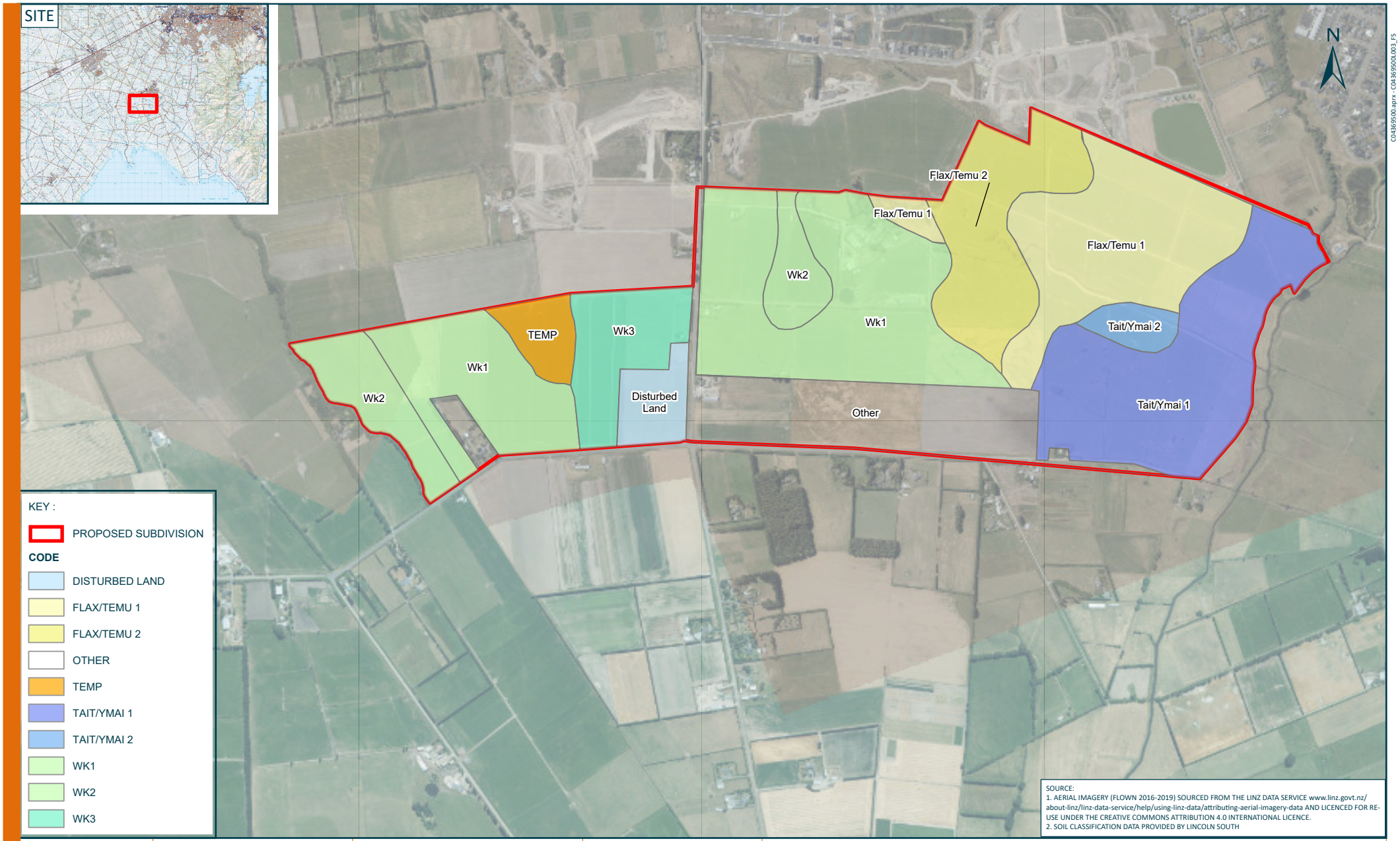
LINCOLN SOUTH DEVELOPMENT



CO4369500.aprx - CO4369500L003_F5

0 250 500
METRES

SCALE : 1:15,000 (A4)

NO.	REVISION	DATE	BY
A	ISSUED FOR REVIEW	MAY 21	MR

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FIGURE

FIGURE 3: PROPOSED SUBDIVISION SOILS - EM SURVEY

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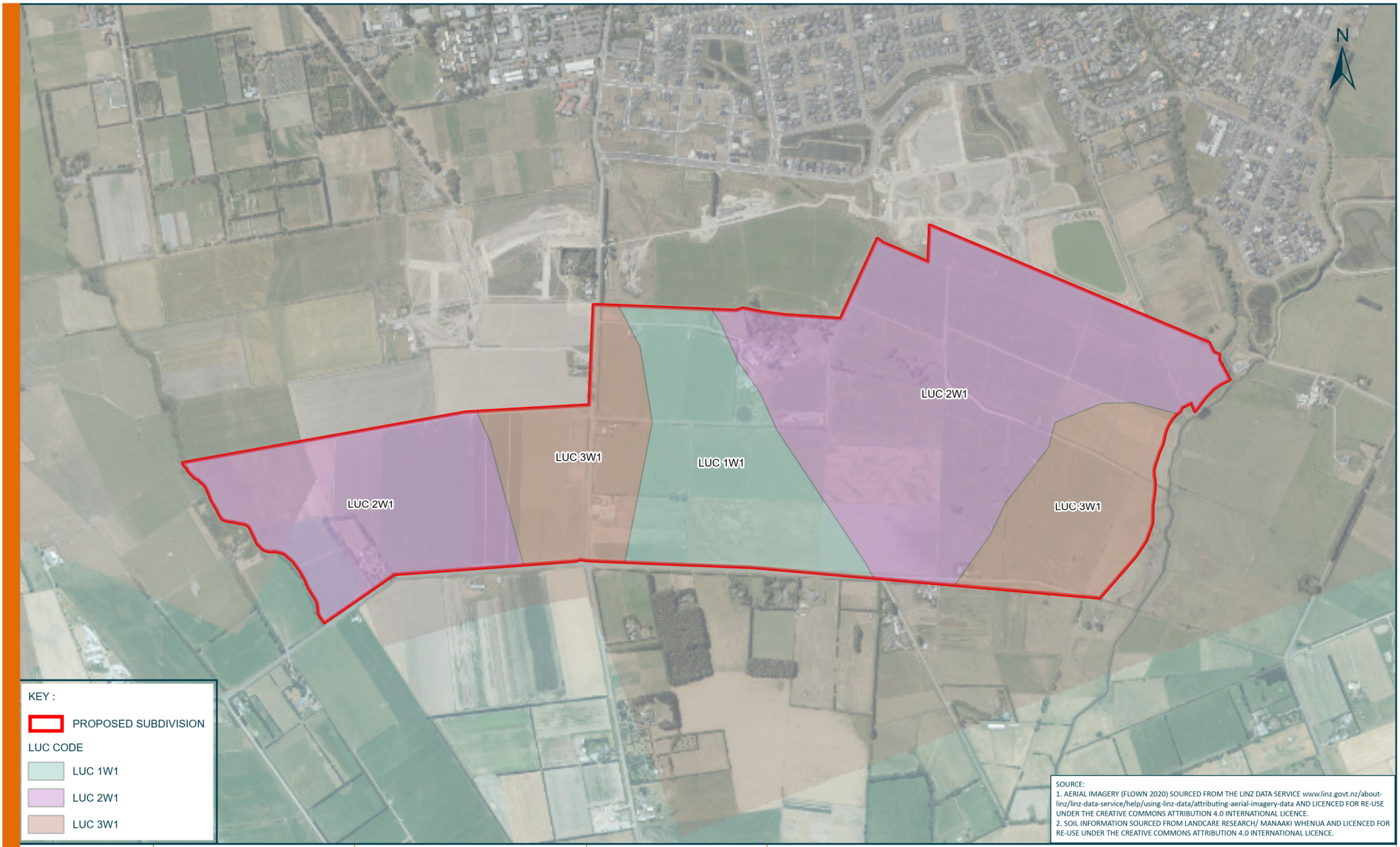
LINCOLN SOUTH DEVELOPMENT

CO4369500.aprx - CO4369500_A4L_FIGURE_4



0 250 500
METRES

SCALE : 1:15,000 (A4)

NO.	REVISION	DATE	BY
A	ISSUED	MAY 21	MR

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FIGURE

FIGURE 4: LAND USE CLASSIFICATION

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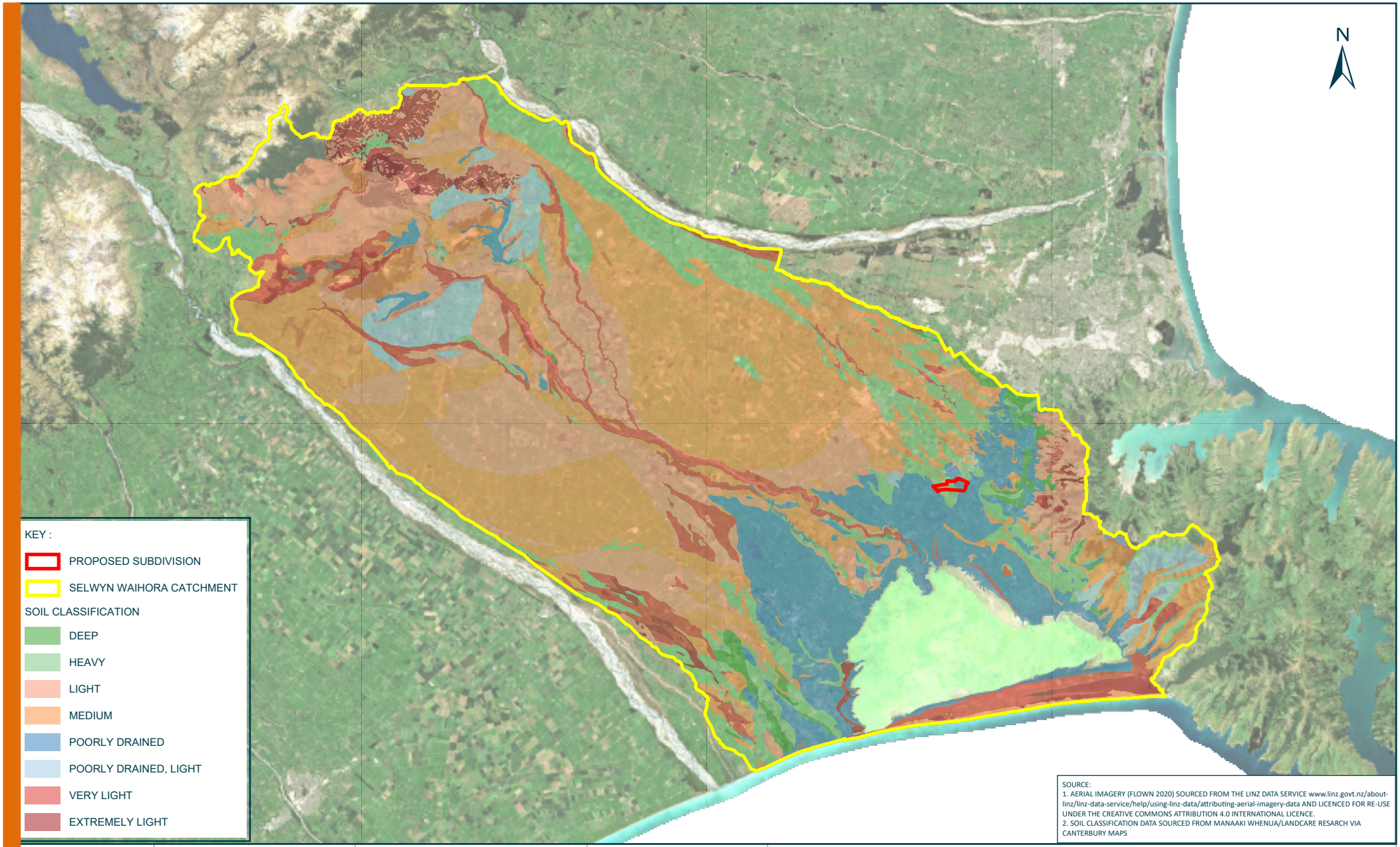
LINCOLN SOUTH DEVELOPMENT

C04369500.aprx - C04369500_A4L_FIGURE_5



pdp

0 5000 10000
METRES

SCALE : 1:450,000 (A4)

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FIGURE

FIGURE 5: SELWYN WAIHORA SOILS

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