Land Use Capability classification assessment

1799A Great South Road, Bombay 2579
(Lot 6 DP 156089)

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1. Introduction

Landsystems undertook a Land Use Capability (LUC) classification assessment of an 8.69 ha area (Lot 6 DP 156089) at 1799A Great South Road, Bombay 2579. (**Figure 1**). A simplified map of the assessment area is shown in **Figure 2**. The purpose of the assessment was to confirm the LUC units at property scale and the presence of Auckland Unitary Plan (AUP) land containing elite and prime soil, and highly productive land as defined by the National Policy Statement for Highly Productive Land 2022 (NPS-HPL). The assessment including desktop and on-site assessment components.

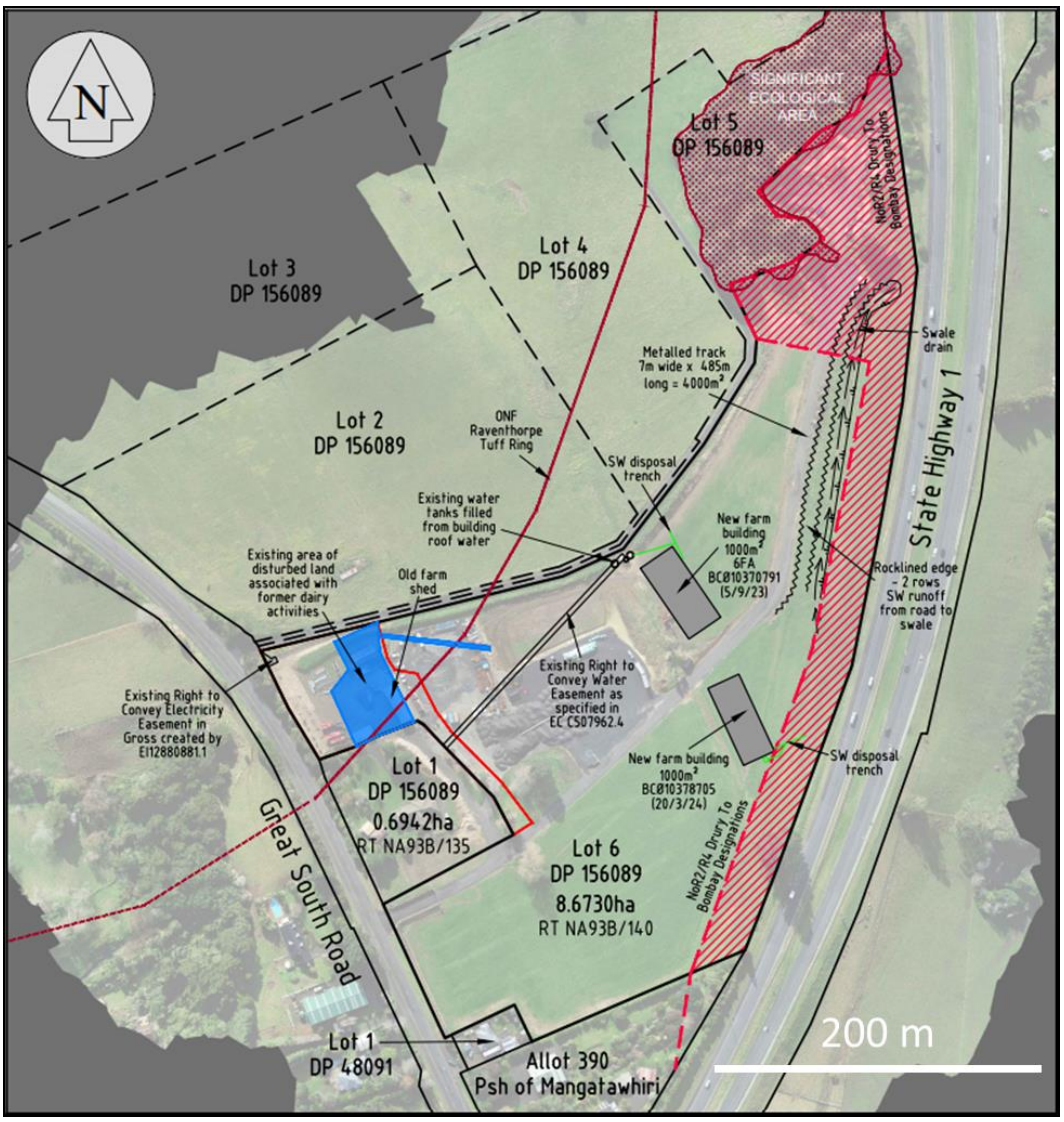

***Figure 1**. Assessment area (Lot 6 DP 156089) and surrounding lots at 1799A Great South Road, Bombay 2579 (from Site Plan of Receiving Environment at 1799A Great South Road, Bombay, TSC).*

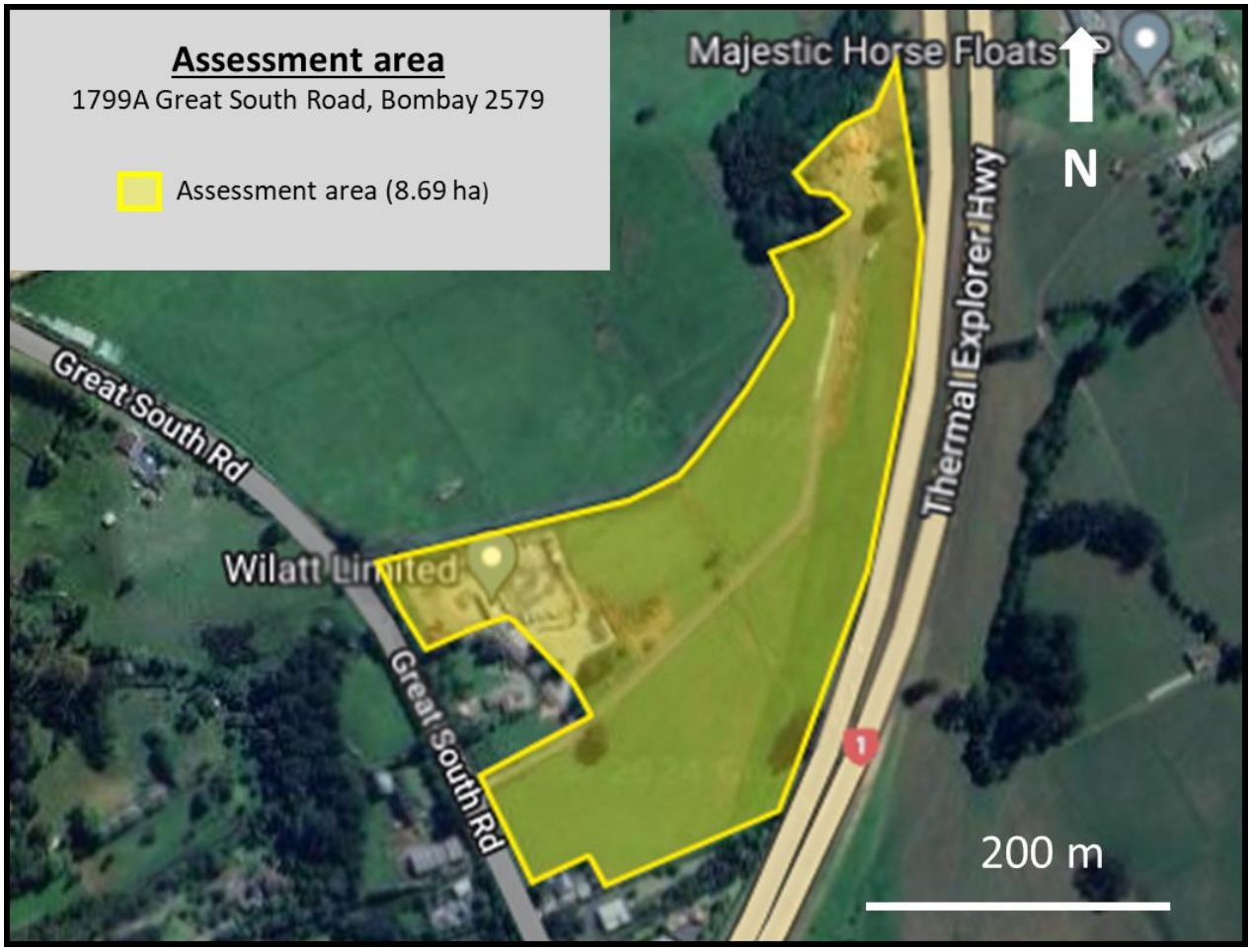

***Figure 2**. Simplified map of assessment area (Lot 6 DP 156089) at 1799A Great South Road, Bombay 2579.*

2. Classification definitions

Land Use Capability classification

Land Use Capability (LUC) assesses an area's capacity for sustained productive use, considering physical limitations, soil type, management requirements and soil conservation needs.

A Land Use Capability assessment is a systematic arrangement of the different types of land according to those properties that affect its capacity for long term and sustained production. It is a system that primarily assesses the land for arable (cropping) use.

The assessment is based on a national land classification system used by soil conservators for farm planning since the 1950s. A detailed description of the LUC classification is provided in the Land Use Capability Survey Handbook, a 3rd edition of which was published in 2009 (Lynn et al., 2009)[1]. The current definitions for Land Use Capability (LUC) classes are provided in the Land Use Capability Handbook (Lynn et al., 2009):

[1] Lynn, IH, Manderson, AK, Harmsworth, GR, Eyles, GO, Douglas, GB, Mackay, AD, Newsome, PJF (2009) Land Use Capability Handbook - a New Zealand handbook for the classification of land 3rd Ed. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science 163pp.

Class 1: the most versatile multiple-use land with minimal physical limitations for arable use.

Class 2: very good land with slight physical limitations to arable use that can be readily overcome by management and soil conservation practices.

Class 3: land with moderate physical limitations to arable use. These limitations restrict the range of crops and the intensity of cultivation, and/or make special soil conservation practices necessary.

Class 4: land with severe physical limitations to arable use. These limitations substantially reduce the range of crops which can be grown, and/or make intensive soil conservation (and management) necessary.

Class 5: 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 (except where flood-prone).

Class 6: land that is not suitable for arable use and has slight to moderate limitations and hazards under a perennial vegetation cover. Erosion is commonly the dominant limitation, but it is readily controlled by appropriate soil conservation.

Class 7: land that is not suitable for arable use and has severe limitations and hazards under a perennial vegetation cover. Erosion is commonly the dominant limitation, with the land requiring active and intensive soil conservation to be productive.

Class 8: land that is not suitable for arable, pastoral or production forestry use.

AUP land containing elite and prime soil

The Auckland Unitary Plan (Updated 18 April 2024) defines elite land as:

Land containing elite soil:
Land classified as Land Use Capability Class 1 (LUC1). This land is the most highly versatile and productive land in Auckland. It is:

- *well-drained, friable, and has well-structured soils;*
- *flat or gently undulating; and*
- *capable of continuous cultivation.*

Includes:

- *LUC1 land as mapped by the New Zealand Land Resource Inventory (NZLRI);*
- *other lands identified as LUC1 by more detailed site mapping;*
- *land with other unique location or climatic features, such as the frost-free slopes of Bombay Hill;*
- *Bombay clay loam;*
- *Patumahoe clay loam;*
- *Patumahoe sandy clay loam; and*
- *Whatitiri soils.*

Prime land is also very good land but with some minor limitations compared to elite land. The Auckland Unitary Plan defines prime land as:-

Land containing prime soil:
Land identified as Land Use Capability classes two and three (LUC2, LUC3) with slight to moderate physical limitations for arable use. Factors contributing to this classification are:

- *readily available water;*
- *favourable climate;*
- *favourable topography;*
- *good drainage; and*
- *versatile soils easily adapted to a wide range of agricultural uses.*

The definition for land containing elite soil lists features of highly versatile and productive land. The land is described as well-drained, friable, and has well-structured soils. The topography is flat or gently undulating and the soil capable of continuous cultivation. If land is not classified as LUC class 1, all these conditions need to be met for the land to be elite.

The AUP does not itself define "well drained" or "friable", however, the New Zealand Soil Description Handbook[2] defines well drained (on p148) and friable (on p84). Flat or gently undulating slopes are defined in the Land Use Capability Survey Handbook[3] (p21) as slopes that are 0 to 3 degrees.

'Well structured' and 'capable of continuous cultivation' are not defined. However, using LUC class 1 soil characteristics as a guide then a suitable definition for 'well structured' would be soil that is moderately or strongly pedal, or has earthy structure (Soil Description Handbook p58 & 60). The continuous cultivation definition that best suits Class 1 land is the arable use definition in the LUC Survey Handbook (on p153). This is land suitable for cultivation for cropping and able to grow at least one crop or more per season without permanently degrading the soil.

The most versatile soils in New Zealand are Allophanic soils (e.g. Karaka soils). Favourable topography for arable use is commonly regarded as slopes of 0 to 15 degrees. Slopes steeper than 15 degrees have moderate to severe susceptibility to erosion when cultivated and are not ideal for arable use.

Good drainage can be defined as well drained or moderately well drained drainage classes. Under these conditions there is a minimum of 60 to 90 cm to a water table. Having a freely drained soil is required to be able to grow crops sensitive to wet soil (e.g. kiwifruit). Well drained elite soils are ideal for this (water table greater than 90 cm deep), but prime land may also be suitable. Imperfectly and poorly drained soils are too wet for some horticultural crops and the land is not as versatile as prime land.

Land containing prime soil is arable, versatile, has favourable topography and good drainage. There are no serious climate or soil water storage issues. Unfortunately, these characteristics for land containing prime soil are not defined. AUP land containing elite or prime soil, and other productive land was classified using the definition interpretation used by soil scientists in the Auckland region for previous private plan changes[4].

National Policy Statement for Highly Productive Land

The National Policy Statement for Highly Productive Land 2022 (NPS-HPL)[5] came into force on the 17th of October 2022.

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[2] Milne JDG, Clayden B, Singleton P.L, Wilson AD. 1995. Soil Description Handbook. Lincoln, New Zealand, Manaaki Whenua Press. 157p.

[3] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.

[4] www.aucklandcouncil.govt.nz/UnitaryPlanDocuments/pc-45-appendix-9.2-soil-assessment-report.pdf; www.aucklandcouncil.govt.nz/UnitaryPlanDocuments/pc-73-appendix-n-land-use-capability-and-soil-assessment.pdf

[5] MfE 2024. National Policy Statement for Highly Productive Land 2022 with amendments. August 2024.

"Highly productive land" is defined as:

> *means land that has been mapped in accordance with clause 3.4 and is included in an operative regional policy statement as required by clause 3.5 (but see clause 3.5(7) for what is treated as highly productive land before the maps are included in an operative regional policy statement and clause 3.5(6) for when land is rezoned and therefore ceases to be highly productive land).*

Our understanding is that NPS-HPL clause 3.5(7) applies because maps produced in accordance with clause 3.4 have not yet been included in an operative regional policy statement as required by clause 3.5. Clause 3.5(7) says:

> *(7) Until a regional policy statement containing maps of highly productive land in the region is operative, each relevant territorial authority and consent authority must apply this National Policy Statement as if references to highly productive land were references to land that, at the commencement date:*
>
> *(a) is*
>
> *(i) zoned general rural or rural production; and*
>
> *(ii) LUC 1, 2, or 3 land; but*
>
> *(b) is not:*
>
> *(i) identified for future urban development; or*
>
> *(ii) subject to a Council initiated, or an adopted, notified plan change to rezone it from general rural or rural production to urban or rural lifestyle.*

The NPS-HPL includes the following definition of LUC 1, 2, or 3 land:

"LUC 1, 2, or 3 land means land identified as Land Use Capability Class 1, 2, or 3, as mapped by the New Zealand Land Resource Inventory or by any more detailed mapping that uses the Land Use Capability classification".

For the purpose of defining and mapping highly productive land on the site, a 2024 Environment Court decision (Decision No. [2024] NZEnvC 83)[6] determined that only the NZLRI LUC map information at the time the NPS-HPL 2022 became operative (17th October 2022) can be used.

3. Non-productive land and modified soil areas

For an accurate assessment of LUC classification for a property, the assessment should be based on the current condition of the area (i.e. mapped in current state). This is important because some land management practices (e.g. the placement of tracks, excavation of drains, and general earthworks) result in irreversible changes to the soil (i.e. changes other than those that can be remediated by management practices and return the soil to its intrinsic state). These areas are referred to as non-productive land. Examples of non-productive land include native vegetation, wetlands and riparian areas, tracks, and buildings and curtilage.

Non-productive land can include areas where the soil has been modified by truncation, placement of fill or extensive mixing. Where these areas do not resemble a functioning soil, the areas are not considered to be available for primary production (i.e. they are non-productive land). Where these areas do resemble a

[6] https://www.environmentcourt.govt.nz/assets/Documents/Publications/2024-NZEnvC-083-Blue-Glass-Limited-v-Dunedin-City-Council.pdf

functioning soil (such as the reinstatement of a soil profile following gravel extraction) the land can be assigned a LUC classification.

For this assessment the productive area of the site (to which the LUC classification can be applied) is the site area excluding non-productive land.

4. Regional scale soil and LUC map information (1:50,000 scale)

An initial desktop LUC assessment was undertaken for the entire assessment area. Available map information, soil reports and geospatial data included:

- New Zealand Land Resource Inventory (NZLRI) layers, including the New Zealand Fundamental Soil Layer (NZFSL) and Land Use Capability Layer (providing map units of dominant soil type and LUC unit)[7]
- S-Map Online (providing map units of Soil Siblings)[8]

Of the available map information sources, the S-Map Online soil map information, NZFSL and NZLRI map information are at a regional scale (approximately 1:50,000 scale).

NZLRI (1:50,000 scale) soil and LUC classification

Based on the available NZLRI and NZFSL map information the soils and LUC units in the assessment area are mapped as shown in **Figure 3**.

Based NZLRI map information, 100% of the property[9] is mapped as moderately well drained Hamilton clay loam on undulating slopes (slope class B) with an LUC classification of 2e2.

Table 1 gives the general characteristics of the soils and LUC units as mapped in **Figure 3**.

***Table 1**. Summary of the NZLRI soil and LUC map unit characteristics in the assessment area.*

Soil type (NZSC Soil Order)	Parent material	Soil drainage	Slope class	LUC unit (limitation)
Hamilton clay loam (Granular Soil)	'Hamilton Ash'	Moderately well drained	B	2e2 (erosion)

[7] https://lris.scinfo.org.nz/layer/48134-nzlri-north-island-edition-2-all-attributes/
[8] https://smap.landcareresearch.co.nz/maps-and-tools/app/
[9] https://lris.scinfo.org.nz/layer/48134-nzlri-north-island-edition-2-all-attributes/

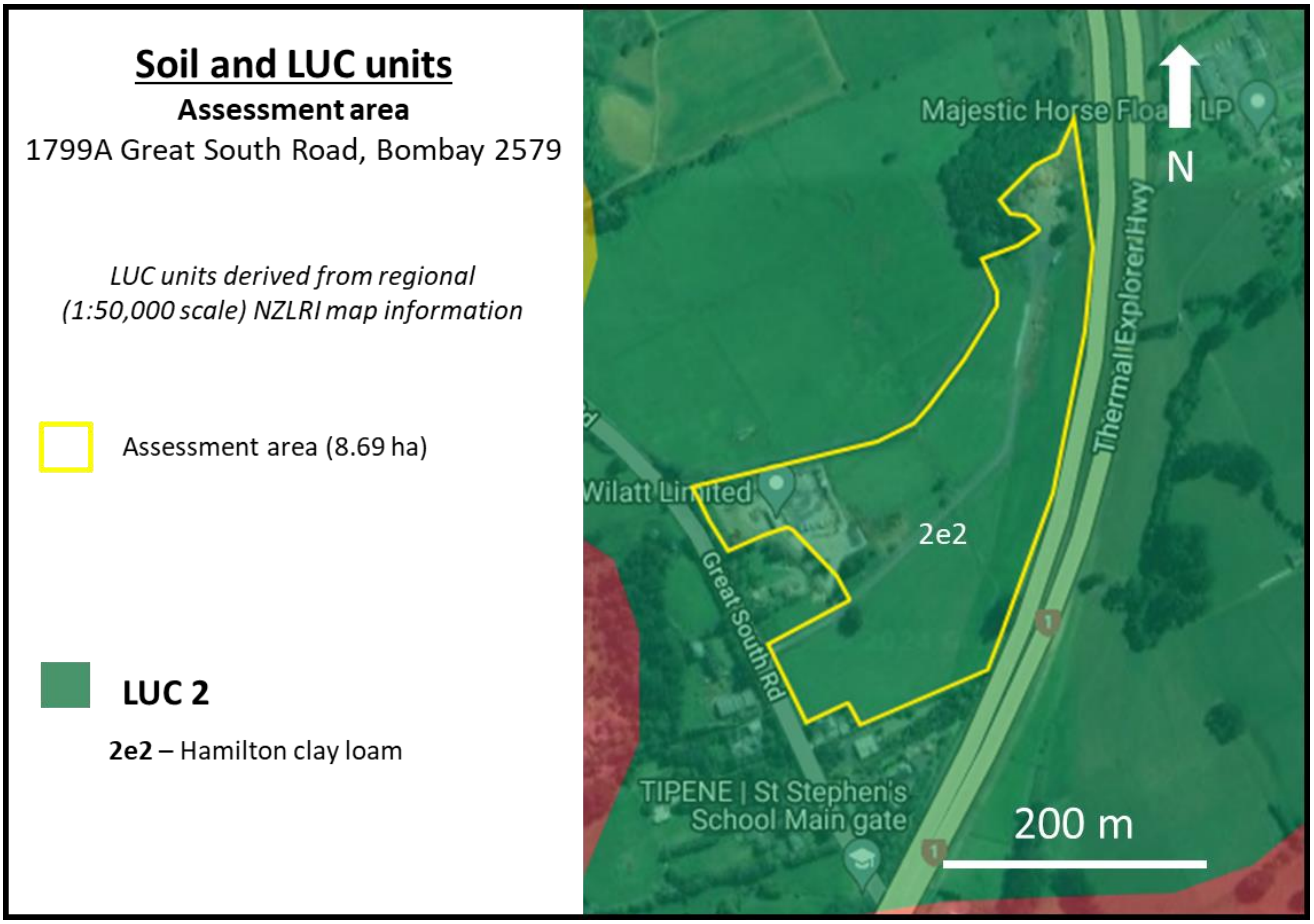


***Figure 3**. LUC units for the assessment area, derived from available regional scale NZLRI map information.*

S-Map Online

The S-Map soil map information is sourced from S-Map Online and is mapped at 1:50,000 scale. S-Map soil polygons are only available on the S-Map Online website. The soil names for each map unit are "soil siblings", with a probability of occurrence (%) and certainty rating provided for each soil sibling in a map unit. S-Map Online identified the soils in the assessment area as 98% Granular Soil and 2% Brown Soil (**Figure 4**).

A simplified S-Map soil sibling map for the assessment area is provided in **Figure 5** with S-Map soil sibling information and the estimated proportion of each soil sibling in the map unit.

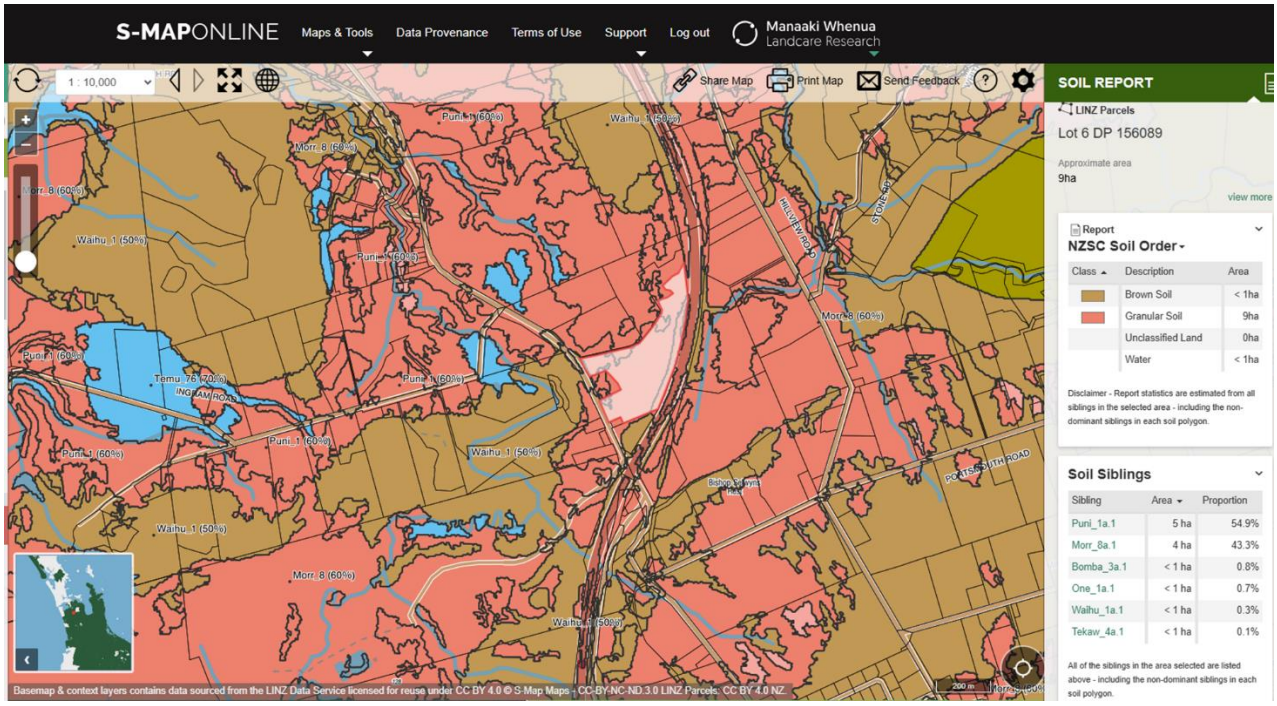


***Figure 4**. S-Map soil (Soil Order and soil sibling) distributions for the assessment area.*

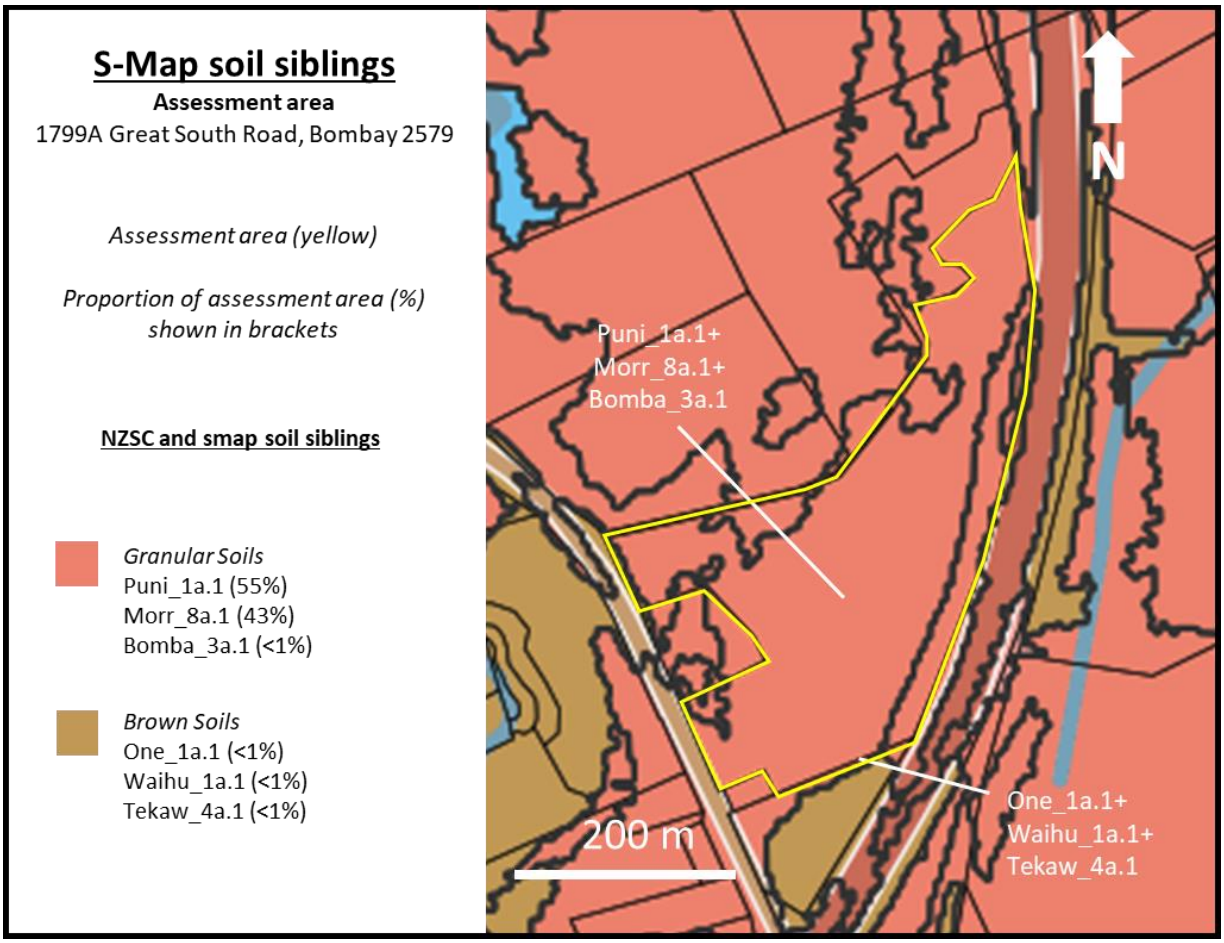


***Figure 5**. Simplified S-Map soil sibling map units the assessment area.*

Table 2 provides a summary of the S-Map soil sibling map unit characteristics, including parent material, soil depth, soil texture and drainage, for the assessment area. This information is derived from S-Map Online factsheets and can be sourced from the S-Map Online website[10].

***Table 2**. S-Map soil sibling map unit characteristics for the assessment area, 1799A Great South Road.*

S-Map soil sibling	Soil Order[11] (Subgroup code)	Soil material	Soil depth	Soil texture	Soil drainage	Correlated soil series name[12]
Puni_1a.1	Granular (NOM)	Rhyolitic rock	Deep (> 1m)	Clay	Imperfectly drained	Not available
Morr_8a.1	Granular (NOT)	Rhyolitic rock	Deep (> 1m)	Clay	Moderately well drained	Patumahoe
Bomba_3a.1	Granular (NOL)	Rhyolitic rock	Deep (> 1m)	Clay	Well drained	Not available
One_1a.1	Brown (BXT)	Rhyolitic and basaltic rock	Deep (> 1m)	Clay	Moderately well drained	Not available
Waihu_1a.1	Brown (BMM)	Basaltic rock	Deep (> 1m)	Loam	Imperfectly drained	Not available
Tekaw_4a.1	Brown (BMT)	Basaltic rock	Deep (> 1m)	Loam	Moderately well drained	Not available

The S-Map soil map information provides a more spatially detailed representation of the soils on the site than the NZLRI 1:50,000 soil map information. However, because of the absence of land characteristics information (e.g. slope) for the soil map units, there is currently no direct correlation with LUC units. Some, but not all, of the S-Map soil map units correlate to the soil series identified by the NZLRI map information. In this report, we have retained the DSIR's soil nomenclature (e.g. soil type and series names) in preference to the S-Map soil sibling nomenclature to allow for direct correlation of the soils with the LUC units provided by the NZLRI map information and associated NZLRI Extended Legends.

5. NPS-HPL assessment based on regional map information

Based on the available 1:50,000 scale NZLRI information and applying the NPS-HPL, LUC 2e2 land is considered highly productive land (**Figure 6**).

[10] https://smap.landcareresearch.co.nz/maps-and-tools/app/
[11] NZSC – New Zealand Soil Classification: Hewitt AE (2010) New Zealand Soil Classification. 3rd ed. Landcare Research Science Series No. 1. Lincoln, Manaaki Whenua Press.
[12] https://smap.landcareresearch.co.nz/maps-and-tools/app/

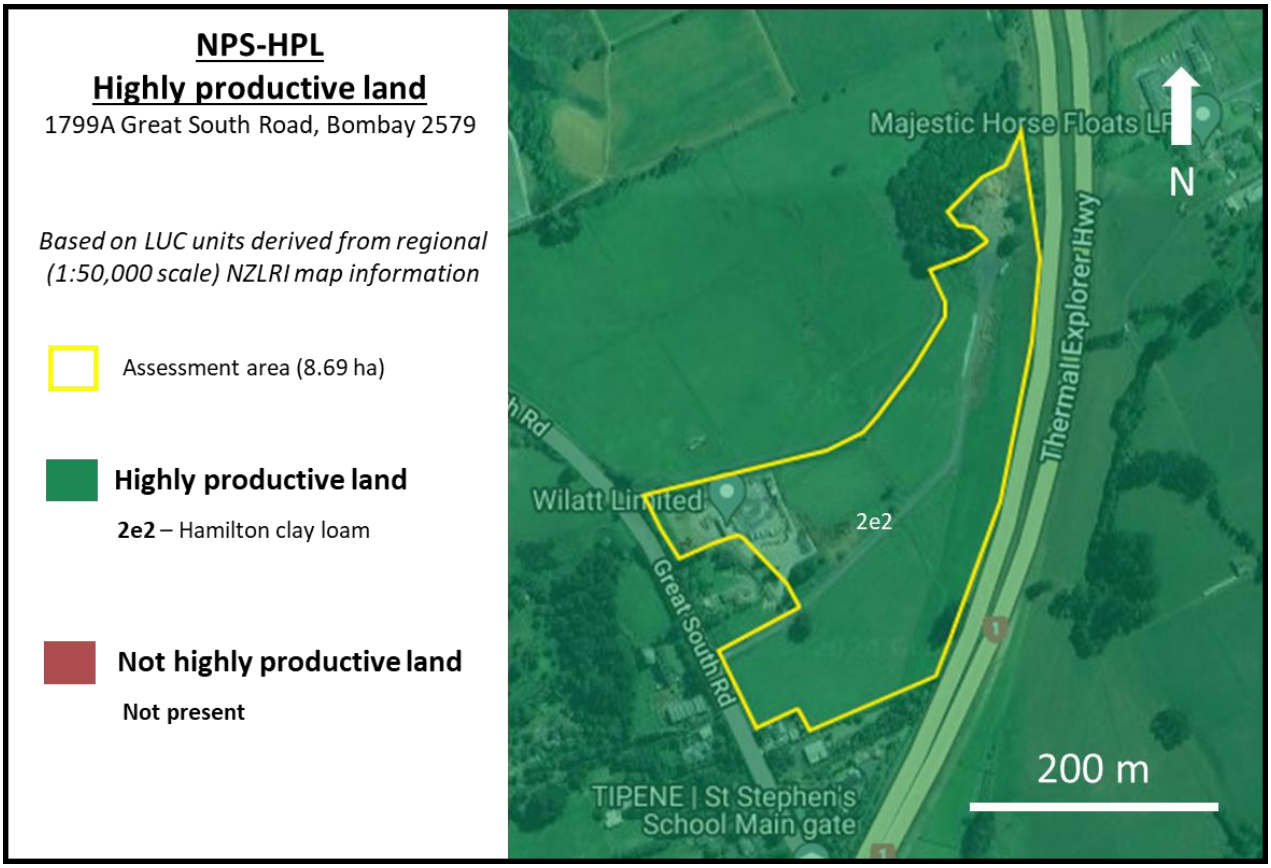


Figure 6. *The distribution of NPS-HPL defined highly productive land within the assessment area, based on the NZLRI (1:50,000 scale) map information.*

6. Regional scale map information limitations

The LUC classification can be applied (mapped) at any scale and regional scale LUC map units can differ from those identified at property scale. Property scale mapping is typically mapped at a scale of 1:10,000, while catchment and regional maps are mapped at 1:15,000 to 1:50,000 scale. The LUC Handbook sets out recommended mapping scales for inventory surveys and LUC mapping (p100).

Mapping LUC at a property scale can identify different LUC units (and map units) than depicted by regional scale LUC mapping. This is because property scale mapping includes more observations compared with regional scale mapping.

Soil and LUC maps are usually drawn at a specific scale depending on the smallest area of interest for a particular use and the density of field observations. For example, a 1:5,000 scale map requires on average four observations/ha while a 1:50,000 scale map requires 0.04 observations/ha (or four observations per 100 ha).

With GIS tools and geospatial databases, it has become easy to manipulate maps, creating the temptation to rescale a map beyond its original scale of collection. Enlarging maps from their original scale will not provide the same accuracy or contain more detail than a coarse scale map. This is because they are not based on sufficient field observations to delineate soil map units at the finer scales portrayed. For the regional scale LUC map information, map unit boundaries may not align with the topography (slope) and other geographic features (such as rivers or terraces). Therefore, to correctly identify and map the LUC units at property scale, on-site assessment using the LUC classification criteria described in Lynn et al. (2009) would be required.

The purpose of this background information is to illustrate and emphasise that the 1:50,000 scale NZLRI information provides excellent physical base data for planners (a planning tool) but is not fit for purpose as a plan (map) unless undertaken at the correct scale. Therefore, the on-site assessment in this report is

considered more appropriate (and accurate) for providing soil and LUC information for the purpose of assessing the presence of elite or prime soil and soil resources as a function of productive capacity and informing land productivity.

7. On-site LUC classification assessment

Method

Landsystems undertook an on-site property scale (1:10,000 scale) LUC assessment of the 8.69 ha assessment area at 1799A Great South Road according to standard methods (Milne et al., 1993[13] and Lynn et al., 2009[14]). The on-site assessment was undertaken on Wednesday 19th of July 2023.

The on-site mapping does not constitute a detailed soil survey rather the focus is on characterisation of soil and land properties to apply the LUC classification, in turn used to determine the extent of elite, prime and NPS-HPL highly productive land on the site. However, recorded soil properties are used to identify limitations that may affect the productivity of the site.

The on-site assessment included soil observations by hand auger across the site using a free survey approach. Ten recorded soil augers observations (excluding additional observations for checking boundaries) were undertaken to determine the LUC units.

Observations of slope angle, topography and soil parent material were made over the relevant area. Soil augering up to 100 cm depth (where possible) was used to assess soil properties such as soil horizons, drainage, plant root depths, texture, structure, and colour.

All soils were assessed in current condition and areas with modified soils and areas considered to be non-productive land were identified and mapped. Soil series and types have been used for this report (as opposed to S-Map soil siblings) to provide clearer correlation with LUC units provided by the regional NZLRI LUC map information. LUC classification was assigned based on the criteria provided in Lynn et al. (2009). LUC units were assigned based on the closest fitting LUC unit provided by the regional NZLRI LUC map information. Where no corresponding LUC unit was available, the unit was coded with LUC class and limitation (e.g. 4s).

Mapping scale

Applying conventional soil mapping protocol, between eight and 32 observations across the 8.69 ha assessment area would be sufficient to support a map scale of between 1:5000 and 1:10,000, which is considered appropriate for property scale decision making[15].

8. On-site point observations

The location and description of 20 auger observations for assessment area are provided in **Figure 7** (a larger image is included at the back of the report). Details of each observation point, including soil order, slope class, drainage, texture profile and depth of the A horizon is given in **Table 3**.

[13] Milne JDG, Clayden B, Singleton P.L, Wilson AD. 1995. Soil Description Handbook. Lincoln, New Zealand, Manaaki Whenua Press. 157p.
[14] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.
[15] Grealish G. 2017. New Zealand soil mapping protocols and guidelines. Envirolink Grant: C09X1606. Manaaki Whenua – Landcare Research

***Table 3**. Description of on-site point observations in the assessment area, 1799A Great South Road, Bombay.*

Observation point	NZSC Soil Order	A horizon depth (cm)	Soil profile texture (to 1 m)	Soil drainage
1	Granular	19	Silty clay loam over clay loam with concretions over clay	Moderately well to Imperfectly drained
2	Granular	18	Silty clay loam over clay loam with concretions over clay	Moderately well to Imperfectly drained
3	Granular	20	Silty clay loam over clay loam with concretions over clay	Moderately well to Imperfectly drained
4	Granular	19	Silty clay loam over clay loam with concretions over clay	Moderately well to Imperfectly drained
5	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly drained
6	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly drained
7	Granular	20	Silty clay loam over clay loam over clay	Moderately well drained
8	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly drained
9	Granular	22	Silty clay loam over clay loam over clay	Moderately well drained
10	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly to poorly drained
11	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly drained
12	Granular	10	Clay loam over clay loam with abundant concretions over gravelly clay	Imperfectly drained
13	Fill Anthropic Soil	0	Concrete at surface (cannot auger)	Imperfectly drained
14	Fill Anthropic Soil	0	Gravel at surface (cannot auger)	Imperfectly drained
15	Granular	18	Clay loam over clay loam with abundant concretions over gravelly clay	Imperfectly drained
16	Metal track	0	Permanent gravel over compacted subsoil	-
17	Granular	22	Clay loam over clay loam with abundant concretions over gravelly clay	Imperfectly drained
18	Granular	21	Clay loam over clay loam with abundant concretions over gravelly clay	Imperfectly drained
19	Permanent gravel yard	0	Permanent gravel over compacted subsoil	-
20	Granular	25	Silty clay loam over clay loam over clay	Moderately well drained

Figure 7. *On-site point observations for the assessment area, 1799A Great South Road, Bombay 2579.*

9. On-site soil and LUC classification

A summary of the soil and LUC unit identified in the assessment area is provided in **Table 4**.

The assessment area is located within the Raventhorpe Volcanic Complex, specifically within the Raventhorpe Tuff Ring, a complex of basaltic lava flow and tuff material, commonly formed through the explosive interaction of magma with surface or ground water. **Figure 8** illustrates the approximate location of the assessment area with respect to the volcanic deposits of the Raventhorpe Tuff Ring.

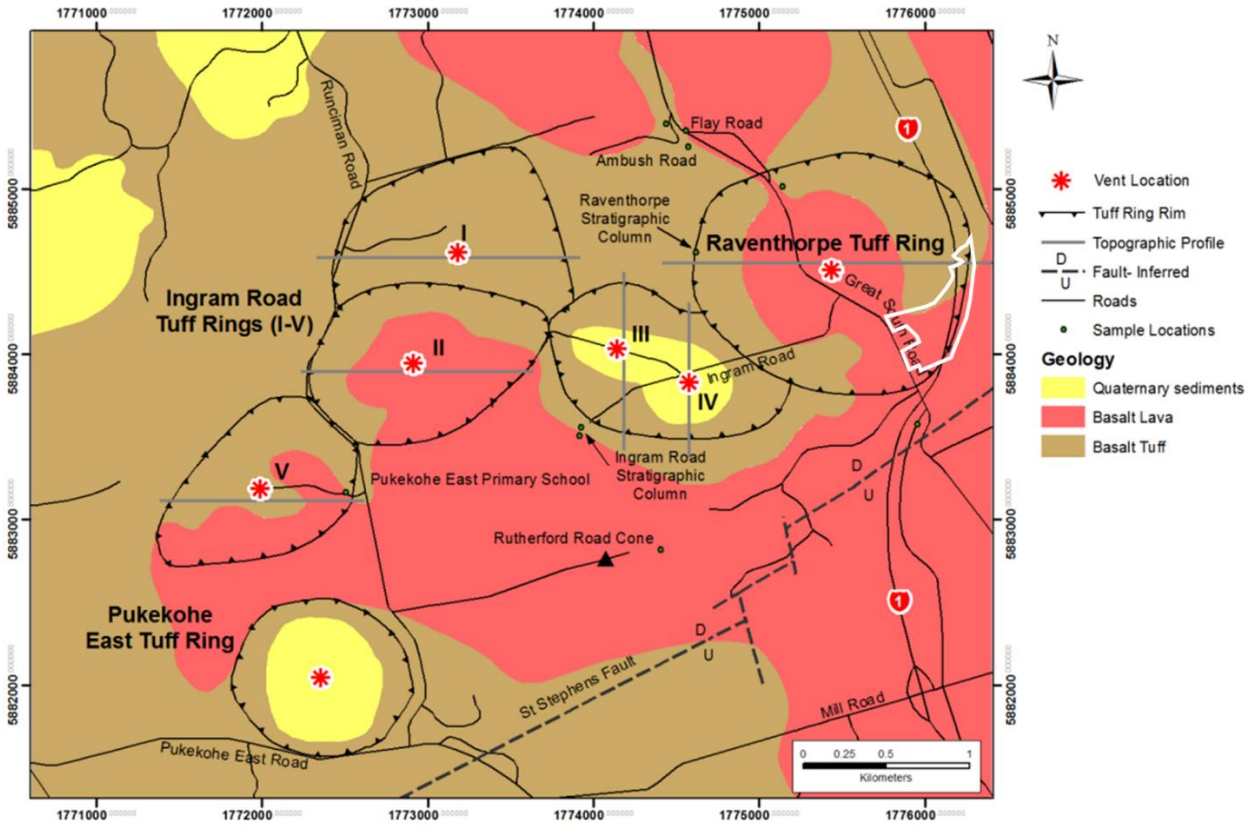


***Figure 8**. Map of the Raventhorpe Volcanic Complex, surrounding lava flows, faults and the approximate location of the assessment area in white (modified from Taylor, 2012)[16].*

The main soils observed and examples of non-productive land within the assessment area is shown in **Figures 9** and **10**. The soil profiles should be considered example soil profiles for each soil as the profile for actual soil observed in the field at any given point may differ slightly from the example shown.

[16]Taylor, S. N. (2012). Volcanology of the Raventhorpe and Pokeno West Volcanic Complexes, South Auckland Volcanic Field (Thesis, Master of Science (MSc)). University of Waikato, Hamilton, New Zealand. Retrieved from https://hdl.handle.net/10289/6516

***Table 4**. Soils and LUC unit identified in the assessment area, 1799A Great South Road, Bombay 2579.*

Soil type (NZSC Soil Order#)	Parent material	Texture profile	Soil drainage	Soil depth	Dominant slope class	Dominant LUC unit (limitation)
Hamilton clay loam (Granular Soil)	'Hamilton Ash'	Silty clay loam on clay loam on clay	Moderately well drained	Deep	A+B (0-5°)	2e2 (erosion)
Hamilton clay loam, concretionary phase (Granular Soil)	'Hamilton Ash'	Silty clay loam on clay loam (concretionary) on clay	Moderately well to Imperfectly drained	Deep	A (0-3°)	2s3 (soil)
Hamilton clay loam, concretionary phase (Granular Soil)	'Hamilton Ash'	Clay loam on clay loam (concretionary) on gravelly clay	Imperfectly drained	Shallow to moderately deep	A+B (0-4°)	3s3 (soil)
Modified Soil (Fill Anthropic Soil)	Deposited fill on soil developed in 'Hamilton Ash'	Gravel at surface or shallow clay loam on gravel	Imperfectly drained	Very shallow (topsoil absent or <10 cm)	A (0-3°)	4s* (soil)
Non-productive land (NPL)	Buildings, sheds, permanent gravel yards, 1-2 m high subsoil bunds, water tanks, swale drain, metal track					NPL

*LUC class and limitation only as no corresponding LUC unit in NZLRI Extended Legend; #as defined by the New Zealand Soil Classification[17]

The detailed on-site assessment identified that dominant soil in the flat to gently undulating southwestern part of the assessment area as the moderately well to imperfectly drained, deep, Hamilton clay loam, concretionary phase (Granular Soil), with a LUC classification of 2s3 (refer observation points 1 to 4 in **Table 3** and **Figure 7**). The Hamilton clay loam, concretionary phase, typically has a silty clay loam topsoil of 20 cm, underlain by a clay loam upper subsoil with few, medium black concretions (up to 0.5 cm in diameter), over a clay subsoil. An example profile of this soil is shown in **Figure 9A**. Concretions are soft and the soil is easily augered.

Ferromanganese (Fe-Mn) nodules and concretions are stone-like accumulations of iron and manganese oxides that form in soils with poor to imperfect internal drainage. Also known as redox concentrations these signify short-term water saturation (and oxygen depletion) interspersed with periods of oxidation[18].

In the northwest of the assessment area on flat to undulating slopes the imperfectly drained, Hamilton clay loam, concretionary phase, with gravelly clay subsoil dominates (refer observation points 12, 15, 17, 18 in **Table 3**, **Figure 7** and **9C**). Depth to gravels is variable and 1-5 cm gravels can be encountered within the top 20 cm of the soil profile (**Figure 9E**), however, comprising less than 35% volume, giving this land an LUC classification of 3s3. The gravels are likely volcanic and associated with the Raventhorpe Tuff Ring. Black, medium to coarse (up to 2 cm in diameter), Fe-Mn concretions, increase with depth from few to abundant, can occur in the topsoil, and comprise up to 60% volume in the subsoil (**Figure 9D** and **9F**). LUC class 3 land

[17] Hewitt AE. 2010. New Zealand Soil Classification. 3rd ed. Landcare Research Science Series No. 1. Lincoln, Manaaki Whenua Press.
[18] Hewitt, A.E., Balks, M. R., and Lowe, D.J., 2021. The Soils of Aotearoa New Zealand. Chapter 5 Gley Soils. Springer International Publishing.

has moderate physical limitations to arable use, and in this case, moderate structural impediments to cultivation, imperfect drainage, and stony soils.

There are two small areas of moderately well drained, deep, Hamilton clay loam (refer observation points 7, 9 and 20 in **Table 3**, and **Figure 7**), that run adjacent to the eastern boundary of the assessment area, an extension of the NZTA designation area (batter and drain), and the northwest of the assessment area between Great South Road and the existing sheds. These soils typically had a 20 to 25 cm A horizon (silty clay loam), over clay loam upper subsoil over clay (**Figure 9B**) and LUC classification of 2e2.

There are small areas of Fill Anthropic Soil (refer observation points 5, 6 and 13, 14 in **Table 3** and **Figure 7**). Land mapped as containing Fill Anthropic Soil has either a very shallow topsoil over gravel, or no topsoil and gravel at the surface (and unable to auger through) (**Figures 10C, 10D** and **10E**). These soils were classified as LUC 4s and have "severe physical limitations for arable use" and these limitations substantially reduce the range of crops which can be grown, and/or make intensive soil conservation and management necessary. In this case, LUC 4s land has severe structure impediments to cultivation (very shallow topsoil lacking natural fertility and/or stony)[19].

The balance of the assessment area includes the NZTA designation area (approximately 2.0 ha) and non-productive land (approximately 1.6 ha), including buildings and farm sheds, permanent gravel yards, 1-2 m high subsoil bunds, water tanks, drain, metalled track (**Figures 10A** and **10B**).

[19] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.

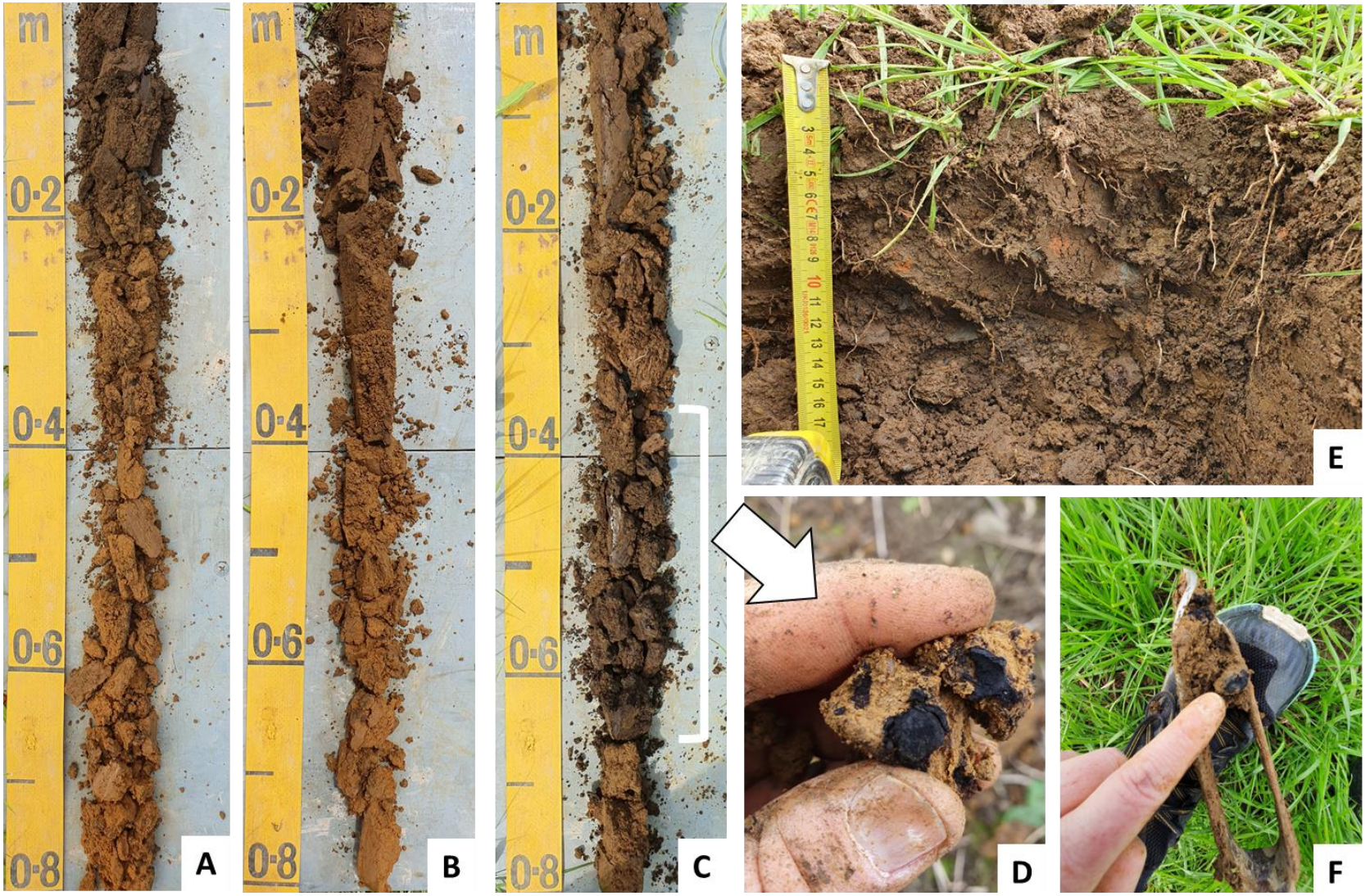


***Figure 9**. Example soil profiles of soils identified in assessment areas. A) Hamilton clay loam, concretionary phase on LUC 2s3 land; B) Hamilton clay loam on LUC 2e2 land; C) Hamilton clay loam, concretionary phase on LUC 3s3 land; D and F) Large 1-2 cm concretions, up to 60% volume at 40 cm depth in LUC 3s3 land; and E) 15-35% gravels within 20 cm of the surface in LUC 3s3 land.*

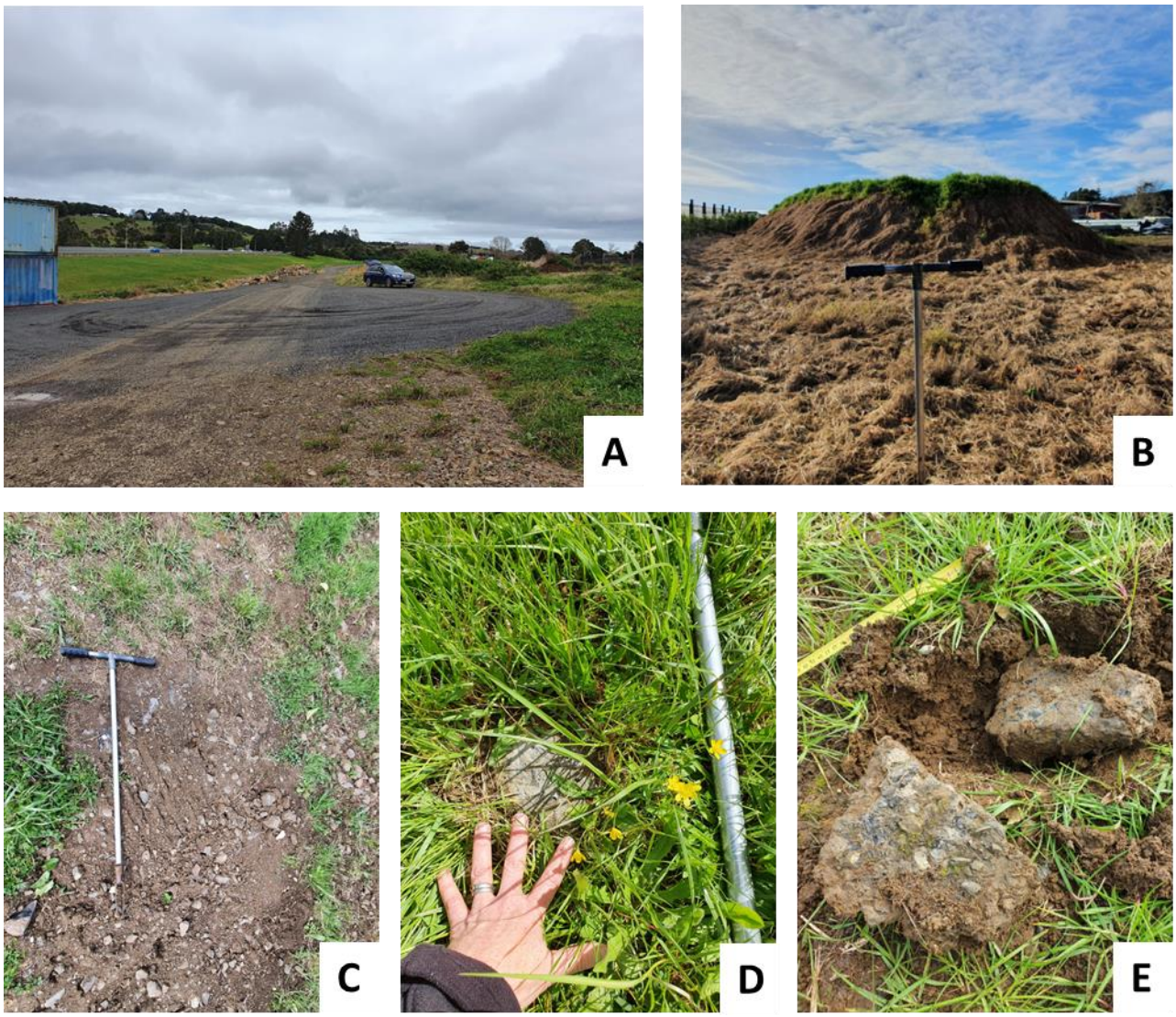


***Figure 10**. Examples of non-productive land and Fill Anthropic Soils identified in LUC 4s areas within the assessment area. A) Metal track and non-productive land near swale drain; B) 1.5-2 m high subsoil bund that surrounds assessment area; C) Fill Anthropic Soil in east; D and E) Concrete embedded into surface in LUC 4s area left of metal track.*

The estimated distribution of LUC units in the assessment area is shown in **Figure 11** (a larger map is provided at the end of the report).

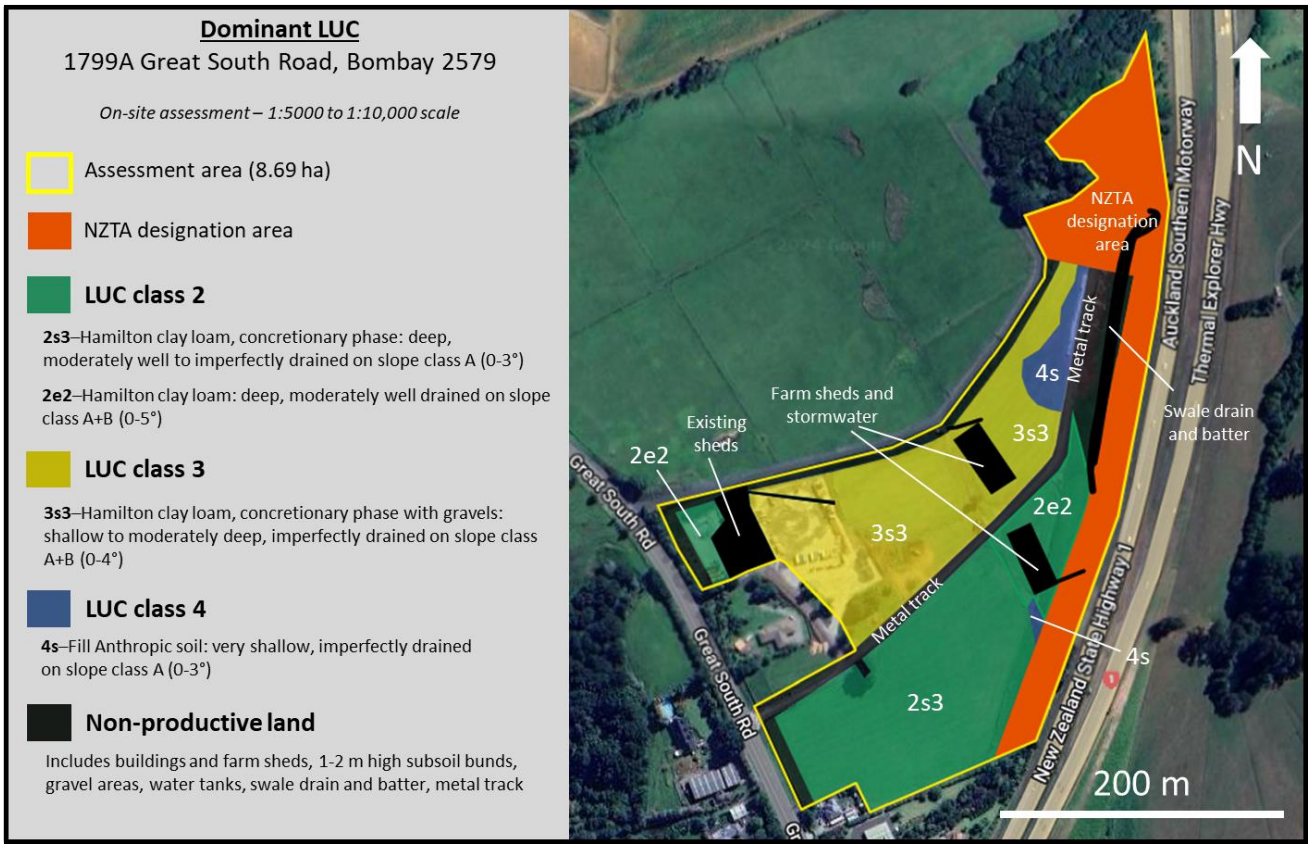


Figure 11. *The distribution of LUC units for the assessment area, 1799A Great South Road, Bombay 2579.*

10. On-site mapped AUP land containing elite and prime soil

The on-site mapped LUC map units for the assessment area were further classified according to the Auckland Unitary Plan (updated 18 April 2024) definition of elite and prime soil and are shown in **Figure 12** (a larger map is provided at the end of the report) and **Table 5**.

Table 5*. AUP elite and prime soils identified in the assessment area, 1799A Great South Road, Bombay 2579.*

Dominant LUC unit	AUP elite/prime/other productive land	Area ha, (%)*
2e2	Prime	0.5 (6)
2s3	Prime	2.1 (24)
3s3	Other productive land	2.2 (25)
4s	Other productive land	0.2 (3)
NPL^	-	1.6 (19)
NZTA designation area	-	2.0 (23)

based on flow chart Figure *% areas rounded to whole number; ^NPL = Non-productive land/modified soil.

Applying the AUP definition for land containing elite and prime soil, moderately well drained LUC 2e2 and moderately well to imperfectly drained LUC 2s3 are classed as prime soil, and imperfectly drained 3s3 and 4s land are classed as other productive land.

Figure 12. *The distribution of AUP defined elite and prime soil within the assessment area, 1799A Great South Road, Bombay 2579.*

11. Summary

Based on the regional scale NZLRI LUC map information and applying the NPS-HPL, the assessment area is LUC 2e2 and is considered NPS-HPL highly productive land.

The 1799A Great South Road assessment area is 8.69 ha in size. Based on the on-site assessment, the dominant soils include the imperfectly drained, shallow to moderately deep, imperfectly drained Hamilton clay loam, concretionary phase with gravels (LUC 3s3); and moderately well to imperfectly drained, deep, Hamilton clay loam, concretionary phase on flat to gently undulating slopes (LUC 2s3).

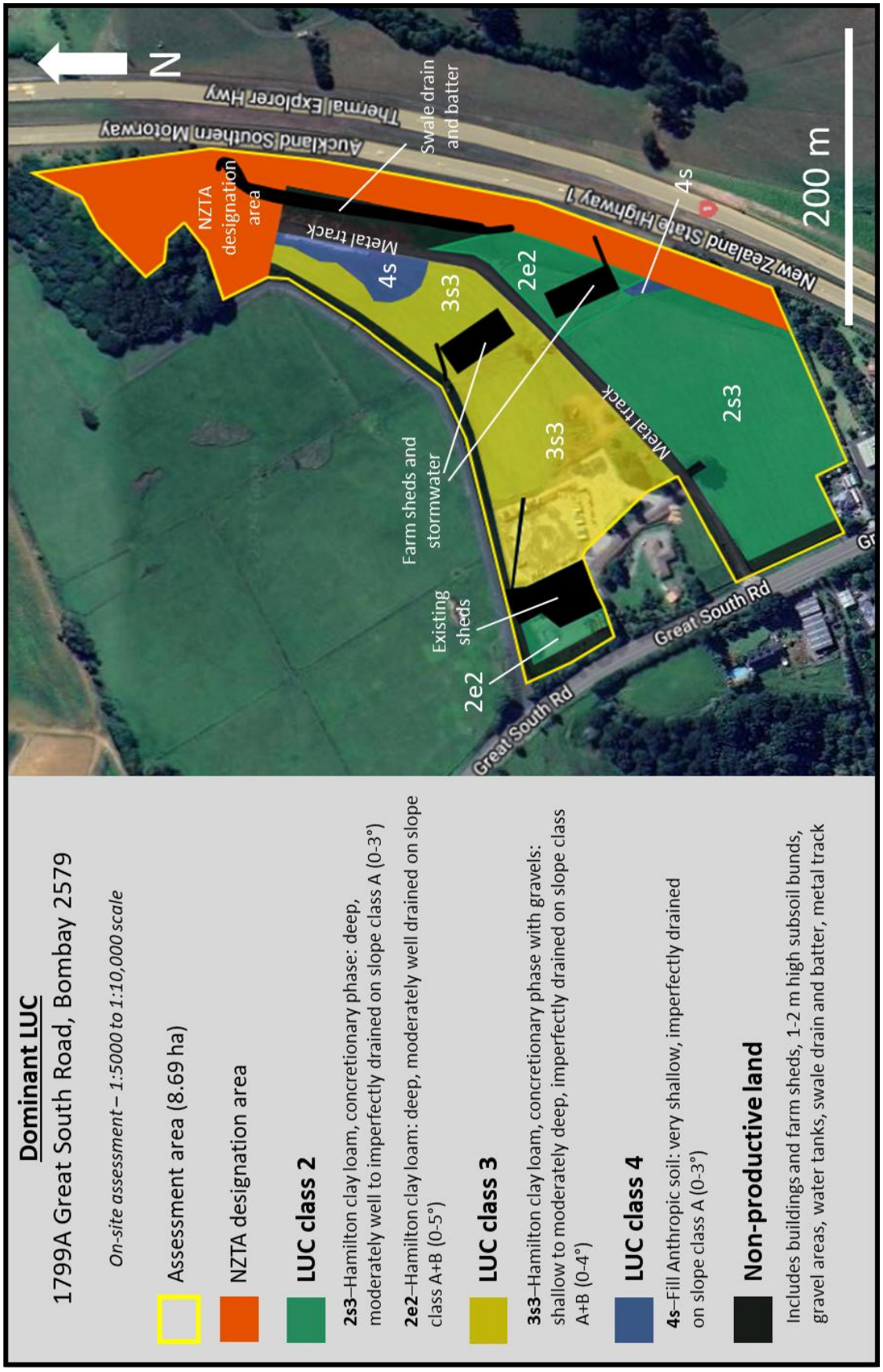
There are two small areas of moderately well drained, deep, Hamilton clay loam, that run adjacent to the eastern boundary and the northwest of the assessment area between Great South Road and the existing sheds (LUC 2e2). There are small areas of Fill Anthropic Soil which is either a very shallow topsoil over gravel, or no topsoil and gravel at the surface (unable to auger through) (LUC 4s). The characteristics of this Fill Anthropic Soil are consistent with the LUC handbook definition of land with "severe physical limitations to arable use".

The balance of the assessment area includes the NZTA designation area and non-productive land, including buildings and farm sheds, permanent gravel yards, 1-2 m high subsoil bunds, water tanks, drain, and metalled track.

Based on the on-site mapping and applying the AUP definition for land containing elite and prime soil, elite soil was not mapped on the site. LUC 2e2 and 2s3 land is prime soil. Due to the imperfect drainage characteristics of the 3s3 land on site, and very shallow, stoney nature of the LUC 4s land, the remaining available productive land is classed as other productive land.

12. Enlarged map image from Figure 7.

13. Enlarged map image from Figure 11.



14. Enlarged map image from Figure 12.