IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY**
	Applicant

ŌTAKI TO NORTH OF LEVIN HIGHWAY PROJECT

TECHNICAL ASSESSMENT N - PRODUCTIVE LAND

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EXECUTIVE SUMMARY

1. The Ōtaki to north of Levin highway Project ("**Ō2NL Project**" or "**Project**") involves the construction, operation, use, maintenance and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) and a shared use path ("**SUP**") between Taylors Road, Ōtaki (and the Peka Peka to Ōtaki expressway ("**PP2Ō**") and State Highway 1 ("**SH1**") north of Levin.

2. This assessment identifies how much productive land (based on highly productive and highly versatile soils) the proposed Ō2NL Project affects. It uses a geographic information system ("**GIS**") to categorise land in the proposed corridor under the land use capability ("**LUC**") classification system.

3. The LUC system groups land into eight different classes based on geology, soils, slope, erosion, and vegetation. In general, classes 1 to 4 contain land that is suitable for arable production, classes 5 to 7 are suitable for agricultural/pastoral production and class 8 is only suited for retirement or protection forestry.

4. For this assessment the New Zealand Land Resource Inventory ("**NZLRI**") has been used to ascertain the highly productive and highly versatile land. Highly productive land is all the land that is LUC classes 1 to 3 and highly versatile land is LUC classes 1 and 2 plus 3e1 and 3e2 land. The National Policy Statement for Highly Productive Land ("**NPS-HPL**") was released on 12 September 2022. It classifies highly productive land as land zoned rural and of LUC 1, 2 or 3.[1] The NPS-HPL, its policies and its relevance to and effects on the Ō2NL Project, are assessed within Chapter I of the Assessment of Effects on the Environment ("**AEE**").

5. The Horowhenua District is approximately 105,602 ha in size. About 43,766 ha (41%) is classified as highly productive soil (LUC classes 1 to 3) and 31,639 ha (30%) can be classified as highly versatile soil (contains LUC classes 1 and 2 plus LUC units 3e1 and 3e2). On a national level the Horowhenua District has about 1% of the country's highly productive soil and about 2% of the country's highly versatile soil.

6. Two different footprints have been used as part of this analysis. The first is a 20m buffer around the road corridor plus a 5m buffer around the spoil, material supply sites, and laydown areas. It can be assumed that this is the

[1] NPS-HPL, Part 3 (Implementation), clause 3.5(7).

maximum area that is impacted from the Project. The second is the footprint of the completed road (and road reserve) plus a 5 metre buffer. It is assumed that this area is the minimum area or footprint of the project

7. The minimum area of private land within the proposed Ō2NL Project corridor that will be lost to potential production is about 235.6 ha. Of this about 229.5 ha is classified as highly productive land and 100.3 ha is highly versatile land. The maximum area of private land within the proposed Ō2NL Project corridor that could be lost to potential production is about 369.9 ha. Of this about 358.7 ha is classified as highly productive land and 167.4 ha is highly versatile land. The difference between the minimum and maximum area that could be lost is about 134.3 ha and, in reality, much of this area will be brought back into production. The extent of the restored land (and to what state it will be restored) is unknown.

8. I note that of the highly productive land (but not highly versatile land) 29.4 ha are in the process of being rezoned for residential and associated development at Tara-Ika, east of Levin.

9. More broadly, there are an estimated 135-140 properties that are affected by (as in, part of their land area is within) the proposed Ō2NL Project corridor. The cumulative area of all these properties is between 2,334.1 and 2,348.2 ha. The Ō2NL Project affects between 10% and 16% of the total area of the properties that are touched by the corridor.

10. Of the privately owned land that will be lost to the proposed Ō2NL Project corridor:

    (a) between 142.0 and 231.6 ha is from sheep and beef land use;

    (b) between 36.9 and 53.5 ha is from market gardening;

    (c) between 37.1 and 55.8 ha is from dairying;

    (d) between 14.4 and 21.7 ha is from lifestyle/dwellings;

    (e) between 4.6 and 6.1 ha is from horticulture; and

    (f) less than 1 ha each is from forestry and bush.

11. The Ō2NL Project corridor will run through a number of existing properties. This will create between 57 and 71 new areas of land that will be physically separated (by the highway) from the remainder of the relevant property. Of

these new areas of land, 40 are less than a hectare, between 19 and 28 are between 1 and 8 ha. For properties greater than 8 ha:

(a) under one footprint there is a reduction in the number of properties greater than 8 ha by two properties; and

(b) under the other footprint the number of properties increases by three properties due to the dissection of the existing property by the proposed road.

12. Without amalgamation, those new areas of physically separated land that are less than 1 ha as a result of the proposed Ō2NL Project corridor could be considered to be effectively non-productive. This means that about 21 ha of additional highly productive land or 16 ha of highly versatile land could be lost from productive uses as a result of the proposed Ō2NL Project corridor. There is the opportunity for this land to be amalgamated into existing productive units so as to minimise loss / fragmentation.

INTRODUCTION

13. My full name is Iain Lachlan Grant and I am the technical expert for Waka Kotahi NZ Transport Agency ("**Waka Kotahi**") identifying the highly versatile soils affected by the Ō2NL Project on productive land.

14. I have been involved with the Ō2NL Project since 2015.

15. The analysis work undertaken as part of this assessment has formed the basis of the economics assessment undertaken by Dr Doug Fairgray (Technical Assessment O (Economics and town centre impacts), provided in Volume IV).

Qualifications and experience

16. I have the following qualifications and experience relevant to this assessment:

(a) I hold a Master of Agricultural Science with honours (specialising in land resources, erosion processes and soil mechanics) from Massey University, Palmerston North. I also hold a Bachelor of Agricultural Science (specialising in soils, nutrient management, agricultural engineering and farm management) from Massey University.

(b) From 2005 to present I have worked as the director of the land management consultancy company LandVision Ltd specialising in soil, land resources and LUC mapping, whole farm planning, effluent and nutrient management, and sustainable land resource management throughout the country. To date LandVision Ltd has soil and LUC mapped in excess of one million hectares of farm land for farm and environmental planning on dairying, sheep and beef, horticulture, gardening and forestry properties.

(c) As part of LandVision Ltd I have been involved in land resource mapping at the paddock scale on 31 properties covering about 7,300 ha in the Horowhenua District between Ōtaki to North Levin. All the soils found in the proposed Ō2NL Project corridor would have been covered within this mapping work.

(d) Between 1992 and 1996 I worked as a land management officer/soil conservator for the Manawatū-Whanganui Regional Council ("**Horizons**") and covered the Horowhenua District.

(e) As part of my Master's thesis I undertook research work on three soils found in the proposed Ō2NL Project corridor, two of which are highly versatile soils.

Code of conduct

17. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

18. The purpose and scope of this assessment is to determine the impact of the Ō2NL Project on highly productive land.

Assumptions and exclusions in this assessment

19. The analysis to determine the impact on highly productive land has used the NZLRI 1:50,000 scale database which is suitable at the district scale but less

accurate at the farm scale. The 1:50,000 scale database was the best information available without physically remapping the corridor.

20. My assessment is based on the Ō2NL Project concept design GIS shape files.[2] The first concept shape file ("**20220719**") contains a 20m buffer around the road corridor plus a 5m buffer around the spoil, material supply sites, and laydown areas and is referred as the "**maximum footprint**" (or "**Max FP**"). The second concept shape file ("**221006**") is the footprint of the completed road (and road reserve) plus 5 metres and is referred as "**minimum footprint**" (or "**Min FP**").

21. In terms of the impact on productive land the actual impact will be somewhere between the extents of these two shape files as the area used for spoil, material supply and laydown areas may be returned to productive use following the completion of the Project. The extent of this land, and to what degree it is returned to productive use, is however unknown.

EXISTING ENVIRONMENT

22. The physical properties of the Levin and Kiwitea soils are some of the best in the country and with the district's climate are suitable to intensive market gardening and horticulture. Property sizes within the Ō2NL Project corridor are often small but generally this does not restrict intensive market gardening as intensive market gardening often operates under a lease arrangement during a rotation. However, as the productive land size is reduced below 1 ha the attractiveness for intensive market gardening is significantly diminished. Further, these highly productive and highly versatile soils/land are also very suited to intensive pastoral farming so can operate effectively on a number of smaller parcels spread around an area.

23. Most of the proposed Ō2NL Project corridor is located on the flat to undulating terrace country. The high terraces are formed from loess and often overlying either gravels or weakly consolidated sandstone. Where the loess origins are tephra or volcanic material, the land/soil is highly versatile land. Where the loess has not formed from tephra or volcanic material or they have formed under lower rainfall, the drainage is often restricted by the presence of a fragipan. Such soils/land is highly productive but not necessarily highly versatile.

[2] O2NL_ConstructionBuffer_20220719 shape file and O2NL_DF5_ConstructionBuffer_5m_DesignOnly_221006 shape file.

24. The "intermediate terraces" which are lower in elevation to the high terraces are much younger. Their underlying geology is generally gravels or alluvium over gravels and the depth to the gravels can vary. This affects their land use suitability and productivity. For the soils on this landscape to be highly productive they need to have at least 30 cm of topsoil present.

25. Those soils formed on the low terraces (the current river terraces) can have a mixture of soil properties (soil texture, soil structure and drainage) that dictate their versatility and productivity.

PROJECT DESCRIPTION

26. The Ō2NL Project involves the construction, operation, use, maintenance and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) and an SUP between Taylors Road, Ōtaki (and the PP2Ō) and SH1 north of Levin. The Ō2NL Project includes the following key features:

    (a) a grade separated diamond interchange at Tararua Road, providing access into Levin;

    (b) two dual lane roundabouts located where Ō2NL crosses State Highway 57 ("**SH57**") and where it connects with the current SH1 at Heatherlea East Road, north of Levin;

    (c) four lane bridges over the Waiauti, Waikawa and Kuku Streams, the Ohau River and the North Island Main Trunk ("**NIMT**") rail line north of Levin;

    (d) a half interchange with southbound ramps near Taylors Road and the new PP2Ō expressway to provide access from the current SH1 for traffic heading south from Manakau or heading north from Wellington, as well as providing an alternate access to Ōtaki;

    (e) local road underpasses at South Manakau Road and Sorensons Road to retain local connections;

    (f) local road overpasses to provide continued local road connectivity at Honi Taipua Road, North Manakau Road, Kuku East Road, Muhunoa East Road, Tararua Road (as part of the interchange), and Queen Street East;

(g) new local roads at Kuku East Road and Manakau Heights Road to provide access to properties located to the east of the Ō2NL Project;

(h) local road reconnections connecting:

(i) McLeavey Road to Arapaepae South Road on the west side of the Ō2NL Project;

(ii) Arapaepae South Road, Kimberley Road and Tararua Road on the east side of the Ō2NL Project;

(iii) Waihou Road to McDonald Road to Arapaepae Road/SH57;

(iv) Koputaroa Road to Heatherlea East Road and providing access to the new northern roundabout;

(i) the relocation of, and improvement of, the Tararua Road and current SH1 intersection, including the introduction of traffic signals and a crossing of the NIMT;

(j) road lighting at conflict points, that is, where traffic can enter or exit the highway;

(k) median and edge barriers that are typically wire rope safety barriers with alternative barrier types used in some locations, such as bridges that require rigid barriers or for the reduction of road traffic noise;

(l) stormwater treatment wetlands and ponds, stormwater swales, drains and sediment traps;

(m) culverts to reconnect streams crossed by the Ō2NL Project and stream diversions to recreate and reconnect streams;

(n) a separated (typically) three metre wide SUP, for walking and cycling along the entire length of the new highway (but deviating away from being alongside the Ō2NL Project around Pukehou (near Ōtaki)) that will link into shared path facilities that are part of the PP2Ō expressway (and further afield to the Mackays to Peka Peka expressway SUP);

(o) spoil sites at various locations along the length of the Project; and

(p) five sites for the supply of bulk fill /earth material located near Waikawa Stream, the Ohau River and south of Heatherlea East Road.

BACKGROUND INFORMATION

The Land Use Capability Classification System

27. New Zealand adopted the LUC system in the mid 1950s for the purpose of soil conservation. Since this time the whole of New Zealand has been mapped between 1:63,000 and 1:50,000 scale and the system is commonly used for both regulatory planning by councils and farm planning throughout the country.

28. The 2nd edition of Landuse Capability Classification of the Wellington Region, which contains the Ō2NL, was completed in 1992 (Page 1992) at 1:50,000 scale.

29. The LUC system is comprised of two key components:

    (a) Land Resource Inventory ("**LRI**"):

    LRI is the compilation of five physical factors which are: underlying rock type, the soil type, slope, erosion type and severity, and vegetation. These five factors are considered to be critical for land use and management.

    (b) Land Use Capability:

    The five LRI factors described above are used to determine the LUC. There are three components to the LUC system and these are shown in Figure N.1 below and described in the following sections.

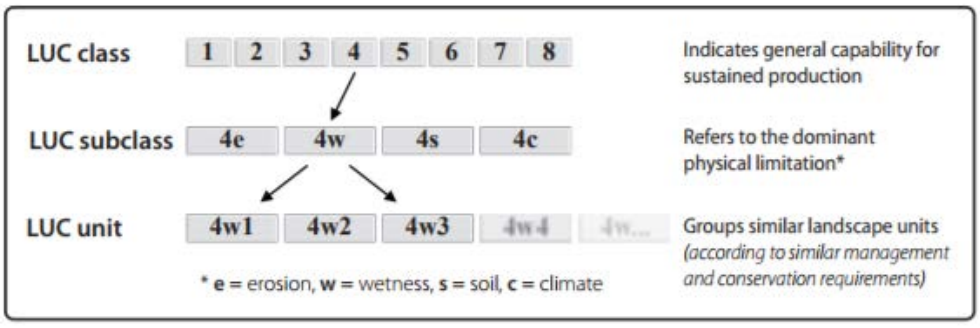

Figure N.1. The components of the LUC classification system.

    (i) LUC Class

    The LUC class system is based on the level of limitation for arable and pastoral use. The classes go from 1 to 8 where classes 1 to 4 are suitable for arable use (and pastoral or forestry), classes 5 to 7 are suitable for pastoral or forestry use

(not arable) and class 8 land is only suited for retirement or protection forestry.

Figure N.2 below shows the land use suitability with respect to LUC class.

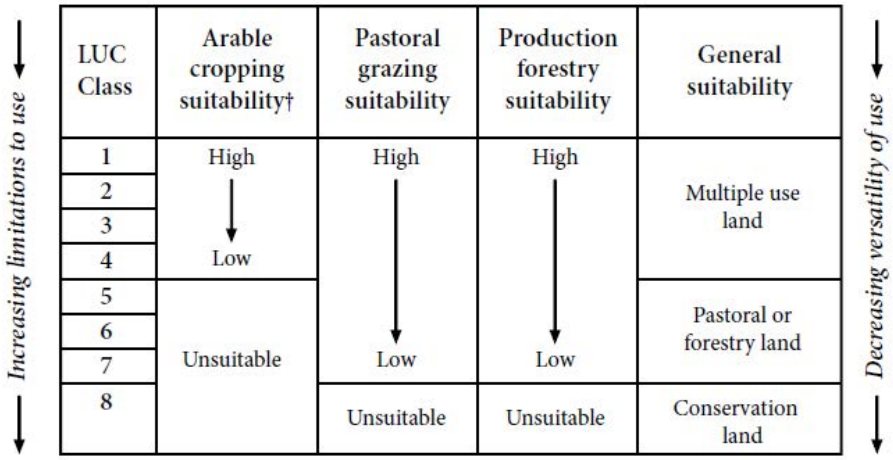

Figure N.2 – The land use suitability within the LUC classification system.

The definitions of the eight different LUC classes are broadly described in Table N.5 below.

Table N.5. Descriptions of the LUC classes.

Class 1	LUC Class I is the most versatile multiple-use land with minimal physical limitations for arable use. It has high suitability for cultivated cropping (many different crop types), berry production, pastoralism, tree crops and production forestry. Class 1 land is flat or undulating (0-7°), has deep (>90 cm) resilient and easily worked soils, and there is minimal risk of erosion. Soils are characterised as being fine textured (silt loam, or fine sandy loam), well drained, not seriously affected by drought, well supplied with plant nutrients, and responsive to fertilisers. Climate is favourable for the growth of a wide range of cultivated crops, and for pasture or forest, and does not significantly limit yields. Land which has a slight limiting physical characteristic such as wetness, risk of flooding, or drought can be included in LUC Class I, where that limitation is removable by permanent works. Waterways associated with Class 1 land may have slight streambank erosion.
Class 2	This is very good land with **slight physical limitations to arable use**, readily controlled by management and soil conservation practices.
Class 3	Class 3 land has **moderate physical limitations to arable use**.
Class 4	Class 4 land has **severe physical limitations to arable use**.

Class 5	This is high-producing land with physical limitations that make it unsuitable for arable cropping, but only negligible to slight limitations or hazards to pastoral, vineyard, tree crop or production forestry use.
Class 6	Class 6 land is not suitable for arable use, and has slight to moderate physical limitations and hazards under a perennial vegetative cover.
Class 7	Class 7 land is unsuitable for arable use, and has severe physical limitations or hazards under perennial vegetation.
Class 8	Class 8 land has very severe to extreme physical limitations or hazards which make it unsuitable for arable, pastoral, or commercial forestry use.

Generally the only horticultural crop that breaks these definitions above on LUC classes 5 to 7 is viticulture which can produce very well in very stony LUC class 7 soils. This is not relevant for the Horowhenua District.[3]

(ii) LUC Subclass

The LUC subclass is the subcategory of the LUC class which identifies the main limitation to land use. Four limitations are used in the classification system and include:

(1) "**erodibility**" – land susceptible to erosion.

(2) "**wetness**" – high water table, slow internal drainage, and/or flooding are main limitations.

(3) "**soil**" – limitation is within the soil (stoniness, shallow profiles, salinity etc.).

(4) "**climate**" – climate is main limitation. Could include: summer drought, high rainfall, high winds etc.

(iii) LUC Unit

The LUC unit groups together areas mapped with similar land inventories (ie geology, soil type, slope, erosion and vegetation) which require the same kind of management; the same kind of conservation treatment; or which are suitable for the same crops. For example, LUC class 2s1 is class 2 land, with a soil limitation, that requires very little management for maximum production.

[3] Noting the presence and operation of the Ōhau Wines vineyard.

Highly Productive and Highly Versatile Soils and Land

30. The terms "soil" and "land" are often misinterpreted and misused interchangeably. There are numerous different definitions and opinions of each of these words but in short soil is only one factor of land. Soil is the growing medium for plants, whilst land incorporates many other factors discussed in the section on "Productive and Versatile Land".

31. Both soil and land can then be described as "versatile" and/or "productive". They are described as "high-class", "high value", "elite" or "fertile". The following sections describe both.

Highly Productive and Versatile Soil

32. Soil is defined by the United States Department of Agriculture (2017) as:[4]

> *a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment.*

33. Productive soils have the ability to provide water and nutrients to produce high yields. A soil being productive or not is dependent on the soil properties such as soil texture, structure, soil organic matter, drainage and depth. Some soils may be productive for some or one crop but not productive for other crops.

<u>Highly Productive Soils</u>

34. Soil productivity is largely determined by its ability to provide water and nutrients to allow deep rooting of agricultural plants. The key physical properties that are needed to achieve this are soil texture, structure, soil consistence, organic matter content and drainage.

[4] United States Department of Agriculture (2017). *'What is soil?'*, *Natural Resources Conservation Service soils,* https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054280 (accessed 15 October 2017).

Versatile Soils

35. The best soils in New Zealand are coined to be "versatile" or "high-class". Versatile soils are critical for the supply of nutrients required for optimum plant and food growth.[5] A versatile soil is one that is:[6]

> *capable of many uses needs to be deep, fine-textured, moist, free-draining, loamy, and have organic-rich topsoil. These properties best enable plant roots to take up nutrients, water and oxygen, and get enough support for rapid growth. Fertility is highest in soils young enough not to have been leached and old enough to have built up organic matter. They are also derived from parent rocks that are well supplied with essential nutrients.*

36. The productivity of soil in New Zealand is loosely based on the LUC system. Versatile soils in New Zealand are rare and include LUC classes 1 and 2 and potentially some of the better LUC units from class 3 land. About 5.2% of the New Zealand land area is LUC classes 1 and 2 (Eyles *et al*. 2009) and therefore can be termed highly versatile soil.

Productive and Versatile Land

37. Land incorporates soil plus a number of other factors. There have been numerous attempts to define productive and versatile land. In *Canterbury Regional Council v Selwyn District Council*,[7] the Environment Court, presented a comprehensive list of factors that need to be taken into consideration when labelling land "versatile". These are shown in Table N.6 below:

38. Table N.6: The Treadwell list of factors needed to be considered when defining productive and versatile land.

[5] Hewitt, A. *"Soils - What makes a good soil?",* Te Ara - the Encyclopedia of New Zealand, http://www.TeAra.govt.nz/en/soils/page-9 (accessed 20 October 2017).
[6] Hewitt, A. *"Soils - What makes a good soil?",* Te Ara - the Encyclopedia of New Zealand, http://www.TeAra.govt.nz/en/soils/page-9 (accessed 20 October 2017).
[7] *Canterbury Regional Council v Selwyn District Council*, ENC Decision No W142/96, 15 October 1996.

Table N.6. The Treadwell list of factors that need considering for highly versatile land.

• Soil texture • Soil structure • Soil water holding capacity • Soil organic matter stability • Site's slope • Sites drainage • Temperature of the site • Aspect of the site • Storm water movements • Flood plain matters • Wind exposure • Shelter planted • Availability of irrigation water	• Transport, both ease and distance • Effect of use on neighbours • Effects of the neighbours on the use • Access from the road • Proximity to airport • Proximity to port • Supply of labour • Previous cropping history • Relevant contamination • Sunlight hours • Electricity supply • District scheme • Economic and resale factors

39. In general, the highly productive and versatile soils in the Horowhenua District can satisfy most of the factors in Table N.6 above and can be termed highly productive or versatile land.

40. For this assessment highly productive land contains LUC classes 1 to 3 whilst highly versatile land contains LUC classes 1 and 2. In addition, those free draining units formed from loess or tephra would be classified as highly versatile (ie LUC units 3e1 and 3e2 plus LUC classes 1 and 2).

METHODOLOGY

41. To assess the effects of the Ō2NL Project on the productive land the following methodology was undertaken:

    (a) Ō2NL_ ConstructionBuffer_20220719 and Ō2NL_DF5_ConstructionBuffer_5m_DesignOnly_221006 shape files were used for the analysis.

(b) An Ō2NL Project property shape file was used to determine affected properties. Some adjustment of property boundaries was required on closer inspection of underlying aerial photography and titles and this was generally restricted to the dairying properties where raceways clearly went from one parcel to the next with different ownership. This enabled me to understand general farm operations.

(c) A classification of the current land use within the different property boundaries using 2018-19 aerial photography was undertaken using the GIS (sourced from Land Information New Zealand). The different land use classifications included dairying, sheep and beef, gardening, horticulture, forestry, bush and lifestyle/dwellings. For this exercise the common term “lifestyle blocks” is not the same as “lifestyle/dwellings”. Lifestyle/dwellings are used for non-productive land use and some lifestyle blocks may have both lifestyle/dwellings and productive uses such as sheep and beef.

(d) The LUC/LRI for the affected properties and the area within the proposed roading corridor were determined using the NZLRI database (from Page 1995). This information was used to determine the highly productive and highly versatile land within both the affected properties and within the proposed roading corridor.

RESULTS AND ASSESSMENT OF EFFECTS

Land Resources

42. The land resources of the proposed Ō2NL Project Operational Footprint and affected properties have been obtained from the NZLRI where the underlying geology, dominant soil types, slope, erosion type and severity and vegetation were recorded. This survey was completed in 1992 (Page 1995) at a scale of 1:50,000. Although this survey was completed about 30 years ago, the only inventory factor outdated is the vegetation and possibly erosion type and severity. The latter is related to vegetation. All other factors remain constant. To overcome this, a combination of the LUCAS 2016 land use database from MFE and recent aerial photography interpretation (flown 2018-19) has been used.

43. Appendix N.1 contains descriptions for the different LUC units found within the affected properties and the corresponding maps are shown in Appendix N.2.

44. Table N.7 below details the extent of the different LUC classes and units present within the two footprints. These are shown in Maps 1-6 in Appendix N.2. Of those areas that are mapped as a compound LUC unit (ie two LUC units) on the maps, the first LUC dominates and has been used for the analysis.

45. The blue and green colours in Table N.7 indicate highly productive and highly versatile land respectively that is discussed in a later section.

Table N.7. The extent of the LUC classes and units on land affected by either the minimum or maximum footprint.

LUC Class	Total area within the footprint (ha)		LUC Units		
	Minimum footprint	Maximum footprint	LUC Unit	Minimum footprint (ha)	Maximum footprint (ha)
1	60.2	94.0	1s 1	0	0
			1c 1	60.2	94.0
2	37.5	68.5	2e 1	21.4	31.0
			2w 2	0	0.2
			2s 1	16.0	37.1
			2s 2	0.1	0.2
3	131.8	197.2	3e 1	2.5	4.0
			3e 2	0.1	0.9
			3e 3	18.3	27.6
			3s 2	55.2	83.7
			3s 4	55.7	79.3
4	6.0	10.5	4s 1	6.0	10.5
6	0.1	0.6	6e 6	0.1	0.6
Total	235.6	369.9		235.8	369.9

46. Table N.7 above shows that the impact on all land is somewhere between 235.6 ha and 369.9 ha depending on how much of the supply sites, spoil sites and laydown areas are ameliorated back into productive use. There is an expectation that most of this land will be returned to productive use.

47. For the land classified as highly productive land (ie LUC classes 1 – 3) the potential area lost to the proposed road is between 229.4 ha and 358.7 ha. For the land classified as highly versatile land (ie LUC classes 1 and 2 plus LUC units 3e1 and 3e2) the potential area lost to the proposed road is between 100.2 ha and 167.4 ha.

48. Nationally, about 14.4% of the New Zealand land area (Lynn *et al*. 2009) is classified as LUC classes 1 to 3, or highly productive soil. About 5.2% are LUC classes 1 and 2, whilst LUC class 1 land alone accounts for about 0.7% of the New Zealand land area.

49. The Horowhenua District is approximately 105,602 ha in size. Of that, about 43,766 ha (41%) is classified as highly productive land (LUC classes 1 to 3) and 31,639 ha (30%) can be classified as highly versatile land (contains LUC classes 1 and 2 plus LUC units 3e1 and 3e2). In the Horowhenua District the proposed Ō2NL Project corridor will take 193.4 ha and 305.1 ha of highly productive land or between 96.2 ha and 160.0 ha is highly versatile land.

50. On a national level the Horowhenua District has about 1% of the country's highly productive land and about 2% of the country's highly versatile land.

51. The amount of highly productive and highly versatile land within the proposed Ō2NL Project Operational Footprint is not large but nationally the extent of highly productive and highly versatile land is diminishing (NPS-HPL 2019).

Current Land Use

52. Table N.8 below details the number of properties and areas within different property sizes affected by the two footprints. The property sizes are split into less than 1 ha, between 1 and 8 ha, and greater than 8 ha categories. The reason these property sizes have been used is because:

    (a) properties less than 1 ha are essentially lost to being productive (if not merged into an existing operation);

    (b) for properties between 1 and 8 ha there may be the opportunity for both market gardening and horticulture; and

    (c) properties greater than 8 ha provide sufficient area for a multitude of uses.

Table N.8 – Property size distribution (of properties located in the Ō2NL Project Operational Footprints).

		Property size			Total
		Less than 1 ha	Between 1 and 8 ha	Greater than 8 ha	
Minimum footprint area	Number of properties	14	76	45	135
	Total property area (ha)	6.7	284.2	2,043.2	2,334.1
	Average property area (ha)	0.5	3.7	45.2	17.4
	Total road corridor area (ha)	3.4	70.7	161.5	235.6
	Average road corridor area per property (ha)	0.2	0.9	3.6	1.7
Maximum footprint area	Number of properties	14	81	45	140
	Total property area (ha)	6.7	298.3	2,043.2	2,348.2
	Average property area (ha)	0.5	3.7	45.4	16.8
	Total road corridor area (ha)	4.6	106.5	258.8	369.9
	Average road corridor area per property (ha)	0.3	1.3	5.8	2.6

53. Table N.8 shows the following:

(a) The total number of properties affected is between 135 and 140.

(b) The total area of the maximum footprint is 369.9 ha and this is 134.3 ha greater than the minimum footprint area.

(c) As the properties get smaller there is a greater proportion of the property affected (as in, within the corridor). For properties less than 1 ha between 40% and 60% of the property area will be affected. For properties between 1 ha and 8 ha it is estimated that between 24% and

35% of the property will be affected. For properties greater than 8 ha between 8% and 13% of the property area will be affected.

54. The land use makeup of these properties has also been considered. These have been differentiated into dairy, sheep and beef, gardening (growing vegetables), horticulture, forestry, bush and lifestyle/dwelling. The distribution is shown in Table N.9 below. It is noted that some properties which make up Table N.9 contain more than one land use hence the reason why the summation of land use types does not tally with the property total.

Table N.9 – Property land use of properties located in the Ō2NL Project.

		Dairy	Sheep & beef	Vegetables	Horticulture	Forestry	Bush	Lifestyle	Total
All sizes of properties									
Number of properties containing	Min FP	6	94	22	5	14	5	66	135
	Max FP	6	96	23	6	14	5	69	140
Total area containing (ha)	Min FP	786.1	828.0	315.5	13.4	315.3	23.3	52.6	2,334.1
	Max FP	786.1	831.9	320.0	14.1	315.3	23.3	57.5	2,348.2
Properties less than 1 ha									
Number of properties containing	Min FP	-	4	1	-	-	-	11	14
	Max FP	-	4	1	-	-	-	11	14
Total area containing (ha)	Min FP	-	2.8	1.0	-	-	-	3.0	6.7
	Max FP	-	2.8	1.0	-	-	-	3.0	6.7
Properties between 1 and 8 ha									
Number of properties containing	Min FP	-	60	8	4	3	1	46	76
	Max FP	-	62	9	5	3	1	49	81
Total area containing (ha)	Min FP	-	192.3	38.2	4.1	7.0	1.2	41.5	284.2
	Max FP		196.1	42.7	4.9	7.0	1.2	46.4	298.3

		Dairy	Sheep & beef	Vegetables	Horticulture	Forestry	Bush	Lifestyle	Total
Properties greater than 8 ha									
Number of properties containing	Min FP	6	30	13	1	11	4	9	45
	Max FP	6	30	13	1	11	4	9	45
Total area containing (ha)	Min FP	786.1	633.0	276.3	9.2	308.3	22.1	8.1	2,043.2
	Max FP	786.1	633.0	276.3	9.2	308.3	22.1	8.1	2,043.2
Average area (ha)	Min FP	131.0	21.1	21.3	9.2	28.0	5.5	0.9	45.4
	Max FP	131.0	21.1	21.3	9.2	28.0	5.5	0.9	45.4

55. Table N.9 shows that the dominant land use of those properties affected by the proposed road are sheep and beef, dairying and gardening. These three land uses alone make up 83%. Forestry within these properties comprises of about 13%. Further to this, those properties greater than 8 ha make up about 88% of the property area.

56. If all land uses with the exception of bush and lifestyle are considered productive uses, then there are between 117 and 121 productive properties covering between 2,258.3 ha and 2267.4 ha.

57. Analysis on the areas within the two footprints of the proposed Ō2NL Project for each land use has been undertaken and is shown in the following table.

Table N.10. Land use distribution within the two footprints for the different property size differentiated according to the total area of the property.

Land use	Min. & max Footprint	Dairy	Sheep & beef	Vegetables	Horticulture	Forestry	Bush	Lifestyle	Total
All sizes of properties									
Number of properties containing	Min.	6	93	20	5	2	2	48	135
	Max.	6	96	23	6	14	5	69	140
	Min.	37.1	142.0	36.9	4.6	0.2	0.4	14.4	235.6

Land use	Min. & max Footprint	Dairy	Sheep & beef	Vegetables	Horticulture	Forestry	Bush	Lifestyle	Total
Total area containing (ha)	Max.	55.8	231.6	53.5	6.1	0.6	0.7	21.7	369.9
Properties less than 1 ha									
Number of properties containing	Min.	0	4	1	0	0	0	11	14
	Max.	0	4	1	0	0	0	11	14
Total area containing (ha)	Min.	-	1.0	0.3	-	-	-	2.1	3.4
	Max.		1.5	0.5				2.7	4.6
Properties between 1 and 8 ha									
Number of properties containing	Min.	0	59	8	4	0	1	31	76
	Max.	0	61	9	4	1	1	35	81
Total area containing (ha)	Min.	-	46.8	10.3	1.7	-	0.4	11.5	70.7
	Max.		70.2	15.7	2.4	0.0	0.7	17.5	106.5
Properties greater than 8 ha									
Number of properties containing	Min.	6	30	11	1	2	1	6	45
	Max.	6	30	11	1	4	2	6	45
Total area containing (ha)	Min.	37.1	94.2	26.3	2.8	0.2	0.0	0.8	161.5
	Max.	55.8	160.0	37.3	3.6	0.6	0.0	1.5	258.8
Average area (ha)	Min.	6.2	3.1	2.4	2.8	0.1	0.0	0.1	3.6
	Max.	9.3	5.3	3.4	3.6	0.1	0.0	0.3	5.8

58. Table N.10 shows that the O2NL proposed corridor will consist of between 235.6 ha and 369.9 ha. The extent will depend on the remedial work of the spoil, burrow and layover areas. The difference between the two footprints is 134.3 ha of which 89.6 ha comes from sheep and beef land, 18.7 ha from dairying and 16.6ha from gardening. In terms of property size, the bulk of the difference comes from properties greater than 8 ha (about 97 ha) and 1 to 8 ha (about 36 ha).

Highly Productive and Versatile Land

Highly Productive Land

59. Under the definitions of the eight LUC classes in Table N5, all of the LUC units within LUC classes 1 to 3 are classified as highly productive land.

60. Table N.16 below categorises those areas with highly productive land/soil within the proposed Ō2NL Project Operational Footprint according to both land use and property type.

Table N.11. A breakdown of the areas of highly productive land (HPL) and their different land uses within the two footprints.

	Footprint	Dairy	Sheep and beef	Gardening	Horticulture	Forestry	Bush	Lifestyle	Total
All sizes of properties									
Number of properties containing HPL.	Min.	6	93	20	5	2	2	48	135
	Max.	6	95	21	5	4	3	52	140
The area of HPL within the corridor.	Min.	32.6	140.4	36.9	4.6	0.2	0.4	14.4	229.5
	Max.	47.8	228.6	53.5	6.1	0.4	0.7	21.7	358.8
The total area of the property is less than 1 ha									
Number of properties containing HPL.	Min.	-	4	1	-	-	-	11	14
	Max.	-	4	1	-	-	-	11	14
The area of HPL within the corridor.	Min.	-	1.0	0.3	-	-	-	2.1	3.4
	Max.	-	1.5	0.5				2.7	4.6
The total area of the property is between 1 and 8 ha									
Number of properties containing HPL.	Min.	-	59	8	4	-	1	31	76
	Max.	-	61	9	4	1	1	35	81
The area of HPL within the corridor.	Min.	-	46.8	10.3	1.7	0	0.4	11.5	70.7
	Max.	-	70.2	15.7	2.4	0	0.7	17.5	106.5

	Footprint	Dairy	Sheep and beef	Gardening	Horticulture	Forestry	Bush	Lifestyle	Total
Total area of the property is greater than 8 ha									
Number of properties containing HPL	Min.	6	30	11	1	2	1	6	45
	Max.	6	30	11	1	3	2	6	45
The area of HPL within the corridor.	Min.	32.6	92.6	26.3	2.8	0.2	0	0.8	155.4
	Max.	47.8	156.9	37.3	3.6	0.4	0.0	1.5	247.6
Average area HPL	Min.	5.4	3.1	2.4	2.8	0.1	0	0.1	3.5
	Max.	8.0	5.2	3.4	3.6	0.1	0.0	0.3	5.5

61. Table N.11 above shows that the amount of highly productive land being lost to the proposed Ō2NL Project is between 229.5 ha and 358.8 ha. The actual amount will be dependent on the quality of the works undertaken restoring the spoil, burrow and layover sites.

62. Between 61% and 64% of the highly productive area is being lost to the proposed Ō2NL Project Operational Footprint is currently under sheep and beef land use, 14-15% in market gardening and 13-14% from dairying. The remaining highly productive land currently in dairying or sheep and beef also has the potential to be gardened. Market gardening as a land use can only occur on highly productive and highly versatile land.

Highly Versatile Land

63. Highly versatile land is the elite land and it includes the following LUC units within the proposed Ō2NL Project Operational Footprint:

    (a) All the LUC units from classes 1 and 2 land.

    (b) From LUC class 3 land: LUC units 3e1 and 3e2 that are formed from allophanic loess or older yellow brown sands respectively. This land is only classified as class III due to slope and the slope has very little impact on its productive versatility. The soils present on these units are also found on flatter units which are classified as class I and II land.

64. It excludes three LUC class 3 units (3e3, 3s2 and 3s4) that are classified as highly productive land because they are not considered highly versatile. This

is because of their drainage characteristics or their depth to gravel that limits their versatility. Despite this, they are still highly productive but without the versatility.

65. The table below shows the impact of the proposed Ō2NL Project Operational Footprint on highly versatile land.

Table N.12. A breakdown of the areas of highly versatile land (HVL) and their different land uses.

	Footprint	Dairy	Sheep and beef	Gardening	Horticulture	Forestry	Bush	Lifestyle	Total
All sizes of properties									
Number of properties containing HVL.	Min.	5	57	10	5	1	1	31	84
	Max.	5	66	12	5	2	1	33	96
The area of HVL within the corridor.	Min.	16.8	55.8	15.8	4.6	0.0	0.4	6.9	100.3
	Max.	27.0	98.2	24.2	6.1	0.0	0.7	11.1	167.4
The total area of the property is less than 1 ha									
Number of properties containing HVL.	Min.	0	1	0	0	0	0	7	8
	Max.	-	1	-	-	-	-	7	8
The area of HVL within the corridor.	Min.	-	0.2	-	-	-	-	0.9	1.1
	Max.	-	0.3	-	-	-	-	1.2	1.5
The total area of the property is between 1 and 8 ha									
Number of properties containing HVL.	Min.	-	42	6	4	-	1	22	53
	Max.	-	49	7	4	-	1	24	62
The area of HVL within the corridor.	Min.	-	30.0	8.0	1.7	-	0.4	5.6	45.7
	Max.	-	44.4	12.3	2.4	-	0.7	9.2	69.0
Total area of the property is greater than 8 ha									
Number of properties	Min.	5	14	4	1	1	-	2	23

	Footprint	Dairy	Sheep and beef	Gardening	Horticulture	Forestry	Bush	Lifestyle	Total
containing HVL	Max.	5	16	5	1	2	-	2	26
The area of HVL within the corridor.	Min.	16.8	25.7	7.8	2.8	0.0	-	0.5	53.6
	Max.	27.0	53.5	11.9	3.6	-	-	0.8	96.9
Average area HVL	Min.	3.4	1.8	2.0	2.8	-	-	0.3	2.3
	Max.	5.4	3.3	2.4	3.6	-	-	0.4	3.7

66. Table N.12 above shows that the minimum highly versatile land lost to the proposed designations is 100.3 ha and the maximum area is 167.4 ha. In reality the actual lost will be between these two figures and the extent of this is dependent on the remedial works of the spoil, burrow and lay down areas at the completion of the Project. The area of HVL within the corridor is between 43% and 45% of the total corridor area. Of all the HVL within the corridor about 93% is currently in a productive use and nearly all of it is on properties greater than 1 ha. Between 54% and 58% of the HVL is on properties greater than 8 ha and between 41% and 46% is on properties between 1 and 8 ha in size. This land is highly versatile and has the ability to sustainably grow a wide range of crops or land uses.

The division of properties

67. When the proposed Ō2NL Project Operational Footprint dissects a property, it has the potential to result in land fragmentation. This section looks at the resulting land parcels or properties as a result of the dissection. There are between 135 and 140 properties dissected by the proposed Ō2NL Project and in doing so will potentially create between 57 and 71 areas of land that are separated from the remainder of the property. For ease of reference these areas are referred to as properties, such that there will be a total of up to 206 ‘properties’ once the Project is constructed. Table N.15 summarises the breakdown of these properties.

Table N.15. A comparison of the property numbers and areas pre and post road construction.

Properties	Footprint	Existing		Post road construction		Change	
		Number	Total area (ha)	Number	Total area (ha)	Number	Total area (ha)
Total number and area of properties	Min FP	135	2,334.1	206	2,098.4	+71	-235.6
	Max FP	140	2,348.2	197	1,978.3	+57	-369.9
Less than 1 ha	Min FP	14	6.7	54	20.9	+40	+14.2
	Max FP	14	6.7	54	20.5	+40	+13.8
Between 1 and 8 ha	Min FP	76	284.2	104	353.6	+28	+69.4
	Max FP	81	298.3	100	345.2	+19	+46.9
Greater than 8 ha	Min FP	45	2,043.2	48	1,723.9	+3	-319.3
	Max FP	45	2043.2	43	1612.6	-2	-430.6

68. Most of the increased properties are small properties less than 1 ha (an additional 40 properties). In terms of area, the biggest reductions occur on properties greater than 8 hectares in size.

69. The property sizes within these categories also decreased and are shown in Table N.16 below.

Table N.16. A comparison of the average property sizes between pre and post road.

Property size category	Footprint	Average areas existing (ha)	Average areas post road (ha)
Average area of all properties	Min FP	17.3	10.2
	Max FP	16.8	10.0
Less than 1 ha	Min FP	0.5	0.4
	Max FP	0.5	0.4
Between 1 and 8 ha	Min FP	3.7	3.4
	Max FP	3.7	3.5
Greater than 8 ha	Min FP	45.4	35.9
	Max FP	45.4	37.5

70. The extra 51-71 areas of land physically separated by the highway will lead to fragmentation. However, these parcels of land could be amalgamated with adjacent properties so as to minimise this.

71. As set out above, without amalgamation, those properties (and areas of physically separated land) that end up being less than 1 ha as a result of the proposed Ō2NL Project Operational Footprint could be considered to be effectively non-productive. The minimum area of highly productive and highly versatile land outside the proposed Ō2NL Project Operational Footprint on parcels of land less than 1 ha is 20.7 ha and 16.6 ha respectively and the maximum area of highly productive and highly versatile land less than 1 ha is 21.2 and 15.3 ha respectively. This means that up to 21.2 ha of additional highly productive land or 16.6 ha of highly versatile land could be lost from productive uses as a result of the proposed Ō2NL Project Operational Footprint, assuming no steps are taken to merge this land into adjacent operations.

OTHER CONSIDERATIONS

Tara Ika Plan Change

72. The proposed Tara Ika Plan Change from Horowhenua District Council ("**HDC**") incorporates about 204.5 ha of highly productive land and incorporates about 29.4 ha of proposed Ō2NL Project corridor. This area would be lost from productive value as a result of the proposed plan change.

PROJECT SHAPING AND AVOIDING AND MINIMISING EFFECTS

73. In determining the proposed Ō2NL Project corridor productive land was one of a dozen or more criteria used in the multi-criteria assessment that informed selection of the Project corridor. The different options assessed are shown in Figures N.14 and N.15 in Appendix N.2.

74. From a highly versatile land perspective there was significantly less impact on highly versatile land for the roading options to the west of SH1 and Punahau / Lake Horowhenua compared to the east. All three options (S8N6, S3N2 and S1N1) were significantly less impactive than any of the options to the east of Levin. It is noted that there were fatal flaws in other criteria assessed for these three options.

75. Figures N.12 and N.13 in Appendix N.2 show that there was no real opportunity to avoid either highly productive or highly versatile land to the

east of Levin due to the highly levels of highly productive and versatile land present in this area. Those with options with the shortest length, particularly on the northern half, reduced the impact. The proposed Ō2NL Project corridor option (S6N4) was not the most impactive option on productive land and nor was it the least impactive option.

76. It is noted that the proposed Ō2NL Project corridor designation width is three to four times wider than the proposed corridor. All assessments undertaken in this report are for the estimated Operational Footprint. Minimising the Operational Footprint area where practical will minimise any potential soil health issues in this zone.

77. In addition to amalgamating titles following construction, any topsoil stripped as part of construction should be used to rehabilitate earthwork areas following construction. This will help reinstate areas located within the construction footprint, including construction compounds and laydown areas, spoil sites and material supply sites. This approach will help ensure that land is reinstated so that it has the same or similar soil quality as it had prior to construction commencing.

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14 October 2022

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APPENDIX N.1 – LAND USE CAPABILITY UNIT DESCRIPTIONS

The following table describes the different LUC units found within the properties affected from the proposed Ō2NL Project. The green shading represents those LUC units that are considered both highly productive and highly versatile. The purple shading represents those units that are just highly productive. The livestock productivity units are a measure of the lands carrying capacity and measured in stock units per hectare (su/ha). One stock unit is equivalent to one 55 kg ewe producing one lamb and eating 550 kg dry matter per year.

Table N.16. LUC unit descriptions

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
1s1 Flat, low river terraces and levees of the floodplains with fine-textured alluvial soils. The soils are deep, fertile and well drained, although they dry out slightly in summer.	Floodplains, low terraces	Fine-grained alluvium.	Recent soils: Manawatu fine sandy loam. Karapoti silt loam and fine sandy loam.	0-3	Intensive pastoral farming. Dairying. Market gardening. Horticulture. Cereals.	24-30
1c1 Flat to gently undulating, high and medium-height terraces with a mantle of loess and minor tephra. The soils are deep, fertile and well drained.	High terraces	Loess and minor tephra.	Intergrades between yellow brown earths and yellow brown loams: Levin silt loam. Kiwitea loam. Waitohu silt loam.	0-3	Intensive pastoral farming. Dairying. Market gardening. Horticulture – kiwifruit, orcharding. Cereals.	27-32 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
2e1 Undulating high and medium-height terraces with a mantle of loess and minor tephra. The soils are deep, fertile and well drained. There is a potential for slight sheet and rill erosion when cultivated. Similar to 1c1 except undulating slopes.	High terraces	Loess and minor tephra.	Intergrades between yellow brown earths and yellow brown loams: Levin silt loam. Kiwitea loam. Waitohu silt loam.	4-7	Intensive pastoral farming. Dairying. Market gardening. Horticulture – kiwifruit, orcharding. Cereals.	27-32 su/ha
2w1 Flat, low river terraces and floodplains with fine-textured alluvial soils. The soils are deep, fertile and imperfectly drained with a slight wetness limitation.	Floodplains, low terraces	Fine-grained alluvium.	Gleyed recent soils: Kairanga silt loam Kairanga fine sandy loam Kairanga silt loam and clay loam Kairanga loam	0-3	Intensive pastoral farming. Dairying. Market gardening. Horticulture – kiwifruit, orcharding. Cereals.	25-30 su/ha
2w2 Flat, low lying basins within the Manawatu floodplain, consisting of interbedded layers of peat and alluvium. The soils have peaty textures and are poorly drained.	Floodplains	Peat and alluvium. Peat over alluvium.	Gleyed recent soils, organic soils: Opiki peaty loam Opiki complex Makerua peaty silt loam Makerua loamy peat	0-3	Intensive pastoral farming with drainage. Gardening. Horticulture. Nurseries. Maize.	22-30 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
2s1 Flat, low river terraces and levees of the floodplains with alluvial soils. The soils are sandy in texture and moderately deep overlying gravels at 60-90 cm. They are fertile and well drained although they tend to dry out in summer. The soils are sandier textured and shallower than 1s1.	Floodplains, low terraces	Fine-grained alluvium.	Recent soils: Manawatu sandy loam. Karapoti brown sandy loam. Manawatu shallow fine sandy loam. Manawatu shallow silt loam. Karapoti shallow fine sandy loam.	0-3	Intensive pastoral farming. Dairying. Gardening. Horticulture.	23-28 su/ha
2s2 Flat to undulating medium-height terraces overlain by slightly consolidated Aeolian sands. Soils are sandy in texture and well drained, tending to dry out in summer. Associated with the oldest dune forming phase.	Terraces overlain by aeolian sands	Weakly to unconsolidated sands.	Yellow brown sands: Koputaroa fine sandy loam. Waitawa fine sandy loam. Koputaroa sand.	0-7	Intensive pastoral farming. Dairying. Gardening. Nursery. Horticulture.	20-26 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
2s3 Flat, medium-height alluvial terraces with well drained, moderately deep soils overlying gravel. Soils dry out in summer. Depth to gravels 60-100+ cm.	Medium-height terraces	Fine-grained alluvium over gravels.	Yellow-brown earths. Yellow-brown shallow and stony soils associated with intergrades between yellow-grey earths and yellow-brown earths: Hautere silt loam. Te Horo silt loam. Heretaunga sandy loam. Ashhurst silt loam. Includes areas of Hautere stony silt loam and Te Horo stony silt loam with more stones in profile.	0-3	Intensive pastoral farming. Dairying. Gardening. Horticulture.	20-26 su/ha
2c1 Flat to gently undulating, high terraces with a mantle of loess and minor tephra. The soils are deep, fertile and well drained. The terraces typically occur between 40-100 m above sea level where rainfall is approximately 1200 mm p.a. Slight frosts and cool temperatures limit cropping versatility. 2cl occurs further inland and at higher elevations than 1cl, with a higher rainfall, lower temperatures and an increased likelihood of frosts.	High terraces	Loess and minor tephra.	Intergrades between yellow-brown earths and yellow-brown loams: Levin silt loam. Kiwitea loam.	0-3	Intensive pastoral farming. Gardening Orcharding. Cereals. Dairying.	23-30 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
3e1 Dissected terrace land formed from unconsolidated sands and conglomerate. Soils are intergrades between yellow-brown earths and yellow-brown loams developed from loess and minor tephra. Potential for moderate sheet and rill erosion when cultivated. Note the slope.	High, dissected terraces	Loess and minor tephra.	Intergrades between yellow-brown earths and yellow-brown loams: Levin silt loam. Kiwitea loam.	4-15	Intensive pastoral farming. Gardening Orcharding. Cereals. Dairying.	23-30 su/ha
3e2 Rolling to undulating downlands of slightly consolidated aeolian sands. Soils are sandy textured and well drained. There is a potential for slight to moderate sheet, rill and wind erosion when cultivated.	Terraces overlain by aeolian sands	Slightly unconsolidated sands.	Yellow-brown sands: Koputaroa fine sandy loam, rolling phase. Koputaroa sand.	4-15	Intensive pastoral farming. Dairying. Horticulture. Gardening. Cereals.	17-21 su/ha
3e3 Rolling dissected terrace land and fans with a mantle of loess over sands conglomerate and colluvium.	High, dissected terraces	Loess or loess over colluvium	Intergrades between yellow-grey earths and yellow-brown earths. Yellow grey earths: Shannon silt loam. Waitohu silt loam. Tokomaru silt loam, rolling phase. Kokotau silt loam.	4-15	Intensive pastoral farming. Dairying. Horticulture. Gardening. Cereals.	21-26 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
3s2 Flat, medium height terraces with somewhat excessively drained soils developed from stony alluvium or patchy loess. Stones occur throughout the profile. Depth to gravels is 30-60 cm.	Medium-height terraces	Gravels. Patchy alluvium over gravels. Patchy loess over gravels.	Yellow-brown shallow and stony soils associated with intergrades between yellow-grey earths and yellow-brown earths. Yellow-brown shallow and stony soils associated with yellow-brown earths: Ashhurst silt loam, stony phase Ashhurst stony silt loam Kawhatau stony silt loam Heretaunga stony silt loam	0-3	Intensive pastoral farming. Dairying. Horticulture. Root and green fodder crops.	18-24 su/ha
3s4 Flat to gently undulating high terraces with a mantle of loess. The presence of a subsoil pan causes perching of water. Soils are poorly drained in winter but subject to summer soil moisture deficiencies. 70-80 cm depth to fragipan.	High terraces	Loess	Yellow-grey earths. Intergrades between yellow-grey earths and yellow brown earths: Tokomaru silt loam. Rahui silty clay loam. Ohakea silt loam.	0-7	Intensive pastoral farming with drainage.	21-26 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
4e2 Dissected terrace land and fans formed from unconsolidated to moderately consolidated sands and conglomerate. Soils are yellow-grey earths or intergrades between yellow-grey earths and yellow-brown earths developed from loess.	High, dissected terraces and fan	Loess. Loess and colluvium over unconsolidated to moderately consolidated sands and conglomerate.	Intergrades between yellow-grey earths and yellow-brown earths. Yellow grey earths: Shannon silt loam, rolling phase Shannon silt loam Kiwitea loam Tokomaru silt loam, rolling phase	8-20	Intensive pastoral farming with drainage. Root and green fodder cropping.	18-22 su/ha
4s1 Flat low river terraces with shallow, sandy to stony soils. Soils are somewhat excessively drained and subject to seasonal moisture deficiencies.	Low river terraces	Fine-grained alluvium over gravels	Recent soils: Tukituki sandy loam, stony gravel. Rangitikei loamy sand. Rangitikei sandy loam. Rangitikei shallow fine sandy loam.	0-3	Pastoral farming.	16-20 su/ha
4e6 Moderately steep to steep greywacke hill country in areas with moderate rainfall (1140-1270mm p.a) with soil moisture deficiencies. There is potential for moderate soil slip erosion.	Hills	Patchy loess over greywacke. Greywacke.	Yellow-brown earths and related steepland soils: Korokoro hill soils. Makara steepland soils.	21-35	Pastoral farming with soil conservation.	10-12 su/ha

LUC unit	Landform	Parent material	Dominant soil type	Slope (degrees)	Landuse suitability	Livestock Productivity Su/ha
4e8 Moderately steep to steep greywacke hill country, comprising the hills of the mountain ranges. Typically occurs between 200-500m a.s.l. and in areas of high rainfall (1270-1780 mm p.a.). There is potential for moderate soil slip.	Foothills of the ranges	Greywacke.	Yellow-brown earths and related steepland soils: Akatarawa hill soils. Matamau silt loam, hill soil. Ramiha hill soils. Tuhitarata hill soils. Ruahine steepland soils.	21-35	Extensive pastoral farming.	6-10 su/ha
6s6 Strongly rolling to moderately steep low hills with a mantle of loess over greywacke. The hills are at elevations <300 m a.s.l. and have a moderate rainfall (1 140-1 270 mm p.a.). Slopes are stable but subject to seasonal soil moisture deficiencies.	Low hills	Loess over greywacke (slightly to moderately weathered)	Yellow-brown earths: Korokoro hill soils. Matamau silt loam, hill soil.	16-25	Extensive pastoral farming.	10-13 su/ha
7e2 Steep to very steep greywacke hill country in the foothill of the mountain ranges. Typically occurs at altitudes between 200-500m a.s.l. in areas of high rainfall (1270-1780 mm p.a.). There is potential for moderate soil slip and scree erosion.	Foothills of the ranges	Greywacke.	Steepland soils related to yellow-brown earths: Ruahine steepland soils. Tawai steepland soils.	26-35+	Indigenous bush. Bees	6-8 su/ha

APPENDIX N.2 – MAPS

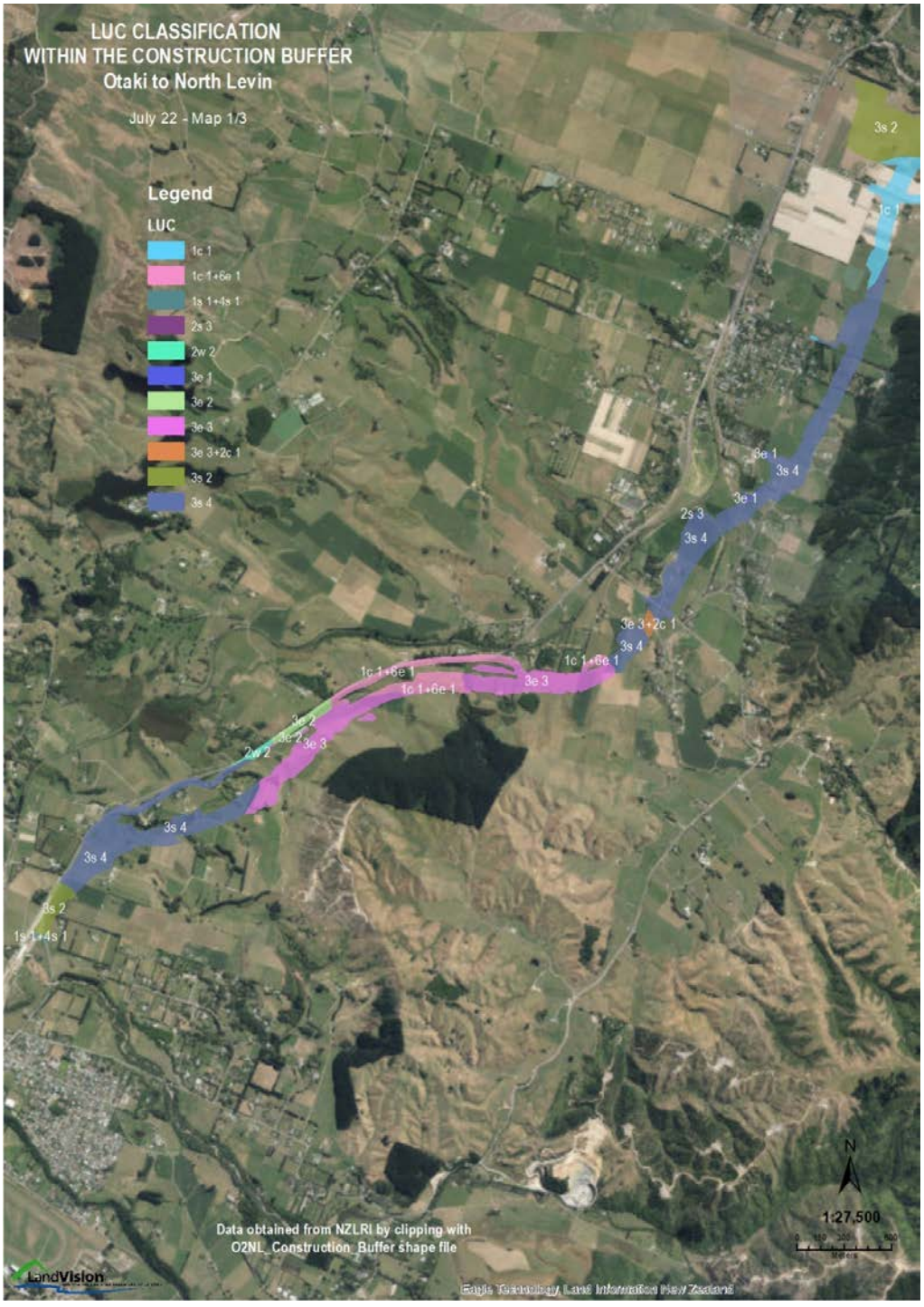

Figure N.3 – LUC Classification within the proposed Ō2NL Project corridor - Map 1of 3.

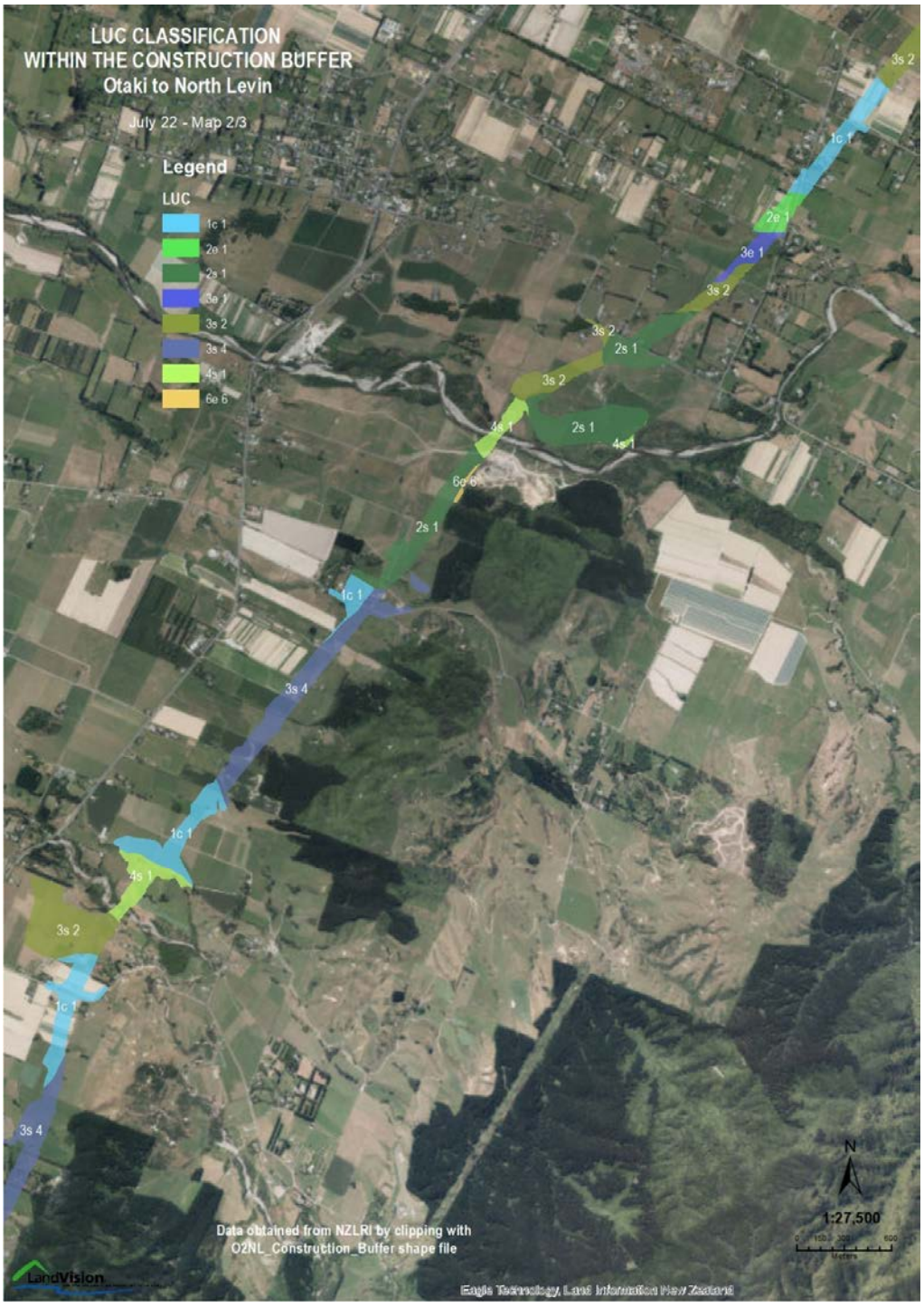

Figure N.4 – LUC Classification within the proposed Ō2NL Project corridor - Map 2 of 3.

Figure N.5 – LUC Classification within the proposed Ō2NL Project corridor - Map 3 of 3.

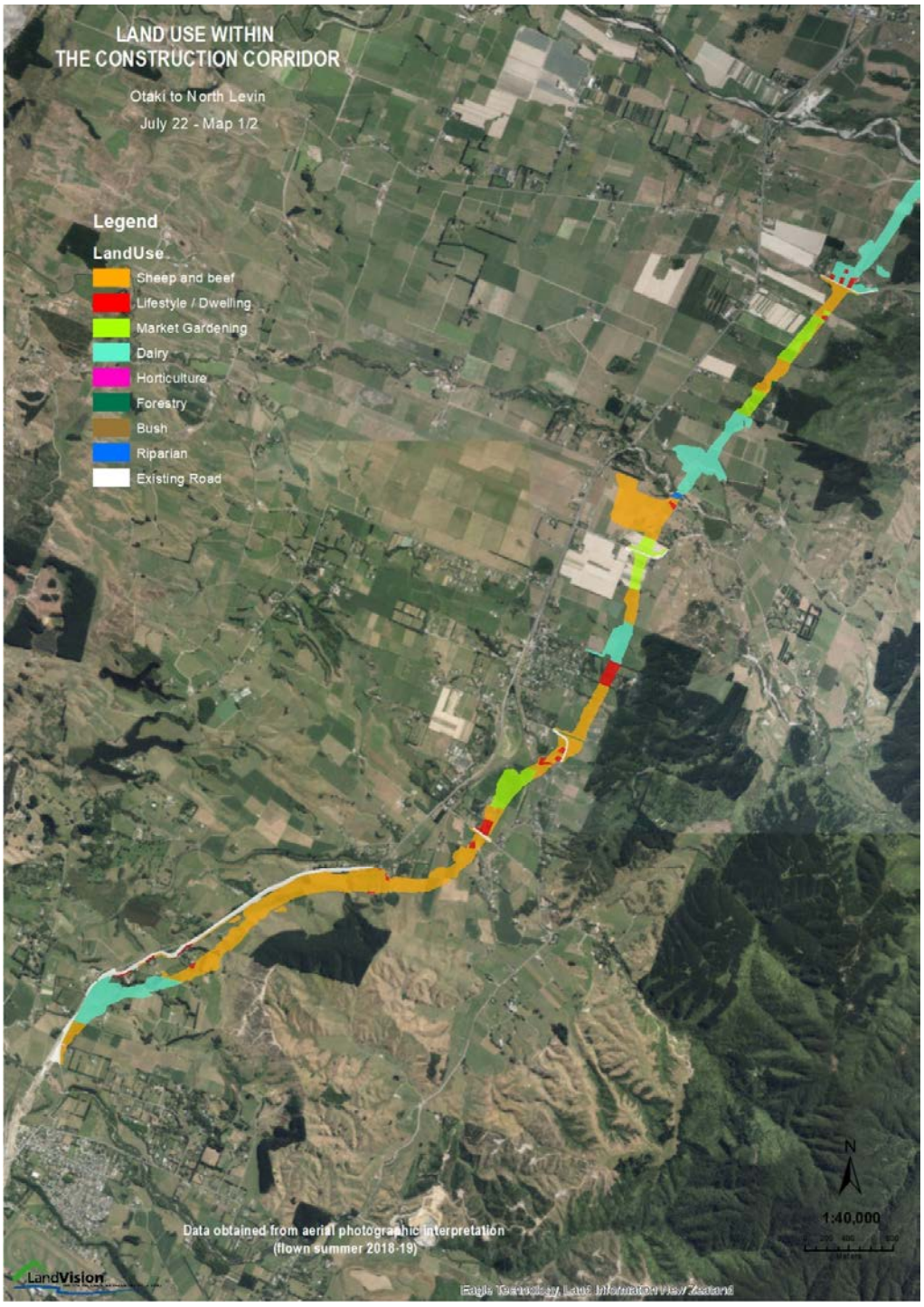

Figure N.6 – Land use within the proposed Ō2NL Project corridor - Map 1 of 2.

Figure N.7 – Land use within the proposed Ō2NL Project corridor Map 2 of 2.

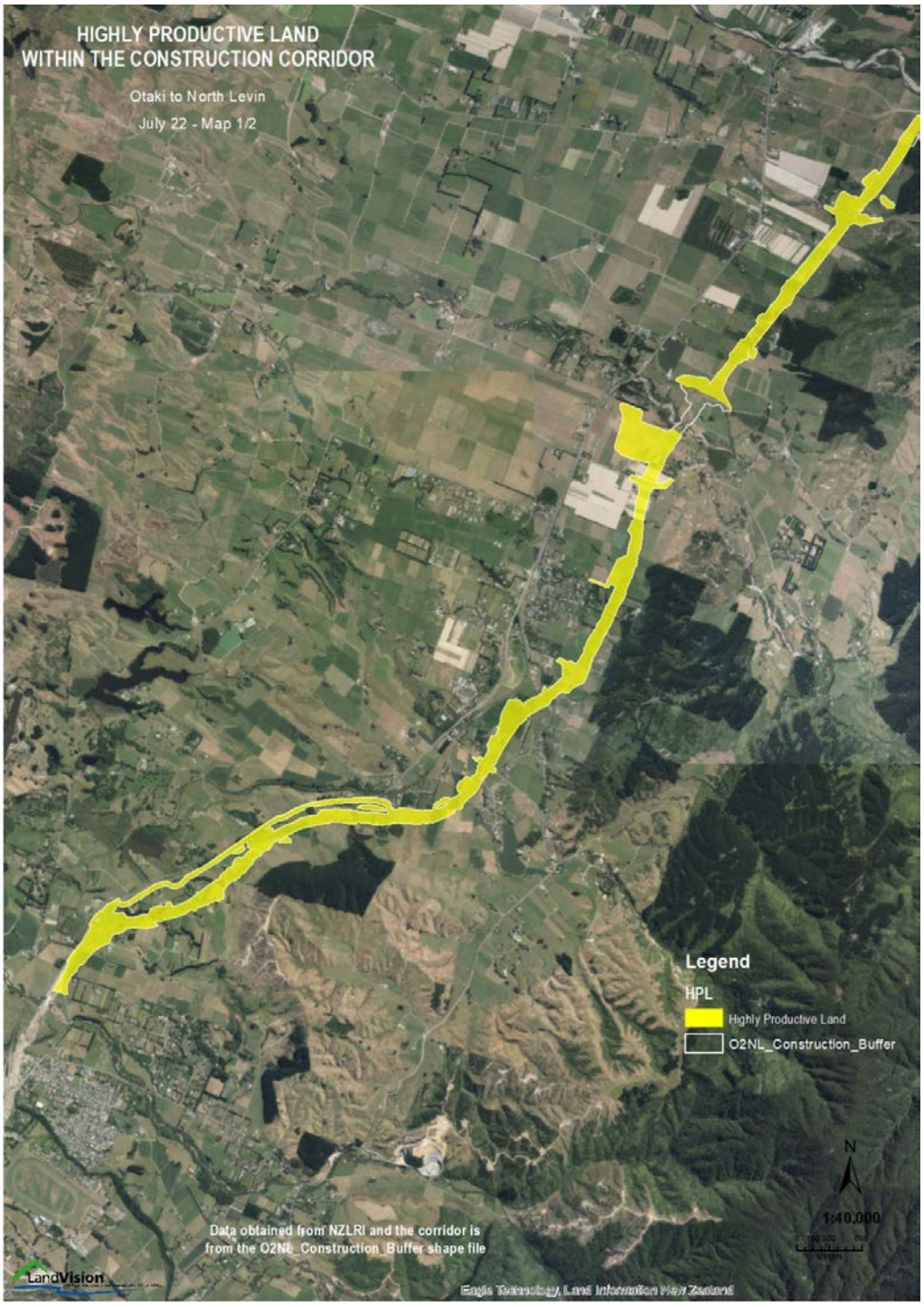

Figure N.8 – Highly productive land within the proposed Ō2NL Project corridor - Map 1 of 2.

Figure N.9 – Highly productive land within the proposed Ō2NL Project corridor - Map 2 of 2.

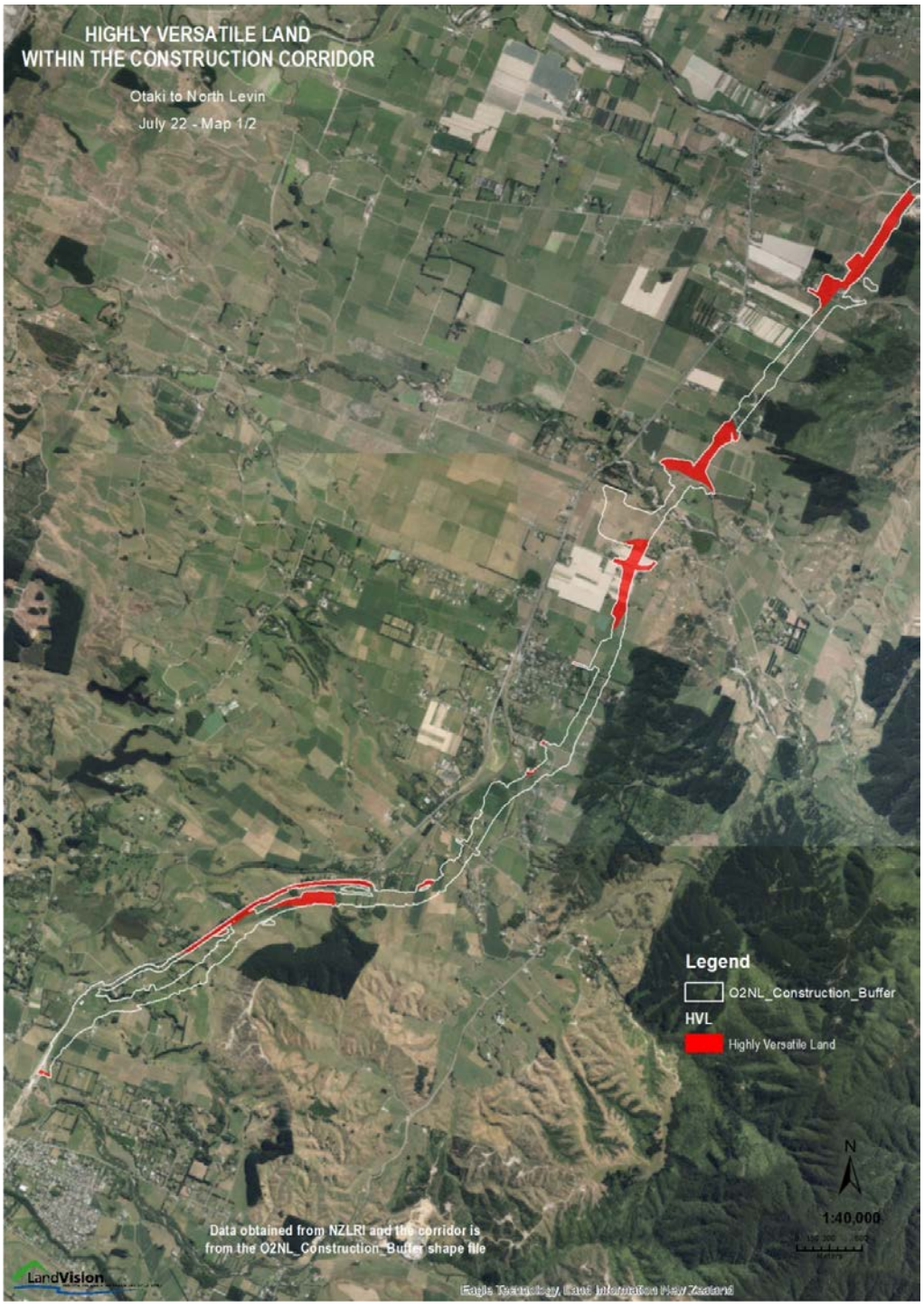

Figure N.10 – Highly versatile land within the proposed Ō2NL Project corridor - Map 1 of 2.

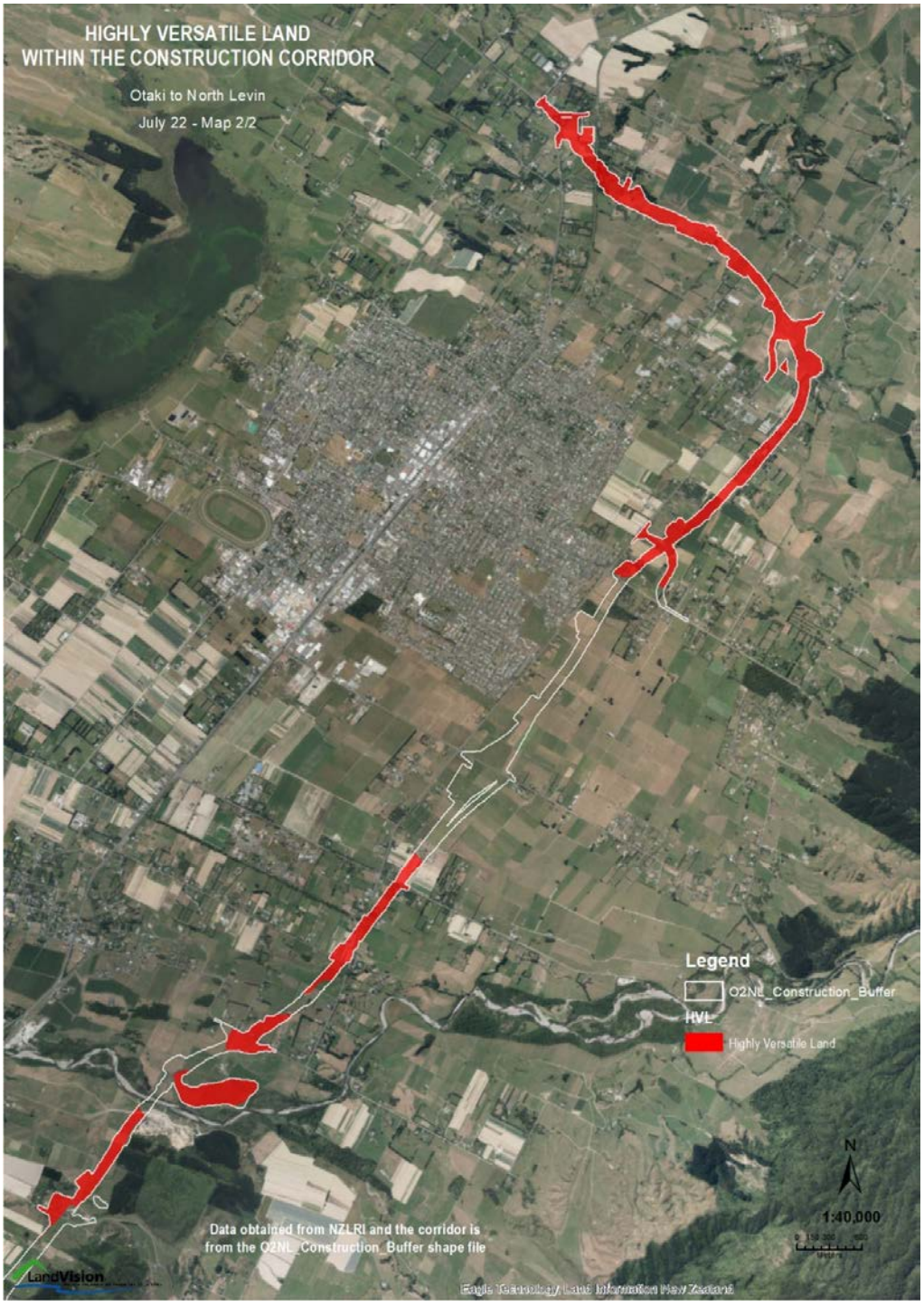

Figure N.11 – Highly versatile land within the proposed Ō2NL Project corridor - Map 2 of 2.

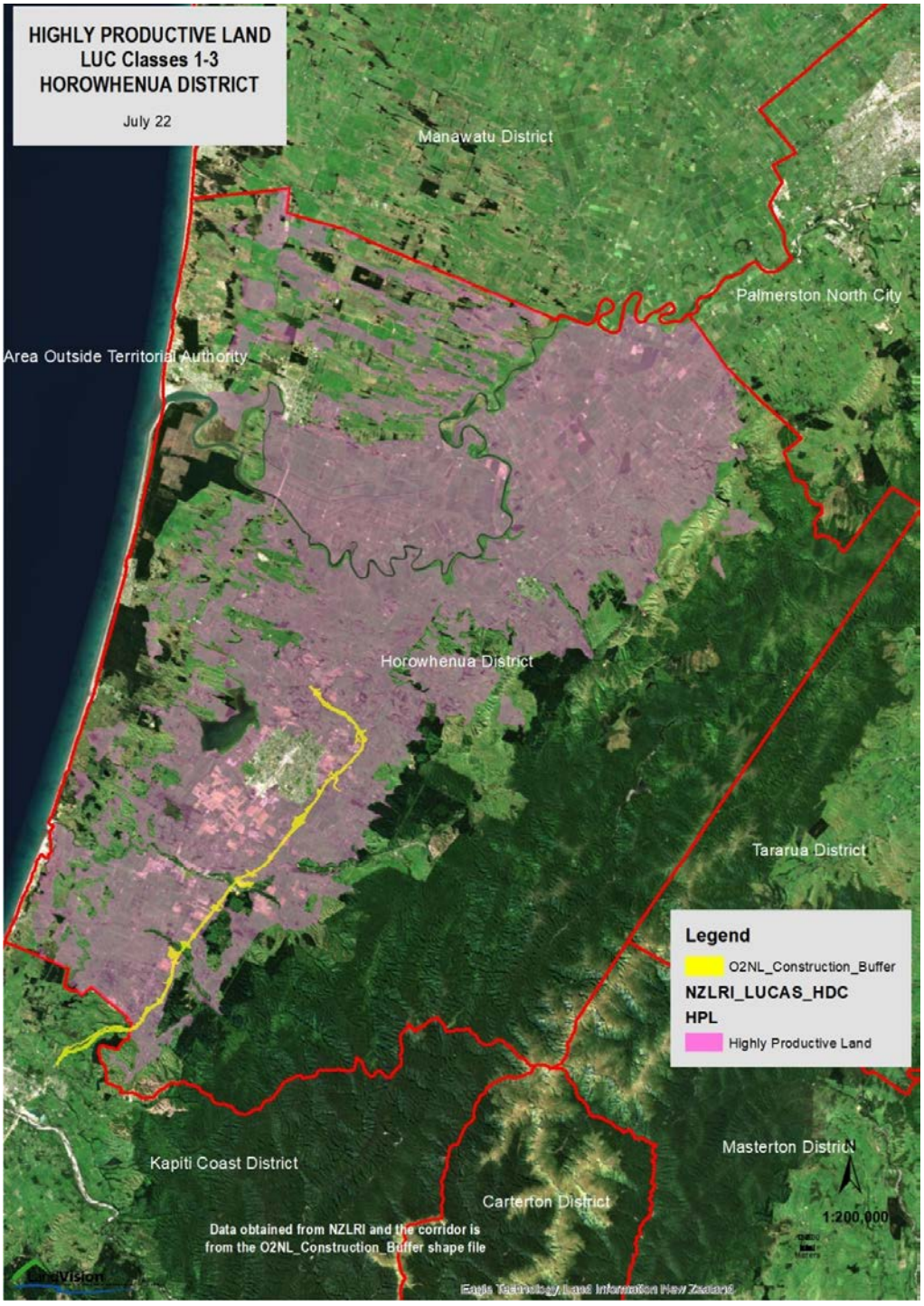

Figure N.12 – Highly productive land in the Horowhenua district.

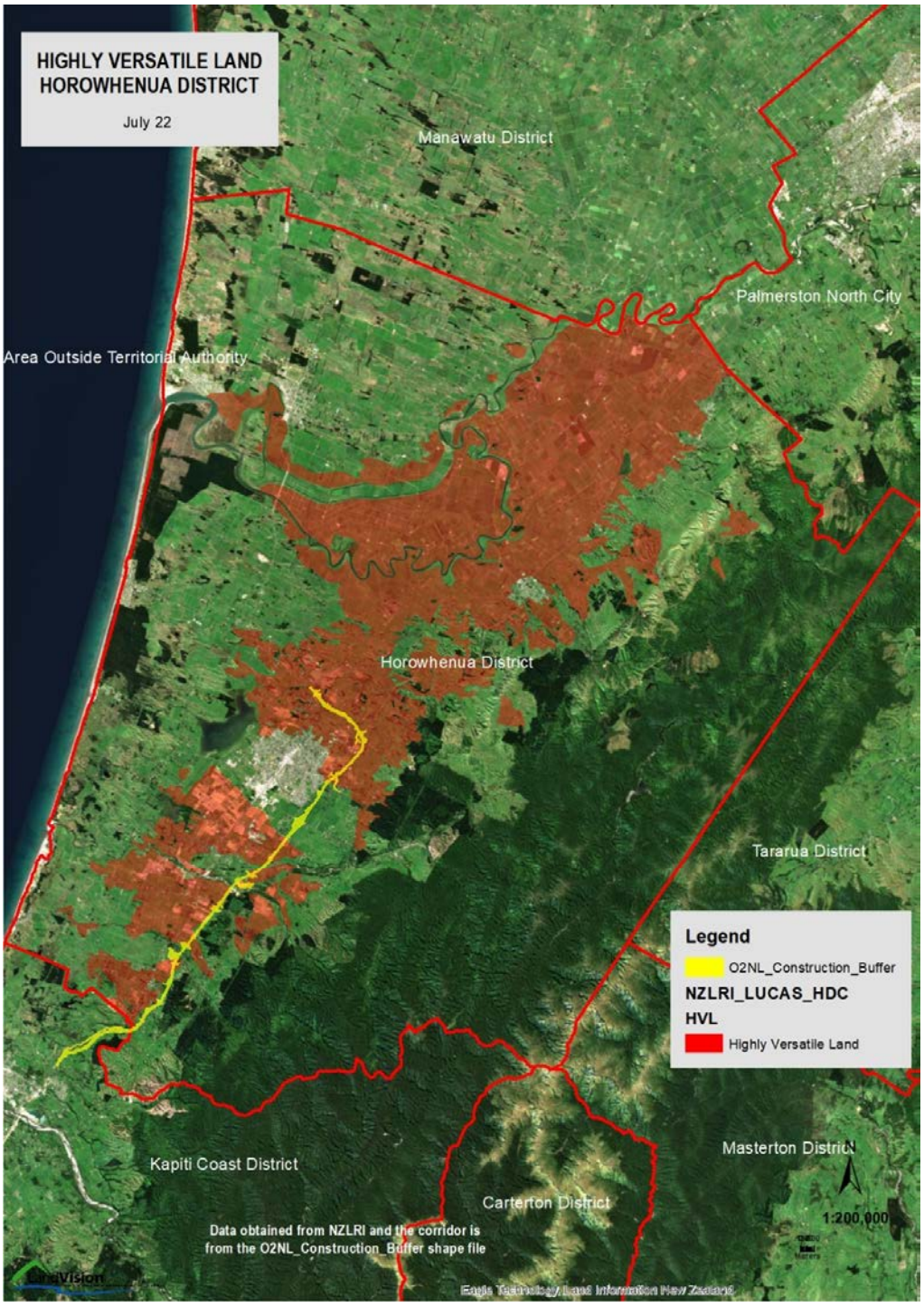

Figure N.13 – Highly versatile land in the Horowhenua District.

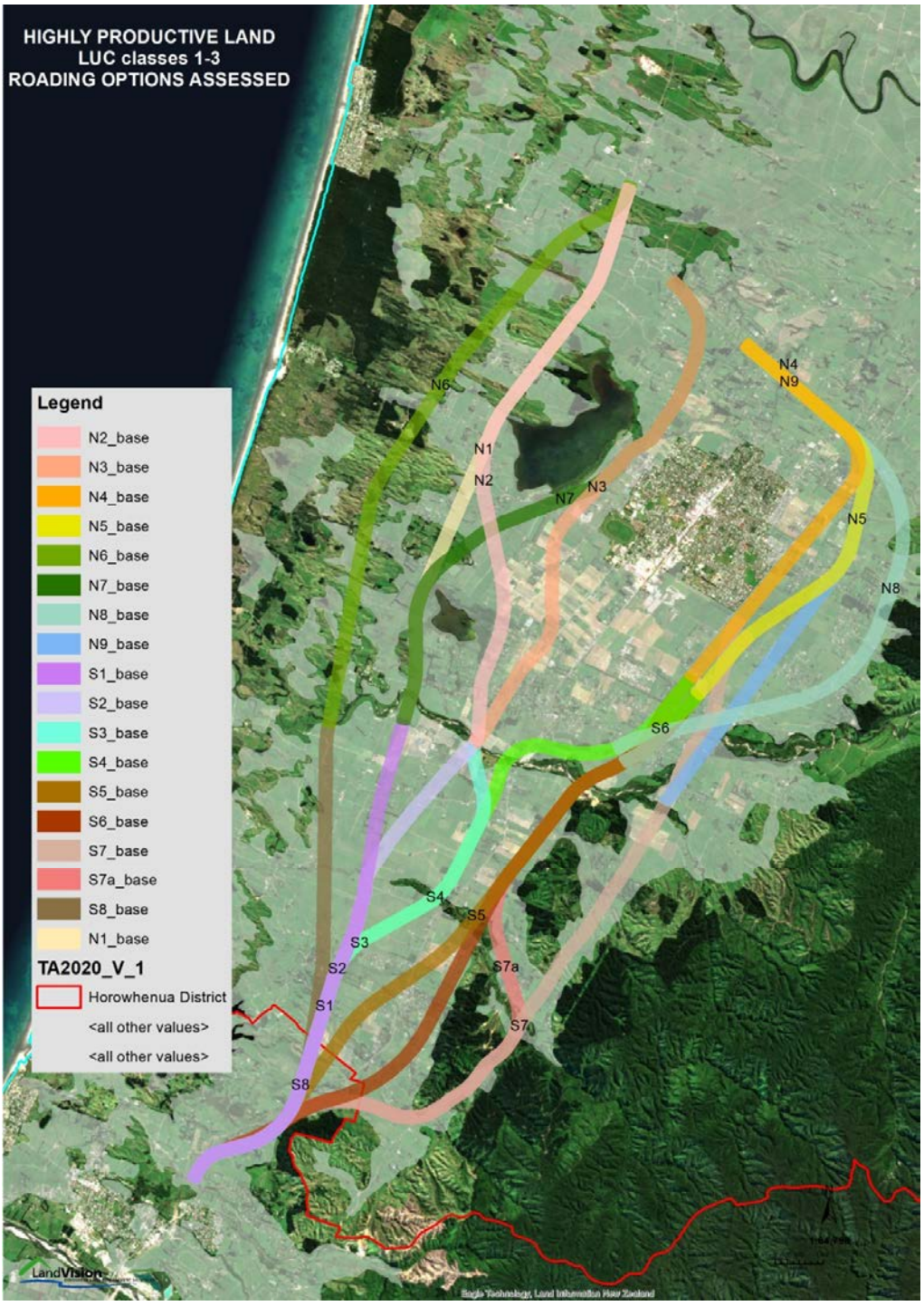

Figure N.14 – Assessed options and the location of highly productive land.

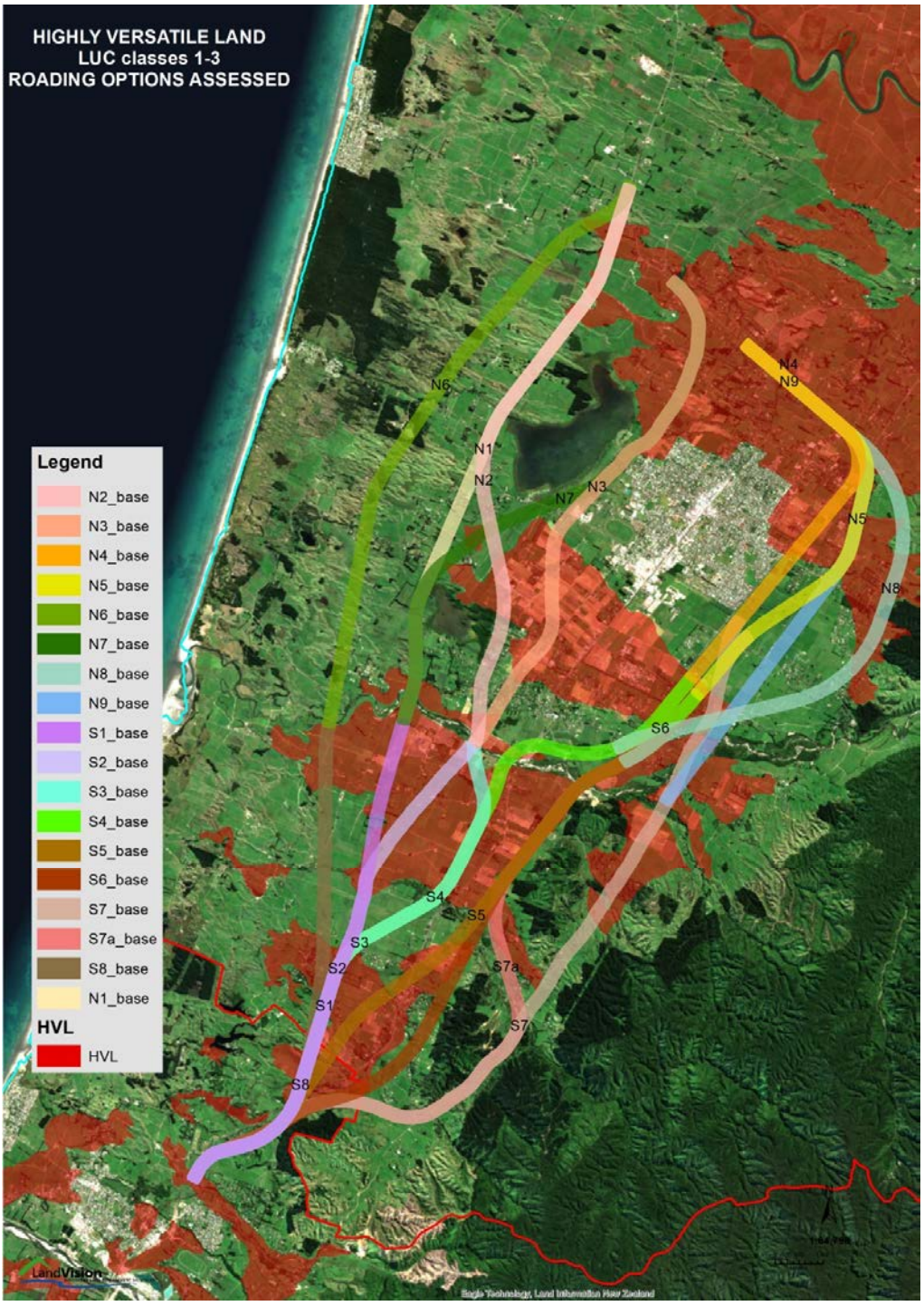

Figure N.15 – Assessed options and the location of highly versatile land.