Landloch

SHIRE OF CRANBROOK: LAND CAPABILITY ASSESSMENT

November 2025

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1 INTRODUCTION

The Shire of Cranbrook is currently assessing an application for the establishment of a *Pinus radiata* plantation within lot 12667, (No 7691) Muir Highway, Frankland River (the Study Area). Under the Shire of Cranbrook Town Planning Scheme No.4 (the Scheme) planning approval is required for any plantation developments. As part of the approvals process, State Government land use planning, policies and mapping for the region are to be considered:

- *Lower Great Southern Strategy 2016* (Western Australian Planning Commission 2016);
- *Strategic Agricultural Land Mapping – South Coast Region* (DPIRD 2018).

A preliminary investigation of the soils and landscape of the Study Area was completed in 2025 (Harper 2025). This report was not a site-specific land capability assessment as per Van Gool et al. (2005), and as such does not assess the capability of the Study Area in regard to supporting a *Pinus radiata* plantation.

Landloch Pty Ltd (Landloch) was engaged to complete an assessment of soils within the Study Area with the objective of completing a land capability assessment. Landloch mobilised one soils technician to undertake assessment and sampling of soils present across the study area in accordance with methodology outlined in a fieldwork program issued prior to mobilisation in November 2025.

This report includes the following:

- Background information on the Study Area;
- A description of the assessment approach;
- A description of the characteristics of the topsoils and subsoils assessed;
- Classifications of the soils, in line with the Australian Soil Classification (ASC) and Western Australian Soil Groups (WASG);
- Allocation of Soil Mapping Units (SMUs) on the basis of soil properties; and
- Completion of land capability assessments for each SMU.

1.1 Background

The Study Area is located 25 km south-west of the town of Frankland River, and approximately 290 km south south-east from Perth, Western Australia within the Shire of Cranbrook. It is approximately 567 ha in size, consisting of two parcels of cleared land currently used for mixed grazing, with isolated remnant bushland. The location of the Study Area, within the regional setting, is given in Figure 1.

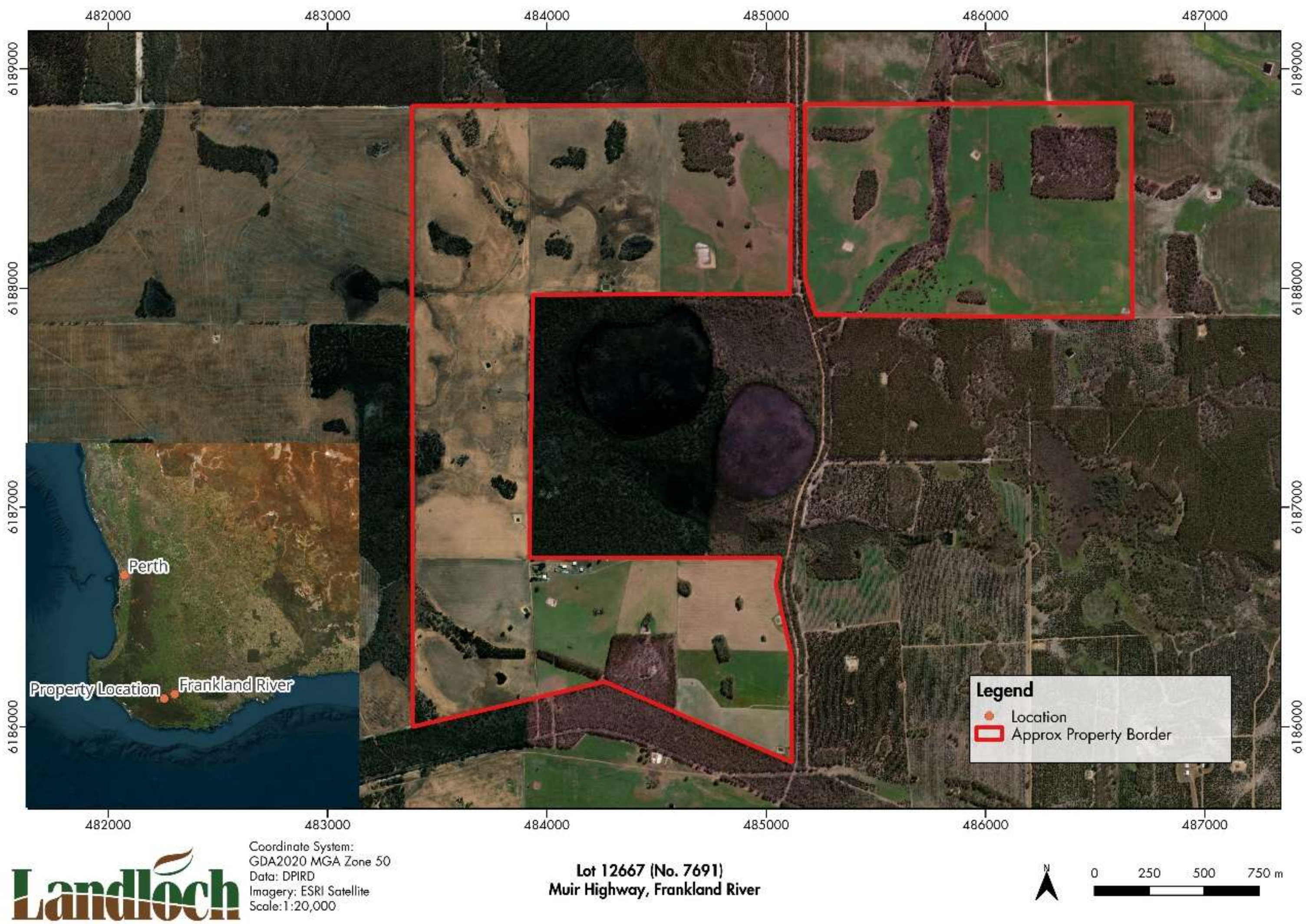


Figure 1: Location of the Study Area at Lot 12667 (No 7691) Muir Highway, Frankland River.

2 LAND CAPABILITY

The Western Australian Department of Primary Industries and Regional Development (DPIRD), formerly the Department of Agriculture and Food Western Australia, provides a methodology for assessing the capacity of land to support a given land use (Van Gool et al. 2005). This is referred to as a Land Capability Assessment (LCA). Land capability considers both the specific requirements of the land use, for example, plant rooting depth or soil water availability, plus the risks of degradation associated with the land use, such as phosphorus export hazard or wind erosion. This assessment method is used to assess the capability of land for agricultural and non-agricultural uses by identifying physical, chemical, and degradation constraints to the land with reference to particular soils and landscapes. The information gathered from LCA can be applied by land managers to improve sustainable land development.

The standards within the land capability assessment framework are similar to the land resource suitability assessment (Stage two) methods described by the Food and Agriculture Organisation (FAO 1976, 1983). The method was specifically developed for use in the south-west agricultural region of Western Australia.

Included in the framework are four land uses for which criteria have been developed:

- Grazing (rainfed);
- Cropping (rainfed);
- Perennial horticulture; and
- Annual horticulture.

Ultimately, five land capability classes are referenced to communicate the capability of a specific land unit for a prescribed land use (Table 1). Typically, a landscape will consist of land with a range of capability classes. These classes are specific to the land use being considered.

Table 1: LCA Capability class ratings.

Capability class	Description
1 Very High	Very few physical limitations present and easily overcome. Risk of land degradation is negligible.
2 High	Minor physical limitations affecting either productive land use and/or risk of degradation. Limitations overcome by careful planning.
3 Fair	Moderate physical limitations significantly affecting productive land use and/or risk of degradation. Careful planning and conservation measures required.
4 Low	High degree of physical limitation not easily overcome by standard development techniques and/or resulting in high risk of degradation. Extensive conservation measures and careful ongoing management
5 Very Low	Severe limitations. Use is usually prohibitive in terms of development costs or the associated risk of degradation.

The capability class is determined by assessment of the land characteristics over an area of interest. A land characteristic is an attribute of the land that can be measured or estimated, and which can be employed as a means of describing land qualities (FAO 1983). A characteristic may influence several different qualities. For example, the land characteristic 'slope' influences the qualities 'waterlogging' and 'water erosion hazard'. As slope increases, the degree of waterlogging is likely to decrease, while water erosion hazard increases. Land qualities are 'those attributes of land that influence its capability for a specified use' (Wells and King 1989). Land qualities are used to help determine capability.

Each land characteristic and quality have a range of possible values. For example, the range of values for the land quality 'water repellence' is high, moderate, low, and nil. These land qualities can be combined to prepare land capability maps, such as capability for dryland cropping or grazing. Each land capability is comprised of a variety of land qualities, with different requirements and qualities considered depending on the type of land use desired.

The soils investigation for this study was completed by Landloch to provide sufficient soils data to facilitate the completion of a land capability assessment concerning the four land uses. Additionally, a specific criterion for tree farming of *Pinus radiata* has been included within the land capability assessment framework, as this is the intended land use for the Study Area.

To conduct a land capability assessment, detailed descriptions of the soils and landscape are required. The process to collect the required data includes an initial desktop review of existing data, a field survey to describe the landscape and soil morphology, including the collection of soil samples. Data from the field survey and laboratory analysis are used to map the soils to existing soil classification schemes, providing a basis for the assessment of soil variability. Soils and landscapes are then grouped into Soil Mapping Units (SMUs) based on similarities in physical and chemical characteristics, landscape position and soil morphology. The SMUs are used as the basis for the land capability assessment, with each SMU assessed against the capability criteria for cropping and grazing.

Generalised regional scale mapping of land use capabilities is available from of DPIRD for the Study Area. This data suggests the general area is suitable for a range of agricultural land uses including the following in ranked order:

1. Vineyards
2. Perennial horticulture
3. Annual horticulture
4. Grazing
5. Dryland cropping

By following the land capability assessment framework this report provides a Land capability assessment for each encountered soil type to a 1:25,000 scale of assessment.

3 ASSESSMENT APPROACH

Broadly, the approach taken to complete the soil investigation, enabling the land capability assessment, included:

- A desktop review of existing soil and landscape information to gain an understanding of the soils expected to occur within the Study Area;
- Field-based survey to ground-truth soil types and sample the soils;
- Data analysis, interpretation, and reporting to:
    - Classify soils into soil types and mapping of their extents;
    - Group soil types into Soil Mapping Units, based on similarities in characteristics and management requirements;
- Complete a land capability assessment for each of the defined Soil Mapping Units.

3.1 Desktop data review

This section outlines the review of existing information relevant to the Study Area and used to inform the approach to the field-based survey, and the process for soil classification and mapping.

3.1.1 Land systems mapping

Broadscale land systems mapping has been conducted over the survey area. Land systems mapping describes and groups land with a recurring pattern of topography, soils, and vegetation. This mapping is useful for regional planning and very extensive (broad scale) land use. It provides a broadscale indication of the variability of the soils present over the Study Area.

The mapping is based off survey data from the 2005 Tonebridge-Frankland soil survey. A total of 8 field observation sites are located within close proximity to the Study Area, situated on surrounding roads and the Cobertup nature reserve.

Three (3) land systems are present over the Study Area, consisting of 7 differing subsystems. A brief description of each land system is provided in Table 2. The Study Area is dominated by one subsystem, the Frankland Hills 4 subsystem. This system consists of poorly drained flats, foot slopes including swamp depressions. The soils contained within this subsystem consist of duplex sandy gravels (Stuart-Street 2005).

Table 2: Summary of land systems within the Study Area.

Land system	Description	Area (Ha)
Bevan subsystem (Perup)	Flat to gently undulating plains. Pale deep sand is dominant with semi wet soil, pale shallow sand and duplex sandy gravel	84
Frankland Hills 1 subsystem	Lateritic crests, upper slopes and isolated low gravelly rises with widespread lateritic duricrust. Loamy and duplex sandy gravels are common	23
Frankland Hills 2 subsystem	Upper to lower slopes surrounding 254Fh_1. Loamy gravels, Duplex sandy gravels and Deep sandy gravels are widespread with Grey deep sandy duplex and loamy earth soils common also. Jarrah - marri forest and woodland with wandoo	91
Frankland Hills 3 subsystem	Minor valleys. Duplex sandy gravel soils are common with loamy and deep sandy gravels	41
Frankland Hills 4 subsystem	Poorly drained flats, lower slopes and footslopes including swamp depressions. Duplex sandy gravel soils are common with Loamy gravel and Semi-wet soils	189
Unicup 1 subsystem	Flat to gently undulating plains. Pale deep sand is dominant with semi wet soil, pale shallow sand and duplex sandy gravel	17
Unicup 3 subsystem	Low gravelly rises. Duplex sandy gravel and grey deep sandy duplex are dominant	34
Total		479

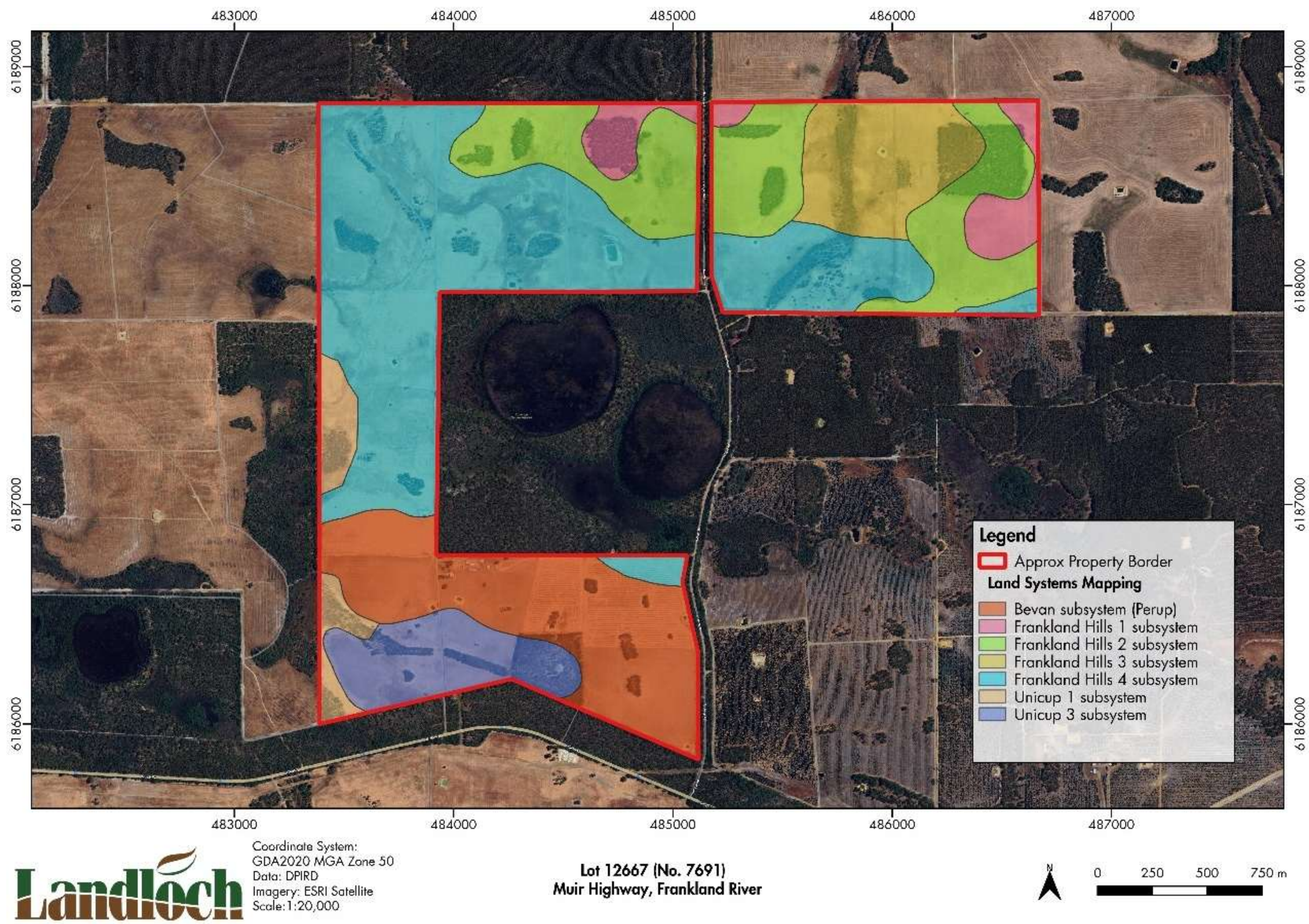


Figure 2: Land systems mapping over the Study Area.

3.1.2 ANSIS

The Australian National Soil Information System (ANSIS) provides broad (1:40,000) soils data for the Study Area. This scale provides a general guide to the types of soils expected to be encountered within the Study Area but lacks the accuracy required for any land capability assessment. ANSIS identifies two possible soil types contained over the Study Area:

- Podosol; and
- Chromosol.

The in-field soils investigation was used to determine the presence and extent to which these soil orders are present within the Study Area, in addition to the presence of other soil orders.

3.1.3 Landscape slope and relief

Change in landscape elevation and gradient play an important role in soil formation and provide an indication of variability of soil type across a landscape. Publicly available DEM (Digital Elevation Model) Lidar imagery over the Study Area was utilised to create 2.0 m contour lines and gradient data (Geoscience Australia, 2011). DEM identifies topographical features that are important to formation of soils and their location.

The Study Area consists of undulating rises and flats with elevation ranging from 240 m in the north to185 m in the south-western corner (Figure 3). Multiple drainage lines are visible across the Study Area.

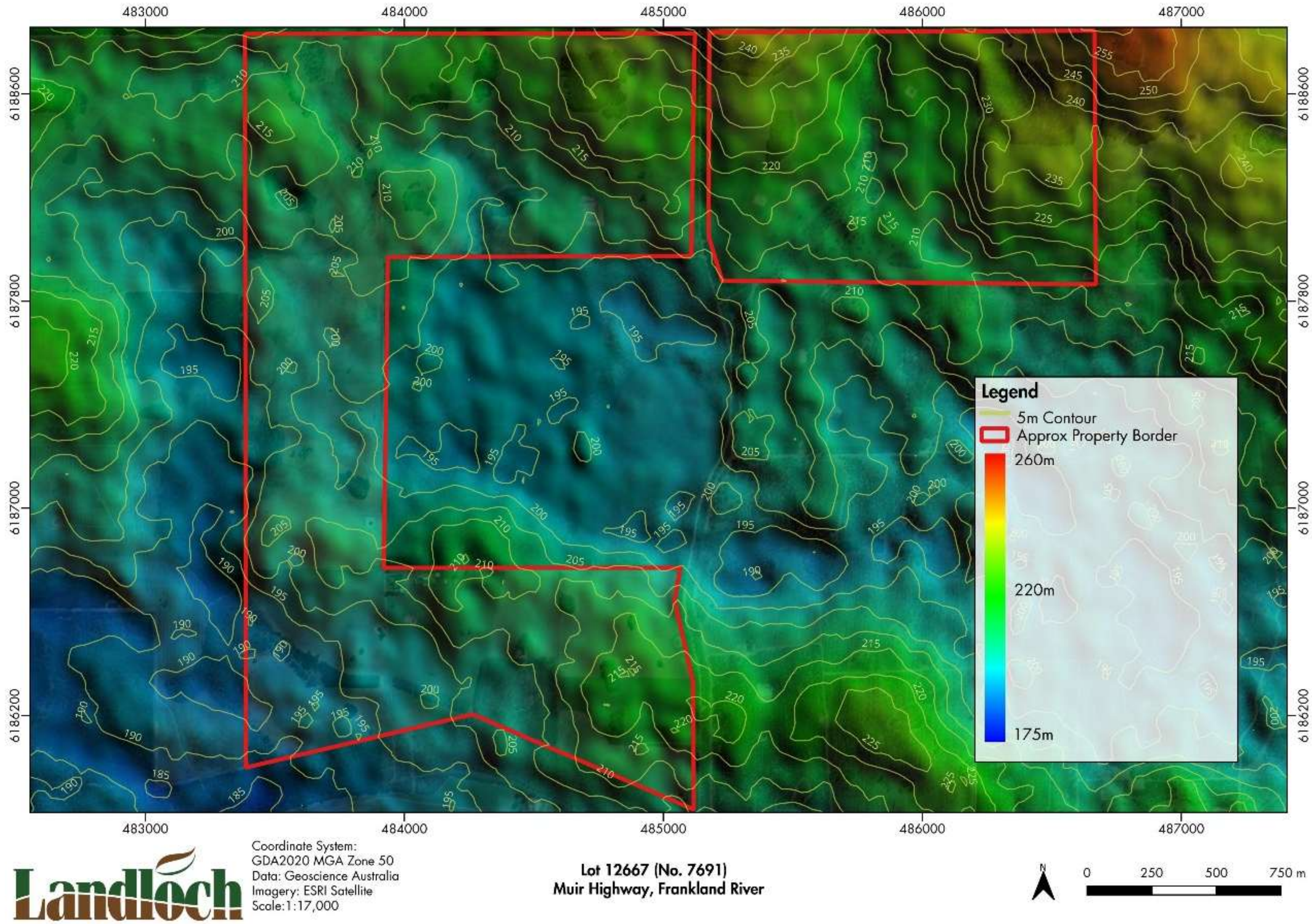


Figure 3: Digital elevation model data and 5m contours over the Study Area.

3.1.4 Murdoch university sampling program

A site-specific land capability assessment for food production and broader agricultural use was undertaken in October 2025 by Professor Richard Harper of Murdoch University. The assessment comprised a detailed desktop review followed by a site inspection incorporating in-situ soil examination and sampling.

During the field component, a total of 67 observation points were established across the Study Area to capture spatial variability in soil type, landscape position, and potential agricultural constraints. From these sites, 31 surface soil samples (0–10 cm depth) were collected and analysed for electrical conductivity (EC) and soil pH in $CaCl_2$ (Rayment and Lyons 2011).

Seasonal waterlogging was identified as a significant limiting factor for dryland agricultural production, with evidence of inundation recorded at 22 of the 67 inspection sites. No depth to water was provided. Surface soil texture classes were also documented across the assessment area, providing context for interpreting drainage behaviour. No occurrences of soil salinity were recorded during the assessment, either through field indicators or laboratory EC results (Harper 2025).

3.2 Field based survey

3.2.1 Mapping scale and survey requirements

The required scale of soil mapping and the size of the survey area dictates the number of soil inspection sites required. The total survey area is 479 ha in size. The inspection site density is defined in the *Guidelines for Surveying Soil and Land Resources* (McKenzie, et al. 2008).

For the objective of providing detailed project planning, and for moderately intensive uses at the 'field' level an inspection site every 5-25 ha is required for a 'Moderately High (detailed)' (1:25,000) level of assessment. This mapping will delineate areas of ~2.5ha and will detail groups of soil with similar properties.

To achieve the required density, between 19-95 inspections sites are required across the Study Area. As part of this assessment, Landloch investigated an additional 8, supplementing the pre-existing dataset. This includes 8 detailed soil profile descriptions (Stuart-Street 2005) and 67 brief ground observations (Harper 2025).

When combined with pre-existing data, this results in a total of 83 observations over the Study Area, equivalent to an inspection density of 1 site per ~6 ha. This allows for a more intense inspection density sufficient to provide the required detail for a land capability assessment.

Table 3: Survey scale and requisite number of inspection sites.

Intensity/Area	Size (ha)	Inspection density	Landloch Sites	Existing Sites	Publication scale	Map unit type	Objective
high intensity	~479	~1 site per 6 ha	8	83	1:25,000 (1 site per 5-25ha)	Mainly simple, some compound, moderately detailed	High intensity uses at 'farm' level, detailed

Details of the recommended proportions of ground observation types (McKenzie et al., 2008) are shown in Table 2.

Table 4: Ground observation types and proportions

Site Types	Details	Recommended Proportions	Adopted proportions
Representative profiles	Detailed morphological and site descriptions to characterise the main soils and landscapes in a survey area. Full laboratory analysis to a depth of 1.0 m.	5–10%	10%
Detailed profiles	Detailed morphological and site descriptions to characterise the main soils and landscapes in a survey area. Select laboratory analysis (diagnosis) to classify soils.	25–50%	10%
Semi-detailed profiles and check sites	Brief mapping observations to confirm mapping boundaries, soil type distributions or other characteristics being mapping in the survey. These are brief with only the minimal amount of information recorded to correlate the site with a soil where a 'detailed' ground observation has occurred.	40–70%	80%

3.3 Selection of inspection sites

The in-field soil assessment was conducted by Landloch in October 2025. Soil inspection sites were pre-selected based on the assessment of available data including existing soils mapping, previous sample sites, aerial imagery and contour data.

Soil inspection sites were relocated in-field where required. A total of 8 soil inspection sites were investigated. Inspection site coordinates are provided in Table 5, and their locations illustrated in Figure 4.

Table 5: Location of sample inspection sites.

Location	Easting (m)	Northing (m)
1	486,986	6,188,363
2	484,889	6,188,235
3	483,914	6,188,093
4	483,720	6,187,337
5	484,691	6,186,375
6	485,953	6,188,053
7	483,897	6,186,640
8	483,667	6,188,366

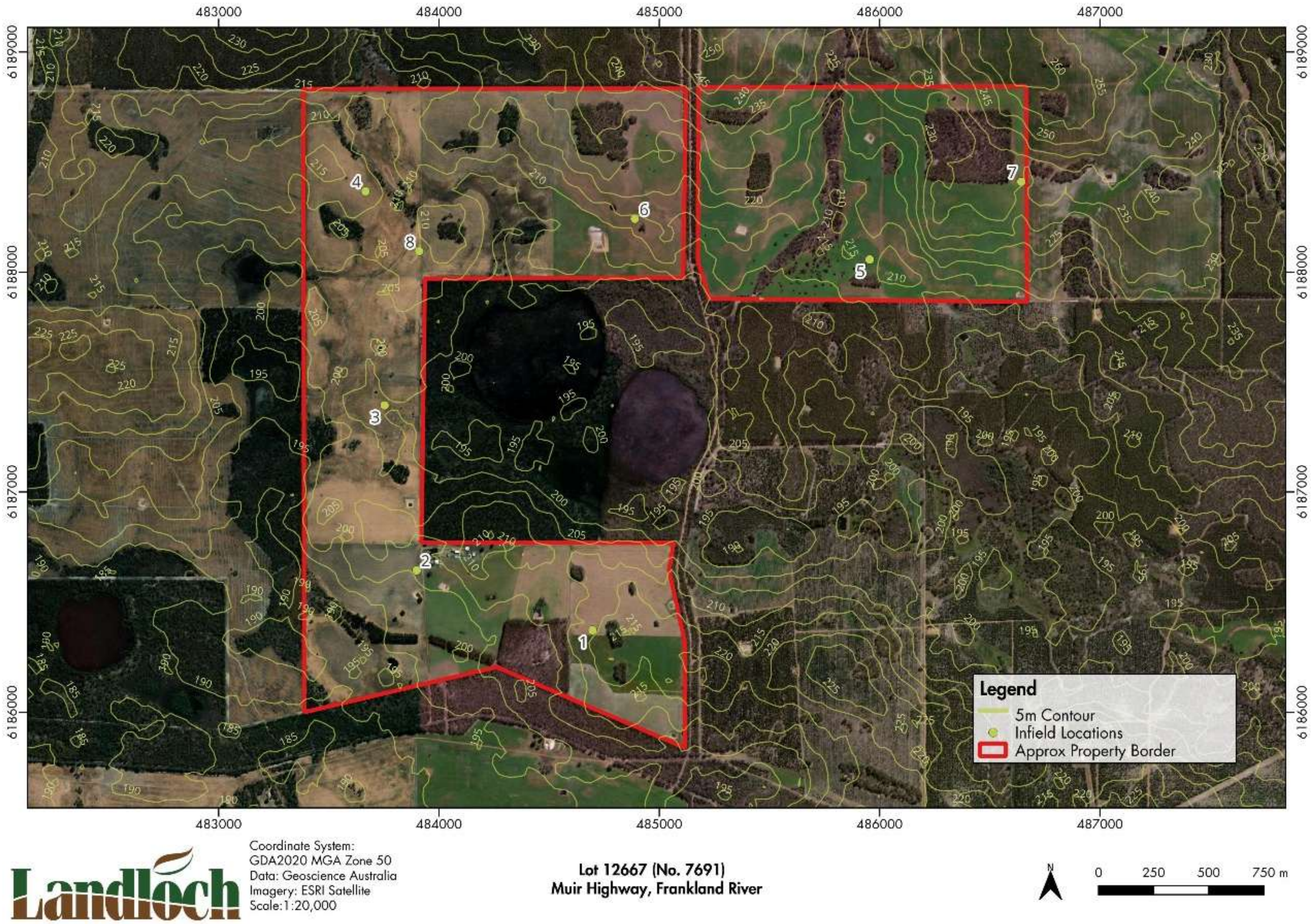


Figure 4: Infield locations of inspection sites with 5 m contour mapping over the study area.

3.4 Site descriptions

Site descriptions, soil profile descriptions, and soils data were recorded at each soil inspection site in line with the Australian Soil and Landscape Survey Field Handbook (NCST 2024).

At each site, a soil pit was dug using a hand tools to a depth of 1m or depth of refusal. Observations of the location, landform, vegetation, land surface, and soil profile were recorded for each site. Such observations included:

- Assessment date;
- GPS coordinates;
- Current land use;
- Dominant vegetation forms;
- Vegetation cover percentage;
- Land surface aspect and microrelief;
- Rock outcrop abundance; and,
- Erosion state, type, and extent.

The following information was recorded for each assessed soil profile:

- Horizon depths and designations;
- Horizon boundary type and distinctness;
- Field texture;
- Colour (Munsell);
- Coarse fragment abundance and size;
- Segregations abundance and size;
- Soil structure type and grade;
- Soil consistency;
- Root abundance and size; and,
- Presence of mottling and segregations.

The information recorded for each soil inspection site is provided in the soil log data sheets (Appendix B).

3.5 Sampling protocol

Soil samples from a range of depths were collected from inspection sites Location 1 - Location 8. A total of 4, 1 kg samples were taken at each site at varying depths based on the depth of the soil pit and/or the homogeneity of the soils within the soil profile. Generally, one sample was taken from the topsoil (A) horizon, and 3 samples from the diagnostic (B - BC) horizons. A total of 32 samples were collected across the 8 soil inspections sites.

4 SOIL CHARACTERISATION

4.1 Soil Testing

Soil samples collected from Location 1 to Location 8 were transported to Landloch's facility in Perth and assessed for the following parameters:

- Coarse fraction percentage (>2mm diameter);
- Electrical Conductivity in water (1:5);
- pH; and
- Water repellence.

In addition to this, all soil samples from the 8 sites (32 samples) were submitted for more detailed laboratory analysis (Table 6). This laboratory analysis was undertaken by a laboratory with a National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) accreditation.

Table 6: Detailed soil laboratory analysis undertaken

Analysis
• $pH_{1:5}$ (water) • $EC_{1:5}$ • Total Cl • Exchangeable cations (K^+, Ca^{2+}, Mg^{2+}, Na^+ & Al^{3+}) • Effective cation exchange capacity (ECEC) • Exchangeable sodium percentage (ESP) • Organic C • Total N & Total P • Available P and K (Colwell) • Total Boron • Available S (KCl) • Trace elements (Cu, Zn, Mn & Fe) • Particle size distribution of the fine fraction (<2mm)

4.2 Soil classification

Soils across the Study Area were classified according to two classification systems.

4.2.1 Australian Soil Classification

The Australian Soil Classification (ASC) (Isbell and NCST 2021) is the national system for soil classification. The scheme defines soil classes on real soil bodies using a key. The ASC uses a set of defined attributes, horizons, and materials to assign a soil profile to a class. Collectively, these concepts are called diagnostic features. Classes are allocated based on a vertical soil profile as seen in an exposed soil pit, and account for geographic attributes of the landform.

4.2.2 Western Australian Soils Groups

The Western Australian Soil Groups (WA soil groups) (DPIRD, 2024) provide a region-specific framework for classifying soils within Western Australia. This system complements the Australian Soil Classification (ASC) by simplifying the soil continuum into a limited number of practical soil types, supporting a generalist level of understanding suitable for land assessment and management. The use of the Western Australian Soil Groups is mandated for Land Capability Assessments undertaken in Western Australia (DPIRD, 2005).

4.2.3 Soil Mapping Units

The soils of the Study Area were grouped into Soil Mapping Units (SMU). SMUs are the basic geographic component of a soils map and can be associated with a single or multiple soil types with definable characteristics. SMUs are developed based on recurring landscapes and soil attributes, with minor variations in soil properties allowable within each SMU. The purpose of SMUs is to groups soils by their management requirements, such as depth, salinity, sodicity, coarse fragments and nutrient values. For the purpose of this project, SMUs were used as the basis for defining the capability of the soils present across the Study Area.

5 SOIL CLASSIFICATION

5.1 Australian Soil Classification

A total of three (3) Australian Soil Classification (ASC) soil orders were identified across the 8 profiles within the Study Area:

- Tenosols;
- Hydrosols; and
- Dermosols.

Tenosols were the most widespread order, occurring on the elevated locations (Locations 1, 2, 6, 7, 8), functioning as rapidly draining, drought-prone soils with very limited water-holding capacity and low inherent fertility. These profiles are weakly developed with limited horizon differentiation, compromising of acidic loamy sands to gravelly sands over weathered subsoil materials.

The Tenosols are associated with the ironstone gravel landscapes, containing very high coarse fragment contents (60–80%), are nutrient-poor, and exhibit low CEC, low organic carbon (0.2–1.0%), and very low Colwell P.

The shallow sandy Tenosols (Location 7) consist of pale, bleached sands with almost no clay, extremely low fertility and periodic hydrophobicity. The sandy profile (Location 8) is also a typical Tenosol despite presence of moisture at depth (850mm).

Dermosols were recorded at Locations 3 and 4 and were characterised by sandy loam to clay loam textures, and the absence of a sharp texture contrast. These soils exhibit moderate acidities (pH 5.5–6.3), higher CEC values (up to 10 meq/100g) in subsoil horizons and greater nutrient retention than the Tenosols. Both locations show signs of seasonal wetness, including mottled subsoils and moisture accumulation zones, reflecting their occurrence on lower slopes or foot slopes.

Dermosols represent some of the more productive soils within the Study Area, with improved water-holding capacity and structural stability, although seasonal waterlogging may constrain crop choice. They are well suited to pasture production and selective perennial horticulture, provided drainage is adequate.

The lower slopes and drainage lines (Locations 3 and 4) include Dermosols, with loamy to clayey textures and moderately structured subsoils that support greater water storage and vegetation potential. A Hydrosol was identified at Location 5, representing a seasonally to perennially wet soil typical of low-lying drainage depressions and valley-floor environments. The profile consists of sand to sandy clay loams with strong greying and mottling, indicating prolonged saturation within 30–80 cm for extended periods of the year. These soils are acidic (pH 5.2–6.0), nutrient-poor, and possess very low CEC (0.3–2.0 meq/100g) in the upper horizons due to intense leaching.

Together, these ASC classes describe a soil–landscape ranging from well-drained, coarse-textured uplands to seasonally wet depressions. A summary of each ASC order and associated soil inspection sites is provided in Table 7.

Table 7: Australian Soil Classification of the soils within the Study Area.

Australian Soil Classification	Description	Locations
Tenosol	Deep Acid Sands & Clayey Sands; acidic, locally hydrophobic, high coarse fragments	1,2,6,7,8
Dermosols	Loamy Earths / Clay Loams; moderately acidic	3,4
Hydrosols	Seasonally wet sand.	5

5.2 Western Australian soils groups

The abovementioned ASC orders correspond closely with the Western Australian Soil Group framework. A total of six WA soil groups, from three super groups, were identified:

- Semi-wet soils;
- Wet soils;
- Shallow sandy duplex gravel;
- Loamy gravel;
- Sandy acid duplex gravel;
- Pale shallow sand.

The distribution of these groups reflects the alternating upland gravelly rises and lower wet depressions typical of the Frankland River district (Tonebridge mapping).

The Ironstone Gravel Soils supergroup dominate the Study Area, with the Loamy Gravel (1215) group encountered at (Sites 1, 2, 4, 6). These soils are shallow, gravelly, and weakly structured, with acidic surface horizons and typically found on higher elevations.

Lower-lying positions (Sites 3, 5, 8) exibit Wet or saline soils with Semi-wet and Wet Soils (Groups 1108 and 1107), reflecting zones of seasonal saturation or prolonged waterlogging.

Finally, a single upland site (Site 7) exhibit shallow sand soil supergroup, Pale Shallow Sand (1405), a grey, shallow sand over gravel.

Overall, the pattern of soil groups indicates a moderately dissected landscape with well-drained, acidic gravelly uplands interspersed with locally wet or seasonally saturated depressions, consistent with the soil–landscape patterns characteristic of the southern Yilgarn–Frankland region.

A summary of each WA soil group and associated soil inspection sites is given in Table 8 below.

Table 8: Western Australian Soil Groups of the soils within the Study Area.

WA super group	WA soil group	Description	Sites	Associated ASC orders
Wet or Saline Soils	Semi-wet soil (1108)	Soil wet within 80cm for at least 2 months of the year. Water is below 30 cm but within or at 80cm	3	Dermosol
	Wet soil (1107)	Soil wet within 30cm for at least 2 months of the year. And wetness persists into the subsoil	5	Hydrosol
Ironstone Gravel Soils	Loamy gravel (1215)	Soil has an ironstone gravel layer that starts within or at 15 cm	1, 6, 2, 4	Tenosol, Dermosol
Shallow Sandy Soils	Pale shallow sand (1405)	Soil with a sandy topsoil texture group with rock or cemented layer at below 30 cm and within 80 cm. Dominant colour is grey.	7, 8	Tenosol

5.3 Soil Mapping Units

The 8 Landloch soil profile inspection sites and were grouped into SMUs based on their morphological properties, chemical characteristics, particle size distributions, ASC classifications, and WA soil groups. A total of three SMUs were defined:

- Wet or Saline Soils
- Ironstone Gravel Soils
- Shallow Sandy Soils

A summary of the SMUs and the soil inspection sites associated with each is provided in Table 9. An overview of the key soil attributes that are common across both SMUs, and those which differentiate the SMUs follows. The spatial distribution of the three soil mapping units is presented in Figure 5.

Table 9: Soil Mapping Units in order of dominance within the Study Area.

SMU	Description	Locations	Approximate Proportion of Study Area (%)
Ironstone Gravel Soils	Typically sandy Soils with high gravel content	1, 2, 4, 6	42
Wet Soils	Deep Acid Sands & Clayey Sands; acidic, locally hydrophobic, high coarse fragments	3, 5	48
Shallow Sandy Soils	Loamy Earths / Clay Loams; moderately acidic	7, 8	10

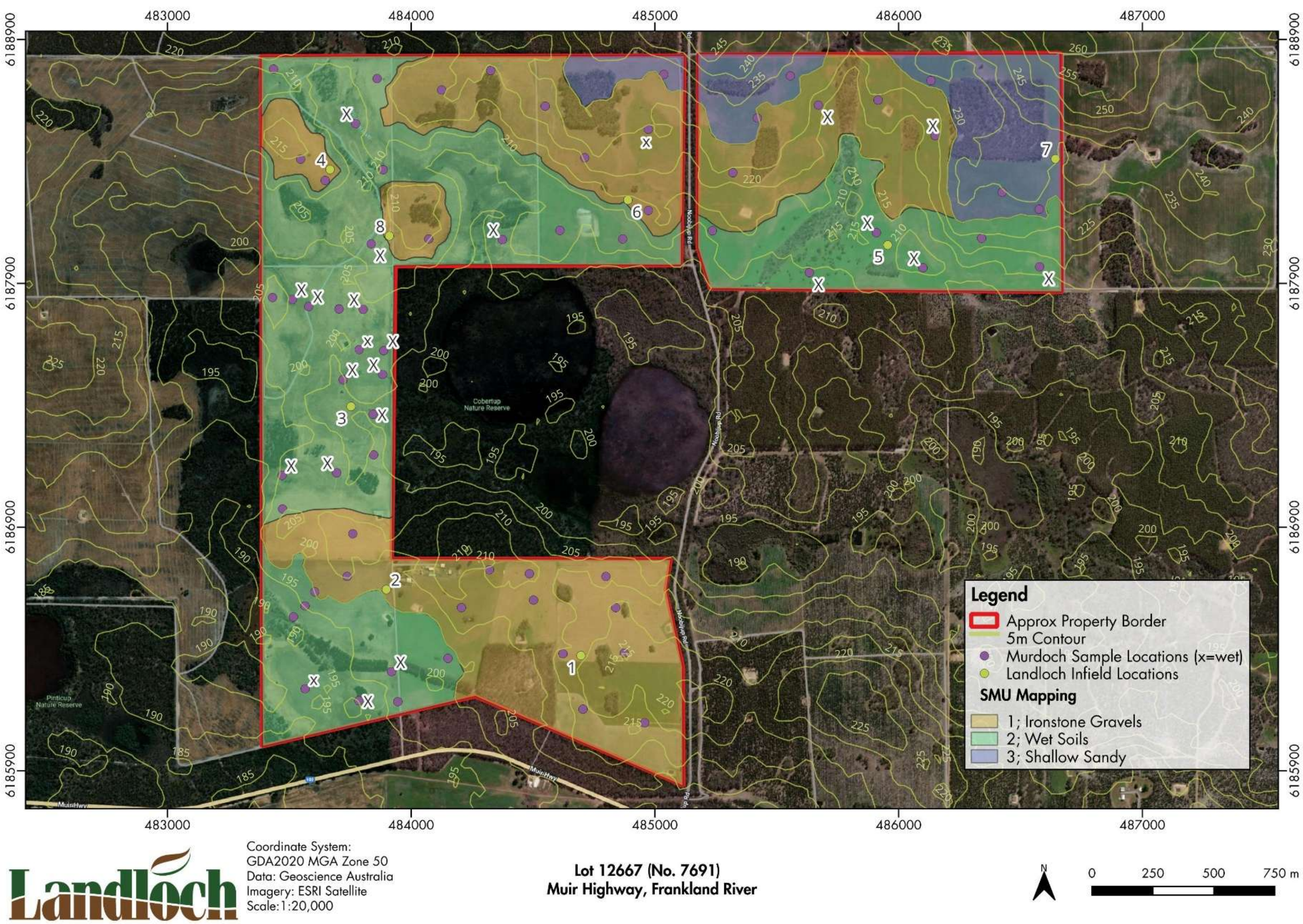
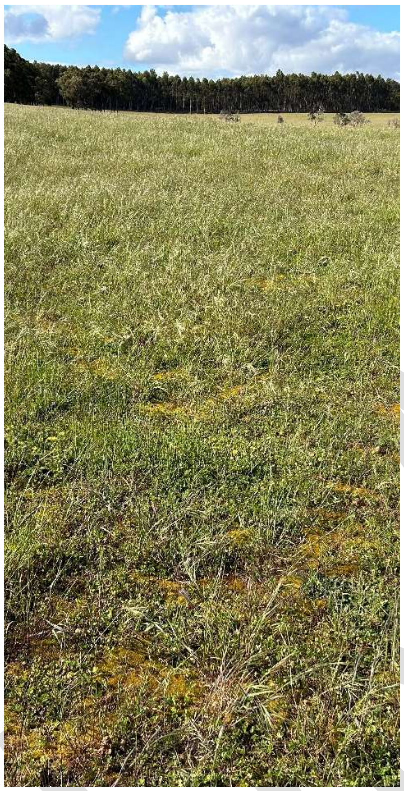


Figure 5: Distribution of soil mapping units identified over the study area with Landloch and Murdoch university sample sites noting wet soil condition displayed.

5.3.1 SMU 1 – Ironstone gravels

The Ironstone Gravel Soils occur across gravelly rises and mid-slopes within the Study Area. These soils represent the dominant upland materials formed over lateritic duricrust and weathered ironstone. A summary of key attributes of Iron stone gravels is provided in Table 10.

Table 10: Summary of the key attributes of the Ironstone Gravel SMU.

Representative Landscape of the Ironstone Gravels (Location 6)		
	ASC Name	*Tenosol / Dermosol*
	Landform	Gently undulating gravelly rises and midslopes forming lateritic uplands and erosional remnants. Soils developed over lateritic duricrust, ferricrete, and weathered saprolite.
	Surface Condition	Brown to reddish-brown sandy loam to clayey sand with 50–80 % ironstone gravel fragments. Surface is firm when moist and slightly hard-setting when dry; friable when disturbed.
	Dominant Vegetation	Grazing grasses
	Slope	2 – 8 % (gentle to moderate convex slopes).
	Site Drainage	Moderate to good; drainage variable due to gravel content and clayey subsoils. Minimal risk of seasonal waterlogging.
	Soil Depth	Shallow to moderately deep (0.6 – 1.0 m). Ironstone gravel layer begins within 10–20 cm
	Permeability	Moderate in surface and subsoil horizons; locally restricted where clayey duplex layers occur
	Chemical Properties	acidic to slightly acidic, non-saline, low fertility
	Soil Observations	Shallow profiles with weak to moderate structure; gravelly A-horizon 10–20 cm thick, grading to mottled clayey B-horizon or lateritic gravel zone

The Ironstone gravel profiles compromise of gravelly sands to clay loams with 50-80% coarse fragments. Depth of refusal ranged from shallow to moderately deep (0.5–0.8 m), with an ironstone gravel layer typically seen within 10–15 cm of the surface. The representative soil profile for the Ironstone gravels is Location 6, described in table 11.

Table 11: The soil profile of Location 6, representative of the Ironstone Gravel SMU.

Soil Profile Photograph	Horizon/ Depth (m)	Description
	**A1** 0 – 0.2	Yellow brown (10 YR 5/6) sand. Massive (apedal) structure. weak moderately moist consistence. Nil mottles. High (20-50%) coarse fragments. Abundant very fine roots. Clear boundary change to:
	B1t 0.20 – 0.60	Brown (7.5 YR 4/4) clayey sand. Massive (apedal) structure. Weak dry consistence. Nil mottles. High coarse fragments. Common very fine roots. Gradual smooth boundary change to:
	BC 0.60 – 0.70	Dark Yellowish Brown (10Y4/4) clayey sand. Massive (apedal) structure. Weak dry consistence. Nil mottles. Very high (50-90%) coarse fragments. No root growth.

The Ironstone gravel soils are strongly acidic to slightly acidic ($pH_{1:5}$ 5.7–6.7), non-saline (EC_{H2O} 0.01–0.07 dS/m), and non-sodic (ESP < 5 %). Organic carbon ranges 0.3–8.1%, with moderate total nitrogen and available phosphorus at surface (Colwell P 12-34 mg/kg). The physico-chemical properties representative of the Ironstone gravels is summarised in Table 12.

Table 12: Summary of the physio-chemical properties of the Ironstone Gravels (Location 6).

Analyte		Depth (m)			
		0–0.1	0.1-0.2	0.2-0.6	0.6-0.7
pHw (1:5)	Unit	5.9	5.9	6.2	6.0
	Rating	Slightly acidic	Slightly acidic	Slightly acidic	Slightly acidic
ECse	dS/m	0.04	0.02	0.01	0.02
	Rating	Non-saline	Non-saline	Non-saline	Non-saline
CEC	Meq/100g	3.22	1.45	0.92	1.04
	Rating	Very low	Very low	Very low	Very low
ESP	%	0.5	0.5	2.4	1.3
	Rating	Non-sodic	Non-sodic	Non-sodic	Non-sodic
Ca:Mg	Ratio	4	3.9	1.1	1.4
	Rating	Balanced	Balanced	Slightly Mg-dominant	Slightly Mg-dominant

5.3.2 SMU 2 – Wet soil

The wet soils occupy low-lying valley floors and drainage depressions. They correspond to the Wet and Semi-Wet Soil groups (WA Soil Groups 1107 and 1108) and align with the Hydrosol–Dermosol orders of the Australian Soil Classification. These soils occur where groundwater or perched saturation persists within 0.3–0.8 m of the surface for several months of the year.

Location 8 is likely to meet the criteria for a wet soil, however the observed water level recorded at 850 mm depth is just below the 800 mm threshold referenced in the Western Australian Soil Groups classification framework. The broader extent of wet soils was inferred using the waterlogging observations recorded during the Murdoch University assessment; however, the lack of measured water table depths in that dataset limits the precision of mapping.

A summary of key attributes for West soils is provided in Table 13 below.

Table 13: Summary of the key attributes of the Wet soils SMU.

Representative Landscape of the Wet soil (Location 3)		
	ASC Name	Hydrosol
	Landform	Broad valley-floor depressions and lower slopes receiving lateral throughflow from surrounding gravelly rises. Local relief < 5 m. These soils occupy drainage lines and wet zones that remain saturated for prolonged periods in winter and spring.
	Surface Condition	Dark grey-brown sandy loam to light clay, moist to saturated through winter. Surface soft when wet
	Dominant Vegetation	High grazing grasses, occasional Melaleuca
	Slope	1–3 % (nearly level to very gentle).
	Site Drainage	Imperfect to poor. Seasonal waterlogging within 0.3–0.8 m
	Soil Depth	> 80 cm overall, though effective rooting depth limited by seasonal saturation
	Permeability	Moderate in sandy surface horizons; slow below 40 cm. Evidence of temporary perching at A/B horizon interface.
	Chemical Properties	Slightly acidic, non-saline
	Soil Observations	Surface horizons contain abundant fine roots and occasional coarse fragments (<10 %)

Wet soil surface horizons consist of dark grey to brown sandy loam to light clay, which remain moist to saturated through winter and early spring. Subsoils display mottled grey, yellow and red colours indicative of seasonal waterlogging, with moderate blocky structure and occasional fine root channels. Iron and manganese segregations are common below 30 cm. Effective rooting depth is restricted by seasonal saturation and occasional dense clay horizons.

The representative soil profile for Wet soils is location 3, described in detail in table 14 below.

Table 14: The soil profile of Location 3, representative of the Wet soils SMU.

Soil Profile Photograph	Horizon/ Depth (m)	Description
	**O** 0 – 0.10	Black (10YR2/1) Sandy clay loam. Sub angular blocky structure. Weak wet consistence. Nil mottles. Moderate 10-20 % Coarse fragments. Abundant very fine roots. Clear boundary change to:
	A1 0.10 – 0.30	Very dark grey (10YR3/1) Light clay (fine sandy). Angular blocky structure. Strong wet consistence. Nil mottles. High 20-50% coarse fragments. Common very fine roots. Abrupt boundary change to:
	B2w 0.30 – 0.50	Light yellowish brown (10YR6/4) Light Clay (fine sandy). Angular blocky structure. Very firm wet consistence. Nil mottles. High 20-50% coarse fragments. No root growth. Gradual smooth boundary change to:
	BC 0.50 – 0.70	Yellowish brown (10YR5/4) light Medium Clay (fine sandy). Angular blocky structure. Strong wet consistence. Nil mottles. High (50-90%) coarse fragments. No root growth.

Chemically, the Wet soils are slightly acidic to acidic (pH 5.9–6.7), non-saline (EC < 0.1 dS/m), and exhibit moderate cation-exchange capacities (6–18 meq/100 g) that increase with clay content at depth. Exchangeable sodium percentages are low (< 2.5 %) at L3 but are elevated at L5 up to 15% at 600-650 depth, classifying them as non- to slightly sodic. The Ca:Mg ratio declines with depth, indicating potential magnesium enrichment in subsoils typical of prolonged wet conditions. Nutrient levels are generally low, with Colwell P < 17 mg/kg and organic C 1–3 %.

The physico-chemical properties representative of the Wet soils is summarised in Table 15.

Table 15: Summary of the physico-chemical measurements for the wet soils (Location 3).

Analyte		Depth (m)			
		0–0.1	0.2–0.3	0.3-0.4	0.7–0.8
pHw (1:5)	Unit	6.2	5.9	6.0	6.0
	Rating	Slightly acidic	Slightly acidic	Slightly acidic	Slightly acidic
ECse	dS/m	0.27	0.09	0.07	0.01
	Rating	Non-saline	Non-saline	Non-saline	Non-saline
CEC	Meq/100g	8.92	8.94	10.40	8.36
	Rating	Low	Low	Moderate	Low
ESP	%	0.8	2.5	1.2	0.9
	Rating	Non-sodic	Non-sodic	Non-sodic	Non-sodic
Ca:Mg	Ratio	1.6	0.4	0.3	0.2
	Rating	Slightly Mg-dominant	Mg-dominant	Mg-dominant	Mg-dominant

5.3.3 SMU 3 Shallow Sandy Soils

Shallow Sandy Soils occur on upper slopes and ridge crests, typically overlying lateritic or cemented layers within 30–60 cm of the surface. Profiles consist of pale grey to bleached sands with weak horizon development and minimal organic accumulation.

A summary of key attributes for Shallow sandy soils is provided below in Table 16.

Table 16: Summary of the key attributes of the Shallow sandy soils SMU.

Representative Landscape of the Shallow sandy soils (Location 7)	
ASC Name	Tenosol
Landform	Upland ridge crests and upper slopes forming broad, gently undulating interfluves above the ironstone gravels and wet valley floors.
Surface Condition	Pale grey to bleached quartz sand with very low cohesion and weak single-grain structure. Occasional lateritic pebbles
Dominant Vegetation	Stands of remanent Jarrah/Marri forest
Slope	2 – 5 % (gentle upper slopes).
Site Drainage	Rapid surface and subsurface drainage; minimal water retention. No seasonal waterlogging observed.
Soil Depth	Shallow (< 0.6 m) to moderately deep sands, overlying lateritic or cemented ferruginous hardpan at 40 – 60 cm depth.
Permeability	Rapid in the surface and subsurface horizons; impeded locally at the hardpan or duricrust interface.
Chemical Properties	Acidic, non-saline, low organic carbon
Soil Observations	Weak horizon development; A1 horizon 10–15 cm thick with minor organic matter, underlain by bleached A2 and a faint iron-stained B horizon. Hydrophobic when dry.

Surface textures of Shallow sandy soils are loose, single-grain sands with low cohesion and occasional hydrophobic behaviour following dry periods. Subsurface materials may include a cemented ferruginous or siliceous hardpan.

The representative soil profile for Shallow sandy soils is Location 7, presented in Table 17 below.

Table 17: The soil profile of Location 7, representative of the Shallow sandy soils SMU.

Soil Profile Photograph	Horizon/ Depth (m)	Description
	**A1** 0 – 0.15	Black (7.5YR2.5/1) Sand. Massive (apedal) structure. Weak moist consistence. Nil mottles. Low coarse (<2%) fragments. Common very fine roots. Abrupt boundary change to:
	A2 0.15 – 0.40	Light Brownish Grey (10YR6/2) Coarse sand. Massive (apedal) structure. Weak moist consistence. Nil mottles. Nil coarse fragments. Common fine roots. Abrupt boundary change to:
	AC 0.4	Pale Brown (10YRY6/3) Sand (coarse). Massive (apedal) structure. Weak moist consistence. Nil mottles. Low coarse (2-10%) fragments. No roots.

The soils are acidic (pH 4.7–6.0), non-saline, and low in fertility (Colwell P < 10 mg/kg, organic C < 3 %). Coarse fragments are sparse, but ironstone gravels/nodules may occur in the B horizon.

The physico-chemical properties representative of the Shallow sandy soils is summarised in Table 18.

Table 18: Summary of the physico-chemical measurements for the Shallow sandy soils (Location 7).

Analyte		Depth (m)			
		0–0.1	0.2–0.3	0.3-0.4	0.7–0.8
pHw (1:5)	Unit	6.0	5.7	6.0	5.9
	Rating	Slightly acidic	Slightly acidic	Slightly acidic	Slightly acidic
ECse	dS/m	0.03	0.02	<0.010	<0.010
	Rating	Non-saline	Non-saline	Non-saline	Non-saline
CEC	Meq/100g	2.48	1.36	0.58	0.56
	Rating	Very low	Very low	Very low	Very low
ESP	%	0.9	1.7	5.6	4.6
	Rating	Non-sodic	Non-sodic	Borderline sodic	Non-sodic
Ca:Mg	Ratio	2.7	2.2	0.4	0.12
	Rating	Balanced	Balanced	Mg-dominant	Mg-dominant

6 LAND CAPABILITY

Land capability refers to the ability of land to support a specified land use on a sustainable basis without causing land degradation.

Each Soil Mapping Unit (SMU) within the Study Area has been assessed for four key land uses under the Western Australian Land Capability Framework (Gool et al. 2005):

- Dryland Grazing (rainfed)
- Dryland Cropping (rainfed)
- Perennial Horticulture
- Annual Horticulture

The assessment draws upon land qualities based on soil morphological, chemical, and physical data collected from eight representative sites. The land qualities considered include soil water storage, rooting depth, surface soil structural stability, water erosion hazard, salinity, pH, and drainage.

The land qualities for each SMU were assessed and assigned a rating, and are presented below in Table 19.

Table 19: Land qualities assigned for each SMU.

Land quality /(capability subscript)	Land quality rating		
	SMU 1: Ironstone gravels (slopes 3-5%, SL_3)	SMU 2: Wet soils (poorly drained flat, FPD)	SMU 3: Shallow sandy soils (slopes 3-5%, SL_3)
Flood hazard (f)	L (Low)	L (Low; Moderate rainfall*)	L (Low)
Land instability (c)	N (Nil; <10% slopes)	N (Nil; <10% slopes)	N (Nil; <10% slopes)
pH 0-10cm (zf)	Mac (5.8-5.9)	Mac (6.1-6.3)	Mac (5.2-6.0)
pH 50-80cm (zg)	Slac (6.2-6.7)	Slac (6.0-6.7)	Mac (5.6-5.9)
Phosphorus export (n)	L (Low; Landform, hillside seeps)	VH (Very High; saturation + P mobility)	L (Low; Landform, hillside seeps)
Rooting depth (r)	M (50-80cm)	S (15-30cm)	M (50-80cm)
Salinity hazard (y)	NR (High positions in landscape)	PR (Low local relief)	NR (High positions in landscape)
Salt spray exposure (zi)	N (None)	N (None)	N (None)
Surface salinity (ze)	N (Nil; EC <15mS/m)	N (Nil; EC <15mS/m)	N (Nil; EC <15mS/m)
Site drainage potential (zh)	R (Nil; Moderately rapid/Landform)	MW (Low Slow-Moderate/Landform)	R (Nil; Moderately rapid/Landform)
Surface Soil Structure Decline (zb)	L (Low)	L (Low)	L (Low)
Soil water storage (m)	ML (Moderately low; Texture)	H (High; Texture)	ML (Moderately low; Texture)
Soil workability (k)	G (Good)	P (Poor, Waterlogging)	G (Good)
Subsurface acidification (zd)	M (Moderate)	M (Moderate)	H (High)
Subsurface compaction (zc)	L (Low)	H (High)	H (High)
Trafficability (zk)	G (Good)	P (Poor, Waterlogging)	G (Good)
Water erosion (e)	VL (Very Low)	L (low; potential sheet flow)	VL (Very Low)
Water repellence (za)	L (Low)	N (Nil)	N (Nil)
Waterlogging (l)	N (Nil)	H (High; slow to moderately slow permeability)	N (Nil)
Wind erosion (w)	L (Low; >50% coarse, loose, loamy sand)	M (Moderate; <20% coarse, loose, light sand)	H (High; <20% coarse, loose, light sand)

*Mean annual rainfall for Frankland Vineyards 594.2 mm BOM 1975-currenthttps://www.bom.gov.au/climate/averages/tables/cw_009843.shtml)

6.1 SMU 1 Ironstone Gravel Soils

The Ironstone Gravels have a capability class of 2 (High) for all four land uses. This corresponds to minor physical limitations impacting either productive land use and/or resulting in land degradation. A Class 2 rating indicates only minor physical limitations, which may influence productive land use or increase the risk of land degradation if not managed appropriately.

The specific land qualities influencing capability are summarised below.

Land Quality	Annual Horticulture	Perennial Horticulture	Grazing	Dryland Cropping
pH 0-10cm	2	2	2	2
pH 50-80cm	1	1	1	2
Rooting Depth	2	2	1	2
Surface Soil Structure Decline	-	-	2	2
Soil water storage (m)	1	1	2	2
Subsurface compaction	-	1	1	2
Overall Capability	2 (High)	2 (High)	2 (High)	2 (High)

Overall, these soils exhibit favourable drainage, moderate to good rooting depth, and stable surface structure, although their low water-holding capacity and shallow gravelly profiles remain notable constraints.

Across all land uses, surface pH, subsoil pH, and rooting depth present minor limitations (Class 2). Grazing and dryland cropping are moderately constrained by surface soil structure decline, while soil water storage and subsurface compaction represent minor constraints for cropping and horticulture. Despite these factors, none of the limitations are severe enough to reduce capability below Class 2.

The combined assessment results in an overall High capability (Class 2) for each land use, indicating that the Ironstone Gravel Soils are generally well suited to agriculture and horticulture.

6.2 SMU2 Wet soils

The Wet soils have varying capability classes ranging from 3 (Fair) for use in grazing to 5 (Very low) for perennial horticulture and dryland cropping. This corresponds to moderate to severe limitations impacting productive land use and/or resulting in land degradation.

The specific land qualities influencing capability ratings for Wet Soils are summarised below:

Land Quality	Annual Horticulture	Perennial Horticulture	Grazing	Dryland Cropping
Flood Hazard	1	2		
pH 0-10cm	2	2	2	2
pH 50-80cm	1	1	1	2
Phosphorus export	4	3	3	3
Rooting Depth	3	5	3	5
Salinity Hazard	3	3	2	3
Site Drainage Potential	1	2	-	-
Surface Soil Structure Decline	-	-	2	2
Soil water storage (m)	1	1	2	2
Soil Workability	4	3	1	4
Subsurface acidification	-	-	1	2
Subsurface compaction	-	1	1	2
Trafficability	3	3	2	4
Water erosion	2	1	1	2
Waterlogging	4	5	3	4
Wind Erosion	2	2	2	2
Overall Capability	4 (Low)	5 (Very low)	3 (Fair)	5 (Very Low)

The dominant constraints relate to poor drainage, seasonal to prolonged waterlogging, and restricted effective rooting depth, all of which limit both agricultural and horticultural suitability.

Additional limitations affecting capability include elevated phosphorus export risk, reduced soil workability, low trafficability, and moderate salinity hazard in some subsoil layers. These factors collectively restrict the range of viable land uses and reduce the capacity of these soils to support intensive or deep-rooted crops. While grazing is feasible under controlled stocking and season management, more intensive land uses such as perennial horticulture and broadacre cropping are considered unsuitable due to the high likelihood of saturation-induced soil degradation.

6.3 SMU 3: Shallow sands

The Shallow sands have varying capability classes ranging from 2 (High) for use in perennial horticulture to 5 (Very low) for dryland cropping. This corresponds to moderate to severe limitations significantly impacting productive land use and/or resulting in land degradation. These classifications reflect moderate to severe physical limitations that constrain productive land use and increase the risk of land degradation if not carefully managed.

The limiting factors identified by the capability assessments are summarised below.

Land Quality	Annual Horticulture	Perennial Horticulture	Grazing	Dryland Cropping
Flood Hazard	1	2	1	1
pH 0-10cm	2	2	2	2
pH 50-80cm	2	2	2	2
Rooting Depth	2	2	3	5
Soil water storage (m)	1	1	2	2
Subsurface acidification	-	-	2	3
Subsurface compaction	-	2	2	2
Wind Erosion	3	2	3	1
Overall Capability	4 (Fair)	2 (High)	3 (Fair)	5 (Very Low)

The primary limiting factors include shallow effective rooting depth, low soil water-holding capacity, high susceptibility to wind erosion, and vulnerability to subsurface acidification. These constraints collectively limit the soil's ability to support deep-rooted crops and reduce resilience under intensive land use.

The capability assessment indicates that perennial horticulture is relatively well supported by these soils due to adaptability to shallow, well-drained profiles, while annual horticulture and grazing are Fair (Class 4 and Class 3) respectively, reflecting moderate limitations that may be managed with appropriate practices such as soil amelioration and groundcover maintenance. In contrast, dryland cropping is rated Very Low (Class 5), largely due to the combined effects of shallow soil depth and low water storage, which severely restrict crop rooting depth and increase production risk under rainfed conditions.

6.4 Land capability for commercial pine plantations

Under the DPIRD Western Australian land evaluation standards, a specific assessment is included for commercial pine plantations. This is a generic regional level assessment which provides a set of ideal soils, with reference to soil type and zone-specific adjustments. This section of the guideline refers to the previous Western Australian soil diagnostic key (DPIRD, 2013) instead of the most recently updated Western Australian Soil Groups (DPIRD,2024) included in the previous land capability assessments.

The resulting land capability for commercial pine plantations based on the WA soil groups found across the survey area is presented in Table 20.

Table 20: Land capability for pine plantations for the soil types and soil landscape mapping zone over the Study Area.

WA super group	WA soil group (2024)	Soil Groups of WA (2013)	Sites	Suitability for Pine Plantations	Approximate Proportion of Study Area (%)
Wet or Saline Soils	Semi-wet soil (1108)	Semi-Wet soil (103)	3	Not suitable	48
	Wet soil (1107)	Wet soil (105)	5	Not suitable	
Ironstone Gravel Soils	Loamy gravel (1215)	Loamy gravel (303)	1, 2, 4, 6	Suitable	52
Shallow Sandy Soils	Pale shallow sand (1405)	Pale Deep sand (444)	7, 8	Suitable	

7 CONCLUSION

This investigation has provided a detailed, site-specific land capability assessment for Lot 12667 Muir Highway, Frankland River. A total of three SMUs were identified across the Study Area, including:

- Ironstone gravel soils
- Wet soil; and
- Shallow sands.

The land capability assessments applied to all SMUs have identified specific limiting factors that may impact the capability of the land with respect to all four agricultural land uses.

Soils are generally acidic and non-saline, with low to very low cation exchange capacities and low fertility, typical of the Frankland district. Seasonal waterlogging is a prominent constraint in low-lying positions.

Under the Western Australian land capability framework, the Ironstone Gravel Soils display high capability for all four standard land uses. Wet Soils are more constrained, with capability ratings ranging from fair (for managed grazing) to very low (for perennial horticulture and dryland cropping) due to waterlogging and poor trafficability. Shallow sandy soils offer high capability for perennial horticulture, but only fair to very low capability for grazing and cropping, primarily due to shallow rooting depth and potential for subsurface acidification.

When assessed specifically for commercial pine plantations, only a subset of soil groups within the Study Area meet DPIRD's suitability criteria. Loamy gravels and pale shallow sands are considered suitable for *P. radiata*, whereas semi-wet and wet soils, and sandy acid duplex/duplex sandy gravels, are assessed as unsuitable.

In practical terms, a plantation could only be sustainably established on discrete portions of the property, with substantial areas unsuitable.

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Site Information

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	25.10.25	Peter Dubbelman	1	Soil pit	483667	50	Tenosol

Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	North
Northing/ Longitude	6188367
Scale	
ASC Ground Truth	Tenosol
Secondary Vegetation Form	Woody
Ground Cover %	Isolated Clumps (<0.2%)
Slope %	5
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	
Drainage (site)	Moderately well-drained
Erosion Extent	None evident
Landform	Upper slope
Soil Surface Condition (dry)	Firm
Land Use	Grazing
Erosion State	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Other Information: WA soils groups; Ironstone Gravel Soils > loamy gravel (1215)

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-100		Abrupt	Clayey Sand	10YR2/2		2-10 % Organic	20-50 % 6-20 mm	Apedal	Massive	Strong (moderately moist)	Abundant (>200) Very fine (<1 mm)	6.0	52.0	0-100
A2	100-200		Clear	Loamy Sand	10YR3/3			10-20 % 6-20 mm	Apedal	Massive	Loose (moderately moist)	Many (25-200) Very fine (<1 mm)	6.0	19.0	100-200
B2	200-300		Gradual	Loamy Sand	7.5YR4/6			20-50 % 6-20 mm	Apedal	Massive	Weak (dry)	Common (10-25) Very fine (<1 mm)	6.0	17.0	200-300
BC	300		Gradual	Loamy Sand	10YR5/6			50-90 % 20-60 mm	Apedal	Massive	Weak (dry)	No roots (0) Not recorded	6.0	16.0	300-400

Other information: Depth of refusal 425 high gravel content

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	25.10.25	Peter Dubbelman	2	Soil pit	483898	50	Tenosol

Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	South
Northing/ Longitude	6186643
Scale	
ASC Ground Truth	Tenosol
Secondary Vegetation Form	Woody
Ground Cover %	Very sparse (0.2-10%)
Slope %	10
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	
Drainage (site)	Moderately well-drained
Erosion Extent	None evident
Landform	Mid-slope
Soil Surface Condition (dry)	Firm
Land Use	Grazing
Erosion State	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: WA soils groups; Ironstone Gravel Soils > Sandy acid duplex gravel (1204)

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-150		Abrupt	Clayey Sand	10YR2/2		2-10 % Iron-Organic Matter	2-10 % 2-6 mm	Apedal	Massive	Weak (moderately moist)	Abundant (>200) Fine (1-2 mm)	5.0	38.0	0-100,
B21	150-250		Abrupt	Sandy Clay Loam	10YR6/3		2-10 % Iron	10-20 % 2-6 mm	Polyhedral	Weak	Weak (moderately moist)	Few (1-10) Very fine (<1 mm)	5.0	15.0	150-250
B2r	250-500		Gradual	Sandy Clay Loam	2.5Y6/3		2-10 % Clayey	10-20 % 2-6 mm	Polyhedral	Weak	Strong (dry)	No roots (0)	5.5	17.0	300-400
BC	500-650		Abrupt	Sand (coarse)	10YR6/6		10-20 % Clayey	20-50 % 20-60 mm	Polyhedral	Moderate	Very strong (dry)	No roots (0)	5.5	21.0	500-650

Other information: Increasing Coarse fragments with depth, depth of refusal 675

Soil Profile Description

Project	2611.25a
Date	25.10.25
Scribe	Peter Dubbelman
Location	3
Observation	Soil pit
Easting/ Latitude	483753
Zone	50
ASC Mapped	Dermosol
Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	South
Northing/ Longitude	6187395
Scale	
ASC Ground Truth	Dermosol
Secondary Vegetation Form	Woody
Ground Cover %	Very sparse (0.2-10%)
Slope %	1
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	Nearby Malaleucas
Drainage (site)	Imperfectly drained
Erosion Extent	None evident
Landform	Open depression
Soil Surface Condition (dry)	Soft
Land Use	Grazing
Erosion State	None evident
Site Type	Detailed + Sampled for Lab
Microrelief	
Type	
Vertical (m)	
Horizontal (m)	
Sampled	
Other Information:	WA soils groups; Wet or Saline soils > Semi-wet (1108)

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
O	0-100		Clear	Sandy Clay Loam	10YR2/1		10-20 % Organic	10-20 % 6-20 mm	Subangular blocky	Moderate	Weak (wet)	Abundant (>200) Fine (1-2 mm)	5.5	251.0	0-100
A1	100-300		Clear	Light Clay (fine sandy)	10YR3/1		10-20 % Iron-Organic Matter	20-50 % 6-20 mm	Angular blocky	Moderate	Strong (wet)	Common (10-25) Very fine (<1 mm)	4.5	82.0	100-200
B2	300-500		Abrupt	Light Clay (fine sandy)	10YR6/4	oxidation of iron red to yellow	10-20 % Iron	20-50 % 6-20 mm	Angular blocky	Moderate	Very firm (wet)	No roots (0)	5.5	63.0	300-400
BC	500-700		Gradual	Light Medium Clay (fine sandy)	10YR5/4		10-20 % Iron	50-90 % 6-20 mm	Angular blocky	Moderate	Strong (wet)	No roots (0)	6.0	91.0	700-800

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	25.10.25	Peter Dubbelman	4	Soil pit	483667	50	Dermosol

Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	North
Northing/ Longitude	6188367
Scale	
ASC Ground Truth	Dermosol
Secondary Vegetation Form	Woody
Ground Cover %	Isolated Clumps (<0.2%)
Slope %	0
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	
Drainage (site)	Moderately well-drained
Erosion Extent	None evident
Landform	Upper slope
Soil Surface Condition (dry)	Soft
Land Use	Grazing
Erosion State	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: WA soils groups; Ironstone gravel soils > Loamy gravel (1215)

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A	0-150		Abrupt	Sandy Loam	10YR3/2		2-10 % Organic	10-20 % 6-20 mm	Apedal	Massive	Firm (moderately moist)	Abundant (>200) Very fine (<1 mm)	5.5	17.0	0-150
B2	150-600		Clear	Sandy Loam	10YR4/4			20-50 % 6-20 mm	Polyhedral	Moderate	Firm (moderately moist)	Common (10-25) Fine (1-2 mm)	5.5	15.0	150-300, 300-600
BC	600-700		Gradual	Sandy Clay Loam	10YR5/6		10-20 % Iron-manganese	50-90 % 6-20 mm	Polyhedral	Moderate	Loose (moderately moist)	No roots (0)	5.0	20.0	600-700

Other information: Refusal in gravel layer ~750

Soil Profile Description

Project 2611.25a	**Date** 25.10.25	**Scribe** Peter Dubbelman	**Location** 5	**Observation** Soil pit	**Easting/ Latitude** 485955	**Zone** 50	**ASC Mapped** Hydrosol

Dominant Vegetation Form Non-woody | **Ground Cover %** Dense (>70%) | **Aspect** South | **Northing/ Longitude** 6188057 | **Scale** | **ASC Ground Truth** Hydrosol

Secondary Vegetation Form Woody | **Ground Cover %** Isolated Plants (<0.2%) | **Slope %** 2 | **Rock Outcrop** No rock outcrop | **Erosion Type** None evident

Vegetation (species) Naerby malaleucas | **Drainage (site)** Very poorly drained | **Erosion Extent** None evident

Landform Lower slope | **Soil Surface Condition (dry)** Soft | **Land Use** Grazing | **Erosion State**

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: WA soils groups; Wet or saline soils soils > Wet soil (1107)

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-100		Clear	Sand	10YR3/1		2-10 % Organic	<2 % 2-6 mm	Apedal	Massive	Weak (wet)	Abundant (>200) Fine (1-2 mm)	5.0	66.0	0-100, 100-300
A2	100-600		Gradual	Sand (coarse)	10YR4/1		Organic	<2 % 2-6 mm	Apedal	Massive	Weak (wet)	No roots (0) Not recorded	6.0	38.0	300-600
A3	600-650		Abrupt	Sand (coarse)	10YR5/2		Other	20-50 % 6-20 mm	Apedal	Massive	Weak (wet)	No roots (0) Not recorded	6.0	33.0	600-650

Other information: Water ponding on surface 20m downhill, hydrosol. water encountered at 150mm. Increasing coarse fragment with depth, root stop at 75mm

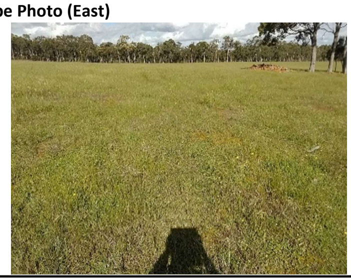
Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	**25.10.25**	Peter Dubbelman	6	Soil pit	484889	50	Tenosol

Dominant Vegetation Form Non-woody	**Ground Cover %** Dense (>70%)	**Aspect** South	**Northing/ Longitude** 6188242	**Scale**	**ASC Ground Truth** Tenosol
Secondary Vegetation Form Woody	**Ground Cover %** Isolated Plants (<0.2%)	**Slope %** 5	**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species)			**Drainage (site)** Well-drained	**Erosion Extent** None evident	
Landform Upper slope	**Soil Surface Condition (dry)** Firm		**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)



Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Other Information: WA soils groups; WA soils groups; Ironstone gravel soils > Sandy acid duplex gravel (1204)

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-200		Clear	Sand	10 YR 5/6		<2 % Organic	20-50 % 6-20 mm	Apedal	Massive	Weak (moderately moist)	Abundant (>200) Very fine (<1 mm)	5.0	21.0	0-100, 100-200
B1	200-600		Gradual	Clayey Sand	7.5YR4/4		Unidentified	20-50 % 6-20 mm	Apedal	Massive	Weak (dry)	Common (10-25) Very fine (<1 mm)	4.5	20.0	200-600
BC	600-700		Gradual	Clayey Sand	10YR4/4		Unidentified	50-90 % 20-60 mm	Apedal	Massive	Weak (dry)	No roots (0)	4.5	15.0	600-700

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	25.10.25	Peter Dubbelman	7	Soil pit	486644	50	Tenosol

Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	South
Northing/ Longitude	6188411
Scale	
ASC Ground Truth	Tenosol
Secondary Vegetation Form	Woody
Ground Cover %	Isolated Plants (<0.2%)
Slope %	7
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	
Drainage (site)	Moderately well-drained
Erosion Extent	None evident
Landform	Upper slope
Soil Surface Condition (dry)	Firm
Land Use	Grazing
Erosion State	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: WA soils groups; Shallow sand soils > Pale shallow sand (1405)

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-150		Abrupt	Sand	10YR2.5/2		<2 % Organic	<2 % 2-6 mm	Apedal	Massive	Weak (moist)	Many (25-200) Fine (1-2 mm)	5.0	23.0	0-100,
A	150-400		Clear	Sand (coarse)	7.5YR2.4/4			2-10 % 6-20 mm	Apedal	Massive	Weak (moist)	Common (10-25) Very fine (<1 mm)	4.0	14.0	100-300, 300-400
BC	400		Abrupt	Sand (coarse)	10YR4/4			2-10 % 6-20 mm	Apedal	Massive	Weak (moist)	No roots (0)	4.0	10.0	400-500

Other information: Increasing coarse fragment with depth, refusal at 500mm depth

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
2611.25a	25.10.25	Peter Dubbelman	8	Soil pit	483910	50	Tenosol

Dominant Vegetation Form	Non-woody
Ground Cover %	Dense (>70%)
Aspect	South
Northing/ Longitude	6188095
Scale	
ASC Ground Truth	Tenosol
Secondary Vegetation Form	Woody
Ground Cover %	Isolated Plants (<0.2%)
Slope %	5
Rock Outcrop	No rock outcrop
Erosion Type	None evident
Vegetation (species)	
Drainage (site)	Moderately well-drained
Erosion Extent	None evident
Landform	Lower slope
Soil Surface Condition (dry)	Firm
Land Use	Grazing
Erosion State	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Shallow sand soils > Pale shallow sand (1405), Water level too low for hydrosol classification.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (µS/m)	Depth of Sample for Lab (mm)
A1	0-150		Gradual	Sand	7.5yr2.5/1		Organic	<2 % 2-6 mm	Apedal	Massive	Loose (moderately moist)	Abundant (>200) Very fine (<1 mm)	4.5	38.0	0-100
A	150-600		Gradual	Sand	2.5Y4/1			<2 % 6-20 mm	Apedal	Massive	Very weak (moderately moist)	Common (10-25) Very fine (<1 mm)	4.5	23.0	100-300, 300-600
A2	600-850		Gradual	Sand (coarse)	10YR6/3		2-10 % Iron	2-10 % 6-20 mm	Apedal	Massive	Weak (moist)	No roots (0)	5.0	27.0	700-850

Other information: Water encountered at 850mm, coarse fragments increasing with depth, refusal at 850mm depth

APPENDIX B: LABORATORY DATA

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Eurofins APAL

Eurofins APAL									TMs-004A	TMs-004B4	TMs-006A	TMs-046	TMs-009B	TMs-017B	TMs-018	TMs-010D	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015C1	TMs-015G	TMs-015G	TMs-015G	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-Cal02	TMs-005	TMs-003	TMs-012C	TMs-012A	TMs-012A	TMs-012A	TMs-012A	TMs-007	TMs-003	TMs-046	TMs-046	TMs-046	TMs-002A1	TMs-002A1
SubmissionID	SamplingDate	BatchID	Batch Position No.	AgentName	Client Name	SampleName	Barcode	SampleDepth	pH 1:5 water	pH CaCl2 (following 4A1)	Organic Carbon (W&B)	MIR - Aus Soil Texture	Colwell Phosphorus	Total Phosphorus	Colwell Potassium	KCl Sulfur (S)	Calcium (Ca) - prewash alc. pH 8.5 NH4Cl	Magnesium (Mg) - prewash alc. pH 8.5 NH4Cl	Potassium (K) - prewash alc. pH 8.5 NH4Cl	Sodium (Na) - prewash alc. pH 8.5 NH4Cl	Calcium (Ca) - prewash alc. pH 8.5 NH4Cl	Magnesium (Mg) - prewash alc. pH 8.5 NH4Cl	Potassium (K) - prewash alc. pH 8.5 NH4Cl	Sodium (Na) - prewash alc. pH 8.5 NH4Cl	Ca:Mg ratio	K:Mg ratio	GTRI	ECR	Exchangeable acidity	Exchangeable aluminium	Exchangeable hydrogen	ECEC	Calcium	Magnesium	Potassium	Sodium	Aluminium	Hydrogen	Chloride	Salinity EC 1:5	Boron	Iron (Fe)	Manganese (Mn)	Copper (Cu)	Zinc (Zn)	Dumas Total Nitrogen	TDS	MIR - Clay	MIR - Sand (+20 micron)	MIR - Silt (2-20 micron)	% Air-dry Moisture Content	Gravimetric water content of air dried fine fraction
									pH units	pH units	% (40°C)		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol/kg	cmol/kg	cmol/kg	cmol/kg				%	cmol/kg	cmol/kg	cmol/kg	cmol/kg	%	%	%	%	%	%	mg/kg	dS/m	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	% dry wt	mg/L	% w/w	% w/w	% w/w	% of dry wt	g/g
146409	2025-10-29	####	1	Landloch - Peter Dubbelman	Landloch	CB01	1E+08	0-10	5.95	5.06	7.1	Loamy sand	33	493	110	4.7	453	55.6	44.8	<6.0	2.26	0.457	0.115	<0.020	4.9	0.25		4.5	0.11	0.05	0.05	2.95	76.6	15.5	3.9	0.4	1.8	1.8	31	0.067	0.57	49	3.1	0.5	0.68	0.43	43	5.7	83.8	10.4	2.4	0.0235
146409	2025-10-29	####	2	Landloch - Peter Dubbelman	Landloch	CB02	1E+08	10-20	5.96	4.98	4.02	Loamy sand	18	299	56	5.1	401	82.5	44.4	6	2	0.679	0.114	0.026	3	0.17		4.9	0.13	0.08	0.04	2.95	68	23	3.9	0.9	2.8	1.5	8	0.031	0.41	43	1.1	0.22	0.25	0.24	20	7.2	79	13.9	1.7	0.0167
146409	2025-10-29	####	3	Landloch - Peter Dubbelman	Landloch	CB03	1E+08	20-30	5.87	4.85	1.21	Loamy sand	7.1	165	<25	5	99	28	19.1	<6.0	0.496	0.23	0.049	<0.020	2.2	0.21		7.4	0.25	0.19	0.06	1.04	47.7	22.2	4.7	0.9	19	5.8	<5	0.022	0.27	21	<0.3	<0.08	0.09	0.049	14	6.5	84	9.6	0.7	0.0066
146409	2025-10-29	####	4	Landloch - Peter Dubbelman	Landloch	CB04	1E+08	30-40	5.94	4.85	0.74	Loamy sand	<5.0	147	<25	3.8	66	28.1	16.9	<6.0	0.328	0.231	0.043	<0.020	1.4	0.19		8.9	0.19	0.14	0.06	0.81	40.6	28.6	5.3	1.4	17	6.8	6	0.017	0.21	14	<0.3	<0.08	0.13	<0.030	11	7.9	80.3	11.8	0.5	0.0054
146409	2025-10-29	####	5	Landloch - Peter Dubbelman	Landloch	CB05	1E+08	0-10	5.75	4.8	4.07	Loamy sand	21	313	43	4.5	302	77.7	36.1	<6.0	1.51	0.639	0.092	0.022	2.4	0.14		5	0.31	0.22	0.09	2.57	58.7	24.9	3.6	0.9	8.6	3.4	<5	0.05	0.45	61	6.6	0.6	0.37	0.37	32	4.5	85.1	10.3	1.4	0.0137
146409	2025-10-29	####	6	Landloch - Peter Dubbelman	Landloch	CB06	1E+08	15-25	6.16	5.01	0.42	Loamy sand	<5.0	75	<25	<2.5	101	34.5	29.8	<6.0	0.505	0.284	0.076	<0.020	1.8	0.27		9.6	<0.02	<0.02	<0.02	0.87	57.9	32.5	8.7	0.9	0	0	8	0.017	0.21	22	0.3	<0.08	0.08	<0.030	11	8.4	83	8.6	0.4	0.0035
146409	2025-10-29	####	7	Landloch - Peter Dubbelman	Landloch	CB07	1E+08	30-40	6.37	5.23	0.45	Sandy loam	<5.0	83	<25	3	118	48.7	17	<6.0	0.591	0.401	0.044	<0.020	1.5	0.11		4.9	<0.02	<0.02	<0.02	1.04	56.7	38.4	4.2	0.8	0	0	<5	0.014	0.3	8.1	<0.3	<0.08	<0.08	<0.030	9	11	82.4	6.6	0.3	0.0033
146409	2025-10-29	####	8	Landloch - Peter Dubbelman	Landloch	CB08	1E+08	50-65	6.69	5.8	0.26	Clay loam	<5.0	143	<25	22	112	68.7	23	<6.0	0.561	0.565	0.059	<0.020	1	0.1		5.8	<0.02	<0.02	<0.02	1.2	46.9	47.3	4.9	0.9	0	0	10	0.021	0.5	4.1	<0.3	<0.08	<0.08	<0.030	14	26.5	63.8	9.7	0.6	0.0056
146409	2025-10-29	####	9	Landloch - Peter Dubbelman	Landloch	CB09	1E+08	0-10	6.16	5.4	3.19	Sandy loam	16	200	53	3.3	1060	414	62.2	16	5.29	3.4	0.159	0.07	1.6	<0.05		2.6	<0.02	<0.02	<0.02	8.92	59.3	38.1	1.8	0.8	0	0	340	0.27	0.95	200	8.4	0.61	0.96	0.22	170	10.4	77	12.6	1.8	0.0181
146409	2025-10-29	####	10	Landloch - Peter Dubbelman	Landloch	CB10	1E+08	10-20	5.87	4.52	2.11	Sandy clay loam	<5.0	135	41	4.3	470	647	65.7	51.7	2.35	5.32	0.168	0.225	0.4	<0.05		4.9	0.87	0.78	0.09	8.94	26.3	59.6	1.9	2.5	8.7	1.1	56	0.092	0.93	240	2.4	0.08	0.15	0.089	59	23.2	68.6	8.1	2.1	0.0205
146409	2025-10-29	####	11	Landloch - Peter Dubbelman	Landloch	CB11	1E+08	30-40	5.96	4.55	0.75	Sandy clay loam	<5.0	89	68	4.3	377	919	43.6	28.9	1.88	7.56	0.112	0.126	0.3	<0.05		2.5	0.72	0.63	0.09	10.4	18.1	72.7	1.1	1.2	6.1	0.9	54	0.072	0.8	100	0.7	<0.08	0.11	0.053	46	25.8	69.8	4.4	1.7	0.017
146409	2025-10-29	####	12	Landloch - Peter Dubbelman	Landloch	CB12	1E+08	70-80	6.03	4.8	0.32	Sandy clay loam	<5.0	71	<25	4.9	234	855	35.2	16.5	1.17	7.03	0.09	0.072	0.2	<0.05		1.9	<0.02	<0.02	<0.02	8.36	14	84.1	1.1	0.9	0	0	110	0.099	0.62	42	<0.3	<0.08	<0.08	<0.030	63	21.3	76	2.7	1.3	0.0128
146409	2025-10-29	####	13	Landloch - Peter Dubbelman	Landloch	CB13	1E+08	0-15	5.74	4.56	3.92	Loamy sand	11	227	26	<2.5	72	34.3	27	<6.0	0.36	0.282	0.069	<0.020	1.3	0.24		11	0.93	0.89	0.04	1.65	21.8	17.1	4.2	0.6	54	2.7	11	0.03	0.27	130	4.8	0.27	0.12	0.22	19	8.5	73.1	18.4	1.9	0.0188
146409	2025-10-29	####	14	Landloch - Peter Dubbelman	Landloch	CB14	1E+08	15-30	5.99	4.75	1.43	Loamy sand	<5.0	107	<25	<2.5	63	<10.0	9.3	<6.0	0.312	<0.080	0.024	<0.020	<0.1	<0.05		3.3	0.4	0.33	0.07	0.69	45.5	<0.2	3.5	<0.2	47	11	10	0.024	0.25	77	1.5	0.18	<0.08	0.069	15	7.7	81.8	10.5	0.8	0.0084
146409	2025-10-29	####	15	Landloch - Peter Dubbelman	Landloch	CB15	1E+08	30-60	6.37	5.07	0.64	Sandy loam	<5.0	67	<25	<2.5	60	45.5	16.6	<6.0	0.298	0.374	0.043	<0.020	0.8	0.11		7.2	<0.02	<0.02	<0.02	0.73	41.1	51.6	5.9	1.4	0	0	<5	0.021	0.2	23	<0.3	0.1	<0.08	<0.030	13	17.7	75.6	6.7	0.4	0.0044
146409	2025-10-29	####	16	Landloch - Peter Dubbelman	Landloch	CB16	1E+08	60-70	6.5	5.12	0.66	Clay loam	<5.0	154	26	2.6	100	91.1	26.7	<6.0	0.498	0.749	0.068	<0.020	0.7	0.09		5.3	<0.02	<0.02	<0.02	1.32	37.8	56.9	5.2	<0.2	0	0	13	0.028	0.36	20	0.4	0.2	<0.08	<0.030	18	27.7	63	9.3	0.8	0.0079
146409	2025-10-29	####	17	Landloch - Peter Dubbelman	Landloch	CB17	1E+08	0-10	6.26	4.91	1.03	Sand	<5.0	39	<25	3.7	161	67.3	11.9	<6.0	0.802	0.554	0.03	0.024	1.4	0.06		3.8	<0.02	<0.02	<0.02	1.41	56.9	39.3	2.2	1.7	0	0	54	0.064	0.11	83	0.9	0.15	0.09	0.045	41	3.5	89.7	6.8	0.3	0.0026
146409	2025-10-29	####	18	Landloch - Peter Dubbelman	Landloch	CB18	1E+08	10-30	6.27	4.95	0.48	Sand	<5.0	20	<25	2.8	29	52.9	16	8.4	0.146	0.435	0.041	0.037	0.3	0.09		12	<0.02	<0.02	<0.02	0.66	22.1	66.1	6.2	5.5	0	0	37	0.041	<0.10	25	<0.3	<0.08	<0.08	<0.030	26	2.9	90.8	6.3	0.1	0.0011
146409	2025-10-29	####	19	Landloch - Peter Dubbelman	Landloch	CB19	1E+08	30-60	6.33	5.16	0.23	Sand	<5.0	15	<25	<2.5	14	41.3	17	7.6	0.071	0.34	0.044	0.033	0.2	0.13		16	<0.02	<0.02	<0.02	0.49	14.5	69.7	8.9	6.8	0	0	28	0.034	<0.10	7.2	<0.3	<0.08	<0.08	<0.030	22	1.4	94.7	3.8	<0.1	<0.001
146409	2025-10-29	####	20	Landloch - Peter Dubbelman	Landloch	CB20	1E+08	60-65	6.65	5.28	0.19	Sand	<5.0	14	<25	<2.5	<10	27.2	17.3	12.2	<0.050	0.224	0.044	0.053	0.2	0.2		27	<0.02	<0.02	<0.02	0.36	11.3	61.8	12	15	0	0	28	0.029	<0.10	8.7	<0.3	<0.08	<0.08	<0.030	18	1	95.4	3.6	<0.1	<0.001
146409	2025-10-29	####	21	Landloch - Peter Dubbelman	Landloch	CB21	1E+08	0-10	5.86	4.93	8.07	Loamy sand	20	342	60	3	477	71.6	36.5	<6.0	2.38	0.589	0.093	<0.020	4	0.16		3.5	0.15	0.08	0.07	3.22	73.8	18.3	2.9	0.5	2.4	2.1	11	0.044	0.48	45	6.5	1.7	0.77	0.36	28	5.2	85.1	9.7	2.5	0.0248
146409	2025-10-29	####	22	Landloch - Peter Dubbelman	Landloch	CB22	1E+08	10-20	5.9	4.75	2.37	Loamy sand	<5.0	133	32	2.5	194	30.5	17.8	<6.0	0.969	0.251	0.046	<0.020	3.9	0.18		4.1	0.18	0.12	0.06	1.45	66.8	17.3	3.1	0.5	8	4.3	<5	0.02	0.28	32	1.5	0.22	0.13	0.085	13	5.6	86.4	8.1	1	0.0098
146409	2025-10-29	####	23	Landloch - Peter Dubbelman	Landloch	CB23	1E+08	20-60	6.2	4.96	0.71	Sand	<5.0	99	<25	<2.5	91	48	18.1	<6.0	0.453	0.395	0.046	0.022	1.1	0.12		7.5	<0.02	<0.02	<0.02	0.92	49.4	43.1	5.1	2.4	0	0	5	0.012	0.15	8.8	<0.3	0.08	<0.08	<0.030	8	5.5	89.7	4.8	0.4	0.0044
146409	2025-10-29	####	24	Landloch - Peter Dubbelman	Landloch	CB24	1E+08	60-70	6.17	4.96	0.87	Loamy sand	<5.0	135	<25	<2.5	115	48.8	20.3	<6.0	0.573	0.401	0.052	<0.020	1.4	0.13		6.3	<0.02	<0.02	<0.02	1.04	55.1	38.6	5	1.3	0	0	<5	0.016	0.18	12	0.4	0.12	<0.08	<0.030	10	6.7	86.3	7.1	0.7	0.0071
146409	2025-10-29	####	25	Landloch - Peter Dubbelman	Landloch	CB25	1E+08	0-10	6.04	4.66	2.62	Sand	<5.0	108	47	<2.5	347	77.8	34.6	<6.0	1.73	0.64	0.089	0.023	2.7	0.14		4.5	<0.02	<0.02	<0.02	2.48	69.7	25.8	3.6	0.9	0	0	12	0.03	0.18	16	7	0.45	0.62	0.16	19	1.9	92.5	5.6	0.5	0.0055
146409	2025-10-29	####	26	Landloch - Peter Dubbelman	Landloch	CB26	1E+08	10-30	5.71	4.14	1.08	Sand	<5.0	38	<25	<2.5	139	38.8	14.4	<6.0	0.693	0.319	0.037	0.024	2.2	0.12		5.6	0.29	0.18	0.11	1.36	50.9	23.5	2.7	1.7	13	8.2	<5	0.016	<0.10	8.5	1.9	<0.08	0.08	0.032	10	2.1	92.8	5.1	0.2	0.0024
146409	2025-10-29	####	27	Landloch - Peter Dubbelman	Landloch	CB27	1E+08	30-40	5.97	4.34	0.29	Sand	<5.0	16	<25	<2.5	25	33.9	15.6	7.4	0.123	0.279	0.04	0.032	0.4	0.14		15	0.1	0.04	0.06	0.58	21.4	48.5	6.9	5.6	7	11	5	<0.010	<0.10	2.4	<0.3	<0.08	<0.08	<0.030	<6	2.2	94.5	3.3	<0.1	<0.001
146409	2025-10-29	####	28	Landloch - Peter Dubbelman	Landloch	CB28	1E+08	40-50	5.92	4.46	0.34	Sand	<5.0	18	<25	<2.5	26	31.1	11.8	6	0.131	0.256	0.03	0.026	0.5	0.12		13	0.12	0.06	0.06	0.56	23.3	45.3	5.3	4.6	11	11	<5	<0.010	<0.10	6.8	<0.3	<0.08	<0.08	<0.030	<6	1.6	94.8	3.6	<0.1	<0.001
146409	2025-10-29	####	29	Landloch - Peter Dubbelman	Landloch	CB29	1E+08	0-10	5.2	3.91	3.04	Loamy sand	7.5	74	48	2.6	215	91.2	25.4	7.2	1.07	0.75	0.065	0.031	1.4	0.09		5	0.31	0.15	0.15	2.23	48.2	33.7	2.9	1.4	6.9	6.9	20	0.045	0.22	48	4.4	0.89	1.2	0.18	28	3.4	89.4	7.2	0.6	0.0059
146409	2025-10-29	####	30	Landloch - Peter Dubbelman	Landloch	CB30	1E+08	10-30	4.75	3.46	1.02	Sand	5.4	30	<25	<2.5	35	36.7	19.4	7.2	0.174	0.302	0.05	0.031	0.6	0.16		15	0.69	0.42	0.28	1.25	13.9	24.1	4	2.5	33	22	9	0.026	0.16	21	0.7	0.21	0.21	0.039	16	1.2	91.8	7	0.2	0.0015
146409	2025-10-29	####	31	Landloch - Peter Dubbelman	Landloch	CB31	1E+08	30-60	5.25	4.32	0.21	Sand	<5.0	14	<25	<2.5	<10	15.7	9.7	<6.0	<0.050	0.129	0.025	0.02	0.3	0.19		22	0.13	0.05	0.08	0.33	9.6	38.7	7.4	6	15	24	16	0.019	<0.10	4.6	<0.3	<0.08	0.08	<0.030	12	1.4	94.6	4	<0.1	<0.001
146409	2025-10-29	####	32	Landloch - Peter Dubbelman	Landloch	CB32	1E+08	70-85	5.68	4.63	0.19	Sand	<5.0	13	<25	<2.5	<10	20.3	<5.0	<6.0	<0.050	0.167	0.012	<0.020	<0.1	0.07		11	0.11	0.06	0.06	0.32	4.4	52.7	3.7	3.2	17	19	24	0.028	<0.10	5.6	<0.3	<0.08	<0.08	<0.030	18	2.2	93.2	4.6	<0.1	<0.001

NOTE 1: Walkley and Black Organic Carbon % (40°C) data presented in this test report have been obtained by a combination of laboratory wet chemistry and the equivalent modelled result from Mid-Infrared Diffuse Reflectance Spectroscopy and Partial Least Squares Regression (PLSR) analysis. An explanatory technical note is available upon request. The exception is for quoted work that specifically required laboratory wet chemistry.