City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

FARM MANAGEMENT

ADDRESS: 2485 BALLAN ROAD, ANAKIE

LOT AND PLAN NUMBER:(LOT 88E PARISH OF ANAKIE)

CLIENT: MARTY JAMES

LOCAL GOVERNMENT: CITY OF GREATER GEELONG

JOB NO: 2622

LAND CLASS 4-AGRICULTURE

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City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Land/Farm Management Plan for the planning application for agricultural use and dwelling.

For Allot. 88E. Parish of Anakie (2485 Ballan Road, Anakie)

Project: 2688

Julie Lee is a rural planner that is qualified in many areas such as Bushfire Planning, Town Planning, Agroecology (Regenerative Agriculture), Conservation and Land Management, Coastal and Water Management , Horticulture and is a sessional lecturer to the Victorian Planning Institute in Integrated Land Management for Farming zone and Biodiversity.

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REV	DATE	DETAILS
	22/7/2025	FINAL
A	3/2/2026	Amend to clarify restriction (CFA), Agricultural use, pastures, water and infrastructure plus third FMP plan. Revise shed and effluent location.

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Natural Resource Link Pty Ltd does not accept any liability for an error, omission or loss or other consequence that may arise from relying on this report. The soil health visual inspection for this

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

report follows the methodology for visual soil inspections by G. Shepherd, Soil Scientist (BioAgrinomics.com New Zealand) Soil testing is by EAL Environmental Analysis Laboratory at Southern Cross University and the review of the results including general recommendation for crops or pasture in this report are general in nature and reflect a brief look of the soils for the planning permit only and the choice of pasture species and ongoing testing of soils will need to be undertaken by an Agronomist.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

TABLE OF CONTENTS

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Images

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Executive Summary

The owners purchased the land a few years ago with the mind to produce quality meet sheep and to reside on the site to facilitate the required improvements to the soil and biodiversity on site along with daily care of the sheep. The comprehensive response looks to improve the viability of the soil by a factor of 5 by facilitating an increase in Land Class through regenerative agriculture.

Their thoughts were to engage me to review the site for its capacity for Agricultural use and I undertook soil test and reviewed the site; which is a state consideration at Clause 14.01-1S. This report follows the E Guide by the Department of Agriculture and considers additional items such as climate change, Land Class and how Agriculture can be improved with an improvement of soil health. This has the capacity to improve productivity and increase financial returns in the long term. Due to the biodiversity on site this application will also look at an Integrated response in the Farm Management Plan to cover the biodiversity issues as well.

This report will have red notes where the information supplied responds to the planning scheme to assist the planner in understanding the nexus between the report and the planning scheme. Whilst there are very few Agricultural undertakings that require the house on site 24/7, these uses such as Poddy Calve rearing and expensive breeding of racehorses are not going to feed Victoria and contribute to Agriculture. This report looks to view the site holistically, devise a way that the viability of the site can be increased, biodiversity protected and managed alongside maintaining amenity and reducing land use conflicts. This looks to meet the objectives of Clause 65 whereby all aspects of the application are assessed, and a good planning outcome is achieved that not only meets on one point but all aspects of the scheme. This also meets the objective of Clause 14.01-1L- 2 Rural dwellings and Clause 35.07.

The landscape is within a rural area to the north-west of the small township of Anakie Junction that consists of a small section of residential lots along the Ballan Road. The surrounding landscape is a mix of National Park (Brisbane Ranges) and remnant bush areas and open pastures. The site is 24.77Ha in size and is a longitudinal block with a small section (north) fronting the junction of the Ballan and Clarkes roads. There is an unconstructed road reserve to the north boundary that is listed on GeoVic as being under a grazing license and to the west is a constructed Durdiwarrah road that although is well constructed but seems to be closed. This application will look to open this road as legal access.

Since the preparation of the draft report the owners have been collecting compost material to use to increase soil health and have not put any motorized vehicles into the high biodiversity area and undertaken sterilisation of footwear when entering the site as to not spread the Phytophthora into new areas on site.

Caring for stock as an absentee farmer is not recommended as there can be stock lost at birthing of both the mother and lambs, fences can be breached leading to land use conflicts with neighbouring farmers and stock or ram entering that will interfere with breeding. Wandering dogs and pest foxes often predate at diurnal periods around dusk and controlling these pests is imperative to the stock.. Currently the sheep are a cross breed and once living on site is going to look at pure Poll Dorset to cross to breed a higher value meet sheep.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Factors such as rising costs of fertilization is leading to the charge to return to more natural ways to maintain soil health and increase resilience for climate change.

The owner feels residing on site provides the option to purchase valuable stock and can move stock around to manage pastures cover crops in a more sustainable manner. Also to monitor fences and at breed is available on site to bring in lambs and bottle feed. The house there will enable monitoring of his stock against theft which he has been concerned about; in addition, the business viability is dependent on this. Insurance is much easier to gain if the landowner is nearby and able to deter theft.

Farms now require Biosecurity to ensure that people do not enter the farm and bring in any pathogens that can affect stock. This requirement practice is fully supported nationally and by the Department of Agriculture it forms part of the Department of Agriculture EGuide for planning application. People entering the farm for delivery of products or picking up stock need a presence on site to facilitate any biosecurity issues that are required. This cannot be completed remotely.

Their thoughts were to engage me to review the site for its capacity for Agricultural use and I undertook soil tests; which is a state consideration at Clause 14.01-1S. This report follows the E Guide by the Department of Agriculture and considers additional items such as climate change, Land Class and how Agriculture can be improved with an improvement of soil health. This has the capacity to improve productivity and increase financial returns thus making the Agricultural business more viable.

It is imperative to note that the requirements of the Bushfire Management Overlay do in part limit some types of farming such that increase the fuel on site and are not accepted by CFA as this does not meet the requirements of Clause 13.02.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Image.1 aerial context of the site (Source Lanchecker)

The landscape is one where there is a mix of small and large holdings with a high percentage of remnant vegetation in private and public ownership under the Bushfire Management Overlay applies to the landscape. The landscape has risen and falls and is well serviced with the main road from Ballan to Geelong to the north. The site has no services and properties in the locality mainly rely on tank water and alternative power supply.

The landscape is one where there are farms, lifestyle blocks, small townships with limited services located south of the Brisbane Ranges National Park. Anakie is a gateway to many tourist destinations and facilities for Ecotourism and for Wineries, accommodation and Fairy Park.

The area is one of high Bushfire risk with important waterways and landscapes that are considered and give due thought to minimise breaks to the open space and amenity of the area.

The site is unusual as it borders a registered council road reserve with a road that is wide and meets the requirement of a 6m wide all-weather road with culverts as shown in the site photos. This however does not seem to be on the road registry to be maintained and preliminary requests were undertaken with many sections in council such as planning and engineering and we were advised that the issue will be reviewed once the application is submitted for a planning application.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Income brief-

The business in brief will look to run Poll Dorset once on site and the site has the capacity to carry for a Land Class 4 of 0.5 DSE per ha. The paddocks for grazing total 8.82ha allowing for 4 sheep to be managed on site without supplementary feeding. A rise to Land Class 3 will increase to 2 DSE/ha allowing this to increase to 17 sheep. However, this requires the landowner to undertake low level grazing with pasture improvements to get the soils to this level and gains will not be realized until 4-6 years depending on climatic conditions.

It is just mere speculation to try and evaluate what increase this will propose in dollar figures when the market it subject to so many changes on an annual basis.

Proposal description

The farm currently runs a few crossbreed sheep and wishes to breed higher value meet sheep to provide an outcome. The ability to develop this further in the future is the soil type and it does not have the ability to increase to a much higher Land Class and must be based on the ability/potential that is evident on site. The amount of lost land to other factors such as the biodiversity which we would never propose to remove but in all reality, this does reduce the agricultural capacity on the site.

Background on the property owners and their aims

The owner has owned the farm for sheep for years and is aware of the vaccinations, drenching and other maintenance issues that this endeavor entails.

Breeding quality stock is needed to create a higher meat value sheep to increase farm returns and along with increasing the soil health it is hoped that the farm returns over a five-year period will look to increase.

The dwelling on site allows the owner to monitor the sheep and be on hand at birth to avoid loss of stock that has historically cost the business money. Currently the stock is cross breeds when there is sufficient pasture cover and breeding quality stock means that without a dwelling on site monitor are at a higher risk for poaching. Poaching from sheep breeders cost breeders an estimated 2.25million stock were stolen from Victorian Farms (Source Stock and Land 8 January 2025, Livestock Trend 2025).

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Proposed Stock

The proposed stock is to breed Poll Dorset with a cross breed to produce a higher value meat sheep.

Image.2 Stocky build of Poll Dorset (Source: Australian Poll Dorset Association, nd)

The Poll Dorset are a breed of choice across Australia that are breaking records across Australia for meat production The advantage of pure Poll Dorset or cross breeding is to develop a high-quality carcass; lambs mature earlier and breeding can occur at any time of the year; which can be adapted to current rainfall predictions enabling pasture development and breeding to be more coefficient. The lamb meat shows an ideal fat to muscle ratio producing an attractive meat product and quality cuts of meat. Poll Dorset also produces a down wool that is ideal for doona and quilt production. (Source: Australian Poll Dorset Association, nd)

This will increase the value of returns in the market and increase ethe viability of agricultural production over time.

Current and historic land use

Currently the land has been used for low level grazing and contains an airfield as shown below The surrounding landscape is similarly used and has areas of biodiversity. (Clause 02.03-4, Clause 14, Clause 35.07-6)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Development objective

To take a snapshot of the land including topography, landforms, restrictions, risks, features, capacity of the soil and soil health. To develop a plan that respects the nature of the land and balance the need to ensure that agriculture is undertaken on site alongside biodiversity. To propose how the soil can be sustainably improved to increase soil health and build resilience against climate change. The report demonstrates how all objectives of the planning scheme can be met to ensure a good planning outcome that delivers social, economic and environmental outcomes to best practice.

Methodology

- Planning scheme online maps (DWELP 2023) for zoning, applicable overlays for the site
- Aerial photography- Landchecker, Vic Map, Lassi, Google Earth to review the current and historical use of the site.
- Naturekit to review the current and historic EVC, Bioregional conservation status and Bioregion data.
- NVR Map for applicable condition scores
- Victorian Resources Online (Department of Agriculture 2024) for soil, land use, geology and historic land capability reports.
- Catchment Management Authority that is applicable to the site for contours, geology, flood information.
- Bureau of Metrology for climate data
- Rowe et al Jan 1981, Guidelines for Land Capability Assessment.
- Spatial data mart for applicable GIS data
- Soil test via EAL Laboratories, Lismore, NSW
- Visualising Vic Ground Water for ground water salinity and depth of ground water
- CeRDI portal for additional information (Federation University)
- Map Share for catchment information, fire history.
- Earthshare Resource Maps
- GeoVic for land tenure/mining. Geology
- Atlas of Living Australia for data on flora and fauna
- Victoria's Climate Tool
- Flora of Vic for Flora Details

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Site Description

PROPERTY CHARACTERISTICS

The site is an odd shape with access to the north (Ballan-Geelong Road) and the site is 61 A 0R ad 34 P which equates to 24.77ha and requires a permit for the development of a dwelling. The land rises slightly from the access to the north to a broad crest mid-point where the soil becomes shallower. Then under the remnant area proceeds to markedly fall away to the southern extent. (Clause 02.03-4, Clause 14, Clause 35.07)

Image.3 Halfway to the crest showing the slight rise on site from north to south.

This image shows the road constructed on site (part of the Durdiwarrah Road).

Image.4 The lower north area has areas where drainage is impeded as indicated by the vegetation.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Image.5 Lack of pasture cover near the crest

Image.6 Near dwelling area top of crest showing rock in the surface and lack of pasture cover

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Image 7 remnant area recruiting back from a slash for fire safety

Image.8 Of slashed area and signs of soil movement from rainfall

The vegetation on site consists of a large patch to the south that is mapped to be EVC 20 Dry Heathy Forest and the open pastures as EVC 16 Lowland Forest.in the Central Victorian Uplands Bioregion (Source: Naturekit). The EVC's have the following Bioregional Conservation status of Least concern.

(Clause 13, Clause 14, Clause 14.01-2S, Clause 35.07-6)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Image.9 In remnant area showing retained small logs

Image.10 Breakdown of Grasstree from Phytophthora infection.

Image11. A group of unaffected Grass Trees on site

Image.12 Nearby lost Grasstrees from Phytophthora infestation.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Image.13 Larger old growth trees in remnant area.

Image.14 Lomandra longifolia with Dandelion weed.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Rainfall and climate change

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	42.8	46.9	50.0	55.8	56.9	56.6	53.0	59.6	68.0	68.5	63.3	54.8	679.7
Lowest	0.8	0.8	1.2	0.8	0.2	3.8	9.0	3.2	11.6	2.8	3.0	1.1	363.2
5th %ile	6.2	3.7	8.0	14.4	16.7	21.3	22.5	25.5	30.3	22.1	15.9	8.0	454.0
10th %ile	9.1	6.7	10.1	18.2	21.4	26.2	27.0	30.9	32.9	27.0	20.6	16.0	491.7
Median	35.6	31.6	40.9	47.4	53.5	51.5	49.5	56.6	59.9	66.3	51.5	45.9	662.2
90th %ile	81.2	106.4	100.7	114.1	97.5	91.1	80.7	91.3	105.5	109.2	109.4	107.2	870.7
95th %ile	115.2	135.7	144.2	128.7	116.6	108.7	96.7	105.7	130.3	118.1	146.3	120.0	931.3
Highest	209.6	248.1	247.1	202.6	153.9	286.1	135.4	164.7	322.4	167.4	241.8	190.8	1228.5

Image.15. Historic comparison from 1874-2023 Annual rainfall-Dirdidwarrah (Adapted from source: Bureau of meteorology 2024)

The rainfall in Durdiwarrah historically averages 662mm pa with a wide variation between 363.3mm to as high as 1228.5mm (1970)

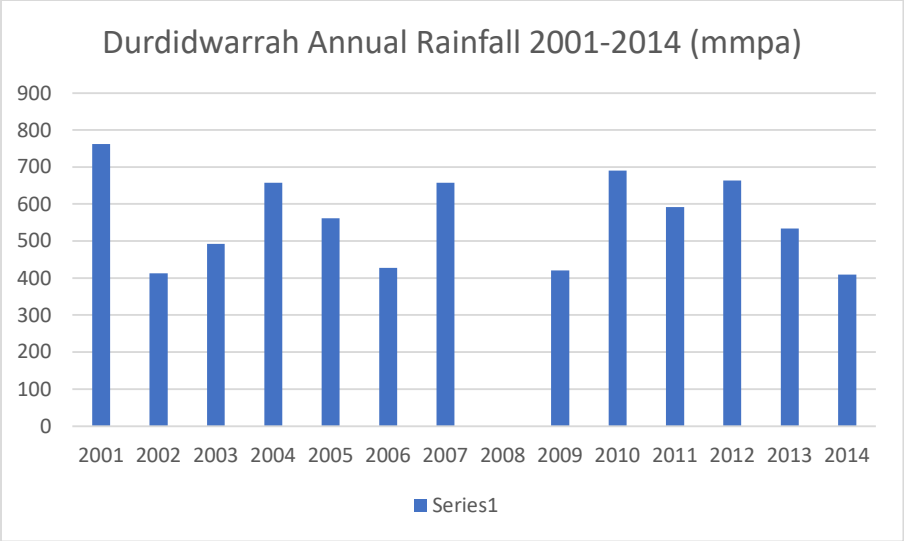


Image.16 Recent rainfall shows a lower mean of 560mm pa over recent years. (Adapted from source: Bureau of meteorology 2024)

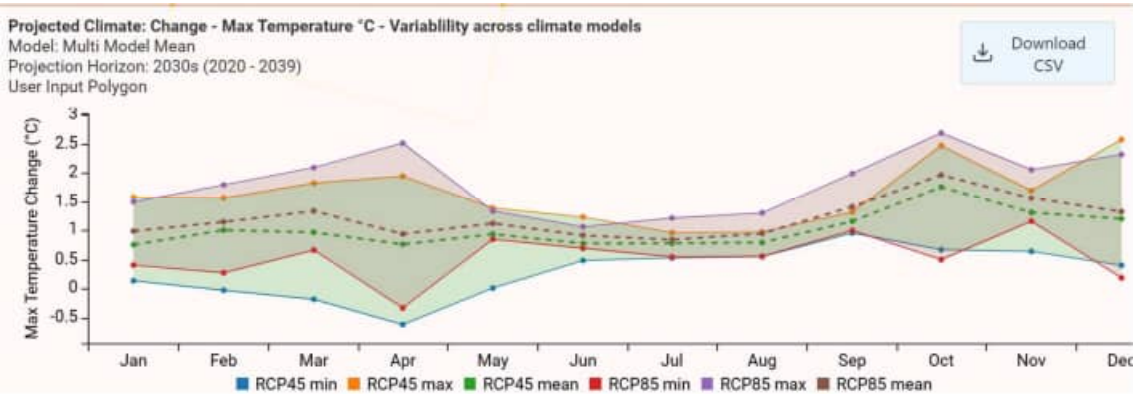


Image 17. Predicted temperature extremes reduction due to climate change (Source: State Government of Victoria, Energy, Environment and Climate Action nd)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Climate change will impact Agriculture in this area with depending on what Represented Concentration Pathway (RCP) is used with heat showing large increases through till May which will have an impact on stock health and for the health of pastures.

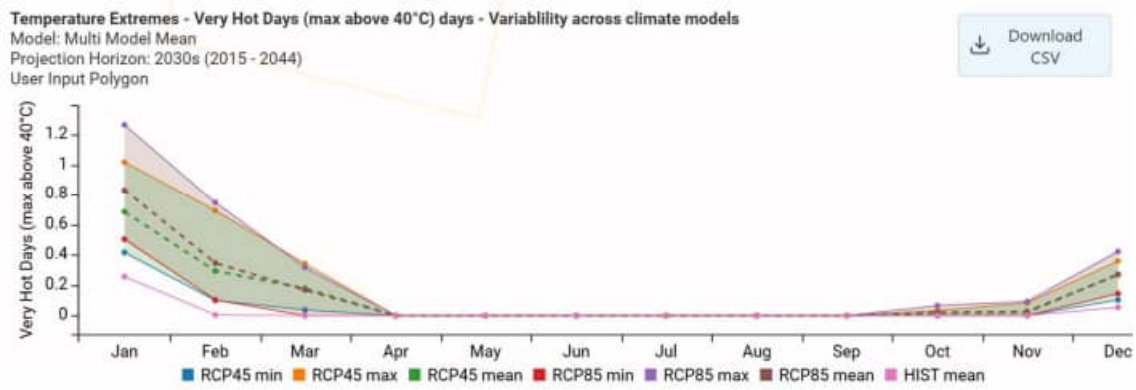


Image.18 Projected reduction in wet days depending on the model (Source: Government of Victoria, Energy, Environment and Climate Action nd)

Extreme hot days that also will impact on stock health and pasture management is estimated to increase extreme temperatures from mid spring to April. Resilience and shade options for grazing will be imperative to the protection of stock health in years to come.

Climate data show that rainfall is variable across the historic and projected climate change data. Typically, from my living in the past this area of Anakie is in a rain shadow and has always been difficult to farm with the variability of rainfall and climate data reflects this. There are warmer days expected over time placing more stress on retention of water in the soils and stock health.

One way to mitigate this is to establish long waters with longer periods in between to establish a deeper root system and less reliance on surface water along with as close to 100% cover as possible. Protection for stock from weather extremes is of high importance as well.(Clause 13, Clause 14.01-2S)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Landform, Geology and Topographic features

Landform

The site in the lower cleared areas on site as shown in this image is 2.1Pf5-5 (mottled duplex soil) which has the following restrictions for agriculture:

- Compaction risk High
- Leaching risk High
- Mass Movement Nil
- Salinisation Low
- Water erosion Low
- Water logging Nil
- Wind erosion Nil

The upper crest and remnant vegetation area on site is 2.1Ss5-6 (Duplex soil) which has the following restrictions for Agriculture:

- Compaction risk High
- Leaching risk High
- Mass Movement Susceptible
- Salinisation Moderate
- Water erosion Moderate
- Water logging Nil
- Wind erosion Nil

The upper crest and south slopes are at risk of salinisation, water erosion and mass movement .

Image.19 Landform and risk of land degradation (Source Soil CRC no date)

Clause 13, Clause 13.07-1S, Clause 14, Clause 14.01-1S, Clause 14.02-1 and Clause 35.06-7)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Soils- Geomorphology

The soil in the agricultural area on site is mapped to be Blackrock Sandstone (Nbb) which consists of Sand, sandstone, conglomerate, minor sandy limestone, local ironstone: pale to dark brown, reddish brown; generally, very well sorted, variably cemented; horizontally laminated to low-angle cross-laminated; glauconitic; contains shelly fossils and burrows.

Image.20 Soil Mapping

The Australian soil classification on site is the lower north area to be WC4 which is a Kurosol and the remainder of the agricultural area is B8 a Rudosol.

Kurosol soils exhibit a strong definition from the a to the B Horizon are strongly acidic and have low fertility. They often have low water holding capacity making them prone to droughts however this was not evident on the site inspection. This section exhibited poor drainage.

Rudosol soils are characterised by low fertility and issues with water retention which was quite evident on the site inspection. One aspect of Rudosols is that the restrictions of these soils can be improved with an increase of organic matter and water retention. These soils often are shallow stony soils with little organic matter and this was clearly evident to the crest area on site. This area is where the dwelling is to be located to site where the soils are the lowest quality.

Image.21 Soil Mapping

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Soils on site

Two soil tests were taken on site and were reviewed for total soil testing. The soil had extreme compaction, and it was extremely difficult to dig into the soil and there was limited structure and macropores.

Site.1.

Image.22. Site.1

Site.1 soil sample showed good depth with low level micropores of the soil, the A Horizon was deep at 15-20 cm before the soil became more impenetrable. The soil review was evident of a sandy loam soil with a darker A horizon of around 8cm depth. The A2 was more bleached and indicative of the risk profile for fertility. No mottling was evident in the soil profile. The growth was even across the site with many deep-rooted tap rooted plants such as flatweed and dandelion along with an scattering of annual grasses.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Soil site.2

Image23 Soil site.2 Lighter grey brown colour

Soil site.2 this site was close to the crest (dwelling area) where the soil was a mixture of a silty/sand loam which was pale in colour and heavily compacted. Rooting depth was shallow and the fertility of the soil colour indicated low fertility. There was little aggregation and pores being a fine soil type. The soil was hydrophobic, lacked any aggregation, fertility and rooting was surface to shallow (less than 5-10cm). This area would have a much lower capacity for agriculture due to the soils. Soil depth and type of soil and soil test results indicate a soil that has limited capacity for improvement and would be at least a Land Class 4.

Image 24.. Soil site 2 close up

Image25. Soil site.2

Soil site.2 shows the rooting depth to be below 10cm in depth.

Image26 .Soil site 2 showing iron-based surface rock.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Soil site.3 was a large bare area that was tested for salinity.

Image. 27 Healthy soil

This report will look to increase the microbial health of the soil, increase fertility and open up the soil with a deeper root system to ameliorate climate change.

Soils on site summary:

The soils showed soil types that mostly have a massive soil structure and display evidence of low fertility and were more highly compacted as you move up the slope.

Highly compacted soils are unable to support deep rooted vegetation and are limited to surface rooted grasses. There is a need to improve this structure in the soils.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Healthy Soils

The soils showed a mixture of friability with low micropores near the surface, the soil was extremely compacted and lacks room for air and water in the soil. The alluvial areas showed a lower level of fertility in the colour of the soil. Highly compacted soils are unable to support deeper rooted vegetation and are limited to surface rooted grasses. There is a need to improve this structure in the soils.

The level of pores in the soil is indicative of a lower level of soil health being that there is less room for air, water and organisms to thrive in the soil.

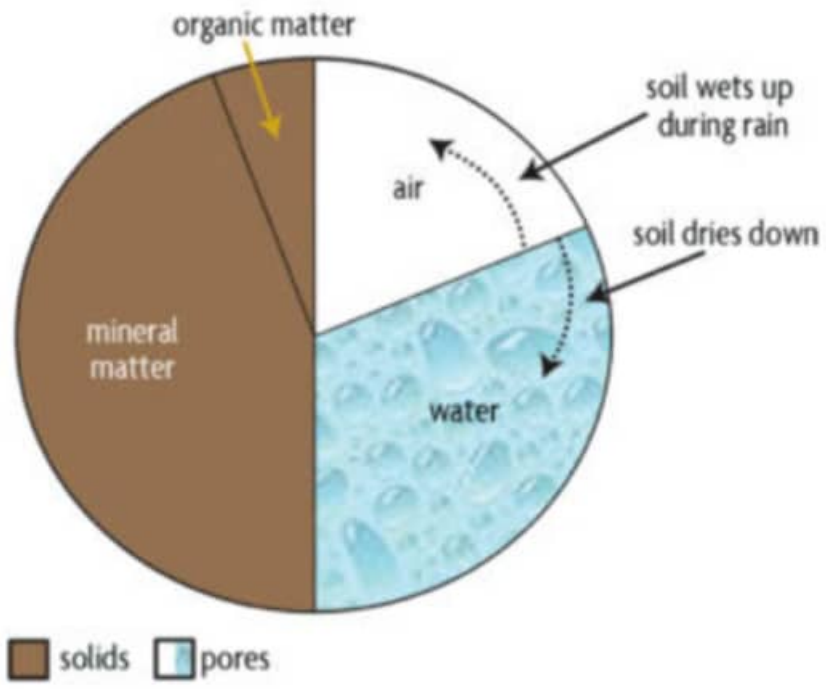


Image. 28 Structure of Healthy soil (Source: Sustainable Agricultural Research and Education 2025)

The soil on site is not representative of the desired physical component as noted by Andrew Clarke. There is a need to improve the soil so that they can sustain a diversity of healthy crops that are resilient against climate change. (Clause 13 and Clause 14.01-2S)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

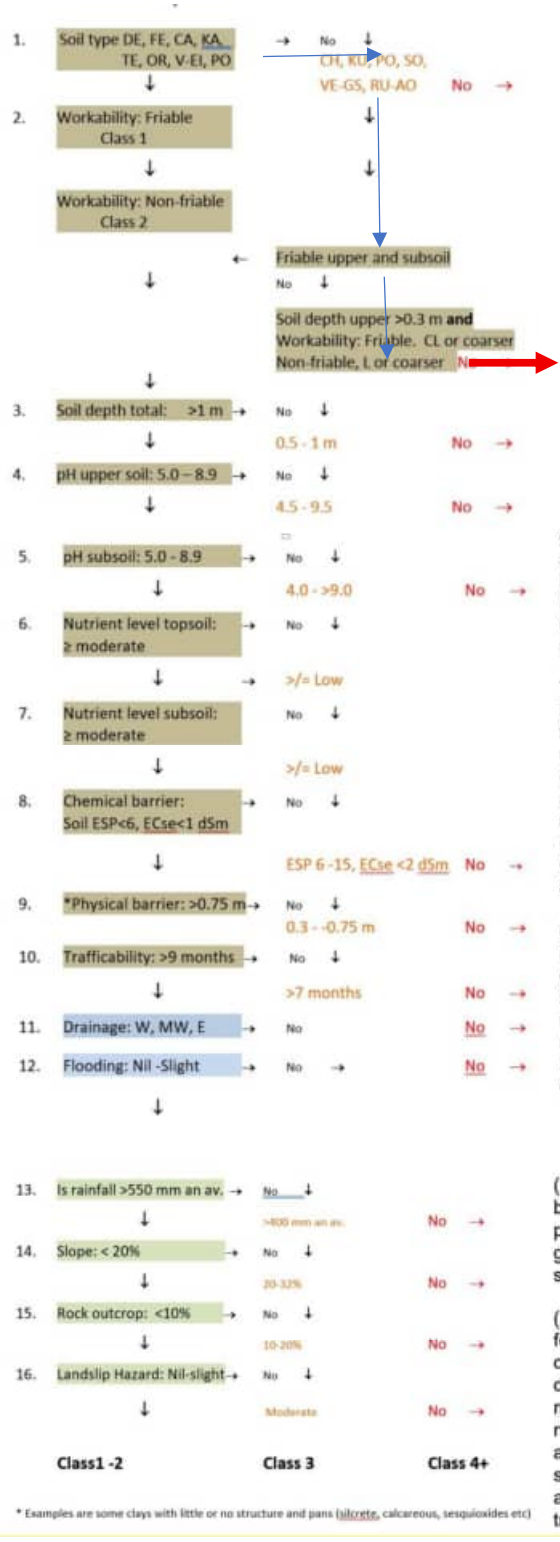
Image.29 Showing site and preferred rooting of pastures. .(Source: Sustainable Agricultural Research and Education 2025)

Soils on site are highly compacted, and root development is indicative of the image to the left and what we are working towards is a denser deeper root system on the right

Increasing the soil health will take the pasture from fine particles (right) with low aggregation to one where the root start to aggregate the soil and increase macropores such as in the image on the left. This will occur with a pasture mix of deeper root species, maintaining a full cover crop, drill seeding, increasing soil health and composition and continuing grazing.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Agricultural potential and land capability classification



(Factor 1) Soil type affects the degree of restriction for gases and biological activity and here it is assumed that physical features are harder to alter than chemical (nutrient) features. Therefore, texture contrast, or restrictive heavier textured soils (e.g. Sodosols), are identified first as less capable than less restrictive soils with no sudden restrictions down the profile (e.g. Ferrosols, Dermosols).

(Factor 2) Workability and friability are key factors influencing productivity and ease of tillage. Even some well-structured soils may lose their effectiveness under wet conditions, and when combined with compaction forces (e.g. wheel and stock traffic). Strongly structured soils with connected spaces (and pores) have more effective internal drainage (i.e. are more permeable).

The upper soil depth is important for germination and plant development and sufficient depth over a heavier subsoil could be more than adequate for some crops. (Factor 3) A deeper soil profile with fewer restrictions to root and water movement is preferred.

The measurement of acidity/alkalinity via pH is a broad indicator of the nutrient status of the soil and potential toxicities, for both the surface soil (Factor 4) and the subsoil (Factor 5); only the extremes are excluded at this stage before a more direct assessment of nutrient status (Exchangeable Bases and Cation Exchange Capacity) of both the upper soil (Factor 6) and subsoil (Factor 7);

(Factor 8) Some soil chemical properties influence plant growth. A high proportion of exchangeable sodium (i.e. ESP) in the nutrient base can cause plant growth restrictions in terms of both direct effects on roots and indirectly by altering soil structure. High soluble salt content is another possible chemical barrier to plant growth.

(Factor 9) If there are no significant chemical barriers then there is the possibility of physical restrictions such as rock, stone or gravel. High clay content with limited structure could also be restrictive.

(Factor 10) Trafficability is an important feature of the land that influences agronomic operations. This is generally correlated with drainage (Factor 11). Trafficability potential may mean that some positive attributes (e.g. nutrient status) are sacrificed for greater access throughout the year, though issues such as compaction need to be assessed according to the amount of likely traffic/stocking.

(Source: Planning Vic Oct 2018) Using this methodology the site would be a **Class 4** for Agriculture.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Regarding this site the soils would be classified as a Class 4 productive soil as the soil upper depth is not over 30cm and has low fertility.

Soil Testing on site

> "Soil is considered a living and complex ecosystem harbouring a wide array of both micro- and macrobiota that regulate its properties. The intensification of agriculture with modern technology has deteriorated the capacity of soil to maintain its functions, affecting long-term productivity and causing a loss of ecosystem services." Bender, S.F.; Wagg, C.; van der Heijden, M.G. An underground revolution: Biodiversity and soil ecological engineering for agricultural sustainability. Trends Ecol. Evol. 2016, 31, 440–452.

Two sites were tested on site and test under the Haney Soil system to determine the current health of soils, organic levels and nutrient deficiencies at EAL Laboratories.

(Clause 13)

Nutrient Management

Haney Soil Tests-EAL Laboratories

To determine the graphs the soils on site are a Fine soil.

Red means you need to pay immediate attention to and are well below the critical range, blue notes the levels are low but not optimum and green denotes the levels are optimum.

Soil respiration was low across the site ranging from 69 to 89mg/kg CO^2 (ppm).

These results where cover has been maintained are in the above average category and can still be improved to aim to reach levels of around 200+ This can be due to taking soil samples when the soils are very dry and microbial activity moves deeper in the soil profile, soil site 4 was the lowest and the soils on this site are often waterlogged.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Soil Respiration Ranking Table:

CO2-C in ppm	Ranking	Implications
0-10	Very Low	Very little potential for microbial activity; slow nutrient cycling and residue decomposition; high carbon residue may last >2-3 yrs. with limited moisture; Nearly no N credit given; Additional N may be required due to microbial immobilization
11-20	Low	Minimal potential for nutrient cycling; residue management can still be a problem; Very little to no N credit given
21-30	Below Average	Some potential for nutrient cycling; residue management can still be a problem with prolonged use of high carbon crops; Little N credit given
31-50	Slightly Below Average	Low to moderate potential for microbial activity; Some N credit may be given
51-70	Slightly Above Average	Moderate potential for microbial activity; Moderate N credit may be given; May be able to start reducing some N fertilizer application
71-100	Above Average	Good potential for microbial activity; Moderate N credit may be given depending on size of organic N pool; Can typically reduce N application rates
101-200	High	High potential for microbial activity; more carbon inputs may be needed to sustain microbial biomass; moderate to high N credit from available organic N pools may be given; N fertilizer reduction can be substantial
>201	Very High	High to very high potential for microbial activity; residue decomposition may be <1 yr.; keeping the soil covered could be a problem in some systems; high potential for N mineralization and N credits from available organic N pools may be given; N fertilizer reduction can be substantial

Image.30. (Source: Ward Laboratories Inc nd)

Respiration is a direct biological activity measurement, integrating abundance and activity of microbial life. Thus, it is an indicator of the biological status of the soil community, which can give insight into the ability of the soil's microbial community to accept and use residues or amendments, to mineralize and make nutrients available from them to plants and other organisms, to store nutrients and buffer their availability over time, and to develop good soil structure, among other important functions.

Management: The soil's biological activity is improved by keeping the soil covered with plants or residues throughout the season, adding fresh, microbially degradable amendments, growing biomass in place by maintaining living roots for as much of the year as possible, increasing diversity of species in the system through rotations, interseeding, or intercropping, and by reducing the use of biocides such as pesticides, fungicides, and herbicides. Beneficial soil biological activity tends to decrease with increasing soil disturbance such as tillage, heavy traffic, and compaction, as well as with extremes in low or high pH, or contamination by heavy metals or salts.

Organic carbon (water extractable carbon) in the soil is low to ideal

Results ranged from 70 to 94 and should target a range in the Green section (image below) whereby results over 600 is optimum. The desired range **> 300 (ppm or mg/kg).** Organic matter contributes to nutrient retention and turnover, soil structure, moisture retention and availability, degradation of pollutants, and carbon sequestration. Soils that are continually managed for high

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

organic matter tend to require lower farm inputs and be more resilient to drought and extreme rainfall. It has been argued that organic matter management is soil health management.

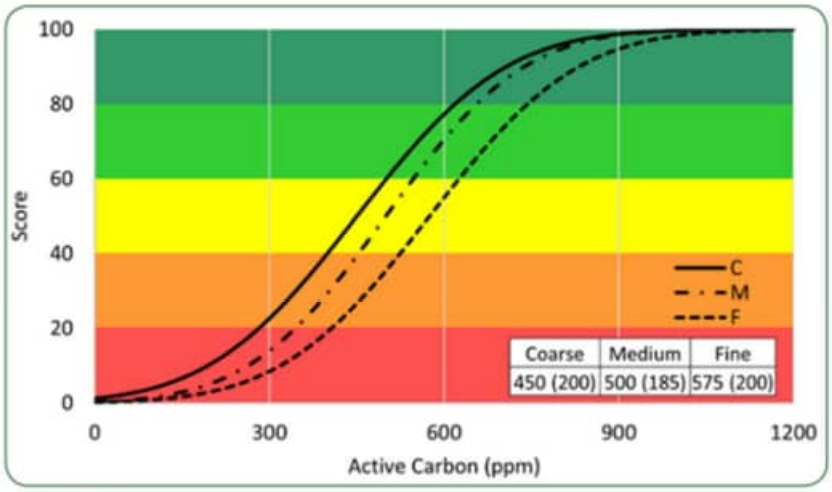


FIGURE 2.38. Active carbon scoring functions and upper value limits for Coarse (C), Medium (M) and Fine (F) textural classes. Mean and standard deviation (in parenthesis) for each class are provided. In this case more is better. Higher active carbon scores indicate a trend toward more organic matter building up in the soil through biological activity.

Image 31 Optimum active carbon rates (Source Cornell University June 2017)

Management constraints and maintaining optimal organic matter content Intensive tillage and lack of carbon inputs decrease organic matter content and overall soil health with time. Results for this soil needs to target a minimum of 300 ppm (mg/kg) and above to improve soil health to support resilience to disease and to climate change.

Likewise, increasing organic matter in the soil takes dedication, patience and time to rebuild. It is unlikely that a single incorporation of a green manure will noticeably increase the percent organic matter. Rather, adding more stable organic matter such as compost, or possibly biochar, can improve water infiltration and retention in the short term. Retention and accumulation of OM in the long term is improved by reducing tillage intensity and frequency (as much as is feasible within the constraints of the production system), and repeated use of diverse organic matter additions from various sources (amendments, residues, and the active growth of crops, forages, or cover crops, particularly their roots) which all stimulate both microbial community growth and the stabilization (sequestration) of carbon in aggregates. This is what your microbes feed on.

Water extractable Nitrogen

These levels are 11-12 mg/kg (ppm) and most soils range from 5-30 ppm so these results are good. These levels reflect the measure of organic and inorganic nitrogen that can be extracted by water. Generally, levels above 20 indicate low nitrogen and phosphorous mineralisation; which can reflect low fertility and is impacted by drought, moisture and climate.

Ph of the site is slightly alkaline with ranges from 5.37-5.05

The optimum pH is around 6.2-6.8 for most crops. (exceptions include potatoes and blueberries, which grow best in more acidic soil). If pH is too high, nutrients such as phosphorus, iron, manganese, copper and boron become unavailable to the crop. If pH is too low, calcium, magnesium, phosphorus, potassium and molybdenum become unavailable.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

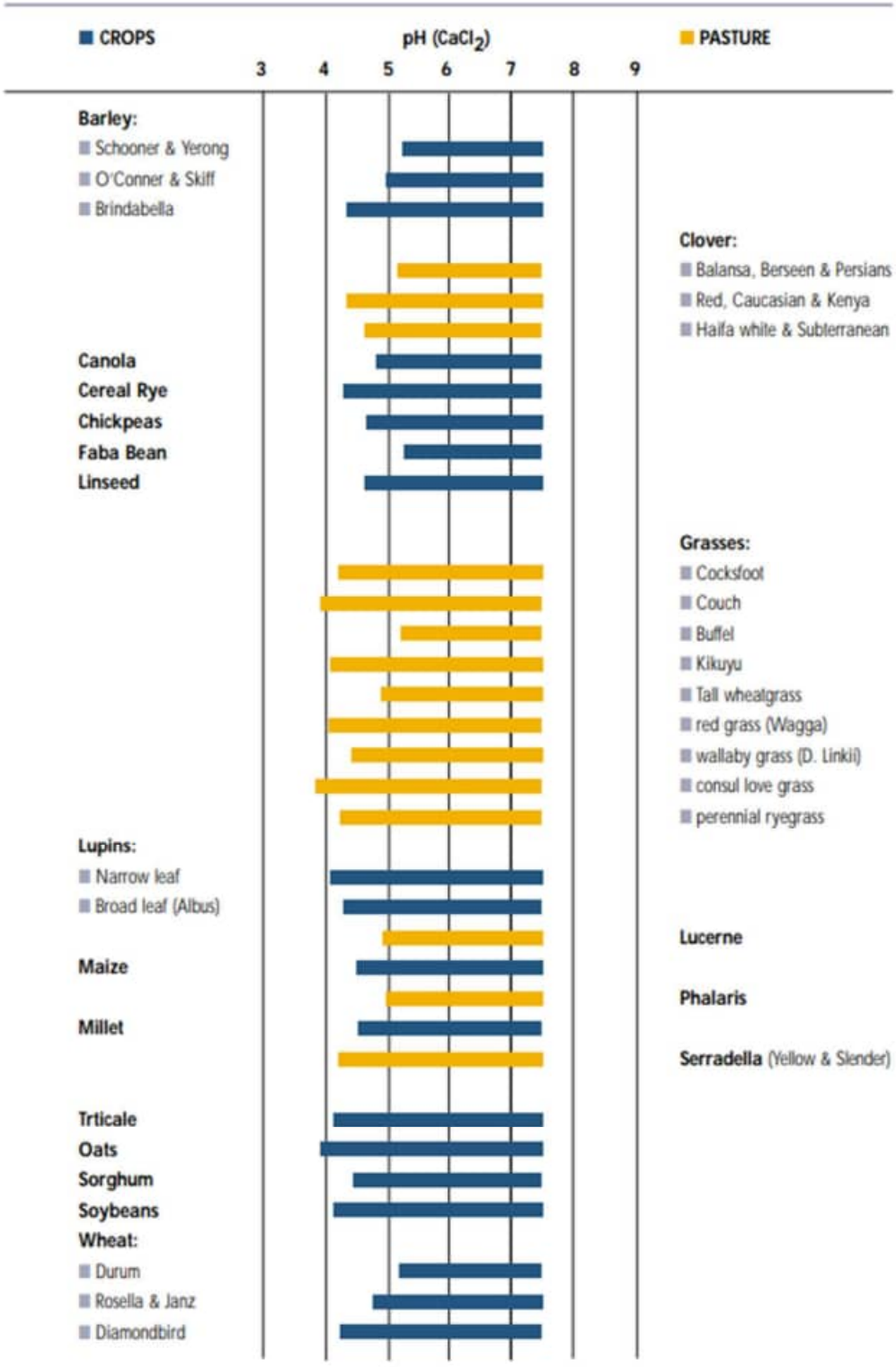


Image.32 Understanding Soil Ph, (Source: NSW Agriculture June 2000)

Management: Routinely test levels.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Phosphorous levels on site ranged from 4.1-3.9 mg/kg (ppm) which is classified as very low with one being 28 looking to move outside of the optimum level.

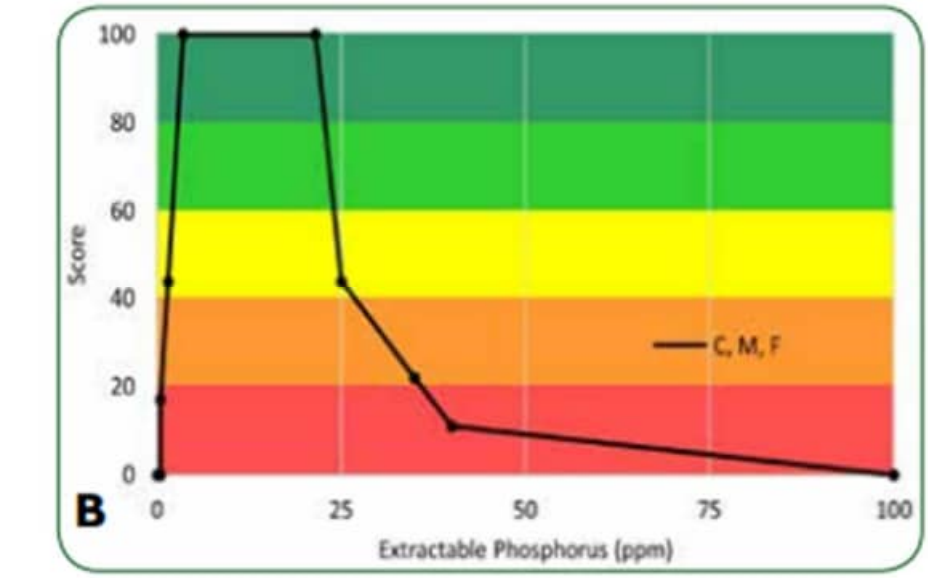


Image.33 Optimum Phosphorous levels (Source Cornell University June 2017)

Management: These levels are mostly at the maximum range and will require ongoing monitoring to slightly reduce the levels back to the optimum levels.

Excessively high P values indicate a risk of adverse environmental impact. P can be considered a contaminant and runoff of P into fresh surface water will cause damage through eutrophication, for this reason over application is strongly discouraged, especially close to surface water, on slopes, and on large scales. Increase graminoides to around dam to avoid eutrophication for any runoff from the farm. Blood n Bone, Fish Meal or any protein rich or dairy based product can be added to compost to increase phosphorous and when added to the soil will naturally aid in the increase in Phosphorus. Phosphorus can be used in a foliar spray to increase phosphorous to existing crops or steep protein into a tea and water on crops.

Available phosphorus

Phosphorus is essential for plant growth and is vital for early root formation. Soil minerals can react strongly with applied phosphorus and only a small proportion may be available for plant uptake. In Victorian pasture soils, plant-available phosphorus is usually tested using the Olsen P test and results are presented in milligrams per kilogram (mg/kg) or parts per million (ppm).

Table 2. Ranges of Olsen P and their availability to plants

Olsen P (mg/kg)	Availability
Below 9	Low — except for native pastures
9 to 14	Marginal
14 to 20	Adequate
20 to 27	Elevated
Above 27	Very high

Image. 34 Department of Agriculture (Victoria) Energy, Environment and Climate Change 2025

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Potassium on site ranged widely from 13-16 for the other results which generally range very low for pasture on finer soils. Potassium and phosphorous is removed from pastures each season and the levels require ongoing monitoring.

Based on weight of nutrient per quantity of product (kg)

Product	Amount	Phosphorus (P)	Potassium (K)
Hay (grass, clover mix)	1 tDM	2–3.5	15–25
Lucerne/clover hay	1 tDM	2.5–3.5	20–30
Oaten hay	1 tDM	2	15–20
Pasture silage	1 tDM	4.3	27

Image.35. loss of P and K from pastures (Source: Agriculture Victoria 9 Dec 2024).

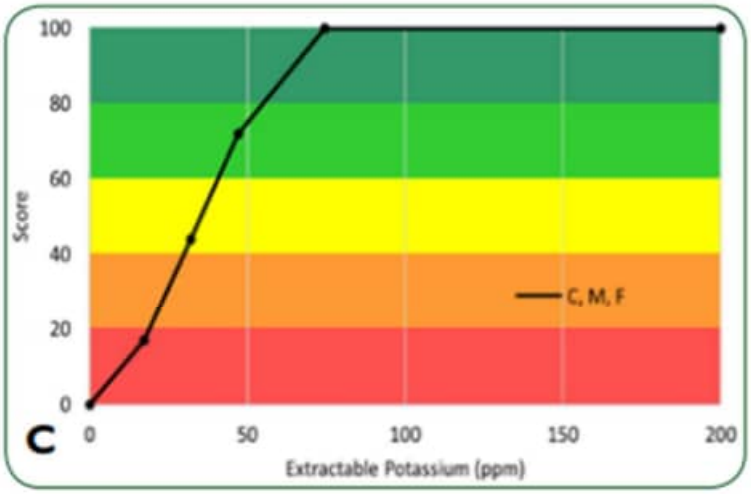


FIGURE 2.40 A-C. Scoring function graphs for pH (A), extractable phosphorus (B) and extractable potassium (C) for Coarse (C), Medium (M) and Fine (F) textural classes.

Image.36 Optimum Potassium levels (Source Cornell University June 2017)

Potassium is an essential macronutrient in horticultural crops and contributes to heat and cold tolerance of crops and promotes fruit development. K is an essential plant macronutrient that plays a role in photosynthesis, respiration, energy storage and transfer, regulation of water uptake and loss, protein synthesis, activation of growth-related enzymes, and other processes. Plants with higher potassium tend to be more tolerant of frost and cold. Thus, good potassium levels may help with season extension. While soil pH only marginally affects K availability, K is easily leached from sandy soils and is only weakly held by increased OM, so that applications of the amount removed by the specific crop being grown are generally necessary in such soils.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Potassium is needed for a wide range of important processes within the plant including:

- cell wall development
- flowering
- seed set.

Available potassium is measured by the Colwell K or Exchangeable K soil tests. The appropriate target for available potassium depends on soil type, because the holding and supply capacity of potassium in soils can differ.

When potassium levels are high, potassium inputs can be reduced from the fertiliser regime until levels fall.

Table 3. Soil type and target levels of potassium (mg/kg)

Target levels	Sands	Sandy loams	Clay loams	Clays	Peats
Low	< 50	< 80	< 110	< 120	< 250
Moderate	50 to 100	80 to 120	110 to 160	120 to 180	250 to 350
Ideal	101 to 150	121 to 200	161 to 250	181 to 300	351 to 600
High	> 150	> 200	> 250	> 300	> 600

Image. 37 Department of Agriculture (Victoria) Energy, Environment and Climate Change 2025

Management: Potassium is removed from foraging and the harvesting of crops and there is a requirement to add in Potassium. Grazing only will also still deplete soils by around a third of grazing/pastures and the first sign of deficiency is the loss of legumes. Potassium feeds legumes, legumes provide nitrogen, nitrogen feeds grass. (Wisconsin University nd)

You can help retain Potassium by increasing soil moisture, cover crops, wood ash, composting, soil aeration, oxygen level, soil temperature and tillage levels. A no-till regime will reduce the availability of Potassium in the soil. (Source: University of Minnesota 2018)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Minor trace elements Magnesium, iron, manganese, zinc.

Table 1.1: Recommended minimum element concentrations in pasture dry matter for grazing cattle and sheep[1]

	Cattle	Sheep
Macrominerals	**g/kg**	**g/kg**
Calcium	3.5	3.0
Phosphorus	3.0	2.0
Sodium	1.5	1.0
Chlorine	2.0	1.0
Potassium	5.0	4.5
Sulfur	1.5	2.0
Magnesium	1.5	1.0
Trace elements	**mg/kg**	**mg/kg**
Iron	40	40
Zinc	25	20
Manganese	25	25
Copper[2]	5 to 12	5
Cobalt	0.10	0.10
Iodine	0.50	0.50
Molybdenum	0.10	0.10
Selenium	0.05	0.05

[1] Based on data presented by the ARC (1980), Grace (1983), NRC (1978), Underwood (1981) these amounts represent the average requirements for growth, pregnancy or lactation, in grazing livestock.
[2] Copper requirements are strongly affected by the concentrations of molybdenum, sulphur and iron.

Image.38 Minimum trace elements for grazing (Victorian Farmers Federation 2025)

Magnesium in the soil tests

These levels across the site ranged from 37-44 mg/kg (ppm)with is high; dryland pastures require 15-20mg/kg, with 25-30mg/kg for irrigated and improved pastures. (Source: New South Wales Government nd) These pastures will be improved with a higher diversity of crops, the use of compost and soil health improvement and look to have at least 25-30mg/kg

Management: Dolomite is used to correct magnesium levels in soils but does alter the pH to alkaline which is required on the site. Ongoing monitoring of pH and the Phosphorous levels in the soils will be required that the soil do not get too acidic. It is imperative that ongoing testing by an Agronomist can monitor the chemical levels in the pastures.

Iron

These levels are in and well above the required range of 4.5. (Source: White.R and Krstic.M 2019) (107-161) results is consistent across the site.
Iron (along with molybdenum) is an essential element required for biological nitrogen fixation. This mineral is a key player in photosynthesis. It is required for the synthesis of chlorophyll and for maintenance of the structure and functioning of the chloroplasts (the sugar factories).
Many metabolic pathways are activated by iron, including several that are directly related to plant immunity and resilience.
Adequate iron, in plant-available form, is essential for protein synthesis.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Iron is strongly linked to all-important oxygen. It is an indispensable oxygen carrier for chlorophyll production and it is a central component of respiratory enzyme systems.
Iron increases leaf thickness and darkens the leaf, so that the greener, more robust solar panel can absorb more solar energy. Victorian soils rarely show a deficiency in Iron and Iron toxicity has not been noted; extremely high levels of 6000mg/kg have been shown to interfere with the copper metabolism of sheep and cattle. (Victorian Agriculture 1996-2025A)

Management: Optimum levels and will just be assessed with routine testing.

Manganese in the soil test.

Manganese levels are adequate in these soils being 1.9-5.5/kg (ppm). (Victorian Agriculture 1996-2025C)

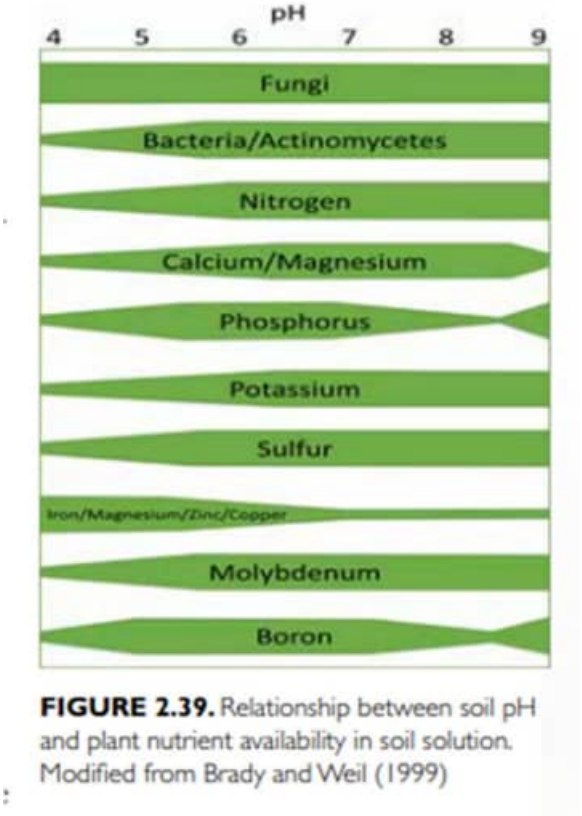


FIGURE 2.39. Relationship between soil pH and plant nutrient availability in soil solution. Modified from Brady and Weil (1999)

Image.39 pH relationship to nutrient (Source Cornell University June 2017)

Deficiency of this mineral is increasingly common and if you are assaulting your soil with copper fungicides and glyphosate, you can pretty much guarantee that you have compromised availability.
There are other factors that impact manganese, including:
Alkaline soils seriously impact manganese availability and foliar correctives are an essential strategy.
High iron in the soil will impact manganese, so deficiency of this mineral is common in the red soils (the red colour is iron oxide).
Sandy soils are notoriously deficient as they lack the clay component that houses the cation, manganese.
Glyphosate kills manganese reducing organisms responsible for solubilising and delivering this mineral. Glyphosate breaks down to another toxic substance called AMPA, which persists and accumulates in the soil for 11 years.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Copper is similarly persistent in the soil. As a heavy metal, it does not leach, it builds and builds. This mineral negatively impacts all beneficial soil life, while antagonising the uptake of manganese. It is actually the least sustainable of all fungicides, and yet it is the principal disease management tool in organics.
Tropical soils that are heavily weathered are also prime candidates for manganese deficiency, particularly during the monsoon.
High calcium, from calcitic soils, or those that have been over-limed, will also impact manganese availability.

Management: Manganese will need to be closely monitored and foliar sprays can be undertaken for deficiencies. Avoiding the use of Glyphosate and copper fungicides will assist in improving the level of Manganese in the soil

Zinc in the soil tests were similar at 0.1-0.2 mg/kg (ppm)and will need to be improved to support stock. Levels between 15-25mg is preferred for grazing. (Source: Victorian Agriculture 1996-2025B) For grazing sheep recommended minimum levels are at least 20mg/kg (Source: Victorian Agriculture 1996-2025 C)

Zinc is an essential element for plant metabolism and growth. It is a constituent of metalloenzymes, or a cofactor for several enzymes such as anhydrases, dehydrogenases, oxidases and peroxidases, and plays an important role in regulating nitrogen metabolism, cell multiplication, photosynthesis, and auxin synthesis in plants. It also plays an important role in the synthesis of nucleic acids and proteins and helps in the utilization of phosphorous and nitrogen during seed formation. While Zn is crucial for the above-mentioned processes, high levels of uncompleted Zn are toxic to plants, and Zn is associated with the blockage of xylem elements and the inhibition of photosynthesis through alteration of electron transport and the capacity of rubisco to fix CO2

Management: Monitor for Zn levels and regularly monitor the pH of the soils. Zinc will increase in the soils with the addition of organic matter.

Other:

Nitrates: The results for nitrates were very low ranging from 0.5-1.2mg/kg (ppm) are low due to the pasture resting so results are expected below 5ppm (mg/kg). The lower pasture exhibits some drainage issues and when soils are waterlogged they will use nitrates to support microbial respiration. One of these was under crop with a requirement to be over 5 mg/kg, this chemical is absorbed into roots being readily available to crops. Looking to increase these levels is necessary. The high level in site.4 is an outlier as this site is often wet and you would expect this form of nitrogen to be released as NO^3.
Nitrate concentration in soil is a good indicator of available nitrogen to plants. The required soil nitrate-nitrogen (NO^3-N) for specific crops varies from crop to crop but in general, a concentration range of 10-50 mg/kg is desired. Pasture management will need to ensure that Nitrates availability is increased across the site.

Management: The land holder needs to sustainably manage the site to ensure that Nitrification is greatly reduced. Nitrogen is one of the most important nutrients for plant growth and hence heavily applied in agricultural systems via fertilization. Nitrification, that is, the conversion of ammonium via nitrite to nitrate by soil microorganisms, however, leads to nitrate leaching and gaseous nitrous oxide production and as such to an up to 50% loss of nitrogen availability for the plant. Nitrate leaching also results in eutrophication of groundwater, drinking water and

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

recreational waters, toxic algal blooms and biodiversity loss, while nitrous oxide is a greenhouse gas with a global warming potential 300× greater than carbon dioxide.

"Nitritation accomplishes the oxidation of ammonia to nitrite, while nitratation phase oxidizes nitrite to nitrate. This process is majorly engineered by some group of nitrifying bacteria and archaea in a complex chemical transformation, and they are affected by several factors. The factors include synthetic fertilizers, chemical nitrification inhibitors and other agrochemicals. The effects are evaluated with total soil nitrogen, mean annual temperature, pH and microbial biomass nitrogen (Ayiti Oluwatobi Esther , Babalola Olubukola Oluranti 2022).

In time past, the rotation of crops was carried out in farming to exploit endophyte nitrogen-fixing rhizobia inhabiting legumes and microorganisms in organic waste to produce beneficial nutrients, ammonia and nitrate for plant use. The practice was safe but could not continually be relied on because it does not provide enough for the plant usage. This resulted in the use of synthetic fertilizer which provides an immediate replacement to naturally produced nutrients. Unfortunately, it negatively affects the rate of nitrification in the long run (Verma et al., 2018). Those with ammonia speed up the rate of nitrification excessively since they provide an immediate substrate for ammonia oxidizers to act on. Also, synthetic fertilizers with phosphate elevate the process of nitrification 12 times by raising soil pH to favor the process (DeForest and Otuya, 2020). This often leads to an oversaturation of nutrients beyond what the biota in the environment can assimilate. Generally, where there is an increase in soil nitrifying microorganisms as a result of synthetic fertilizer application, it is only temporal (Quemada et al., 2019)

Details on composting is included in Appendix. 8

Salinity: Salinity levels for this site where taken an were 0.040 dS/m which is optimal for plant growth.(Source: Agriculture Victoria 17 Dec 2024)

C: N Ratio: The test results indicated consistent levels across the site from 11.9-16.7 (ratio) being rated as marginal to good The lower slope was good with levels dropping to the upper slope/. Microbes require sufficient nitrogen relative to carbon to decompose organic matter and release nutrients, thus the C:N ratio of the soil organic matter, plus it's overall quantity, can provide indications of soil fertility and quality. (Source: Hamilton.L and Anderson.G , 2015)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Organic C:N Ratio Ranking Table:

Ratio Result	Ranking	N Implications	Management Needs
>20:1	Poor; Too much organic C and/or not enough organic N	N tie up by microbes: No N credit given from WEON pool	Increase legumes in rotation or covers; reduce high carbon inputs; graze longer to reduce carbon
Between 15:1 – 20:1	Marginal	Some N tie up; Slower mineralization; Lower N credit from WEON	Increase legumes in rotation or covers; reduce high carbon inputs; graze longer to reduce carbon
Between 8:1 – 15:1	Good	Less N tie up; greater potential for N mineralization; higher credit from WEON	Make slight adjustments if near the boundaries to keep within this range
Between 10:1 – 12:1	Ideal	Greatest potential for N mineralization from WEON pool; good balance of available energy and N for microbes	Increase intensity to drive both WEOC and WEON up together to help increase biological processes
<8:1	Poor; Too little organic C and/or too much organic N	Limited energy for microbial activity; N credit may still be high if soil respiration and WEON are also high	Increase carbon inputs; graze shorter to retain carbon

Image.40 C:N Ratio Source Ward Laboratories 2019)

Management: The soils require more organic carbon. Soil organic carbon is a measurable component of soil organic matter. Organic matter makes up just 2–10% of most soil's mass and has an important role in the physical, chemical and biological function of agricultural soils.
Organic matter contributes to nutrient retention and turnover, soil structure, moisture retention and availability, degradation of pollutants, and carbon sequestration.
Soil Organic carbon can be increased in many ways such as shown below. This site will benefit from nitrogen fixing cover crops and longer periods of grazing.

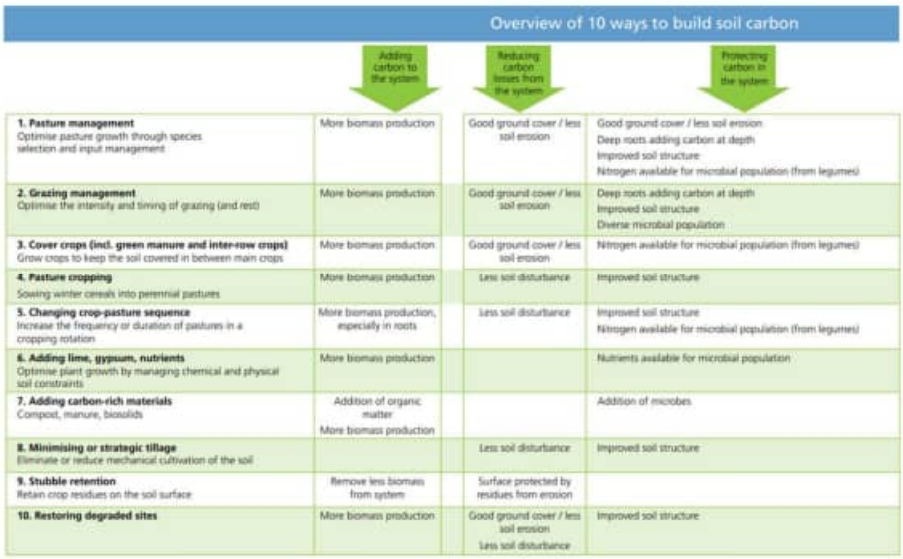


Image.41 NSW. Local Land Services June 2020)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Organic matter with a low C:N ratio (< 20:1) is generally considered high quality as its breaking down results in a higher level of nutrient available for plants. Conversely, organic matter with a high C:N ratio (> 30:1) is generally considered lower quality as it can be slower to breakdown thus results in lower levels of nutrients freed up for plants

Poultry manure	5:1
Humus	10:1
Cow manure	17:1
Legume hay	17:1

Green compost	17.1
Lucerne	18:1
Field pea	19:1

Image 42 (Source: Hamilton.L and Anderson.G , 2015)

Calcium: Calcium levels on this site are ideal ranging from 56-54 so these ranges are low and this needs to be closely monitored as lack of calcium can lead to stock loss.

Agricultural soils require a minimum of 100-200 mg/kg This element is essential for plant growth; increases will occur with the adjustment of the pH and these levels will require routine testing.

Management: Sources of calcium

Large additions of Ca inputs such as lime or gypsum may be recommended to address soil pH and sodicity problems. If soil pH is adjusted to above 5.5, or ESP reduced below 5%, calcium is unlikely to be in low supply. When targeted inputs are needed during the growing season, several highly soluble Ca sources are available. They may be best applied to the active root zone to promote rapid uptake.

Lime (~40% Ca) should be used on acid soils at rates to adjust the soil pH to the target level. Typical rates are 2.5 to 7.5 t/ha and a lime requirement test will assist in identifying an appropriate rate. In cropping systems, lime should be applied several months ahead of planting and mechanically incorporated. Lime will not dissolve in alkaline soils so should not be considered as a Ca source in those situations.

Gypsum (~23% Ca) is used as a Ca supplement and as a soil ameliorant. When used, surface applied gypsum needs to be applied well ahead of planting.

Phosphate fertilizers contain quite large amounts of Ca. For example, single superphosphate has ~20% Ca and triple superphosphate has ~15% Ca. There is very little Ca in MAP or DAP.

Foliar sources such as calcium nitrate (19% Ca), calcium ammonium nitrate (~10% Ca) and chelated calcium can be beneficial to address potential deficiencies, but only a limited amount of Ca can be assimilated this way. However, a foliar application near the tissue at risk (such as developing

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

almonds or apples) can reduce the risk of the effects of Ca deficiency. There is no published evidence in Australia to show that adding Ca enhances N uptake, and it is difficult to propose a mechanism by which this might occur.

Soil Organic Matter (SOM) The soil organic matter levels were recorded between 3.49% and 6.09% and Australian soils usually range between 2-10% of the soil mass and is essential to the soils physical, chemical and biological function. Organic matter renders soils more resilient to environmental change and also influences characteristics such as colour and workability. Microbes digest up to 90 per cent of organic carbon that enters a soil in organic residues. In doing so, they respire the carbon back into the atmosphere as carbon dioxide (CO2). Microbes continually break down organic residues eventually converting a small proportion of them to humus, which gives the topsoil its dark colour. While up to 30 per cent of organic inputs can eventually be converted to humus depending on soil type and climate, in Australian agricultural soils this value is often significantly less. (Grains Research and development Corporation, July 2013)

Summary

The overall soil health is 8-11 which is a low score usually range from 0-50 with most soils under 30. The higher this increases to 30 is indicative of the soil health improvement. This score balances the carbon and nitrogen compared to the microbial respiration. (Clause 13.0, Clause 14.01-1S)

These results demonstrate that the soils are lacking in organic carbon, water extractable nitrogen, potassium, phosphorous, zinc and Manganese with poor results. This reflects that the soils lack fertility. The water extractable organic carbon is low indicating a low amount of carbon available to soil microbes. The water extractable Nitrogen demonstrates low mineralisation of nitrogen and phosphorus.

The soil quality on this site is not sufficient to maintain growth with yield and growth and without risking harm to stock.

Requirements to improve soil health.

Increase carbon

To increase carbon in the soil looking to reduce tillage is required as tilling will break up the aggregates and carbon is lost to the atmosphere as CO^2. Tillage also compromised soil health microbes and pathogens are compromised; a single disc to reduce disturbance is recommended. Wet areas where soils can loose carbon through nitrification are best planted with moist loving trees such as Eucalyptus camaldulensis (River Red Gum) this will help retain soil carbon and the trees will also store carbon this also provides an alternate income from coppicing the trees for firewood and offers protection to stock in extreme weather conditions. Diversifying cover crops and over sowing crops with drilling rather than let the fields lay fallow assist in the retention of carbon in the soils. Pasture management and moving stock continually through paddocks such as strip grazing is essential. Composting and applying waste back to the soils will increase carbon and increase soil health; increasing soil health naturally will reduce the need to supplement with chemical fertilisation

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

that will reduce costs. Composting should look to increase green and brown compost to the soils to not only increase bacteria but fungi back to the soil. (Clause 14.01-1S)

> "Soil carbon farming can also have economic, community and human health benefits. The improvements in soil health, increases in crop yields and productivity can enhance farm profitability. In addition, it can create new revenue streams by enabling farmers to sell their carbon credits, which they can earn through the sequestration of carbon in the soil." (Source: Carbon Sync, nd)

Compaction

Compaction is evident in these soils and controlled traffic lines confines machinery to specific traffic lanes these will be implemented in the farm management plan. To increase soil health long term a deep tillage using a Yeomans Plough is required to break up the surface compacted layer. To allow for moisture filtration and to allow roots to grow. The soil must be dry after rains so that they hold some moisture but are not moist.; use the technique that if you can roll the soil it is too wet and if it runs through your hand it's too dry. The soil should still be crumbly but not roll into a rod this is the ideal moisture for opening the soils to ameliorate compaction. Move stock throughout the farm and move stock off wet soils as soon as possible. Run machinery through the paddocks in the same patterns each time to limit areas that are compacted. (Clause 14.01-1S)

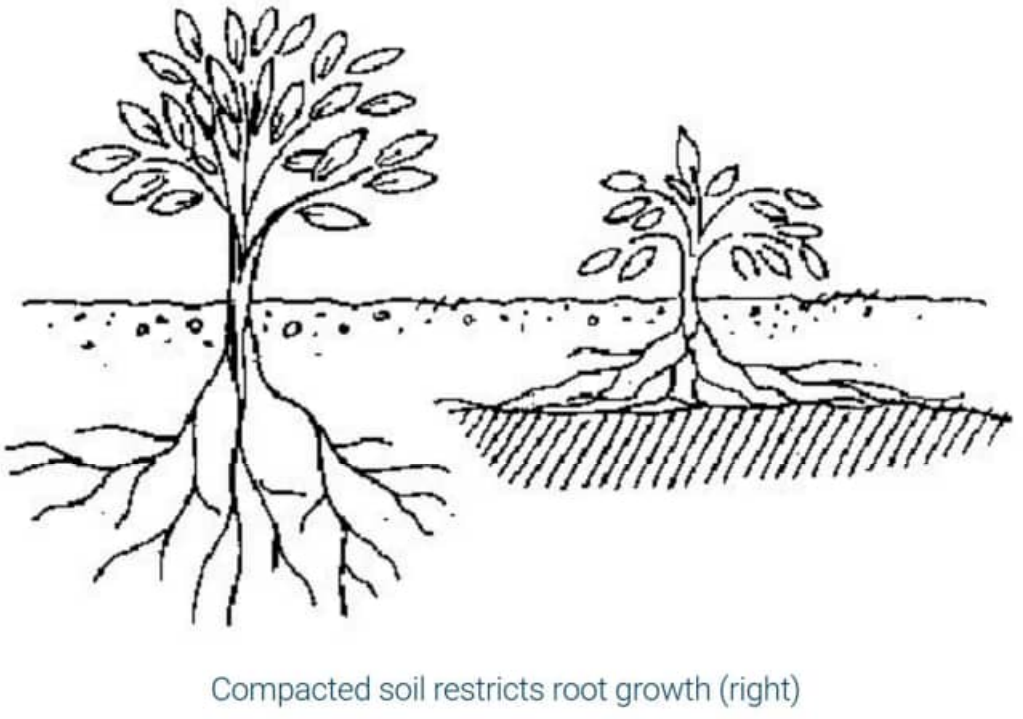


Image 43: Soil compaction (Source NSW nd)

Retaining cover crop on site will avoid compaction and can buffer between the compression from machinery. The use of deeper-rooted perennials in the mix will deepen the roots into the

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

substratum and help to break soil compaction and allow air and moisture to reach deep into the soils. This also provides resilience against climate change.

Mineralisation

Increasing soil fertility will increase with cover crop production and is a natural way to improve soils. Applying Nitrogen fertilisers will lead to the immobilisation of N in the microbial biomass and reduce mineralisation. Increasing organic matter to feed the microbes, cover crops and pasture management will aid microbes to decompose soil organic matter and increase mineralisation. (Source: Peter Bolo, Monicah Mucheru-Muna, Michael Kinyua, George Ayaga, Sylvia Nyawira, Job Kihara, 13 May 2024)

Low Potassium levels

These soils are known to have high risk of leaching and a finding of low potassium levels is not uncommon in these situations. Fodder crops such as Canola and Hay remove 100kg/ha of Potassium from the soils. Potassium is essential to support legumes and is lost through grazing and is first seen in the legumes. One of the soil tests on site showed poor growth and no nodules on the legumes in the mix this is the first sign of Potassium deficiency. (Source: University of Wisconsin-Madison 2025)

Increasing rooting depth with crops will enable plants to access potassium in the soil, once levels are rectified allowing legumes to flower will increase Potassium in the soil. Managing potassium in the soil manages the nitrogen as potassium feeds legumes, legumes provide nitrogen, nitrogen feeds grass.

Nitrate levels

Nitrate levels in the soil depend on the type of soil and this soil seems to leach nitrogen readily. Growing crops all year round, rotating crops with nitrogen fixing legumes, the addition of manure and compost especially green manures with a high C:N ratio are beneficial.

Soil Health

It has covered in the soil test summary what requirements are necessary to improve the soil health. I use the Haney Soil testing system as primarily I am not only concerned with the nutrient levels but the health and diversity of the soil (microbial)

“The diversity of organisms living within soils is critical to all earth ecosystems because soil organisms:

- are essential for the cycling of ecosystem nutrients.
- are necessary for plant growth and plant nutrition.
- improve the entry of water into soil and its storage in the soil.
- provide resistance to erosion.
- suppress pests, parasites and disease.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

- aid the capture of carbon.
- are vital to the world's gas exchange cycles.
- break down organic matter.
- Soil biodiversity is recognised as a critical influence on agriculture as it can enhance sustainability through improved:
- soil structure
- soil water movement
- nutrient availability
- suppression of pests and diseases.

The Food and Agriculture Organization of the United States (FAO) estimates the socio-economic value of soil biodiversity exceeds US$1542 billion.

Soil health improvements will benefit the viability of the farm in the long run; it takes time to improve soil health. Soil health is imperative to repairing land degradation from historic farming practices. This site will benefit from improving soil health, undertaking grazing, the use of diverse cover crops, residue retention, minimum tillage, capturing soil carbon, use of compost and rotational grazing.

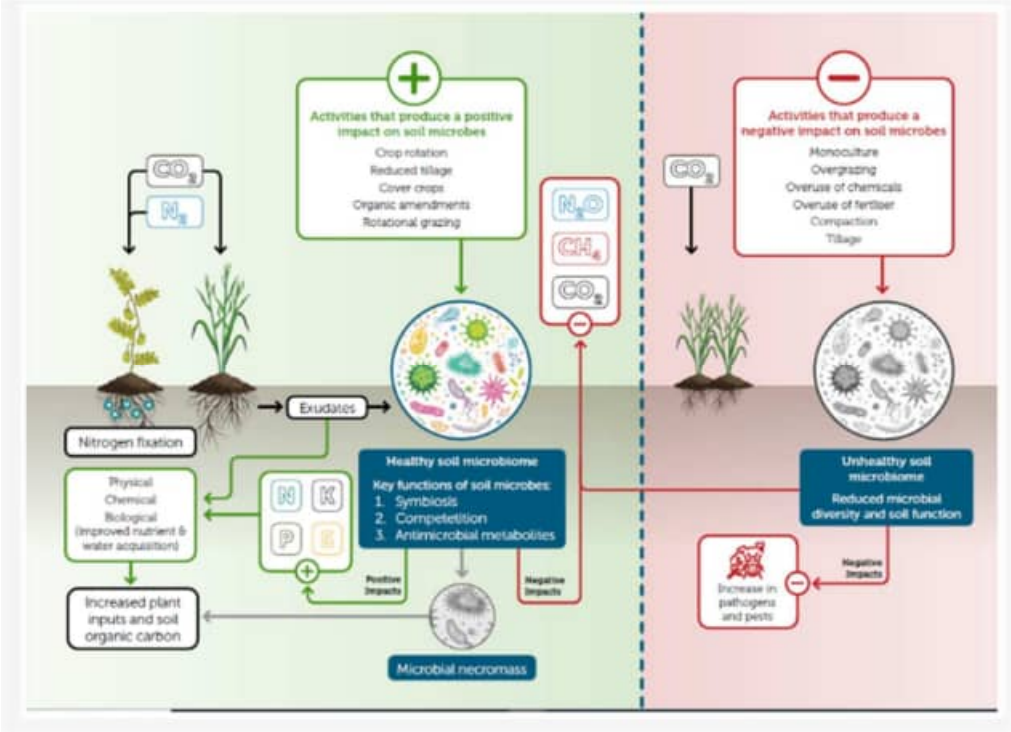


Image.44 Plant × microbe × environment × management interactions impacting soil organic carbon (SOC) and soil health.

(Source :Khangura, R.; Ferris, D.; Wagg, C.; Bowyer, J. 2023)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

RA Principles	RA Practices	RA Benefits	Microbial Mechanisms

•Minimise soil disturbance
•Keep soils covered
•Keep living roots in soil year round
•Encourage diversity
•Integrate livestock
	• No/minimum tillage
	• Stubble retention
	• Diverse crop rotations
	• Multispecies cover crops
	• Intercropping
	• Composting and use biostimulants
	• Rotational grazing
	• Reduce synthetic inputs
		• Improved soil health through
		  • Increased soil carbon
		  • Improved microbial functions and associated nutrient cycling
		  • Improved soil moisture
		  • Improved resilience to pests and diseases
		• Nutrient rich food
		• Reduced greenhouse gas emissions
			•Liquid carbon pathway
			•Improved uptake of water and minerals
			•Enhanced soil aggregation, plant growth and photosynthesis

Image.45. RA (Regenerative Agriculture) principles, practices, and purported benefits and mechanisms to improve soil health. (Source :Khangura, R.; Ferris, D.; Wagg, C.; Bowyer, J. 2023)

Soil Biodiversity

Soils that support natural, non-agricultural ecosystems usually have the greatest soil biodiversity.

Soils support our agriculture.

In agriculture, soils that receive less manufactured inputs (e.g. chemical fertilisers and pesticides) generally have higher soil biodiversity.

Grazing systems which encourage plant diversity usually have higher soil biodiversity, due to the greater availability of food resources from roots and litter, which support a greater variety of organisms in the soil.

Cropping systems generally have low soil biodiversity, unless they increase inputs of carbon and nitrogen to the soil, which will increase soil microbial populations. Crop management techniques that increase soil organic matter will also increase soil stability and soil biodiversity.

The application of organic matter to the soil, such as crop stubble, supports greater populations of surface feeding creatures including earthworms.

Management techniques such as crop rotation and reduced tillage increase the quantity and quality of organic matter available to soil organisms and develop a more stable environment that encourages more soil biodiversity.

Plant diversity is essential to maintain food production and provides many benefits such as suppression of pest and pathogens, improved water retention. Legume crops are essential to

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

increases Nitrogen into the soil naturally and increases Soil Organic Carbon by at least 6-8% than a monoculture.

Composting

Composting is a balance of plant (both green and brown) and animal materials.

Green Compost example is Pig and chicken (animal) manure with young soft non woody cover crops and cycles nutrients and provides essential bacteria to the soils.

Image:46 Green composting C:N ratio (Source Pet Poo Skiddoo 2024)

Brown compost example is Lignified brown plant material, mature cover crops and manures with bedding. Dry dead plant materials. Brown compost adds fungal life and builds organic matter in soils.

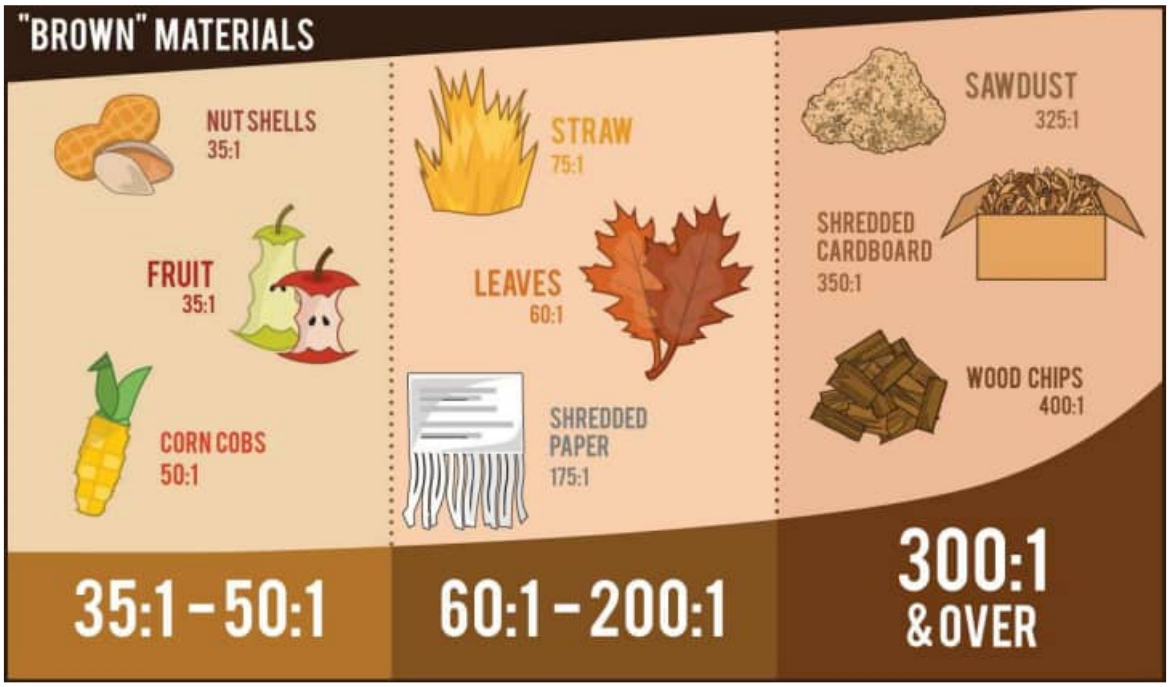


Image: 47 Green composting C:N ratio (Source Pet Poo Skiddoo 2024)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Compost can be produced quickly over 14 days from a mix of 3:1 Brown to Green in windrows and turned every 3 days over a 14-day period. This compost will be a higher bacterial base than a compost developed over a longer period. Soil borne bacteria and fungi assist the market garden by supressing diseases and restore the ecological balance.

Cover crops and diversity.

Maintaining cover always benefits the soils and cover should look to always retain at least a 90% cover on the farm. Diversity of species in cover crops that are chosen to grow when the main crop has finished to ensure that there is always growth in the soils at all times of the year.

This is one of the most essential techniques for this site.

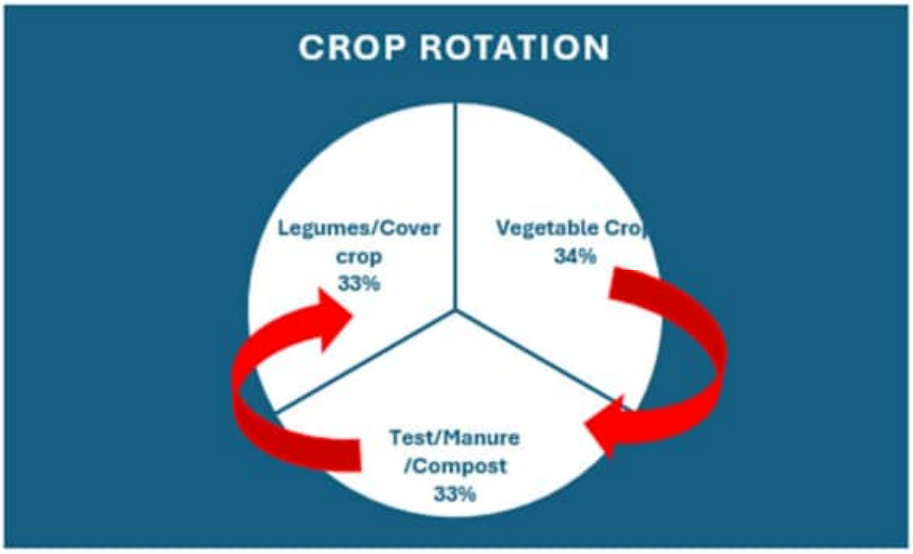
Cover crops on this site will be sown in conjunction with an Agronomist who can select a diverse species mix to inter sow between the finished market garden crop. It is essential there are nitrogen fixers and deeper-rooted perennials in the mix.

Combining the cover crop with the residue has been shown to stimulate microbial diversity and function and is the driver in nutrient release especially in sandy soils, with long erm positive impacts on yield. (Source: Dos Santos Cordeiro, C.F.; Echer, F.R.; Araujo, F.F. Cover crops impact crops yields by improving microbiological activity and fertility in sandy soil. J. Soil Sci. Plant Nutr. 2021, 21, 1968–1977.)

“Plant diversity is important in both natural and managed systems and is thought to be essential for maintaining soil productivity. Crop diversification provides a multitude of benefits, including increased crop productivity and biodiversity, suppression of pests and pathogens, and improved water and soil quality [87]. Without the use of nitrogen fertilisers, legume cover crops have a positive impact on the yield of the subsequent main crop A meta-analysis of 1001 paired observations from 121 papers found that species mixes increased SOC content and stock by 6–8% more than monocultures. Source: Chen, X.; Chen, H.Y.H.; Chen, C.; Ma, Z.; Searle, E.B.; Yu, Z.; Huang, Z. 2019)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Crop Rotation



Crop rotation allows for soil health to be improved with nutrients from manures, compost and chemical intervention if it cannot be achieved naturally. This practice reduces reliance on chemical interventions that are unsustainable, expensive and can contribute to land and water degradation. A natural cycle improves soil health and adds necessary soil organic carbon which is essential to this soil especially when deeper rooted and nitrogen fixing crops are used to increase labile carbon and soil structure.

“Deep-rooted perennials may benefit from sequestering Soil organic carbon (SOC) at greater depths, especially in marginally productive soils. Over a 22-year period, a comparison of SOC sequestration potential and stocks in tagasaste (a woody N-fixing perennial) and annual crops in high rainfall zones of WA revealed that tagasaste had a higher C sequestration rate and stock to a depth of 0.9 m. (Source: Wochesländer, R.; Harper, R.J.; Sochacki, S.R.; Ward, P.R.; Revell, C. Tagasaste 2016)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Grazing Stock

Grazing forms an essential part of farm production and is essential to stressing the plants to forming new growth in response to predation. This response involves increasing root mass and to do this the grasses exuding essential sugars into the soil to feed the microbes; the microbes then produce carbon in the soil. Microbes in the soil co-exist and often move into the roots of the plants and lead to greater root depth (Rhyzosphere) and exudes a gluey sticky substance that glues the soil particles together and increases aggregation. Aggregation is essential in soils for the development of pore spaces and improves aeration and drainage in soils.

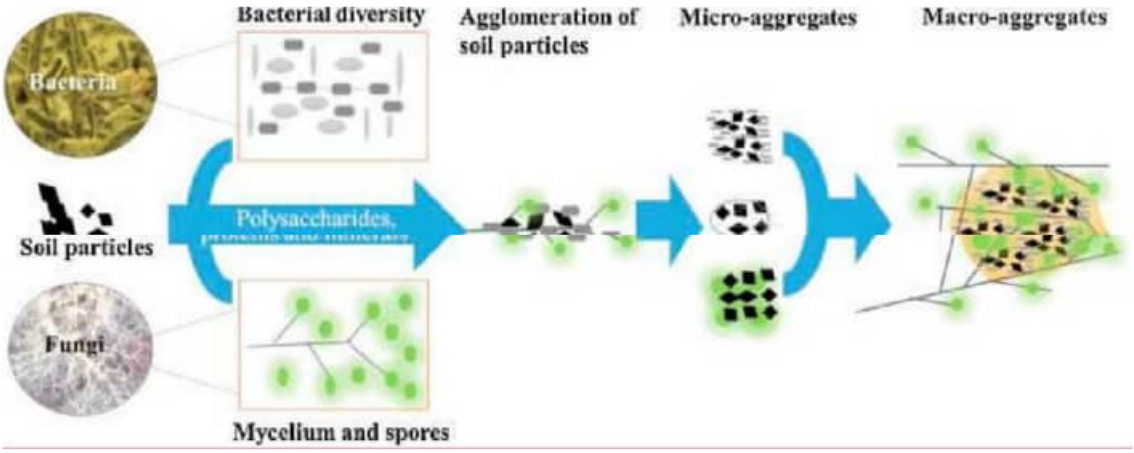


Image 48. Importance of grazing to the improvement of soil aggregates (Source: Muhammad Imtiaz Rashid, Liyakat Hamid Mujawar, Tanvir Shahzad, Talal Almeelbi, Iqbal M.I. Ismail, Mohammad Oves, (2016)

Grazing needs to ensure that it is light, and that stock are rotated around the farm. Light grazing is essential to fungi and bacteria in the soil that leads to the decomposition of organic soil carbon. Over and under grazing has a detrimental impact on the balance and health of the soil.

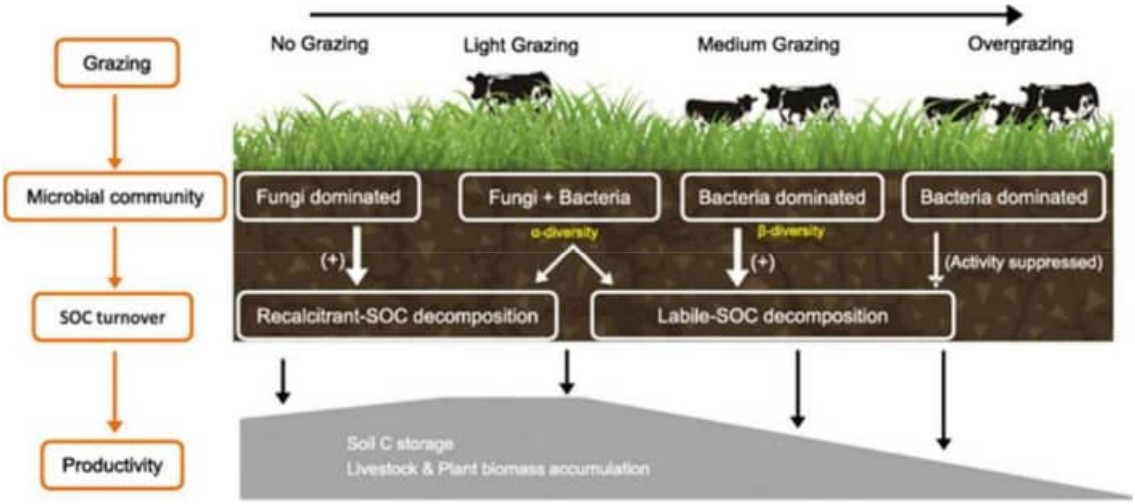


Image.49 Soil Organic Carbon from grazing strategies (Source: Xun, W., Yan, R., Ren, Y. et al 2018)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Grazing is recommended on site in the inter rows between the orchard trees and during and towards the end of the cover crop to stimulate root growth. Stock will be placed in for short periods in strips and removed once cover is down to a 3-4 cm depth. It is recommended that the grazing is a smaller animal such as sheep to reduce the risk of compaction to the soils.

Water requirements and use

Potable water is not available to the site and all structures where possible will be used to collect and store water. There are water tanks that collect from the dwelling roof to collect water any additional shedding that maybe put in at a later date to store machinery etc will need to collect water. There is also the ability to apply for a bore if required.

Site Plan

A farm and site plan has been supplied that details the layout of the farm and are included in the appendix to this report.

Management Zones

Domestic Zone

All buildings, structures and works are to be contained within this zone. All domestic activity is to be limited to this area and any domestic animals contained in this zone using internal fencing This is the only zone where vehicle access is allowed unless the farm management plan shows vehicle access to pastures..

Ensure that any works in this area ensures that all sediment is controlled within this area and has no ability to enter the waterway.

90% cover to be always maintained.

Driveways and vehicles access to be all weather permeable surfaces to control run off.

All weeds are to be monitored for and removed on a regular basis to ensure that they do not spread to other areas.

No weed species or environmental weeds to be planted in the garden to ensure they do not spread to other sensitive areas.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Farming Zone

The objective of the farming zone area is for agriculture.

Management objectives apply to this area:

- Fencing must be maintained in good order and repaired immediately if necessary.
- Area to be mostly fenced in accordance with the Farm Management Plan to ensure grazing is rotational and allow some paddocks to be improved when not grazed.
- Summer grazing during extreme for paddock 4 and daily reviews to make sure cover is retained at 90%. The use of the tree cover will ensure a reduced impact on animal stress and will also sequester carbon in the soil. Alternative shelters will be required during periods of recruitment of native species that occurs from later summer through to the following spring. Do not remove organic matter from below trees as this mulches down into the soil.
- Landowner must maintain and protect all scattered trees from stock and ensure that regeneration can occur around the base. The trees are to be fenced with a 5m radius from the main trunk.
- Weeds must be monitored and maintained as they emerge.
- 90% cover to be always maintained in all paddocks.
- On going composting of soils and review of soil health by an Agronomist.
- Any other works as nominated by a consultant Agronomist.
- Drainage to be improved in conjunction with an Agronomist.
- Cover species to be increased to ensure growth all year in paddocks under the guidance of an Agronomist.
- Provide suitable barriers to all old growth scattered trees with a minimum radius of 5m to ensure that the stem is not always impacted by stock. Any damage to these structures must be attended to so that damage to the trees cannot occur.
- All traffic routes to be constructed and maintained.

Conservation Protection Zone

Native vegetation is fully protected in this area including any fallen timber or dead standing trees, including fine fuels.

Management objectives apply to this area:

- Fencing must be maintained in good order and repaired immediately if necessary. This fence must not include any barbed wire, be wildlife friendly.
- No grazing by livestock

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

- There is no stockpiling/storage or soil disturbance.
- Landowner must maintain and protect all live native vegetation and allow for natural regeneration.
- Weed control must be always undertaken by a suitably qualified contractor to reduce any high-risk weeds.
- Photo points are to be established, and images collected each year to understand how the area is responding to management.
- No removal of material for firewood
- No vehicle access
- Any human access to this area must undertake cleaning of shoes prior to entry as specified in Appendix 10… so as to control the spread of Phytophthora in this area.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Locality Plan

Adjoining land use

The landscape is mixed has a mix use with grazing being the predominant land use and housing on the ridges with access to connective road networks.

Adjoining land use (Clause 02.03-4, Clause 14, Clause 35.07-6)

The landscape is mixed with grazing being the predominant land use around the site with a mix of residential living and cropping along with the National Park in the landscape.

Image. 50 VLIUS (Oct 2018)(Source: Australian Collaborative Land Use and Management Program Partners Oct 2018)

The red is 3.2.0 Grazing on modified pastures (site as well)

Purple is 3.3.1 Dryland cropping

Gold is 3.4.9 Perennial-Horticulture Grapes

Green is 5.4.2 Rural Residential with agriculture.

Pink is 5.8.2 Quarry

Blue is 1.1.3 National Park

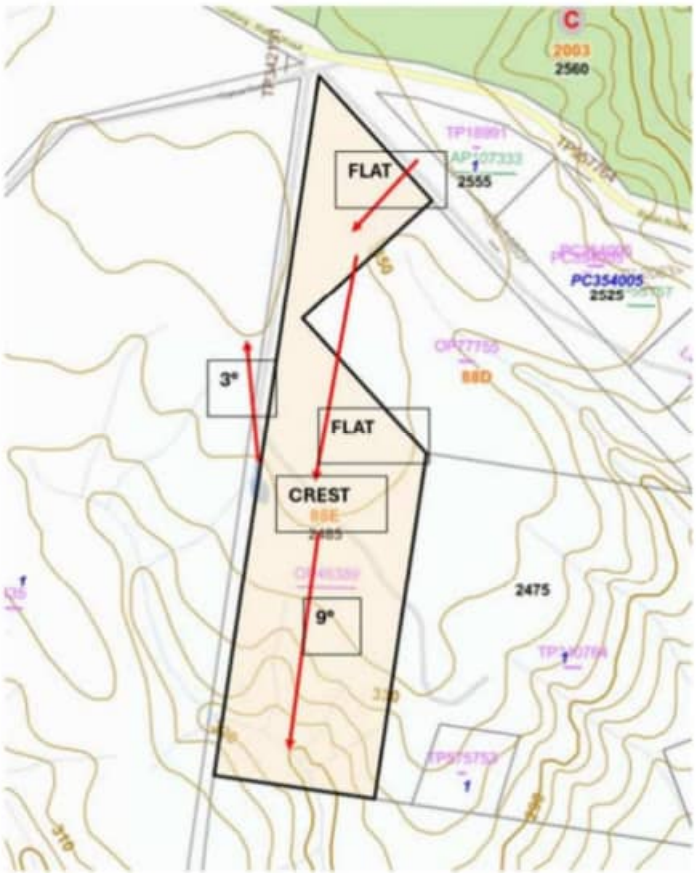


Image:51 Slopes on the site (Adapted from Department of Transport and Planning, Version 2.5.1 10m contours)

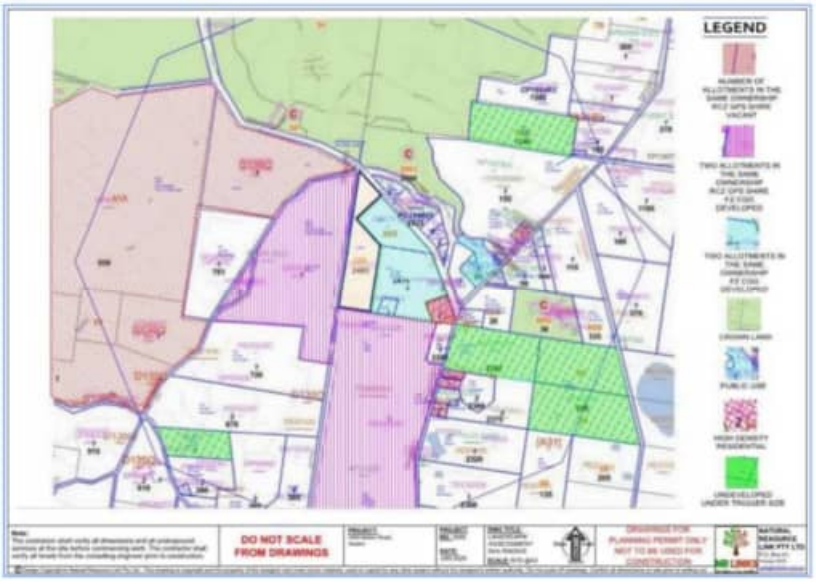


Image.52 Landscape land use plan

The adjacent properties are mostly developed out of the fifty properties, only six require a permit for a dwelling. The development is a mix of high-density residential lots under 2ha and

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

developed lots with crown land. The density adjacent to the site are half large lots

over 30ha and the others 3-4ha in size; this would deem the site to be in an area

that has a high density of dwellings.

Amenity risk, measures and management

The proposed use is already a feature in the landscape and unlikely to contribute a detriment to any existing uses. No large buildings or clearing of vegetation is proposed that would contribute to a change in the amenity; the siting cannot be viewed from the Ballan road due to tree cover.

The house is a sympathetic single level house of a similar size to that existing in the landscape and will not change the amenity of the location.

Setbacks

The proposed dwelling has a front setback of 92m (West); the side setback to the north is 556m and to the south is 616m and to the rear (East) is 121.6m

The closest dwelling is not in the same ownership:

2475 Ballan Road (SE) is 434m

2525-2545 Ballan Road (NE) is 496m

Separation

Setbacks to sensitive use such as high-density residential development (township) is 645m to the WSW from this site to the smaller residential lot.

Setbacks to adjacent properties

The proposed dwelling is well over 100m from any adjacent dwelling and achieves all setbacks in the scheme.. The proposed dwelling is not located close to any sensitive use areas.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Pasture Improvement

Grazing- Integrating sheep

It is imperative to continue grazing on the entire site as this stimulates re-growth and the production of a healthy Rhisosphere which will continue to open macropores in the soil and feed the microbes in the soil.

The Integration of sheep adds nutrients to the soil that is positive for C sequestration and soil biota, reduces the need to spray for weeds. Additionally, The the continuation of grazing of the cover crops stimulates regrowth and root development and increases the activity to the Rhizosphere which improves soil micropores. The use of this small breed enables grazing during the year which is essential to improving soil health.

Grazing forms an essential part of farm production and is essential to stressing the plants to forming new growth in response to predation. This response involves increasing root mass and to do this the grasses exuding essential sugars into the soil to feed the microbes; the microbes then produce carbon in the soil. Microbes in the soil co-exist and often move into the roots of the plants and lead to greater root depth (Rhyzosphere) and exudes a gluey sticky substance that glues the soil particles together and increases aggregation. Aggregation is essential in soils for the development of pore spaces and improves aeration and drainage in soils.

Rotational grazing is essential to obtain the right balance. Grazing for short periods in the Vineyard to essential reduce the tips back whilst still retaining cover to 100% is essential. Ongoing monitoring on site is imperative to monitor cover and to move stock onto another area.

Cover crops

Cover crops stabilize soils and contribute to the regeneration of soil function and biodiversity on the farm The use of legumes in the mix along with grasses or forbs that have a high level of diversity is essential to ensure continual growth during the year. The mix should aim to contain 2-3 legumes. Cover crops can be used to slow precipitation and alleviate the effects of droughts. Cover crops increase soil carbon and increase the soils' ability to recycle nutrients.The benefits of cover crops will reduce run-off and erosion and increase water penetration into the soil. Cover crops increase microbial biomass and amount of carbon in the soil.

Rotational and strip grazing

I have included a general grazing concept whereby the sheep are rotated across the site so that they are only grazing the tops and retaining 100% cover. The carrying capacity is difficult to quantify as the soils were so compacted it was difficult to establish a current depth of roots. Stock are given a strip that is temporarily fenced with an electric fence and moved through the day.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Pasture Management.

Pastures for stock require a mixture of pasture species to ensure growth all year round and to feed the microbes in the soil.

It is recommended that the pasture species be increased to have at least 2 types of clover with a mix of deeper-rooted perennials. The mix should aim to have species growing for the period that the crop is used.

You will need an Agronomist to work with the landowner to develop the most suitable mix for microclimate on site.

This pasture management deepens the soil and sequester more nitrogen and carbon into the soil to avoid it having to be artificially manipulated each year as suggested by the agronomist.

It is suggested that phosphorous is added to the soil prior to the establishment of legumes as this will increase the nitrogen fixing capacity of the legumes. Phosphorus cycles around the food chain and the addition of green and brown manures, compost, food waste will return the Phosphorous to the soils to sustain plant growth.

Pastures will need to be improved with composted green and brown manures and aerated with a Yeomans Plough to open the soils and then oversewn with nitrogen fixing species. It is suggested that a low level of phosphorus and nitrogen be used initially or as advised from further testing. This is recommended as it will take time to improve the nitrogen deficiencies in the soil. Typically, they are just since the site is not managed sustainably and thus requires ongoing addition of fertilisers. The reliance on chemicals will decrease as the organic matter and manures and compost are returned to the paddocks.

Composting

Is proposed to improve soil health by collecting all green and brown manure on site and composting this to be used to improve soils as covered in Appendix.8

The landowner has been collecting debris to start composting on site as shown here.

Image.53 Composting on site.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Land conservation and biodiversity

A large section of the site where there is a risk of erosion is covered by remnant vegetation . The vegetation on site consists of a large patch to the south that is mapped to be EVC 20 Dry Heathy Forest and the open pastures as EVC 16 Lowland Forest.in the Central Victorian Uplands Bioregion (Source: Naturekit). The EVC's have the following Bioregional Conservation status of Least concern. The vegetation is indicative of the current mapping and the main risk to this area is the access to site that is spreading the risk of Phytophthora. This is a serious issue and all due care must be undertaken to reduce access and any foot traffic must involve cleaning of the shoes.

Image. 54 the landowner consulted with me regarding the leaf litter under the isolated patches in the Farm Zone and understands that this needs to be allowed to breakdown and return to the soil.

Permissions

The business requires registration as a business and needs to apply for a PIC number for this site before the purchase of stock.

There are no EPA approvals required

Services

Utilities

The site does not have the capacity to connect to services.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Biosecurity

The Biosecurity form and signs are in the appendix. Entry is marked to the farm with a warning sign and parking is provided and no entry to the farm is allowed until advised directly by the Livestock Manager. These signs can be downloaded from https://www.farmbiosecurity.com.au/toolkit/gate-signs/ and also details where the signs can be purchased from.

Image 55 Biosecurity sign for farm entry (Source: Farm Biosecurity nd)

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Mortality Management

Trench burial is the most suitable form of on-farm burial. Trench burial involves excavating a trench (or pit), into the ground, placing carcasses and other materials in the unlined pit and covering the materials (backfilling) with excavated earth. Typically, this takes place on the farm where animals are from.

Depending on your property and the number of livestock to be buried, multiple trenches may be needed in safe, spaced-out locations (see below for specific details on the typical size, design and spacing of trenches).

To determine where a burial pit might be dug in an EAD event, a site-specific risk assessment must be undertaken. This will determine if and where on-farm burial can be done safely to manage the risks, particularly to surface and groundwater, and to manage the risk to the surrounding amenity.

The following criteria have been developed to assist you in mapping out any areas on your property that might be suitable for trench burial of carcasses. They are the same elements that Agriculture Victoria staff will consider when undertaking the risk assessment process in an EAD event.

To minimise the risks associated with on-farm disposal of animal carcasses and other wastes, ideally a burial pit should be located:

- at least 200 metres from any groundwater supply (stock and domestic bore)
- at least 2 metres above the water table level (measured from the bottom of the pit)
- at least 200 metres from any surface water (creek, river, lake or spring), excluding dams that are not seeping into groundwater or flowing offsite
- away from surface water drainage features, low points or areas at risk of erosion
- on clay soil of low permeability and good stability
- away from underground and above-ground infrastructure (such as powerlines, telephone and fibre optic lines, gas lines, waterpipes or sewerage)
- above the one in 100-year flood level
- at least 200 metres from another burial area
- on elevated land but with a slope of less than 5% (preferably less than 2%)
- away from conservation areas and areas of cultural sensitivity
- at least 200 metres from the boundary of neighbouring privately owned land
- at least 300 metres from any sensitive use (such as a neighbouring house)
- out of view of the public (by either being far away from public areas or by screening).

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Pest Management

The site is typical of a farm and is well managed, no weeds were evident on the site visit.

Pest Animals

No evidence of pest animals was noted on the site inspection.

It is still imperative to monitor rabbits and foxes on an ongoing basis especially at lambing.

Traffic Management

Due to the compaction risk of soils on site a set traffic route is provided for the farm. Vehicle access to pastures will be limited to the use of the tractor to do soil work or to collect a deceased animal for burial.

The pastures have access to the Durdiwarrah and other minor tracks on site so do not need a set traffic route through the farm.

Fire Safety

Fire safety is important as the site is in a Bushfire Prone area and can be subject to fast moving grass fires driven by winds. In the event of a grassfire or embers from a landscape fire the house will need to be designed to a BAL that is sufficient for the landscape risk.

Labour skill requirements

The labor skills on site are provided primarily by the owners and a consultant Agronomist.

Financial projections/Budgets

The site has a long way to go to improve the soils before the stock is bought for the farm; therefore budgets have not been included as they will demonstrate only expenses for the first 4-6 years.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Potential diversity to improve resilience and viability for the farm (unquantified in monetary terms)

This farm management plan aims too also:

- Increase in carbon sequestration allowing recruitment to establish.
- Increase in grazing on site to stimulate growth to sequester more carbon- rotational grazing.
- Improving soil structure
- Improving soil nitrogen with nitrogen fixing pasture species.
- Ameliorating the risk of compaction of soils- placing a set traffic route to the farm management plan.
- Always retain cover at 100% to reduce soil loss to avoid loss of soil from wind erosion and soil degradation.

Time frame for farm business

The time frame is to build the dwelling, organize a consultant agronomist to assist with regularly testing to improve the soil requirements as outlined in this report. Then look to purchase purebred Poll Dorest stock and develop a breeding program. The soil and farm management process including pasture management and composting will commence on the completion of this report.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

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Appendix.1 Existing Plan

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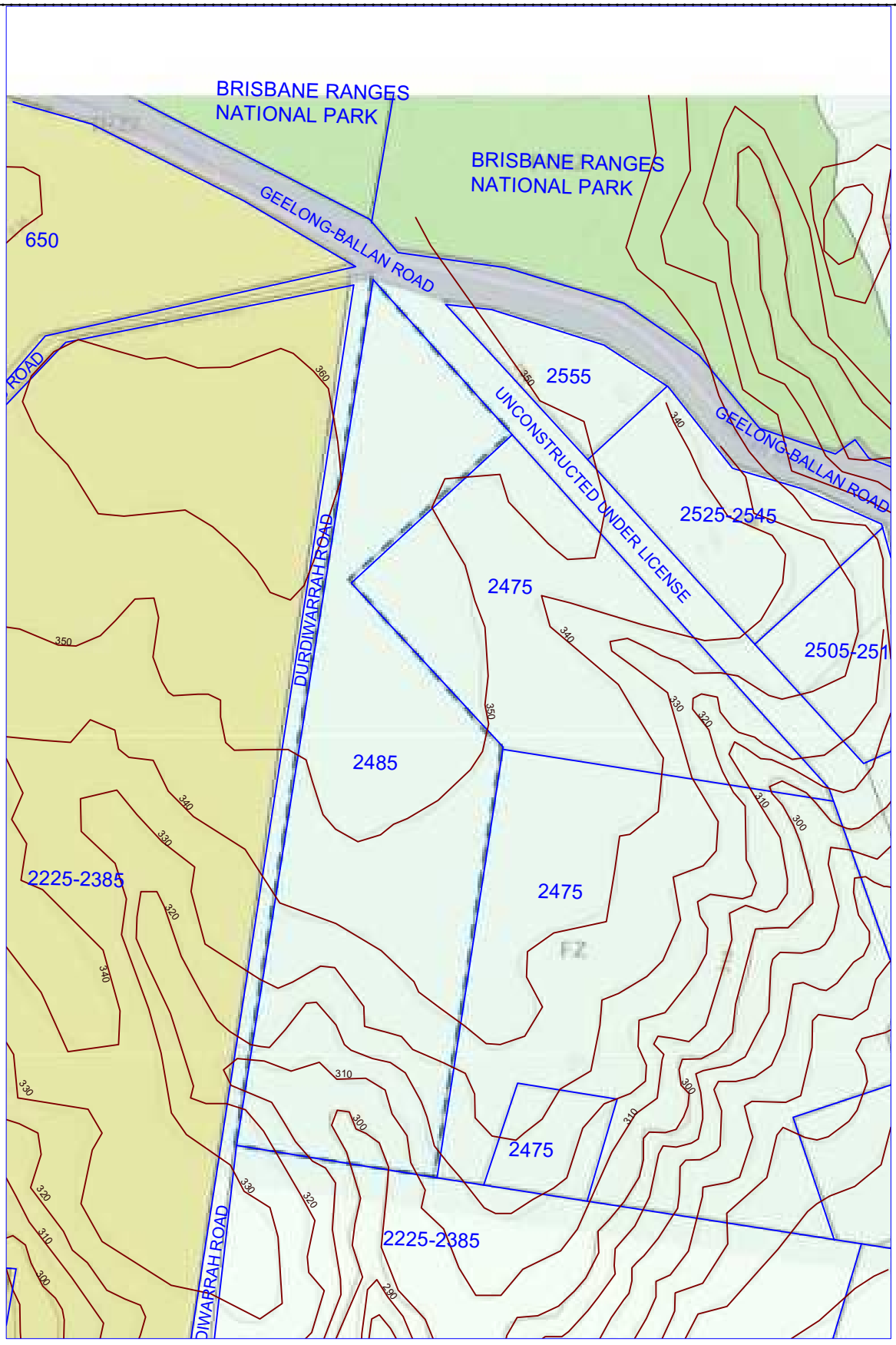

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South

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PROJECT:
2485 Ballan Road,
Anakie

PROJECT NO: *2688*

DATE:
JAN 2025

DWG TITLE:
EXISTING SITE PLAN

SCALE: 1:8000 @A4

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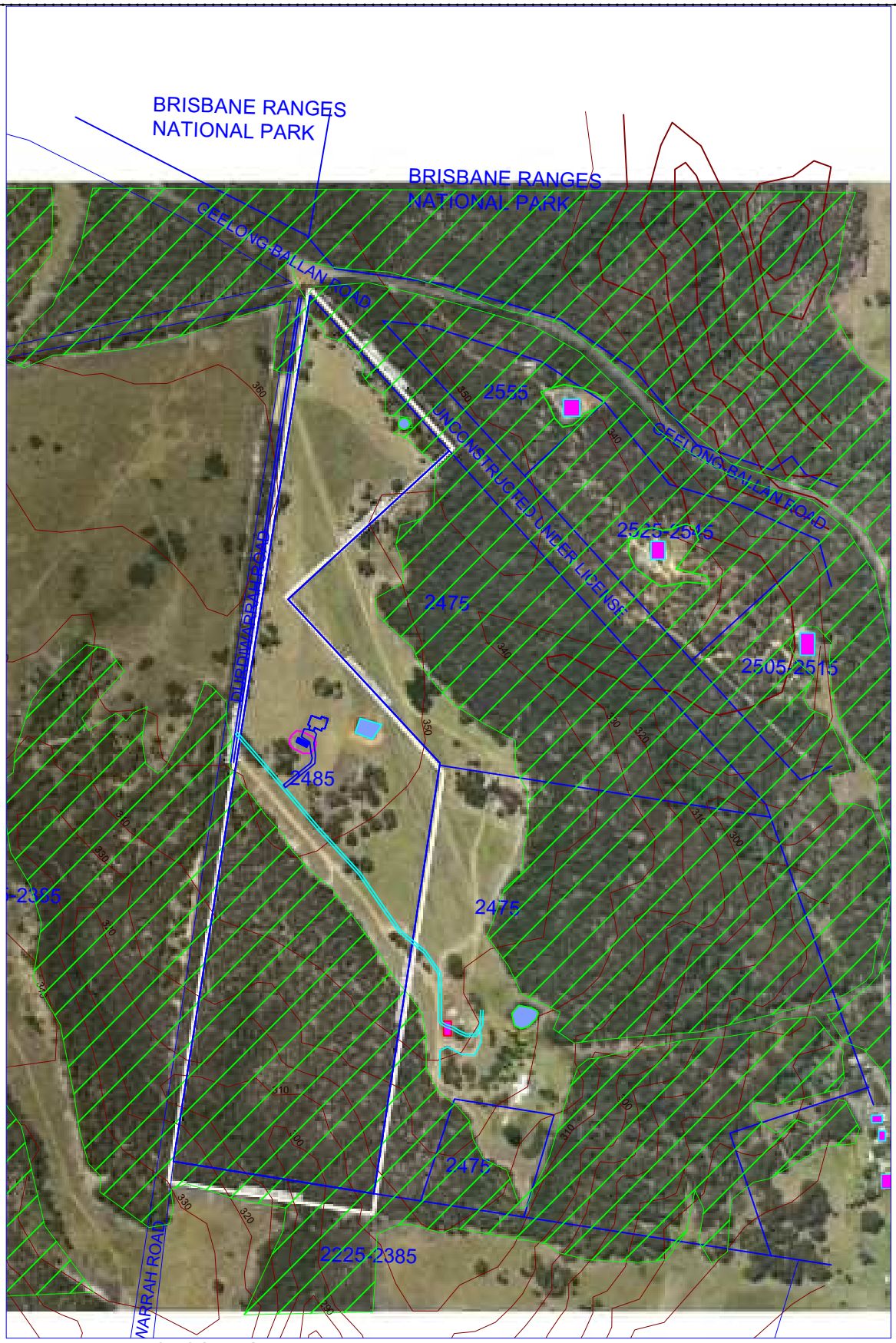
Appendix.2 Proposed development Plan

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026



LEGEND

- EXISTING DWELLING
- EXISTING NATIVE VEGETATION
- CONTOUR (10m) (310)
- EXISTING DAM
- CFA TANK
- PROPOSED DWELLING
- FIRE ACCESS TRACK
- GOVERNMENT ROAD

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*PROPOSED SITE PLAN-**REV-B-2-2-2026***

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PROJECT: 2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED SITE PLAN*

SCALE: 1:8000 @A4

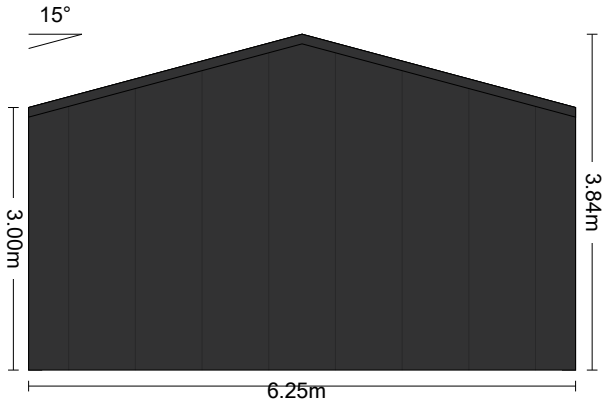
City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

ShedBoss Ballarat

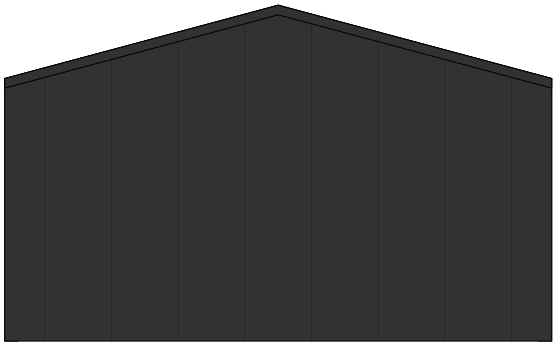
ABN: 55 638 984 713
Address: 21 Albert Street Sebastopol VIC 3356
Email: sales@shedbossballarat.com.au
Web: shedboss.com.au/ballarat/
Phone: 0438 360 409
Fax: 03 53 364 700
Lic No: CDBL-54479

Quotation

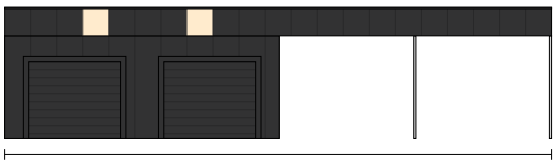
No: **433389**
Date: 24/07/2025
Valid: 7 Days



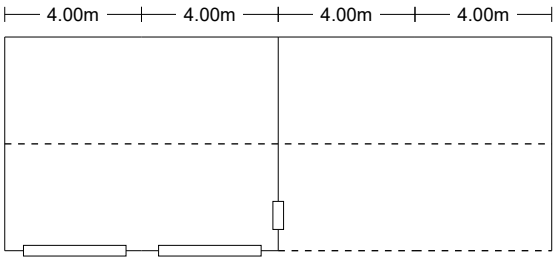
NORTH-WEST ELEVATION



SOUTH-EAST ELEVATION



16.00m NORTH-EAST ELEVATION



SHED FLOOR PLAN

SOUTH-WEST ELEVATION

MONUMENT COLORBOND
FOR SHED

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Appendix.3 Proposed Dimension Plan

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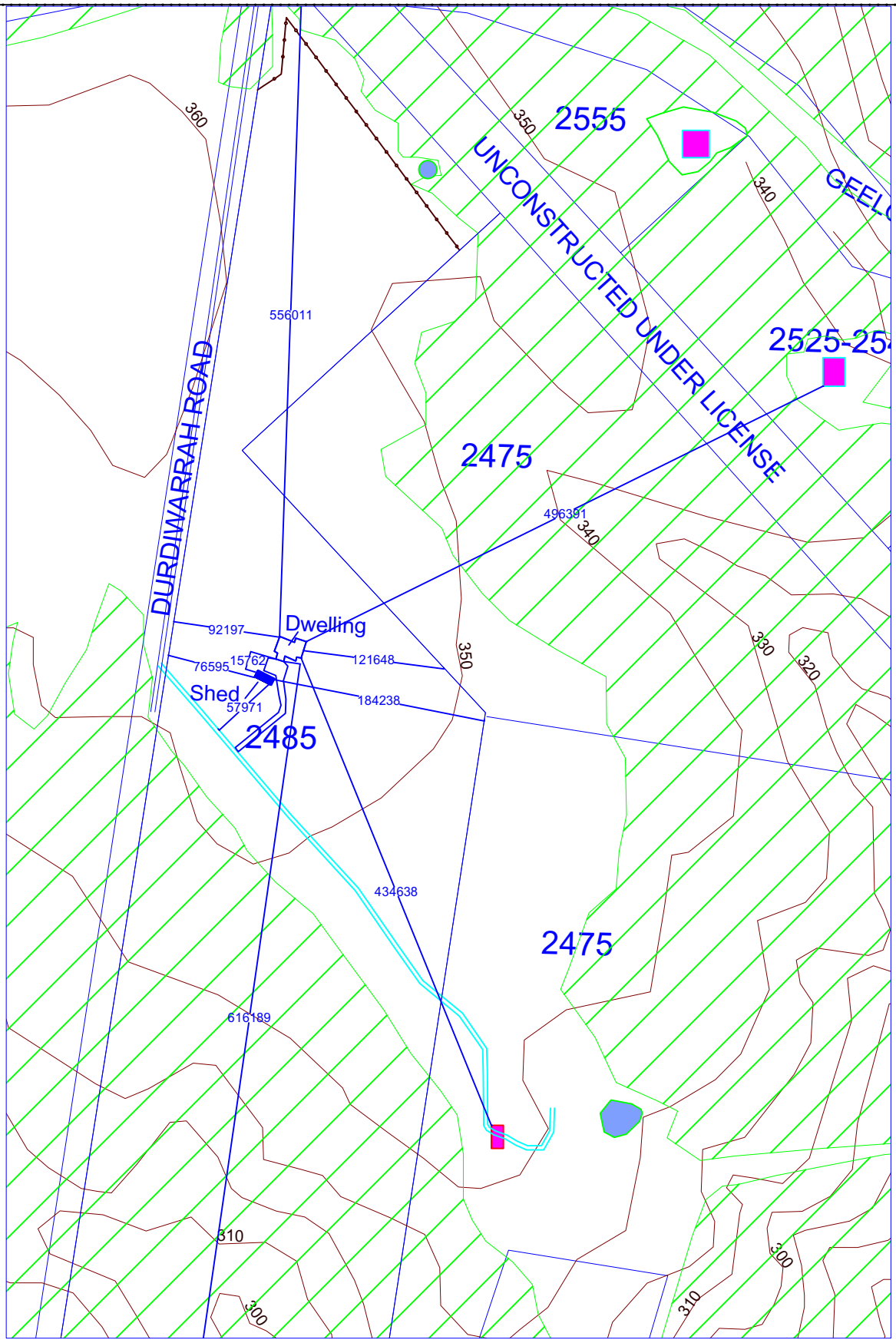

*PROPOSED DEVELOPMENT DIMENSION PLAN-**REV-B-2-2-2026***

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PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED DEVELOPMENT DIMENSION PLAN-REV-A*
SCALE: 1:5000 @A4

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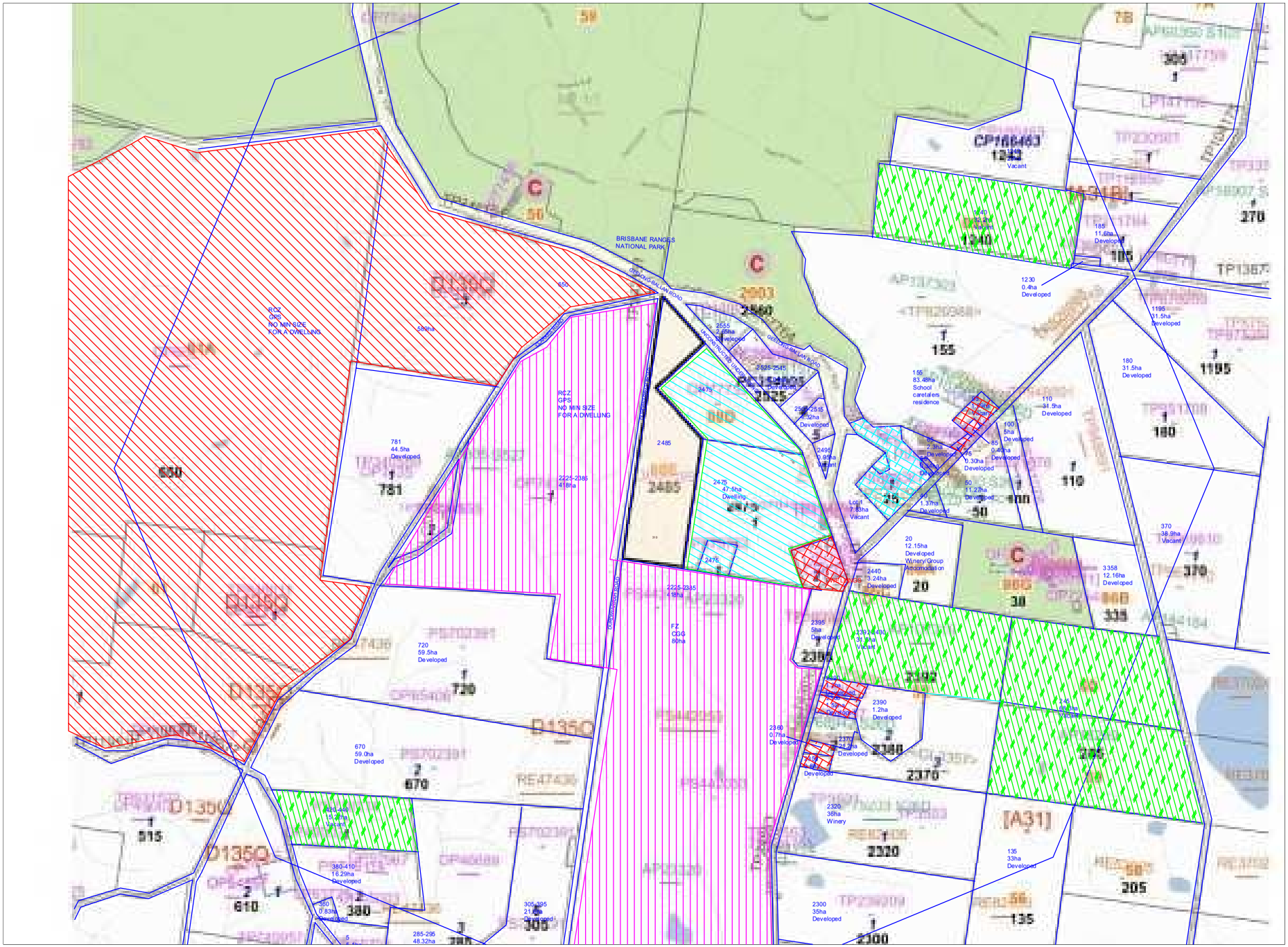
Appendix.4 Land Use Plan-Landscape.



LEGEND

NUMBER OF ALLOTMENTS IN THE SAME OWNERSHIP RCZ GPS SHIRE VACANT

TWO ALLOTMENTS IN THE SAME OWNERSHIP RCZ GPS SHIRE FZ CGG DEVELOPED

TWO ALLOTMENTS IN THE SAME OWNERSHIP FZ CGG DEVELOPED

CROWN LAND

PUBLIC USE

HIGH DENSITY RESIDENTIAL

UNDEVELOPED UNDER TRIGGER SIZE

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PROJECT NO: *2688*

DATE: JAN 2025

DWG TITLE: *LANDSCAPE ASSESSMENT 5km RADIUS*

SCALE: NTS @A3

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Appendix.5 Farm Management Plan-Paddocks

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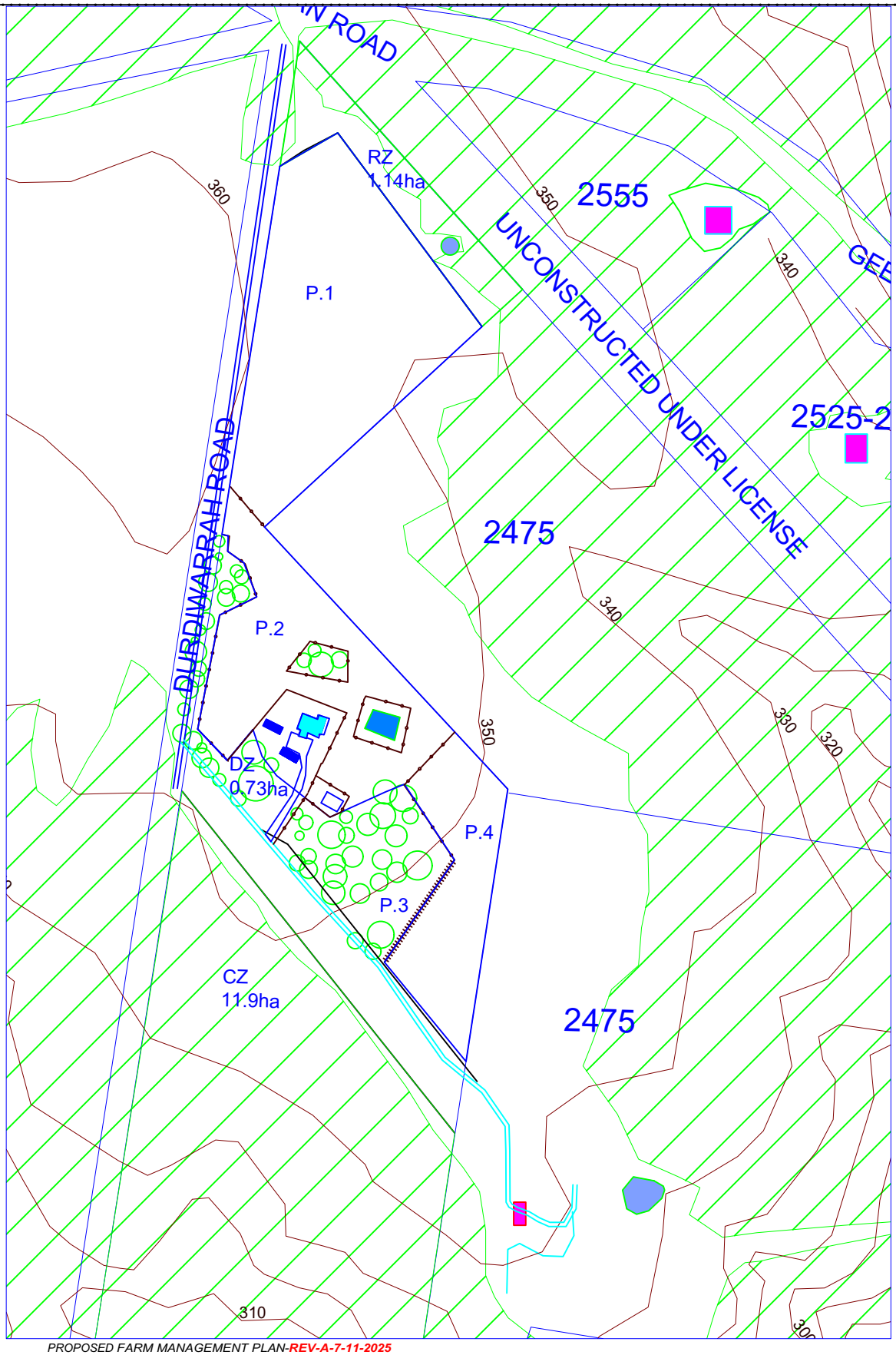

*PROPOSED FARM MANAGEMENT PLAN-**REV-A-7-11-2025***

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PROJECT: 2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED PADDOCK PLAN-REV-A*

SCALE: 1:5000 @A4

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Appendix. 6 **Farm Management Plan-Year.1**

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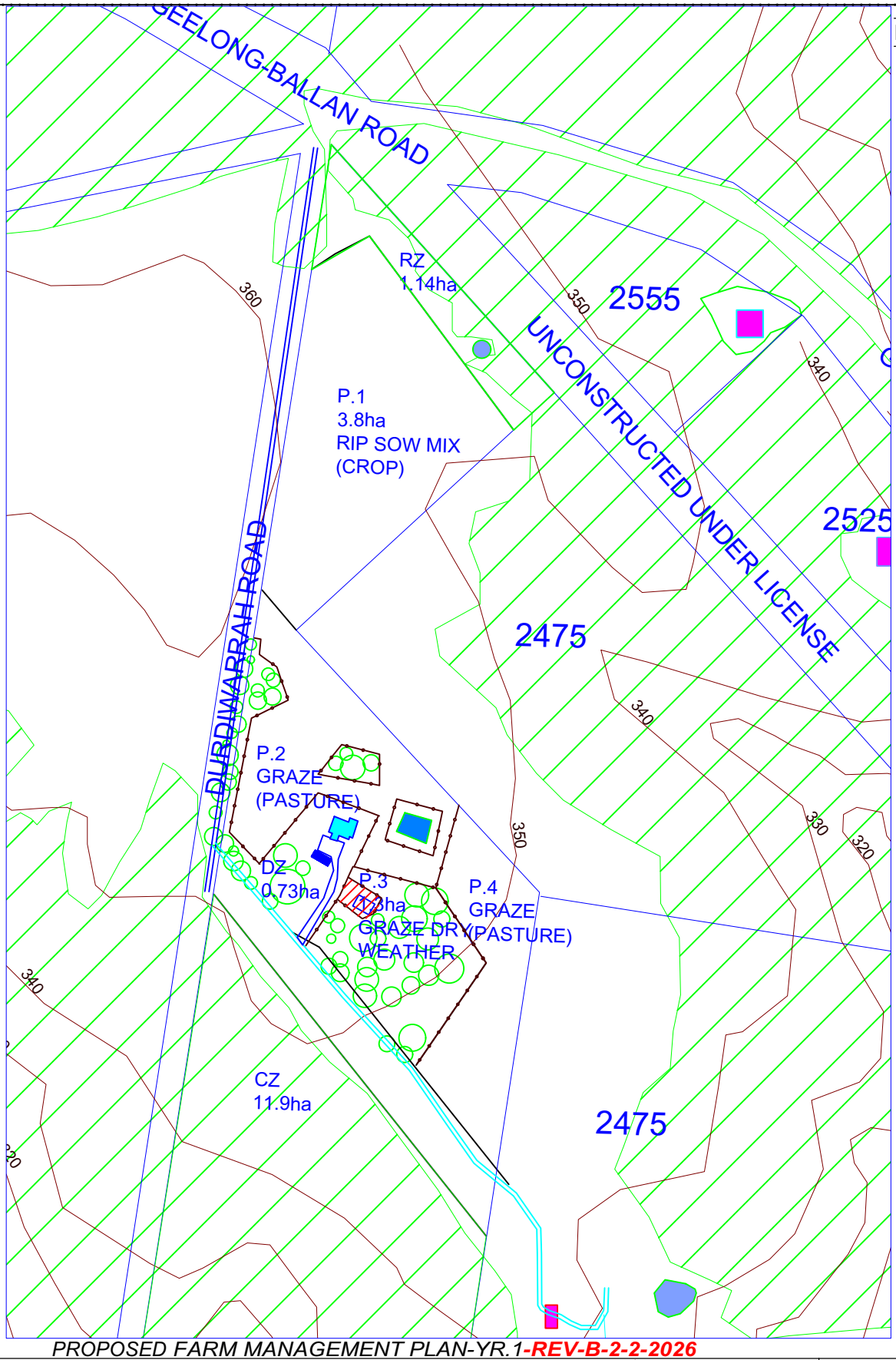

LEGEND

- NEW FENCE
- PROPOSED DWELLING
- PROPOSED OUTBUILDING
- EXISTING DAM
- PROPOSED EFFLUENT
- PROPOSED ROTATIONAL LAND USE
- EXISTING SINGLE TREE

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*PROPOSED FARM MANAGEMENT PLAN-YR.1-**REV-B-2-2-2026***

Note:
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2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED FARM MANAGEMENT PLAN-YR.1*

SCALE: 1:5000 @A4

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Appendix. 7 **Farm Management Plan-Year.2**

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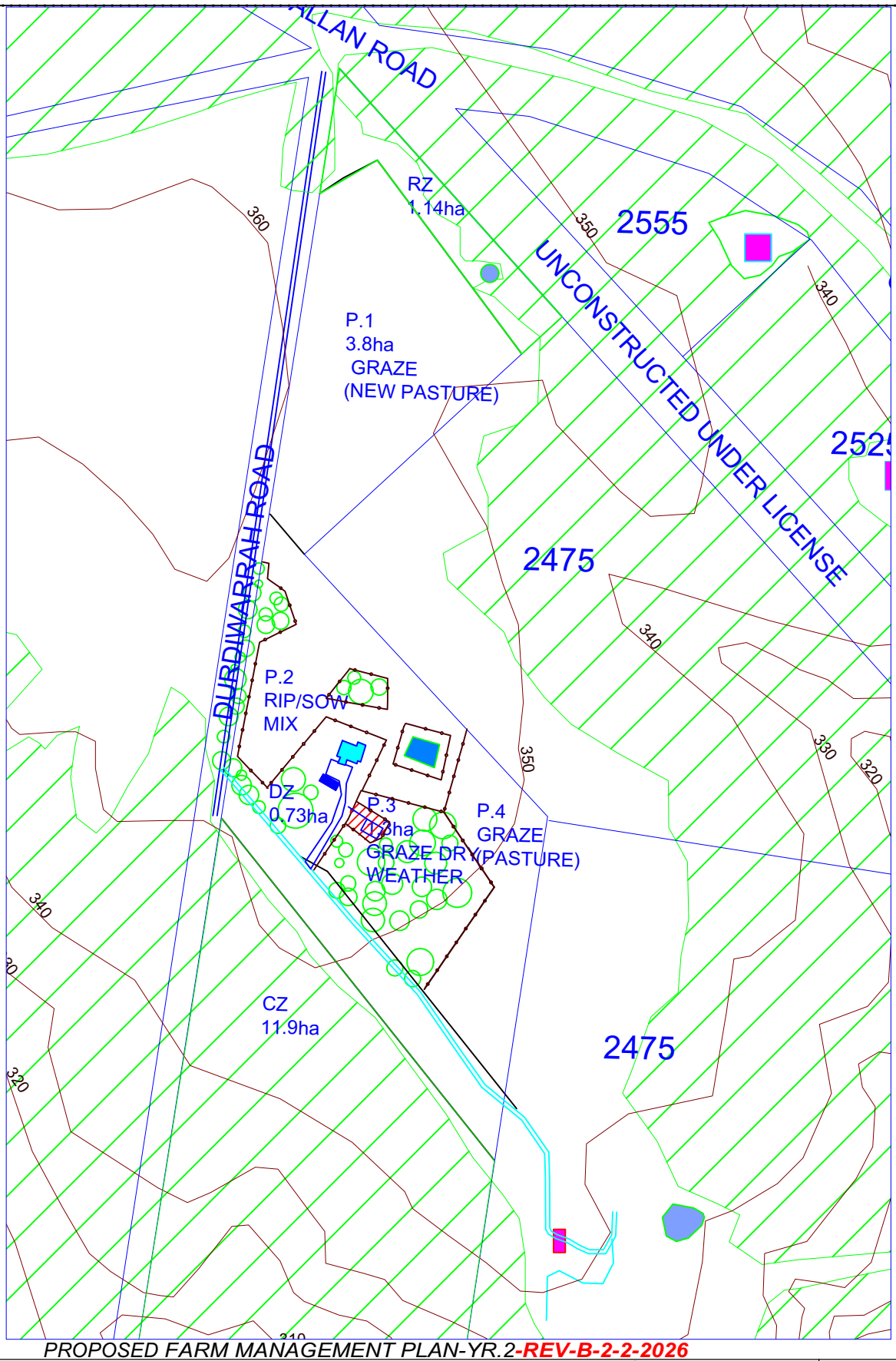

LEGEND

- NEW FENCE
- PROPOSED DWELLING
- PROPOSED OUTBUILDING
- EXISTING DAM
- PROPOSED EFFLUENT
- PROPOSED ROTATIONAL LAND USE
- EXISTING SINGLE TREE

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*PROPOSED FARM MANAGEMENT PLAN-YR.2-**REV-B-2-2-2026***

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PROJECT: 2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED FARM MANAGEMENT PLAN-YR.2*

SCALE: 1:5000 @A4

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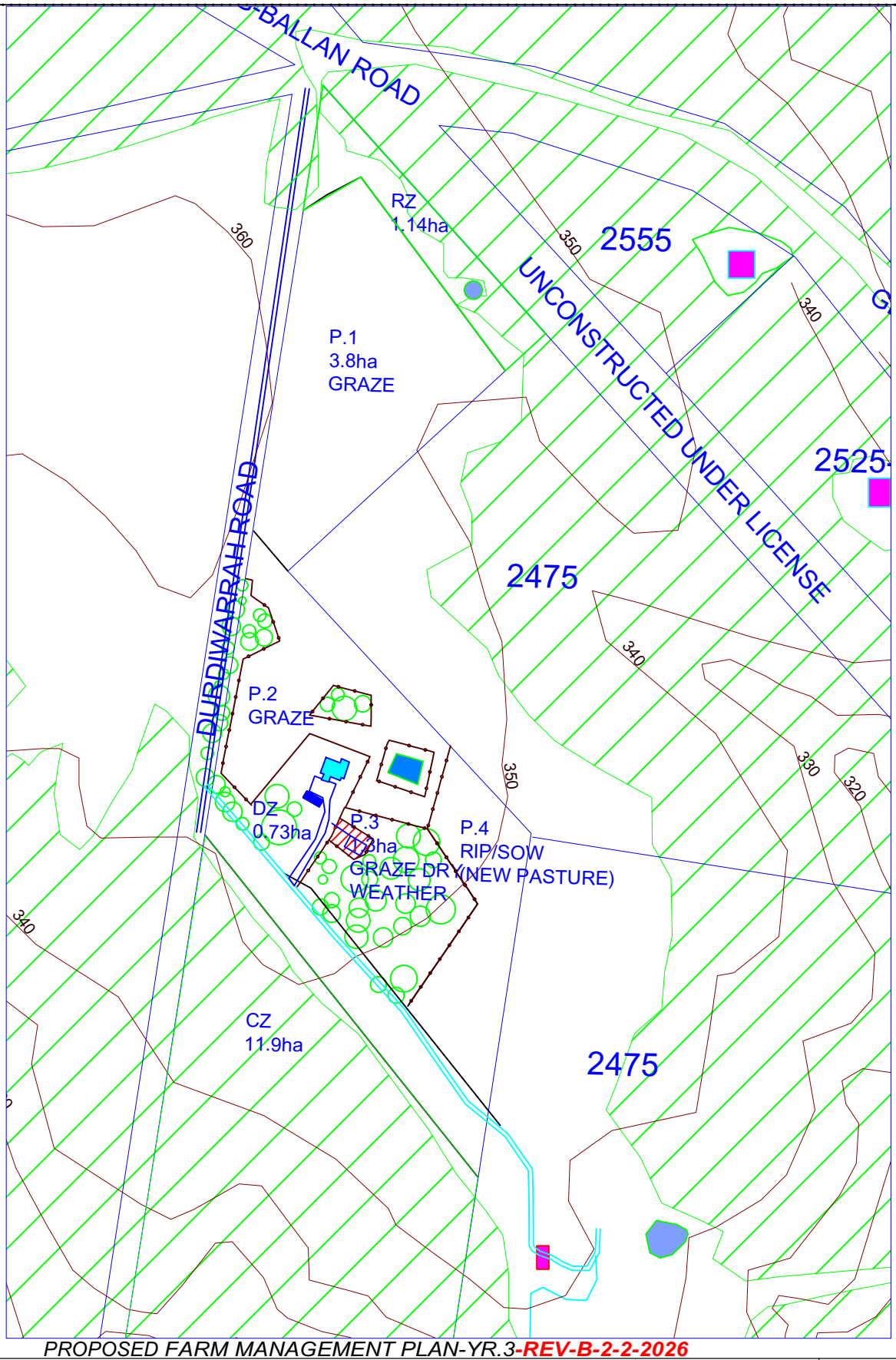
Appendix. 8 Farm Management Plan-Year.3

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026



LEGEND

- NEW FENCE
- PROPOSED DWELLING
- PROPOSED OUTBUILDING
- EXISTING DAM
- PROPOSED EFFLUENT
- PROPOSED ROTATIONAL LAND USE
- EXISTING SINGLE TREE

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*PROPOSED FARM MANAGEMENT PLAN-YR.3-**REV-B-2-2-2026***

Note:
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PROJECT:
2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PROPOSED FARM MANAGEMENT PLAN-YR.3*

SCALE: 1:5000 @A4

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Appendix. 9 Composting

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

NSW GOVERNMENT Department of Primary Industries

primefact

How to compost on farm

May 2021, Primefact 21/280, second edition, replaces Agnote DPI-448

Abigail Jenkins, Development Officer, Soils Unit, Wollongbar

This publication provides the basic information you need to make thermophilic compost from your farm organic wastes.

If you wish to create compost for sale, aim to meet the quality criteria of Australian Standard AS 4454-2012 Composts, Soil Conditioners and Mulches, you should also contact the NSW Environmental Protection Authority and your local council for further advice and to determine your legal responsibilities.

What is composting?

Composting is the breakdown of any organic material (ingredients) into a crumbly, dark, soil-like product in which none of the original material can be easily identified. Various organic waste materials produced by farming such as husk, effluent, vegetable waste and stubble can be used to produce compost. Types of composting include:

- **vermicomposting**, which involves using composting worms
- **passive composting** is the slow degradation of plant waste, such as adding mulch to the soil
- **thermophilic composting** is the rapid breakdown of organic material where the compost pile gets hot and sterilises seeds and pathogens.

When is compost ready to apply?

Do not use any compost before it has finished composting (Figure 1), whether you make your own or not. This is one of the most common pitfalls of using compost. It is especially important because nitrogen will be temporarily taken by the decomposer organisms as they continue to break down organic matter in/on the soil. This makes nitrogen unavailable to the plants and the beneficial organisms will not have established, negating the benefits from using compost.

The composting process takes longer if there is insufficient water or too much carbon-rich material (e.g. wood).

Good quality compost should take about 8 weeks to form; macadamia husk can take up to 12 weeks. When the compost is ready it should have the following distinct characteristics:

- **smell**: nice earthy smell, with no bad (sour or rotten) odours
- **feel**: moist and earthy, not wet and sloppy or dry and powdery
- **appearance**: the pile contains dark soil-sized particles, the original organic materials are not distinguishable
- **temperature**: the pile stops getting hot
- **C:N** between 15:1 and 20:1 (a laboratory test for this costs about $35).

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Figure 1. Fully composted material ready for spreading. Photo: Jeremy Bright.

What you need to make good compost

The rules of composting are the same whether you are making a small pile for your garden or a large windrow for commercial production. The key elements needed when making good thermophilic compost are:

Aeration

To ensure air can move in the compost heap it is important to turn the pile regularly and include a range of different sized and shaped materials. Remember that large pieces of woody material will take much longer to break down than smaller chips.

Moisture

Ideally, water content should be 50 to 60% (it should feel like a moist sponge, but no water comes out when you squeeze it with your fingers). To make sure the pile stays wet enough during the composting process, you may need to add water. See also 'Trouble shooting' on page 5.

Organic ingredients

Good compost must have a balance of carbon-rich (woody material) and nitrogen-rich (green leafy matter or manure) materials (Table 1). Select the correct mix to give a carbon:nitrogen (C:N) of about 30:1 at the start of the composting process.

Carbon:nitrogen is important and can be determined easily when you know the C and N values and weight of the products you are using. To calculate the C:N, divide the total carbon percentage of your selected materials – or ingredients – by the total nitrogen percentage of your materials. You can have as many materials as you like.

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$$C{:}N = \frac{(\text{Weight ingredient 1} \times \%C) + (\text{Weight ingredient 2} \times \%C)}{(\text{Weight ingredient 1} \times \%N) + (\text{Weight ingredient 2} \times \%N)}$$

For example, if you use 4 t macadamia husk + 500 kg broiler litter + 50 kg blood and bone, and using the figures given in Table 1, then:

$$C{:}N = \frac{(4 \times 50) + (0.5 \times 38) + (0.05 \times 42)}{(4 \times 1.3) + (0.5 \times 2.7) + (0.05 \times 13)} = 31{:}1$$

A suitable area

You will need to dedicate an area for at least 8–12 weeks. This area should be relatively flat and free of stones, tree stumps, drainage lines and weeds (especially bulbous weeds). In addition, you can make a good base for the compost pile using crushed blue metal dust. There should be enough room for machinery to turn the compost. The pile should be located so it will not contaminate adjacent land or waterways via wind drift and water run-off.

Cover

You may need to cover your pile if there is excessive rainfall.

Machinery

If making a large amount of compost, you will need machinery to turn the pile. A front-end loader or excavator is ideal. Alternatively, you may consider using a contractor.

Table 1. Approximate carbon and nitrogen content of some common farm wastes.

Material		%C	%N
Carbon-rich	Biochar	Highly variable depending on original feedstock; test to be sure	
	Coffee hulls	48	1.1
	Hardwood sawdust	50	0.06
	Macadamia husk	50	1.3
	Newspaper	25	0.04
	Non-legume hay	42	1.3
	Softwood sawdust	50	0.1
	Straw	56	0.7
	Tree prunings	50	1.0
Nitrogen-rich	Blood and bone	42	13
	Broiler litter	38	2.7
	Cattle (dairy) manure	48	2.7
	Grass clippings	58	3.4
	Horse manure	48	1.6
	Vegetable waste	30	3.0

How to create good compost

Constructing a pile

Mix all materials and construct a pile that is between 1.5 and 2 m high and 2 to 3 m wide. It can be as long as you need. Every 1 m in length will make about 3 cubic metres (m^3) of compost at these dimensions.

Add water so the pile is wet through but not soaked. Check a sample of material from the pile; if it glistens with water but does not drip excess water then it is wet enough.

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Monitor the temperature closely

Keep monitoring the temperature and turn the pile after the correct temperature has been reached each time. During the first week, check the temperature in the pile daily. It should be between 50 and 65 °C. You will probably notice steam rising (Figure 2) and the compost should feel uncomfortably hot (this is now considered a thermophilic compost). This heating up can happen very quickly.

Using a shovel, dig a hole in the middle of the pile and check the temperature with either a thermometer or a data logger that transfers the information to a computer.

When the temperature is right (between 50 and 65 °C), turn the pile. If the temperature is above 70 °C, turn the pile immediately and reduce the pile height to a maximum of 1.5 m.

Important: temperature in the compost pile must reach between 50 and 65 °C to kill any unwanted pathogens and weed seeds, and to break down all the material properly. It must not get hotter than 70 °C as this will reduce the nutrient and carbon value of your compost and kill beneficial decomposer organisms.

Turning the compost pile

When turning the compost pile, ensure the materials from the outside are placed on the inside. This can be achieved by rolling the pile over using a front-end loader or lifting the pile and dropping it again using an excavator.

The pile will probably need to be turned at least five times before the compost is ready for use, but may need up to 10 turns before the temperature is stable, depending on the materials used. Once the pile has stopped producing heat, let it 'cure' for at least 2 weeks before use. Do not skip the curing stage, which can take up to 3 months, but is critical to stabilise the organic materials in the compost. Maturing compost also prevents it from damaging plants once it is applied and reduces nitrogen drawdown – the temporary lock-up of nitrogen caused when an excess of carbon-rich organic materials stimulates decomposition by soil organisms which also increases their nitrogen use. See 'Trouble shooting' on page 5.

Figure 2. A compost pile still composting, notice steam rising from the top of the pile. Photo: Jeremy Bright.

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Benefits of compost

There are many benefits of using compost. One of the most important is the addition of organic matter as this provides food for soil life. It also increases the stability of the soil so it becomes more resistant to erosion and compaction and holds more moisture. Compost also:

- adds organic carbon
- protects soil from erosion
- increases soil structural stability
- improves moisture holding capacity
- increases water infiltration and reduces water run-off
- adds nutrients (as slow release)
- encourages a wide range of soil organisms.

Trouble shooting

Problem	Cause	Solution
Excess water running off	Too wet	Add dry materials or let the pile dry out a little
Bad smell	Anaerobic conditions	Add larger materials and turn more often
Ammonia smell	C:N ratio too low	Add extra high-C materials
Clumping	Compost is too wet	Add dry materials and turn
The pile will not get hot after set up; the composting process does not appear complete	C:N too high	Add high nitrogen materials but avoid fertilisers such as urea
	Moisture content incorrect	Adjust accordingly
	Too little oxygen	Turn pile
Pile too hot	Too much heat being trapped	Reduce pile height; pile should be twice as wide as it is high
	Too dry	Add water but also aerate; failure to aerate can increase microbial activity and add further heat, to the point of combustion

Further information

Australian Standard AS 4454-2012 Composts, soil conditioners and mulches, 4th edn, Standards Australia, https://infostore.saiglobal.com/en-au/standards/as-4454-2012-121773_SAIG_AS_AS_267608/

NSW Environment Protection Authority website, *Protection of Environment Operations Act 1997*, https://www.epa.nsw.gov.au/licensing-and-regulation/legislation-and-compliance/about-the-poeo-act

NSW Environment Protection Authority website, recycling and reuse pages, https://www.epa.nsw.gov.au/your-environment/recycling-and-reuse

NSW Environment Protection Authority. 2016. Resource Recovery Order Part 9, the compost order, https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/wasteregulation/RRO16-compost.ashx

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Reference number: PUB21/280.

Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing (May 2021). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Regional NSW or the user's independent advisor.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Appendix. 10 Soil Tests

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Certificate of Analysis E24-00-1910

Client:	Natural Resource Link Pty Ltd	Laboratory:	Environmental Analysis Laboratory
Contact:	Julie Lee	Contact:	EAL Customer Service Team
Address:	PO Box 61, CLUNES, VIC 3370, Australia	Address:	PO Box 157, East Lismore NSW 2480 Australia
Telephone:	0406 459 522	Telephone:	(02) 6620 3678
Email:	julie@nrlinks.com.au	Email:	eal@scu.edu.au

Customer reference:	2688	Request ID:	EAL /E24-00-1910
Number of samples:	3	Report ID:	E24-00-1910_EALP1_1
Date samples received:	10 December 2024	Issue date:	31 January 2025

Authorised by:	Graham Lancaster
Position:	Senior Manager

Comments: EAL is a NATA accredited laboratory (14960), accredited for compliance with ISO/IEC 17025 - Testing.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Environmental Analysis Laboratory

Certificate of Analysis

Request ID: EAL/E24-00-1910 Report ID: E24-00-1910_EALP1_1 Issue date: 31 January 2025

				Client Sample ID:	2688-1	2688-2	2688-3
				Sample Depth:	10cm	10cm	5cm
				Crop ID:	Graze	Graze	Graze
				Sample Date:	20 November 2024	20 November 2024	20 November 2024
				EAL Sample ID:	E24-00-1910-0001	E24-00-1910-0002	E24-00-1910-0003
Parameter	**Unit**	**Method Reference**	**LOR**	---	---	---	
Haney Soil Health Score	---	** Calculation: (Solvita CO2/10) + (Total Water Extractable Carbon/100) + (Total Water Extractable Nitrogen/10)	<1	8.7	11	---	
Solvita Microbial Respiration	mg/kg CO2	** Solvita CO2 Burst	---	69	89	---	
Water Extractable Organic Carbon	mg/kg	** Shimadzu TOC-L / TNM-L	<1	70	94	---	
Water Extractable Nitrogen	mg/kg	** Shimadzu TOC-L / TNM-L	<1	11	12	---	
Water Extractable Nitrate	mg/kg	** Haney 2010 FIA (Water Extract)	<0.1	0.5	1.2	---	
Water Extractable Ammonium	mg/kg	** Haney 2010 FIA (Water Extract)	<0.1	2.3	2.0	---	
Organic Carbon: Nitrogen	Ratio	** Calculation	---	6.6	7.7	---	
Inorganic Nitrogen	mg/kg N	** Calculation	<1	2.8	3.2	---	
Organic Nitrogen	mg/kg N	** Calculation	<1	7.8	9.0	---	
Calcium H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	56	54	---	
Magnesium H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	37	44	---	
Potassium H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	13	16	---	
Sodium H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	22	13	---	
Phosphorus H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	4.1	3.9	---	
Sulfur H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	6.9	5.0	---	
Zinc H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<0.1	0.1	0.2	---	
Manganese H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<0.1	1.9	5.5	---	
Iron H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	161	107	---	
Copper H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<0.1	0.1	< 0.1	---	
Aluminium H3A-2 extractable	mg/kg	** Haney 2010 ICP-OES (H3A-2 Extract)	<1	77	67	---	
Nitrate H3A-2 extractable	mg/kg	** Haney 2010 FIA (H3A-2 Extract)	<0.1	0.4	0.6	---	
Ammonium H3A-2 extractable	mg/kg	** Haney 2010 FIA (H3A-2 Extract)	<0.1	3.5	3.4	---	
pH (H2O)	units	Rayment & Lyons 2011 - 4A1	---	5.37	5.05	---	
Electrical Conductivity	dS/m	Rayment & Lyons 2011 - 3A1	<0.005	0.050	0.040	---	
Labile Carbon	%	** Blair 1995 - 0.333 M Potassium Permanganate	<0.05	0.38	0.78	---	
Carbon - Total	%	Inhouse S4a	<0.02	1.99	3.48	---	
Nitrogen - Total	%	Inhouse S4a	<0.02	0.17	0.21	---	
Carbon : Nitrogen Ratio	Ratio	Inhouse S4a	<1	11.9	16.7	---	
Estimated Organic Matter	%	Inhouse S4a	<0.04	3.49	6.09	---	
Electrical Conductivity	dS/m	Rayment & Lyons 2011 - 3A1	<0.005	---	---	0.040	

Notes:

- Conversions to kg/ha = mg/kg x 2.24.
- The chloride estimate result (Electrical Conductivity x 640) is considered an estimate, and is generally an over-estimate.
- ** denotes NATA accreditation does not cover the performance of this service.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Certificate of Analysis

Request ID: EAL/E24-00-1910 Report ID: E24-00-1910_EALP1_1 Issue date: 31 January 2025

- .. denotes not requested, no data/information or no guidelines available.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (available on request or at scu.edu.au/eal).
- Analysis conducted between sample arrival date and reporting date.
- This report is not to be reproduced except in full.
- Results only relate to the item tested.
- All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
- Conversions for 1 cmol+/kg = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Appendix. 11 **Phytophthora Management.**

EDITION 4, 2008

Threatened Species Network

Australian Government

WWF

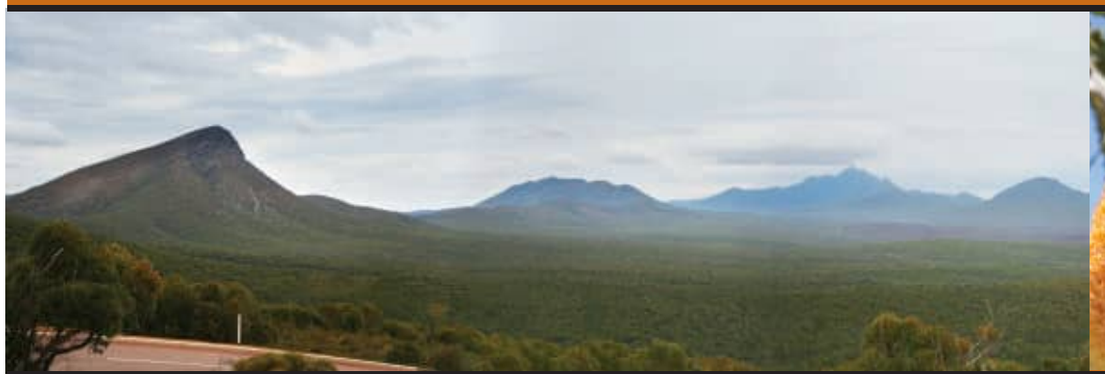
The Threatened Species Network is a community-based program of the Australian Government and WWF-Australia.

The Threatened Species Network

The Threatened Species Network (TSN) advises, collaborates and networks to increase the public's involvement with the protection and recovery of threatened species and their habitats. Since its formation in 1990, the TSN has empowered the community to participate in research, monitoring, management and education projects across the country for the conservation of threatened species. The TSN achieves this through working cooperatively with government agencies, scientists, educators, landholders, Indigenous Australians and community groups.

Managing Phytophthora Dieback in Bushland

A Guide for Landholders and Community Conservation Groups



ALCOA australia's aluminium

Government of Western Australia

swan catchment council

For more information about Phytophthora Dieback please contact your local government authority or the Dieback Working Group
Phone: 0438 044 488
Web: www.dwg.org.au

Dieback WORKING GROUP

Dieback WORKING GROUP

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

This publication is a joint initiative of the Dieback Working Group and the Threatened Species Network.

The Dieback Working Group

The Dieback Working Group consists of representatives from local governments, community conservation groups and State Government agencies. The group was formed in response to the lack of knowledge and management assistance about the plant disease in native vegetation known as 'dieback' which is caused by the introduced water mould *Phytophthora cinnamomi*. Since its formation in 1996, the Dieback Working Group has sought to:

- Increase awareness about the plant disease caused by *Phytophthora cinnamomi*.
- Encourage the adoption of disease prevention and management policies.
- Encourage the implementation of control measures to minimise the spread and impact of the disease.

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Please Note:
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CONTENTS

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

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Introduction

Phytophthora Dieback is a deadly plant disease that can devastate our forests, woodlands and heathlands. The disease is caused by the introduced pathogen *Phytophthora cinnamomi*. Phytophthora Dieback is causing significant damage in the South-west Australia Ecoregion of Western Australia (WA) because:

- Over 40% (2284) of native plant species in the region are susceptible (Shearer et al., 2004)
- the climate and soils of the South-west Australia Ecroregion suit the pathogen's survival and spread, and
- the pathogen was spread widely before it was identified as the cause of permanent damage to our ecosystems.

Organisations such as the Department of Environment and Conservation (DEC), Alcoa and Main Roads WA follow procedures to minimise the risk of their activities spreading the pathogen. Many local governments are also adopting Phytophthora Dieback management policies and implementing management procedures.

Banksia woodland site in the Perth metropolitan area devastated by Phytophthora Dieback.

© Dieback Working Group

Anyone who owns, manages or uses a bushland area can also take steps to ensure that their activities don't introduce or spread the pathogen. The information included in this booklet will help you identify activities that have a high risk of spreading Phytophthora Dieback and how you can significantly reduce this risk.

Southwest Australia Ecoregion

The Southwest Australia Ecoregion is one the world's top 34 'biodiversity hotspots'. It is characterised by an exceptional concentration of species that are found nowhere else (endemic species). More than 4,000 species of endemic plants and 100 endemic vertebrates have been recorded in the region, and new plant species continue to be discovered. Many of these endemic species are rare and endangered, giving the Southwest Australia Ecoregion the highest concentration of rare and endangered species on the continent.

Unfortunately, Phytophthora Dieback is having a devastating impact on the biodiversity of this region.

Southwest Australia Ecoregion of Western Australia. Produced by WWF-Australia using information adapted from Olson & Dinerstein.

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© Chris Dunne

Phytophthora Dieback:
A Deadly Disease of Native Plants

What is Phytophthora Dieback?

Phytophthora Dieback refers to the deadly introduced plant disease caused by *Phytophthora cinnamomi* (pronounced Fy-tof-thora - meaning 'plant destroyer' in Greek). There are over 50 species of *Phytophthora*, but the species that causes the most severe and widespread damage to native plants in WA is *P. cinnamomi*.

In the past, Phytophthora Dieback has been known as 'dieback' and 'Jarrah dieback'. Unfortunately, these names have contributed to confusion about the pathogen. For example, in other parts of Australia, the term 'dieback" is used to describe tree decline caused by such factors as salinity, drought or insect damage. Furthermore, the disease affects a huge number of introduced and native plant species other than Jarrah. Therefore, to overcome this confusion, the term 'Phytophthora Dieback' is now used.

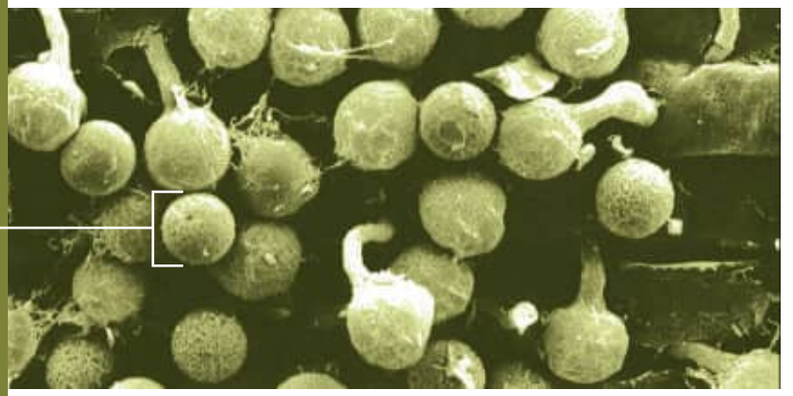
Originally *P. cinnamomi* was classified as a fungus, however it is now classified as an Oomycete or water mould.

Where Does the Pathogen Live?

P. cinnamomi spends its entire life in the soil and in plant tissue. It attacks the roots of plants and causes them to rot. This kills the plant by limiting or stopping the uptake of water and nutrients. The pathogen is able to survive within plant roots during the dry soil conditions commonly experienced during the summer months.

An electron microscope image of zoospores encysting on a host plant's roots.

Zoospores measure approximately 8µm (micrometres) in diameter



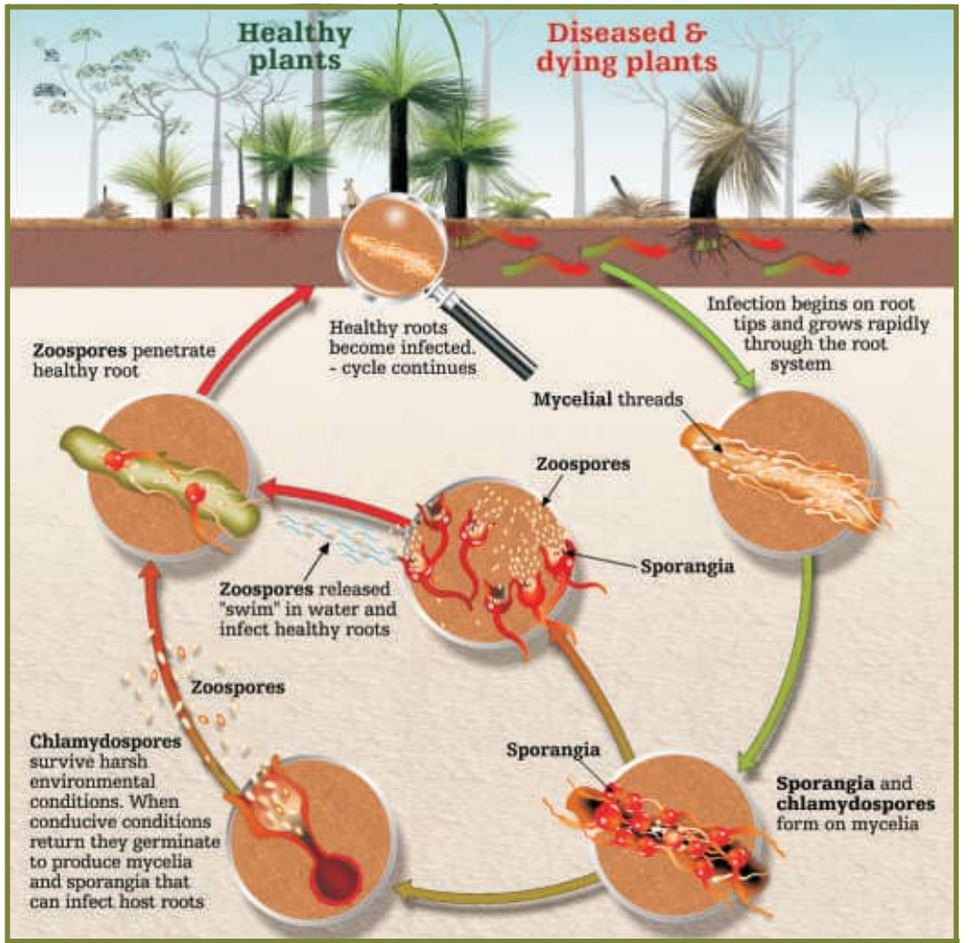
© Giles Hardy

How Does the Pathogen Spread?

In sloping areas Phytophthora Dieback spreads quickly when the microscopic spores move downwards in surface and sub-surface water flows. It spreads slower up-slope and on flat ground (approximately one metre per year) because it is restricted to movement by root-to-root contact.

However, it is human activity that causes the most significant, rapid and widespread distribution of this pathogen. Road construction, earth moving, driving vehicles on bush roads and stock movement can all contribute significantly to the spread of Phytophthora Dieback. Bush restoration projects may also inadvertently spread the pathogen.

Soil that is warm and moist provides the best conditions for Phytophthora Dieback. These conditions allow the pathogen to produce millions of spores. These spores are attracted to the plant roots by swimming through the soil water.



The Phytophthora Dieback Lifecycle

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Phytophthora Dieback:
A Deadly Disease of Native Plants

Which Plants Does the Pathogen Kill?

Over 40% of native WA plant species are susceptible to *Phytophthora cinnamomi* (Shearer et al., 2004). Over 50% of the WA's rare or endangered flora species are susceptible. Many of these susceptible plants are only found in South-west Australia Ecoregion. Some of the regions more common plants are susceptible, including jarrah, banksias, grasstrees (Xanthorrhoea) and zamia palms.

A more extensive list of susceptible plants is available on the Dieback Working Group website www.dwg.org.au/. Many other plants, although not susceptible, can act as a host for the pathogen. This enables it to persist indefinitely in an area once it has been introduced.

A range of horticultural crops and garden plants are also susceptible to *P. cinnamomi* including apple, peach, apricot and avocado trees, grapevines, radiata pine, camellias, azaleas, roses, proteas and rhododendrons (Cahill, 1993; Erwin & Ribeiro, 1996).

Banksia woodland heavily impacted by Phytophthora Dieback.

© Chris Dunne

Gull Rock near Albany is extensively infested with Phytophthora Dieback.

© Dieback Working Group

Bushland free of Phytophthora Dieback, Falls Park, Hovea.

© Sharon Kilgour

Bushland infested with Phytophthora Dieback, Falls Park, Hovea.

© Chris Dunne

This area of Jarrah forest is heavily infested with Phytopthora Dieback. The site was once a gravel extraction area.

© Chris Dunne

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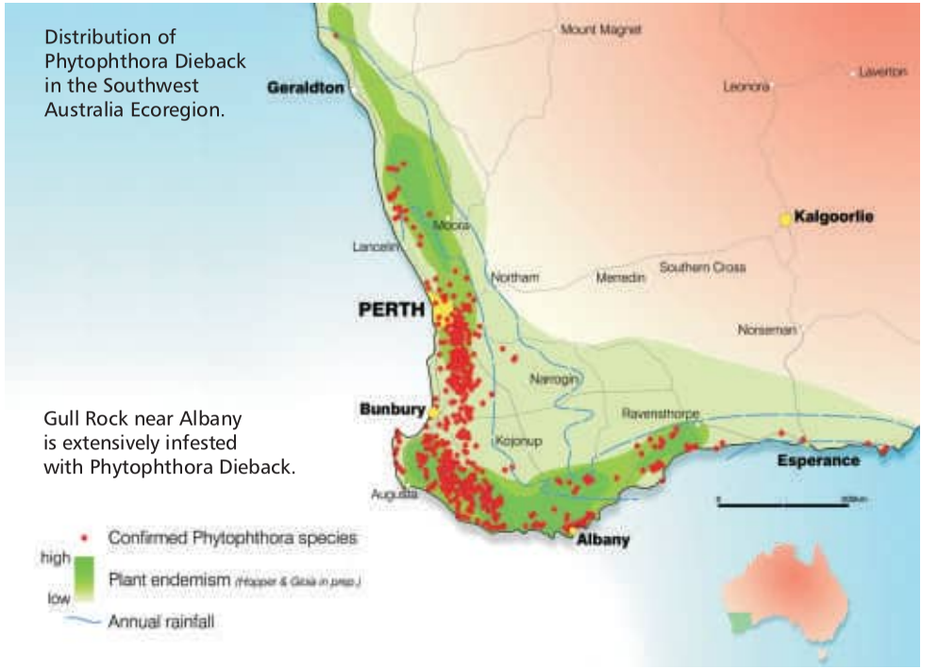
City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Phytophthora Dieback:
A Deadly Disease of Native Plants

History
Phytophthora cinnamomi is not native to WA. It is thought to have arrived in the State shortly after European settlement in soil around the roots of live plants. Before it was realised that *P. cinnamomi* caused death in native vegetation, it had been spread extensively throughout the south-west. The disease was first recognised killing jarrah *(Eucalyptus marginata)* in the jarrah forest near Karragullen in 1921. It wasn't until the mid 1960s that *P. cinnamomi* was identified as the cause the disease.

Geography
Phytophthora Dieback is now widespread throughout the South-west Australia Ecoregion. It is confined to areas with more than 400 mm annual rainfall, and extends between Eneabba in the north and Cape Arid near Esperance in the east. The pathogen causes the highest impact in areas that receive more than 600 mm of annual rainfall. It has infested forests, heathlands and woodlands. Phytophthora Dieback is also widespread in the bushland in and around Perth, but there are still large uninfested areas that require protection.



Distribution of Phytophthora Dieback in the Southwest Australia Ecoregion.

Gull Rock near Albany is extensively infested with Phytophthora Dieback.

Bushland Values Affected by Phytophthora Dieback
When Phytophthora Dieback spreads to bushland, it kills many susceptible plants, resulting in a permanent decline in the diversity of the bushland. It can also change the composition of the bushland by increasing the number of grasses and reducing the number of shrubs. Native animals that rely on susceptible plants for survival are reduced in numbers or are eliminated from sites infested by Phytophthora Dieback.

However, it is important to realise that bushland infested with Phytophthora Dieback still retains important conservation values. It contains remnant vegetation that provides habitat for many native animal species and provides environmental services, such as protecting the landscape from the affects of salinity and erosion. Therefore, it is important to retain and maintain remnant bushland even when it is affected by Phytophthora Dieback.

Honey possums are one of the native animals reliant on susceptible plants for survival.

© Babs & Bert Wells - DEC

Many birds rely on plants affected by Phytophthora Dieback.

© Babs & Bert Wells - DEC

© Dieback Working Group

Protecting Bushland

To manage Phytophthora Dieback in bushland, you need to plan ahead. The introduction or human assisted spread of the pathogen in bushland can be avoided if activities are well planned and management procedures are in place. Phytophthora Dieback management procedures must be integrated into all bushland management activities if the spread and impacts of this disease are to be minimised.

There are three simple steps involved in managing Phytophthora Dieback in bushland.

These are:

1. Assess your bushland
2. Develop and implement management procedures
3. Treat your plants with phosphite

The steps are discussed in detail below.:

Step 1. Assess Your Bushland

Managing Phytophthora Dieback in bushland is most successful when you have determined whether the pathogen is present or absent, and if present, identified what parts of the bushland are infested. Management procedures can still be implemented if you are unsure if the pathogen is present. However, without knowing the location of the Phytophthora Dieback, management will not be as effective, it will be difficult to monitor the success of your work, and you may be taking some precautions that are not necessary.

Remember that when you have had bushland surveyed for Phytophthora Dieback, the result will only be accurate at that point in time. The disease will spread will spread autonomously and new infections can occur. When planning management procedures for controlling Phytophthora Dieback it is important to re-survey for disease movement and new disease outbreaks every one to two years.

There are two options for determining whether Phytophthora Dieback is present in bushland:

1. Engage a professional consultant; or
2. Do it yourself.

Professional consultants

Professional consultants determine the presence of *Phytophthora cinnamomi* by using indicator (susceptible) plants and by testing soil and plant samples. Refer to page 31 for a list of Phytophthora Dieback interpreters. The consultants listed have undertaken accredited training with DEC and have many years of experience in completing Phytophthora Dieback surveys.

The cost of a consultant survey will vary, depending on the size and location of the bushland, and the degree of difficulty experienced in interpreting disease symptoms. Consultant fees usually do not include the cost of processing the soil and plant samples (sample processing usually costs between $70 to $120 per sample). Discuss costs with the consultant prior to the work being undertaken.

Community groups can consider applying for funding from various sources to cover the cost of disease surveys. For more information on these potential funding sources contact the Environmental Officer at your local council or the Dieback Working Group.

Do it yourself

You can complete your own disease survey by studying the plants in the bushland. You will need to have a very good knowledge of native plants, various disease symptoms and other causes of plant deaths for the results of your assessment to be accurate and reliable.

The presence of Phytophthora Dieback is determined by observing susceptible plants that are killed by *P. cinnamomi*. These susceptible plants are called "indicator species". Dead jarrah, banksia, grasstrees, zamia palms, dryandra and hakea are commonly used indicator species. You must be able to discount other factors that could have caused the plant death, such as fire, insects, flood, drought, nutrient deficiencies or toxicities, and other plant disease, for example, Armillaria root rot. If non-susceptible trees, for example red gums, tuarts, flooded gums or wandoo are dying then its likely that the cause of poor plant health is not Phytophthora Dieback.

Tables 1 and 2 list some common plant species and genera from the Jarrah forest and swan coastal plain ain that are susceptible to *P. cinnamomi*, and can be used as Phytophthora Dieback indicator species. For a more detailed list on resistant and susceptible plant species please see consult the Centre for Phytophthora Science and Management website

(www.cpsm.murdoch.edu.au).

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Protecting Bushland

Table 1. Plant genera with species known to be affected by Phytophthora species - including *P. cinnamomi* (CALM, 1999b).

Proteaceae	Myrtaceae	Epacridaceae	Other
Adenanthos	Agonis	Andersonia*	Allocasuarina
Banksia*	Beaufortia	Astroloma*	Anarthia
Conospermum	Calothamnus	Leucopogon*	Boronia
Dryandra	Calytrix	Lysinema*	Conostylis
Franklandia	Eremaea	Monotoca*	Dampiera
Grevillea	Eucalyptus	Sphenotoma*	Dasypogon
Hakea	Hypocalymma	Styphelia*	Daviesia
Isopogon*	Kunzea		Eutaxia
Lambertia*	Melaleuca		Gastrolobium
Persoonia*	Regelia		Hibbertia*
Petrophile*	Scholtzia		Hovea
Stirlingia*	Thryptomene*		Jacksonia
Synaphea	Verticordia*		Lasiopetalum*
Xylomelum			Latrobea
			Macrozamia
			Oxylobium
			Patersonia
			Phlebocarya
			Xanthorrhoea
			Xanthosia

* many species in the genus are severely affected

Iconic species like the Albany woolly bush *Adenanthos sericeus* are susceptible to Phytophthora Dieback.

© Chris Dunne

Hibbertia species are highly susceptible to Phytophthora Dieback.

© Dieback Working Group

Zamia palms *Macrozamia riedlei* are susceptible to Phytophthora Dieback.

© Sharan Kilgour

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Protecting Bushland

As well as observing indicator species, the following vegetation features can be used to indicate the presence of Phytophthora Dieback.

- Total deaths. *P. cinnamomi* kills most plants completely and quickly. Most plants do not die one branch at a time, and there is usually no chance of recovery. For example, an infected banksia often suffers from a sudden death. Occasionally Jarrah trees may look sick for a number of years before suddenly succumbing.
- Lines, groups or localised areas of plant deaths are more likely to be caused by Phytophthora Dieback than odd scattered individual plant deaths in otherwise healthy vegetation.
- Look for an edge effect. Edge effects are most obvious when there is a clear distinction between healthy and diseased vegetation.
- Look for old deaths and recently killed plants, that is, an 'age range' in the deaths. This is because Phytophthora Dieback moves from plant to plant over time, killing each plant as it goes.
- Look for signs of the disease in a range susceptible plant species.
- Look for something that could have introduced the disease, for example, a track, road or vehicle activity.

Laboratory testing

Like the professional consultants, you can also take plant and soil samples and have them tested in a laboratory (refer to page 46 for a list of diagnostic laboratories). Sample results that are positive for *P. cinnamomi* mean that the disease is present at the site. Negative results don't mean that the site is free of the pathogen, as it may simply have been missed when the sample was taken. The chance of a positive sample being recorded can be significantly increased if the tissue sample is collected from a plant that has a lesion (decaying tissue) present underneath the bark at the base of the main trunk.

You will need to get instructions from the laboratory on how to take a sample, the best time to take the sample and how to store and transport it. Sampling usually involves digging up a dead plant to get to the roots. This can be quite a physically demanding task if you are sampling a banksia or grasstree.

Mount Lesueur National Park a biodiversity hotspot is under threat from Phytophthora Dieback.

© Chris Dunne

Waychinicup Nature Reserve near Albany is under threat from Phytophthora Dieback.

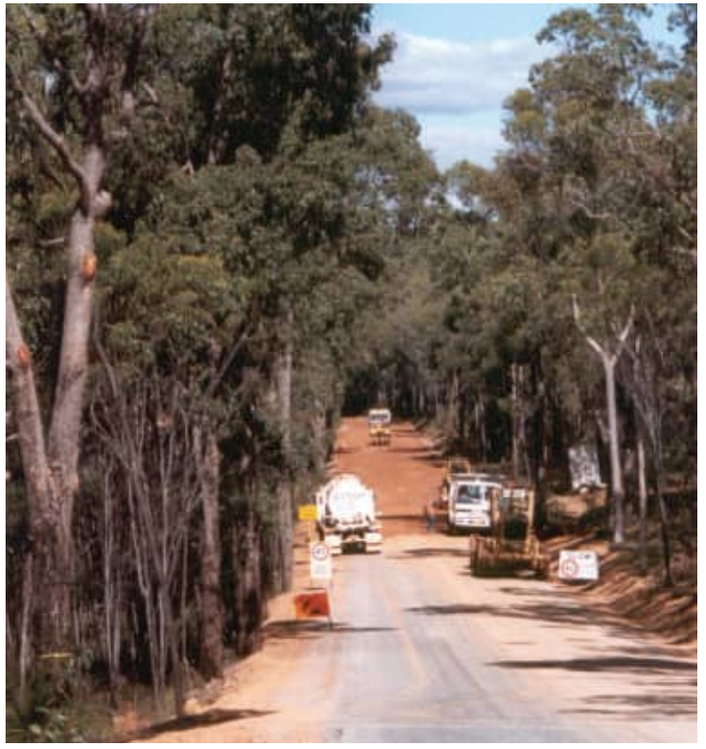
© Sharan Kilgour

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Step 2. Develop & Implement Management Guidelines

The way Phytophthora Dieback is managed in bushland depends on your knowledge of its presence. Select the most appropriate scenario for your situation from the four listed below and refer to the appropriate page.

Each of these situations will require slightly different management to ensure that the pathogen is not introduced, or does not spread further. However, all management guidelines are based on minimising movement of soil, plant material and water, and protecting plants by treating them with phosphite.



Road construction with Phytophthora Dieback infected soil or gravel can lead to the introduction of the disease to adjacent bushland.

© Dieback Working Group

Scenario 1
Phytophthora Dieback Not Present in Bushland

The following control measures will help to keep the bushland free of Phytophthora Dieback.

Planning

- Schedule activities that involve soil disturbance for low rainfall months (November to March) when the soil is dry.
- Minimise the number of tracks through the bushland and ensure that all tracks are well drained. Avoid constructing tracks on the upper slopes of the bushland.
- Minimise soil disturbance during fire break maintenance. Mow, slash or use herbicide rather than grade or plough.
- Ensure that water doesn't drain into the bushland from other areas, e.g. roads. Phytophthora Dieback impact is greatest in wet sites.

For all Activities

- Vehicle access to bushland should be avoided. If a vehicle must enter bushland, ensure that it stays on hard, well-drained tracks and avoids puddles.
- Vehicles, tools, equipment and machinery should be free of all mud and soil when entering bushland.
- Footwear should be free of mud and soil when entering bushland.

Earthworks

- Avoid bringing soil, gravel or sand into the bushland. If this material must be introduced, ensure that it is free of Phytophthora Dieback or purchased from a soil supplier with Nursery Industry accreditation (refer page 46 for information about soil testing and suppliers).

Bushland Restoration

Weeding

- If weeds are being manually removed they should be immediately placed in a container to ensure that plant material or soil is not dropped in other parts of the bushland.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 1
(continued)

Revegetation

If weeds and other disturbances are controlled,revegetation should not be necessary in bushland. Revegetation has a high risk of introducing Phytophthora Dieback, so should be avoided in bushland that has not been infested. However, if revegetation is required:

- Consider direct seeding rather than planting seedlings.
- Complete planting when soil is moist but not wet.
- Purchase plants from nurseries with Nursery Industry accreditation.
- Do not use mulch, or only use mulch that has been well composted (the heating part of the composting process kills *Phytophthora cinnamomi).*
- Water should be from the mains supply. If from a creek, dam or river, the water should be sterilised (refer to page 39).

Access

- Minimise walking in the bushland when the soil is wet and muddy.
- Stay on tracks. Consider up-grading tracks to a hard well-drained surface that does not allow for the easy movement of soil around the bushland.
- Plan walks to start in high parts of the bushland and move to low parts of the bushland.

Communication

- In public reserves, place signs at reserve entrances to highlight the disease situation in the bushland and recommend avoiding access when the soil is wet and sticking to footwear.
- In public reserves, hold a 'wildflower walk' in spring. Highlight the potential impact of Phytophthora Dieback and how visitors can prevent its introduction.
- Look out for activities occurring near the bushland that could introduce the pathogen, for example, road building.

Scenario 1
(continued)

Find out if the activity is operating under hygienic conditions. If not, contact the Environment or Parks Officer at your local council or the relevant authority.

- Discuss the Phytophthora Dieback status of the bushland with neighbouring landholders.

Protecting Vegetation

- Observe susceptible plants and note any deaths. Implement phosphite treatment if plant death occurs (refer to page 33-37).
- Do not dump rubbish or green waste into bushland.

Horses and Livestock

- Keep horses and other stock out of bushland.
- If horses or other stock must enter bushland, ensure that their hooves are free of mud and they stay on hard, well drained tracks.

Fire

- Mow, slash or use herbicide on fire breaks rather than plough or grade.
- Have contractors clean the equipment before entering bushland.

Preventing vehicle access into healthy bushland can prevent the accidental introduction of Phytophthora Dieback.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 2
Phytophthora Dieback in Sections of the Bushland

Managing Phytophthora Dieback in this situation is most successful when the presence of the pathogen in the bushland has been clearly identified and mapped. To minimise the risk of new infestations occurring, the following control measures should be implemented:

Planning

- Survey the bushland and mark the infection boundary.
- Schedule activities that involve soil disturbance for low rainfall months (November to March) when the soil is dry.
- Minimise the number of tracks through bushland and ensure that all tracks are well drained.
- Plan or realign tracks so they don't pass from infested to uninfested areas of bushland, or from low areas to higher areas.
- Minimise soil disturbance during firebreak maintenance. Mow, slash or use herbicide rather than grade or plough.
- Ensure that drainage does not enter the bushland from other areas, e.eg, roads. Disease impact is greatest in wet sites.

For all Activities

- Vehicle access should be avoided. If a vehicle must enter bushland, ensure that it stays on hard, well-drained tracks, and avoids puddles.
- Vehicles, tools, equipment and machinery should be free of all mud and soil on entry and exit from bushland, and when moving from infested to uninfested areas.
- Footwear should be free of mud and soil when entering and exiting the bushland and when moving from infested to uninfested areas.

Earthworks

- Avoid bringing soil, gravel or sand into bushland. If this material must be introduced, ensure that it is free of Phytophthora Dieback or purchased from a soil supplier with Nursery Industry accreditation (refer page 46 for information about soil testing and suppliers).
- Non certified materials can be used in the infested parts.

Scenario 2
(continued)

- Do not move soil or plants from infested to uninfested parts of the bushland.

Bushland Restoration

Weeding

- If weeds are being manually removed, they should be immediately placed in a container to ensure that plant material or soil is not dropped into other parts of the bushland.

Revegetation

- If weeds and other disturbances are controlled, revegetation should not be necessary in bushland. Revegetation has a high risk of introducing Phytophthora Dieback, so should be avoided in bushland that is disease free. However, if revegetation is required:
- Consider direct seeding rather than planting seedlings.
- Select plants that are resistant to Phytophthora Dieback for the infested parts of the bushland (for a list please refer to the publications section of the Dieback Working Group website: www.dwg.org.au)
- Complete planting when soil is moist but not wet.
- Purchase plants from nurseries with Nursery Industry accreditation.
- Do not use mulch, or only use mulch that has been well composted (the heating part of the composting process kills *Phytophthora cinnamomi).*
- Water used should be from the mains supply. If from a creek, dam or river, the water should be sterilised (refer to page 39).

Access

- Minimise walking in the bushland when the soil is wet and muddy.
- Stay on tracks. Consider up-grading tracks to a hard well-drained surface that does not allow for the easy movement of soil around the bushland.
- Avoid walking between infested and uninfested parts of bushland when soil is wet, and plan walks to start high in the bushland and move to lower parts.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 2
(continued)

Communication

- In public reserves, place signs at reserve entrances highlighting the disease situation at the reserve and recommend avoiding access when the soil is wet and sticking to footwear.
- In public reserves, hold a 'wildflower walk' in spring. Highlight the potential impact of Phytophthora dieback and how visitors can prevent it spreading.
- On walking tracks, place signs next to susceptible plants and dead plants that have been killed by the pathogen.
- Look out for activities occurring near the bushland that could spread the disease, for example road building. If the activity is not operating under hygienic conditions, contact the Environment or Parks Officer at your local council or the relevant authority.
- Discuss the Phytophthora Dieback status of the bushland with neighbouring landholders.

Protecting Vegetation

- Treat susceptible vegetation in the bushland with phosphite. Susceptible trees should be injected, and all other vegetation sprayed (refer to page 33 - 37). Consider strategic buffer treatment to protect vegetation at the greatest risk if total area is too large to treat in a cost-effective manner.
- Do not dump rubbish or green waste into bushland.

Horses and Livestock

- Keep horses and other stock out of bushland.
- If horses and stock must enter bushland, hooves should be free of mud and soil when entering and exiting and animals should be kept to hard, well drained tracks.

Scenario 2
(continued)

Fire

- Mow, slash or use herbicide on fire breaks rather than plough or grade.
- Have contractors clean the equipment before entering bushland.
- Construct or maintain fire breaks in the uninfested part of the bushland first, then move into the infested area.

© Dieback Working Group

Diverting runoff or drainage into bushland can provide ideal conditions for the establishment of Phytophthora Dieback.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 3
Phytophthora Dieback in all Parts of the Bushland

If Phytophthora Dieback is present in all parts of a bushland area, it is important that any remaining susceptible vegetation is protected, and that the pathogen is not spread to other bushland. The following control measures should be implemented:

Planning

- Schedule activities that involve soil disturbance for low rainfall months (November to March) when the soil is dry.
- Minimise the number of tracks through the bushland and ensure that all tracks are well drained.
- Minimise soil disturbance during fire break maintenance. Mow, slash or herbicide rather than grade or plough.
- Ensure that water does not drain into the bushland from other areas, e.g. roads. Disease impact is greatest in wet sites.

For all Activities

- Vehicle access should be avoided. If a vehicle must enter bushland, ensure that it stays on hard, well-drained tracks, and avoids puddles.
- Vehicles, tools, equipment and machinery should be free of all mud and soil when exiting the bushland.
- Footwear should be free of mud and soil when exiting the bushland.

Earthworks

- Do not remove landscaping materials, soil or plant material from the bushland.

Bushland Restoration

Revegetation

- If weeds and other disturbances are controlled, revegetation should not be necessary in bushland. However, if revegetation is required:
- Purchase plants from nurseries with Nursery Industry accreditation to prevent other diseases being introduced.
- Select plants that are resistant to Phytophthora Dieback.

Scenario 3
(continued)

- Complete planting when the soil is moist but not wet.

Access

- Minimise walking in the bushland when the soil is wet and muddy.
- Stay on tracks. Consider up-grading tracks to a hard well drained surface that does not allow for the easy movement of soil out of the bushland.

Communication

- In public reserves, place signs at reserve entrances highlighting the disease status of the reserve and recommend avoiding access when the soil is wet and sticking to footwear.
- In public reserves, place signs along tracks next to dead plants that have been killed by Phytophthora Dieback, and explain the impact the disease is having, and how visitors can prevent is spreading further.
- Look out for activities occurring near the bushland that could spread the pathogen, e.g. road building. Inform those responsible that Phytophthora Dieback is present at the site.
- Discuss the Phytophthora Dieback status of the bushland with neighbouring landholders.

Protecting Vegetation

- Treat any remaining susceptible vegetation in the bushland with phosphite. Susceptible trees should be injected, and all other vegetation sprayed (refer to page 33-34). Consider strategic buffer treatment to protect vegetation at the greatest risk if total area is too large to treat cost effectively.
- Do not remove plants from the bushland.

Horses and Livestock

- Keep horses and other stock out of bushland.
- If horses and stock must enter bushland, ensure that the hooves are free of mud and soil when exiting and animals should be kept to hard, well drained tracks.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 3
(continued)

Fire

- Mow, slash or use herbicide on fire breaks rather than plough or grade.
- Have contractors clean the equipment before leaving the bushland.

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Particular care needs to be taken when revegetating dieback free bushland so that the disease is not introduced by way of contaminated plants, soil or mulch.

Scenario 4
Unsure if Phytophthora Dieback is Present

The following procedures should be undertaken in bushland when you don't know if the pathogen is present in order to minimise the risk of the Phytophthora Dieback being introduced and prevent the disease spreading to another site:

Planning

- Schedule activities that involve soil disturbance for low rainfall months (November to March) when the soil is dry.
- Minimise the number of tracks in the bushland and ensure that all tracks are well drained. Avoid constructing tracks on the upper slopes of the bushland.
- Minimise soil disturbance during fire break maintenance. Mow, slash or herbicide rather than grade or plough.
- Ensure that water does not drain into the bushland from other areas, e.g., roads. Disease impact is greatest in wet sites.

For all Activities

- Vehicle access should be avoided. If a vehicle must enter bushland, ensure that it stays on hard, well-drained tracks, and avoids puddles.
- Vehicles, tools, equipment and machinery should be free of all mud and soil when entering and exiting the bushland.
- Footwear should be free of mud and soil when entering and exiting the bushland.

Earthworks

- Avoid bringing soil, gravel or sand into bushland. If this material must be introduced, ensure that it is free of Phytophthora Dieback or purchased from a soil supplier with Nursery Industry accreditation (refer page 46 for information on testing or suppliers).

Bushland Restoration

Weeding

- If weeds are being manually removed they should be placed immediately in a container to ensure that plant material or soil is not dropped in other parts of the bushland.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Scenario 4
(continued)

Revegetation

- If weeds and other disturbances are controlled, revegetation should not be necessary in bushland. Revegetation has a high risk of introducing Phytophthora Dieback, so should be avoided in bushland that is disease free. However, if revegetation is required:
- Consider direct seeding rather than planting seedlings.
- Purchase plants from nurseries with Nursery Industry accreditation.
- Complete planting when soil is moist, but not wet.
- If moving from one area of the bushland to another, ensure that all equipment and shoes are free of mud and soil.
- Do not use mulch, or only use mulch that has been well composted (the heating part of the composting process kills *Phytophthora cinnamomi).*
- Water used in bushland should be from the mains supply. If from a creek, dam or river, the water should be sterilised first (refer to page 39).

Access

- Minimise walking in the bushland when the soil is wet and muddy. Stay on tracks. Consider up-grading tracks to a hard well drained surface that does not allow for the easy movement of soil out of the bushland.
- Plan walks to start in high parts of the bushland and move to lower parts of the bushland.

Communication

- In public reserves, place signs at reserve entrances to recommend avoiding access when the soil is wet and sticking to footwear.
- Look out for people undertaking activities near the bushland that could introduce the pathogen, for example road building. Find out if these activities are operating under hygienic conditions. If not, contact the Environment or Parks Officer at your local council, or the relevant authority.

Scenario 4
(continued)

- Discuss the Phytophthora Dieback status of the bushland with neighbouring landholders.

Protecting Vegetation

- Treat susceptible vegetation in the bushland with phosphite. Susceptible trees should be injected and all other vegetation sprayed (refer to page 33 - 37).
- Do not remove plants from bushland.
- Do not dump rubbish or green waste into bushland.

Horses and Livestock

- Keep horses and other stock out of bushland.
- If horses and stock must enter bushland, ensure that the hooves are free of mud and soil when entering and exiting and keep animals to hard, well drained tracks.

Fire Management

- Mow, slash or herbicide fire breaks rather than plough or grade.
- Contractors should have equipment cleaned prior to entry and before leaving the bushland.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Case Studies
Management Scenarios for Small Properties

Scenario 1

Joan and John own a ¼ acre urban block and have noticed that their rose bushes are slowly dying one by one and that they have also lost a much loved grass-tree.

Management suggestion
Sample the most recent death for *Phytophthora* and if positive treat all host plants with phosphite including rose plants.

Scenario 2

Mike and Sarah own a semi rural ½ acre bush block and have lost anumber of Banksia, grass-trees and mature Jarrah trees. Most of the plants die suddenly and totally with the exception of some of the Jarrah trees that seem to be dying slowly. Mike has noticed that most of the deaths occur in the lowest section of the property but that they are slowly spreading upslope and that the plants tend to die in Spring and Autumn although there have been deaths all throughout the year. Sarah has also noticed that she has trouble keeping her Azaleas and Rhododendrons alive.

Management suggestion
Total treatment of all host plants every 3 years with phosphite as patterns of death indicate Phytophthora Dieback.

Case Studies
Management Scenarios for Small Properties

Scenario 3

Kate and Matthew own a hobby farm of 10 acres in a semi rural location and have noticed that their small grove of avocados have wilting branches even though they are getting plenty of water and nutrients. They have also noticed that their surrounding bush experiences on going scattered deaths in Jarrah, grass-tree and Sheoak and that locals recall a time when Banksia species were dominant in the midstory but now there are hardly any to be seen. Kate and Matthew aren't overly concerned as their bush gardens look in good condition

Management suggestion
Symptoms indicate that the property has an old established infestation around it and that the property itself may be infested. It would be advisable to treat vegetation adjacent to any vector that could introduce the *Phytophthora* spores onto the property to a distance of 10 to 15 metres depending on slope (the steeper the downslope angle the greater the treatment buffer) with phosphite. These vectors could be driveways, drainage lines, firebreaks, pathways or areas adjacent to introduced soil or mulch.

Avocados are very susceptible to *Phytophthora* and these symptoms are indications of infection in avocados (quite different to most native expression). Ideally they would be treated twice yearly with 20% phosphite concentration via stem injection. Native vegetation on the other hand would be treated every three years to provide maximum levels of protection.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Sampling Procedures
for a domestic situation

1. Select an appropriate dead plant

Ideally your dead plant will be:

- freshly dead or as fresh as possible.
- totally dead (if it is not totally dead it may not be Phytophthora Dieback)
- possibly one of many that have died over a period of time indicating that the cause of death is an on going process (like Phytophthora Dieback) rather than something that has come and gone (like fire, drought or frost), and;
- be a plant that is susceptible to Phytophthora dieback, see www.dwg.org.au/

2. Sterilise your sample tool

In order to have confidence in the result of your sample you need to be sure you aren't infecting the sample through a dirty sample tool. Undiluted methylated spirits is an ideal sterilising medium. Remove any loose soil and plant material from the tool and spray on the methylated spirits until the digging part of the tool is saturated and allow to dry . If your sample tool has areas that may harbour soil (for example gaps between the head and the handle), you may need to soak it in a bucket of methylated spirits for an hour or so.

3. Dig around the base of your sample plant

You now need to dig down the collar (the main stem of the plant that goes underground), of the plant into the roots preferably into moist soil. The depth will vary depending on the plant but be sure to take chips of root and enough soil to half fill a standard chinese food container from two or three sides of the plant to increase your chances of recovering a positive sample.

Sampling Procedures
for a domestic situation

4. Place your soil and roots into a suitable bag

Your bag needs to be strong enough to ensure that it will not split open during transport to the laboratory (geologists bags are ideal for this purpose) and be sealed with a cable tie or any other means that will prevent accidental opening. Make sure you have your details written on the bag in clear printing, include the date and the sample number if you are taking more than one sample.

If your sample is dry it is a good idea to moisten it with some distilled water, be sure not to drown it but rather add enough so as to create a moist environment for the *Phytophthora* (remember it is a water mould!). Make sure your sample does not get hot during transit, ideally keep your sample in an esky, in an insulated house or an air-conditioned car out of direct sunlight until you can get it to the lab.

5. Sterilise your sample tool

It is a good idea to get in the habit of re-sterilising your sample tool to avoid cross contamination or introduction of *Phytophthora* into another site. You may also wish to record your sample site with a Global Positioning System (some labs insist on a GPS reference prior to accepting your sample; you can use a metro UBD to find a GPS reference in the metro area), and physically mark your sample site with a piece of flagging tape with your details on it for easier relocation.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Step 3. Treating Your Plants with Phosphite

Phosphite (Phosphonate), is a biodegradable fungicide that protect plants' against Phytophthora Dieback. Phosphite works by boosting the plant's own natural defences and thereby allowing susceptible plants to survive within Phytophthora Dieback infested bushland.

It is important to note that there is no chemical that will eradicate Phytophthora Dieback, including Phosphite. However, an integrated approach can successfully control the spread and impact of the disease. Within bushland an integrated approach may combine the use of strategic phosphite treatment, controlling access, correcting drainage problems and implementing excellent hygiene protocols.

Phosphite controls many species of Phytophthora, including *Phytophthora cinnamomi*. Phosphite is not toxic to people or animals (Shearer et al., 1991) and its toxicity has been compared to table salt. There is a very low pollution risk associated with phosphite. When phosphite is sprayed on to the foliage of plants, it is applied at a very low rate, so any phosphite that reaches the soil is bound to the soil and does not reach the water table.

Phosphite is available from most large nurseries, rural supply stores and treating plants with phosphite is inexpensive. A medium sized jarrah tree costs less than 50 cents in chemical to treat.

Phosphite needs to enter a plant's water transport system in order for it to be effective. This can be done by injecting phosphite into trees, or spraying the leaves of understorey plants. In bushland the most common tree species injected include jarrah, snootygobbles, banksia species, sheoak and woody pears. Only inject trees with a diameter at chest height of 10-14 cm or greater. Phosphite not only protects a plant from P. cinnamomi infection, it can also help a plant to recover if it is already infected. If a jarrah tree is showing signs of infection, treatment with phosphite can help to save it.

Injecting a tree with phosphite provides three to five years protection from Phytophthora Dieback. In contrast, spraying with phosphite provides protection for only one to two years. Because it only provides temporary protection, treatment needs to be ongoing and included in bushland management and future action plans.

Injecting and spraying a large reserve can be a large task for a small community group, so consider applying for funding to employ a private contractor (refer to page 31), Conservation Volunteers Australia, Greencorp or similar labour forces, to assist your group to complete the treatment.

Protecting Bushland

Precautionary Note

This section outlines current best practice of managing Phytophthora Dieback as developed through research by the Department of Conservation and Land Management [now the Department of Environment an Conservation] (CALM 1999a). For information about more research please contact the Science Division at the Department of Environment and Conservation.

In some cases stressed plants that are treated with phosphite will show signs of leaf burning. In most cases this is a short-term effect and the plant will recover with the change of the seasons. In a small number of cases the plants that are already infected may be killed by the added stress of the phosphite treatment. To reduce the likelihood of any potential leaf burning the phosphite rates described are chosen from the lower end of the prescribed range. For injecting that is five per cent and one third of one per cent for spraying.

Prior to undertaking any phosphite treatment of bushland for commercial gain, a contractor must contact the Australian Pesticides and Veterinary Medicine Authority for further information.

1. Injecting Trees

Equipment

- Phosphite injection is not usually done with large syringes or with a number of different types of stem injection equipment, for example the Sidewinder tree injector, Rawlins tree injector or the F1-11 trunk injector.
- Cordless electric drill an appropriate drill bit with syringes (the correct drill bit size is 4 - 4.5 mm or 11/64″ or 6/16″). Follow safety instructions associated with the use of the drill.

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- Phosphite (Phosphite is sold in a 20, 40 or 60 per cent solution, and is commonly sold under the label Fos-ject® or Agri-Fos®). For a list of common phosphite products please refer to the phosphite treatment section of the Dieback Working Group website; www.dwg.org.au .

- Personal protective equipment including safety glasses, gloves, well covered shoes and protective clothes.

Timing

The best time to inject a tree is when water is moving within the tree. Water movement is usually greatest in spring and early summer. Injecting in the morning is usually more successful than in the afternoon. For further information on storage, disposal of containers and first aid consult the material safety data sheet for your phosphite product.

Preparation

- If using 20 per cent phosphite, dilute one part phosphite with three parts water.
- If using 40 percent phosphite, dilute one part phosphite with seven parts water.
- If using 60 per cent phosphite, dilute one part phosphite with eleven parts water.
- Use a good quality water source, preferably scheme water or rain water.

Procedure

1. Drill a hole into the tree. Injection needs to be in the sapwood, so do not drill any deeper than 2-3 cm. Usually the wood colour will change from the brown bark to cream at the correct depth. Drill the hole at waist height so that injecting will be comfortable for you. The hole should be drilled at a slight downward angle.

2. Drill a hole every 20 cm around the tree trunk (approximately one hand span). Multi-stemmed trees need holes in all stems.

3. Follow the instructions that come with the tree injector regarding its set up and use.

4. Insert the nozzle of the syringe or injector into the drilled hole and twist slightly to get a good seal. Slowly push/pump the solution into the tree. Make sure the solution is taken up by the tree and does not run out. Inject 20 mL of the solution into each hole.

5. Monitor plant health. If there is no sign of a decline in plant health, repeat in three to five years' time. If plants show a decline in health prior to three years, repeat treatment.

Protecting Bushland

2. Spraying Plants

The solution for spraying is much weaker than for injecting and contains a small amount of wetting or sticking agent to hold the droplets on the leaf surface until they are absorbed. Not all understorey plants are at risk but it is easier to spray all plants. Phosphite spraying should not be conducted along creek lines and streams as it can cause adverse effects on some amphibious animals.

Equipment

- Backpack sprayer - ensure that it is clean and has not recently contained herbicides or other chemicals.
- Phosphite - sold in a 20, 40 or 60 per cent solution, commonly sold under the label Fos-ject or Agri-Fos.
- Synertrol or BS1000 (available from Mirco Bros 08 9410 2233) or another wetting agent or penetrant approved for use on native plants. Use rates recommended by the manufacturer.

Denmark Dieback Working Group applying phosphite with a fogger in a high conservation value bushland.

© Chris Dunne

Timing

Spraying is most effective from winter to spring in spring and summer. Spraying should not occur one day after rain or one day before rain.

Preparation

Dilute phosphite to approximately 0.5 per cent phosphite for spraying.

- For a 20 per cent phosphite solution this is one part phosphite to 40 parts water. Therefore, to make 10 litres of solution, add 250 mL phosphite to 10 litres of water.
- For a 40 per cent phosphite solution this is one part phosphite to 80 parts water. Therefore, to make 10 litres of solution add 175 mL phosphite to 10 litres of water.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Protecting Bushland

- For a 60 per cent phosphite solution this is one part phosphite to 120 parts water. Therefore, to make 10 litres of solution, add 85 mL phosphite to 10 litres of water.
- Shake well.
- Be sure to add penetrant or wetting agent before use as per the manufacturer's instructions.
- Use the solution immediately and mix frequently.

Procedure for backpack spray unit

1. Place the backpack spray unit on your back and adjust the straps so it is comfortable and the pumping lever is on your preferred side. Adjust the nozzle so it gives a coarse spray to ensure the spray doesn't blow away from the plants.
2. Soak the plants so all leaf surfaces are wet and the solution is seen to be running off. All understorey plants, including grass trees, should be sprayed. 10 litres of solution should last about 15-20 minutes.
3. Monitor plant health. If there is no sign of a decline in health, repeat in one to two years' time.

Larger spray units, for example a spray trailer, can be used and may be more efficient when treating large areas. The chemical concentration should be the same as the concentrations listed above, and the chemicals should be kept well mixed.

Phosphite being applied with a back spray unit.
© Dieback Working Group

Guidelines
for Cleaning and Sterilising

In most cases, removing all mud and soil from vehicles, machinery, tools and equipment is sufficient to minimise the risk of spreading Phytophthora Dieback. Where possible, operators should minimise the movement of soil on vehicles and equipment to reduce the level of cleaning required. The following guidelines provide information on the most effective ways to 'clean down'.

Cleaning vehicles and machinery

- It is best to clean down at a wash down facility rather than doing it in the bush.
- Try to remove soil and mud when it is dry.
- Remove as much mud and soil as possible with a brush, and minimise the amount of water used.
- Use a brush or stick to remove compacted soil.
- Wash down on a hard, well drained surface, for example a road, and on ramps if possible.
- Do not allow mud and 'wash down' water to drain into bushland.
- Don't drive through 'wash down' water.
- Pay particular attention to mud flaps and tyres.

A simple wash down unit consists of a high pressure water system, concrete pad, and a drainage system to collect the potentially contaminated water.
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Guidelines
for Cleaning and Sterilising

Cleaning footwear

- Try to remove mud and soil when it is dry.
- Remove as much mud and soil as possible with a brush, and minimise the amount of water used.
- Collect all mud and soil removed in a bag or bucket, and do not allow it to enter bushland.

However, if you are entering very high value bushland or have come from an area that is infested with Phytophthora Dieback you should take the extra precaution of sterilising tools and footwear. If you are propagating plants then sterilising tools and footwear is essential. Anything to be sterilised should first be cleaned so that all soil and mud is removed.

Cleaning boots and spraying with methylated spirits or bleach can reduce the spread of Phytophthora Dieback.

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Sterilising equipment

- Methylated spirits (undiluted) is suitable for sterilising small hand tools and footwear in the field. Place the methylated spirits in a spray bottle, spray to cover all surfaces and allow a few minutes to dry (follow manufacturers safety instructions).
- Other equipment can be sterilised by soaking in a disinfectant such as bleach (containing the active ingredient sodium hypochlorite). Dilute the bleach (1 part bleach to 10 parts water), soak the tools for a few minutes, then rinse (follow manufacturers safety instructions).

Sterilising water

To sterilise water, add 6 ml of pool chlorine to every 10 litres of water and allow 5 minutes before use (follow manufacturers safety instructions). If the water is turbid a higher rate of chlorine maybe required for successful sterilisation.

Guidelines

Guidelines
for Propagating Plants

Plants used in revegetation should be grown using hygienic methods. Nurseries that are accredited under the Nursery Industry Accreditation Scheme Australia (NIASA) maintain very high hygiene standards. Not all nurseries are accredited as the scheme can require very high standards.

Therefore, if your local nursery is not accredited, ask the nurseryman what procedures are in place to ensure that their plants remain free of Phytophthora Dieback. Further information on the requirements for NIASA accreditation can be obtained from the Nursery & Garden Industry (see contact on page 47).

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For confidence that plants are dieback-free, only purchase plants from nurseries accredited under the Nursery Industry Accreditation Scheme Australia (NIASA).

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Guidelines
for Propagating Plants

Many community groups propagate their own plants for bushland revegetation. If community groups wish to continue this practice and introduce the plants to disease-free reserves, they should implement the following procedures into their propagation methods.

Potting Mix

- Use a quality potting mix. Ensure that it is sterilised and is free of Phytophthora species. In WA there are only a limited number of accredited media suppliers, including Bailey's, Biowise and Richgro.
- Use a well draining potting mix.
- Store potting mix in sterilised, covered bins on a hard dry surface.

Water

- Water obtained from dams & streams or recycled water should be filtered (5µm) and/or sterilised.
- Water from scheme supply, deep bores or rain water does not usually require treatment.

Diseased Plants

- Any plants that appear unhealthy should be removed immediately (including the soil surrounding the plant). Unhealthy plants and the soil with them should be disposed of well away from the propagation area, preferably low in the landscape, into a bin or deep hole.

Equipment and Hygiene

- Wash equipment, tools and pots well away from the propagation and nursery area.
- Disinfect the workbench daily.
- Clean and sterilise propagation tools daily, or if possible, between batches of seedlings.
- Sterilise any tools used to dispose of unhealthy plants.
- To reuse pots, wash them first, soak them in a bleach solution for an hour, and then rinse in clean water.

Storage

- Do not store plants on bare ground. Plants should be stored so that water cannot flow between the bottom of pots. An elevated, mesh covered table is ideal.

Watering Plants

- Avoid over watering.

Guidelines
for Bushwalking

Unfortunately the enjoyable pastime of bushwalking can contribute to the spread of Phytophthora Dieback. However, responsible bushwalkers can take steps to ensure they do not contribute to the spread of the pathogen. If you are planning to bushwalk in your local bushland reserve, in state forest, or in a national park, you can minimise the risk of spreading the pathogen by following these guidelines:

Guidelines

- Contact DEC or the local council for information about suitable bushwalking areas.
- Avoid bushwalking when the soil is wet and muddy (following rain).
- Keep to tracks.
- Avoid muddy areas and puddles.
- Make sure your footwear is free of all mud and soil when arriving at a bushwalking site, and try to keep your footwear as clean as possible during the walk.
- Sterilise footwear when entering high conservation value bushland or when leaving areas infested with Phytophthora Dieback.
- Use footpaths or shoe cleaning facilities when provided.
- Obey 'track closed' signs.
- Make sure your vehicle is clean when arriving at bushwalking sites.
- Park your car in designated car parks.

Frequent bushwalkers may find it useful to carry equipment in their packs and/or vehicle to help keep their footwear clean. A 'bushwalking hygiene kit' should contain a bag to collect scraped off soil/mud, large and small brushes and a bottle of water (from mains supply). Methylated spirits can be applied using a spray bottle to sterilise the soles of shoes.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Guidelines
for Cyclists

Bike tyres can pick up soil and mud and therefore contribute to the spread of Phytophthora Dieback. To minimise this risk, cyclists should follow these guidelines:

Guidelines

- Contact DEC or the local council to find out areas suitable for cycling.
- Stay on tracks.
- Avoid riding your bike following rain and when the soil is wet.
- Avoid muddy areas and puddles.
- Ensure that your bike is free of mud and soil (on the frame and tyres) when you begin your bike ride.
- Do not enter areas that have been closed off to bike riders.
- Do not enter DEC Declared Disease Risk Areas and obey 'track closed' signs. It is illegal for bicycles to enter Disease Risk Areas.

Guidelines
for Horse Riding

Horse riding is a popular activity, particularly in rural and bushland areas. Unfortunately, horse riding can contribute to the spread of Phytophthora Dieback through the spread of soil via the horse's hooves. To minimise the risk, horse riders should follow these guidelines:

Guidelines

- Contact DEC or the local council to find out areas where horse riding is appropriate.
- Avoid riding in bushland areas, particularly following rain or when the soil is wet.
- Avoid muddy areas and puddles.
- Obey signs that specify no horse riding.
- Stay on tracks
- Ensure that your horse's hooves are clean before entering bushland.
- Do not enter declared DEC Disease Risk Areas and obey 'track closed' signs. It is illegal for horses to enter Disease Risk Areas.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Checklist
for a Community Group Work Day

General

- ☐ No soil will be moved between areas within the bushland.
- ☐ Activities are scheduled for days when the soil is too dry to stick to footwear and tools.
- ☐ Equipment, tools and footwear are free of soil and mud.
- ☐ Footwear will be free of mud and soil when entering the bushland, and when moving between areas within the bushland.
- ☐ No vehicles will be taken into the bushland. If vehicles are necessary, they will be clean on entry and confined to hard, well drained surfaces.
- ☐ Techniques that minimise soil disturbance will be used.

Planting

- ☐ Direct seeding has been considered.
- ☐ Tree planting will be conducted in moist, not wet, soil conditions.
- ☐ Plants have been grown using hygienic methods.
- ☐ If using mulch, it has been well composted.
- ☐ Mains or sterilised water is being used to water plants.

Planting

- ☐ If practical weeding is scheduled for dry soil conditions.
- ☐ Weeds will be immediately placed in a bag or container so soil doesn't drop out during transport.

Contacts
and Further Information

Dieback Working Group

- Dieback Working Group - Project Coordinator.
  Phone 0438 044 488.
- Dieback Working Group - Chair (Ian Colquhoun).
  Phone (08) 9397 6813

Dieback interpretation services

- Glevan Consultancy (Evan Brown). Phone (08) 9582 7772.
- Department of Environment and Conservation .
  Phone (08) 9368 4399.
- Coffey Environemnts – Albany (Jeremy Spencer)
  Phone (08) 9892 6400

Dieback treatment contractors

- Dieback Treatment Services (Glenn Tuffnell).
  Phone 1300 785 311

Laboratories for testing soil and plants for Phytophthora Dieback

- Department of Environment and Conservation, Vegetation Health Service. Phone (08) 9334 0317.
- Murdoch University, Centre for Phytophthora Science and Management. Dr Giles Hardy. Phone (08) 9360 6272.
- Curtin University. Dr Elaine Davison. Phone (08) 9266 3106.
- Agwest Laboratories. Department of Agriculture.
  Phone (08) 9368 3693.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Contacts
and Further Information

Nursery accreditation scheme

- Contact the Nursery Industry Association for an updated list of Accredited Wholesale Nurseries and Landscape suppliers.
  Phone (08) 9358 4811.
  Internet http://www.ngia.com.au/accreditation/niasa.asp.

For further information

- The Environment Officer or Parks Officer at your local council.
- Roleystone Dieback Action Group, Ian Colquhoun.
  Phone (08) 9397 6813.
- Your local community conservation group.

Web sites of interest

- AgWest Plant Laboratories
  http://www.agric.wa.gov.au (search for 'Agwest laboratories')
- Centre for Phytophthora Science & Management,
  Murdoch University
  http://www.cpsm.murdoch.edu.au/
- Department of the Environment & Heritage
  http://www.deh.gov.au/ (search for 'dieback')
- Department of Conservation & Land Management
  www.calm.wa.gov.au
  (run a search on 'dieback' or 'Phytophthora cinnamomi')
- Nursery & Garden Industry of Western Australia
  http://www.ngia.com.au/your_industry/your_industry_wa.asp
- The Threatened Species Network
  http://www.wwf.org.au/tsn

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Erwin, D.C. & Ribeiro, O.K. (1996) Phytophthora Diseases Worldwide. ABS Press, St Paul, Minnesota.

Nursery Industry Association (1997) NIASA Best Practice Guidelines for the Nursery Industry Accreditation Scheme, Australia. Sydney.

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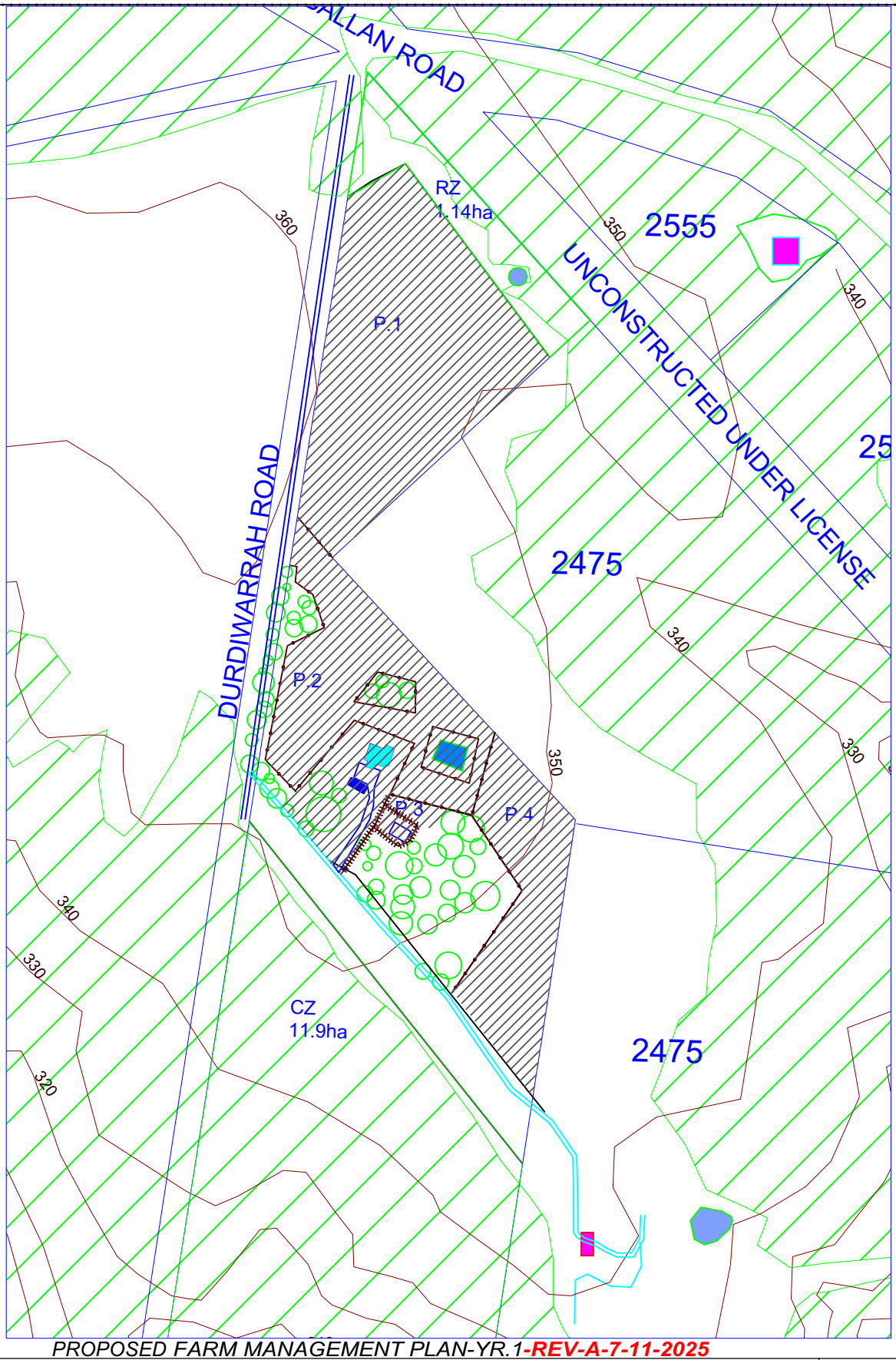
Shearer, B., Wills, R., and Stukey, M. (1991) Wildflower Killers. Landscope Magazine. Department of Conservation and Land Management.

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026

Appendix. 12 **Fuel restriction plan (CFA)**

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026



LEGEND

VEGETATION RESTRICTION ON SITE. ALL HATCHES AREAS ARE TO STAY AS PASTURE OR DEFENDABLE SPACE. NO INCREASE OF FUEL LOAD FROM EMERGENT VEGETATION ALLOWED IN THIS AREA AS SHOWN ON THIS PLAN.

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West NORTH East South

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Julie@nrlinks.com.au

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*PROPOSED FARM MANAGEMENT PLAN-YR.1-**REV-A-7-11-2025***

Note:
The contractor shall verify all dimensions and all underground services at the site before commencing work. The contractor shall verify all levels from the consulting engineer prior to construction.

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PROJECT: 2485 Ballan Road, Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *PASTURE VEGETATION RESTRICTION PLAN*

SCALE: 1:5000 @A4

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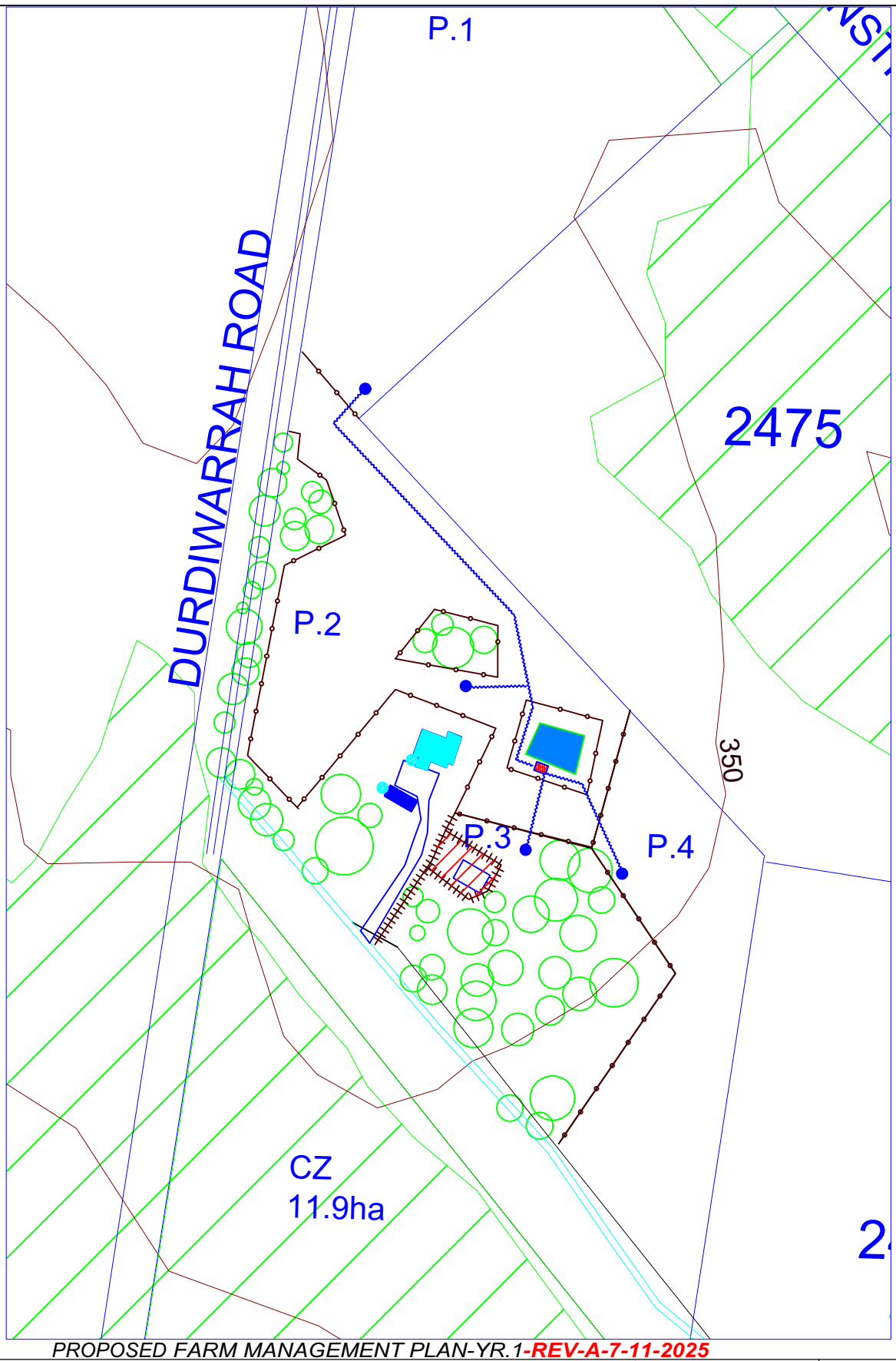
Appendix. 13 **Water storage and infrastructure plan**

City of Greater Geelong, Statutory Planning - Date Received 09/02/2026



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Note:
The contractor shall verify all dimensions and all underground services at the site before commencing work. The contractor shall verify all levels from the consulting engineer prior to construction.

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Anakie

PROJECT NO: *2688*

DATE: *NOV* 2025

DWG TITLE: *WATER INFRASTRUCTURE PLAN*

SCALE: 1:3000 @A4