BEFORE AN INDEPENDENT HEARINGS COMMISSIONER
ON BEHALF OF SELWYN DISTRICT COUNCIL

UNDER	the Resource Management Act 1991
IN THE MATTER	a request by Hughes Development Limited for a private plan change to the Selwyn District Plan to rezone 163 Halkett Road and 1066 West Coast Road in West Melton for the development of approximately 124 lots
AND	**Hughes Development Limited** (Applicant)

EVIDENCE OF SHARN BERNARD HAINSWORTH ON BEHALF OF HUGHES DEVELOPMENT LIMITED

Highly Productive Land

13 March 2023

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Introduction

1. My full name is Sharn Bernard Hainsworth and I am a Principal Consultant for the environmental science and project management consultancy Land Use Assessments Limited (LUC Assessments Ltd). I have been in this role for 2 1/2 years. Prior to this I was a Pedologist with the Manaaki Whenua Landcare Research, where I represented Landcare Research in the pan-sector LUC Governance Group. I have worked in the areas of pedology, land management and environmental science and for over 21 years. I have also owned a drystock farm for 7 years.

2. I have a Bachelor of Science with a major in Earth Science (Massey University); Graduate Diploma of Science (Earth Science) (Massey University); and a Master of Science (Earth Science) (University of Waikato). I hold an Intermediate Certificate in Overseer Nutrient Management modelling. I am a member of the New Zealand Society of Soil Science and the New Zealand Association of Resource Management. I am a member of the LUC Governance Group.

3. My experience and expertise include regional scale soil mapping using S-map and the New Zealand Soil Classification in every region in New Zealand except the West Coast. I have also undertaken Land Use Capability mapping at regional scale, farm scale, and more detailed scales for subdivisions across hill country and peri-urban areas around Auckland, Waikato-King Country, Bay of Plenty, Hastings, Manawatu, Whanganui, Horowhenua and Tasman. I have also worked for Horizons Regional producing SLUI Whole Farm Plans and with MPI Māori Agribusiness on a wide range of agricultural/horticultural development projects. I have prior experience in CPG New Zealand Ltd where I was involved with the production of farm plans and land-based wastewater treatment schemes.

4. I was engaged by the submitter, Hughes Developments Limited (**HDL**) in December 2022 to provide a Land Use Capability Assessment (**LUC Assessment**) to inform its proposed rezoning of the

subject site, being 163 Halkett Road and 1066 West Coast Road,[1] West Melton (the **Site**), for residential development (**Proposal**). That Proposal is the subject of a private plan change to the Operative Selwyn District Plan (**Operative Plan**) (**PC74**).

5. The LUC Assessment is attached at **Attachment A** of my evidence.

Scope of evidence

6. My evidence is presented on behalf of HDL, and summarises the key findings of the LUC Assessment in relation to:

   a. The soil and LUC profile of the Site.

   b. The nature and spatial extent of "LUC 1, 2 and 3 land" within the Site.

   c. The constraints on that land for land-based primary production and the implications of those constraints in terms of the directions within National Policy Statement for Highly Productive Land 2022 (**NPS-HPL**).

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

   a. The evidence of Mr Victor Mthamo on productivity of the Site.

   b. The Section 42A report prepared by Selwyn District Council (**SDC** or the **Council**) officer.

Code of conduct

8. 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 9 of the Environment Court Te Kōti Taiao o Aotearoa Practice Note 2023. 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

[1] Legally described as Lots 1 and 2 DP 34902.

not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Executive summary

9. The Site is Land Use Capability (**LUC**) class 3s, and faces a number of significant constraints on its use for land-based primary production activities. Those constraints include the variability of the soils across the Site in terms of depth and draining capacity, and the pattern of those soils across the Site. They also include the prospect of reverse sensitivity effects from undertaking those activities adjacent to residential neighbourhoods, increased fire risk, and the lack of available water for irrigation.

10. In my opinion, these constraints would significantly compromise the viability of primary production activities on the Site. For that reason, I consider that there would be negligible costs associated with the loss of this land for primary production, and support PC74 and HDL's proposed rezoning of the Site in terms of the directions of the NPS-HPL.

Soil and LUC profile of the Site

11. The Site is 20.687ha.

12. The Site is currently divided into paddocks, with established shelterbelts planted along many of the internal boundaries, and along the interface with SH 73. A dwelling is located in the central part of the Site, along with various farm buildings. A network of paved/gravelled tracks (including a large harness horse training track), driveways and curtilages extend around/near those buildings and along the edges of the paddocks.

New Zealand Land Resource Inventory mapping

13. The NZLRI system provides an inventory of rock, soil, slope, vegetation and erosion for geographically discrete land units at a 1:63,360 or 1:50,000 scale. The NZLRI map units have been reclassified according to the range of land uses that the land is capable of sustaining long term: using a 1-8 ranking called LUC.

14. Class 1 land has the least limitations and is capable of sustaining the widest range of land uses, and Class 8 is the most constrained and can sustainably support a very limited range of land uses. Class 1-4 land is considered arable. Class 1-2 land is considered to have minimal limitations and capable of supporting a wide range of land uses whereas Class 3-4 have increasingly severe constraints and a corresponding decrease in land uses that can be sustained long term. For example, very shallow soils are capable of sustainably supporting a lower range of productive land uses than shallow soils, and moderately deep soils can support a wider range again, so these would have different LUC Classes.

15. LUC Class 3 land contains some land that has a small number of constraints of concern, such as surface erosion risk when land is cultivated, but that land can otherwise be considered equivalent to Class 2 land. However, there is a lot of Class 3 land that has more constraints, or a wider range of constraints, that impact on the range of land uses that can be supported on it.

16. The NZLRI system does not consider land that is highly suitable for single land uses but is otherwise not capable of sustainably supporting a wide range of land uses (such as the very shallow and stony 7s "Gimblett Gravels" in the Hastings District) which have the equivalent LUC Class as the bed of rivers.

17. The NZLRI system is encapsulated in a series of regional scale worksheets produced in the 1970s and 1980s (1:63,360 or inch to the mile), the LUC Survey Handbook (Lynn et al. (2009)), and various books about LUC suites (mainly published for areas of the North Island. In the 1990s, the 1:63,360 scale NZLRI worksheets were transposed into a GIS-based shapefile in metric 1:50,000 scale. They have no more detail than a 1:63,360 regional scale map.

18. In circa 2019 the LUC units in the NZLRI (which were originally only correlated regionally) were superseded by the nationally correlated nzCORR units. nzCORR units are located within the newest version of the NZLRI. As such, the nzCORR units are the primary units that regional councils will define what is and is not highly productive land from, unless they accept exemptions or more detailed LUC mapping.

19. The NZLRI is referenced as the default source for mapping of "LUC 1, 2 and 3 land" within the NPS-HPL, which is defined as:

Land identified as Land Use Capability class 1, 2 or 3, as mapped by the NZLRI or by any more detailed mapping that uses the Land Use Capability classification.

20. The current version of 1:50,000 (regional) scale NZLRI layer shows the Site comprises flat to undulating alluvial plains and terraces with moderately shallow and/or stony Pallic, Brown and Recent soils with low (<800 mm) rainfall. Under the NZLRI, these soils are classified as LUC Class 2e land near Halkett Rd with the rest of the Site containing LUC class 3s land (refer Figure 1 below).

Figure 1: LUC map units from the legacy 1:50,000 NZLRI map

21. Based on the NZLRI mapping, the entirety of the Site falls within the NPS-HPL definition of LUC 1, 2 and 3.

Site-specific Land Use Assessment mapping

22. To support an assessment of the proposed rezoning under the NPS-HPL, my colleague and I undertook a more detailed soil and LUC mapping of the Site at 1:12,500 scale on 3rd Nov 2022 and 11th Jan 2023.

23. The methodology used for that mapping is described in detail in section 4.3.2 of the LUC Assessment. It follows guidelines on the minimum level of detail required for a 1:12,500 scale LUC map (Table 1-3) according to Grealish et al (2017), but in short:

    a. 74 observations were made of soils and land at the Site. This is an observation density of 3.6 obs/ha. Soil profiles were classified according to Milne et al. (1995) and Webb and Lilburne (2011), Hewitt (2010) and correlated with desktop data.[2]

    b. Of the 74 observations, 32 soil observations made earlier by the Geotech firm ENGEO were also reclassified according to Lynn et al., (2009). The resulting reclassified data is recorded in **Attachment B.** [3]

    c. In undertaking these observations, specific attention was given to the depth, texture, and stoniness of each of the soil horizons and the overall soil profile. The presence and depth of firm and coarse or massive soil horizons (dense pans in the soil) was also evaluated, along with the extent of rising water tables in the area. These properties influence LUC Classes through the degree of limitations of the capability of the land in the map units exerted by soil or wetness limitations.

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[2] 2023, Hainsworth and Laubscher, Land Use Capability Assessment Report. Section 5.1. pp12-14.

[3] The location of these observation points and the observations undertaken by LUC Assessments are shown in Appendix 1, p 21 of the LUC Assessment.

d. LUC Classes and subclasses were then assigned to each soil profile according to Lynn et al (2009). Lynn et al (2009) is the central part of the NZLRI system that enables new mapping and new classifications. It is the latest version of the LUC Survey Handbook. The book also shows soil and land characteristics to be classified into LUC classes and subclasses.

24. From this work, we were able to produce 1:12,500 scale site-specific soil and LUC maps of the Site, which is significantly more detailed than the current NZLRI mapping (Figure 2). A summary of the area (ha), LUC allocation and closest S-map Sibling equivalent related to are shown in Figure 5 and Table 1.

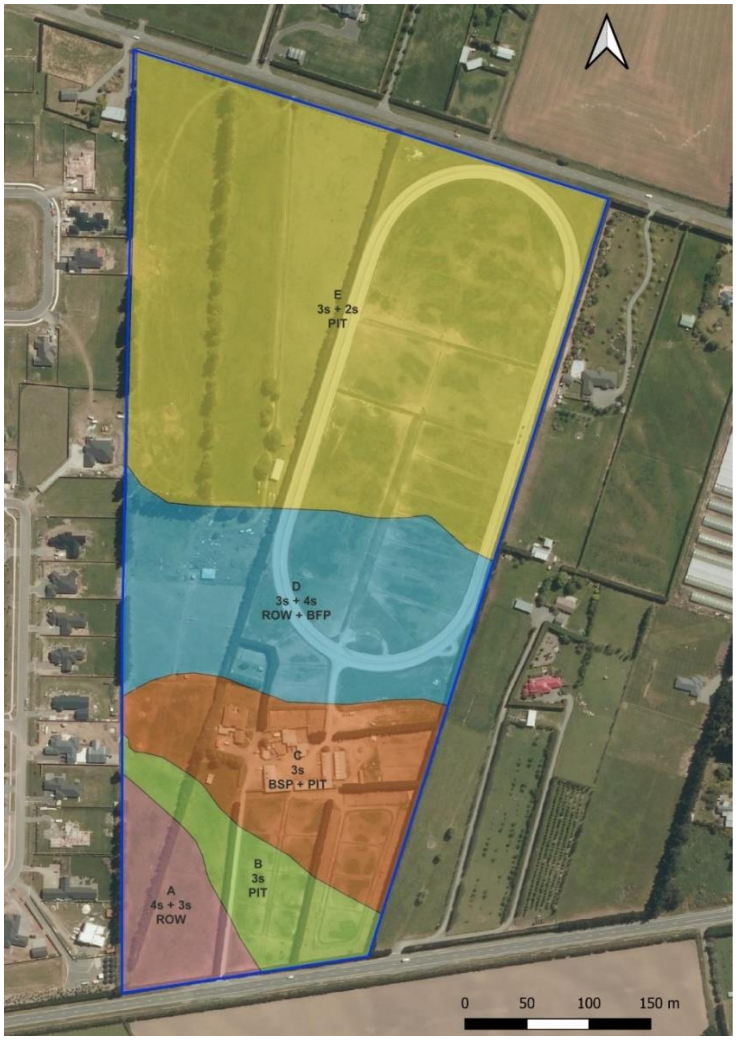

Figure 2: 1:12,500 scale LUC map showing NZSC classification to subgroup level and with correlated S-map siblings. NZSC codes BSP= Pallic Sandy Brown, PIT= Typic Immature Pallic, ROW=Weathered Orthic Recent. Units are labelled A,B,C,D,E

Table 1: A summary of the area (ha), LUC allocation and S-map Sibling equivalent related to Figure 2 showing the 5 main map units (A-E)

Unit	Area (ha)	LUC	HPL	NZSC	**S-map** equivalent
A	1.1	4s + 3s	Not HPL	ROW +PIT	Eyre_23a.1 (50%) + Eyre_4a.1 (50%)
B	1.3	3s	HPL	PIT	Templeton_4a.2 (100%)
C	2.8	3s	HPL	BSP + PIT	Halkett_2a.1 (90%) + Templeton_4a.2 (10%)
D	4.1	3s + 4s	HPL	ROW + BFP	Eyre_23a.1 (45%) + Eyre_2a.1 (30%) Waikiwi_53b.1 (25%)
E	11.1	3s + 2s	HPL	PIT + BSP	Eyre_2a.1 (40%) + Templeton_4a.1 (35%) + Halkett_1a.1 (25%)

25. This more detailed mapping reveals a slightly different but no less significant soil profile of the Site compared to the NZLRI mapping.

26. The map shows the soil map units occur in thin stripes perpendicular to the parcel boundaries (west-northwest to east-southeast). Land parcels and associated infrastructure on the neighbouring blocks is also oriented this way. To remediate this issue would involve acquiring several neighbouring blocks to enable land management to be matched to the naturally occurring spatial pattern of land types in this area.

27. A detailed profile of these units is set out in the Land Use Capability Assessment, but in brief:

    a. **Unit A** (1.1 ha, LUC 4s+3s) The southwest of the site contains a small triangle (1.1 ha) containing shallow and very shallow soil with gravels at or within 20cm of the soil surface and has very low available soil moisture. They have distinct topsoils but limited soil structure has developed in their subsoils. They are young soils, called Recent Soils. The soils in this map unit have been correlated with as closely as possible with the S-map Sibling equivalents of Eyre_23a.1 and Eyre_4a.1. The soils occur as Eyre_23a.1 (50%) + Eyre_4a.1 (50%). Soil Map Unit A has been reclassified as LUC 4s and 3s according to Lynn et al. (2009) based on depth to gravels.

    b. **Units B** (1.3ha, LUC 3s) There is a small unit (1.3 ha) containing soils that have pale coloured subsoil with moderately developed medium to coarse blocky and

prismatic soil structure. They ha a soil depth of about 40 cm. The S-map sibling that most closely aligns with these soils is the moderately deep Templeton_4a.2 soil. Unit B has been mapped across the southern half of the site. It reclassified as LUC 3s according to Lynn et al. (2009) based on the depth to gravels.

c. **Unit C** (2.8ha, LUC 3s) The stables and dwelling are located on a higher, older surface. This is a complex on deep to moderately deep, sandy Pallic Sandy Brown Soils. These soils occur in a map unit complex i.e., dunes present in this map unit (leading to the Halkett soils) are not easily discernible at the soil surface as landforms. Therefore, there are no landforms to predict where each of the soils occur throughout this map unit.

   In this complex the Halkett_2a.1 and Templeton_4a.1 S-map siblings have been correlated with the soils found on the site. It reclassified as LUC 3s according to Lynn et al. (2009) based on sandy texture.

d. **Unit D** (4.1ha, LUC 3s and 4s) Near the southern end of the training track, there is a map unit containing shallow loamy, Pallic Firm Brown Soil (correlated with the S-map sibling equivalent Waikiwi 53b.1), and shallow (S-map sibling equivalent Eyre_4a.1) and very shallow (S-map sibling equivalent Eyre_23a.1) soils. These soils occur in an association, with the Waikiwi soils occurring on dunes and the Eyre soils occurring in multiple small swales and channels in the map unit. The variability of these soils and the shallow nature of the soils (with associated low to very low moisture holding capacity) cause these soils to be less capable of sustaining a wide range of land uses, and of being in a better LUC Class.

e. **Unit E** (11.1 ha, LUC 3s and 2s) nother unit of deep loamy Pallic Sandy Brown Soils (S-map sibling equivalent is Halkett1a.1) with moderately deep Typic Immature Pallic (S-map sibling equivalent is Templeton_4a.1 and

Templeton_2a.2) and shallow (S-map sibling equivalent Eyre_2a.1).

This unit occurs in a complex, although in some places the dunes landforms are obvious on the surface, so it tends **towards** an association at those locations. Halkett soils tend to be on the dunes and Templeton and Eyre soils in the swales and channels. Each land component is quite small and impractical to utilise for arable or horticultural production.

28. All subclasses identified in Table 1 carry an "s" denoting that the dominant limitation of each map unit is a soil limitation. In all cases on this property the limitation is related to limited available soil moisture due to either gravels or a dense pan being close to the soil surface or sandy soils that do not hold water for long enough for plant roots to make use of precipitation before it leaches away.

LUC Classes conclusion

29. If measured by the area of the entire map unit based on the dominant LUC unit in each map unit, 19.587 ha of the 20.687 ha Site contain LUC 3 land.

30. According to Lynn et al. (2009) LUC Class 3 land on stony flats and terraces has moderate physical limitations to arable use with low moisture holding capacity (droughty). Theoretically it is suitable for cultivated crops, vineyards, berry fields, pasture, and tree crops. and is vulnerable to leaching nitrogen when intensively used. In reality (as discussed further below), this Site is too droughty for berry fields, there is limited or no water available for sustaining vineyards, and market gardening and process peas would not suit the highly variable soils on the Site.

31. The "versatile land" definition in the Canterbury Regional Plan is limited to LUC Class 1 & 2. The new definition of highly productive land (**HPL**) from the NPS-HPL is broader, including LUC Classes 1-3.

32. If the other elements of the NPS-HPL definition are met, then that part of the Site would fall within that definition (shown on Figure 3 below).

There is 1.1 ha of the Site is mapped as Class 4s + 3s land, at 1:12,500 scale (Figure 3). LUC 4 land is not classified as HPL under the NPS-HPL. None of the reclassified land would fall within the definition of "versatile land".

Figure 3: HPL map based on 1:12,500 scale LUC map, with areas

Nature and extent of LUC 1, 2 and 3 land

33. Based on the more detailed mapping undertaken, approximately 19.587 ha (or 95%) of the Site meets the definition of "LUC 1, 2 and 3 land" in the NPS-HPL.

34. The LUC Class 3s units covering most of the Site are shallow (contain between 20-45cm of loamy soil over gravels) and have a low moisture holding capacity. Although too small to show on the map, within the majority of LUC 3s units, the investigations also identified pockets of

LUC 4 and 5 soils, particularly in and near the tracks or where these is existing infrastructure on the site. Confined areas of LUC 2 soils were also identified near the existing dwelling and stables. As described below, this variability has particular implications for the productive capability of the Site.

Constraints on productive capacity

35. The soil investigations and supporting desktop analysis undertaken for the Site highlighted several features which, in my opinion, would severely constrain the successful establishment of land based primary production on the Site.[4]

36. I note that a number of these constraints are also highlighted in the evidence of Mr Mthamo. I endorse his analysis and his findings as to productivity and the constraints facing the Site.

Soil moisture

37. The available water capacity of soils on this site are generally low therefore making the soils drought-prone in prolonged dry periods. With an annual average rainfall of approximately 800mm/yr and long dry periods with high evapotranspiration in normal summers, the range of land uses and yields from those land uses significantly constrained without irrigation water on this site. In general, the soils on the site are vulnerable to leaching of nitrogen, potassium and sulphate-sulfur when intensively used, due to high bypass flow characteristics associated with the stony soil profiles. This means that fertiliser constantly has to be added to crops to keep yields up, and it can lead to leaching of nutrients to groundwater.

Soil variability

38. Common to most of the soil units we mapped was the variability in, and association, between soil siblings and their properties (such as depth and available soil moisture).

39. Variable soil occurrence like what is found on the Site can create

[4] Land-based primary production under the NPS-HPL means production from, agricultural, pastoral, horticultural, or forestry activities, that is reliant on the soil resource of the land.

significant issues for the successful establishment and management of crops. It can lead to variability in germination times, differences in irrigation needs during the growth of crops, differences in optimal harvest dates, and variability in yields. All of these issues would necessitate complex crop management techniques which, particularly given its small size, would significantly compromise the economic viability of primary production activities at the Site.

40. The issues with variability are further exacerbated by the patterns of the soils (oriented west/northwest to east/southeast on the above Figures) compared with the configuration of the Site (oriented north-south). This 'misalignment' further compounds constraints for productivity in an already constrained site because of differential germination, crop ripening and yields when moving north-south across the site (the direction machinery would work because of the long and thin nature of the relatively small site). The site is small, and the tractors and equipment are big, and they need a lot of headroom for the turning circle of the tractors.

Other site features

41. The presence of gravel tracks around the Site further detract from its capacity for primary production activities. As noted above, these tracks are located among the LUC 3s map units but are LUC Class 5 because *of the gravel content at the surface. High content of compounded gravel is difficult to rehabilitate for production purposes.*

42. Productivity is detrimentally impacted by the role these features will play in further creating differential germination, crop ripening and yields for any future crops established on the site

43. Forestry would be possible on the soils on the Site, but the droughty nature of the soils means that establishment would be more patchy and costly as trees will due to water stress each time planting occurs. Also, many drought tolerant timber species, especially the most common species such as *P radiata* and eucalyptus species are highly flammable. There is a risk to urban dwellings being caught on fire and there is a risk that sparks or firebugs from in the adjacent urban area could ignite a fire in the block.

Conclusion

44. The variability of soil depth across small areas throughout the site place moderate to severe constraints on the ability of the Site to sustainably support a wide range of primary production-based land uses. While expensive high-tech crop management techniques such as variable rate irrigation could help address some of those constraints, the deployment of those techniques on a Site of this size would, in my opinion, render those activities economically unviable.

45. As set out above, theoretically LUC 3 land is suitable for cultivated crops, vineyards, berry fields, pasture, tree crops, and forestry. In this case, however, the Site is too droughty for berry fields, and there is limited or no water available for sustaining vineyards or tree crops. Market gardening and process peas would not suit the highly variable soils on the Site. Forestry is unsuitable on a small site next to town that is often hot, dry, and windy because of fire risk.

46. In my opinion, the Site would be most suitable for occasional cropping and for making hay and bailage. However, economic considerations aside, allowing these crops (long grass) to grow in an area that normally has low rainfall and hot windy days in summer increases the risk of fire and prevalence of animal pests. Given the proximity of the Site to the West Melton township and the costs involved in their management, these risks could well preclude use of the Site for those crops.

47. For these reasons, I consider there would be negligible costs associated with the loss of this land for primary production, and support PC74 and HDL's proposed rezoning of the Site in terms of the directions of the NPS-HPL.

Sharn Hainsworth

13 March 2023

ATTACHMENT A – LUC ASSESSMENT

Land Use Capability Assessment
West Coast Road, West Melton

Clients: Hughes Developments

Land Use Capability Assessments

Land Use Capability Assessment

Sharn Hainsworth and Nadia Laubscher

LUC Assessments Ltd

Prepared for:

Hughes Developments

1066 West Coast Road
West Melton
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Contents

1 Summary

Project and Client

- This Land Use Capability (LUC) assessment has been prepared for Hughes Developments Limited, 1066 West Coast Rd, West Melton, Selwyn.

Objective

- The report provides a 1:12,500 scale soil and LUC map of the property. The LUC map is based on Lynn et al (2009). The LUC information was reclassified into maps showing the areas of Highly Productive Land (definition: LUC Class 1-3 land).

Method

- 74 observations were made of soils and land at the 20.4 ha subject site to produce a 1:12,500 scale site specific LUC map of the property. This is an observation density of 3.7 obs/ha. The 1:12,500 LUC map was then reclassified into LUC Class 1-3 land ("Highly Productive Land" (HPL) and LUC Class 4-8 land ("Other Land").

Findings

- The site contains a mixture of HPL and other land. None of the site is Versatile Land. If measured by the area of the entire map unit based on the dominant LUC unit in each map unit, 19.587 ha of the 20.687 ha site contain HPL. There is 1.1 ha of the site is mapped as Class 4s + 3s land and has been categorized as predominantly not HPL when mapped at 1:12,500 scale.

- Overall, LUC Assessments Ltd believes that from a soil and LUC perspective, while 19.587 ha of HPL has been mapped on this 20.687 ha site according to the NPS-HPL definition, the following factors render it fanciful to consider this site capable of sustainable, economically viable production that uses the soil on the site:

    a. It is not Versatile Land when surveyed at 1:12,500 scale.

    b. Severe constraints exist relating to the range of land uses possible that is more in keeping with LUC Class 4 land not LUC Class 3 land. The Class 3s and Class 4s land on the site is at the lowest end of the spectrum for productivity in terms of the HPL definition.

    c. The site is only suitable for occasional cropping due to the soils present.

    d. Practical constraints due to land parcel vs soil pattern.

    e. The presence of soil complexes with contrasting management requirements within map units; and

f. Existing infrastructure on the site has created a series of inclusions of LUC Class 5s spread across the site that occur in areas too small to map but that never-the-less adversely impact on productivity.

2 Introduction

This report provides the method, data and findings accompanying a 1:12,500 site-specific map of Highly Productive Land for Hughes Developments Limited, 1066 West Coast Rd, West Melton, Selwyn.

3 Background

3.1 New Zealand Land Resource Inventory

The land parcel lies between West Coast Rd and Halkett Rd.

The current version of 1:50,000 (regional) scale New Zealand Land Resource Inventory (NZLRI) layer (Figure 2) shows the 20.4 ha land parcel at 1066 West Coast Rd, West Melton, Selwyn is flat to undulating alluvial plains and terraces with moderately shallow and/or stony Pallic, Brown and Recent soils with low (<800 mm) rainfall. The property contains LUC Class 2 land near Halkett Rd and the rest of the property contain LUC class 3 land.

The Versatile Land Definition in the Selwyn District Plan and the Canterbury Regional Plan includes LUC Class 1 & 2. The new definition of Highly Productive Land (HPL) from the NPS-HPL is broader, including LUC Classes 1-3. The legacy 1:50,000 scale NZLRI layer shows that the site contains a small amount of Versatile Land in the north of the site. The entire 20.4 ha is classified as HPL.

Figure 1: LUC map units from the legacy 1:50,000 NZLRI map

3.2 Soils

The soils on this site are associated with an older higher terrace (part of a large fan), and a lower floodplain unit. The soils are predominantly shallow with loamy parent materials over greywacke gravels. The soils are pale coloured, having developed in an 800mm/yr annual average rainfall. The site also contains low dunes that are sandy. The site contains many old river channels and bars so the depth to gravels changes over short distances in unpredictable patterns (complexes).

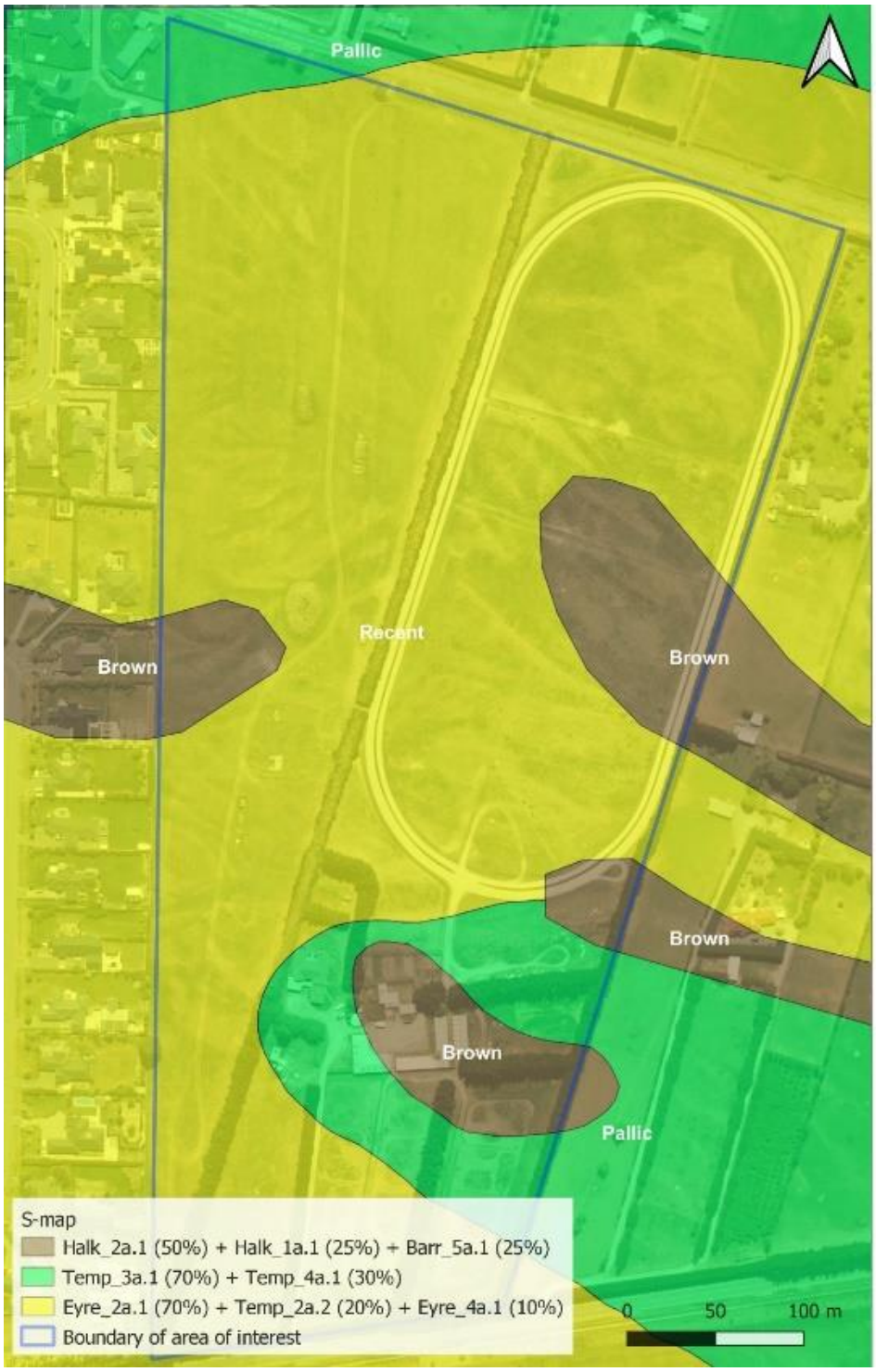

Figure 2: Regional scale 1:50,000 S-map soil map with Siblings

4 Method

4.1 Field observations

LUC Assessments Ltd undertook a soil and LUC survey at 1:12,500 scale on 3rd Nov 2022 and 11th Jan 2023. Thirty-two soil observations made earlier by the Geotech firm ENGEO were also reclassified according to Lynn et al., (2009). The resulting reclassified data are recorded in Appendix 2.

43 observations were made of soils and land at the 20.4 ha subject site to produce a 1:12,500 scale site specific LUC map of the property. Using 74 observations, this is an observation density of 3.7 obs/ha. To undertake a detailed, site-specific LUC assessment for a subdivision, the minimum level of detail required is a1:12,500 scale map. Lynn et al., (2009) and Grealish et al (2017) state that to make a site-specific 1:12,500 scale map an observation density of a minimum of 2 observations/ha is required.

LUC Assessments Ltd observed the landform, parent materials and soil profiles using boreholes from an Eijkelkamp soil auger and pits dug with a spade. Soil horizons were described from the soil surface down to 1m or to top of the gravels below according to Milne et al. (1995) and Webb and Lilburne (2011). Soil profiles were classified according to Milne et al. (1995) and Webb and Lilburne (2011), Hewitt (2010) and correlated with S-map soil siblings.

4.2 Assignment of LUC Classes and subclasses

LUC Classes and subclasses were assigned to each soil profile according to Lynn et al (2009). Specific attention was given to the depth, texture, and stoniness of each of the soil horizons and the overall soil profile. The presence and depth of firm and coarse or massive soil horizons (dense pans in the soil) was also evaluated. Section 3.2.2-3.2.4 and Table 16 in Section 3.3.3 in Lynn et al (2009) informed the LUC classes assigned to each soil profile and LUC map unit, along with reference to Table 14 in Section 3.3.2.

The factors that LUC Assessments Ltd investigated in soil profiles on the site included soil textures, depth to gravels and extent of rising water tables in the area. These properties influence LUC Classes through the degree of limitations of the capability of the land in the map units exerted by soil or wetness limitations. This is described and classified in Table 14 in Section 3.3.2, and Table 16 in Section 3.3.3 in Lynn et al. (2009).

5 Results

The locations of reclassified ENGEO observations and LUC Assessments Ltd observations are shown in Figure 4 below. The data recorded and the classifications provided for soil profiles described in the field by LUC Assessments is provided in Appendix 1. The data recorded and the classifications provided for soil profiles described in the field by ENGEO is provided in Appendix 1 with Figure 7.

Figure 3: Location of observations on site, additional map of LUC Assessments observations recorded are included in Appendix 1)

5.1 Land Use Capability

The new site-specific 1:12,500 scale soil and LUC map is provided in Figure 5. A summary of the area (ha), LUC allocation and S-map Sibling equivalents related to Figure 5 showing the 5 main map units (A-E) are included in Table 1.

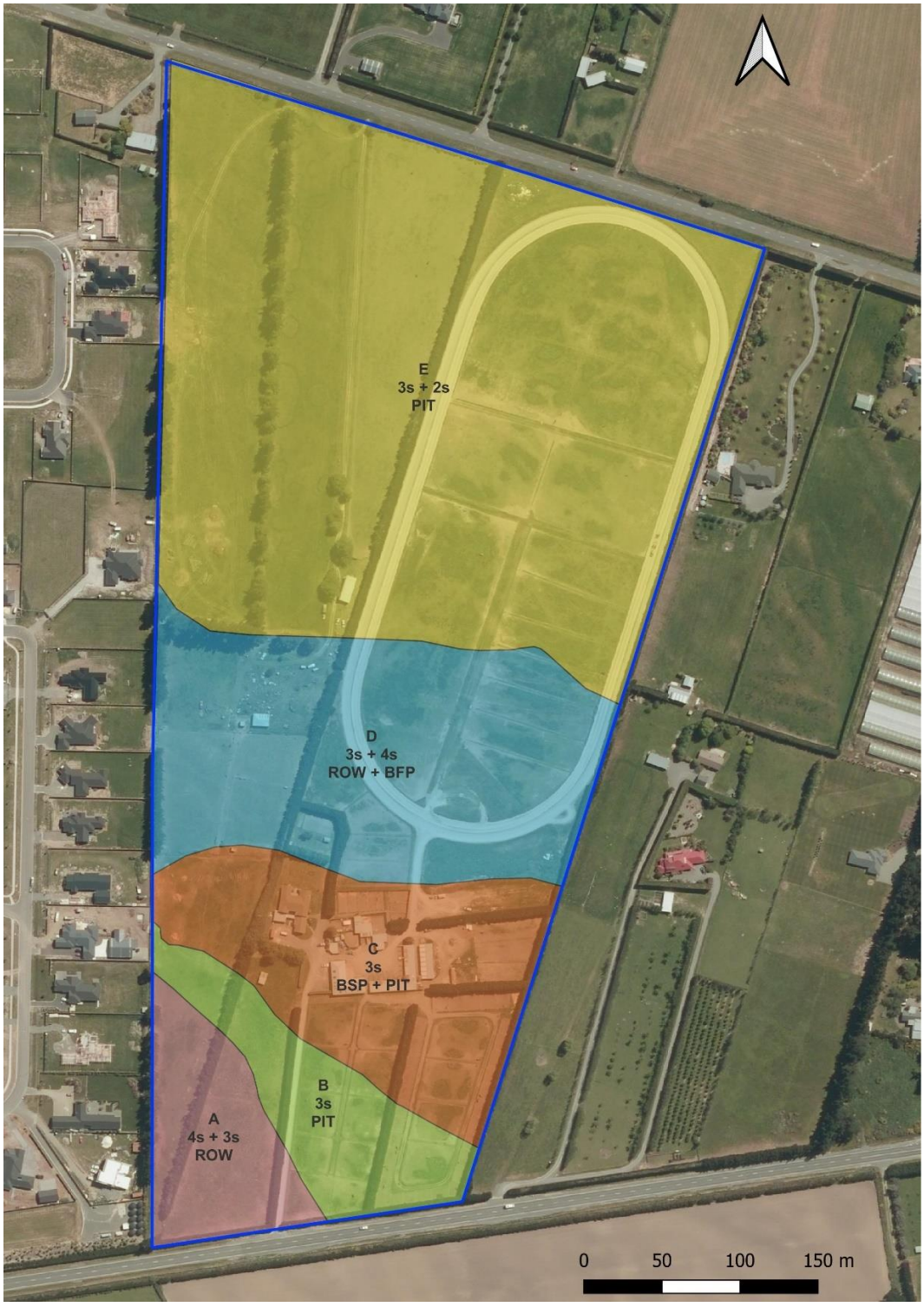

Figure 4: New 1:12,500 scale soil and LUC map

Unit	Area (ha)	LUC	HPL?	NZSC	**S-map** equivalents
A	1.1	4s + 3s	Not HPL	ROW +PIT	Eyre_23a.1 (50%) + Eyre_4a.1 (50%)
B	1.3	3s	HPL	PIT	Templeton_4a.2 (100%)
C	2.8	3s	HPL	BSP + PIT	Halkett_2a.1 (90%) + Templeton_4a.2 (10%)
D	4.1	3s + 4s	HPL	ROW + BFP	Eyre_23a.1 (45%) + Eyre_2a.1 (30%) Waikiwi_53b.1 (25%)
E	11.1	3s + 2s	HPL	PIT + BSP	Eyre_2a.1 (40%) + Templeton_4a.1 (35%) + Halkett_1a.1 (25%)

The map shows the soil map units occur in thin stripes perpendicular to the parcel boundaries (west-northwest to east-southeast). Land parcels and associated infrastructure on the neighbouring blocks is also oriented this way. To remediate this issue would involve acquiring several neighbouring blocks to enable land management to be matched to the naturally occurring spatial pattern of land types in this area.

5.1.1 Unit A

The southwest of the site contains a small triangle (1.1 ha) containing shallow and very shallow soil with gravels at or within 20cm of the soil surface and has very low available soil moisture. They have distinct topsoils but limited soil structure has developed in their subsoils. They are young soils, called Recent Soils. The soils in this map unit have been correlated with as closely as possible with the S-map Sibling equivalents of Eyre_23a.1 and Eyre_4a.1. The soils occur as Eyre_23a.1 (50%) + Eyre_4a.1 (50%). Soil Map Unit A has been reclassified as LUC 4s and 3s according to Lynn et al. (2009) based on depth to gravels. The map unit contains variations in soils with contrasting available soil moisture, leading to likely issues with crop management.

5.1.2 Unit B

There is a small unit (1.3 ha) containing soils that have pale coloured subsoil with moderately developed medium to coarse blocky and prismatic soil structure. They ha a soil depth of about 40 cm. The S-map sibling that most closely aligns with these soils is the moderately deep Templeton_4a.2 soil. Unit B has been mapped across the southern half of the site. It reclassified as LUC 3s according to Lynn et al. (2009) based on the depth to gravels.

5.1.3 Unit C

The stables and dwelling are located on a higher, older surface. This is a complex on deep to moderately deep, sandy Pallic Sandy Brown Soils. These soils occur in a map unit complex i.e. dunes present in this map unit (leading to the Halkett soils) are not easily discernible at the soil surface as landforms. Therefore, there are no landforms to predict where each of the soils occur throughout this map unit.

In this complex the Halkett_2a.1 and Templeton_4a.1 S-map siblings have been correlated with the soils found on the site. It reclassified as LUC 3s according to Lynn et al. (2009) based on sandy texture.

The patchy nature of soil occurrence with a deep sandy soil and a loamy soil on gravels in this unit leads to issues with variability in germination times, differences in irrigation needs during the growth of crops and differences in optimal harvest dates and variability in yields within

only a small area of land should the infrastructure be removed, and the area be returned to an arable or horticultural (Figure 5).

Figure 1: Differential drying patterns indicating different soil depths and different amounts of available water capacity in the different soils.

5.1.4 Unit D

Near the southern end of the training track, there is a map unit containing shallow loamy, Pallic Firm Brown Soil (correlated with the S-map sibling equivalent Waikiwi 53b.1), and shallow (S-map sibling equivalent Eyre_4a.1) and very shallow (S-map sibling equivalent Eyre_23a.1) soils. These soils occur in an association, with the Waikiwi soils occurring on dunes and the Eyre soils occurring in multiple small swales and channels in the map unit. The variability of these soils and the shallow nature of the soils (with associated low to very low moisture holding capacity) cause these soils to be less capable of sustaining a wide range of land uses, and of being in a better LUC Class.

5.1.5 Unit E

Another unit of deep loamy Pallic Sandy Brown Soils (S-map sibling equivalent is Halkett1a.1) with moderately deep Typic Immature Pallic (S-map sibling equivalent is Templeton_4a.1 and Templeton_2a.2) and shallow (S-map sibling equivalent Eyre_2a.1).

This unit occurs in a complex, although in some places the dunes landforms are obvious on the surface, so it tends towards an association at those locations. Halkett soils tend to be on the dunes and Templeton and Eyre soils in the swales and channels. Each land component is quite small and impractical to utilise for arable or horticultural production. As with other map units on the property, to try and employ a blanket land use across both soil types would lead to complex crop management issues due to variability in contrasting soil properties, such as available soil moisture, over such short distances.

5.2 Highly Productive Land/ Versatile Land

The Versatile Land Definition in the Selwyn District Plan and the Canterbury Regional Plan includes LUC Class 1 & 2. The new definition of Highly Productive Land (HPL) from the NPS-HPL is broader, including LUC Classes 1-3. All subclasses on this map carry an "s" denoting that the dominant limitation of each map unit is a soil limitation. In all cases on this property the limitation is related to limited available soil moisture due to either gravels or a dense pan being close to the soil surface or sandy soils that don't hold water for long enough for plant roots to make use of precipitation before it leaches away.

When considering our site-specific mapping, the site contains a mixture of HPL and non-HPL, but none of the site is classified as Versatile Land indicating that the HPL that is present is at the low end of the spectrum of productivity included in HPL. If measured by the area of the entire map unit based on the dominant LUC unit in each map unit, 19.587 ha of the 20.687 ha site contain HPL. There is 1.1 ha of the site is mapped as Class 4s + 3s land and has been categorized as predominantly not HPL when mapped at 1:12,500 scale (Figure 6, Table 2)

The LUC Class 3s units covering most of the site are shallow (contain between 20-45cm of loamy soil over gravels) and has a low moisture holding capacity. This land is defined as HPL, but it contains numerous inclusions of 4s (very shallow) and 5s (stony tracks and curtilages of dwellings and stables (Figure . According to Lynn et al. (2009) LUC Class 3 land on stony flats and terraces has moderate physical limitations to arable use with low moisture holding capacity (droughty). Theoretically it is suitable for cultivated crops, vineyards, berry fields, pasture, and tree crops. and is vulnerable to leaching nitrogen when intensively used. In reality, this site is too droughty for berry fields, there is limited or no water available for sustaining vineyards, and market gardening and process peas would not suit the highly variable soils on the site.

According to Lynn et al. (2009) LUC Class 4 land is considered to have severe physical limitations to arable use and is suitable for no more than 1-in-5 year cropping, and is suitable for pasture, tree crops and can be used for vineyards and olives.

The site is most suitable for occasional cropping and for making hay and baylage. Given that the site is already abutting the edge of West Melton township, there are problems with fire risk and animal pests associated with allowing long grass to grow in an area that normally have a low rainfall with hot windy days in summer.

Table 1: Area of HPL

Unit	LUC	HPL/VL	Area (ha)
B	3s (south of site)	HPL/Not VL	1.3
C	3s + 2s	HPL/Not VL	2.8
D	3s + 4s	HPL/Not VL	4.1
E	3s (north of site)	HPL/Not VL	11.387
	Sub Total		19.587
A	4s + 3s	Not HPL/Not VL	1.1
	Sub Total		1.1
	Total		**20.687**

Figure 6: New site-specific 1:12,500 scale LUC and HPL map

Overall, LUC Assessments Ltd believes that from a soil and LUC perspective, while 19.587 ha of HPL has been mapped on this 20.687 ha site according to the NPS-HPL definition, the following factors render it fanciful to consider this site capable of sustainable, economically viable production that uses the soil on the site:

1. It is not Versatile Land when surveyed at 1:12,500 scale.

2. Severe constraints exist relating to the range of land uses possible that is more in keeping with LUC Class 4 land not LUC Class 3 land. The Class 3s and Class 4s land on the site is at the lowest end of the spectrum for productivity in terms of the HPL definition.

3. The site is only suitable for occasional cropping due to the soils present.

4. Practical constraints due to land parcel vs soil pattern.

5. The presence of soil complexes with contrasting management requirements within map units; and

6. Existing infrastructure on the site has created a series of inclusions of LUC Class 5s spread across the site that occur in areas too small to map but that never-the-less adversely impact on productivity.

6 Conclusion

The site contains a mixture of HPL and other land. None of the site is Versatile Land. If measured by the area of the entire map unit based on the dominant LUC unit in each map unit, 19.587 ha of the 20.687 ha site contain HPL. There is 1.1 ha of the site is mapped as Class 4s + 3s land and has been categorized as predominantly not HPL when mapped at 1:12,500 scale.

The pattern of soils on the site (oriented west/northwest to east/southeast) compared with the configuration of the site (oriented north-south) further compounds constraints for productivity in an already constrained site because of differential germination, crop ripening and yields when moving north-south across the site (the direction machinery would work because of the long and thin nature of the relatively small site).

The presence of gravel tracks around the site detract from the productivity of the site. The tracks are too small to map out individually but are Class 5s land amongst otherwise Class 3 and Class 4 land. Productivity is detrimentally impacted by the role these features will play in further creating differential germination, crop ripening and yields for any future crops established on the site.

The other polygon units making up the total area of HPL were LUC Class 3s and one unit with LUC Class 3s + 2s. This map unit contains the curtilages of existing dwellings and stables (Class 5s but each of the areas is too small to map separately).

The site is dominated by LUC Class 3s units, that are at the low end of the spectrum of productivity of what is defined as HPL in the NPS-HPL. Regional and District plans do not recognize this land as Versatile Land. According to Lynn et al., (2009) LUC Class 3 land on stony flats and terraces has moderate physical limitations to arable use with low moisture holding capacity (droughty) and is vulnerable to leaching nitrogen when intensively used. It has moderate physical limitations to arable use. It is suitable for cultivated crops, vineyards, berry fields, pasture, and tree crops.

According to Lynn et al. (2009) LUC Class 4 land is considered to have severe physical limitations to arable use and is suitable for no more than 1-in-5 year cropping, and is suitable for pasture, tree crops and can be used for vineyards and olives.

The site is most suitable for occasional cropping and for making hay and baylage. Given that the site is already abutting the edge of West Melton township, there are problems with fire risk and animal pests associated with allowing long grass to grow in an area that normally have a low rainfall with hot windy days in summer.

Overall, LUC Assessments Ltd believes that from a soil and LUC perspective, while 19.587 ha of HPL has been mapped on this 20.687 ha site according to the NPS-HPL definition, the following factors render it fanciful to consider this site capable of sustainable, economically viable production that uses the soil on the site:

1. It is not Versatile Land when surveyed at 1:12,500 scale.

2. Severe constraints exist relating to the range of land uses possible that is more in keeping with LUC Class 4 land not LUC Class 3 land. The Class 3s and Class 4s land on the site is at the lowest end of the spectrum for productivity in terms of the HPL definition.

3. The site is only suitable for occasional cropping due to the soils present.

4. Practical constraints due to land parcel vs soil pattern.

5. The presence of soil complexes with contrasting management requirements within map units; and

6. Existing infrastructure on the site has created a series of inclusions of LUC Class 5s spread across the site that occur in areas too small to map but that never-the-less adversely impact on productivity.

7 References

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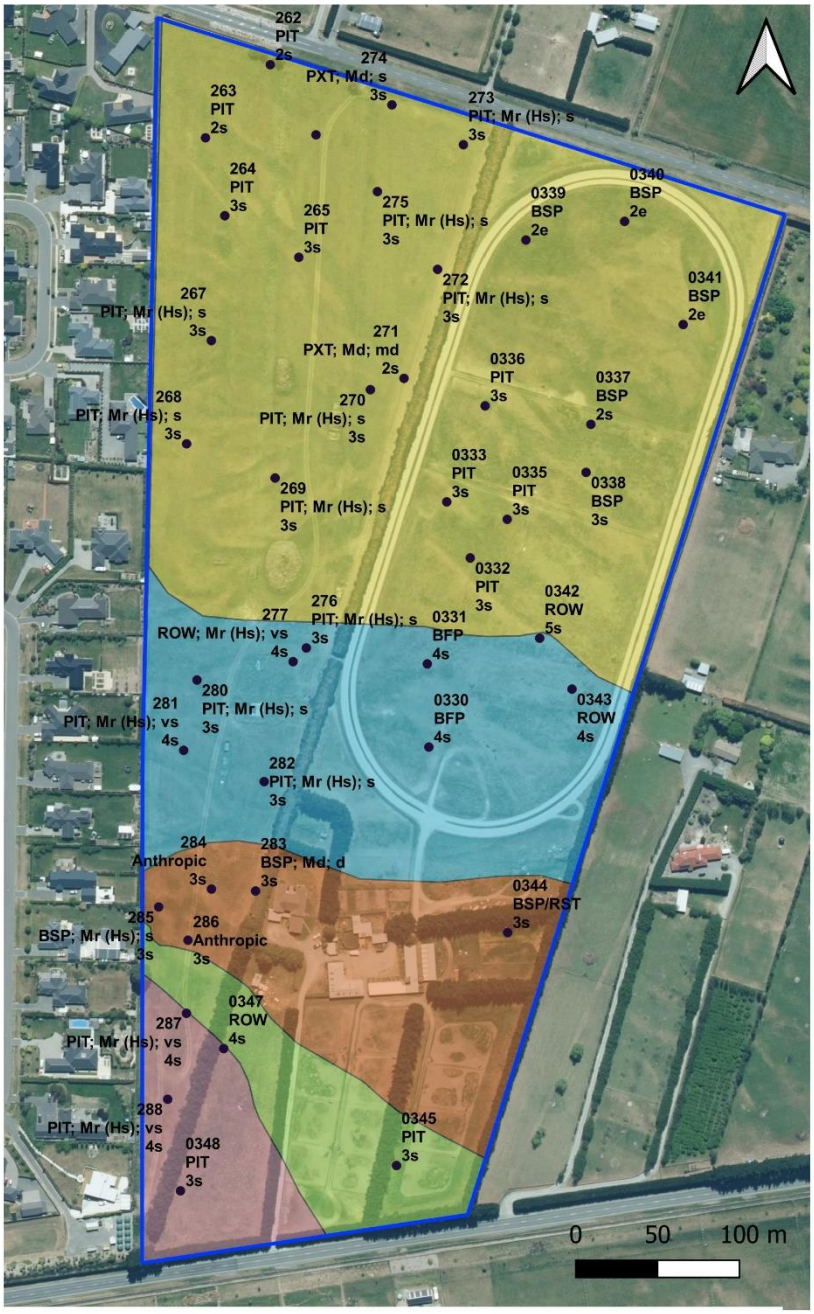
8 Appendix 1 Map of observation locations



Units

- Eyre_23a.1 (50%) + Eyre_2a.1 (30%) Waikiwi_53b.1 (20%)
- Eyre_4a.1 (50%) + Eyre_23a.1 (50%)
- Halkett_2a.1 (90%) + Templeton_4a.2 (10%)
- Templeton_4a.2 (100%)
- Eyre_2a.1 (40%) + Templeton_4a.1 (35%) + Halkett_1a.1 (25%)

9 Appendix 1 – Soil observations

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
330	4s	BFP	Waikiwi_53b.1	Ap (tLs) 0-10 cm BC(x) (LCf) 10-30 cm BC1 (Aw) 30-35 cm BC2 (VAl) 35+ cm	
331	4s	BFP	Waikiwi_53b.1	Ap (tLs) 0-10 cm BC(x) (LCf) 10-30 cm BC1 (Aw) 30-35 cm BC2 (VAl) 35+ cm	
332	3s	PIT	Templeton_4a.2	Ap (tLw) 0-15 cm Bw (LFs) 15-40 cm BC1 (Aw) 40-45 cm BC2 (VAl) 45+ cm	
333	3s	PIT	Templeton_4a.2	Ap (tLw) 0-15 cm Bw (LFs) 15-40 cm BC1 (Aw) 40-50 cm BC2 (VAl) 50+ cm	

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
335	3s	PIT	Templeton_4a.2	Ap (tLw) 0-15 cm Bw (LFs) 15-45 cm BC1 (Aw) 45-55 cm BC2 (VAl) 55+ cm	
336	3s	PIT	Templeton_4a.2	Ap (tLw) 0-20 cm Bw (LFs) 20-40 cm BC (VAl) 40+ cm	
337	3s	BSP	Halkett_2a.1	Ap (tLw) 0-20 cm Bw (LFs) 15-40 cm BC (Aw) 40+ cm	
338	3s	BSP	Halkett_2a.1	Ap (tLw) 0-10 cm Bw (LFs) 10-20 cm BC1 (Lw) 20-35 cm BC2 (VAl) 35+ cm	

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
339	2e	BSP	Halkett_1a.1	Ap (tLw) 0-20 cm Bw (LFw) 20-40 cm BC (Lw) 40-90 cm	
340	2e	BSP	Halkett_1a.1	Ap (tLw) 0-20 cm Bw (LFw) 20-40 cm BC1 (Lw) 40-60 cm BC2(Lw) 60-90 cm	
341	2e	BSP	Halkett_1a.1	Ap (tLw) 0-20 cm Bw (LFw) 20-40 cm BC1 (Lw) 40-70 cm BC2(VAl) 70+ cm	
342	5s	ROW	Eyre_4a.1	Gravel at surface	
343	4s	ROW	Eyre_4a.1	Ap (tLw) 0-10 cm Bw (LFw) 10-20 cm BC (VAl) 20+ cm	

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
344	3s	RST/BSP	Halkett_2a.1	Ap (tLw) 0-10 cm Bw (Aw) 10-90 cm	
345	3s	PIT	Templeton_4a.2	Ap (tLw) 0-20 cm Bw (LFs) 20-40 cm BC (VAl) 40+ cm	
347	4s	PIT	Eyre_4a.1	Ap (tLw) 0-20 cm BC (VAl) 20+ cm	

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
348	3s	PIT	Eyre_4a.1	Ap (tLw) 0-20 cm Bw (LFs) 20-35 cm BC (VAl) 35+ cm	
262	3s	PIT; Mr		s	
263	2s	PIT;Mg		md	
264	3s	PIT; Mr		s	
265	3s	PIT; Mr		s	
266	4s	PIT; Mr		s	
267	3s	PIT; Mr		s	
268	3s	PIT; Mr		s	
269	3s	PIT; Mr		s	
270	3s	PIT; Mr		s	
271	2s	PXT; Mg		md	
272	3s	PIT; Mr		s	
273	3s	PIT; Mr		s	
274	3s	PXT; Md		md	
275	3s	PIT; Mr		s	
276	3s	PIT; Mr		s	
277	4s	PIT; Mr		vs	
280	3s	PIT; Mr		s	
281	4s	PIT; Mr		vs	
282	3s	PIT; Mr		s	
283	3s	BSP; Md		d	

ID	LUC*	NZSC**	S-map equivalent	Description***	photo
284	3s	BSP; Mr		s	
285	3s	PIT; Mr		s	
286	3s	PIT; Mr		s	
287	4s	PIT; Mr		vs	
288	4s	PIT; Mr		vs	

*LUC according to Lynn et al. (2009)

**PIT=Typic Immature Pallic; ROW = Weathered Orthic Recent, BSP= Pallic Sandy Brown, BFP= Firm Pallic Brown,

NZSC allocations according to Hewitt (2010)

*** Horizon designation (e.g. Ap and tLw) and depths (vs = very shallow 0-20cm, s= shallow 20-45cm, md = moderately deep 45-<100cm, d = deep >100cm) (Milne et al., 1995) in brackets (Webb & Lilburne, 2011)

10 Appendix 2 -ENGEO results

Table 2:ENGEO results* interpretation by LUC Assessments Ltd

ENGEO ID	Description	Assigned LUC
HA1	Gravel at 80 cm	2s
HA2	Gravel at 60 cm, sand from 20 cm	3s
HA3	Gravel at 50 cm	2s
HA4	Gravel at 100 cm, sand from 20 cm	3s
HA5	Gravel at >100 cm, sand from 40 cm	2s
HA6	Gravel at 50 cm	2s
HA7	Gravel at 30 cm	3s
HA8	Gravel at 30 cm	3s
HA9	Gravel at 90 cm, sand from 20 cm	3s
HA10	Gravel at 50 cm	2s
HA11	Gravel at 20 cm	4s
HA12	Gravel at 60 cm, sand from 50 cm	2s
HA13	Gravel at 20 cm	4s
HA14	Gravel at 50 cm	2s
HA15	Gravel at 50 cm	2s
HA16	Gravel at 30 cm, sand from 20 cm	3s
HA17	Gravel at 50 cm, sand from 30 cm	3s
TP1	Sandy fine to coarse gravel at 40 cm	3s
TP2	Gravel at 80 cm, sand from 40 cm	2s
TP3	Sandy fine to coarse gravel at 60 cm	2s
TP4	Sandy fine to coarse gravel at 10 cm	4s
TP5	Sandy fine to coarse gravel at 20 cm	4s
TP6	Sandy fine to coarse gravel at 30 cm	3s
TP7	Sandy fine to coarse gravel at 30 cm	3s
TP8	Sandy fine to coarse gravel at 10 cm	4s
TP9	Sandy fine to coarse gravel at 40 cm	3s
TP10	Sandy fine to coarse gravel at 10 cm	4s
TP11	Sandy fine to coarse gravel at 100 cm, sand at 20 cm	3s
TP12	Sandy fine to coarse gravel at 100 cm, sand at 30 cm	3s
TP13	Sandy fine to coarse gravel at 70 cm	2s
TP14	Sandy fine to coarse gravel at 50 cm	2s
TP15	Sandy fine to coarse gravel at 40 cm	3s

*ENGEO Private Plan Change Request Geotechnical Investigation 1066 West Coast Rd, West Melton Canterbury, submitted to Hughes Development (2018

ATTACHMENT B

ENGEO ID	Description	Assigned LUC
HA1	Gravel at 80 cm	2s
HA2	Gravel at 60 cm, sand from 20 cm	3s
HA3	Gravel at 50 cm	2s
HA4	Gravel at 100 cm, sand from 20 cm	3s
HA5	Gravel at >100 cm, sand from 40 cm	2s
HA6	Gravel at 50 cm	2s
HA7	Gravel at 30 cm	3s
HA8	Gravel at 30 cm	3s
HA9	Gravel at 90 cm, sand from 20 cm	3s
HA10	Gravel at 50 cm	2s
HA11	Gravel at 20 cm	4s
HA12	Gravel at 60 cm, sand from 50 cm	2s
HA13	Gravel at 20 cm	4s
HA14	Gravel at 50 cm	2s
HA15	Gravel at 50 cm	2s
HA16	Gravel at 30 cm, sand from 20 cm	3s
HA17	Gravel at 50 cm, sand from 30 cm	3s
TP1	Sandy fine to coarse gravel at 40 cm	3s
TP2	Gravel at 80 cm, sand from 40 cm	2s
TP3	Sandy fine to coarse gravel at 60 cm	2s
TP4	Sandy fine to coarse gravel at 10 cm	4s
TP5	Sandy fine to coarse gravel at 20 cm	4s
TP6	Sandy fine to coarse gravel at 30 cm	3s
TP7	Sandy fine to coarse gravel at 30 cm	3s

ENGEO ID	Description	Assigned LUC
TP8	Sandy fine to coarse gravel at 10 cm	4s
TP9	Sandy fine to coarse gravel at 40 cm	3s
TP10	Sandy fine to coarse gravel at 10 cm	4s
TP11	Sandy fine to coarse gravel at 100 cm, sand at 20 cm	3s
TP12	Sandy fine to coarse gravel at 100 cm, sand at 30 cm	3s
TP13	Sandy fine to coarse gravel at 70 cm	2s
TP14	Sandy fine to coarse gravel at 50 cm	2s
TP15	Sandy fine to coarse gravel at 40 cm	3s

*ENGEO Private Plan Change Request Geotechnical Investigation 1066 West Coast Rd, West Melton Canterbury, submitted to Hughes Development (2018