Premise

TERRAIN SOLAR

Marulan Solar Farm

Water Cycle Management Study

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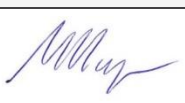
Hugh Shackcloth-Bertinetti		Martin Haege		David Walker	

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1 INTRODUCTION

1.1 Background

Premise has been commissioned by the proponent (Terrain Solar) to prepare this Water Cycle Management Study (WCMS) to support a State Significant Development Application (SSD 13137914) for a proposed solar farm, battery energy storage system (BESS) and associated works at 740 Carrick Road, Carrick NSW 2580 within the Goulburn Mulwaree Council (GMC) Local Government Area (LGA).

The development is known as the Marulan Solar Farm (MSF) and is proposed to be located on Lot 55 DP1141136, which connects to Munro Road.

The development site has an area of approximately 1,400 hectares, of which 375.5 hectares is to be occupied by the proposed approximately 150 megawatt (MW) solar farm.

The site is located within the Sydney Drinking Water Catchment, specifically the Wollondilly River sub-catchment.

1.2 Purpose

Chapter 8 (Sydney Drinking Water Catchment) of the *State Environmental Planning Policy (Biodiversity and Conservation) 2021* (BC SEPP) applies to the site as it is located within the Sydney Drinking Water Catchment.

Section 8.8 of Chapter 8 (Sydney Drinking Water Catchment) of the BC SEPP states:

(1) A consent authority must not grant consent to the carrying out of development under Part 4 of the Act on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on water quality.

(2) For the purposes of determining whether the carrying out of the proposed development on land in the Sydney drinking water catchment would have a neutral or beneficial effect on water quality, the consent authority must, if the proposed development is one to which the NorBE Tool applies, undertake an assessment using that Tool.

As the proposed MSF is development under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and it is located within the Sydney Drinking Water Catchment, the consent authority must be satisfied that the development would have a neutral or beneficial effect on water quality.

This report has been prepared in accordance with the *Neutral or Beneficial Effect on Water Quality assessment Guidelines* (WaterNSW, 2021) (the 'NorBE Guidelines') to determine whether the development would have a neutral or beneficial effect on water quality.

2 SITE FEATURES

An overview of site features is provided in **Figure 1** overleaf and described in the following sections.

2.1 Topography

The site features undulating topography with low peaks, shallow gullies and creeks scattered throughout, generally coinciding with mapped watercourses.

A review of elevation within the site via Google Earth Mapping identifies a high point of 680 m Average Height Datum (AHD) in the south-west and low point of 617 m AHD along Narambulla Creek.

2.2 Land use

The site is currently used for agriculture, including grazing and cropping.

The following is noted with respect to land use zoning in the locality:

- The majority of the development site is zoned RU1 – Primary production except for the access road from Munro Road that is zoned RU2 – Rural Landscape.
- Land zoned RU1 – Primary Production extends north and east of the development site.
- The south-eastern boundary of the development site borders land zoned RU2 – Rural Landscape.
- The south-western and western boundary of the development site borders land zoned C3 – Environmental Management.

2.3 Land and soil capability

A Land and Soil Capability (LSC) assessment has been prepared in accordance with the NSW Office of Environment and Heritage (OEH, 2012) *Land and Soil Capability Assessment Scheme: Second Approximation* (LSC Scheme) and accompanies the EIS.

Overall land and soil capability for the development footprint ranges from Class 5 (moderate – low capability land) to Class 7 (very low capability land).

2.4 Hydrology

A review of the NSW Base Map and Satellite Imagery available via the ePlanning Spatial Viewer (DPIE) and Near map Satellite imagery was conducted to identify existing hydrology within the site.

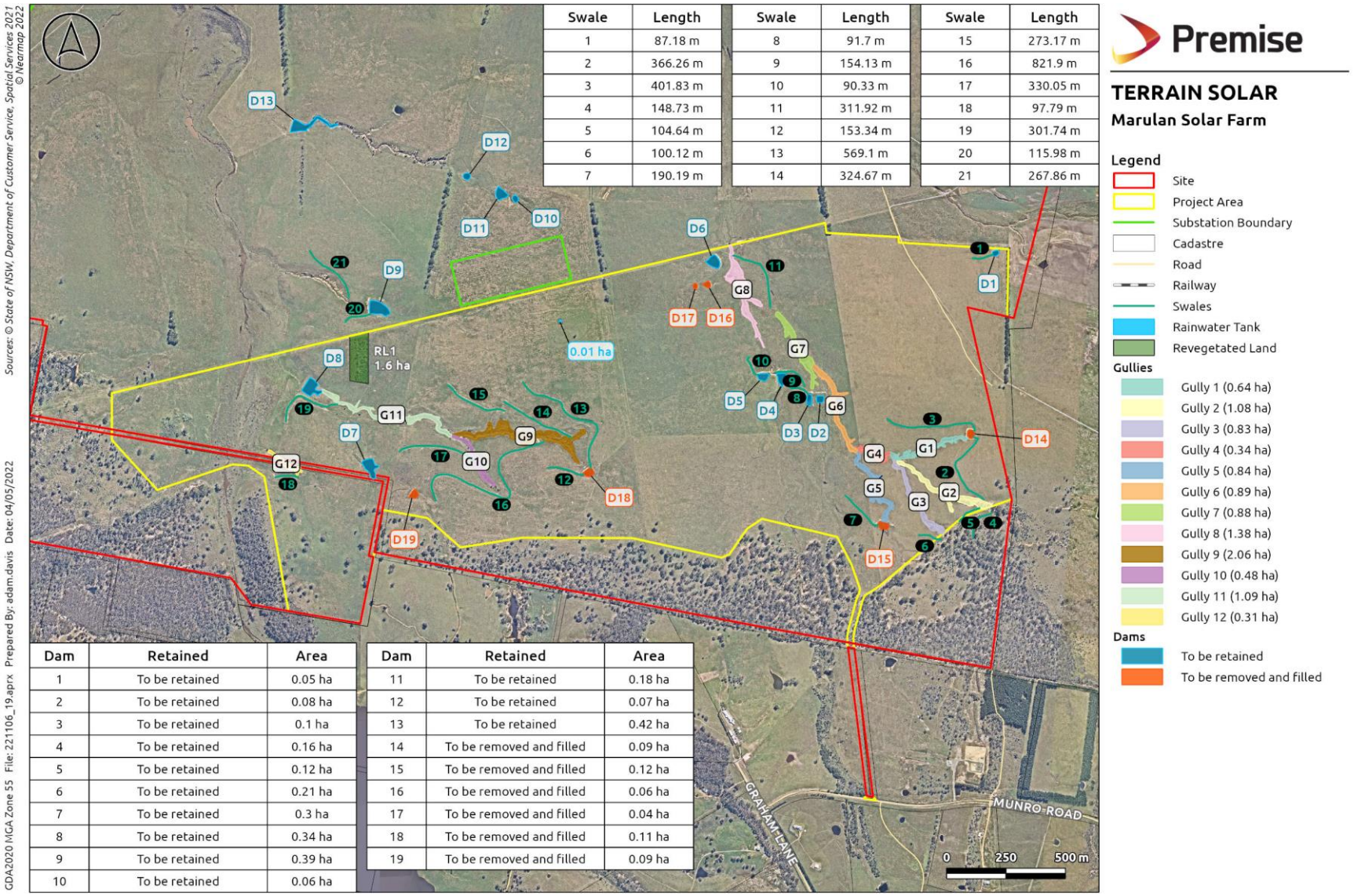
The site is traversed by three (3) named ephemeral creeks and their tributaries. Mapped watercourses at the site are all 4th order Strahler streams and include:

- Lockyersleigh Creek
- Osborns Creek
- Narambulla Creek

Watercourses and tributaries within the site generally drain (at an approximate grade of 0.52 – 0.83 %) towards the north-west and eventually flow into the Wollondilly River. The Wollondilly River is located approximately 600 m north-west of the site at its closest point.

The Wollondilly River starts west of Crookwell (approximately 39 km north-east of the site) and flows south-east towards Goulburn and then north-east towards Towrang. The river eventually drains into Lake Burragorang, located approximately 67 km (straight line distance) north-west of the site. The Wollondilly River and Lake Burragorang form part of the Sydney Drinking Water Catchment.

Figure 1 – Site features



Swale	Length	Swale	Length	Swale	Length
1	87.18 m	8	91.7 m	15	273.17 m
2	366.26 m	9	154.13 m	16	821.9 m
3	401.83 m	10	90.33 m	17	330.05 m
4	148.73 m	11	311.92 m	18	97.79 m
5	104.64 m	12	153.34 m	19	301.74 m
6	100.12 m	13	569.1 m	20	115.98 m
7	190.19 m	14	324.67 m	21	267.86 m

Dam	Retained	Area
1	To be retained	0.05 ha
2	To be retained	0.08 ha
3	To be retained	0.1 ha
4	To be retained	0.16 ha
5	To be retained	0.12 ha
6	To be retained	0.21 ha
7	To be retained	0.3 ha
8	To be retained	0.34 ha
9	To be retained	0.39 ha
10	To be retained	0.06 ha

Dam	Retained	Area
11	To be retained	0.18 ha
12	To be retained	0.07 ha
13	To be retained	0.42 ha
14	To be removed and filled	0.09 ha
15	To be removed and filled	0.12 ha
16	To be removed and filled	0.06 ha
17	To be removed and filled	0.04 ha
18	To be removed and filled	0.11 ha
19	To be removed and filled	0.09 ha

3 WATER QUALITY MANAGEMENT

3.1 Methodology

Assessment of stormwater quality impacts was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) developed by the Cooperative Research Centre for Catchment Hydrology.

MUSIC was developed as an aid to decision making and predicts the performance of stormwater quality management systems. It enables users to evaluate conceptual designs of stormwater management systems to ensure they are appropriate for their catchments. By simulating the performance of stormwater quality improvement measures, MUSIC determines if proposed systems can meet specified water quality objectives.

MUSIC can simulate the performance of a group of stormwater management measures, configured in series or in parallel to form a "treatment train". MUSIC runs on an event or continuous basis, allowing analysis of the merit of proposed strategies over the short-term and long-term.

Parameters used in the modelling are described in the following sections.

3.2 Catchments

The site has been treated as an independent sub-catchment assuming the site receives no runoff from any surrounding areas or catchments. This is a valid assumption as the proposed development will not change catchment parameters upstream of the site.

For the purpose of this assessment, the site was separated into three (3) catchments associated with drainage channels for Narambulla Creek and Lockyersleigh Creek, depicted in **Figure 2** (overleaf) and including the following catchment areas:

- Narambulla Creek (Western Catchment) – 189.6 ha
- Lockyersleigh Creek (Eastern Catchment), including the access handle – 172.83 ha
- Lockyersleigh Creek (North-eastern Catchment) – 33.27 ha

Source nodes and treatment nodes have been specified within the sub-catchment to represent the generation and treatment of stormwater under the existing and developed conditions. These nodes are detailed in the following sections.

3.3 Assessment area

The area of the site which was included within this assessment is 395.7 ha which accounts for the maximum proposed footprint of the development. Water quality modelling was confined to the three (3) catchments defined within the site.

The assessment area was divided by catchment and into smaller subsections for modelling purposes. Divided soil units are specified in **Table 1** and depicted in **Figure 3** below.

Table 1 – Divided Soil Unit

Divided Soil Units	Area (ha)
Soil Unit 1 (Northeast)	33.27
Soil Unit 1 (Northwest)	22.06
Soil Unit 1 (South)	16.50
Soil Unit 2 (Central South-1)	7.06
Soil Unit 2 (Central South-2)	6.51
Soil Unit 2 (North)	11.7
Soil Unit 2 (South-East)	1.15
Soil Unit 3 (East)	76.1
Soil Unit 3 (Southwest)	2.2
Soil Unit 3 (Substation)	8.96
Soil Unit 3 (West)	63.01
Soil Unit 4	17.11
Soil Unit 5 (East)	40.53
Soil Unit 5 (West)	35.05
Soil Unit 6	16.17
Soil Unit 7 (East)	9.23
Soil Unit 7 (West)	17.98
Soil Unit 8 (Switchyard North)	8.77
Soil Unit 9 (Access Corridor)	0.58
Soil Unit 10 (Access Corridor)	1.76
Total Area	**395.7**

Figure 2 – Catchment areas

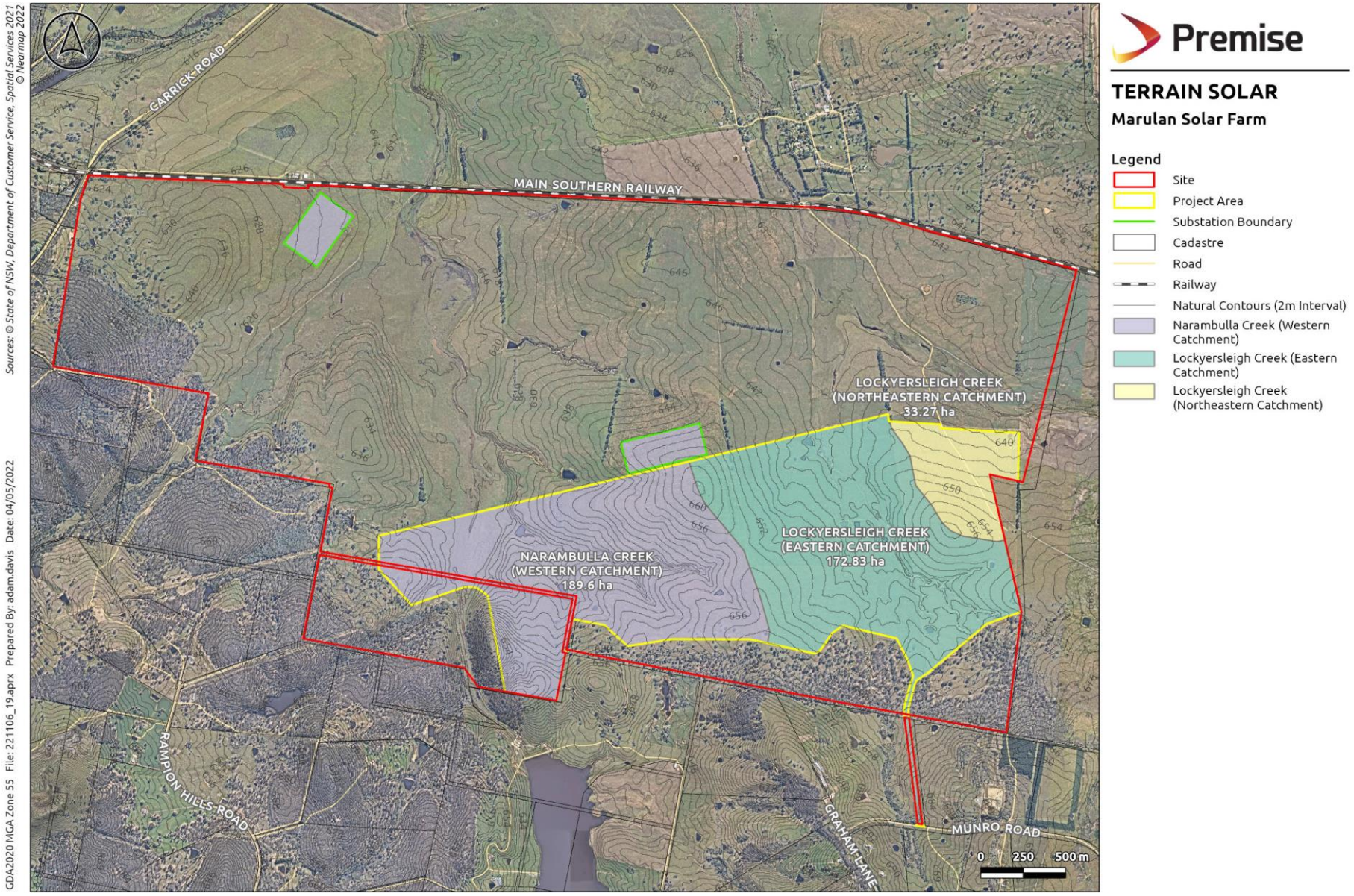
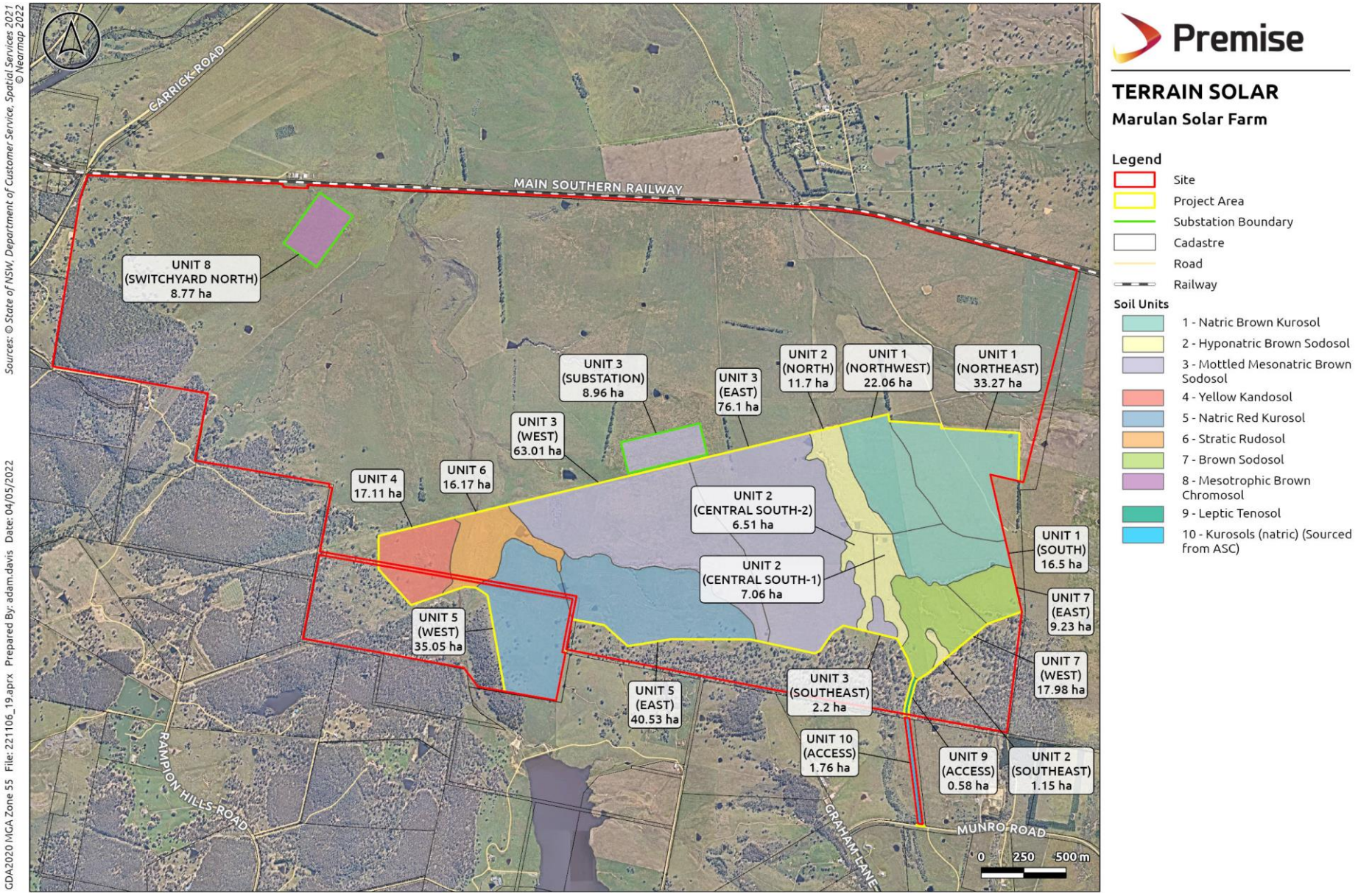


Figure 3 – Divided Soil Units



3.4 Source nodes

Source nodes were determined in reference to *Using MUSIC in Sydney's Drinking Water Catchment (SCA) 2nd Edition (*Water NSW, 2019) ('the Manual'). Source nodes used in the pre- and post-development modelling are outlined below.

3.4.1 Pre-Development Source Nodes

Source nodes were added to the pre-development model and included areas specified in **Table 2**.

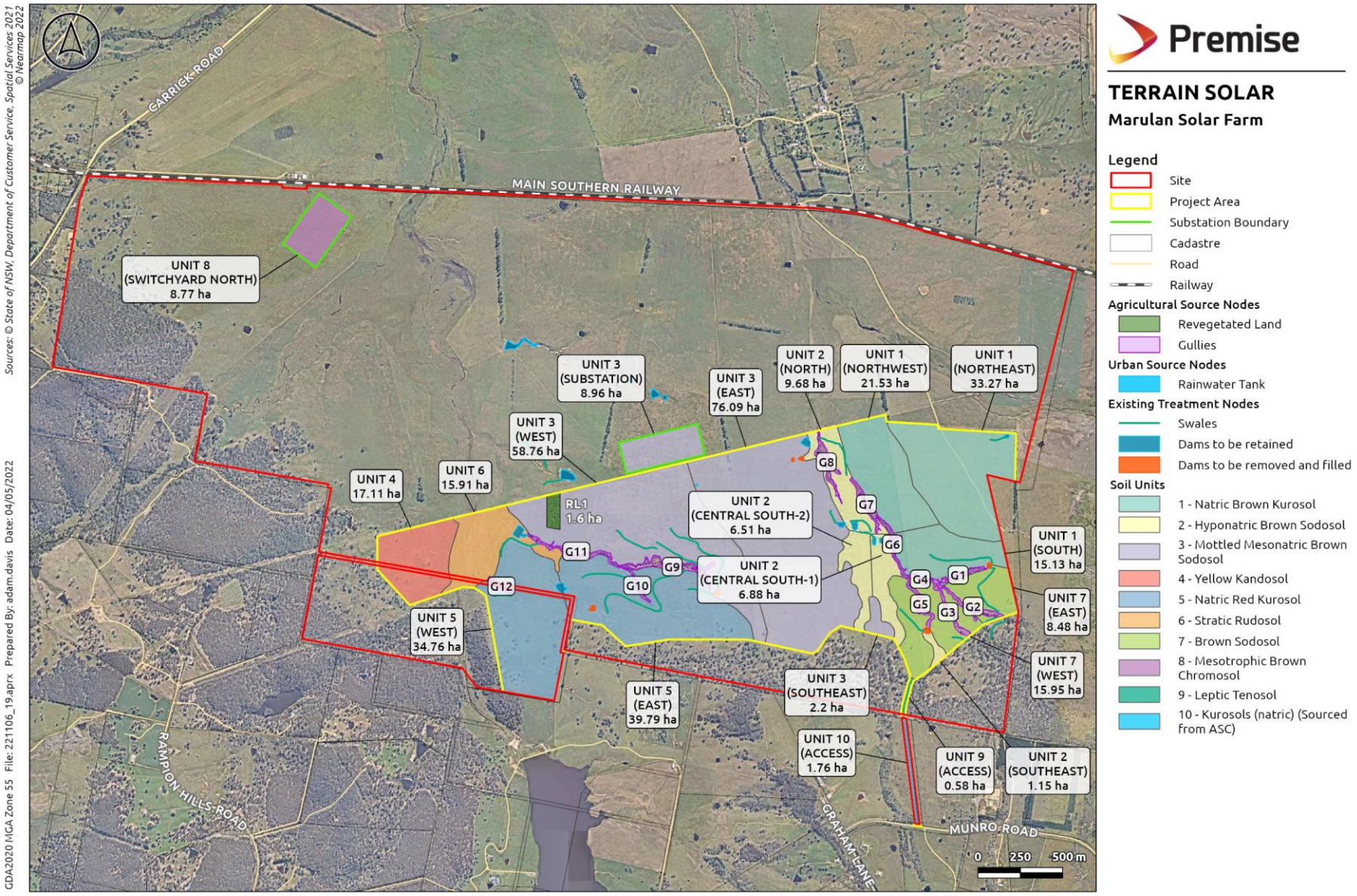
- Where required the areas for soil units were recalculated to exclude source nodes within their areas including gullies, the rainwater tank and revegetated land. Pre-development source nodes including recalculated soil units are depicted in **Figure 4.**

Table 2 – Pre-development source nodes and modelling assumptions

Area modelled	Model surface	Area (ha)
Soil Unit 1 (Northeast)	Agricultural land Use	33.27
Soil Unit 1 (Northwest)	Agricultural land Use	21.53
Soil Unit 1 (South)	Agricultural land Use	15.13
Soil Unit 2 (South-East)	Agricultural land Use	1.15
Soil Unit 2 (Central South-1)	Agricultural land Use	6.88
Soil Unit 2 (Central South-2)	Agricultural land Use	6.51
Soil Unit 2 (North)	Agricultural land Use	9.68
Soil Unit 3 (East)	Agricultural land Use	76.09
Soil Unit 3 (West)	Agricultural land Use	58.76
Soil Unit 3 (Southwest)	Agricultural land Use	2.2
Soil Unit 3 (Substation)	Agricultural land Use	8.96
Soil Unit 4	Agricultural land Use	17.11
Soil Unit 5 (West)	Agricultural land Use	34.76
Soil Unit 5 (East)	Agricultural land Use	39.79
Soil Unit 6	Agricultural land Use	15.91
Soil Unit 7 (East)	Agricultural land Use	8.48
Soil Unit 7 (West)	Agricultural land Use	15.95
Soil Unit 8 (Switchyard North)	Agricultural land Use	8.77
Soil Unit 9 (Access Corridor)	Agricultural land Use	0.58
Soil Unit 10 (Access Corridor)	Agricultural land Use	1.76
Total Soil Unit Area (Pre-Development)		**383.27**
Gully 1 (Soil Unit 1)	Eroding Gully	0.64
Gully 2 (Soil Unit 7)	Eroding Gully	1.08
Gully 3 (Soil Unit 7)	Eroding Gully	0.83
Gully 4 (Soil Unit 7)	Eroding Gully	0.34
Gully 5 (Soil Unit 7)	Eroding Gully	0.84

Area modelled	Model surface	Area (ha)
Gully 6 (Soil Unit 1)	Eroding Gully	0.89
Gully 7 (Soil Unit 2)	Eroding Gully	0.88
Gully 8 (Soil Unit 2)	Eroding Gully	1.38
Gully 9 (Soil Unit 3)	Eroding Gully	2.06
Gully 10 (Soil Unit 5)	Eroding Gully	0.48
Gully 11 (Soil Unit 5)	Eroding Gully	1.09
Gully 12 (Soil Unit 5)	Eroding Gully	0.31
Total Gully Area (Pre-Development)		**10.83**
Rainwater Tank	Roof	0.01
Revegetated Land	Revegetated Land Use	1.6
Total Pre-Development Modelled Area		**395.7**

Figure 4 – Pre-Development Model



3.4.1.1 Agricultural source nodes

Agricultural source nodes, effective impervious areas, and rainfall threshold values for agricultural/grazing land use were adopted for modelling a pre-development scenario.

The following informed the modelling:

- Rainfall thresholds were calculated for agricultural land use in reference to Table 4.3 of the Manual.
- The agricultural land use of the development footprint was separated into ten (10) soil units, nine (9) identified within the LSC assessment and one (1) identified from the ASC. Soil units within the assessment area were divided into subareas.
- Soil and groundwater parameters including soil storage capacity, field capacity and runoff were calculated in reference to Table 4.4 and Table 4.5 of the Manual and reflected soil descriptions for between 0 and 0.5 m summarised within the land and soil capability assessment (LSC) (Premise, 2021). The adopted parameters are provided in **Table 3**.

Separate agricultural source nodes for eroding gullies and revegetated land were included within the modelling. These surfaces used soil parameters from surrounding soil units. Separate pollutant concentration parameters were calculated for eroding gullies and revegetated land (refer to **Section 3.5**).

Table 3 – Soil and groundwater parameters

Parameter	Soil Type									
	1	2	3	4	5	6	7	8	9	10[1]
Pervious area properties										
Soil storage capacity, mm	98	139	139	108	98	88	98	139	108	98
Initial storage, %	25	70	25	25	25	25	25	25	25	25
Field capacity, mm	70	69	69	73	70	70	70	69	73	70
Infiltration capacity coefficient	250	360	360	250	250	180	250	360	250	250
Infiltration capacity exponent	1.3	0.5	0.5	1.3	1.3	3	1.3	0.5	1.3	1.3
Groundwater properties										
Initial depth, mm	10	10	10	10	10	10	10	10	10	10
Daily recharge rate, %	60	100	100	60	60	25	60	100	60	60
Daily baseflow rate, %	45	50	50	45	45	25	45	50	45	45
Daily deep seepage rate, %	0	0	0	0	0	0	0	0	0	0

[1]Soil Unit 10 was determined in reference to the Australian Soil Classification Scheme as a Kurosol (Natric). Soil and groundwater parameters were determined in reference to other Kurosols sampled within the site including Soil Unit 1 and 5.

3.4.2 Post-development source nodes

Urban source nodes were added to the post development model and included areas specified in **Table 4**.

Table 4 – Urban nodes and modelling assumptions

Area modelled	Model surface	Comments
Solar panel arrays	Roofs	Solar panels were modelled as roofs and accounted for divided soil units, exclusion zones and landscaping.
Construction compound	Unsealed roads	Construction compound would be formed using a trafficable gravel surface, like a gravel road.
Array access roads	Unsealed roads	Unsealed internal array access roads.
Access roadways and Creek Crossings	Unsealed roads	Unsealed internal access roads.
Site Access Roadway	Sealed Road	Sealed site access road connecting to Munro Road.
Substation	Unsealed roads	The full extent of impacted area for the substation was included.

Table 5 outlines the categorisation of post development source nodes used within the model and their effective area.

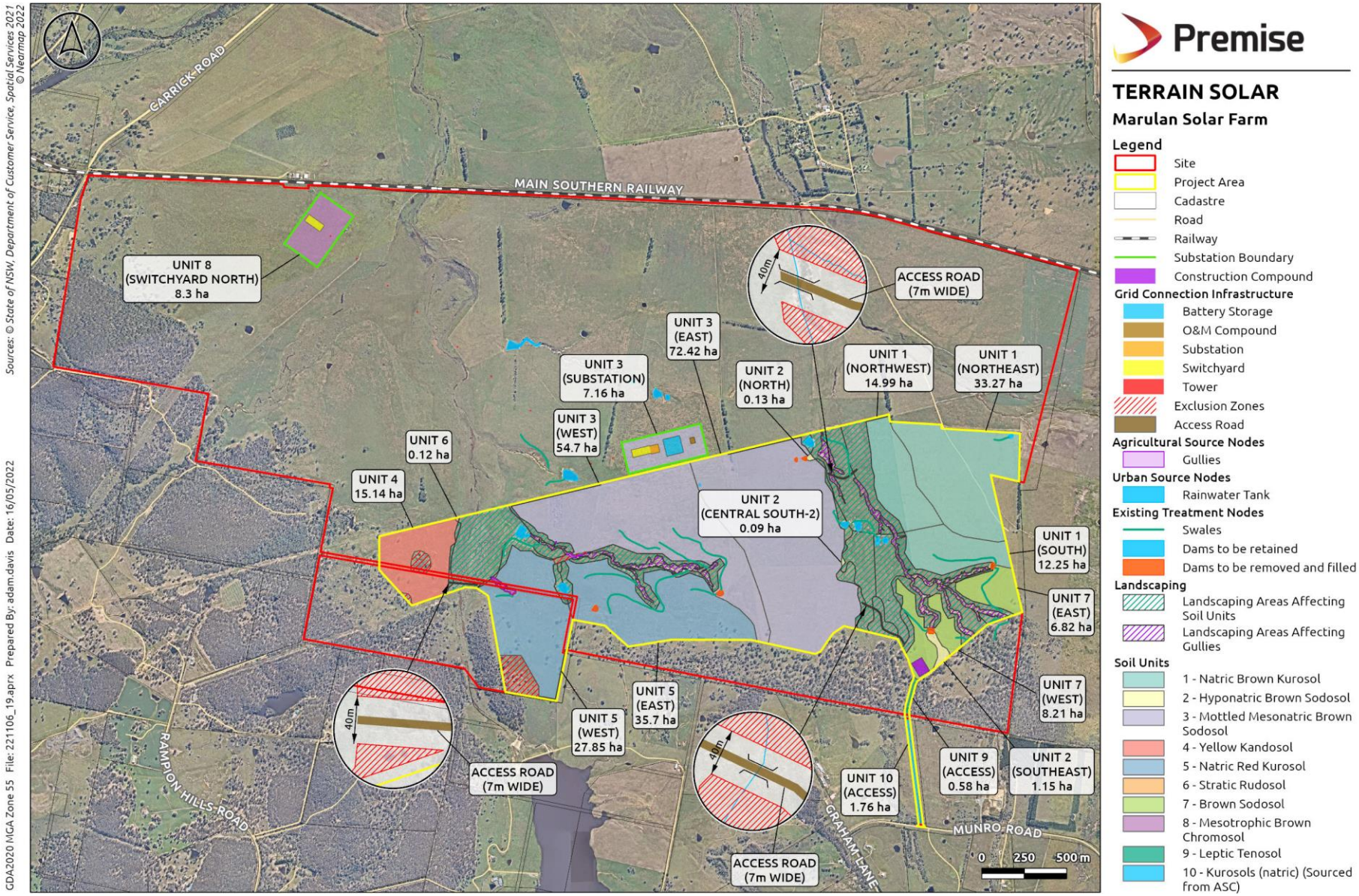
Table 5 – Post development source nodes

Development	Source Node	Type of Source Node	Total Impervious Area (%)	Rainfall Threshold (mm)
Solar Panel Arrays	Urban	Roof	Varies depending on area of array in each catchment.[1]	0.3
Internal Array access roads	Urban	Unsealed Road	50%	1.5
Unsealed access roads	Urban	Unsealed Road	50%	1.5
Sealed access road	Urban	Sealed Road	100%	1.5
Construction Compound	Urban	Unsealed Road	50%	1.5
Substation	Urban	Unsealed Road	50%	1.5
Switchyards	Urban	Unsealed Road	50%	1.5
BESS	Urban	Unsealed Road	50%	1.5

Figure 5 overleaf details soil units areas amended to exclude landscaping, exclusion zones and the installation of known site infrastructure. A full list of source nodes used in the post development model Is provided in **Section 3.4.2.1.**

[1] Although solar arrays are proposed for most of the site, the area covered by the proposed solar panels is not considered as impervious as the ground underneath the solar panels will remain as grass. Solar panels are 100% impermeable and are designed in a way that they can angle towards the sun. This allows stormwater to drain freely off the solar panels onto the underlying ground which remains permeable. Only runoff from the last row drains onto ground that also receives rainfall. Therefore the area of the last array row is modelled as impervious.

Figure 5 – Post-Development Model



3.4.2.1 Access Roadway and Creek Crossings.

Access roadways were divided into soil unit areas and modelled for the connection to Munro Road and for crossings of Narambulla and Lockyersleigh Creek. Centrepoint line lengths and an estimated road width of 7 metres were used to determine the approximate area of roadways. Soil units and gullies impacted by access roadways are detailed in **Table 6.**

Access roadways were included as separate source nodes in the post development model and excluded from modelled soil unit areas (refer to **Section 3.4.2.3**). The site access was modelled as a sealed road with all other roadways modelled as unsealed.

Table 6 – Soil units impacted by Access Roadways.

Soil Unit	Road Area (ha)
Soil Unit 1 (Northwest)	0.02
Soil Unit 2 (North)	0.09
Soil Unit 2 (Central South-1)	0.05
Soil Unit 2 (Central South-2)	0.03
Gully 8 (Soil Unit 2)	0.02
Soil Unit 3 (East)	0.02
Soil Unit 3 (Southeast)	0.17
Soil Unit 4	0.02
Soil Unit 6	0.1
Soil Unit 9 (Access)	0.15
Soil Unit 10 (Access)	0.47
Total Sealed Roadway Area	**1.14**
[1]Note the access road area for Soil Unit 7 (West) was excluded from the post development model as its total area was less than 0.01 ha.	

3.4.2.2 Solar Panel Arrays and impacted soil units.

Solar panel array areas were modelled using the measurements outline in **Table 7.**

Table 7 – Solar panel array measurements

Measurement	Orientation	Distance (m)
Panel Length	North to South	2.4
Panel Width	West to East	1.4
Spacing between String Posts	West to East	5
Spacing between Panels[1]	West to East	2.62
Panel Set[2]	West to East	5.02
[1]Spacing between panels has been calculated with panels in a horizontal orientation. [2]Panel Set represents the width of an individual panel and the unoccupied space before the next panel.		

The modelling utilised the panel dimensions in **Table 7** to determine the below percentages (rounded to the nearest whole number) for each soil unit potentially impacted by a solar array.

- Total Agricultural Land Area Between Panels - 52%
- Total Impervious and Pervious Panel Area - 48%

To remain conservative the model has altered these percentages to account for the inclusion of internal array access roads and to separate impervious and pervious panel areas. Total pervious panel roofed areas were treated as part of each soil unit and modelled as agricultural source nodes**.** The following percentages were adopted for soil units impacted by solar panel arrays:

- Total Remaining Agricultural Land Use – 99% (includes total agricultural land use between panels (51.5%) and pervious panel roofed area 47.5%))
- Impervious Panel Roofed Area (taken from impervious and previous panel area) – 0.5%
- Internal Array Access Road (taken from agricultural land between panels)– 0.5%

Soil units impacted by solar panel arrays are detailed in **Table 8.** Total soil unit areas used in the pre-development model were amended to exclude access roadways, landscaping, exclusion zones and site infrastructure resulting from the development.

The post development model excluded impervious panel roofed areas and internal array access road areas calculated as less than 0.01 ha.

Table 8 – Soil units impacted by solar arrays

Soil Unit	Total Soil Unit Area (ha)	Total Remaining Agricultural Land Use Area (ha)	Impervious Panel Roofed Area (ha)	Internal Array Access Road Area (ha)
Soil Unit 1 (Northeast)	33.27	32.94	0.17	0.17
Soil Unit 1 (Northwest)	14.99	14.84	0.07	0.07
Soil Unit 1 (South)	12.25	12.13	0.06	0.06
Soil Unit 2 (Southeast)	1.15	1.14	0.01	0.01
Soil Unit 2 (North)	0.13	0.13	0.00	0.00
Soil Unit 2 (Central South-2)	0.09	0.09	0.00	0.00
Soil Unit 3 (West)	54.7	54.15	0.27	0.27
Soil Unit 3 (East)	72.42	71.70	0.36	0.36
Soil Unit 4	15.14	14.99	0.08	0.08
Soil Unit 5 (East)	35.7	35.34	0.18	0.18
Soil Unit 5 (West)	27.85	27.57	0.14	0.14
Soil Unit 6	0.12	0.12	0.00	0.00
Soil Unit 7 (East)	6.82	6.75	0.03	0.03
Soil Unit 7 (West)	8.21	8.13	0.04	0.04
Totals	**282.84**	**280.01**	**1.41**	**1.41**
Note rounding errors have occurred with the calculation of some areas.				

3.4.2.3 Post Development Model Source Node Summary

Table 9 summarises areas used within the post development model. Source nodes within the post development model were amended to reflect the following:

- The areas of all soil units used in the pre-development model were amended to exclude landscaping, exclusion zones and site infrastructure.
- The following soil units were replaced by landscaping and no longer had an agricultural land use area modelled:
  - Soil Unit 2 (Central South-1)
  - Soil Unit 3 (Southeast)
- Post development soil unit areas impacted by solar panel arrays were included as separate source nodes and reflect "Total Remaining Agricultural Land Use" as detailed in **Section 3.4.2.2**, **Table 8.**
- Solar Array areas for each impacted soil unit were included as separate source nodes and reflect "Impervious Panel Roofed Area" detailed in **Section 3.4.2.2**, **Table 8.**
- Internal array access road areas for each impacted soil unit were included as separate source nodes and reflect "Internal Array Access Road Area" detailed in **Section 3.4.2.2**, **Table 8.**
- Access roadways for each impacted soil unit were included as separate source nodes and reflect areas detailed in **Section 3.4.2.1, Table 6.**
- Site infrastructure including the construction compound, O&M Compound, substation, switchyards and BESS were included as separate source nodes.
- With the exception of gullies 11 and 12, all gullies within the pre-development model have been removed. All other gullies are contained within proposed landscaping areas as detailed in the Appended Landscape Plan (**Appendix A)**. A portion of gully 11, not impacted by landscaping, has been retained for the post development model.
- Landscaping areas for each impacted soil unit and gully were included as separate source nodes.
- Remaining portions of exclusion zones were divided by soil unit and included as separate agricultural land use source nodes.
- Revegetated Land in Soil Unit 3 (West) was removed, and the respective area of Soil Unit 3 (West) increased.
- The rainwater tank within Soil unit 3 (East) was retained.
- All connection towers were excluded.

Table 9 – Post development source nodes and modelling assumptions

Area modelled	Model surface	Area (ha)
Soil Unit 1 (Northeast)	Agricultural land use	32.94
Soil Unit 1 (Northwest)	Agricultural land use	14.84
Soil Unit 1 (South)	Agricultural land use	12.13
Soil Unit 2 (Southeast)	Agricultural land use	1.14
Soil Unit 2 (North)	Agricultural land use	0.13
Soil Unit 2 (Central South-2)	Agricultural land use	0.09
Soil Unit 3 (West)	Agricultural land use	54.15
Soil Unit 3 (East)	Agricultural land use	71.70
Soil Unit 3 (Substation)	Agricultural land use	7.16
Soil Unit 4	Agricultural land use	14.99
Soil Unit 5 (East)	Agricultural land use	35.34
Soil Unit 5 (West)	Agricultural land use	27.57

Soil Unit 6	Agricultural land use	0.12
Soil Unit 7 (East)	Agricultural land use	6.75
Soil Unit 7 (West)	Agricultural land use	8.13
Soil Unit 8 (Switchyard North)	Agricultural land use	8.30
Soil Unit 9 (Access)	Agricultural land use	0.43
Soil Unit 10 (Access)	Agricultural land use	1.29
Total Soil Unit Area (Post-Development)		**297.20**
Solar Array, Soil Unit 1 (Northeast)	Roof	0.17
Solar Array, Soil Unit 1 (Northwest)	Roof	0.07
Solar Array, Soil Unit 1 (South)	Roof	0.06
Solar Array, Soil Unit 2 (Southeast)	Roof	0.01
Solar Array, Soil Unit 3 (West)	Roof	0.27
Solar Array, Soil Unit 3 (East)	Roof	0.36
Solar Array, Soil Unit 4	Roof	0.08
Solar Array, Soil Unit 5 (East)	Roof	0.18
Solar Array, Soil Unit 5 (West)	Roof	0.14
Solar Array, Soil Unit 7 (East)	Roof	0.03
Solar Array, Soil Unit 7 (West)	Roof	0.04
Total Solar Array Area		**1.41**
Internal Array Access Roads, Soil Unit 1 (Northeast)	Unsealed Road	0.17
Internal Array Access Roads, Soil Unit 1 (Northwest)	Unsealed Road	0.07
Internal Array Access Roads, Soil Unit 1 (South)	Unsealed Road	0.06
Internal Array Access Roads, Soil Unit 2 (Southeast)	Unsealed Road	0.01
Internal Array Access Roads, Soil Unit 3 (West)	Unsealed Road	0.27
Internal Array Access Roads, Soil Unit 3 (East)	Unsealed Road	0.36
Internal Array Access Roads, Soil Unit 4	Unsealed Road	0.08
Internal Array Access Roads, Soil Unit 5 (East)	Unsealed Road	0.18
Internal Array Access Roads, Soil Unit 5 (West)	Unsealed Road	0.14
Internal Array Access Roads, Soil Unit 7 (East)	Unsealed Road	0.03
Internal Array Access Roads, Soil Unit 7 (West)	Unsealed Road	0.04
Total internal Access Road Area		**1.41**
Landscaping, Soil Unit 1 (Northwest)	Revegetated land	6.52
Landscaping, Soil Unit 1 (South)	Revegetated land	2.88
Landscaping, Soil Unit 2 (Central South-1)	Revegetated land	6.83
Landscaping, Soil Unit 2 (Central South-2)	Revegetated land	6.39
Landscaping, Soil Unit 2 (North)	Revegetated land	9.45
Landscaping, Soil Unit 3 (East)	Revegetated land	3.66

Landscaping, Soil Unit 3 (Southeast)	Revegetated land	2.03
Landscaping, Soil Unit 3 (West)	Revegetated land	5.54
Landscaping, Soil Unit 4	Revegetated land	0.55
Landscaping, Soil Unit 5 (East)	Revegetated land	3.97
Landscaping, Soil Unit 5 (West)	Revegetated land	2.65
Landscaping, Soil Unit 6	Revegetated land	15.55
Landscaping, Soil Unit 7 (East)	Revegetated land	1.66
Landscaping, Soil Unit 7 (West)	Revegetated land	7.13
Landscaping, Gully 1 (Soil Unit 1)	Revegetated land	0.64
Landscaping, Gully 2 (Soil Unit 7)	Revegetated land	1.08
Landscaping, Gully 3 (Soil Unit 7)	Revegetated land	0.83
Landscaping, Gully 4 (Soil Unit 7)	Revegetated land	0.34
Landscaping, Gully 5 (Soil Unit 7)	Revegetated land	0.83
Landscaping, Gully 6 (Soil Unit 1)	Revegetated land	0.89
Landscaping, Gully 7 (Soil Unit 2)	Revegetated land	0.88
Landscaping, Gully 8 (Soil Unit 2)	Revegetated land	1.36
Landscaping, Gully 9 (Soil Unit 3)	Revegetated land	2.06
Landscaping, Gully 10 (Soil Unit 5)	Revegetated land	0.48
Landscaping, Gully 11 (Soil Unit 5)	Revegetated land	1.01
Landscaping, Gully 12 (Soil Unit 5)	Revegetated land	0.01
Total Landscaping Area		**85.22**
Gully 11 (Soil Unit 5)	Eroding Gully	0.08
Gully 12 (Soil Unit 5)	Eroding Gully	0.30
Total Remaining Gully Area		**0.38**
O&M Compound, Soil Unit 3 (Substation)	Unsealed Road	0.09
Substation, Soil Unit 3 (Substation)	Unsealed Road	0.24
Switchyard, Soil Unit 3 (Substation)	Unsealed Road	0.47
Switchyard, Soil Unit 8 (Switchyard North)	Unsealed Road	0.47
BESS, Soil Unit 3 (Substation)	Unsealed Road	1.00
Total Connection Infrastructure Area		**2.27**
Construction Compound, Soil Unit 7 (West)	**Unsealed Roads**	**0.61**
Rainwater Tank, Soil Unit 3 (East)	**Roof**	**0.01**
Access Road, Soil Unit 1 (Northwest)	Unsealed Road	0.02
Access Road, Soil Unit 2 (North)	Unsealed Road	0.09
Access Road, Soil Unit 2 (Central South-1)	Unsealed Road	0.02
Access Road, Soil Unit 2 (Central South-2)	Unsealed Road	0.05
Access Road, Gully 8 (Soil Unit 2)	Unsealed Road	0.17

Access Road, Soil Unit 3 (East)	Unsealed Road	0.03
Access Road, Soil Unit 3 (Southeast)	Unsealed Road	0.02
Access Road, Soil Unit 4	Unsealed Road	0.10
Access Road, Soil Unit 6	Unsealed Road	0.02
Access Road, Soil Unit 9 (Access)	Sealed Road	0.15
Access Road, Soil Unit 10 (Access)	Sealed Road	0.47
Total Access Road Area		**1.14**
Exclusion Zone 1, Soil Unit 3 (West)	Agricultural land use	0.11
Exclusion Zone 2, Soil Unit 5 (East)	Agricultural land use	0.12
Exclusion Zone 3, Soil Unit 6	Agricultural land use	0.14
Exclusion Zone 4, Soil Unit 5 (West)	Agricultural land use	4.25
Exclusion Zone 5, Soil Unit 4	Agricultural land use	1.41
Total Exclusion Zone Area		**6.03**
Total Post Development Model Area		**395.7**[1]

3.5 Pollutant generation rates

The land use proposed requires various modelled surfaces that each have distinct pollution generation characteristics.

A summary of the pollutant generation rates used in MUSIC modelling is provided in **Table 10**. These values are based on recommended pollutant concentration data from Table 4.6 and Table 4.7 of WaterNSW (2017) *Using MUSIC in Sydney's Drinking Water Catchment (SCA) 2nd Edition, June 2019.*

Pollutant loads are calculated based on the WaterNSW (2017) concentrations, rainfall, runoff and the effectiveness of the proposed treatment systems.

Table 10 – Adopted pollutant concentrations for Source Nodes

	Model Surface	Agricultural land use		Roof		Sealed Roads		Unsealed roads		Eroding gullies		Revegetated Land	
	Flow	Base	Storm	Base	Storm	Base	Storm	Base	Storm	Base	Storm	Base	Storm
Average Concentration (mg/L-log$_{10}$)	Total Suspended Solids	1.3	2.15	0	1.3	1.2	2.43	1.2	3	1.2	3	1.15	1.95
	Total Phosphorus	-1.05	-0.22	0	-0.89	-0.85	-0.3	-0.85	-0.3	-0.85	-0.3	-1.22	-0.66
	Total Nitrogen	0.04	0.48	0	0.3	0.11	0.34	0.11	0.34	0.11	0.34	-0.05	0.3

3.6 Existing treatment nodes

Several existing treatment nodes including farm dams and vegetated swales (contour banks) were included in the pre-development scenario. Existing treatment nodes are described in the following sections.

3.6.1 Farm dams

Existing farm dams were added to the pre-development scenario as ponds to reflect water storage within the site. A summary of the farm dams used in the MUSIC modelling is provided in **Table 11** and depicted in **Figure 1.**

The development has been modelled to result in the removal of six (6) dams including dam numbers 14 through 19.

Table 11 – Existing farm farms

Dam Number	Retained/Removal	Area (m^2)	Area (ha)
1	To be retained.	548	0.05
2	To be retained.	827	0.08
3	To be retained.	954	0.1
4	To be retained.	1590	0.16
5	To be retained.	1193	0.12
6	To be retained.	2123	0.21
7	To be retained.	3010	0.3
8	To be retained.	3442	0.34
9	To be retained.	3924	0.39
10	To be retained.	564	0.06
11	To be retained.	1784	0.18
12	To be retained.	678	0.07
13	To be retained.	4161	0.42
14	To be removed and filled.	899	0.09
15	To be removed and filled.	1217	0.12
16	To be removed and filled.	578	0.06
17	To be removed and filled.	351	0.04
18	To be removed and filled.	1111	0.11
19	To be removed and filled.	925	0.09

3.6.2 Vegetated swales

Existing vegetated swales were added to the pre-development scenario to reflect existing water treatment within the site. Swales varied in length but are predominantly situated near eroded gullies. A summary of the vegetated swales used in the MUSIC modelling is provided in **Table 12** and depicted in **Figure 1.** All swales were modelled with an approximate base width of 1 metre, top width of 5 metres and depth of 0.5 metres. Vegetation Height for swales was modelled at 0.25 metres. It was assumed that the development would either retain existing swales, or, if removed as a result of construction, that these would be replaced elsewhere within the site.

Table 12 – Existing vegetated swales

Swale Number	Length (m)
1	87.2
2	366.3
3	401.8
4	148.7
5	104.6
6	100.1
7	190.2
8	91.7
9	154.1
10	90.3
11	311.9
12	153.3
13	569.1
14	324.7
15	273.2
16	821.9
17	330.1
18	97.8
19	301.7
20	116.0
21	267.9

3.7 Proposed treatment nodes

It was assumed that the development would include the following treatment nodes:

- Retention of 13 farm dams (assumed 6 dams would be removed – refer to **Section 3.6.1**)
- Retention of an equivalent amount of existing drainage swales (contour banks) within the site; and
- Additional grass swales which would be constructed as part of the site drainage system. These were assumed to be spaced through each section of the development footprint and would convey runoff to the main drainage lines. Treatment swales used in the post development model are outlined in **Table 13**.
- All proposed treatment swales had storage properties detailed in **Table 14.**
- All existing treatment swales had storage properties detailed in **Table 15.**

Table 13 – Treatment Swales

Treatment Swale Number	Description of Location	Length (m)
1	Lockyersleigh Creek (Northeastern Catchment) along Northern boundary of Soil Unit 1 (Northeast)	460
2	Lockyersleigh Creek (Eastern Catchment) along NorthEastern boundary of Soil Unit 3 (East)	940
3	Northern Boundary of Soil Unit 3 (Substation)	480
4	Lower Narambulla Creek (Eastern Sub-Catchment)	500
5	Lower Narambulla Creek (Western Sub-Catchment) along Eastern Boundary of Soil Unit 4)	450
6	Upper Narambulla Creek (Northwestern Sub-Catchment) along Eastern and North-Eastern boundary of Soil Unit 8 (Switchyard North)	380
7	Lockyersleigh Creek (Eastern Catchment) along Western boundary of Soil Unit 1 (Northwest).	760
8	Lockyersleigh Creek (Eastern catchment) along Northern boundary of Soil Unit 1 (Northwest).	150

Table 14 – Proposed Treatment Swale Storage Properties

Length	Bed Slope % (m)	Base Width (m)	Top Width (m)	Depth (m)	Vegetation Height (m)	Exfiltration Rate (mm/hr)
Varies depending on length of swale (refer to Table 13).	3.00	2.0	8.0	0.5	0.250	2.0

Table 15 – Existing Treatment Swale Storage Properties

Length	Bed Slope % (m)	Base Width (m)	Top Width (m)	Depth (m)	Vegetation Height (m)	Exfiltration Rate (mm/hr)
Varies depending on length of swale (refer to Table 13Table 12).	3.00	1.0	5.0	0.5	0.250	0.0

3.8 Meteorological data

The development is within the Wollondilly River sub-catchment. The meteorological data for the MUSIC modelling was Zone 1 from the WaterNSW website.

3.9 Model period and time step

The scenario period had a length of 4 years starting from 1995 to 1999. The time step for the modelling of all the scenarios was 6 minutes.

3.10 Model scenarios

Two scenarios were modelled using MUSIC, described below:

- Existing – represents existing catchment conditions with existing farm dams and drainage swales; and
- Post-Development – represents the proposed solar farm development, including removal of some farm dams, retention of an equivalent amount ofdrainage swales, plus the addition of surface water management devices (additional swales) for the development.

3.11 Model results

Mean annual pollutant loads are summarised in **Table 16**. Results are expressed as the sum of the pollutant loads for the east and west catchment. NorBE criteria are achieved for all modelled pollutants.

Table 16 – MUSIC Modelling Results

Pollutant (Mean Annual Loads)	Pre-development	Post Development (with treatment)	% Reduction (Pre to Post Development with treatment)
Flow (ML/yr)	385	380	1%
Total Suspended Solids (kg/yr)	16,300	8,210	50%
Total Phosphorus (kg/yr)	75.6	56.9	25%
Total Nitrogen (kg/yr)	613	589	4%
Gross Pollutants (kg/yr)	0	0	0%

Cumulative frequency graphs for existing and post development conditions for Total Phosphorus and Total Nitrogen are provided in **Figure 6, Figure 7** and **Figure 8** . These represent the results for the combined catchments. Results show:

- Phosphorus concentrations are slightly higher in the post development case, however, are lower that the pre -development case at the 98th percentile concentration.
- Nitrogen concentrations are slightly higher in the post development case, however, are lower that the pre- development case at the 98th percentile concentration.
- Total Suspended Solid concentrations are lower than the pre-development case between the 50th to 98th percentile and therefore achieve NorBE requirements.

Figure 6 – Total Phosphorus cumulative frequency

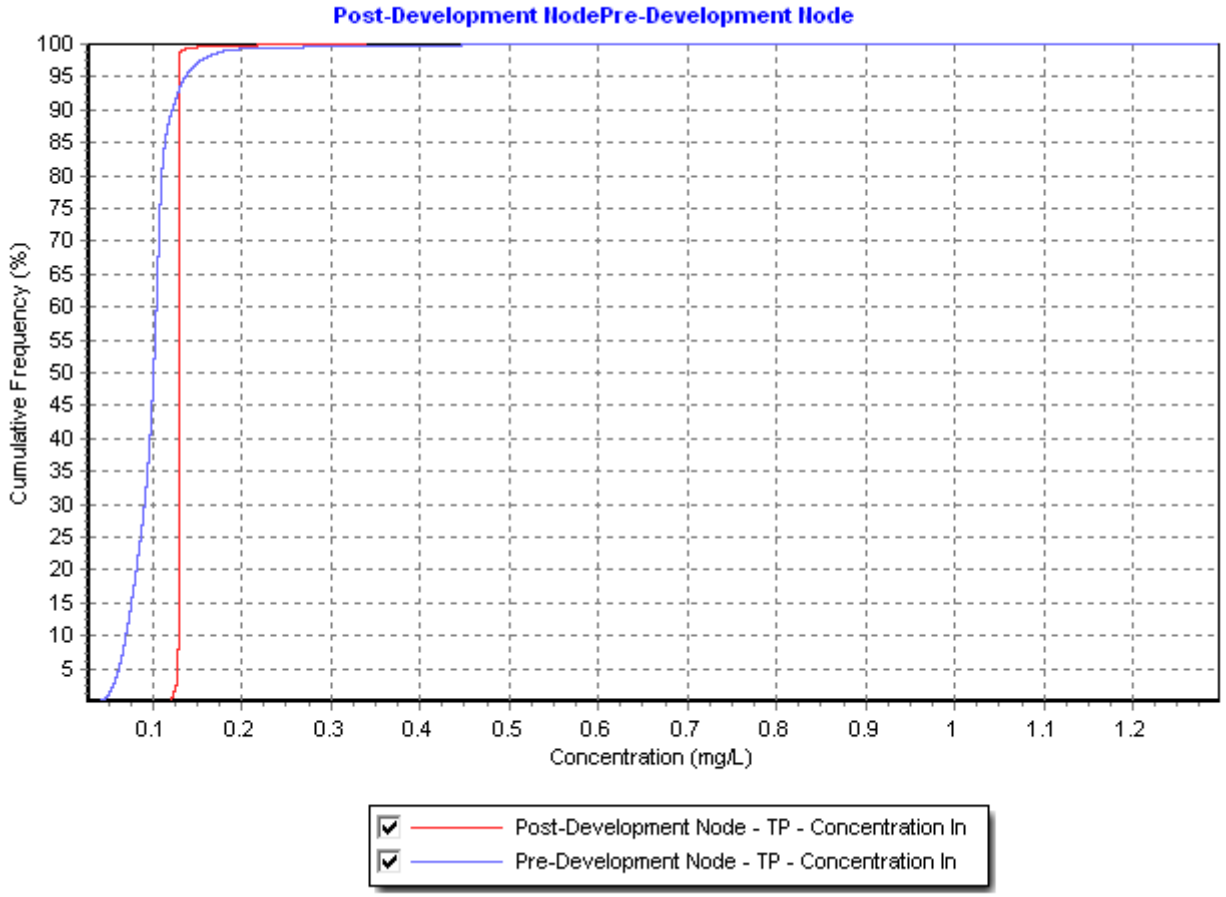


Figure 7 – Total Nitrogen cumulative frequency

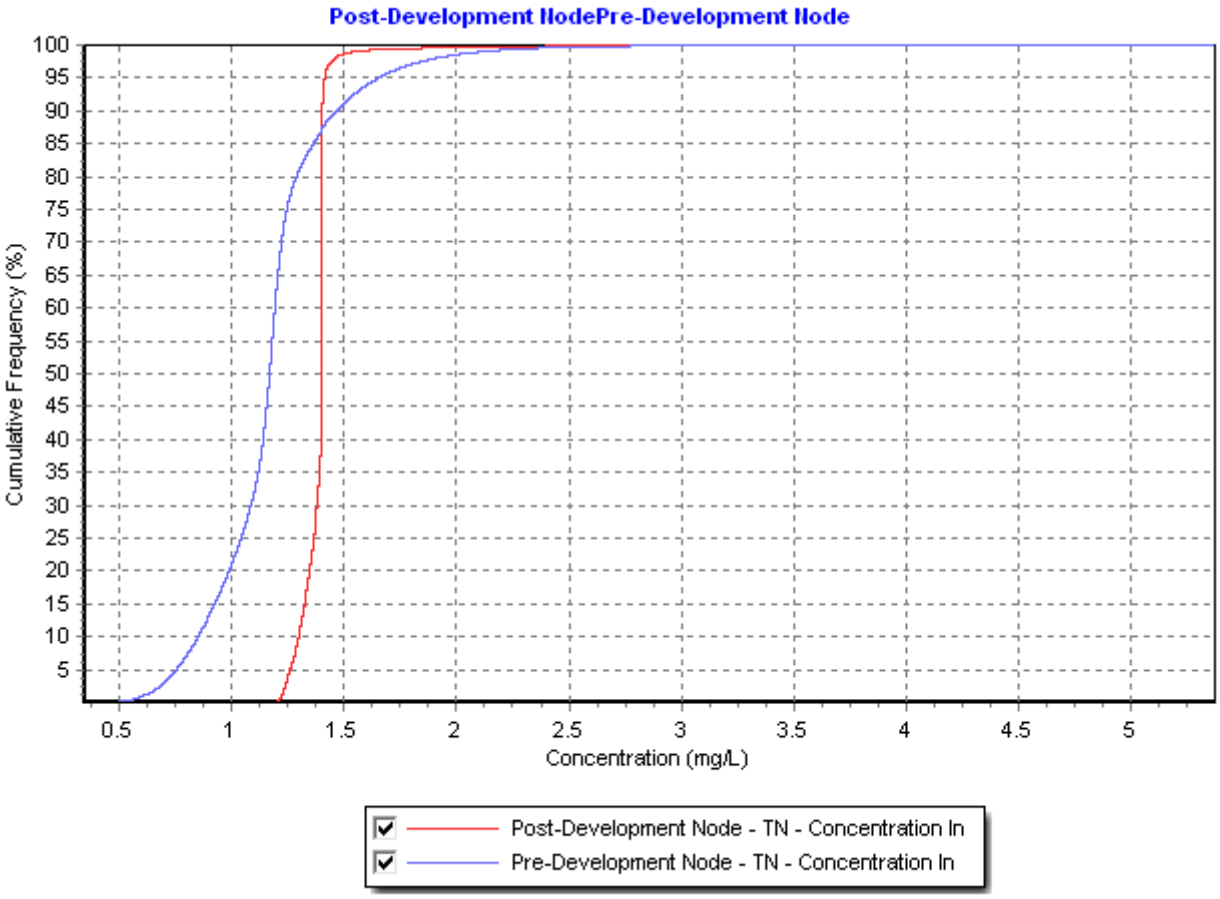
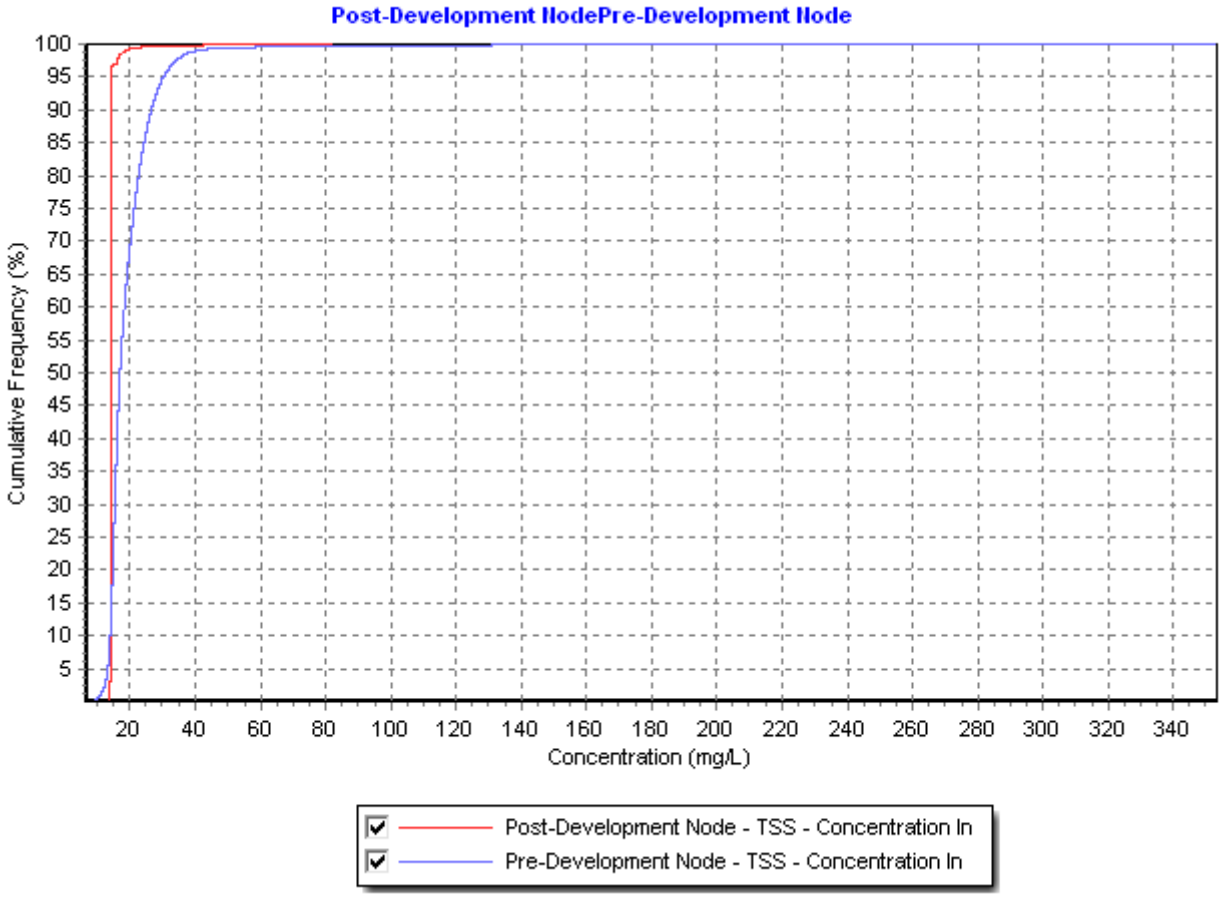


Figure 8 – Total Suspended Solids cumulative frequency



3.12 Water quality conclusion

The modelled post-development total suspended solids and total phosphorus are more than 10% less than the pre-development case. Total nitrogen levels were reduced by 5% and gross pollutants remained the same.

Nitrogen levels may require additional treatment options to satisfy a 10% reduction, which is used to account for uncertainty within MUSIC modelling. Nevertheless, Mean Annual Load reductions were achieved for all pollutants.

The total suspended solids concentrations for the post development scenario were lower than the pre-development case between the 50th and 98th percentiles. Total phosphorus and total nitrogen concentrations for the post development scenario, however, were slightly greater that the pre-development conditions between the 50th and 98th percentiles.

The proposed development and stormwater modelling would be subject to further detailed assessment and design during the engineering design phase. Additional treatment options to reduce phosphorus and nitrogen levels through the 50th and 98th percentiles may be required to satisfy NorBE requirements.

3.13 Stormwater management during construction

Construction related soil and water impacts would be managed through the development and implementation of a Soil and Water Management Plan (SWMP) that would address:

- Staging;
- Erosion control strategies;
- Progressive rehabilitation; and
- Site management and maintenance techniques.

The SWMP would be reviewed and finalised in conjunction with the engineering design at the Construction Certificate stage to ensure that control measures can be effectively designed and located.

4 CONCLUSION

Results of MUSIC modelling demonstrate that post development pollutant loads are less than and/or equal to pre-development pollutant loads. While cumulative frequency graphs portray a slight increase in Phosphorus and Nitrogen levels between the 50th to 98th percentile a neutral or beneficial effect is achieved for mean annual loads within the post development model.

The proposed development, if undertaken in accordance with the principles outlined in this assessment, would ensure that stormwater pollutants were reduced and that mean annual load reductions in Total Suspended Solids and Total Phosphorus meet NorBE. Total Nitrogen Mean annual loads may require additional treatment to satisfy NorBE requirements.

Additional reductions to phosphorus and nitrogen levels through the 50th and 98th percentile may require the inclusion of additional treatment detailed during the engineering design phase.

All system components would be subject to further detailed assessment and design during the engineering design phase, based on the principles outlined in this assessment.

References

Engineers Australia (2006) Australian Runoff Quality. National Committee on Water Engineering.

WaterNSW (2021) Neutral or beneficial effect on water quality assessment guidelines.

WaterNSW (2017) Using MUSIC in Sydney's Drinking Water Catchment, 2nd Edition.

Landcom (2004) Managing Urban Stormwater -Soils and Construction, Volume 1, Fourth Edition

APPENDIX A

LANDSCAPING PLAN

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Marulan Solar Farm

740 Carrick Road, Terrain Solar Pty Ltd

Landscape Concept

May 2022

EXISTING CONDITIONS:

The site includes a few scattered trees but is otherwise cleared and has historically been used for grazing and cropping. There is a single row of mature trees along part of the eastern boundary of the site (image 1), and extending along fence lines, north of the site. These rows of trees, possibly planted as wind breaks, are a landscape feature in this area.

The gently undulating landform within the site descends to shallow gullies, creeks and dams, including Narambulla Creek and Lockyersleigh Creek, each containing a few low native shrubs and trees (image 2).

There is also some native vegetation on the adjoining low hills to the south of the site, which forms a visual screen (image 3). There are ornamental trees and gardens along the surrounding driveways and around the residential dwellings (image 4 and 5).

Image 4 - Ornamental trees at Lockyersleigh House, forming a parkland setting to the property

Image 5 - Poplar and other ornamental species forming a wind break and visual screen near Lockyersleigh House

LANDSCAPE STRATEGY:

A landscape concept plan has been developed based on consideration of the potential visibility of the site. The objectives of this landscape plan are to:

- Reduce the visibility of the site from adjacent sensitive recievers (including neighbouring residences, Carrick Road and the Hume Highway) over time
- Improve the character of the landscape through the restoration of native vegetation
- Provide habitat and increase local biodiversity through the use of local plant species.

The landscape plan identifies seven landscape treatments for the site. These are:

1. Native screen planting, lower slopes
2. Native screen planting, upper slopes
3. Riparian vegetation, dry lower slopes
4. Riparian vegetation, wet upper slopes
5. Scattered trees on upper slopes
6. River Tussock grassland
7. Pasture grasses

These landscape treatments are shown on the landscape plan on Figure 2.

To ensure the suitability of planting for the local conditions, the plant species proposed for these landscape treatments have been selected from the:

- *Goulburn Mulwaree Development Control Plan 2009*, Appendix B Preferred Planting Species
- *Planting your patch, A guide to revegetation on your property,* State of New South Wales Local Land Services, 2016.

Advice from the project ecologist has also been incorporated into the plant selection.

Further consultation with Council Officers and local land care groups would be undertaken during detail design.

Image 1 - Existing trees along fenceline, at eastern site boundary

Image 2 - Native planting along Lockyersleigh Creek, north of the site, viewed from Carrick Road

Image 3 - Native planting along southern site boundary, viewed from Munro Road

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Marulan Solar Farm

Landscape Concept

FIGURE 1: EXISTING CONDITIONS & LANDSCAPE STRATEGY

Date: 22 April 2022
Issue: Rev2

Drawn: FW/SR

Key:

- Existing trees to be retained
- Vegetation to be removed
- **1.** Native screen planting- lower slopes
- **2.** Native screen planting- upper slopes
- **3.** Riparian vegetation- wet lower slopes
- **4.** Riparian vegetation- dry upper slopes
- **5.** Scattered trees- upper slopes
- **6.** River Tussock grassland
- **7.** Access road screening (subject to stakeholder engagement)
- **8.** Pasture Grasses

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Marulan Solar Farm

Landscape Concept

FIGURE 2: LANDSCAPE PLAN

Date: 16 May 2022 Issue: Rev3

Drawn: FW/SR

NATIVE SCREEN PLANTING

A mix of native trees and shrubs with a dense and compact habit have been selected to provide a maximum screening effect.

The following plant list includes some acacias which are 'pioneer species'. These plants will establish quickly and form an effective visual screen in the short term. While these pioneer species are relatively short lived (i.e. 7-12 years), they will disperse seed and new plants will regenerate so that a self-sustaining vegetation screen is maintained in the long term. Pioneer species assist with weed management and support the growth of longer lived species, such as Eucalypts.

1. NATIVE SCREEN PLANTING - Lower slopes

Plant list:

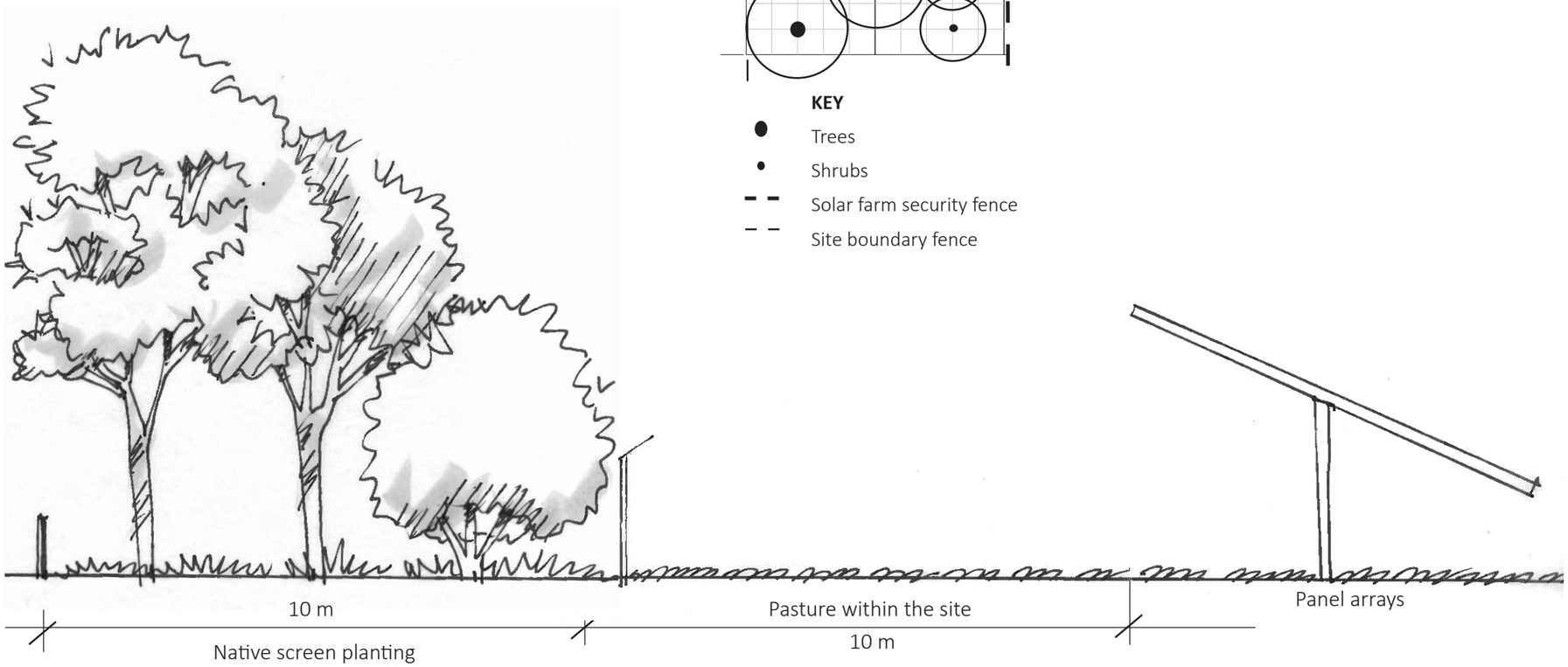
Species name, Common name	Mature height
Native trees	
*Acacia decurrens, Green Wattle**	*6m*
*Acacia mearnsii, Black wattle**	*6m*
*Acacia parramattensis, Tindale**	*10m*
*Acacia dealbata, Silver Wattle***	
*Allocasuarina luehmannii, Bull oak**	*10m*
*Allocasuarina verticalla, Drooping she-oak**	*10m*
*Eucalyptus amplifolia, Cabbage Gum **	*30m*
*Eucalyptus blakelyi, Blakely's Red Gum**	*25m*
*Eucalyptus bridgesiana, Apple Box**	*25m*
*Eucalyptus cinerea, Argyle apple***	*15-30m*
*Eucalyptus ovata, Black Gum**	*15-30m*
*Eucalyptus melliodora, Yellow Box**	*30m*
*Eucalyptus pauciflora, Snow Gum**	*15m*
*Eucalyptus stellulata, Black sallee**	*15m*
Native shrubs	
*Callistemon citrinus, Crimson Bottlebrush**	*1-2m*
*Jacksonia scoparia, Dogwood**	*4m*
*Leptospermum polygalfolium, Tea Tree**	*3m*

Source:
* *Goulburn Mulwaree Development Control Plan 2009*, Appendix B Preferred Planting Species
** Selected on advice from project ecologist

2. NATIVE SCREEN PLANTING - Upper slopes

Plant list:

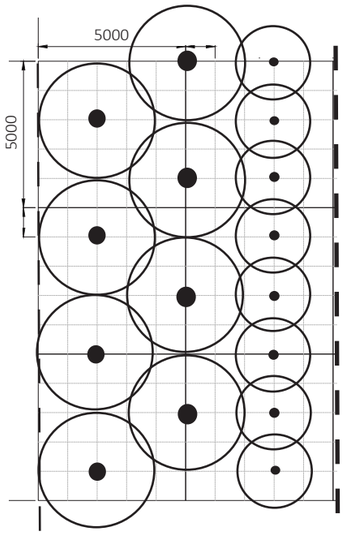
Species name, Common name	Mature height
Native trees	
*Eucalyptus blakelyi, Blakely's Red Gum**	*25m*
*Eucalyptus bridgesiana, Apple Box**	*25m*
*Eucalyptus cinerea, Argyle apple***	*15-30m*
*Eucalyptus pauciflora, Snow Gum**	*15m*
*Eucalyptus stellulata, Black sallee**	*15m*
*Eucalyptus tereticornis, Forest Red Gum***	*15-30m*
Native shrubs	
*Acacia decurrens, Green Wattle**	*6m*
*Acacia mearnsii, Black wattle**	*6m*
*Acacia parramattensis, Tindale**	*10m*
*Callistemon citrinus, Crimson Bottlebrush**	*1-2m*
*Jacksonia scoparia, Dogwood**	*4m*
*Leptospermum polygalfolium, Tea Tree**	*3m*



A - A Indicative cross section - Native screen planting

Plant set-out matrix

Trees and shrubs will be staggered to maximise the screening effect as per the following diagram.



KEY

- Trees
- Shrubs
- Solar farm security fence
- Site boundary fence

Scale: 0m 1 2 5m

Specification notes

- Three offset rows of trees and shrubs as per the set out matrix.
- 12 month establishment followed by a 24 month maintenance period
- Activities during establishment would include watering, weed management and replacement of dead plant stock as required.
- Activities during the maintenance period would include weed management, topping up of mulch as required and replacing dead plant stock as soon as practicable.

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Marulan Solar Farm

Landscape Concept

FIGURE 3: NATIVE SCREEN PLANTING

Date: 22 April 2022 Drawn: FW/SR
Issue: Rev2

RIPIARIAN AREAS

Riparian areas would be revegetated with a mix of locally native trees and shrubs including species to provide habitat for native wildlife. This mix of trees will create a framework for natural regeneration.

Riparian vegetation would be planted along the first and second order streams in accordance with the *NRAR Guidelines for controlled activities on waterfront land* (2018). That is 10 metres above the top of bank (20 metre + channel width) for 1st order streams, and 2- metres above the top of bank (40 metres + channel width) for 2nd order streams.

Larger trees would be setback from the solar farm fence to minimise overshadowing. There would be random distances between rows of trees (3 m to 10 m) and some rows would include curves to improve habitat complexity. Plant density and layout should be in accordance with the *Planting your patch, A guide to revegetation on your property.*

3. RIPARIAN AREAS - Wet lower slopes
Plant list:

Native trees

Species name, Common name	Mature height
*Acacia dealbata, Silver Wattle**	*8m*
Acacia mearnsii, Black Wattle	*15m*
Acacia melanoxylon, Blackwood	*20m*
Allocasuarina luehmannii, Bull oak	*10m*
*Eucalyptus amplifolia, Cabbage Gum **	*30m*
*Eualyptus blakelyi, Blakelys red gum**	*25m*
Eucalyptus pauciflora, Snow Gum	*20-30m*
Eucalyptus stellulata, Black Sallee	*15m*
*Eucalyptus ovata, Black Gum**	*15-30m*
Eucalyptus aggregata, Black Gum	*18m*
*Melaleuca ericifolia, Swamp Paperbark**	*4-5m*
*Melaleuca styphyloides, Prickly Paperbark**	*10m*

Shrubs & Grasses

Species name, Common name	Mature height
Callistemon sieberi, Swamp bottlebrush	*2m*
Hakea microcarpa, Small fruit Hakea	*2m*
Leptospermum polygalifolium, Yellow tea tree	*1-3m*
Leptospermum myrtifolium, Myrtle tea tree	*1-3m*
Lomandra longifolia, Spiny Matrush	*1m*
Poa labillardieri, common tussock grass	

4. RIPARIAN AREAS - Dry upper slopes
Plant list:

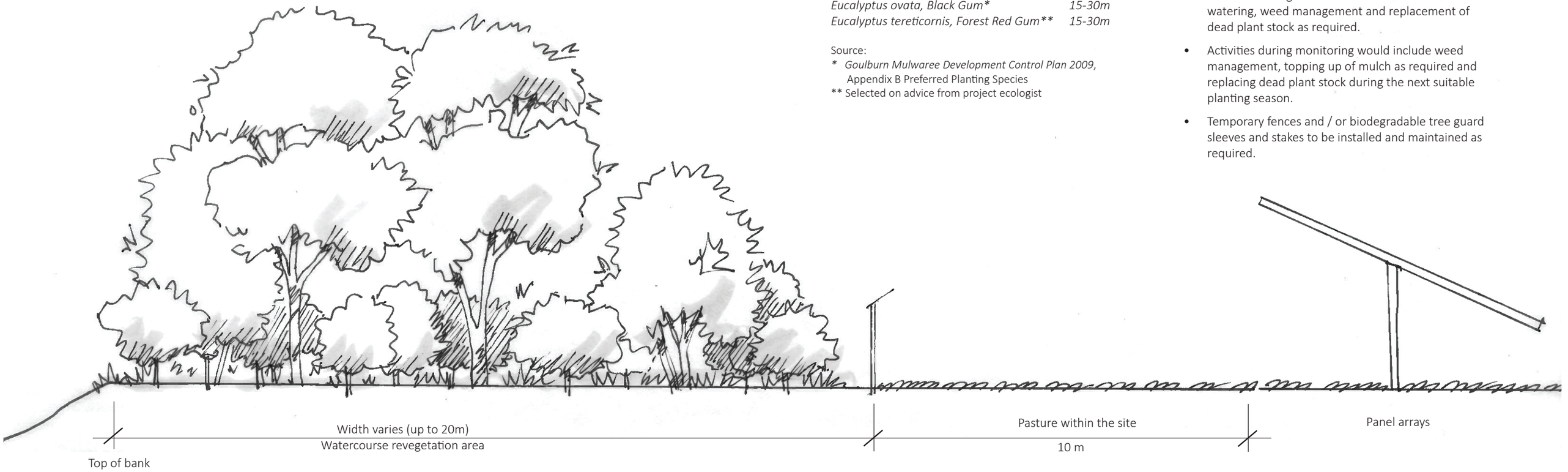
Native trees

Species name, Common name	Mature height
*Acacia dealbata, Silver Wattle**	*8m*
*Acacia mearnsii, Black Wattle***	*15m*
*Eucalyptus amplifolia, Cabbage Gum **	*30m*
*Eucalyptus bridgesiana, Apple box**	*25m*
*Eucalyptus cinerea, Argyle apple***	*15-30m*
*Eucalyptus ovata, Black Gum**	*15-30m*
*Eucalyptus tereticornis, Forest Red Gum***	*15-30m*

Source:
* *Goulburn Mulwaree Development Control Plan 2009,* Appendix B Preferred Planting Species
** Selected on advice from project ecologist

Specification notes

- Weeds, including *Juncus acutus* to be removed
- No trees or shrubs should be planted in the channel or main water flow area
- Spot planting technique to be used to retain groundcover and minimise site disturbance,
- Trees to be setback from the solar farm fence by a minimum of 10 metres
- Individual planting holes to be excavated, backfilled with ameliorated site soil and mulch to be applied across disturbed area
- 12 month establishment followed by a 24 month maintenance period
- Individual planting holes to be excavated, backfilled with ameliorated site soil and mulch to be applied across disturbed area
- Plants will be 50 x 50 mm tubestock or similar
- Activities during establishment would include watering, weed management and replacement of dead plant stock as required.
- Activities during monitoring would include weed management, topping up of mulch as required and replacing dead plant stock during the next suitable planting season.
- Temporary fences and / or biodegradable tree guard sleeves and stakes to be installed and maintained as required.



B - B Indicative cross section - Riparian areas

Scale: 0m 1 2 5m

iris

Marulan Solar Farm

Landscape Concept

FIGURE 4: RIPARIAN AREAS

Date: 22 April 2022
Issue: Rev2

Drawn: FW/SR

5. SCATTERED TREES ON UPPER SLOPES

Groups and scattered idividual trees would be located on the upper slopes of the site and within the adjacent field.

These trees will be local native species with a single trunk and open canopy. These will provide some filtering of views where the solar farm can be seen from elevated areas, provide tree canopy cover and habitat.

Plant list:

Large native trees

Species name, Common name	Mature height
*Eucalyptus amplifolia, Cabbage Gum **	*30m*
*Eucalyptus bridgesiana, Apple box**	*25m*
*Eucalyptus cinerea, Argyle apple***	*15-30m*
*Eucalyptus melliodora, Yellow box**	*30m*
*Eucalyptus tereticornis, Forest Red Gum***	*15-30m*

Source:
* *Goulburn Mulwaree Development Control Plan 2009*, Appendix B Preferred Planting Species
** Ecologist advice

Plant set-out

Trees would be setout in an informal layout, with individual and groups of trees . All trees to be set back a minimum of 10 metres and larger trees by 20 metres from the solar farm fence to minimise overshadowing of the panel array area.

Specification notes

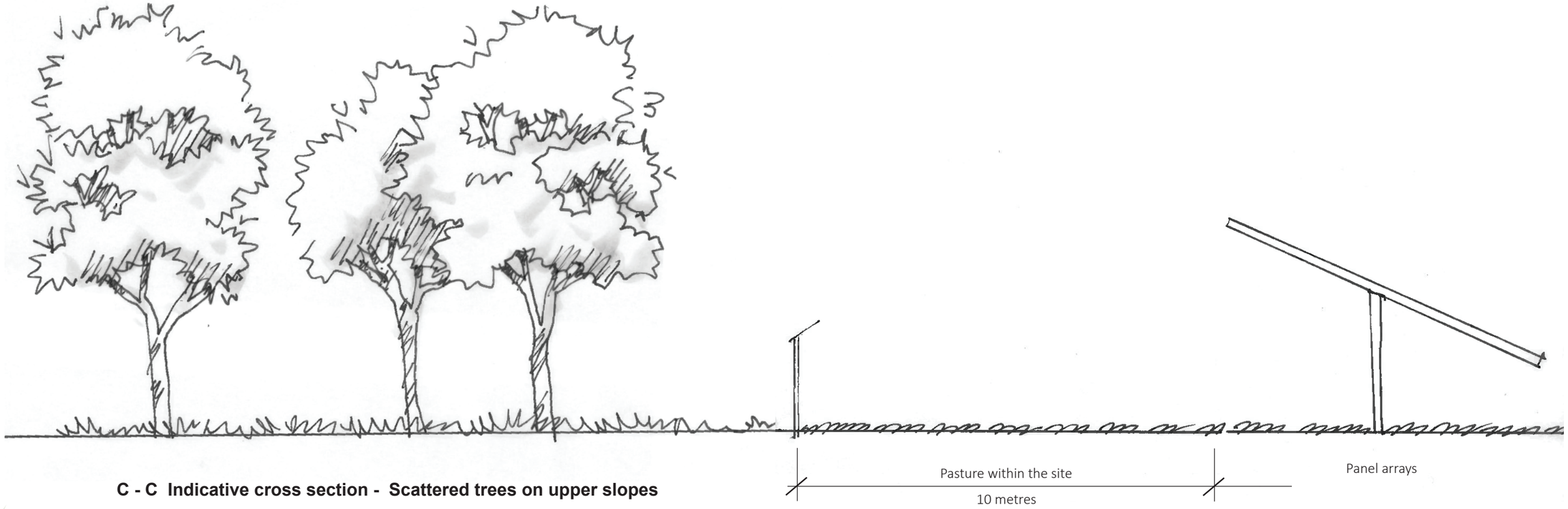
- Individual planting holes to be excavated, backfilled with ameliorated site soil and mulch to be applied across disturbed area.
- Plants will be 50 x 50 mm tubestock or similar
- There would be 12 month establishment followed by a 24 month maintenance period
- Activities during establishment would include watering, weed management and replacement of dead plant stock as required. Activities during monitoring would include weed management
- Activities during maintenance would include weed management, topping up of mulch as required and replacing dead plant stock during the next suitable planting season.
- Temporary fences and / or tree guard sleeves and stakes to be installed and maintained as necessary.

6. RIVER TUSSOCK GRASSLAND

The native Rivwer Tussock Grassland is part of a Critically Endangered Ecological community. Improvement of this zone would involve removal of weeds including Hawthorn and Blackberry.

8. PASTURE GRASSES

Areas within the solar farm fence will be sown with pasture grasses to allow for grazing of the property during operation.



C - C Indicative cross section - Scattered trees on upper slopes

iris

Marulan Solar Farm

Landscape Concept

FIGURE 5: SCATTERED TREES IN PASTURE AREAS

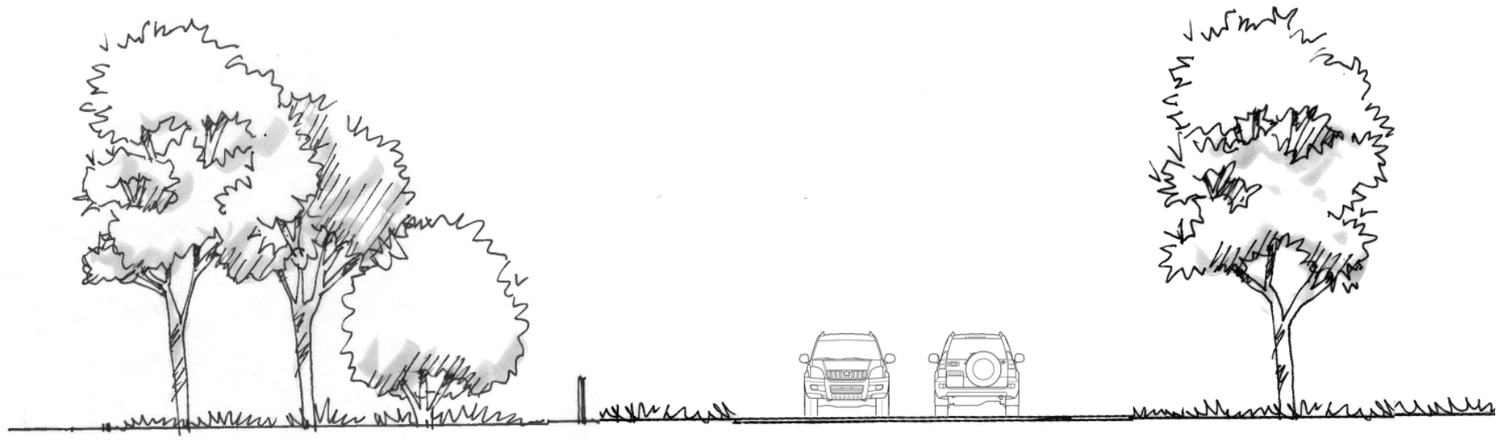
Date: 22 February 2022 Drawn: FW/SR
Issue: Rev2

7. ACCESS ROAD SCREENING

Options for trees within the access corridor, or within neighbouring properties.

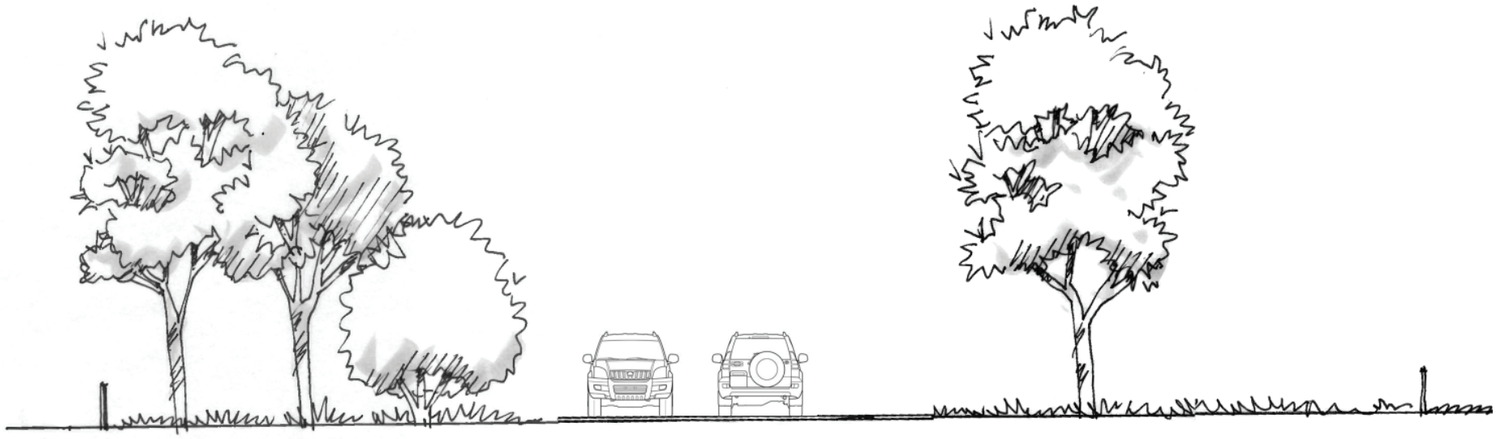
D - D Indicative cross section - Access Road screening

Vegetation within the access road corridor and on neighbouring property to fill gaps in existing screening vegetation.



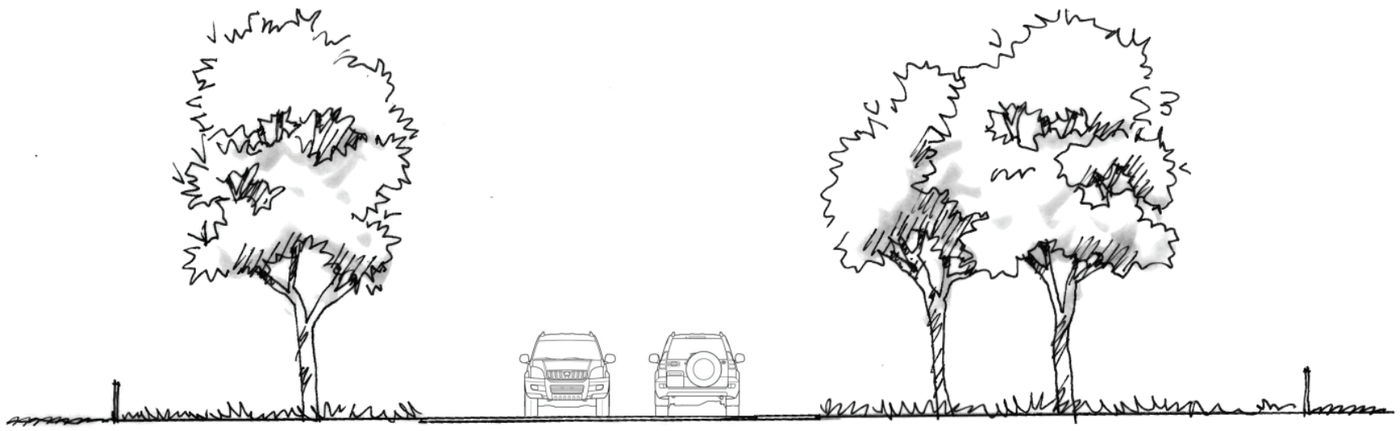
E - E Indicative cross section - Access Road screening (Option A)

Vegetation within the access road corridor, including trees and shrubs.



E - E Indicative cross section - Access Road screening (Option B)

Vegetation within the access road corridor, including scattered trees.



Premise