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## Appendix E

# Surface Water and Groundwater Assessment

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# Surface water and groundwater assessment

**Normanville Energy Park**

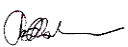


WestWind Energy

25 November 2024

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| <b>Project name</b>   |          | Normanville Energy Park – Surface Water & Hydrogeology Assessment  |                         |  |                    |   |            |
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# Executive Summary

WestWind Energy Pty Ltd proposes to develop the Normanville Energy Park (NMEP), 'the Project', in northwestern Victoria and as such, is undertaking environmental investigations to inform project approvals. This report outlines the desktop surface water and groundwater assessment for the NMEP.

## **Surface Water**

- The Project area and buffer zone consist of the main overland flow paths identified as well as several tributary overland flow paths that may either direct water to the main channels or could be distribution channels for irrigation
- Whilst flooding associated with the Avoca River and Loddon River floodplains during a 1 in 100-year flood event does not appear to extend into the Project area from the flood mapping undertaken, the following is noted regarding potential flooding interfaces:
  - Given the number of channel drains and close proximity of formalised channels to the east of the Project, flooding of channels may extend beyond the eastern boundary of the Project area that has currently been mapped
  - Given the flat nature of the site there may be local flooding or drainage issues associated with the channels that pass through the Project area, that may also exacerbate any surrounding flooding issues
- The surface water risks associated with flooding or impacting the downstream receiving waterway environments are generally low, including:
  - Changes to overland flow paths and major drainage paths, impacting the flow and regime of downstream waterways
  - Contaminated runoff from site (sediment, spills, etc) during construction or operation to downstream receiving waterways impacting water quality
- Surface water risks associated with the Project can be appropriately managed through standard construction management measures such as selective siting, bunding, spill control, and sediment and erosion controls

## **Groundwater**

- The windfarm project is underlain by a multi-aquifer system. The Parilla Sands is interpreted to be the regional water table aquifer. The other aquifers are too deep to interact with the proposed development.
- There is very limited groundwater development in the region, which is potentially reflected by the generally saline nature of the water table aquifer. Fresher groundwater has, however, been mapped nearer to the major waterways, e.g. Avoca and Loddon Rivers, however, these lies outside of the Project area.
- Available groundwater level information is limited, but generally indicates groundwater levels are greater than 10 m below ground level. The exception to this is at the northern and eastern boundaries of the Project area, where regional mapping infers groundwater between 5 m and 10 m below ground level.
- The significant depth to groundwater would suggest that it does not discharge to waterways locally
- Based on existing designs, most of the windfarm turbine foundations and immediate infrastructure are proposed to be constructed above the water table and therefore direct interaction with the groundwater environment would be limited. Regarding this infrastructure, groundwater risks identified on the risk register were all classified as being low.
- Risks identified relating to buried transmission lines were classified as low. The proposed transmission line easement crosses under two identified 1 m LiDAR delineated flow paths, further investigation should be carried out to understand the groundwater depth and directional drilling techniques adopted to minimise potential for impact to the existing local surface water – groundwater setting. Similarly, within the site boundary further flow paths are shown to intersect with the works footprint locations and underground connections within the site boundary.

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- Relevant controls to protecting groundwater during the construction and operation of the Project are considered to be:
  - Preparation and implementation of a construction environment management plan
  - Existing controls under the *Water Act 1989* regarding the requirement of a technical hydrogeological assessment to support the licensing of groundwater take and use
  - Where the alignment of transmission lines is to cross under delineated flow paths, further investigation should be carried out to confirm the potential for groundwater intersection, and to inform design of directional drilling construction approaches
- The groundwater risks associated with the Project can be appropriately managed through standard construction environmental management measures such as selective siting, bunding, directional drilling trench cut-offs and spill control.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.2, the assumptions set out in section 1.4 and qualifications contained throughout the Report.

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# Contents

|  |            |
|--|------------|
| <b>Glossary</b>  | <b>vii</b> |
| <b>1. Introduction</b>                                       | <b>1</b>   |
| 1.1 Purpose of this report                                   | 1          |
| 1.2 Limitations  | 1          |
| 1.3 Scope of works   | 1          |
| 1.4 Assumptions  | 1          |
| <b>2. Legislative context</b>                                | <b>3</b>   |
| 2.1 Relevant legislation                                     | 3          |
| 2.2 Approvals  | 4          |
| 2.2.1 Surface water  | 4          |
| 2.2.2 Groundwater  | 4          |
| <b>3. Assessment method</b>                                  | <b>5</b>   |
| <b>4. Site characterisation</b>                              | <b>7</b>   |
| 4.1 Site location  | 7          |
| 4.1.1 Study area definition                                  | 7          |
| 4.1.2 Topography   | 7          |
| 4.1.3 Land use   | 7          |
| 4.2 Climate  | 9          |
| 4.3 Geological setting                                       | 9          |
| 4.3.1 Regional stratigraphy                                  | 9          |
| 4.3.2 Surface geology  | 10         |
| 4.3.3 Surface soils  | 11         |
| <b>5. Waterways and drainage</b>                             | <b>15</b>  |
| 5.1 Floodplain management                                    | 15         |
| 5.1.1 Drainage   | 15         |
| 5.1.2 Flood extents  | 20         |
| 5.1.3 Index of stream condition                              | 23         |
| 5.1.4 Ramsar Sites   | 23         |
| 5.2 Environmental values of waterways near the Project       | 23         |
| 5.2.1 Environmental Protection Act 2017 environmental values | 23         |
| <b>6. Hydrogeology</b>                                       | <b>25</b>  |
| 6.1 Identified aquifers                                      | 25         |
| 6.2 Level of confinement                                     | 25         |
| 6.3 Groundwater management                                   | 25         |
| 6.3.1 Background to resource management                      | 25         |
| 6.3.2 Relevant groundwater management area                   | 25         |
| 6.4 Study area groundwater use                               | 26         |
| 6.4.1 Data limitations                                       | 26         |
| 6.4.2 Bore use   | 26         |
| 6.4.3 Bore depths  | 29         |
| 6.5 Aquifer hydraulic parameters                             | 29         |
| 6.5.1 Site specific  | 29         |
| 6.5.2 Regional mapping                                       | 29         |

**ADVERTISED  
PLAN**

|            |  |           |
|------------|--|-----------|
| 6.6        | Groundwater quality                              | 29        |
| 6.6.1      | Classification of groundwater                    | 29        |
| 6.6.2      | Groundwater quality indicators and objectives    | 30        |
| 6.6.3      | Background salinity                              | 31        |
| 6.6.4      | Protected environmental values                   | 32        |
| 6.6.5      | Environmental values                             | 34        |
| 6.7        | Groundwater potentiometry                        | 35        |
| 6.7.1      | Site monitoring                                  | 35        |
| 6.7.2      | Regional mapping                                 | 36        |
| 6.7.3      | State observation bores                          | 36        |
| 6.8        | Groundwater dependent ecosystems                 | 40        |
| 6.8.1      | Definition                                       | 40        |
| 6.8.2      | GDEs in study area                               | 40        |
| 6.9        | Potential acid sulfate soils                     | 44        |
| 6.9.1      | Definition                                       | 44        |
| 6.9.2      | Potential in study area                          | 44        |
| 6.10       | Conceptual hydrogeological model                 | 46        |
| <b>7.</b>  | <b>Proposed development</b>                      | <b>48</b> |
| 7.1        | Project description                              | 48        |
| 7.2        | Development activities and the water environment | 48        |
| 7.2.1      | Environmental aspects                            | 48        |
| 7.2.2      | Surface water                                    | 49        |
| 7.2.3      | Groundwater                                      | 50        |
| <b>8.</b>  | <b>Water risk assessment</b>                     | <b>51</b> |
| 8.1        | Existing conditions                              | 51        |
| 8.2        | Avoidance and design                             | 51        |
| 8.3        | Risk assessment                                  | 51        |
| 8.3.1      | Overview of risk assessment method               | 51        |
| 8.3.2      | Risk assessment process                          | 51        |
| 8.3.3      | Assigning a consequence level                    | 52        |
| 8.3.4      | Assigning a likelihood level                     | 54        |
| 8.3.5      | Assigning a level of risk                        | 54        |
| 8.4        | Risk register                                    | 55        |
| 8.4.1      | Surface water                                    | 55        |
| 8.4.2      | Groundwater                                      | 55        |
| <b>9.</b>  | <b>Impact assessment</b>                         | <b>63</b> |
| 9.1        | Discussion of surface water risks                | 63        |
| 9.1.1      | Assessment of construction impacts               | 63        |
| 9.1.2      | Operation (and decommissioning)                  | 65        |
| 9.2        | Discussion of groundwater risks                  | 66        |
| 9.2.1      | Assessment of construction impacts               | 66        |
| 9.2.2      | Operation (and decommissioning)                  | 68        |
| 9.3        | Climate change                                   | 68        |
| 9.3.1      | Surface water                                    | 68        |
| 9.3.2      | Groundwater                                      | 69        |
| <b>10.</b> | <b>Summary of mitigation measures</b>            | <b>70</b> |
| <b>11.</b> | <b>Conclusions</b>                               | <b>73</b> |
| <b>12.</b> | <b>Recommendations</b>                           | <b>74</b> |
| <b>13.</b> | <b>References</b>                                | <b>75</b> |

**ADVERTISED  
PLAN**

## Table index

|          |   |    |
|----------|---|----|
| Table 1  | Summary of State legislation                            | 3  |
| Table 2  | Study area land use                                     | 7  |
| Table 3  | Summary of climate                                      | 9  |
| Table 4  | Generalised regional stratigraphy                       | 10 |
| Table 5  | Driller's Lithological log of SOBN 77105 and 52363      | 12 |
| Table 6  | Environmental values of the Loddon River                | 23 |
| Table 7  | Summary of bore use and bore yield information          | 26 |
| Table 8  | Protected environmental values and groundwater segments | 30 |
| Table 9  | Groundwater indicators and objectives                   | 30 |
| Table 10 | Discussion of environmental values                      | 34 |
| Table 11 | SON Bore summary  | 36 |
| Table 12 | Aspects and impacts                                     | 49 |
| Table 13 | Guide to consequence levels                             | 53 |
| Table 14 | Guide to likelihood levels                              | 54 |
| Table 15 | Risk matrix   | 54 |
| Table 16 | Risk rating acceptability                               | 54 |
| Table 17 | Water Risk register                                     | 56 |
| Table 18 | Mitigation measures                                     | 71 |

## ADVERTISED PLAN

## Figure index

|           |   |    |
|-----------|---|----|
| Figure 1  | Overview of EES assessment framework                | 5  |
| Figure 2  | Project area  | 8  |
| Figure 3  | Study area Surface Geology                          | 14 |
| Figure 4  | Existing Surface Water Conditions                   | 17 |
| Figure 5  | Surface Water and 10m LiDAR delineated flow paths   | 18 |
| Figure 6  | Surface Water and 1m LiDAR delineated flow paths    | 19 |
| Figure 7  | 1 in 100 Year Flood Extent                          | 21 |
| Figure 8  | January 2011 Historic Flood Extent                  | 22 |
| Figure 9  | Study area groundwater bores                        | 28 |
| Figure 10 | Bore Total Depth Histogram                          | 29 |
| Figure 11 | Water Table Salinity (mg/L)                         | 33 |
| Figure 12 | Hydrograph for bores 6584, 71105 and 71106          | 36 |
| Figure 13 | Depth to Water Table (m)                            | 38 |
| Figure 14 | State Observation Network monitoring bore locations | 39 |
| Figure 15 | Groundwater Dependent Ecosystem (GDE) – Aquatic     | 42 |
| Figure 16 | Groundwater Dependent Ecosystem (GDE) – Terrestrial | 43 |
| Figure 17 | Potential Acid Sulfate Soils                        | 45 |
| Figure 18 | Study area hydrogeological conceptualisation        | 47 |
| Figure 19 | Mitigation hierarchy                                | 70 |

# Appendices

Appendix A Delineated Flow Paths

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## Glossary

| Acronym | Definition   |
|---------|--|
| AASS    | Actual Acid Sulfate Soil   |
| AC      | Alternating Current  |
| ADWG    | Australian Drinking Water Guidelines   |
| AHD     | Australian Height Datum  |
| ANZG    | Australian and New Zealand Guidelines  |
| ARI     | Annual Recurrence Interval   |
| AS      | Australian Standard  |
| BOM     | Bureau of Meteorology  |
| CMA     | Catchment Management Authority   |
| CEMP    | Construction Environment Management Plan                                     |
| DC      | Direct Current   |
| DEECA   | Department of Energy, Environment and Climate Action                         |
| EC      | Electrical Conductivity  |
| EES     | Environmental Effects Statement  |
| EPA     | Environment Protection Authority   |
| EPBC    | Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) |
| EPR     | Environment Protection Regulations   |
| ERS     | Environment Reference Standard   |
| GDE     | Groundwater Dependent Ecosystem  |
| GED     | General environmental duty   |
| GEDIS   | Geological, Exploration and Development Information System                   |
| GIS     | Geographic Information System  |
| GMA     | Groundwater Management Area  |
| GQRUZ   | Groundwater Quality Restricted Use Zones                                     |
| GMW     | Goulburn-Murray Water  |
| ISC     | Index of stream condition  |
| MNES    | Matters of national environmental significance                               |
| MW      | Megawatt   |
| NEPM    | National Environment Protection Measures                                     |
| NEM     | National Electricity Market  |
| NMEP    | Normanville Energy Park  |
| NZS     | New Zealand Standard   |
| O&M     | Operation and Maintenance  |
| PASS    | Potential Acid Sulfate Soil  |
| PCV     | Permissible Consumptive Volume   |
| PFAS    | Per- and poly-fluoroalkyl substances   |
| RLWT    | Reduced Level Water Table  |

| <b>Acronym</b> | <b>Definition</b>                    |
|----------------|--------------------------------------|
| SDS            | Safety Data Sheets                   |
| SON            | State Observation Network            |
| SWL            | Standing Water Level                 |
| TDS            | Total Dissolved Solids               |
| VAF            | Victorian Aquifer Framework          |
| WMIS           | Water Measurement Information System |
| WSPA           | Water Supply Protection Area         |
| WTG            | Wind Turbine Generator               |

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## 1. Introduction

### 1.1 Purpose of this report

WestWind Energy Pty Ltd (WestWind) engaged GHD Pty Ltd (GHD) to undertake a surface and groundwater assessment for the proposed Normanville Energy Park (NMEP), 'the Project', in northwestern Victoria. The objective of the Project was to document the existing conditions, identify the potential impacts (during construction and operation) to both surface water and groundwater and determine whether site specific controls would be required to prevent site activities from adversely affecting the water environment. That is, whether the construction and operation of the proposed wind farm would have a detrimental impact to surface and groundwater.

### 1.2 Limitations

*This report has been prepared by GHD for WestWind Energy and may only be used and relied on by WestWind Energy for the purpose agreed between GHD and WestWind Energy as set out in section 1.3 of this report.*

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*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

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*Accessibility of documents*

*If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.*

### 1.3 Scope of works

The scope of works was documented in GHD proposal 12601890-PRP-0 issued 21 December 2022. This groundwater and surface water assessment included:

- A review of the existing surface water and groundwater conditions
- Development of a water risk register
- Assessment of potential impacts arising from the proposed windfarm development on the water environment

### 1.4 Assumptions

This investigation has relied on a number of data sources including:

- Published geological and hydrogeological mapping
- State drilling records: Geological, Exploration and Development Information System (GEDIS), Water Measurement Information System (WMIS)
- Government produced literature including land use planning information, meteorological, and topographical data
- GIS layers, and LiDAR and recent imagery data supplied by WestWind

These data sources have been referenced, where relevant, throughout this report. A complete list of references is provided in Section 13 of this report.

This surface water and groundwater assessment is based on the site boundary provided by WestWind on 24 April 2024, and the subsequent updates to this outlined via email by WestWind.

This report has been prepared independent of other technical studies being undertaken for NMEP or commissioned by WestWind, including flora and fauna and contaminated land studies. Discussion of groundwater dependent ecosystems (GDEs) in this report is limited to their potential presence and likely degree of dependence. The presence, absence or otherwise of threatened or migratory species is out of scope for this study and is assumed to be included in the flora and fauna studies, with interpretation of potential impacts undertaken by others at a future date.

This assessment report has also been completed under the assumption that the existing Koorangie Terminal Station was designed and constructed appropriately proceeding an independent surface water and groundwater assessment associated with the works. It is assumed that the works associated with the existing terminal station and its current upgrades were subject to a CEMP which specifies standards and measures to minimise risk from a surface water and groundwater perspective. It is also noted that the Project includes minor upgrades to the Koorangie Terminal Station that are confined to the western portion of the terminal station footprint. Only the augmentation works and extent of these minor upgrades proposed by the Project have been considered in this report.

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## 2. Legislative context

### 2.1 Relevant legislation

A summary of the key Commonwealth and state legislation relevant to the water environment is provided in Table 1.

Table 1 Summary of State legislation

| Act   | Description   | Relevance to project  |
|---|---|---|
| <i>Water Act 1989</i> (Victoria)                  | In the context of groundwater, the <i>Water Act 1989</i> principally deals with the sustainable, efficient, and equitable management and allocation of the resource. It also provides a means for the protection and enhancement of all elements of the terrestrial phase of the water cycle.   | A licence is required to construct works on a waterway or to abstract groundwater.  |
| <i>Environment Protection Act 2017</i> (Victoria) | <p>The <i>Environment Protection Act 2017</i> empowers the Environment Protection Authority Victoria (EPA Victoria) to implement regulations and protect the environment from pollution and the management of wastes. The Act regulates the discharge or emission of waste to water, land or air by a system of Works Approvals and licences. It has the objectives of preventing and managing pollution and environmental damage, and the setting of environmental quality goals and programs.</p> <p>No groundwater approvals are required under the <i>Environment Protection Act 2017</i>.</p> <p>The cornerstone of the 2017 Act is the General Environmental Duty (GED). GED is defined as “a person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable”. To comply with GED, the Project must:</p> <ul style="list-style-type: none"> <li>– Identify and assess risks to human health or the environment posed from an activity</li> <li>– Assess options to eliminate and reduce risks</li> <li>– Implement controls to reduce risks</li> </ul> <p>The EP Act is supported by subordinate legislation, including regulations and the Environment Reference Standard (ERS).</p> | <p>The ERS:</p> <ul style="list-style-type: none"> <li>– Identifies environmental values that the Victorian community want to achieve and maintain</li> <li>– Provides a way to assess those environmental values in locations across Victoria</li> <li>– Has indicators and objectives to measure people’s actions against these values</li> </ul> <p>The indicators and objectives set out in the ERS will be used as a standard to measure any potential impacts of the Project on environmental values.</p> <p>Other guidelines documents provide guidance on how the Project can comply with the GED, including:</p> <ul style="list-style-type: none"> <li>– About Stormwater (EPA Victoria 2020a)</li> <li>– Civil construction, building and demolition guide (EPA Victoria 2020b)</li> <li>– Managing soil disturbance (EPA Victoria 2020c)</li> <li>– Managing stockpiles (EPA Victoria 2020d)</li> <li>– Working within or adjacent to waterways (EPA Victoria 2020e)</li> <li>– Managing truck and other vehicle movement (EPA Victoria 2020f)</li> </ul> |

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| Act   | Description   | Relevance to project   |
|---|---|--|
| <i>Environment Effects Act 1978 (EE Act)</i><br>(Victoria)  | The <i>Environment Effects Act 1978</i> provides for assessment of proposed projects that are capable of having a significant effect on the environment. The Act enables statutory decision-makers (Ministers, local government, and statutory authorities) to make decisions about whether a project with potentially significant environmental effects should proceed.<br><br>The Act enables the Minister administering the <i>Environment Effects Act</i> to decide that an Environment Effects Statement (EES) should be prepared.   | This report assesses the potential surface water and groundwater impacts associated with the Project, and will guide WestWind Energy in considering whether the Project is capable of having a significant effect on the environment with regards to surface water and groundwater.  |
| <i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i><br>(Commonwealth) | The Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) promotes the conservation of biodiversity by providing protection for threatened species, threatened ecological communities, migratory and marine species, and other protected matters. The Australian Government Department of Climate Change, Energy, the Environment and Water administers the EPBC Act.  | This is relevant where the Project impacts the health and condition of waterways and groundwater dependent ecosystems that may be relied upon by EPBC Act listed species.<br><br>WestWind has advised that a separate flora and fauna assessment has been commissioned which will include an assessment of matters relevant to the EPBC Act. |
| <i>National Environment Protection Council Act 1994 (NEPC Act)</i><br>(Commonwealth)              | The NEPC Act resulted in the establishment of the National Environment Protection Council (NEPC) and National Environment Protection Measure (NEPM).<br><br>NEPMs are a set of national objectives designed to assist in protecting or managing particularly aspects of the environment. A NEPM was established for the Assessment of Site Contamination (ASC) (NEPC 1999) which was amended in 2013.<br><br>The NEPM (ASC) provides a national approach to provide adequate protection of human health and the environment, where site contamination has occurred, through the development of an efficient and effective national approach to the assessment of site contamination.<br><br>No approvals are required under the NEPC Act. | This is considered a relevant guideline where contaminated groundwater (and water, land, air) may be encountered by the Project.   |

## 2.2 Approvals

### 2.2.1 Surface water

The North Central Catchment Management Authority (NCCMA) has statutory responsibilities under the *Water Act 1989* to monitor, manage and administer control over works which may impact upon designated waterways. To ensure the health of waterways is not adversely affected, works and activities within the bed and banks of designated waterways require approvals (Works on Waterways Permit).

All works on waterways are subject to the *Aboriginal Heritage Act 2006* and must comply with the Aboriginal Heritage Regulations (2007).

### 2.2.2 Groundwater

The following approvals are required under the *Water Act 1989* relating to groundwater:

- Licence to construct a bore (greater than 3 m deep)
- Licence to take and use groundwater

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## 3. Assessment method

This section describes the method that is common to the surface water and groundwater assessments undertaken. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects (refer Figure 1).

The approach adopted in the assessment has been guided by an evaluation framework that is broadly consistent with what would be required under an EES.

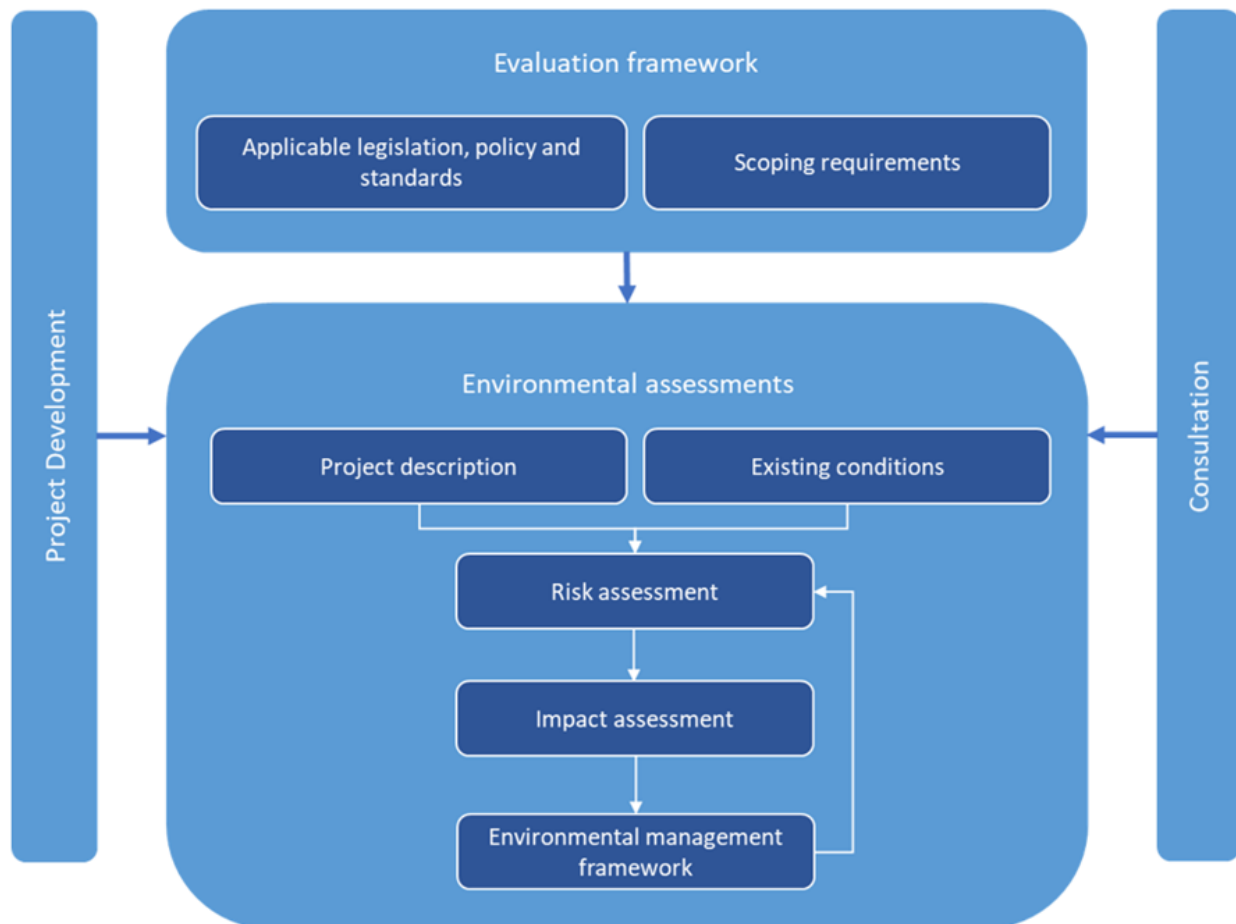


Figure 1 Overview of EES assessment framework

An effective impact assessment should:

- Be consistent with the principles of a systems and risk-based approach
- Put forward a sound rationale for the level of assessment and analysis undertaken for any environmental effect or combination of environment effects arising from all components and stages of the Project

The surface water and groundwater assessment undertaken encompasses consideration of physical systems, ecological systems, human communities, land use effects and economic effects as relevant to the Project. The assessment described in this report has been undertaken using a precautionary approach according to the following steps:

- Characterisation of the existing environmental conditions
- Review of the Project design and the proposed construction and operation activities in the context of the existing conditions to determine the location, type, timing, intensity, duration and spatial distribution of Project components and activities in relation to sensitive receptors

- An initial risk assessment to evaluate the likelihood and consequence of the proposed Project activities in the context of the initial mitigation measures to determine the relative importance of environmental risks associated with the Project
- Assessment of potential direct and indirect environmental impacts to analyse the spatial and temporal extent, magnitude and nature of the potential impacts giving consideration to the sensitivity and significance of affected receptors
- Evaluation of the predicted outcomes against applicable legislation, policy, and standards
- Evaluation of the potential for cumulative impacts caused by impacts of the Project in combination with impacts of other projects that are taking place or are proposed nearby
- Identify mitigation measures where necessary, to address potentially significant environmental effects
- Identification and evaluation of the residual environmental effects including magnitude, duration, and extent, taking into account the proposed mitigation measures and their likely effectiveness

Based on the findings of the surface and groundwater assessment, mitigation measures may be required to monitor and evaluate environmental management and contingency measures in relation to the residual environmental effects. These are described in section 1.

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## 4. Site characterisation

### 4.1 Site location

The Normanville Energy Park is a proposed wind farm project located in the Gannawarra Shire, approximately 15 km southwest of Kerang. The wind farm area covers approximately 1,933 ha. Associated with the wind farm, is a proposed buried transmission line route/easement that will connect to the proposed existing Koorangie Terminal Station located 4 km to 5 km north of the wind farm boundary. The Avoca River runs to the northwest of the site, and there are a number of scattered lakes in the wider region.

#### 4.1.1 Study area definition

The Project area has been shown in Figure 2 (defined by the red NMEP site boundary, yellow NMEP transmission line easement and green Koorangie Terminal Station footprint). As groundwater and surface water catchment processes occur on a large scale, a much larger area defined by a buffer zone of ~5 km around the Project area was used to define the study area.

#### 4.1.2 Topography

The topography of the study area is relatively flat and lies between 80 m and 100 m above sea level.

#### 4.1.3 Land use

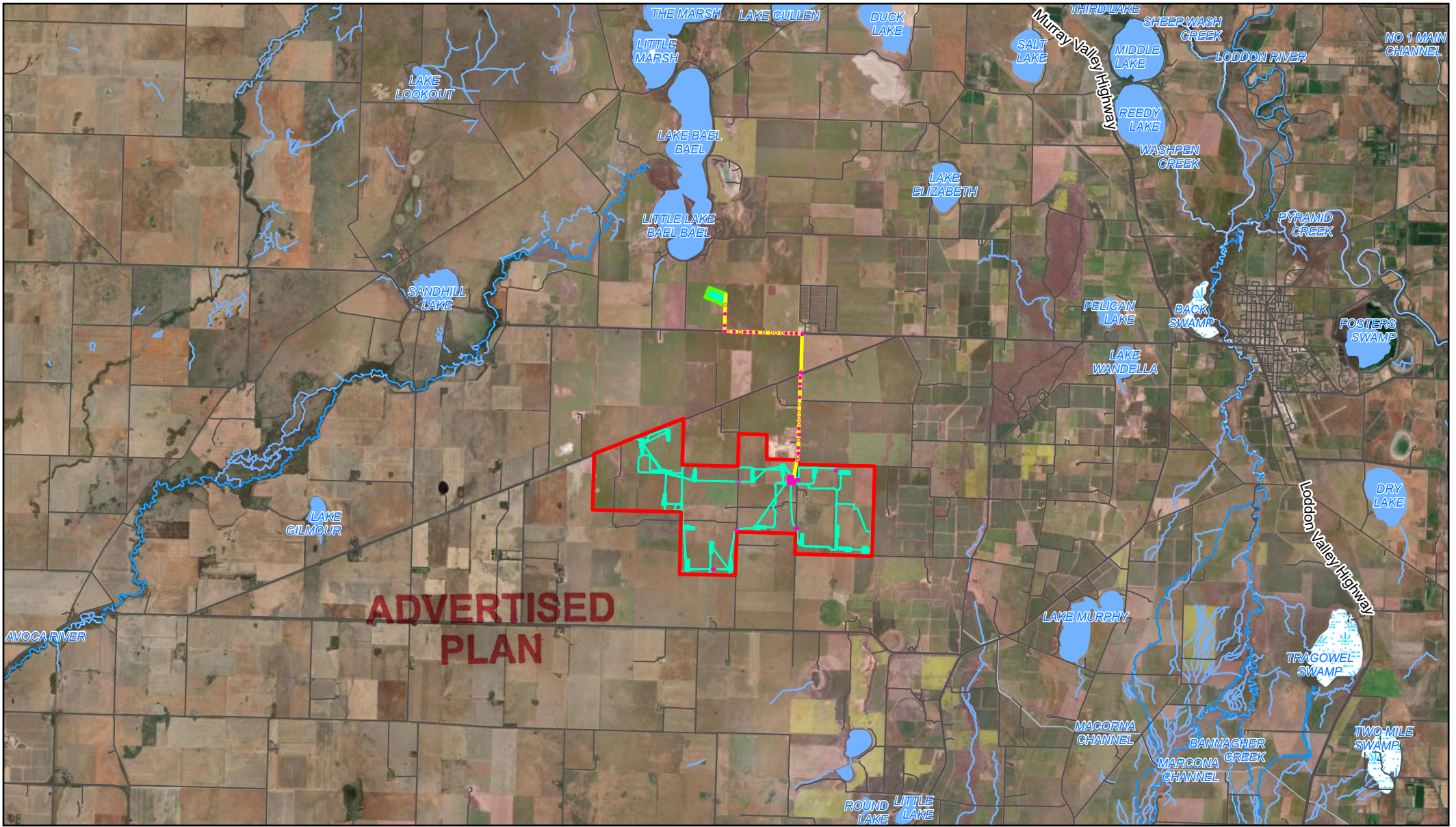
The study area is predominantly used for agricultural practices, including livestock grazing and broad acre/irrigated cropping. Sparsely scattered remnant patches of wooded vegetation are present across the Project area and wider study area. Higher concentrations of wooded vegetation are targeted along road reserves and riparian areas e.g. waterways.

A summary of the surrounding land uses and potential risks to water quality is included in Table 2.

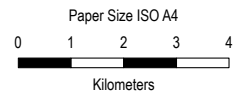
Table 2 Study area land use

| Direction                      | Land use activity  | Potential water quality risks   |
|--------------------------------|--|---|
| North-South<br>West-East       | Zoned farming land (FZ)<br>Public Conservation and<br>Resource Zone (PCRZ) | Application of fertilisers, weedicide/herbicide<br>Livestock manure<br>Fuel and oil leaks from farm machinery<br>Use of recycled water  |
| North of NMEP<br>site boundary | Public Use Zone (PUZ6)<br>- Landfill                                       | Kerang Landfill – asbestos, contaminated soil (Cat C), solid inert waste,<br>putrescible waste<br>Note a Council owned sandstone quarry (Denyer's Pit) is located directly<br>south of the landfill. Water (assumed to be rainfall runoff or groundwater<br>seepage) is collecting in the base of this former quarry. |

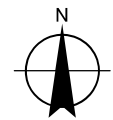
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- |  |                            |           |             |
|--|----------------------------|-----------|-------------|
| NMEP Site Boundary                       | Koorangie Terminal Station | Highway   | Watercourse |
| NMEP External Transmission Line Easement | NMEP Works Footprint       | Arterial  | Lake        |
| NMEP Temporary Construction Area         |                            | Collector | Swamp       |
|  |                            |           | River       |
|  |                            |           | Stream      |



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 54



**Normanville Energy Park Pty Ltd (NMEP)**  
 Surface Water and Groundwater Assessment  
 of the Normanville Energy Park

Project No. 31-12601890  
 Revision No. 4  
 Date 19/11/2024

**Normanville Energy Park Location**

**FIGURE 2**

## 4.2 Climate

Climate data was obtained from the Bureau of Meteorology's Kerang climate station (80023). The mean rainfall data, based on those years since 1900, and also since 1990, to reflect more recent climate, is summarised in Table 3. The average annual rainfall of around 370 mm is considerably less than the annual evaporation.

Table 3 Summary of climate

| Month                | Long Term (1900-2023) |                          | Short term (1990-2023) |                          |
|----------------------|-----------------------|--------------------------|------------------------|--------------------------|
|                      | Monthly rainfall (mm) | Monthly Evaporation (mm) | Monthly rainfall (mm)  | Monthly Evaporation (mm) |
| January              | 25.0                  | 258.0                    | 28.7                   | 250.7                    |
| February             | 24.8                  | 211.6                    | 24.0                   | 200.9                    |
| March                | 27.4                  | 171.2                    | 21.6                   | 165.0                    |
| April                | 24.5                  | 100.4                    | 26.0                   | 96.6                     |
| May                  | 35.7                  | 57.0                     | 29.7                   | 54.6                     |
| June                 | 34.6                  | 36.7                     | 32.9                   | 36.1                     |
| July                 | 35.8                  | 41.4                     | 34.0                   | 41.1                     |
| August               | 36.9                  | 63.2                     | 33.1                   | 62.9                     |
| September            | 36.6                  | 96.2                     | 38.3                   | 96.3                     |
| October              | 37.9                  | 143.7                    | 32.7                   | 145.6                    |
| November             | 29.9                  | 190.2                    | 39.3                   | 186.1                    |
| December             | 26.7                  | 241.2                    | 29.0                   | 232.9                    |
| <b>Annual totals</b> | <b>376</b>            | <b>1,610.9</b>           | <b>369</b>             | <b>1,569.6</b>           |

Note:

1. Site elevation: 82 m
2. Station location: Lat: -35.7236, Long: 143.9196
3. Based upon data from 1990 to 2023

## 4.3 Geological setting

### 4.3.1 Regional stratigraphy

The study area is located in the Riverine plains, which is a part of the broader Murray geological basin (Murray Basin). The Murray Basin is a structurally controlled sedimentary basin which has been filled with Tertiary aged marine and non-marine sediments, and which are overlain in many locations by Quaternary aged aeolian, fluvial and lacustrine sediments. The depth of the sediments can extend to around 400 m, and rest unconformably upon a Palaeozoic basement. Based upon their depth of occurrence, the basement rocks are not discussed further in this assessment.

Understanding the depositional history of the basin is important to identifying the aquifers and their character throughout the basin. The Murray Basin can be split into three main depositional sequences (lower and middle Tertiary, and upper Tertiary/Quaternary) which correlate with periods of sea level rise and fall. A summary stratigraphy is provided in Table 4.

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**Table 4** Generalised regional stratigraphy

| Period     | Epoch                   | Formation/Group                                       | Map Codes                  | Lithology  |
|------------|-------------------------|---|----------------------------|--|
| Quaternary | Holocene                | Alluvium (undifferentiated)<br>Coonambidgal Formation | Qxy, Qxm,<br>Qa1, Ql1, Ql2 | Lagoon and swamp deposits, silt, clay.<br>Fluvial, lacustrine clay, sand, sandy clay.  |
|            | Pleistocene             | Lowan (Molineaux)<br>Formation                        | Qxm                        | Aeolian fine to medium grained dune sands  |
|            |                         | Woorinen Formation                                    | -                          | Aeolian dune sand, calcareous, clayey,<br>palaeosols   |
|            |                         | Shepparton Formation                                  | Nws                        | Fluvial silts, sands, sandy clay, and minor<br>gravels   |
| Tertiary   | Pliocene to<br>Miocene  | Parilla Sand  | Nwl                        | Very fine to coarse grained sands, silty<br>sands, silts, with sandy conglomerates and<br>micaceous clays  |
|            | Miocene to<br>Paleocene | Renmark Group   | -                          | Fluvio-lacustrine deposits: gravel, quartz<br>sand, silt and clay; pyritic, ferruginised,<br>unconsolidated to poorly consolidated;<br>minor seams of brown coal |
| Devonian   | Upper                   | Lake Boga Granite                                     |                            | Intrusive two-mica granite, medium to<br>coarse grained porphyritic  |

Notes: Map codes applied in Figure 3

The earliest deposition occurred during the early Tertiary with the deposition of the fluvial Renmark Formation which has been further differentiated into the Warina Sands (older) and Olney Formation (younger). The second sequence occurred during the mid Tertiary, when sea level rises resulted in the inundation of parts of the western areas of the Murray Basin. Marls and limestones were deposited in the western areas (Murray Group), and clays (Geera Clay) in shallow marginal-marine conditions. The mid-Tertiary deposition is not represented locally as the ancient coastline did not extend as far to the northeast as the study area.

The third depositional sequence occurred during the upper Tertiary and involved a series of marine transgressions and regressions. Clays were deposited in the marine areas (i.e. overlying the Murray Group), and sands deposited in fluvial and fluvio-lacustrine environments further inland to the east (i.e. Loxton – Parilla Sands and Calivil Formations). Tectonic uplift dammed the Murray River drainage system and formed Lake Bungunnia, resulting in the deposition of the clays in the western areas, and fluvial – lacustrine sediments of the Shepparton Formation in the eastern areas.

Geologically recently there was a period of aridity and salinisation. Aeolian erosion and deposition led to the development of extensive dune fields and calcrete formation. Such is typically represented by east-west orientated linear dunes of the Lowan Sands and Woorinen Formation. Shepparton Formation sediments were reworked in drainage lines to form the Coonambidgal Formation, which is laterally restricted to present day waterways.

## 4.3.2 Surface geology

The surface geology is presented in Figure 3. The Parilla Sands (Nwl) is the main outcropping lithology in the southeast of the Project area. Towards the northwest of the Project area is an outcrop of Lowan Formation sediments. In the east of the Project area, mapping interprets Shepparton Formation sediments, which are associated with the floodplains of the Loddon River.

A lithological profile can be interpreted from State Observation Network (SON) bore 71105, located near the western boundary of the Project area, and bore 52363, approximately 4.5 km southwest of the Project area. The lithological logs have been summarised in Table 5. The Renmark Group is marginal marine to terrestrial in origin and therefore the presence of ligneous materials such as coal is indicative of the formation. The Parilla Sands can have cemented bands, and at shallow depths, however, these can be mistaken for dune deposits e.g. Lowan Sand. Irrespective of the stratigraphy, the drilling indicates that upwards of 150 m of unconsolidated sediments can underlie the site.

### 4.3.3 Surface soils

Following the Australian Soil Classification (Isbell, 2016), Chromosol soils, are the dominant type in the study area. Chromosols are texture contrast soils with a sandy or loamy surface horizon overlying a clay-textured horizon.

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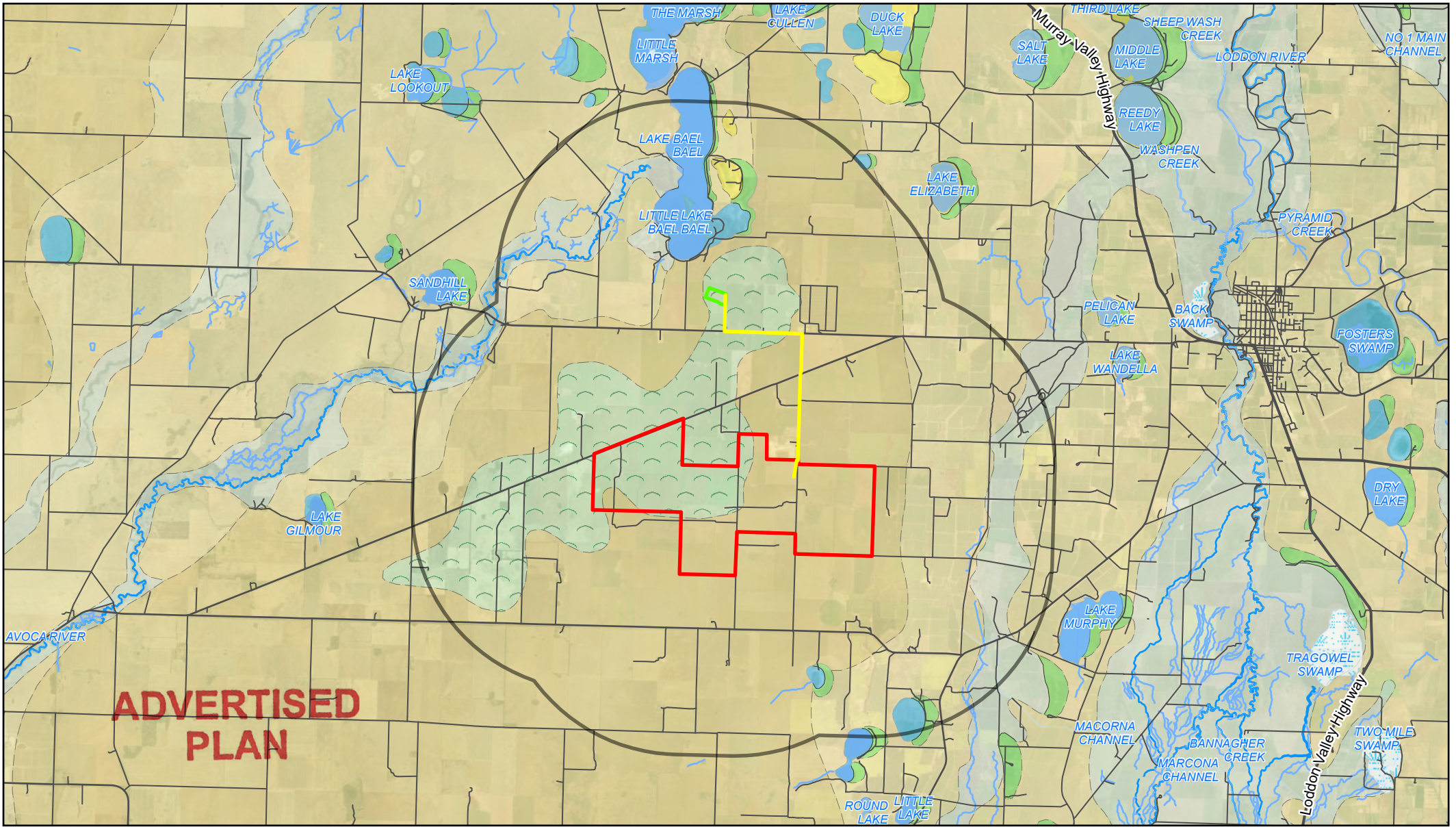
Table 5 Driller's Lithological log of SOBN 77105 and 52363

| SOBN 71105 |        |  |   | SOBN 52363 |        |   |                          |
|------------|--------|--|---|------------|--------|---|--------------------------|
| From (m)   | To (m) | Comments                               | Interpreted stratigraphy                                | From (m)   | To (m) | Comments  | Interpreted stratigraphy |
| 0          | 1      | SAND: fine, brown                      | Parilla Sand (may have thin overlying Quaternary sands) | 0          | 2      | CLAY: soft, brown                                 | Shepparton Formation     |
| 1          | 9      | SANDSTONE: brown and white             |   | 2          | 17     | SANDSTONE: Yellow and white with clay             | Parilla Sand             |
| 9          | 13     | SANDSTONE: white with rough SAND       |   | 17         | 18     | SANDSTONE and SAND                                |                          |
| 13         | 18     | SANDY CLAY: white & light brown        |   | 18         | 25     | SANDSTONE: with white SANDY CLAY                  |                          |
| 18         | 20     | CLAY: red & white                      |   | 25         | 30.5   | SANDSTONE: brown, with mottled clay and ironstone |                          |
| 20         | 23.5   | SANDSTONE: brown & brown sandy clay    |   | 30.5       | 37     | CLAY; light blue with small sand bands            |                          |
| 23.5       | 26     | SANDSTONE: brown, with white CLAY      |   | 37         | 56.5   | SAND: fine, brown with thin, grey CLAY            |                          |
| 26         | 32     | CLAY: grey and light grey, soft        |   | 56.5       | 63     | SAND: fine and COAL                               |                          |
| 32         | 36     | CLAY: soft, grey with white SAND bands |   | 63         | 77     | CLAY: ligneous, hard                              |                          |
| 36         | 45     | SAND: white and orange, fine           |   | 77         | 89     | CLAY: soft, ligneous, and sandy grey CLAY         | Renmark Group            |
| 45         | 50     | SAND: very fine white & orange         | Renmark Group   | 89         | 102.5  | COAL: dark brown                                  |                          |
| 50         | 53     | SAND: fine white with fine COAL        |   | 102.5      | 111    | SAND: fine, white                                 |                          |
| 53         | 57     | SAND                                   |   | 111        | 114.5  | COAL: brown with brown CLAY bands                 |                          |
| 57         | 62     | CLAY: ligneous                         |   | 114.5      | 119.5  | COAL: brown                                       |                          |
| 62         | 71.5   | SAND: fine with fine COAL              |   | 119.5      | 124.5  | SANDY CLAY: ligneous, brown                       |                          |
| 71.5       | 74     | CLAY: ligneous                         |   | 124.5      | 130    | SAND: medium to fine                              |                          |
| 74         | 75     | SAND: dark, fine                       |   | 130        | 136.5  | SAND: medium with fine GRAVEL                     |                          |
| 75         | 82     | CLAY: ligneous grey                    |   | 136.5      | 143    | SAND and CLAY, ligneous                           |                          |
| 82         | 89     | COAL: dark brown & ligneous CLAY       |   | 143        | 154.8  | GRANITE: weathered                                | Basement                 |

| SOBN 71105 |        |   |                          | SOBN 52363 |        |          |                          |          |
|------------|--------|---|--------------------------|------------|--------|----------|--------------------------|----------|
| From (m)   | To (m) | Comments                                | Interpreted stratigraphy | From (m)   | To (m) | Comments | Interpreted stratigraphy |          |
| 89         | 94     | CLAY: grey and fine SAND                |                          |            |        |          |                          |          |
| 94         | 96.5   | SAND: fine dark                         |                          |            |        |          |                          |          |
| 96.5       | 102.5  | CLAY: ligneous and fine SAND and COAL   |                          |            |        |          |                          |          |
| 102.5      | 105    | SAND: fine                              |                          |            |        |          |                          |          |
| 105        | 108    | CLAY: ligneous, and light brown CLAY    |                          |            |        |          |                          |          |
| 108        | 117    | SAND: fine & light brown CLAY           |                          |            |        |          |                          | Basement |
| 117        | 118.5  | SAND: fine & light brown CLAY           |                          |            |        |          |                          |          |
| 118.5      | 124    | SAND: fine to coarse & white CLAY bands |                          |            |        |          |                          |          |
| 124        | 137.2  | GRANITE: Weathered                      |                          |            |        |          |                          |          |

Note: Stratigraphy interpreted from the lithological descriptions.

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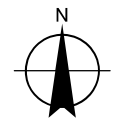
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- NMEP Site Boundary
- NMEP External Transmission Line Easement
- Koorangie Terminal Station
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp
- River
- Stream
- Geological structure 250k
- conformity
- disconformity
- geological unit boundary
- unconformity
- Geological unit 250k
- Nwl
- Nws
- Qa1
- Ql2
- Qm1
- Qxm
- Qxy

Paper Size ISO A4

Kilometers

Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 54



**Normanville Energy Park Pty Ltd (NMEP)**  
**Surface Water and Groundwater Assessment  
of the Normanville Energy Park**

Project No. **31-12601890**  
Revision No. **4**  
Date **19/11/2024**

**Surface Geology** **FIGURE 3**

# 5. Waterways and drainage

## 5.1 Floodplain management

### 5.1.1 Drainage

#### Methodology

A high-level desktop surface water assessment has been undertaken to provide information on floodplain management and surface water drainage within the Project area which includes the main site boundary, transmission line route and western portion of Koorangie Terminal Station footprint (Figure 2). The assessment has been carried out with review of existing elevation data (both coarse and higher resolution data), automatically delineated flow paths (through GIS software) and available flood mapping data within the buffer zone of 5 km. Overland flow paths that are located beyond the buffer zone were considered in the assessment in the case that they crossed through the Project area and to catchment outlets or points of discharge beyond the site boundary and 5 km buffer zone. The assessment has included the use of several (publicly available) data sources:

- Nearmap satellite and road imagery
- DEECA Vicmap Hydro watercourse and water area overlays
- Vicmap 10 m LiDAR (coarse)
- Victoria Flood Database historic flood extents
- NCCMA Flood Eye 1% AEP extent
- 1 m LiDAR (higher resolution data for the Project area collected 12/05/2024, provided by WestWind)

The Proponent collected 1 m LiDAR in January 2024, which is considered to provide an up to date and appropriate representation of topographical and drainage conditions for the Project Area.

Watercourse data available in the DEECA Vicmap Hydro – Watercourse layer and dataset was considered to provide context about the floodplain behaviour and terminal points within the Study Area. However, upon review and comparison with the 1 m LiDAR supplied by WestWind and high-resolution aerial imagery, it was found that many of the channels and drains in the Watercourse layer do not align with the recent 1 m LiDAR.

Given that many of the drains and channels within the layer do not align with the most recent LiDAR or aerial imagery, it has been assumed that this layer is outdated and is not an accurate representation of drainage and existing surface water conditions across the Study Area and hence is not an accurate or reliable representation of drainage for the purpose of this assessment.

Existing conditions have instead been assessed by interpreting the general direction and behaviour of surface water using the remaining data sources listed above. Automatically derived flow paths were generated using GIS software that interpreted LiDAR inputs. The derived flow paths have been used throughout the assessment to provide insight into the general locations and directions of overland flow paths that would activate during flood events in the area and their respective outlets.

The greater study area was delineated using 10 m LiDAR as this data set extended beyond the Project area boundary and allowed for an understanding of surface water downstream of the site boundary. Automatically derived flow paths from the 10 m LiDAR were used to estimate main sub-catchments and respective outlets. More specific and accurate flow paths were derived from the 1 m LiDAR as this dataset provided more recent and detailed information in relation to topography and surface water. However, this information is limited to the Project area, as the 1 m LiDAR only extends 500 m past the site boundary.

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## Existing Conditions

The Project area is located on land between the Avoca River, which is approximately 5 km north-west of the site boundary, and the Loddon River, approximately 10 km east of the site boundary (refer to Figure 4). Focusing on the site boundary, transmission line and the 5 km buffer zone, most of the land generally slopes from south to north towards Bael Bael, while land to the east of the Project area slopes from west to east towards Kerang.

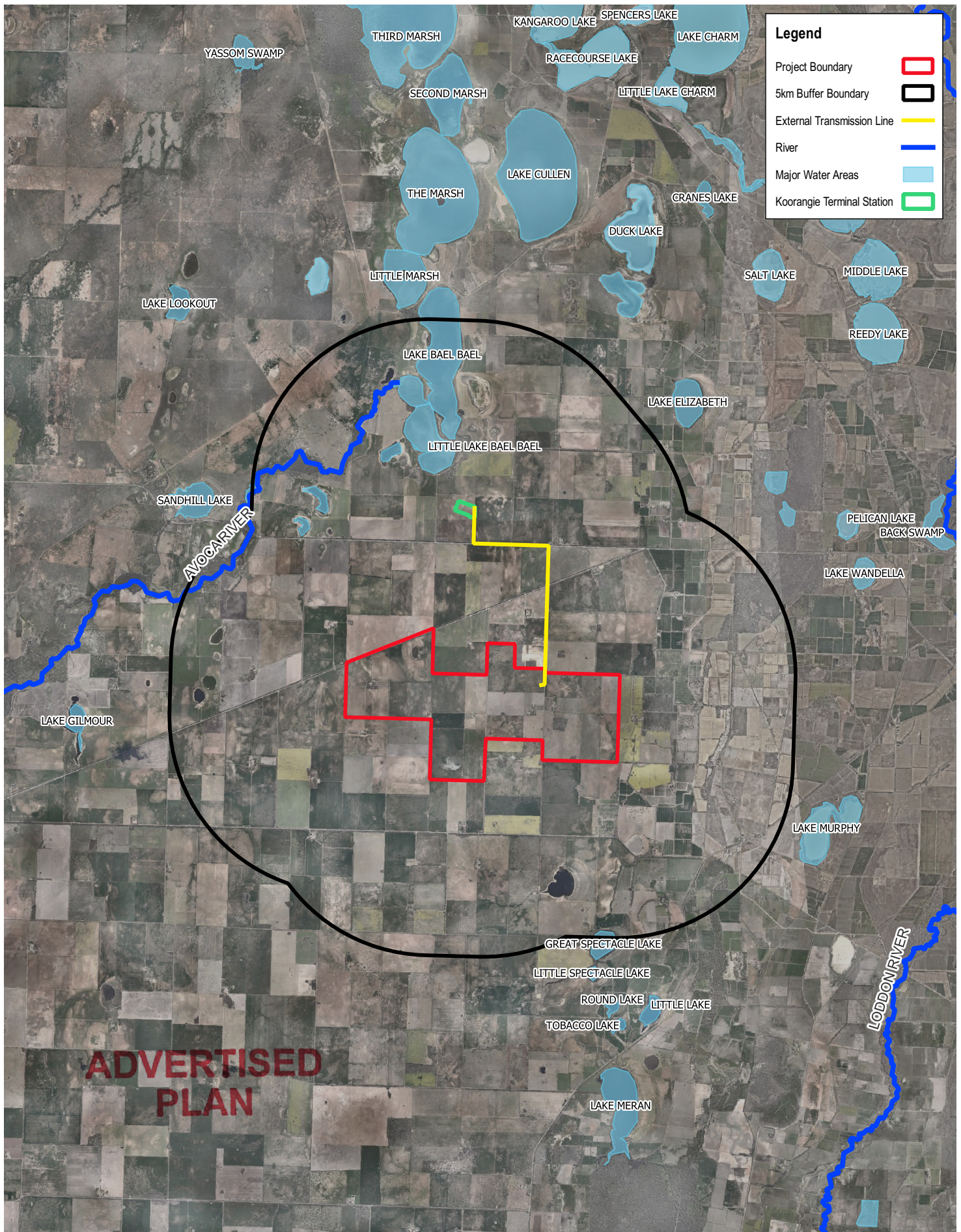
Both the Avoca River and the Loddon River flow northward. The Avoca River is an intermittent river that drains towards Lake Bael Bael, and in times of higher flows may spill into the Kerang Wetlands and reach the Murray River. The Loddon River is a perennial river system that flows north becoming a part of the Murray River floodplain after joining with Pyramid Creek at Kerang. Several automatically delineated overland flow paths exist within the Project area and wider 5 km buffer zone (Figure 5 and Figure 6). Some of the overland flow paths, delineated from both the 1 m and 10 m LiDAR, appear to discharge to the Avoca River. These flow paths are located in the western portion of the Project area, approximately 6 km upstream of the discharge point at the Avoca River. There do not appear to be any flow paths that interact with the Loddon River. Instead, the surface water from the central and eastern portions of the Project area discharges via overland flow paths that pass through the Project area and 5 km buffer zone to Lake Bael Bael, Lake Elizabeth Wildlife Reserve and Duck Lake Wildlife Reserve, located north of the Project.

It should be noted that overland flow paths that have been automatically delineated from the 10 m LiDAR present a general representation of expected surface water flow behaviour during a large rainfall event that generates overland flows (Figure 5). Given the coarse level on detail within this dataset, these flow paths mainly provide an indication of the overall connectivity beyond the 5 km buffer area and allowed for the estimation of sub-catchments and the determination of respective outlets or discharge points.

The automatically delineated flow paths from the 1 m LiDAR present a more accurate representation of locations of overland flow, however, are limited to within the Project area (Figure 6). Many of the overland flow paths delineated from the 1 m LiDAR pass through the site boundary and appear to continue to direct surface water runoff to the general areas of overland flow, interpreted from the 10 m LiDAR (see Appendix A for additional flow path figures). More detailed local drainage assessment is recommended to be considered as part of detailed design of the Project to confirm the connectivity and characteristics of the overland flow paths.

The proposed works are located partly within an irrigation district and there is a network of minor drainage channels that deliver water into irrigated cropping areas and local storages. However, given the extent and depth of these drainage channels, it is difficult to determine the connectivity and direction of flow, however the capacity and general flow conveyance is assumed to be small and hence are unlikely to affect downstream receptors with environmental significance.

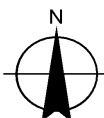
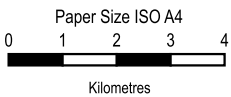
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**Legend**

- Project Boundary
- 5km Buffer Boundary
- External Transmission Line
- River
- Major Water Areas
- Koorangie Terminal Station

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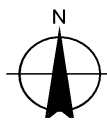
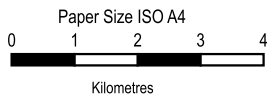
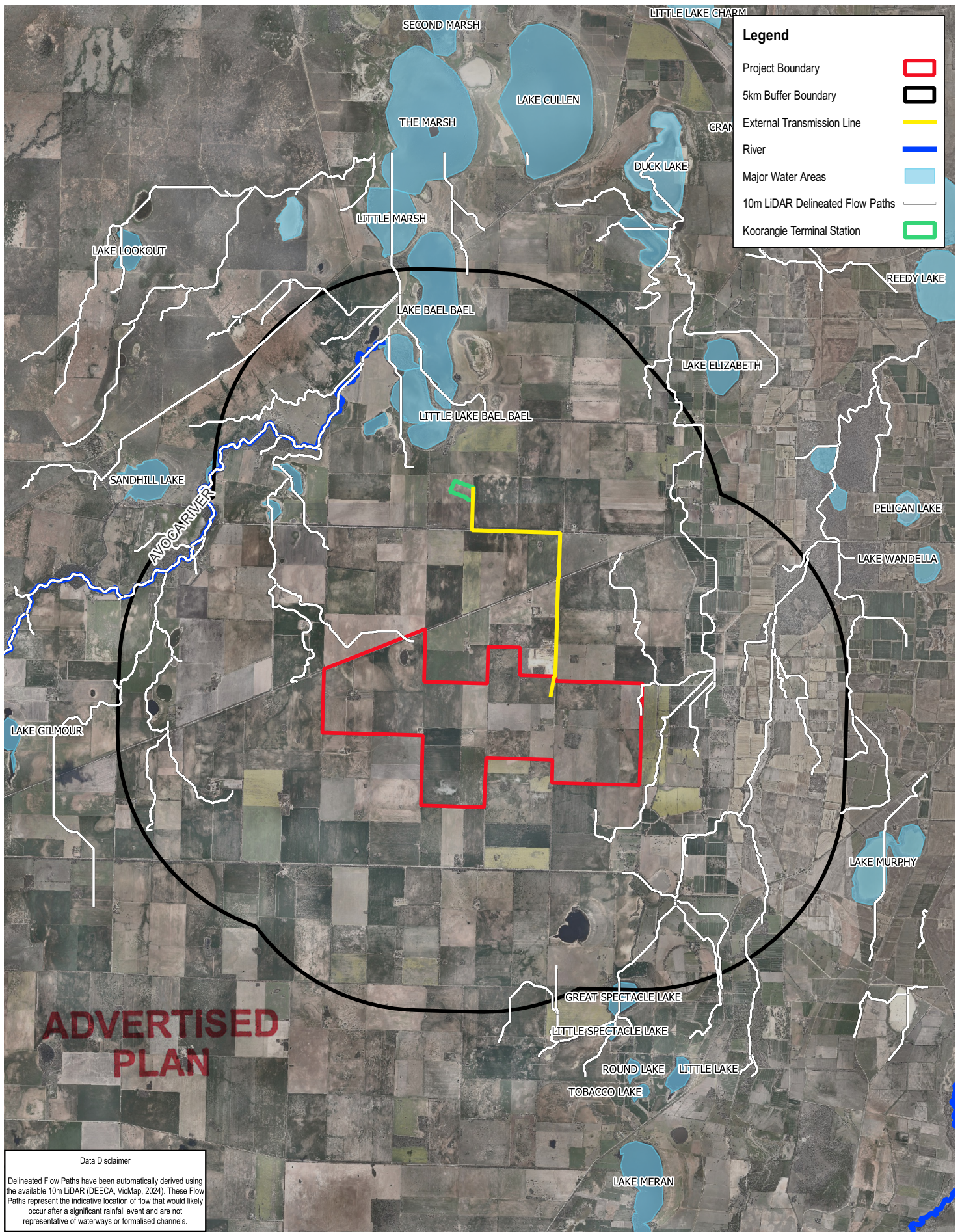


**Normanville Energy Park Pty Ltd (NMEP)**  
 Surface water and groundwater assessment  
 of the Normanville Energy Park

Project No. 31-12601890  
 Revision No. 5  
 Date 11/20/2024

**Surface Water Existing  
 Conditions**

**FIGURE 4**



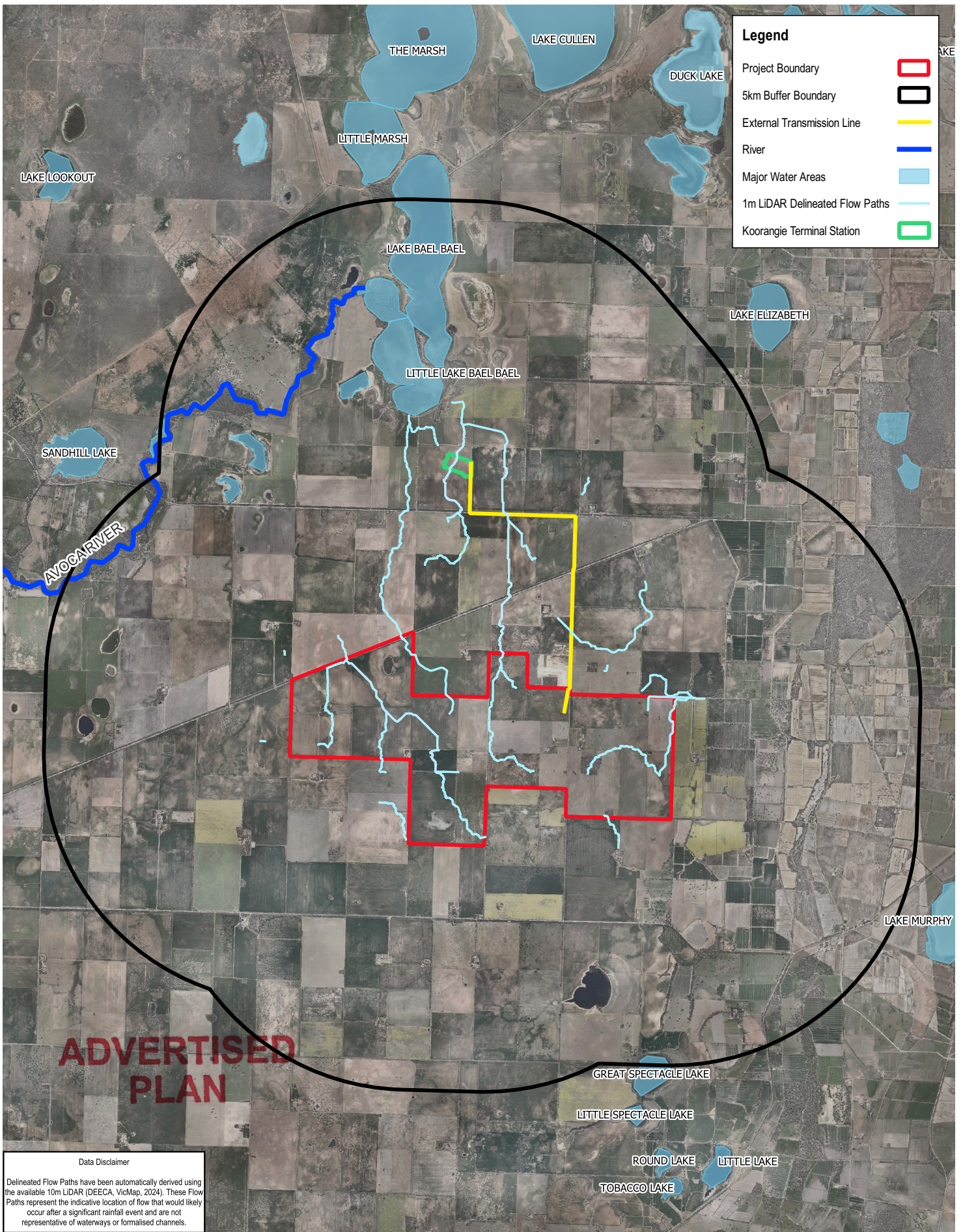
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 Grid: GDA 2020 MGA Zone 54

Normanville Energy Park Pty Ltd (NMEP)  
 Surface water and groundwater assessment  
 of the Normanville Energy Park

Project No. 31-12601890  
 Revision No. 5  
 Date 11/20/2024

**Surface Water and 10m LiDAR  
 Delineated Flow Paths**

**FIGURE 5**

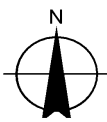
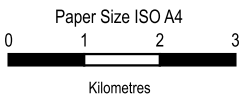


**Legend**

- Project Boundary
- 5km Buffer Boundary
- External Transmission Line
- River
- Major Water Areas
- 1m LiDAR Delineated Flow Paths
- Koorangie Terminal Station

**Data Disclaimer**

Delineated Flow Paths have been automatically derived using the available 10m LiDAR (DEECA, VicMap, 2024). These Flow Paths represent the indicative location of flow that would likely occur after a significant rainfall event and are not representative of waterways or formalised channels.



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 2020  
 Grid: GDA 2020 MGA Zone 54

**Normanville Energy Park Pty Ltd (NMEP)**  
 Surface water and groundwater assessment  
 of the Normanville Energy Park  
**Surface Water and 1m LiDAR  
 Delineated Flow Paths**

Project No. 31-12601890  
 Revision No. 4  
 Date 11/20/2024

**FIGURE 6**

## 5.1.2 Flood extents

Flood mapping of 1 in 100-year flood extents are shown in Figure 7 and indicate that flooding is not known to occur within the site boundary or around the transmission line easement. Flooding associated with the Avoca River and Loddon River floodplains during a 1 in 100-year flood event does not extend into the project area from the flood mapping undertaken. Flooding from the Avoca River during a 1 in 100-year flood event extends to approximately 3.5 km northwest of the main site boundary and approximately 1 km north-west of the easement boundary.

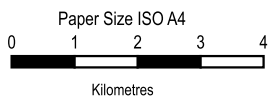
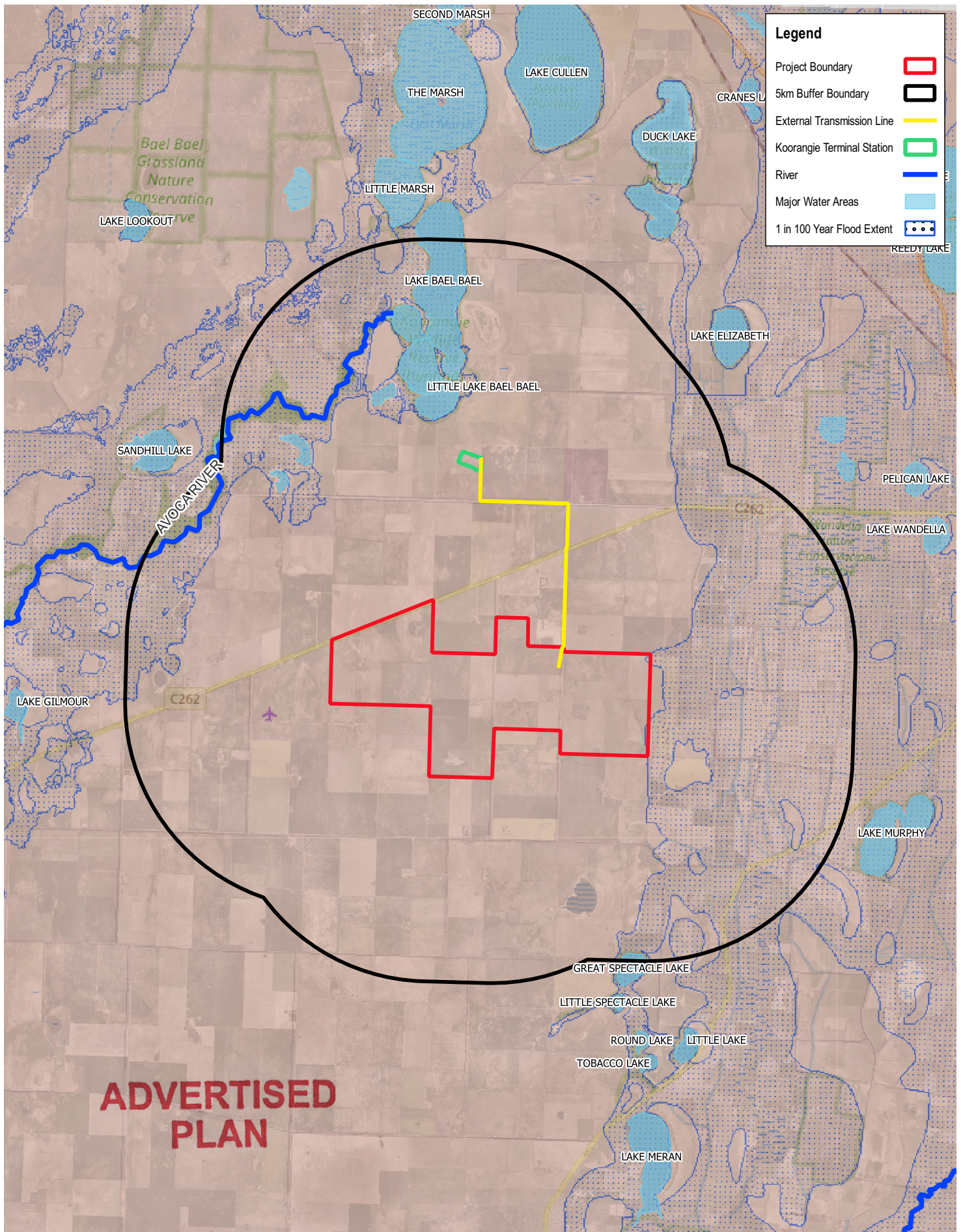
Flooding from the Loddon River appears to branch out approximately 5 km west of the river, along the edge of the eastern boundary of the proposed project site. However, given that there are overland flow paths in the eastern portion of the Project area that appear to directly interface with the 1 in 100 year flood extent, significant rainfall events may result in temporary flooding extending beyond the eastern boundary of the project site.

Given the flat nature of the site there may be local flooding or drainage issues associated with overland flow paths and local storages that exist within the Project area. To determine which areas within the Project area would be subject to inundation through the local drainage paths during significant rainfall events, local drainage flood modelling is recommended during the detailed design phase of this project.

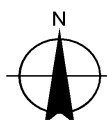
The local drainage flood modelling would provide insight into depth and velocity of local surface water during rainfall events and any associated risks to infrastructure. We note the distinction between a floodplain assessment of the major waterways and floodplains (i.e. the presented flood mapping of historic and 1 in 100 year flood extents for the Loddon and Avoca rivers that do not interact with the site boundary), and the flooding assessment for the local drainage and overland flow paths through or near the project area. It is expected that the flood impacts to the site from local drainage flow paths would be readily addressed as part of siting and designing associated drainage infrastructure. Local drainage flood modelling is recommended to be considered as part of detailed design of the Project to minimise impacts during construction and operation.

A high intensity rainfall event occurred in mid January 2011 resulting in flooding, the extents of which are shown in Figure 8. The historic extent of the January 2011 floods presents a similar result to the 1 in 100-year flood extents (refer Figure 7), although flooding to the east of the Project area is not as widespread. The 2011 historic flood extent suggests that flooding during such an event is more confined to the rivers, streams, and channels within the direct floodplains, as well as local depressions. This flood extent did not reach the eastern boundary of the Project area, however, inundation extended to only 300 m away from the south-east corner of the Project area.

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Map Projection: Transverse Mercator  
Horizontal Datum: GDA 2020  
Grid: GDA 2020 MGA Zone 54

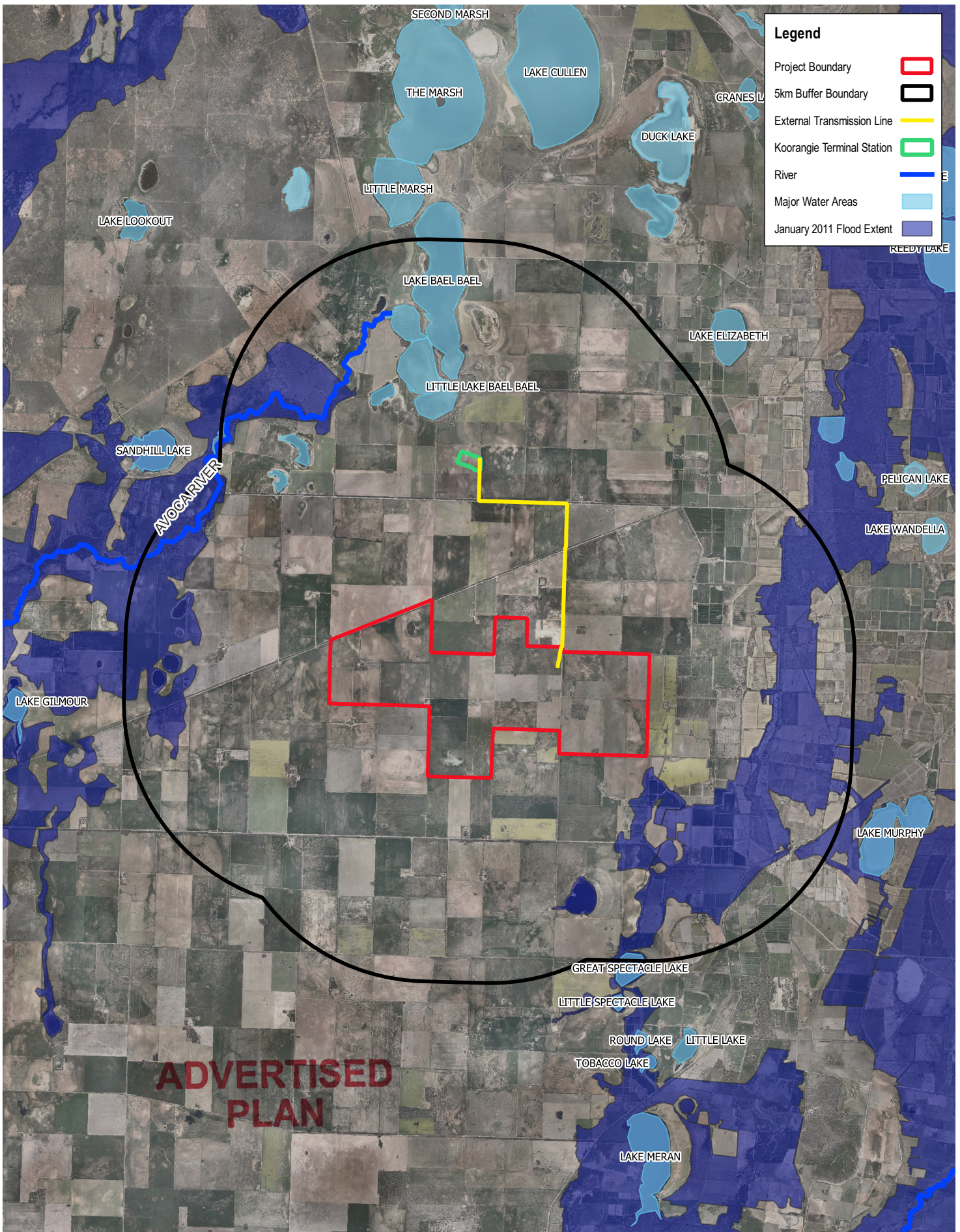


Normanville Energy Park Pty Ltd (NMEP)  
Surface water and groundwater assessment  
of the Normanville Energy Park

1 in 100 Year Flood Extent

Project No. 31-12601890  
Revision No. 5  
Date 20/11/2024

**FIGURE 7**

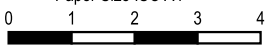


**Legend**

- Project Boundary
- 5km Buffer Boundary
- External Transmission Line
- Koorangie Terminal Station
- River
- Major Water Areas
- January 2011 Flood Extent

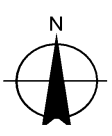
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Paper Size ISO A4



Kilometres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 2020  
Grid: GDA 2020 MGA Zone 54



**Normanville Energy Park Pty Ltd (NMEP)**  
Surface water and groundwater assessment  
of the Normanville Energy Park

**January 2011 Flood Extent**

Project No. 31-12601890  
Revision No. 5  
Date 11/20/2024

**FIGURE 8**

### 5.1.3 Index of stream condition

No major waterways are intersected by the Project area and as such, there are no reaches assessed as part of the ISC3.

### 5.1.4 Ramsar Sites

The Kerang Wetlands Ramsar site falls within the study area (but not the Project area itself).

## 5.2 Environmental values of waterways near the Project

### 5.2.1 Environmental Protection Act 2017 environmental values

A list of environmental values to be protected in a waterway are defined by the *EP Act 2017* (Vic) – and listed in the ERS (EPA Victoria 2021). The environmental values for the Loddon River are listed in Table 6.

Table 6 Environmental values of the Loddon River

| Environmental values   | ERS notes and relevance to study area  | Is environmental value present in Loddon River in vicinity of study area |
|--|--|--|
| Water dependent ecosystems (slightly to moderately modified) | <p>ERS - Water quality that is suitable to protect the integrity and biodiversity of water dependent ecosystems including:</p> <ul style="list-style-type: none"> <li>– The integrity of riparian vegetation as it contributes to the health of water dependent ecosystems and bank stability</li> <li>– Groundwater quality that does not adversely affect surface water ecosystems</li> <li>– Groundwater quality that does not adversely affect natural ecosystems that require access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis to maintain their communities of organisms, ecological processes, and ecosystem services. This includes wetlands, rivers and streams reliant on groundwater baseflow, some terrestrial vegetation and some estuarine and near-shore marine systems, stygofauna and troglifauna</li> <li>– Maintenance of fish passage</li> </ul> <p>Study area - Waterways (rivers, creeks, and wetlands) support a diversity of highly valued natural flora and fauna (North Central CMA 2014).</p> | ✓  |
| Human consumption (after appropriate treatment)              | <p>ERS - Surface water quality that is suitable for use by drinking water suppliers for delivery, after appropriate treatment, to consumers of drinking water. Surface water quality that is suitable for use by the Wonthaggi desalination plant.</p> <p>Study area - Cairn Curran Reservoir was constructed to supply water for domestic use to customers along the Loddon River. It is operated by Goulburn-Murray Water (GMW) and is located approximately 150 km south of Kerang.</p>   | ✗  |
| Agriculture and irrigation                                   | <p>ERS - Water quality that is suitable for agricultural activities such as stock watering and irrigation, as well as a range of other uses such as the irrigation of domestic gardens, commercial agriculture, parks, and golf courses.</p> <p>Study area - Cairn Curran Reservoir (approximately 150 km south of Kerang) was constructed to supply water for irrigation and stock watering to customers along the Loddon River. Tullaroop Reservoir (approximately 170 km south of Kerang) stores water for supplies to irrigated properties along Tullaroop Creek and the Loddon River. Both reservoirs are operated by GMW. In addition, there are 669 water entitlements throughout the Loddon basin with a total volume of 29,596 ML.</p>  | ✓  |

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| Environmental values                         | ERS notes and relevance to study area   | Is environmental value present in Loddon River in vicinity of study area |
|--|---|--|
| Human consumption of aquatic foods           | ERS - Surface water quality that is suitable to support the availability and safe human consumption of fish and any other aquatic plant, algae or invertebrate from natural populations, commercial and recreational catch.<br>Study area - The Loddon River is a popular for recreational fishing and there is potential that anglers may eat the fish they catch.   | ✓  |
| Aquaculture                                  | ERS - Surface water quality that is suitable for the production of fish and any other aquatic plant, algae or invertebrate for human consumption via aquaculture.<br>Study area – Regional waterways are not used for commercial aquaculture.   | ✗  |
| Industrial and commercial                    | ERS - Water quality that is suitable for industrial and commercial use.<br>Study area - The latest Commonwealth Scientific and Industrial Research Organisation (CSIRO) report found that 32% of available surface water was diverted for use in irrigated agriculture, stock, and domestic, and urban water supply. Irrigation water in the northern part of the catchment is also sourced from the Goulburn, Campaspe, and Murray River systems. Groundwater within the Loddon–Avoca region is used for urban, stock, and domestic and irrigation purposes.<br>Groundwater accounts for about 9% of total water use in the region.  | ✗  |
| Water-based recreation (primary contact)     | ERS - Water quality that is suitable for primary contact recreation (for example swimming, diving, water skiing, caving, and spas), secondary contact recreation (for example boating and fishing) and for aesthetic enjoyment.<br>Study area - Waterways (rivers, creeks, and wetlands) in the area are highly valued by the regional community for recreational and aesthetic reasons (North Central CMA 2014).   | ✓  |
| Water-based recreation (secondary contact)   |   | ✓  |
| Water-based recreation (aesthetic enjoyment) |   | ✓  |
| Traditional Owner cultural values            | ERS - Water quality that protects the cultural values of Traditional Owners, having recognised primary responsibility for protecting the values of water for cultural needs, to ensure that Traditional Owner cultural practices can continue. Values may include traditional aquaculture, fishing, harvesting, cultivation of freshwater and marine foods, fish, grasses, medicines, and filtration of water holes.<br>Study area - The Barapa Barapa and Wamba Wamba are the Traditional Owners in the northern part of the Loddon catchment, and the Djaara (Dja Dja Wurrung People) in the southern part of the catchment. Artefacts of cultural practices are present throughout the Loddon system, and it is highly valued. | ✓  |

Note the environmental values do not apply to water in:

- Constructed **stormwater, agriculture** or irrigation drains, or irrigation channels
- Wetlands
- Landfill cells
- Waste and wastewater treatment systems
- Reticulated water supply distribution systems
- Off-stream private dams
- Water tanks

Lowland reaches of the Loddon River are located within the Murray and Western Plains segment where waterways are considered to be slightly to moderately modified.

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## 6. Hydrogeology

### 6.1 Identified aquifers

Based upon a review of the lithological profile, hydrogeological mapping (O'Rorke *et al.*, 1992) and groundwater resource reports obtained from DEECA, the study area is underlain by a multi-aquifer system. In general terms, the aquifers underlying the region are as follows:

- Upper system (approximately the upper 75 m)
  - Parilla Sands aquifer
  - Shepparton Formation and undifferentiated Quaternary sediments where present, and where saturated
- Deep system (>85 m)
  - Renmark Group
  - Bedrock (basement) sedimentary (fractured rock) and igneous (fractured rock)

### 6.2 Level of confinement

The shallow aquifer system represents the regional water table and is considered to lie within the Parilla Sands. Any alluvium or Shepparton Formation fluvial sediments within the Project area are generally very thin or absent, or unsaturated.

### 6.3 Groundwater management

#### 6.3.1 Background to resource management

DEECA has recognised areas of intensive groundwater use throughout Victoria. The principal management unit for groundwater resources in Victoria is the Groundwater Management Unit or GMU. A GMU may be a Groundwater Management Area (GMA), a Water Supply Protection Area (WSPA) or an Unincorporated Area. An Unincorporated Area is a region falling outside of a GMA or WSPA.

Under the *Water Act 1989*, the Minister for Water may declare the total volume of groundwater (and/or surface water) which may be taken in an area. This is termed the Permissible Consumptive Volume (PCV). The total volume of water allocated under the PCV became a trigger for declaration of a GMA (or WSPA).

The *Water Act 1989* requires that all persons who wish to extract groundwater (except domestic and stock users) apply for a groundwater licence. Groundwater licences are issued to protect the rights of licence holders, ensure that water is shared amongst users, and to ensure that environmental requirements are protected. The Victorian Water Register was established as a public register of all water-related entitlements.

Within WSPAs, caps or moratoriums on the issue of additional extraction licenses are often present. Owing to the implications on groundwater development, Ministerial approval, including the development of management plans, were required to convert a GMA to a WSPA.

#### 6.3.2 Relevant groundwater management area

The study area does not fall within a recognised GMA. There are no moratoriums on the issue of new groundwater entitlements, however, groundwater licence applications would be subject to technical assessment and GMW determinations under the *Water Act 1989*.

The study area occurs within the GMW service area.

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## 6.4 Study area groundwater use

### 6.4.1 Data limitations

A search of DEECA's WMIS was completed to identify groundwater bores in the area and characterise groundwater use near the proposed site, as shown in Figure 9.

The following comments are made regarding the WMIS data:

- Bores installed prior to the proclamation of the original *Water Act 1969* may not be registered as there was no mandatory requirement to licence bores prior to this date.
- WMIS does not provide information regarding the operation status of the bores.
- Bores installed without a bore construction licence are unlikely to be registered on WMIS (unless detected by later audits).
- Many bores have not been surveyed for location. Bore locations registered were often those initially proposed on the bore construction licence application. In many instances drilling contractors could not gain access to these sites and final locations often have a positional accuracy greater than  $\pm 250$  m.
- The information registered on the WMIS is subject to the accuracy of the bore completion reports submitted by drilling contractors.
- Information registered on WMIS is subject to change since the completion of the bore e.g. water level information, pump setting depth, groundwater quality.
- Some information is not available on WMIS e.g. pump setting depth and bore ownership.

### 6.4.2 Bore use

A search identified 54 bores within an approximate 5 km radius from the boundary of the Project area. A breakdown of bore numbers by use type has been provided in Table 7, and their locations are shown in Figure 9.

Table 7 Summary of bore use and bore yield information

| Bore Use                  | Count     |
|---------------------------|-----------|
| Domestic and Stock        | 14        |
| Investigation/Observation | 28        |
| Non-Groundwater           | 7         |
| Not Known                 | 5         |
| <b>Total</b>              | <b>54</b> |

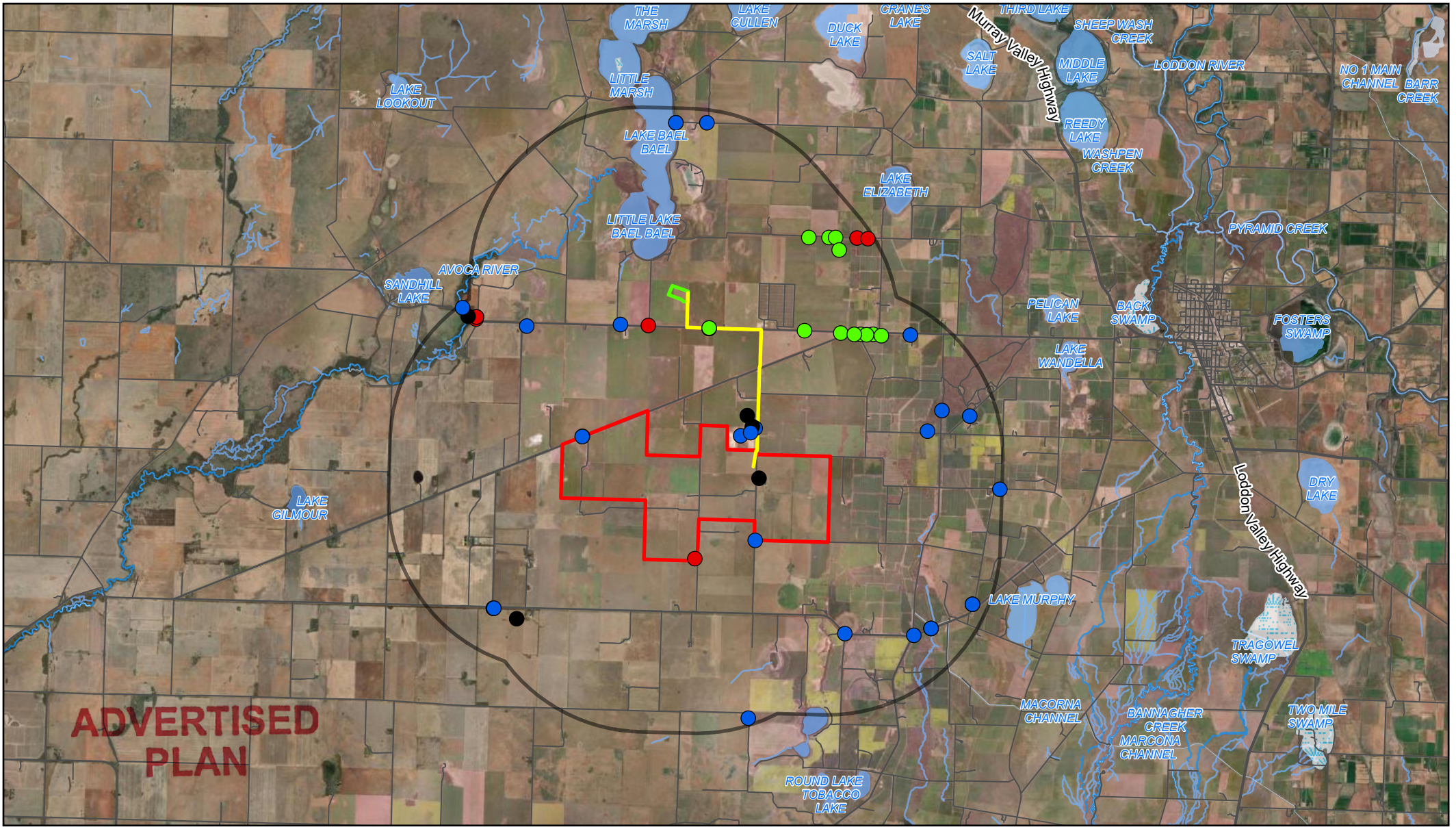
Only 14 bores with an abstractive use (stock and/or domestic) were identified. The majority of bores were drilled for investigation or observation purposes. These are likely associated with salinity investigation programs. Seven bores are classified as non-groundwater, and the remaining five bores are classified as unknown.

Figure 9 shows eight bores located within the Project area or at the site boundary.

- Nested SON Bores 71105 and 71106 are located directly on the northwestern boundary, along Kerang-Quambatook Road (refer to Section 6.7.3 for further details).
- Bore 311183, drilled to 154 m in 1980, and bore 311184, drilled to 130 m in 1981. Both bores are classified as being non-groundwater, i.e. mineral exploration.
- Bore 71098, bore 71099 and bore 71100 drilled in 1967, drilled to 13 m, 7 m and 15 m respectively. These bores are classified as being used for domestic/stock.
- Bore 71104, use unknown, the bore was drilled to 89 m in 1970. It possibly represents a groundwater investigation bore.
- Bore 6584, a groundwater investigation bore drilled in 1976 to 21 m depth. This is likely a salinity investigation bore.

Of relevance as potential groundwater data sources, a second nested site of SON bores (52363, 52364 and 52365) is located approximately 4 km southwest of the Project area. The understanding of bore use in the area provides an indication of groundwater levels and quality (such as salinity) within the Project area. If extraction for construction purposes is considered for this Project, this may provide an initial conceptualisation of the groundwater system and its current state. This information is also provided as part of assessing environmental values relevant to the Project Site further discussed in Section 6.6.

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- NMEP Site Boundary
- NMEP External
- Transmission Line Easement
- Koorangie Terminal Station
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Flat
- Lake
- Swamp
- River
- Stream

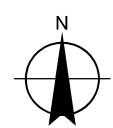
**Bore Use**

- Domestic and/or Stock
- Investigation/Observation
- Non Groundwater
- Not Known

Paper Size ISO A4

Kilometers

Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 54



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Surface Water and Groundwater Assessment  
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Project No. 31-12601890  
Revision No. 4  
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**Groundwater Users**

**FIGURE 9**

### 6.4.3 Bore depths

A histogram of the total depths for the bores within a 5 km radius of the Project area is shown in Figure 10. This indicates that the majority of bores are less than 25 m deep. Most of these are either shallow observation bores (including two dryland salinity observation bores), or stock/domestic bores.

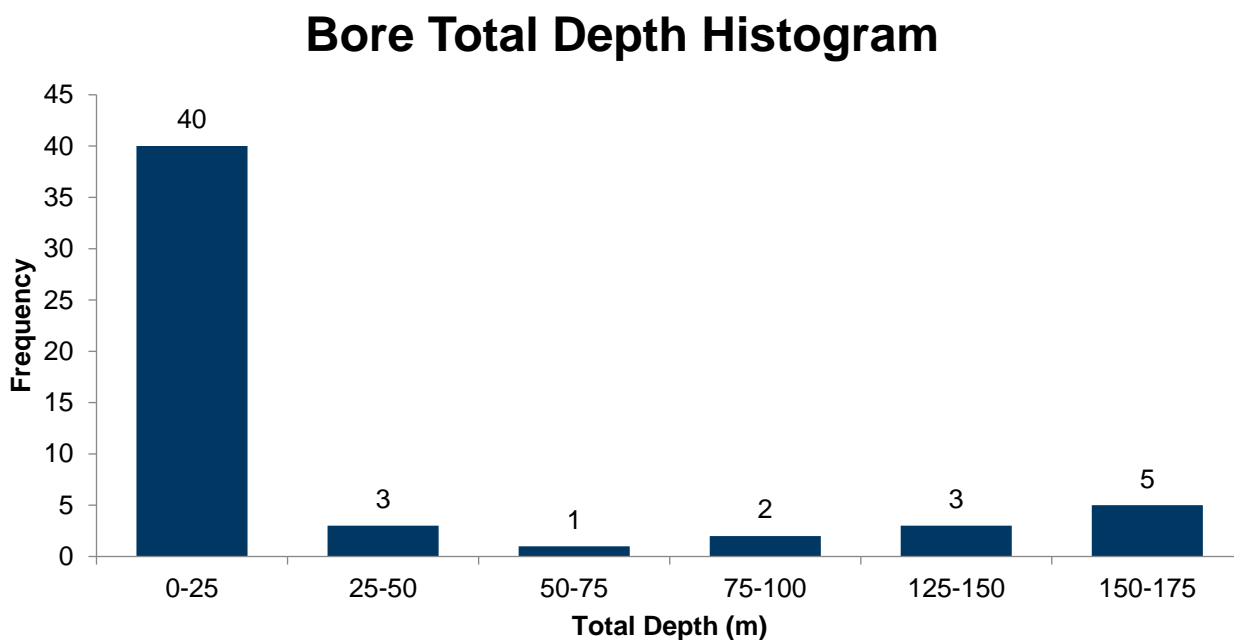


Figure 10 Bore Total Depth Histogram

## 6.5 Aquifer hydraulic parameters

### 6.5.1 Site specific

There were no site-specific aquifer testing investigations identified through this review.

An insight into the transmissivity of the aquifers can be gained from bore yield information. However, only one bore within the study area has yield information. This is SON bore 52363, located southwest of the Project site boundary and is screened between 126 m to 129 m, in the deeper Renmark Group.

### 6.5.2 Regional mapping

O'Rorke *et al.* (1992) documented a hydraulic conductivity range for the Parilla Sands of 1 m/day to 5 m/day.

## 6.6 Groundwater quality

### 6.6.1 Classification of groundwater

The *EP Act 2017* commenced on 1 July 2021 and has been described in Section 2.1, along with the ERS. The ERS (2020) provides that groundwater is categorised into segments, with each segment having particular identified values. The segments and their environmental values are summarised in Table 8.

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**Table 8** Protected environmental values and groundwater segments

| Environmental value                                 | Segment (TDS mg/l) |                   |                    |                    |                    |                     |                |
|---|--------------------|-------------------|--------------------|--------------------|--------------------|---------------------|----------------|
|   | A1<br>(0-600)      | A2<br>(601-1,200) | B<br>(1,201-3,100) | C<br>(3,101-5,400) | D<br>(5,401-7,100) | E<br>(7,101-10,000) | F<br>(>10,000) |
| Water dependent ecosystems and species              | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   | ✓              |
| Potable water supply (desirable)                    | ✓                  |                   |                    |                    |                    |                     |                |
| Potable water supply (acceptable)                   |                    | ✓                 |                    |                    |                    |                     |                |
| Potable mineral water supply                        | ✓                  | ✓                 | ✓                  | ✓                  |                    |                     |                |
| Agriculture and irrigation (irrigation)             | ✓                  | ✓                 | ✓                  |                    |                    |                     |                |
| Agriculture and irrigation (stock watering)         | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   |                |
| Industrial and commercial use                       | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  |                     |                |
| Water-based recreation (primary contact recreation) | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   | ✓              |
| Traditional Owner cultural values                   | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   | ✓              |
| Buildings and structures                            | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   | ✓              |
| Geothermal properties                               | ✓                  | ✓                 | ✓                  | ✓                  | ✓                  | ✓                   | ✓              |

Note: TDS – Total Dissolved Solids (mg/L). Source ERS (2020).

## 6.6.2 Groundwater quality indicators and objectives

The indicators and objectives for groundwater, for each environmental value have been summarised in Table 9. The environmental values may not apply to groundwater if:

- There is insufficient aquifer yield to sustain the environmental value, having regard to variations within the aquifer and reasonable bore development techniques to improve yield
- The application of that groundwater, such as for irrigation, may be a risk to the environmental values of land or the broader environment due to the soil properties
- The background water quality level exceeds (or is less than, in the case of indicators such as pH, dissolved oxygen and many biological indicators) the relevant objective specified in Table 9 and as a result the environmental value cannot be achieved

**Table 9** Groundwater indicators and objectives

| Environmental value  | Indicators  | Objectives  |
|--|---|---|
| Water dependent ecosystems and species (in surface waters)   | For groundwater that discharges to surface water, the indicators are the indicators applicable to the relevant surface water as specified in Division 3 of Part 5 of the ERS            | The level that ensures the groundwater does not affect receiving waters to the extent that the level of any indicator in the receiving waters: <ul style="list-style-type: none"> <li>– Exceeds the level of that indicator (if specified as an upper limit)</li> <li>– Is less than the level of that indicator (if specified as a lower limit)</li> <li>– Specified for surface water in Division 3 of Part 5 of the ERS</li> </ul> |
| Water dependent ecosystems and species (in subterranean waters with a hydrogeological setting conducive to the presence of troglofauna and stygofauna) | Indicators that are relevant to the subterranean species of troglofauna and stygofauna, which may include TSS, salinity, toxicants in water, toxicants in sediment and dissolved oxygen | The level that ensures the groundwater quality does not adversely affect the troglofauna and stygofauna that depend on the groundwater.   |

| Environmental value                         | Indicators   | Objectives  |
|---|--|---|
| Potable water supply                        | Indicators specified in the ADWG   | Health-related guideline value for each indicator specified in the ADWG.<br>Aesthetic guideline value for each indicator specified in the ADWG. |
| Potable mineral water supply                | Indicators specified in the ADWG   | Health guideline values for each indicator specified in the ADWG.<br>Aesthetic guideline values for each indicator set out in the ADWG.         |
| Agriculture and irrigation (irrigation)     | Indicators specified for irrigation and water for general on-farm use in the ANZG  | Level of that indicator specified in the ANZG   |
| Agriculture and irrigation (stock watering) | Indicators specified for livestock drinking water quality in the ANZG  | Level of that indicator specified in the ANZG   |
| Industrial and commercial                   | Indicators specific to the particular industrial or commercial activity and their use of water   | Groundwater quality that is suitable for its industrial or commercial use   |
| Water-based recreation                      | E. coli  | 10 E. coli/100mL (if no human faecal contamination sources identified)<br>0 E. coli/100mL (if human faecal contamination sources identified)    |
|   | Chemical hazards, aesthetic effects  | Level of indicators (where specified) and descriptions in applicable guidance, in the Recreational Water Guidelines                             |
| Buildings and structures                    | pH, sulphate, chloride, redox potential, salinity or any chemical substance or waste that may have a detrimental impact on the structural integrity of buildings or other structures | Groundwater that is not corrosive to or otherwise adversely effecting structures or building  |
| Geothermal                                  | Temperature between 30°C and 70°C.   | Geothermal properties of groundwater to be maintained for current and future users of the resource  |

Note: ANZG - means the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)

The background water quality level is the objective for an indicator if:

- The objective is not able to be attained due to the background water quality level of that indicator
- The background water quality level better protects the environmental values than the objective specified in Table 9

The ERS (2021) requires that occupational health and safety, odour and amenity also be considered, due to the fact that vapours sourced from impacted groundwater may present a potential risk to workers, and that odours or discolouration may result in degradation of overall environmental values of groundwater.

## 6.6.3 Background salinity

### 6.6.3.1 Onsite bores

Inferred Renmark Group aquifer SON bores 71105 and 71106 located on the northwestern boundary along Kerang-Quambatook Road each have a single salinity measurement of 22,033 mg/L TDS and 29,441 mg/L TDS respectively. However, both measurements were recorded in 1988.

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### **6.6.3.2 Regional mapping**

The water table aquifer (Parilla Sand) of the study area is reported to be saline, with salinity in excess of 14,000 mg/L TDS. Salinity within the deeper aquifer system (Renmark Group) can be fresher and below 1,500 mg/L TDS. O'Rorke et al (1992) provided a regional interpretation of the salinity of the water table aquifer system, which has been reproduced in Figure 11.

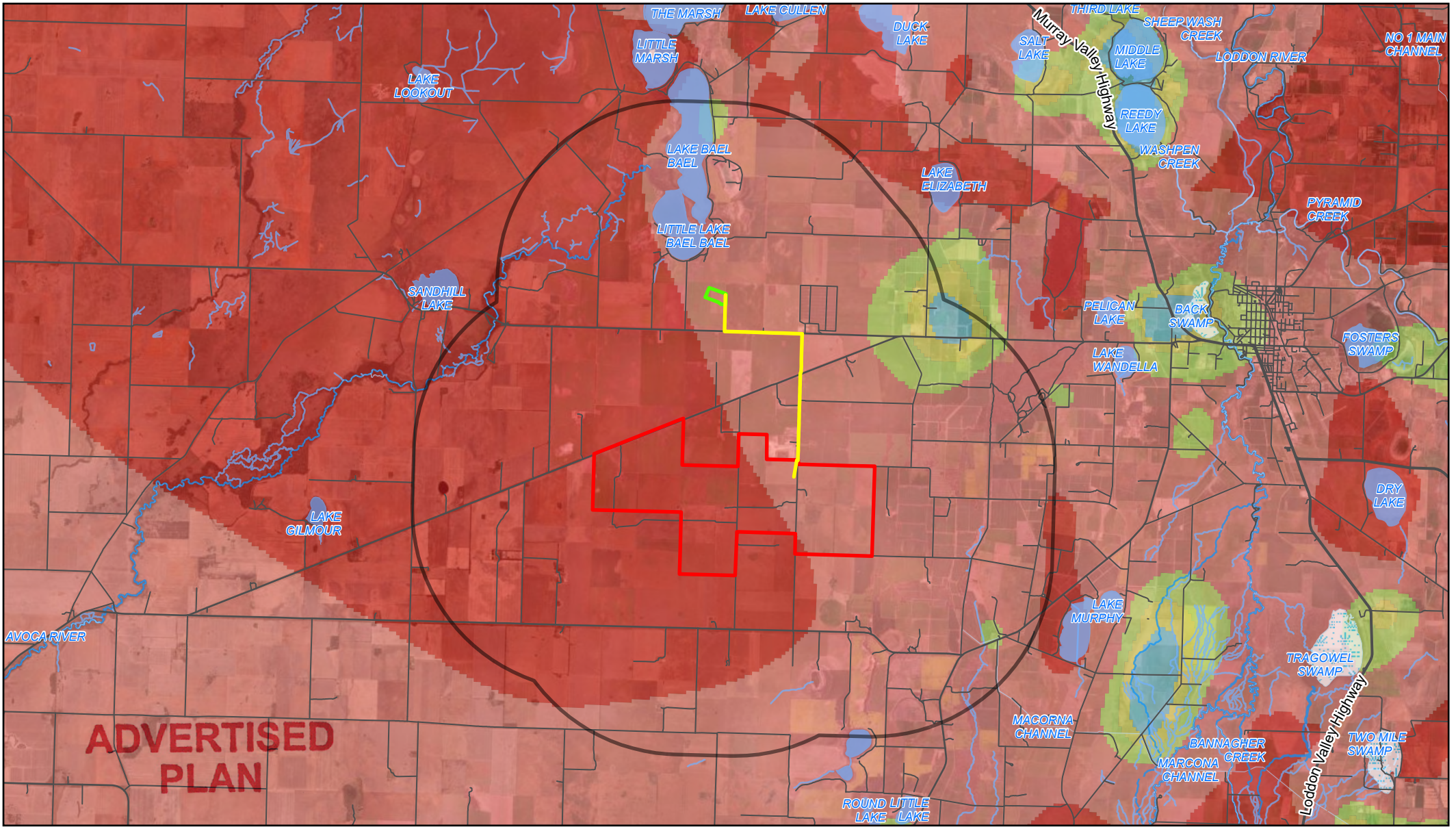
### **6.6.3.3 Neighbouring bores**

There was a paucity of salinity data available from the DEECA's WMIS for all bores located within a 5 km radius of the Project area. The available information confirmed the regional mapping, with salinities over 18,000 mg/L TDS.

## **6.6.4 Protected environmental values**

Based on available salinity data, groundwater quality needs to be maintained to protect all the environmental values as per segment F (refer to Section 6.6.1).

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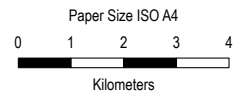
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- NMEP Site Boundary
- NMEP External Transmission Line Easement
- Koorangie Terminal Station
- 5km Buffer Boundary

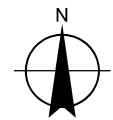
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp

- River
- Stream

- Water table - salinity (mg/l)
- 0 - 500
  - 500 - 1000
  - 1000 - 3500
  - 3500 - 7000
  - 7000 - 13000
  - 13000 - 35000
  - 35000 - 100000



Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 54



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**Surface Water and Groundwater Assessment  
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Project No. 31-12601890  
Revision No. 4  
Date 19/11/2024

**Water Table Salinity**

**FIGURE 11**

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## 6.6.5 Environmental values

A discussion of the existing environmental values of groundwater and their relevance to the proposed development has been provided Table 10.

Table 10 Discussion of environmental values

| Environmental value                                 | Existing Use   | Relevance  |
|---|--|--|
| Water dependent ecosystems and species              | Yes<br>(Avoca River, Little Lake Bael Bael, Lake Bael Bael and wetland area) | <b>Relevant</b><br>Groundwater quality must be maintained to protect aquatic ecosystems at the point of groundwater discharge.<br>Little Lake Bael Bael (Approximately 4.4 km north of site boundary), Lake Bael Bael (5.5 km north of site boundary) <sup>1</sup> , Avoca River (2.5 km northwest of site boundary), and unnamed wetland areas (roughly 3 km east of the site boundary) will be the nearest receptor, and the ERS (2020) indicates that they fall within the Murray and Western Plains segment which is a slightly to moderately modified water dependent ecosystem. Given that groundwater levels are interpreted to be deep (~20 m across the majority of the site), the likelihood of interaction local to the Project area is low, but uncertain. |
| Potable water supply (desirable)                    | No   | <b>Not relevant</b><br>Bores with a domestic use have been identified in the study area, however, these tend to be located near the Avoca River where fresher recharge and lower salinity groundwater may be present. Underlying the site, the water table aquifer is too saline for potable applications, without treatment (desalination).<br>Groundwater salinity is considered too high to support this value and therefore it is considered not relevant as an environmental value.   |
| Potable water supply (acceptable)                   | No   |  |
| Potable mineral water supply                        | No   | <b>Not relevant</b><br>The groundwater is not within a recognised mineral water province and is not known to display properties desirable in a mineral water e.g. spritzig or effervescence. There is a limited likelihood of groundwater being used for this purpose.   |
| Agriculture and irrigation (irrigation)             | No   | <b>Not relevant</b><br>Bores with an irrigation use have not been identified within the study area. The regional groundwater salinity is too saline for irrigation applications without treatment (desalination). This is not considered to be an environmental value of groundwater locally.  |
| Agriculture and irrigation (stock watering)         | Possibly   | <b>Relevant</b><br>Nearby stock bores have been identified; however, it is noted that groundwater salinity locally to the Project area is generally only suitable for the more salt tolerant species such as sheep and goats. Based on regional mapping, the western parts of the site are likely to have groundwater that is too saline for even the salt tolerant species. Use of groundwater for livestock watering is consistent with the surrounding land uses. This is a relevant environmental value.   |
| Industrial and commercial use                       | No   | <b>Not relevant</b><br>No existing bores with a commercial or industrial use were identified. The use of groundwater for industrial activities may be constrained by the groundwater quality (elevated salinity). However, it could be used in the future, subject to the type of industry. This is considered a relevant environmental value.   |
| Water-based recreation (primary contact recreation) | Yes  | <b>Relevant</b><br>There are a number of waterways near to the study area including Avoca River.   |

<sup>1</sup> For consistency, the distance referring to Little Lake Bael Bael and Lake Bael Bael will refer to the distance between the northern most point of the red site boundary intersecting at Kerang-Quambatook Road and the southern bank of Little Lake Bael Bael, i.e. approximately 4.4 km.

| Environmental value               | Existing Use | Relevance   |
|-----------------------------------|--------------|---|
| Traditional Owner cultural values | Yes          | <b>Relevant</b><br>A review of Victoria's Registered Aboriginal Parties ( <a href="http://achris.vic.gov">achris.vic.gov</a> ) indicates that traditional owners have not been formally recognised for the Project area and wider surroundings. It is noted that WestWind has engaged directly with First People's Organisation due to the absence of a RAP in the area. Such engagement included project introductions and description of cultural heritage values in the Project area. No engagement with the local traditional owners has been undertaken as part of this desktop work by GHD. In the absence of such engagement, it has been assumed that protection of groundwater that discharges into nearby waterways is required to maintain traditional owner cultural values and will be managed directly by WestWind for the Project. |
| Buildings and structures          | No           | <b>Not Relevant</b><br>There are some buildings, including residential properties, located in the region, however these are assumed to have shallow foundations. Based on regional mapping, water levels tend to be roughly 10 m to 20 m below the surface, which suggests a limited likelihood of interaction with these structures at least locally to the Project area.  |
| Geothermal properties             | No           | <b>Not relevant</b><br>The groundwater is too shallow to have an elevated temperature and therefore this value is not considered a relevant environmental value to be protected at the site.  |

## 6.7 Groundwater potentiometry

### 6.7.1 Site monitoring

There are eight existing bores that fall on/within the boundary of the Project area (refer Figure 12), however, only three bores (6584, 71105, 71106) has available groundwater level monitoring data. The monitoring record for these bores is shown in Figure 12. The following observations are made:

- Bore 6584 inferred as screening the water table aquifer has groundwater levels between 17 m to 20.8 m below ground level (bgl). Figure 12 shows a general rising groundwater level trend. The steep rise in 2012 is unusual and possibly represents an issue with the monitoring response.
- Bore 71105 inferred as screening the Renmark Group aquifer and has groundwater levels ranging between 12.51 m to 13.25 m bgl. Figure 12 shows a general rise in water level, peaking in 2004, before a general decrease in water level to present date.
- Bore 71106 inferred as screening the Renmark Group aquifer and has groundwater levels ranging between 11.19 m to 11.69 m bgl. Figure 12 shows a general rise in water level, peaking in 2004, before a general decrease in water level to 2010. An abrupt rise in water level is recorded in 2010, followed by a general gentle decrease, and then another abrupt rise in water level in 2023. The unusual abrupt rises may be representative of an issue with the monitoring response.

Note that only bore 6584 is inferred to screen the water table aquifer, and therefore water levels in bore 6584 are most relevant to the Project.

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# ADVERTISED PLAN

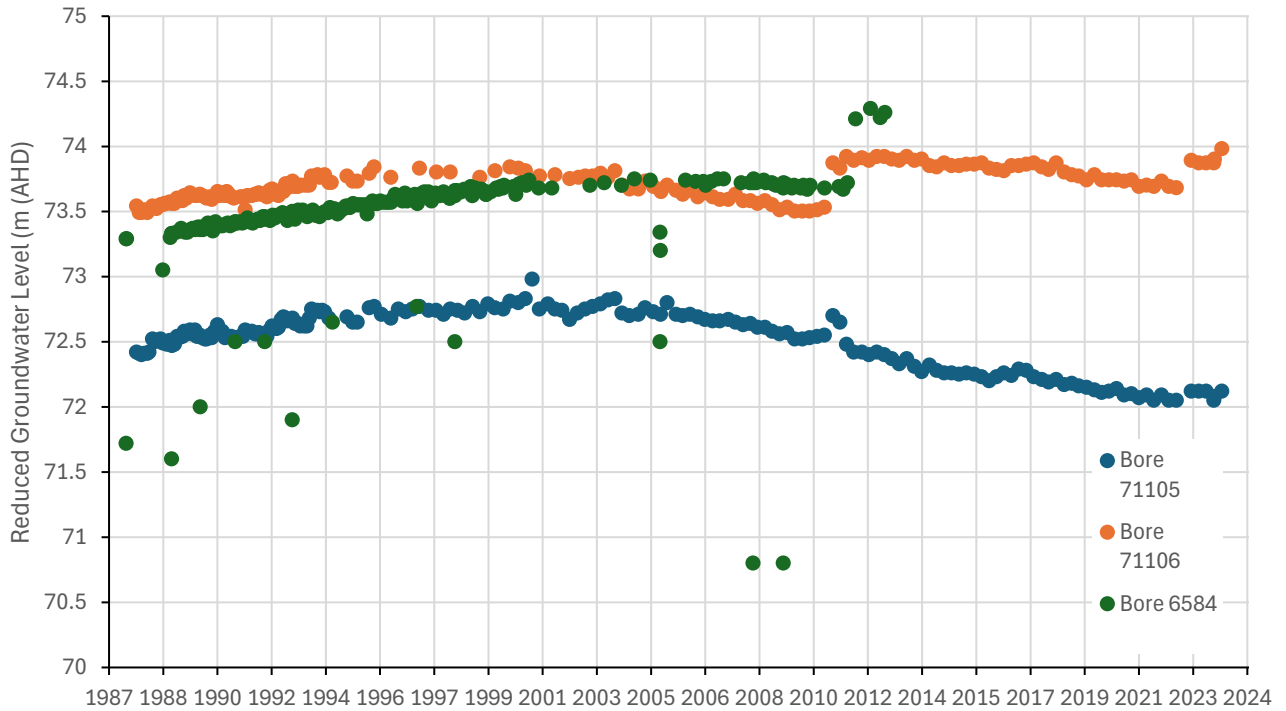


Figure 12 Hydrograph for bores 6584, 71105 and 71106

## 6.7.2 Regional mapping

Regional depth to water mapping is available from DEECA and has been reproduced in Figure 13. The depth to water is interpreted to be approximately 10 m to 20 m bgl, with shallower depths occurring in the northern and eastern boundaries of the Project area (<10 m bgl), and in the vicinity of the Koorangie Terminal Station.

## 6.7.3 State observation bores

A search was undertaken to identify SON bores near to the Project area as these can have time-series water level monitoring data. Based upon records contained on the DEECA WMIS, five active SON bores were identified within the study area and their locations have been shown in Figure 14.

The bores are located in two nested groups located on the northwestern boundary along Kerang-Quambatook Road, and approximately 4.5 km southwest of the Project area. A summary of available information has been provided in Table 11.

Table 11 SON Bore summary

| Item                            | North Nested Site |           | Southwest Nested Site |           |           |
|---------------------------------|-------------------|-----------|-----------------------|-----------|-----------|
|                                 | 71105             | 71106     | 52363                 | 52364     | 52365     |
| Easting (m)                     | 746112.7          | 746105.0  | 743525.8              | 743534.4  | 743543.7  |
| Northing (m)                    | 6038740.6         | 6038735.8 | 6033760.8             | 6033759.1 | 6033763.2 |
| Date constructed                | 1987              | 1987      | 1987                  | 1988      | 1988      |
| Total depth (m)                 | 137.19            | 75        | 154.82                | 70        | 12.5      |
| Elevation Top of casing (mAHD)  | 85.30             | 85.17     | 96.66                 | 96.87     | 96.95     |
| Elevation Ground Surface (mAHD) | 84.73             | 84.55     | 96.26                 | 96.37     | 96.95     |
| Screen from                     | 110.9             | 63        | 126                   | 55        | 5         |
| Screen to                       | 114               | 69        | 129                   | 58        | 10        |

| Item                           | North Nested Site |            | Southwest Nested Site |            |              |
|--------------------------------|-------------------|------------|-----------------------|------------|--------------|
|                                | 71105             | 71106      | 52363                 | 52364      | 52365        |
| Screen lithology               | SAND              | SAND       | SAND                  | SAND/COAL  | SAND         |
| Hydrostratigraphic unit        | Renmark Fm        | Renmark Fm | Renmark Fm            | Renmark Fm | Parilla Sand |
| Monitoring record from         | 1987              | 1987       | 1988                  | 1988       | 1988         |
| Monitoring record to           | 2024              | 2024       | 2024                  | 2024       | 2012         |
| RLWT from                      | 72.05             | 73.49      | 72.80                 | 72.93      | DRY          |
| RLWT to                        | 72.98             | 73.98      | 73.39                 | 73.74      | DRY          |
| Number of Water level readings | 193               | 180        | 179                   | 178        | 121          |
| Groundwater Quality TDS (mg/L) | 22,033            | 29,441     | 567                   | 21,051     | 1,413        |

Note:

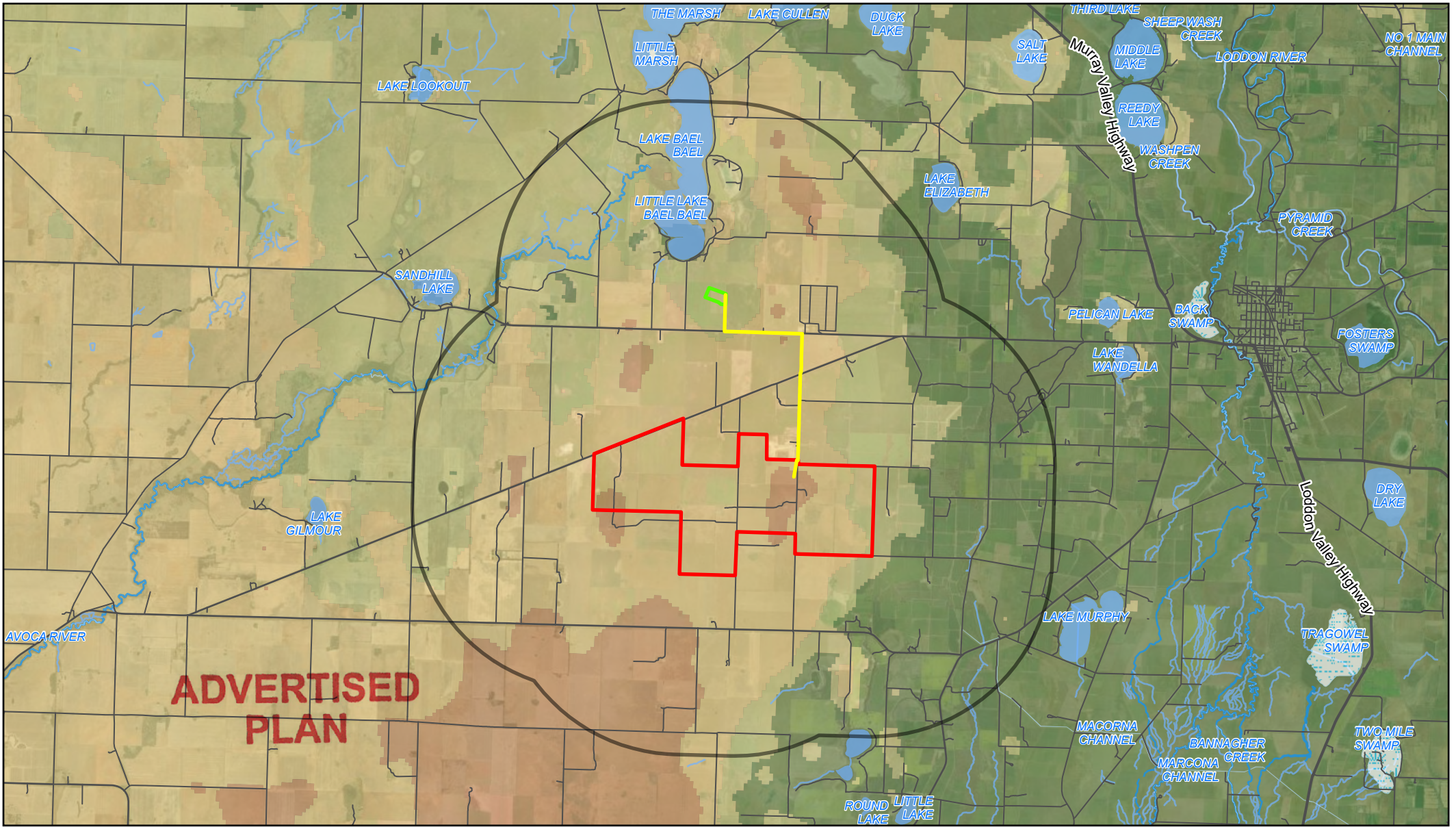
TOC – Top of Casing, GS – Ground Surface, TDS – Total Dissolved Solids, AMG – Australian Map Grid, AHD – Australian Height Datum, UKN - Unknown.

Coordinates GDA94 MGA55

Renmark Gp = Renmark Group (Lower Tertiary), Parilla Sand (Upper Tertiary)

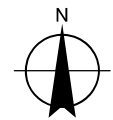
With the exception of bore 52365, the SON bores develop the deeper Renmark Group aquifer system. Therefore, their groundwater level responses do not reflect conditions within the water table aquifer but rather an aquifer that is typically greater than 50 m bgl. A hydrograph for bores 71105 and 71106 located on the site boundary is provided as Figure 12. Hydrographs for the remaining SON bores have not been produced due to proximity and inferred screening within the Renmark Group aquifer system.

**ADVERTISED  
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- ▬ NMEP Site Boundary
- ▬ NMEP External Transmission Line Easement
- ▭ Koorangie Terminal Station
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp
- 5
- 10
- 20
- 50
- 100

Paper Size ISO A4  
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 Kilometers  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 54

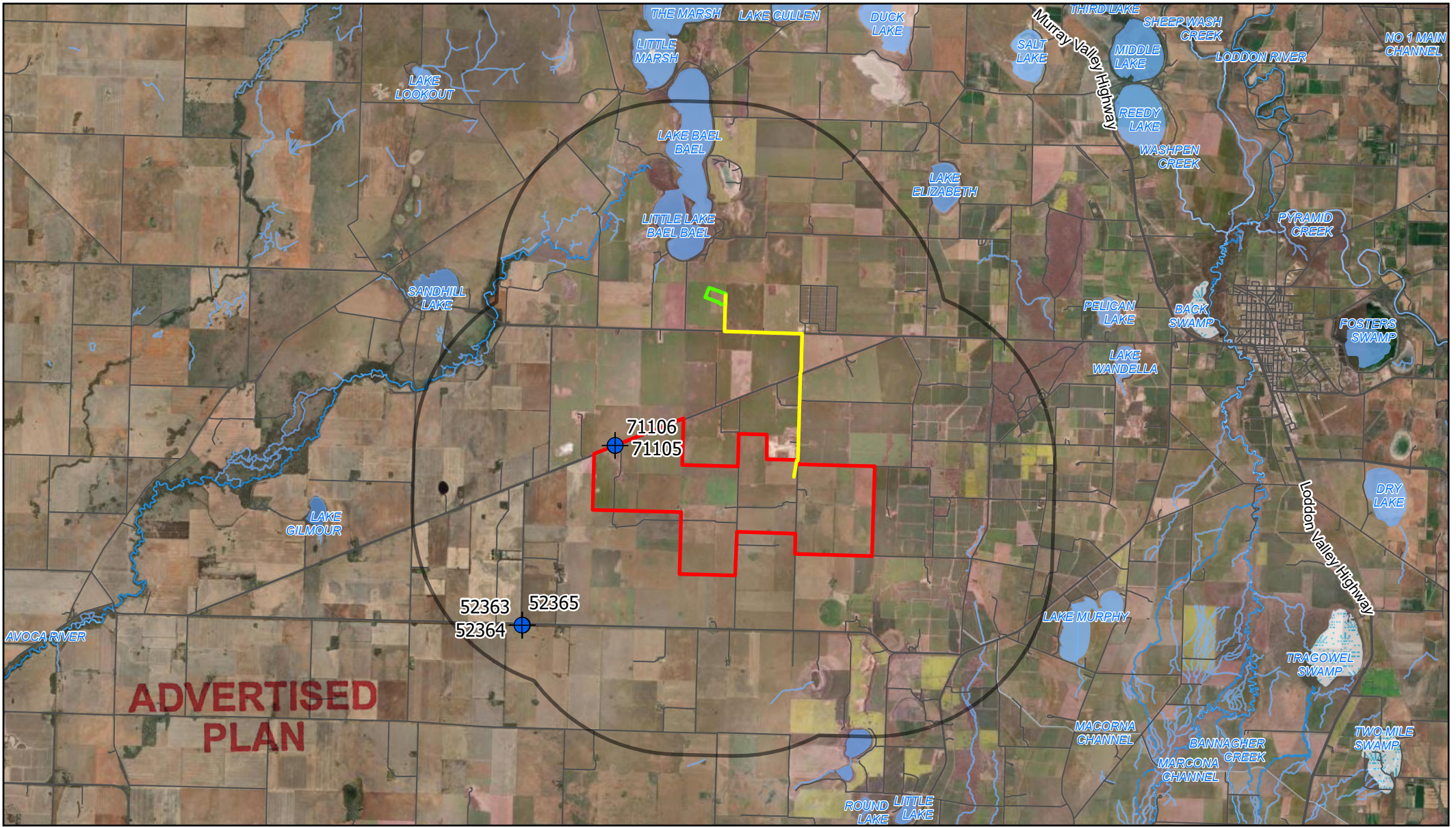


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Project No. 31-12601890  
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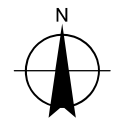
**Water Table Depth**

**FIGURE 13**



- ▭ NMEP Site Boundary
- ▭ NMEP External Transmission Line Easement
- ▭ Koorangie Terminal Station
- ⊕ Bores
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp
- River
- Stream

Paper Size ISO A4  
 0 1 2 3 4  
 Kilometers  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 54



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 of the Normanville Energy Park  
**State Observation Network  
 Monitoring Bores**

Project No. 31-12601890  
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**FIGURE 14**

## 6.8 Groundwater dependent ecosystems

### 6.8.1 Definition

A GDE is an ecosystem which has its species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC, 1996). That is, they are natural ecosystems that require access to groundwater to meet all (obligatory) or some (facultative) of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. If the availability of groundwater to GDEs is reduced, or if the quality is allowed to deteriorate, these ecosystems are impacted.

Not all GDEs draw upon groundwater directly and not all are solely reliant upon groundwater. In many cases groundwater commonly provides an important and reliable source of water to many ecosystems and can be the primary factor in controlling the distribution of ecosystem types. GDEs can depend upon the surface or subsurface expression of groundwater. In Australia, six types of GDEs have been identified:

- Terrestrial vegetation that relies upon the availability of shallow groundwater. Terrestrial vegetation such as trees and woodlands may be supported seasonally or permanently by groundwater. These may comprise shallow or deep-rooted communities that use groundwater to meet some or all of their water requirements. Animals may depend on this vegetation and therefore indirectly depend on groundwater. Groundwater quality generally needs to be high to sustain vegetation growth.
- Wetlands such as paperbark swamp forests and mound springs. These sites may be permanent or ephemeral systems that receive seasonal or continuous groundwater contribution to water ponding, groundwater discharge, or shallow water tables.
- River baseflow systems where groundwater discharge provides a significant baseflow component to the river. Interaction would depend on the nature of stream bed and underlying aquifer material and the relative water level heads in the aquifer and the stream.
- Aquifer and cave ecosystems, where life exists independent of sunlight, e.g. stygofauna and troglofaunal. These ecosystems can reside within a groundwater resource.
- Terrestrial fauna (native and introduced) that rely upon groundwater as a source of drinking water.
- Estuarine and near-shore marine systems, e.g. coastal mangroves, salt marshes and sea-grass beds, which rely upon the submarine discharge of groundwater.

### 6.8.2 GDEs in study area

The National Groundwater Dependent Ecosystem Atlas (BOM, 2012) was interrogated to identify potential GDEs within the study area. Interpreted aquatic GDEs and terrestrial GDEs are shown in Figures 15 and 16 respectively.

There are no aquatic GDEs located within the Project area, based upon the regional data presented by the BOM. The nearest surface water body to the site is Little Lake Bael Bael, located approximately 4.4 km north of the site, and is classified as a wetland area. Little Lake Bael Bael is located approximately 1.3 km north west of the northern extent of the transmission line easement and Koorangie Terminal Station footprint.

There are no terrestrial GDEs located within the Project area, however, there are a number of scattered woodland areas to the east of the Project area. No known terrestrial GDEs occur along the transmission line easement or within the provided Koorangie Terminal Station footprint (refer to Figure 2). Only two small isolated patches of Woorinen Mallee (moderate potential from national assessment) occur on the northern side of Lalbert-Kerang Road, on and adjacent to the transmission line easement. Surrounding the transmission line easement, along two sections of Lalbert-Kerang Road, small areas of Woorinen Mallee and Ridged Plains Mallee vegetation are present. An isolated patch of Ridge Plains Mallee vegetation is also present north of Kerang-Quambatook Road.

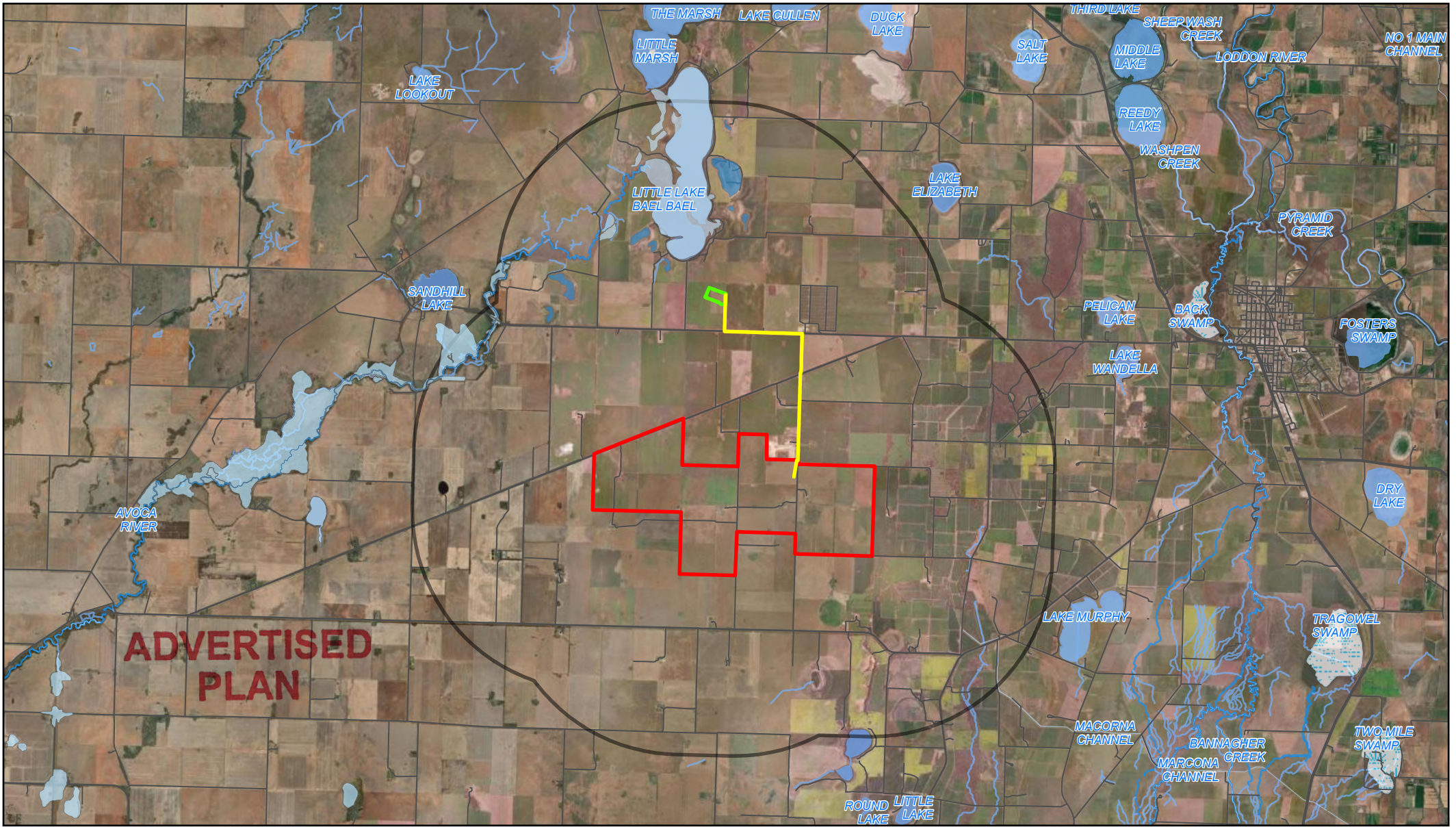
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PLAN**

The presence of stygofauna is relatively unknown in Victoria and GHD is not aware of any publicly available, mapped datasets for the state. Hose *et al* (2015) documented factors that determine the presence of stygofauna, which include:

- Aquifers with large (mm or greater) pore spaces
- The abundance and diversity of stygofauna typically decrease with depth below ground (i.e. generally <100 m)
- Aquifers with fresh to brackish water, generally with salinities <5,000  $\mu\text{S}/\text{cm}$
- Aquifers rich in oxygen, i.e. >0.3 mg/L dissolved oxygen
- Stygofauna are more abundant in areas of surface water – groundwater exchange, compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge

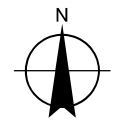
The potential for stygofauna to be present in the study area is considered to be constrained by the nature of the aquifer materials, which can be fine grained, as well as the elevated groundwater salinity.

**ADVERTISED  
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- NMEP Site Boundary
- NMEP External Transmission Line Easement
- Koorangle Terminal Station
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp
- River
- Stream
- Known GDE
- High potential GDE
- Moderate potential GDE
- Low potential GDE
- Unclassified potential GDE

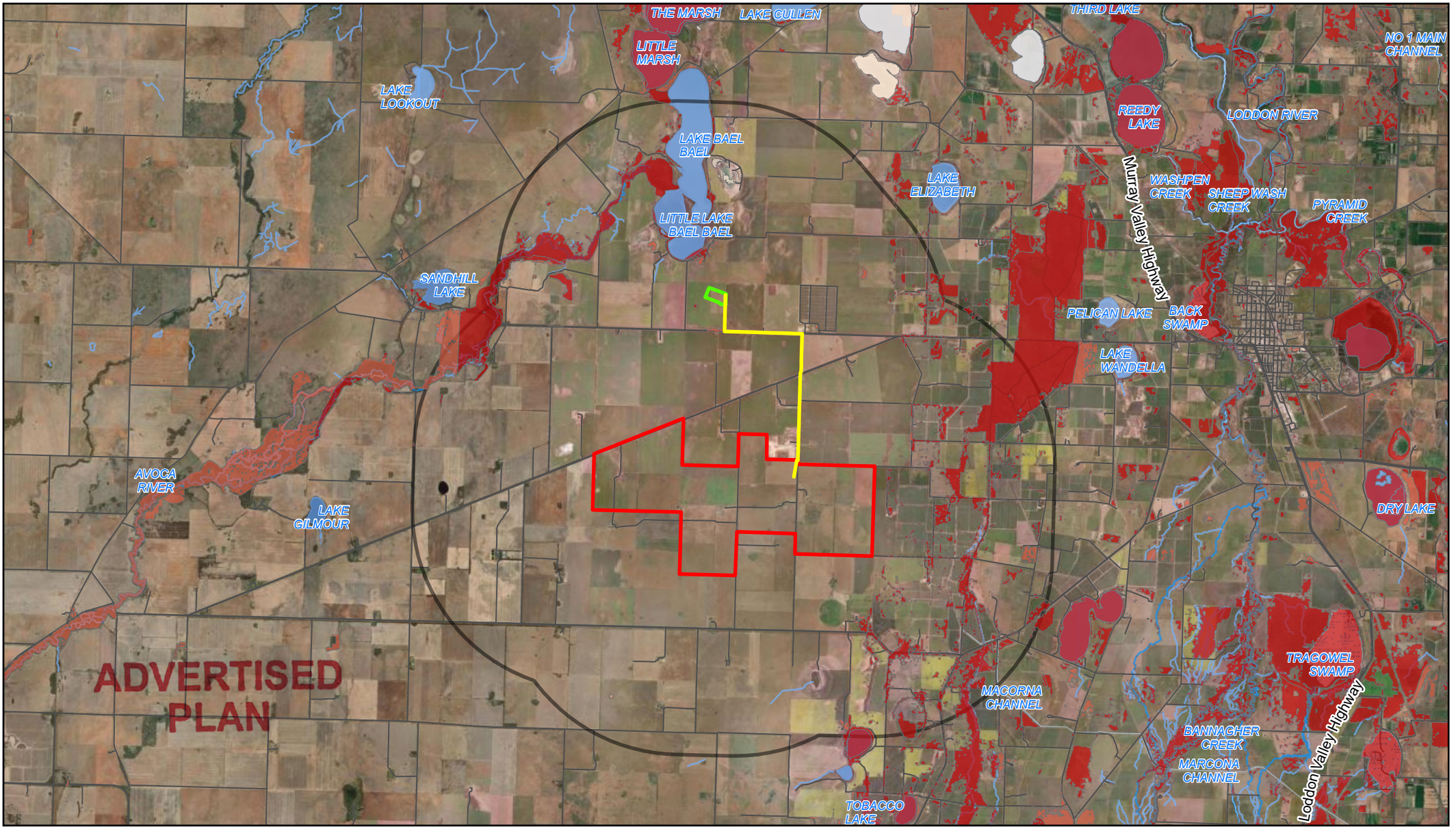
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 Grid: GDA2020 MGA Zone 54



**Normanville Energy Park Pty Ltd (NMEP)**  
**Surface Water and Groundwater Assessment of the Normanville Energy Park**  
**Aquatic Groundwater Dependent Ecosystems**

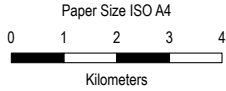
Project No. 31-12601890  
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**FIGURE 15**

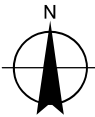


**ADVERTISED PLAN**

- |  |           |             |                            |
|--|-----------|-------------|----------------------------|
| NMEP Site Boundary                       | Highway   | River       | High potential GDE         |
| NMEP External Transmission Line Easement | Arterial  | Stream      | Moderate potential GDE     |
| Koorangie Terminal Station               | Collector | Watercourse | Low potential GDE          |
| 5km Buffer Boundary                      | Lake      | Swamp       | Unclassified potential GDE |



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 54



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**Surface Water and Groundwater Assessment of the Normanville Energy Park**  
**Terrestrial Groundwater Dependent Ecosystems**

Project No. 31-12601890  
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 Date 19/11/2024

**FIGURE 16**

## 6.9 Potential acid sulfate soils

### 6.9.1 Definition

Acid sulfate soils are soils, sediments, unconsolidated geological material or disturbed consolidated rock mass that contain elevated concentrations of the metal sulfide. It occurs principally in the form of pyrite (iron sulphide). These soils can be rich in organics and were formed in low oxygen or anaerobic depositional environments.

The soils are stable when undisturbed or located below the water table. However, when oxygen is introduced, the sulphides oxidise to sulphate, with resultant soils having low pH and potentially high concentrations of heavy metals.

Groundwater levels may rise as a result of recovery from construction dewatering activities or leaching of infiltrating rainfall through the sulphate rich zones. This can result in oxidisation of materials and the mobilisation of pH and heavy metals into the environment where they can potentially impact deep-rooted vegetation, aquatic flora and fauna, and can be aggressive to reactive materials (such as concrete, steel) of foundations, underground structures (such as piles, pipes, basements) or buried services in contact with groundwater. It can also result in the discharge of acid groundwater to receiving surface water systems.

The occurrence of acid sulfate soil can be present in the form of:

- Potential Acid Sulfate Soil (PASS) – Soil that contains unoxidised metal (iron) sulfides. This is usually in oxygen free or waterlogged conditions. When exposed to oxygen through drainage or disturbance, these soils produce sulfuric acid.
- Actual Acid Sulfate Soil (AASS) – Potential acid sulfate soil that has been exposed to oxygen and water and has generated acidity.

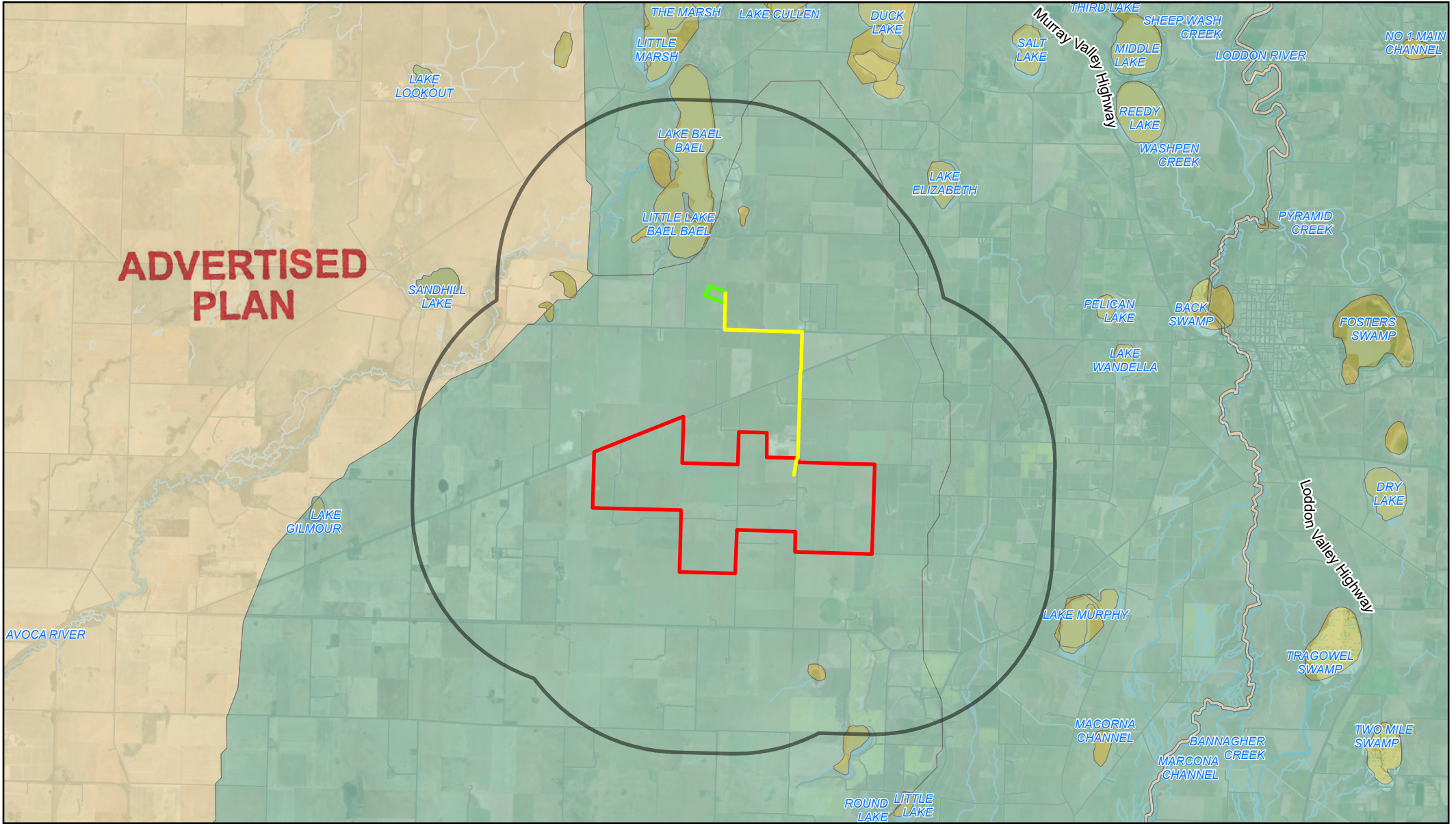
There are two main pathways for the activation of acid sulfate soil to form groundwater impacts:

- Excavation of PASS soils above the water table and their management, such as acid run-off from stockpiles and treatment areas, filling, handing of spoil from excavations.
- Dewatering required as part of the construction of features below the water table. Such is unlikely to be required by the Project.

### 6.9.2 Potential in study area

CSIRO's Atlas of Australian Acid Sulfate Soils was interrogated, and the results are shown in Figure 17. The mapping indicates that the site and surrounds have an extremely low probability and very low confidence of acid sulfate soils occurring.

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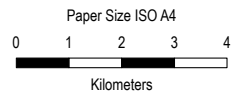


# ADVERTISED PLAN

- ▬ NMEP Site Boundary
- ▬ NMEP External Transmission Line Easement
- ▬ Koorangie Terminal Station
- 5km Buffer Boundary
- Highway
- Arterial
- Collector
- Watercourse
- Lake
- Swamp
- River
- Stream

**Acid Sulfate Soil Classification**

- A4 High Probability/very Low Confidence
- B4 Low Probability/Very Low Confidence
- C4 Extremely Low Probability/Very Low Confidence



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 54



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**Surface Water and Groundwater Assessment**  
**of the Normanville Energy Park**

Project No. 31-12601890  
 Revision No. 4  
 Date 19/11/2024

## Potential Acid Sulfate Soils

## FIGURE 17

# ADVERTISED PLAN

## 6.10 Conceptual hydrogeological model

A hydrogeological conceptualisation has been prepared to aid the description and understanding of the groundwater related processes that could be occurring on the site.

The conceptualisation is a tool that formalises an understanding of the major components of a hydrogeological system, their interaction and how external changes can modify the system. They can often be a highly simplified way of expressing what is known about a system and can assist in defining (and/or testing hypotheses regarding) the critical components that make up the structures, processes and interactions, the relationships of cause and effect, and more generally, how a system works.

The information gathered during this assessment has been synthesised to generate a conceptual hydrogeological model (CHM) of the project study area. Each aspect of this model is described below and depicted diagrammatically in Figure 18. The section has been orientated east to west through the Project area. The section is not to scale, as the Avoca River lies approximately 10 km to the west of the Project area.

The basal sequence of the Murray Basin sediments is the Renmark Group which comprises sands, silts, clays, and coals. It is likely to lie around 60 m or more below the ground surface. Groundwater resource reports sourced from DEECA, suggest that the Renmark Group is hydraulically isolated from the above Parilla Sands by an aquitard system of Lower-Mid Tertiary clays, silt, siltstone, and marl. However, available groundwater level information for the Renmark Formation and Parilla Sands indicates that their potentiometry can be similar.

Based on the Murray Darling Basin Hydrogeological Map Series (Swan Hill 1:250,000) mapsheet, the section shows there is a thin layer of aeolian fine to medium grained dune sands of the Lowan Formation to the northwest of the Project area. Outcrops of Shepparton Formation fluvial silt, sand and minor gravel are shown to outcrop at the Avoca River to the west and to the east of the Leaghur Fault. The Leaghur Fault is interpreted to have occurred early in the Pliocene (Upper Tertiary) and its surface expression is largely absent owing to further deposition of the Shepparton Formation.

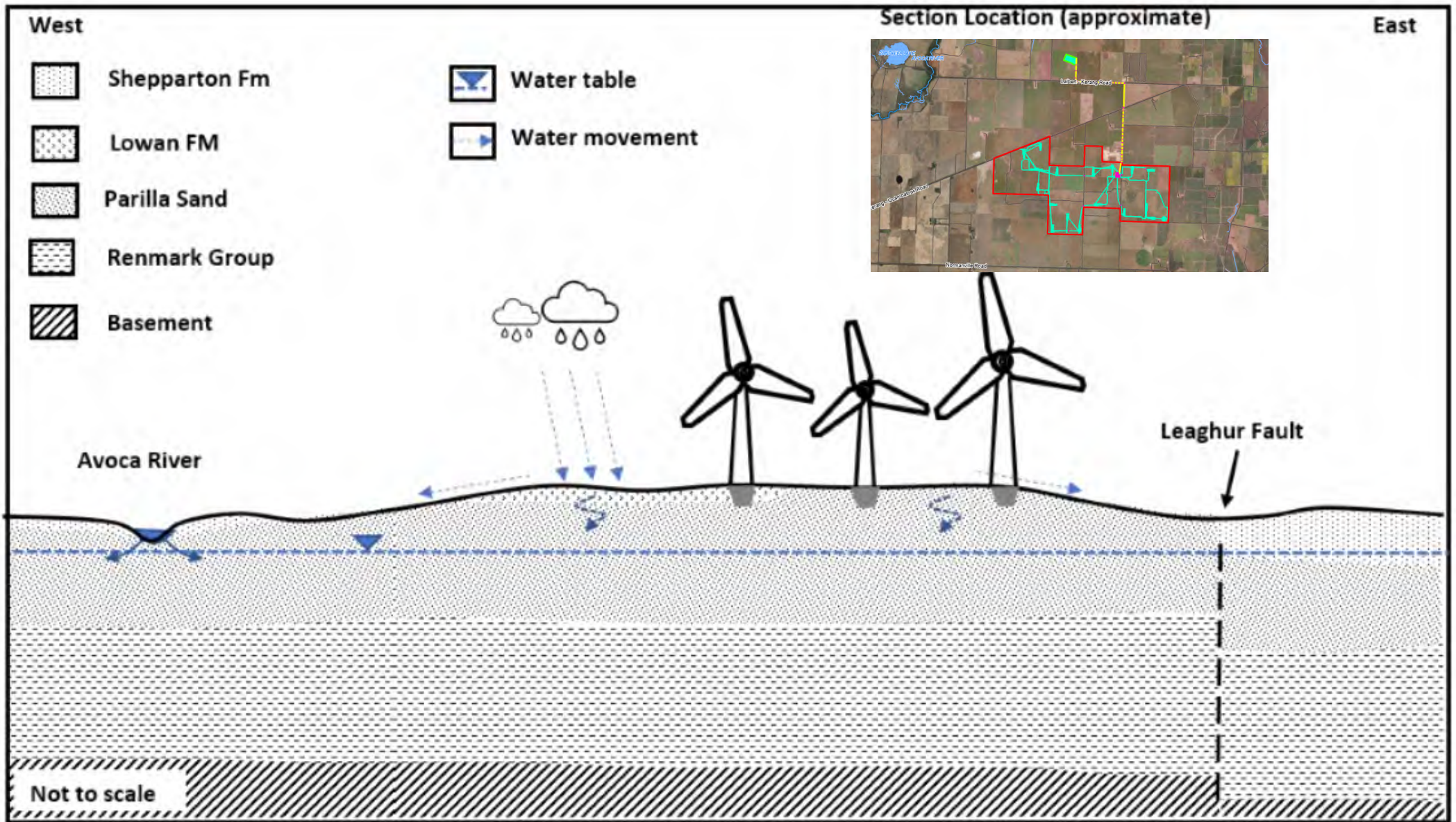
Groundwater levels are estimated around 73 m AHD, or 10 m to 20 m below the ground surface depending on topography. The exception to this is at the northern and eastern boundary of the Project area, where groundwater levels are estimated between 5 m to 10 m bgl. The inference at these locations is that the water table occurs within the Parilla Sands, with a saturated thickness of roughly 40 m, before transitioning into the Renmark Group sediments. O'Rorke *et al* (1992) interprets the regional groundwater flow in the water table aquifer to be northwest (and therefore it has not been shown in the conceptual schematic).

The water table aquifer is recharged through infiltrating rainfall occurring throughout the catchment. A smaller component of recharge is expected from leakage from nearby rivers (Avoca and Loddon) during flood events, and from surrounding lakes. Based upon the depth to groundwater, spring flow and groundwater discharge is not likely to occur on the site.

Although the wind turbine foundations for NMEP are yet to be designed, based upon documentation applied by WestWind, expected turbine foundations are approximately 3.5 to 4 m deep and have been presented on the conceptual schematic. The depth of underground electricity cables connecting the turbines to each other, and the internal collector station has not yet been specified (and is not shown on the conceptual schematic). However, it is likely that these will be shallow, within the top few metres of the ground surface.

Buried transmission lines within the easement corridor are proposed to connect the wind farm to the proposed Koorangie Terminal Station, located 4 km to 5 km north of the Project. Transmission line alignment depth is yet to be confirmed, however, the transmission lines are likely to be shallow (approximately 0.75 m to 4 m deep). It should be noted that depending on transmission line alignment depths, there is the potential to cross under flowpaths within the easement boundary and at the Koorangie Terminal Station. In this case, ground investigations should be carried out to confirm groundwater depth.

Foundations for the Project would be confirmed through geotechnical investigation however, existing information indicates that water levels across the majority of the Project area are greater than 10 m deep and that the Project is not likely to directly interact with the water table. Foundations for upgrades at the Koorangie Terminal Station may encounter shallower groundwater (<10 m), due to the proximity to Little Lake Bael Bael. In this case, foundation and piling depths should consider the need to carry out ground investigations to confirm groundwater depth.



- NMEP Site Boundary
- NMEP External Transmission Line Easement
- Koorangie Terminal Station
- NMEP Works Footprint
- NMEP Temporary Construction Area

Paper Size ISO A4

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Surface Water and Groundwater Assessment  
of the Normanville Energy Park

Project No. 31-12601890  
Revision No. 2  
Date 19/11/2024

Conceptual model

**FIGURE 18**

# 7. Proposed development

## 7.1 Project description

The Project involves the installation of up to 17 wind turbines across an approximate 1,933 ha area. Alignment of the turbines is proposed to be interconnected by a network of new access tracks and underground cables. Each turbine is electrically connected to a central Collector Station located within the site boundary. The Project has a proposed easement corridor, connecting buried transmission lines from the windfarm site to the proposed Koorangie Terminal Station 5 km north of the site.

Based upon information provided by WestWind, the turbine specification has not been designed yet, however, the Project will include the installation of the following elements:

- Seventeen wind turbine generators (WTGs), between 5 and 8 MegaWatts (MW) each, with a maximum blade-tip height of up to 280 m
- WTG foundations, hardstand and laydown areas
- Approximately 26.25 km of internal access tracks of 5.5 m trafficable width and 7 m width at bends
- Internal electrical cabling (underground) connecting WTGs to the internal collector station
- One internal collector station
- Approximately 7.2 km external transmission line (underground), connecting the internal collector station to the third-party Koorangie Terminal Station
- Minor upgrades to the Koorangie Terminal Station (western portion of the footprint only)
- Up to two proposed meteorological masts (anemometers) (i.e. one permanent and one temporary)
- Minor road intersection and site access upgrades
- Temporary construction areas including construction compound, numerous turn-around bays, concrete batching plant, equipment & materials laydown area
- Other operational infrastructure, including site offices and amenities

Based on our understanding the transmission line will be buried following the alignment shown in yellow on each of the figures in this report and would include the following:

- Existing grid capacity and connection options
- Underground 33 kV i.e., estimated approximately 1 m depth with direct drilling under overland flow paths

## 7.2 Development activities and the water environment

### 7.2.1 Environmental aspects

The construction and operation of a windfarm may affect surface and groundwater, and surface and groundwater may affect the Project. Details of these potential impacts are discussed in the following sections and have been summarised in Table 12.

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Table 12 Aspects and impacts

| Environment   | Aspect  | Impact  |
|---------------|---|---|
| Surface water | Effect of the Project on surface water and receiving environments                                       | <ul style="list-style-type: none"> <li>– Roadways, hardstand areas, windfarm towers, transmission line and Koorangie Terminal Station upgrades may require earthworks which could alter overland flows</li> <li>– Construction run-off entering waterways</li> <li>– Spills/hazardous materials handling could contaminate waterways</li> </ul>   |
|               | Effect of surface water on the construction and operation of the Project and associated infrastructure. | <ul style="list-style-type: none"> <li>– Inundation events effecting safety and timing of construction</li> <li>– Inundation events effecting access roads and tower foundations e.g. erosion</li> </ul>  |
| Groundwater   | Effect of the Project on groundwater  | <ul style="list-style-type: none"> <li>– Deep excavations intersecting groundwater may require temporary dewatering. This can affect existing groundwater users, GDEs, the generation and release of acidic leachates.</li> </ul>   |
|               | Effect of groundwater on the construction and operation of the Project and associated infrastructure.   | <ul style="list-style-type: none"> <li>– Large inflows into excavations during construction may cause delays and increased construction costs</li> <li>– Spills/hazardous materials handling could contaminate groundwater</li> <li>– Shallow groundwater could result in waterlogging and difficulties in re-establishing vegetation</li> <li>– Shallow groundwater could affect durability of construction materials</li> </ul> |

## 7.2.2 Surface water

Although most of the land within and around the Project area grades towards to the north, nearby overland flow paths to the east of site boundary may cause local flooding in the main site area after a significant rainfall event. Floodplain mapping indicates areas to the east of the site boundary are subject to flooding during a 1 in 100-year flood event (Figure 7). While the land around this area grades from west to east away from the Project area, local changes to ground elevation and flow paths during construction and operation of the Project have the potential to result in local flooding if appropriate flow conveyance and flood management measures are not put in place.

Existing conditions within the Project area include several delineated overland flow paths that indicate the general direction and location of surface water distribution across the site. Much of the Project area, transmission line easement and the Koorangie Terminal Station is located within the catchment that directs runoff to several overland flow paths, which discharge to Little Lake Bael Bael, approximately 4.4 km north of the site and approximate 1.3 km north west of the easement boundary and Koorangie Terminal Station.

Runoff from the eastern portion of the main site appears to discharge west to east, towards a 10 m LiDAR delineated flow path, directing surface water to Lake Elizabeth Wildlife Reserve and Duck Lake Wildlife Reserve. The western portion of the site includes several delineated overland flow paths that appear to discharge surface water runoff north-west of the site, towards the Avoca River.

Given that much of the runoff from the Project area is directed to sensitive receptors north of the Project area, such as Lake Bael Bael, Lake Elizabeth Wildlife Reserve and the Avoca River, works associated with the construction and operation of the Project have the potential to impact receptors downstream. Appropriate measures such as erosion and sediment control and protection of existing flow paths, should be undertaken before construction works commence to minimise impacts on the receiving water bodies. Particular consideration should be taken where proposed works directly interface or cross overland flow paths.

Several areas of proposed infrastructure within the site boundary, as well as the transmission line route and Koorangie Terminal Station, interface with overland flow paths (refer Figure 6). It should be noted that surface water runoff around the transmission line easement area is likely to discharge to Lake Bael Bael via the overland flow paths delineated from the LiDAR.

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Although the transmission line is proposed to be buried underground, excavation during construction has the potential to impact overland flow paths and surface water quality. Similarly, given that the Koorangie Terminal Station is located in close proximity to an overland flow path that discharges towards Little Lake Bael Bael, proposed works associated with the terminal station have the potential to impact water quality of receiving environments downstream. The proposed works associated with Koorangie Terminal Station are limited to the western portion of the terminal station footprint located approximately 200 m south-west of the delineated overland flow path that intersects with the overall footprint.

It should also be noted that the delineated flow paths are indicative of the location and direction of surface water runoff in the area. More detailed local drainage surface water modelling is recommended to assist with the micro-siting of infrastructure and sizing of drainage infrastructure. This understanding will also enable more effective implementation of standard construction environmental controls.

### 7.2.3 Groundwater

The existing conditions suggest that the depth to groundwater is deep, generally greater than 10 m bgl. The exception to this is at the northern boundary of the easement corridor and at the eastern boundary of the windfarm area, where groundwater level is estimated to occur between 5 m to 10 m bgl. It is therefore likely that there will be limited direct interaction with the groundwater environment. The following is noted:

- The footprint of the Project is small relative to the intake zone for the aquifer system. The Project is not likely to affect groundwater recharge.
- The foundations are likely to be relatively shallow and are not likely to require any dewatering to enable subsurface construction.
- Underground transmission lines are likely to be shallow, however may require drilling under identified delineated flow paths and potentially in the vicinity of the landfill and quarry sites, further assessment for potential construction considerations for should be worked through during detailed design to account for this, where applicable.
- Groundwater quality could be affected by spills of hazardous materials, e.g. refuelling activities.
- There is an opportunity for groundwater to be used as an alternate water supply for construction activities. The development of groundwater will require approvals under the *Water Act 1989*. The salinity of groundwater may limit opportunities for its use as a construction water supply.

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## 8. Water risk assessment

### 8.1 Existing conditions

A comprehensive assessment was undertaken to understand the existing conditions of the study area, to inform the environmental impact assessment for the works. A summary of existing conditions for surface water and groundwater has been provided in Sections 5 and 6 respectively.

### 8.2 Avoidance and design

Relevant to this topic, the following measures have been assumed in relation to the design, construction, and operation of the Project to avoid and minimise impacts:

- Installation of crossings that directly interface with the channels to be avoided
- Siting of access tracks on existing formal and informal tracks and benches where possible
- Building access tracks to follow land contours avoiding the need for significant excavations
- Building tracks and tower foundation to achieve a balance of cut and fill in trail construction, meaning that surplus spoil would not require disposal and fill would not be imported (it is noted that some material may be imported to stabilise and cap access tracks)

### 8.3 Risk assessment

#### 8.3.1 Overview of risk assessment method

An environmental risk assessment has been completed to identify environmental risks associated with construction and operation of the Project. A risk-based approach is integral to an impact assessment and has the objectives to:

- Provide a consistent evaluation tool that is used for all assessments to systematically rate the key issues associated with the Project
- Identify key risks associated with the Project that may require further examination through the detailed impact assessment
- Inform project development and/or development of measures to avoid, mitigate and manage environmental impacts

#### 8.3.2 Risk assessment process

The risk assessment process adopted is consistent with AS/NZS ISO 31000:2018 Risk Management Process. The following tasks were undertaken to identify, analyse and evaluate risks:

- Use existing environmental conditions and identify applicable legislation and policy to establish the context for the risk assessment
- Develop likelihood and consequence criteria and a risk matrix
- Consider construction, operational and decommissioning activities in the context of existing conditions to determine risk pathways
- Identify standard controls and requirements to mitigate identified risks
- Assign likelihood and consequence ratings for each risk to determine risk ratings considering design, proposed activities and standard mitigation

The assessment of risk combines the consequences of a threat and the likelihood of that consequence occurring, resulting in an overall risk rating. Any risk with an overall rating of medium or above requires further analysis in line with the avoid, minimise, or manage hierarchy.

Risk can be defined as a combination of:

- The magnitude of potential consequences of an event occurring
- The likelihood of the consequence event occurring

Mitigation measures which have been proposed by the proponent (Westwind) have been included in the 'initial' risk rating. The residual risk ratings for each impact include the initial mitigation measures along with those proposed to further minimise risk of impact occurring.

### 8.3.3 Assigning a consequence level

Consequence refers to the outcome of an event affecting an asset, value, or use. Table 13 presents the consequence framework describing the consequence levels from 'insignificant' to 'severe'. The consequence criteria have been developed in the form of project-wide criteria rather than discipline specific, to enable a consistent assessment of consequences across a range of potential environmental effects.

Consequence criteria is assigned based on the maximum credible consequence of the risk pathway occurring. Where uncertainty regarding consequences existed, a conservative approach to assessing risk has been adopted.

Consequence criteria considered the following characteristics:

- Spatial extent of impact
- Duration and reversibility of potential impacts
- Sensitivity and significance of the receiving environment
- Magnitude, or severity of potential impact

Each risk pathway would be assigned a level of consequence taking into account the guidance in Table 13. The consequence level, together with the likelihood level would be used to determine a risk rating in accordance with the risk matrix presented in Section 8.3.5.

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Table 13 Guide to consequence levels

| Level   | Criteria  |
|---|---|
| <p><b>Insignificant</b></p> <p>Impacts are barely recognised and/or quickly recovered from. No specific remediation required.</p>   | <p>No detectable changes or very short-term and localised.</p> <p>Readily reversible (insignificant) impact (&lt;1 year for recovery).</p> <p>Resilient or highly disturbed receiving environment or population.</p> <p>No impact to native vegetation or habitat.</p> <p>Surface water/groundwater: No detectable changes to water levels, flow, or quality with no measurable effect on assets, values or uses beyond the immediate occurrence or expression of the hazard.</p>   |
| <p><b>Minor</b></p> <p>Hazard is perceived but has minor and typically temporary effects. Some remediation may be required.</p>   | <p>Short-term localised detectable changes.</p> <p>Impact likely to be readily reversible (within 5 years for recovery).</p> <p>Resilient or disturbed receiving environment or population.</p> <p>Surface water/groundwater: Changes to water levels, flow, or quality with isolated and short-term effect on assets, values or uses. Minor contamination of natural waterway or wetland occurs, but water quality remains within applicable EPA or ANZG guidelines for existing beneficial uses. Water extraction or diversion reduces surface water flows or groundwater available for environmental uses, but with no detectable effect on dependent species or ecosystems and carried out within terms of water licence. Minor environmental contamination event (of land and/or water). Clean-up and rehabilitation may be required but can be completed within days.</p> |
| <p><b>Moderate</b></p> <p>Hazard has moderate, noticeable impact, in terms of severity, duration and/or frequency of occurrence. Moderate treatment or remediation effort may be required. Hazard event would be the subject of limited community concern.</p>  | <p>Short or medium-term detectable changes at a number of locations within the study area.</p> <p>Impact likely to be medium-term and reversible (5–10 years for recovery).</p> <p>Undisturbed receiving environment or population.</p> <p>Short-term, localised impacts on critical habitats.</p> <p>Surface water/groundwater: Changes to water levels, flow, or quality with moderate effect on assets, values or uses. Localised contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS for weeks to months. Environmental contamination event (of land and/or water) with clean-up and rehabilitation expected to run for weeks and cost \$10k–\$1 million.</p>   |
| <p><b>Major</b></p> <p>Hazard has major impact, in terms of severity, duration and/or frequency of occurrence. Treatment or remediation effort is required. Some effects may be irreversible. Remediation of environmental contamination would require significant private and public resources. Hazard event would be the subject of widespread community concern.</p> | <p>Long-term changes that are significant regionally.</p> <p>Impact likely to be medium to long-term and potentially irreversible (&gt;10 years to recover).</p> <p>Sensitive receiving environment or population.</p> <p>Material impacts on critical habitats.</p> <p>Surface water/groundwater: Significant changes to water levels, flow or quality with assets, values or uses significantly compromised. Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS for up to one year. Environmental contamination event (of soil-land and/or water) of a magnitude that would necessitate a regional emergency management incident response. Clean-up and rehabilitation expected to run for months and/or cost \$1–10 million.</p>  |
| <p><b>Severe</b></p> <p>Hazard has critical impact, in terms of severity and/or duration. Treatment or remediation effort is required, although some effects may be irreversible. Remediation of environmental contamination would require significant private and public resources. Hazard event would be the subject of widespread community outrage</p>              | <p>Permanent changes that are significant at a State or Commonwealth level.</p> <p>Impact likely to be long-term and irreversible.</p> <p>Highly sensitive receiving environment or population.</p> <p>Significant impacts on critical habitats.</p> <p>Surface water/groundwater: Extensive changes to water levels, flow or quality with assets, values or uses irreversibly compromised. Contamination of surface water/groundwater aquifer leading to disruption of beneficial uses as defined by ERS for more than one year. Environmental contamination event (of soil-land and/or water) of a magnitude that a State-level incident response is required. Incident response, clean-up and rehabilitation expected to run for years and/or cost ≥\$10 million.</p>  |

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## 8.3.4 Assigning a likelihood level

'Likelihood' is the combination of the chance of an event and the chance of the identified consequence occurring. The likelihood criteria range from 'rare' where the event and consequence may occur only in exceptional circumstances to 'almost certain' where the event and consequence is expected to occur in most circumstances. Likelihoods are assigned for the maximum credible consequence according to the levels presented in Table 14.

Table 14 Guide to likelihood levels

| Descriptor     | Explanation   |
|----------------|---|
| Almost Certain | The event is expected to occur in most normal circumstances.<br>90% - 100% chance of occurring                  |
| Likely         | The event will probably occur in most normal circumstances.<br>70% - 90% chance of occurring                    |
| Possible       | The event might occur at some time.<br>30% – 70% chance of occurring  |
| Unlikely       | The event could occur at some time.<br>5% – 30% chance of occurring   |
| Rare           | Highly unlikely, but the risk event may occur in exceptional circumstances.<br>Less than 5% chance of occurring |

## 8.3.5 Assigning a level of risk

Risk is defined as combination of the likelihood of an event occurring and the consequence of that event occurring. A risk rating was determined by these factors using the risk matrix, presented in Table 15.

Table 15 Risk matrix

|            |                    | Consequence       |           |              |           |            |
|------------|--------------------|-------------------|-----------|--------------|-----------|------------|
|            |                    | Insignificant (5) | Minor (4) | Moderate (3) | Major (2) | Severe (1) |
| Likelihood | Almost Certain (A) | Medium            | High      | Very High    | Very High | Very High  |
|            | Likely (B)         | Medium            | Medium    | High         | Very High | Very High  |
|            | Possible (C)       | Low               | Medium    | Medium       | High      | Very High  |
|            | Unlikely (D)       | Low               | Low       | Medium       | High      | High       |
|            | Rare (E)           | Low               | Low       | Medium       | Medium    | High       |

When risks are rated as medium or above, the impacts associated with the risk pathway are assessed in an increasing level of detail and would prompt further exploration of potential mitigation and management actions to reduce the overall impact.

Once the risk rating has been established, some risks will need to have controls in place to reduce them to an acceptable level. Higher risk levels should take priority. Table 16 provides guidance on what steps need to be taken depending upon the risk rating.

Table 16 Risk rating acceptability

| Risk level | Description   |
|------------|---|
| Very High  | Totally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels.   |
| High       | Generally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels. |
| Medium     | May be acceptable provided the risk has been minimised as far as reasonably practicable.                |
| Low        | Acceptable level of risk provided the risk cannot be eliminated.  |

## 8.4 Risk register

The intent of this risk assessment is to identify the key risks of the site construction and operations upon the surface water and groundwater environment and inform the development of a surface water and groundwater monitoring program and/or other controls to address these risks. Specifically, this risk assessment demonstrates that these risk mitigation protocols reduce the latent risk to tolerable thresholds in line with industry norms and legislative requirements. The completed risk register has been attached as Table 17.

### 8.4.1 Surface water

The surface water risks associated with flooding or impacting the downstream receiving waterway environments are considered low. The key risks identified included:

- Changes to overland flow paths, impacting the flow regime of receiving environments such as downstream waterways, water bodies and wildlife reserves
- Changes to overland flow paths and surrounding land, increasing erosion and sediment to receiving environments such as downstream waterways, water bodies and wildlife reserves
- Control discharge (pumping) from site sump storages to downstream receiving waterways and water bodies impacting water quality
- Uncontrolled discharge, as a result of stormwater runoff from site to downstream receiving waterways and water bodies impacting water quality
- Construction spills and the handling and storage of hazardous materials

### 8.4.2 Groundwater

Groundwater is not likely to be intersected during the construction and operation of the Project. All risks relating to groundwater have been classified as being low and can be managed with standard engineering controls.

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Table 17 Water Risk register

| Risk No. | Source/Activity         | Pathway  | Receptor  | Project Phase | Assumed Existing control(s)   | Comment  | Post control risk analysis |             | Level of risk |
|----------|-------------------------|--|---|---------------|---|--|----------------------------|-------------|---------------|
|          |                         |  |   |               |   |  | Likelihood                 | Consequence |               |
| SW1      | Construction activities | Storage and handling of hazardous materials results in contamination of surface run-off, receiving waterways and other sensitive receptors | Overland flow paths.<br>Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies.<br>Avoca River.<br>Irrigation areas downstream of flow paths and minor drainage channels. | Construction  | Construction environment management plan (CEMP) implemented.<br>Spill kits and response procedures.<br>An appropriate setback distance from overland flow paths discharging to sensitive receptors - applied for infrastructure and materials handling to minimise direct impacts to receiving waterways, lakes and receiving environments. | The local topography generally grades toward the north and is vegetated and pervious, it is unlikely that significant volumes of contaminated runoff would reach Loddon River or Avoca River. Similarly, Lake Bael Bael and Lake Elizabeth are an adequate distance from the Project site. Risk can be appropriately managed by standard construction controls such as spill kits, bunding of chemical storage areas and response procedures. Appropriate management and controls will reduce the risk of contamination of irrigation areas downstream of main discharge channels. | Rare (E)                   | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity         | Pathway   | Receptor  | Project Phase | Assumed Existing control(s)   | Comment  | Post control risk analysis |             | Level of risk |
|----------|-------------------------|---|---|---------------|---|--|----------------------------|-------------|---------------|
|          |                         |   |   |               |   |  | Likelihood                 | Consequence |               |
| SW2      | Construction activities | Exposure and erosion of soil causing increased amounts of sediment in surface runoff and contamination of runoff, receiving waterways and other sensitive receptors | Overland flow paths.<br>Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies.<br>Avoca River.<br>Irrigation areas downstream of flow paths and minor drainage channels. | Construction  | CEMP implemented.<br>Appropriate erosion controls and sediment barriers to protect overland flow paths during construction of infrastructure and transmission line.<br><br>An appropriate setback distance from or crossings over overland flow paths - applied for infrastructure to minimise direct impacts to receiving waterways. | The local topography generally grades toward the north and is vegetated and pervious, which will likely reduce the volume of sediment reaching receiving waterways.<br><br>Risk can be appropriately managed through standard construction controls such as sediment barriers and those specified in EPA Publication 1834.<br><br>Overland flow paths located within the Project area and that cross the transmission line easement have a higher associated risk during the construction phase of the associated infrastructure. An appropriate setback distance (or appropriate crossing) from overland flow paths discharging to sensitive receptors and appropriate construction controls must be implemented. | Unlikely (D)               | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity                      | Pathway  | Receptor   | Project Phase | Assumed Existing control(s)   | Comment  | Post control risk analysis |             | Level of risk |
|----------|--------------------------------------|--|--|---------------|---|--|----------------------------|-------------|---------------|
|          |                                      |  |  |               |   |  | Likelihood                 | Consequence |               |
| SW3      | Operation and Maintenance activities | Storage and handling of hazardous materials results in contamination of surface run-off, receiving waterways and other sensitive receptors | Overland flow paths.<br>Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies.<br>Avoca River. Irrigation areas downstream of flow paths and minor drainage channels. | Operation     | Operation environment management plan.<br>An appropriate setback distance from overland flow paths discharging to sensitive receptors - applied for infrastructure and materials handling to minimise direct impacts to receiving waterways, lakes and receiving environments.. | The local topography generally grades toward the north and is vegetated and pervious, it is unlikely that large volumes of contaminated runoff will reach Loddon River or Avoca River. Similarly, Lake Bael Bael and Lake Elizabeth are an adequate distance from the Project site. Risk can be appropriately managed by standard construction controls such as spill kits, bunding of chemical storage areas and response procedures.<br>Appropriate management and controls will reduce the risk of contamination of irrigation areas downstream of main discharge channels. | Rare (E)                   | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity                       | Pathway  | Receptor  | Project Phase | Assumed Existing control(s)   | Comment   | Post control risk analysis |             | Level of risk |
|----------|---------------------------------------|--|---|---------------|---|---|----------------------------|-------------|---------------|
|          |                                       |  |   |               |   |   | Likelihood                 | Consequence |               |
| SW4      | Construction activities and Operation | Changes to land as a result of construction and temporary or permanent infrastructure impacting surface elevation and overland flow paths resulting in changes to floodplain behaviour (localised flooding/reduction in runoff after a rainfall event) | Overland flow paths.<br>Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies.<br>Avoca River.<br>Irrigation areas downstream of flow paths and minor drainage channels. | Construction  | CEMP implemented.<br>Design of infrastructure to ensure major flow path flows discharging to sensitive receptors and waterways are not altered or restricted. | If local drainage paths that discharge water to Lake Bael Bael, Lake Elizabeth and other adjacent lakes are disrupted, the volume and regime of the lakes may be impacted.<br><br>Disruption of main overland flow paths that discharge runoff to irrigation areas downstream may impact the volume of water available for irrigation (approvals from GMW may be needed).<br><br>Overland flow paths located within the Project area and that cross the transmission line easement have a higher associated risk during the construction phase of the associated infrastructure. An appropriate setback distance (or appropriate crossing) from overland flow paths discharging to sensitive receptors and appropriate construction controls must be implemented. | Unlikely (D)               | Minor (4)   | Low (L)       |
| SW5      | Construction activities               | Controlled pumping of surface water on site (from sumps) discharging to receiving waterways  | Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies.<br>Avoca River.   | Construction  | CEMP implemented.   | Discharge of wastewater from site must be conducted in accordance with EPA Publication 1834 (2020).   | Unlikely (D)               | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity         | Pathway   | Receptor   | Project Phase | Assumed Existing control(s)   | Comment  | Post control risk analysis |             | Level of risk |
|----------|-------------------------|---|--|---------------|---|--|----------------------------|-------------|---------------|
|          |                         |   |  |               |   |  | Likelihood                 | Consequence |               |
| SW6      | Construction activities | Direct disturbance to overland flow path or drainage channel causing potential for bed and bank erosion due to pipeline trenching | Lake Bael Bael, Lake Elizabeth, Duck Lake, and other adjacent water bodies that are downstream of proposed pipeline. | Construction  | CEMP implemented. Appropriate erosion controls and sediment barriers to protect overland flow paths that directly interface with pipeline trenching during construction of transmission line. This should include surface protection works to minimise erosion potential. | Any direct impacts to overland flow paths due to construction of transmission line may require surface protection works (to prevent erosion) or other controls to be implemented as part of the CEMP.  | Unlikely (D)               | Minor (4)   | Low (L)       |
| GW1      | Construction activities | Storage and handling of hazardous materials results in contamination of underlying groundwater                                    | Nearby groundwater users. GDEs   | Construction  | Construction environment management plan implemented. Spill kits and response procedures.   | Significant depth to water renders aquifer less sensitive to contamination events. Very few existing groundwater users identified (saline groundwater). Risk can be appropriately managed by standard construction controls such as spill kits, bunding of chemical storage areas and response procedures. | Rare (E)                   | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity                      | Pathway  | Receptor                       | Project Phase | Assumed Existing control(s)  | Comment  | Post control risk analysis |             | Level of risk |
|----------|--------------------------------------|--|--------------------------------|---------------|--|--|----------------------------|-------------|---------------|
|          |                                      |  |                                |               |  |  | Likelihood                 | Consequence |               |
| GW2      | Operation and Maintenance activities | Storage and handling of hazardous materials results in contamination of underlying groundwater   | Nearby groundwater users. GDEs | Operation     | Operation environment management plan.   | Significant depth to water renders aquifer less sensitive to contamination events. Very few existing groundwater users identified (saline groundwater). Risk can be appropriately managed by standard construction controls such as spill kits, bunding of chemical storage areas and response procedures. | Rare (E)                   | Minor (4)   | Low (L)       |
| GW3      | Construction activities              | Use of groundwater as construction water supply or fire fighting results in changes in groundwater level   | Nearby groundwater users. GDEs | Construction  | Licensing approvals required under the <i>Water Act 1989</i> from the delegated rural water authority. | Noted that groundwater salinity may limit the opportunities for using groundwater as an 'alternate' water supply.  | Rare (E)                   | Minor (4)   | Low (L)       |
| GW4      | Construction activities              | Shallow groundwater is unexpectedly encountered during the excavation of foundations of windfarm. Dewatering causes changes (declines) in groundwater level. | Nearby groundwater users. GDEs | Construction  |  | Likely to be short term dewatering. Site investigations undertake to inform Windfarm design. Desktop assessment indicates regional groundwater level to be deep.   | Rare (E)                   | Minor (4)   | Low (L)       |

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| Risk No. | Source/Activity         | Pathway   | Receptor   | Project Phase | Assumed Existing control(s)  | Comment  | Post control risk analysis |             | Level of risk |
|----------|-------------------------|---|--|---------------|--|--|----------------------------|-------------|---------------|
|          |                         |   |  |               |  |  | Likelihood                 | Consequence |               |
| GW5      | Construction activities | Shallow groundwater is unexpectedly encountered during the excavation of transmission line trenches. Dewatering causes changes (declines) in groundwater level. | Nearby groundwater users.<br>GDEs  | Construction  |  | Likely to be short term dewatering.<br>Site investigations undertake to inform transmission line design.<br>Desktop assessment indicates regional groundwater level to be at least 5 m bgl at its shallowest within the easement boundary. | Unlikely (D)               | Minor (4)   | Low (L)       |
| GW6      | Construction activities | Crossing of overland flow paths during transmission line installation results in greater connection of surface water and underlying groundwater system.         | Losses from channel<br>Waterlogging by overland flow path crossing<br>Local preferential flow path created | Construction  | Ground investigation along transmission route to confirm groundwater depth<br>Installation of trench breaker either side of overland flow paths crossing<br>Drilling and installation of transmission lines via directional drilling under overland flow paths | Direct drilling under overland flow paths is a common construction practise  | Unlikely (D)               | Minor (4)   | Low (L)       |

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# 9. Impact assessment

## 9.1 Discussion of surface water risks

### 9.1.1 Assessment of construction impacts

#### 9.1.1.1 Impact to surface water quality (risk SW1, SW2, SW5, SW6)

##### *Description*

Surface water runoff, waterways and water bodies provide environmental value and should be protected from external impacts during construction and operation of the windfarm and transmission line. Existing surface water quality should be maintained so that impacts to receiving waterways and environments are avoided or minimised. Potential surface water quality changes may arise during construction and operation phases of the Project from:

- Spillage, improper handling, storage, and application of hazardous materials
- Erosion of ground surfaces and increased sediment load in runoff after a rainfall event
- Controlled pumping of surface water on (sumps) site to receiving waterways
- Disturbance causing potential erosion of channel bed or bank due to pipeline trenching through channel

##### *Assessment*

It is unlikely that construction activities generate local surface water quality impacts from spillage or improper handling and application of hazardous materials, such as the refuelling and maintenance of construction plant and equipment. The risk associated with these environmental incidents is low because it would be a requirement to implement controls to manage chemicals, fuels, and hazardous materials to manage these risks, e.g. construction environmental management plan (CEMP), reducing the impact of the incident if was to occur.

A hazardous material reaching a receiving waterway or water body (such as the Avoca River or Lake Bael Bael) and impacting the quality of water downstream is unlikely as the ground surface within the Project area gradually grades towards the north and is vegetated and pervious. However, given that overland flow paths pass through the Project area, transmission line easement route and Koorangie Terminal Station footprint, and discharge surface water runoff to the Avoca River and several lakes downstream of the Project, it is possible that hazardous material may reach the receiving water bodies and irrigation areas downstream of main overland flow paths if appropriate mitigation is not adopted.

It is a reasonable expectation that if a release of hazardous material occurred to the environment, incident response procedures would likely occur promptly, such as the use of spill kits/containment and reduce the severity of the consequence. It is recommended that all hazardous materials are used and stored at an appropriate distance from the channels that pass through the Project area to prevent discharge to receiving waterways and waterbodies.

Erosion of ground surfaces and increased sediment load in runoff as a result of exposed soil or disrupted flow paths has the potential to impact surface water and the quality of receiving waterways. Appropriate erosion and sediment controls and measures to reduce soil disturbance (e.g. as per EPA Publication 1834, and re-established vegetation cover) should be put in place before construction begins and monitored and maintained throughout the construction and operation phase of the Project. Completing works outside of the 1 in 100-year modelled flood extent is recommended to reduce the risk of impacts to infrastructure and water quality as a result of erosion during a flood event. In the absence of flood modelling of local drainage or overland flow paths within the Project area, an appropriate setback distance should be applied to overland flow paths discharging to receiving sensitive receptors throughout the construction phase.

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Direct disturbance to overland flow paths during the construction of the transmission line route may lead to potential for erosion of channel bed and banks. Erosion of channel bed and banks will likely impact the water quality within the waterway and any receiving waterway or water body downstream. Any works associated with the construction and trenching of the transmission line that have direct impacts to overland flow paths will require appropriate controls and measures to avoid and reduce channel bed and bank erosion. Management measures for this risk include enforcing a minimum construction depth below the overland flow path and monitoring of water quality. Controlled timing and duration of works (i.e. during low flow conditions) with direct waterway impacts should also be implemented to minimise the impact to water quality.

Particular consideration should be given to works associated with the transmission line and Koorangie Terminal Station as the overland flow paths that interface with the footprint of these infrastructure discharge runoff from the surrounding area directly to Little Lake Bael Bael. Mitigation measures to minimise the impact of these works to downstream receiving environments include appropriate storage and management of hazardous materials (as per the CEMP), temporary diversion of overland flow paths, sediment traps and re-establishment of vegetation cover.

Similarly, control measures for pumping water or wastewater collected onsite during construction to local waterways should also be implemented and monitored to reduce the impact to surface water quality. Discharge to waterways would need approval from the CMA (and the EPA may be a referral agency). Appropriate time between a rainfall event and pumping should be considered before discharging the water to receiving waterways. This is to allow sediment and other contaminants to settle in an onsite sump or pond. The quality of water being collected on site should be monitored to ensure that contaminants from project works are not being discharged to receiving waterways and water bodies. Water that does not meet EPA requirements, will be managed and treated on site, or collected, taken offsite and treated, following the Victorian EPA guidelines by the Project.

The implementation of a CEMP and on-going monitoring during construction would be required to identify whether surface water has been adversely impacted and an appropriate management response is required.

This risk remains valid during the operation phase of the Project. However, the frequency of site visitation, volumes of hazardous materials being stored and handled, and the volume of traffic are likely to be significantly reduced compared to that occurring during the construction phase.

### **9.1.1.2 Impact to drainage paths and surface water runoff (risk SW4, SW6)**

#### ***Description***

Surface water runoff, waterways and water bodies provide environmental value and should be protected from external impacts during construction of nearby works. Natural and formalised overland flow paths should be upheld throughout the Project to reduce impacts downstream to sensitive receptors and irrigation areas. Overland flow paths and ground elevation may be interrupted or compromised during the construction phase of the Project as a result of excavation, access track development and construction of wind turbines and other infrastructure.

#### ***Assessment***

It is unlikely that discrete earthwork construction activities associated with the infrastructure (i.e. turbines) will result in changes to land elevation and disrupt local overland flow paths that discharge surface water runoff to sensitive receptors downstream of the Project area. There is more potential for impacts from associated construction activities (i.e. when constructing access tracks that interface with overland flow paths) that have the potential to temporally disrupt flow paths and channels. However standard mitigation measures are considered adequate to manage these impacts (i.e. CEMP).

Overland flow paths that discharge to sensitive receptors downstream of the Project area should be avoided during the construction phase of the Project. In the absence of flood modelling of local drainage or overland flow paths within the Project area, an appropriate setback distance should be applied to overland flow paths discharging to receiving sensitive receptors throughout the construction phase. Commencing works away from these flow paths by implementing an appropriate setback distance (or appropriate crossing or culvert) will reduce the risk of local flooding on site, while also maintaining the quality and volume of surface water runoff discharging to receiving waterways and water bodies such as Lake Bael Bael and Lake Elizabeth and irrigation areas downstream of main overland flow paths.

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Direct disturbance to overland flow paths during the construction of the transmission line route may increase the potential of erosion of channel bed and banks. Any works associated with the construction and trenching of the transmission line that have direct impacts to overland flow paths will require appropriate controls and measures to avoid and reduce channel bed and bank erosion.

Appropriate control measures should be implemented if construction activities are to take place inline or congruent with local flow paths (e.g. diversion and trenching works). Control measures will be required during the construction and trenching of the transmission line north of the main site, noting that trenching will only take place along some segments of the transmission line route. Enforcing a minimum construction depth below overland flow paths impacted by the transmission line route, will reduce the consequence associated with the impact. Rehabilitation of overland flow paths and the surrounding area impacted by construction may be required to return surface water runoff behaviour to existing conditions.

It is noted that proposed works associated with the upgrade of the Koorangie Terminal Station are limited to the western portion of the terminal station footprint and are unlikely to have an impact of any existing overland flow paths. However, given the proximity to nearby overland flow path that intersects with the overall terminal station footprint, appropriate construction controls, such as redirection of runoff, should be considered to minimise disturbance impacts to surface water and downstream environments.

To reduce the risk of flooding on site, local drainage and storage should be implemented around construction areas located around drainage paths. If possible, runoff is recommended to be redirected to local channels or flow paths that discharge to their original outlets, e.g. Lake Bael Bael. This control measure will reduce risks in relation the flow regime of channels around the Project area and the receiving waterways downstream of the Project area.

The implementation of a CEMP and on-going monitoring during construction would be required to identify whether local onsite flooding is occurring and if surface water runoff has been adversely impacted and if an appropriate management response is required.

## 9.1.2 Operation (and decommissioning)

### 9.1.2.1 Impact to surface water quality (risk SW3)

As per SW1, outlined in Section 9.1.1.1 applies to the respective description and assessment of this risk (during operation and maintenance).

### 9.1.2.2 Impact to drainage paths and surface water runoff (risk SW4)

#### **Description**

Surface water runoff, waterways and water bodies provide environmental value and should be protected from external impacts during operation of nearby works. Natural and formalised overland flow paths should be upheld throughout the Project to reduce impacts downstream sensitive receptors and irrigation areas. Overland flow paths and ground elevation may be interrupted or compromised during the construction phase of the Project as a result of excavation, access track development and construction of wind turbines and other infrastructure.

#### **Assessment**

It is unlikely that operational activities and the location of infrastructure will result in changes to land elevation and disrupt local overland flow paths that discharge surface water runoff sensitive receptors downstream of the project area.

Overland flow paths that discharge to sensitive receptors downstream of the Project area should be avoided during micro-siting of project infrastructure. In the absence of flood modelling of local drainage or overland flow paths within the Project area, an appropriate setback distance should be applied to overland flow paths discharging to receiving sensitive receptors for all project infrastructure.

Locating infrastructure away from these flow paths or implementing appropriate crossing or mitigation infrastructure (i.e. culverts or crossing), will reduce the risk of local flooding on site, while also maintaining the quality and volume of surface water runoff discharging to receiving waterways and water bodies such as Lake Bael Bael and Lake Elizabeth and irrigation areas downstream of main overland flow paths.

Completing works outside of the 1 in 100-year modelled flood extent is recommended to reduce the risk of impacts to infrastructure. Siting infrastructure outside of the 1 in 100-year flood extent is also recommended to minimise the risk to adjacent land caused by a change in local ground elevation and surface type, hence causing a change in flood extent.

## **9.2 Discussion of groundwater risks**

### **9.2.1 Assessment of construction impacts**

#### **9.2.1.1 Impact to groundwater quality (risk GW1, GW2)**

##### ***Description***

Under the *EP Act 2017* and the ERS, groundwater has defined environmental values depending on its salinity and groundwater quality which must be protected to preserve these identified beneficial uses. Potential groundwater quality changes may arise during construction and operation phases of the Project from:

- Spillage, improper handling, storage and application of hazardous materials
- ReInjection of groundwater seepage
- Incompatibilities with construction materials, such as leaching from imported backfill, chemical additives to grouts and sealing resins
- Saltwater intrusion/mixing of native groundwaters of different salinity

##### ***Assessment***

It is rare that construction activities generate local groundwater quality impacts from spillage or improper handling and application of hazardous materials, such as the refuelling and maintenance of construction plant and equipment. The likelihood of these environmental incidents is low because it would be a requirement to implement controls to manage chemicals, fuels, and hazardous materials to manage these risks, e.g. through a CEMP.

Furthermore, a hazardous material (pollutant) needs sufficient time and a pathway to access the groundwater environment. It must be able to migrate vertically from the surface through the soil profile to the water table. It is a reasonable expectation that if a release of hazardous material occurred to the environment, incident response procedures would likely occur promptly, such as the use of spill kits/containment and would reduce the severity of the consequence. Available information on the existing conditions indicates that groundwater levels are deep and therefore they are not highly vulnerable to spill events.

The implementation of a CEMP and on-going monitoring during construction would be required to identify whether groundwater has been adversely impacted and an appropriate management response is required.

Future geotechnical investigations undertaken for the Project may consider the assessment of groundwater level conditions, if this is required to inform subsurface designs.

This risk remains valid during the operation phase of the Project. However, the frequency of site visitation, volumes of hazardous materials being stored and handled, and the volume of traffic are likely to be significantly reduced compared to that occurring during the construction phase.

#### **9.2.1.2 Impact to existing users and depletion of groundwater resources (risk GW3)**

##### ***Description***

Groundwater resources may be developed for a water supply to service construction effort or used as an alternative to mains supply/carted water. Pumping from a production bore will influence groundwater levels, which could affect the operation of private bores, or nearby GDEs.

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## **Assessment**

There is increasing pressure for contractors to use alternative supplies of water for construction purposes to reduce stress on potable drinking water supplies. For example, groundwater may be considered for use for dust suppression, compaction control or concrete batching. The groundwater quality would need to be assessed to determine its suitability for such purposes, and such is outside the scope of the current impact assessment. It is noted that regional hydrogeological mapping interprets the groundwater to be saline which would limit the likelihood of it being used as an alternate water supply without treatment (e.g. desalination).

Any groundwater bores installed for construction water supply or permanent water supply would need to be licensed by GMW in accordance with the *Water Act 1989* and would be subject to its licensing determinations. As part of any licensing determination, a proponent would be required to complete a technical hydrogeological assessment to support the groundwater licensing. This would include an assessment of impact to existing users, surface water flows and water availability. A groundwater supply would not be licensed unless the risks of extraction on groundwater (other users, the environment) are deemed acceptable by GMW.

The lack of bores neighbouring the Project with an extractive beneficial use indicates that groundwater quality is poor. It also suggests that the risk of such occurring is low and likely to be manageable.

### **9.2.1.3 Encountering unexpected shallow groundwater (risk GW4, GW5)**

#### **Description**

Perched groundwater could occur where shallow coarse grained dune sediments are underlain by fine grained sediments within the Parilla Sands. Deeper excavations required for the turbine towers and/or transmission line trenches may unexpectedly encounter groundwater that is perching above the regional water table. This may create seepage into excavations (which would require management itself) or potentially dewatering to provide stable and safe working conditions within excavations. At the northern boundary of the easement corridor and at the eastern boundary of the windfarm, regional groundwater depth is estimated to be 5 m to 10 m bgl. If geotechnical investigations show that groundwater is shallower at these locations, dewatering controls should be taken into design consideration. Dewatering would reduce groundwater levels, which could affect the operation of private bores, or nearby GDEs.

#### **Assessment**

This risk has been classified as being low due to:

- The Proponent has advised GHD that geotechnical site investigations will be completed to characterise the ground conditions (and ground risks) associated with the Project (potentially including wind turbine construction and transmission line installation). Such investigations would provide a better understanding of the whether perched groundwater would be intersected, and/or shallower groundwater depths towards the northern and eastern boundaries.
- Owing to potentially small, saturated thickness the volume in storage in perched aquifers is likely to be small, and flow rates likely low. Under these conditions, seepage flows are likely to be manageable by conventional methods e.g. pumping from excavation sumps. Similarly, associated windfarm infrastructure and buried easement transmission lines are estimated be installed at shallow depths. Therefore, any potential intersection of the water table is likely to be limited and manageable by conventional methods.
- There are few bores with an abstractive benefit in the region, and these would target the higher yielding, productive zones of the aquifer (Parilla Sands). Dewatering would be influencing water levels in the shallow perched system and therefore not influencing the operation of the deeper bores.
- Construction of excavations with short term only, i.e. occurring over a period of weeks or months. Following the cessation of construction and any associated dewatering activities, water levels in the aquifer are expected to recover.

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#### 9.2.1.4 Crossing of waterways during transmission line installation (GW6)

##### **Description**

There is the potential that proposed transmission lines within the easement corridor will transect local waterways/channels. The exact interaction between groundwater and waterways, if any, within the Project area is not known. Furthermore, the alignment of the transmission lines within the easement corridor is yet to be confirmed. It can be reasonably expected that permeable backfill materials used during the construction of the transmission lines may preferentially transmit groundwater, be it perched water or regional groundwater. If present, these micro-scale flow systems are not known. Impacts to groundwater may arise from changes to the existing level of hydraulic connection as a result of transmission line construction.

GHD understands, through information provided by WestWind, that the intention is for directional drilling techniques to be considered for implementation as part of transmission line installation, along locations where crossing of waterways is required.

##### **Assessment**

The depth of groundwater, waterway conditions and interaction between the waterways and groundwater are key elements in determining the impact to groundwater from a crossing. The crossing construction methodology will determine the amount of dewatering (and thus potential for impact) to occur. Timing of the construction is another factor, particularly with ephemeral streams, as well as the lithology present at the crossing. This risk within the easement corridor has been classified as being low due to:

- The regional water table is interpreted to be deep (~20 m across the majority of the site). Towards the northern boundary of the easement corridor the water table is potentially shallower, between 5 m to 10 m bgl. It is therefore unlikely that transmission lines will intercept the water table, resulting in a low likelihood of creating a hydraulic connection between the waterways and the water table. Geotechnical investigations are recommended at crossover locations to better understand any surface water and groundwater interactions.
- Engineering controls during transmission line construction and on-going operation can be implemented to minimise potential impact to groundwater. Ground conditions during and following construction should be achieved that maintain the pre-construction hydraulic conditions. Trench cut-offs are one identified mitigation measure that can be implemented to achieve this in terms of preventing lateral migration of any perched groundwater (or hydraulically connected surface water) along permeable pipeline backfill materials. Geotechnical investigations are recommended at crossover locations to inform engineering design. This will assist in determining the most appropriate management measures required. Such investigations would inform the proposed directional drilling where crossing of waterways is required.

#### 9.2.2 Operation (and decommissioning)

The risks of project operation on groundwater are considered low and manageable.

### 9.3 Climate change

According to DELWP (2020) and its predictive modelling, there are multiple lines of evidence that Victoria will be hotter and drier in the future.

#### 9.3.1 Surface water

Although climate change has not been explicitly assessed within the Project area, climate change effects may lead to an increased frequency and magnitude of peak flows in waterways, as the frequency of high intensity rain events are predicted to also increase.

To ensure that there are no long-term flooding impacts to the Project, the control measures to consider in relation to climate change are appropriate location of works away from overland flow paths and where necessary, the implementation of drainage infrastructure and storage.

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Given that the Project area generally slopes from south to north and there are no local depressions within the site boundary, the overall risk of on-site flooding is low. The existing flood extents of the 1 in 100-year event and 2011 historic flood event reach the eastern site boundary and hence the eastern portion of the site has a higher chance of flooding. Climate change is expected to affect the flooding risk of the eastern portion of the Project area, as overall flows, and magnitudes of peak flows within Loddon River may increase as a result of climate change. However, the flood risk of the remainder of the Project area is not expected to be affected by climate change.

It has been recommended that the main wind farm infrastructure (turbines, substations, and other buildings) continue to be located outside of the 1 in 100-year event flood extent to protect infrastructure, and other works such as access paths and crossings be undertaken without impacting flood characteristics of the site. Underground cabling and access tracks with culverts may be located within the 1 in 100-year event flood extent.

As the frequency of high intensity rain events are predicted to also increase, surface water runoff is also likely to increase, heightening the risk of erosion and sediment from soils around project infrastructure impacting water quality. Recommended controls to manage erosion and sediment will provide long term security if implemented and monitored appropriately throughout the operation of the Project and the risk of impact on water quality remains low under climate change conditions.

### 9.3.2 Groundwater

Climate change may affect rates of recharge and the future availability of groundwater. DELWP (2020) indicates that climate change may increase the frequency of high intensity rain events that provide significant recharge events for groundwater systems.

The Parilla Sands is a water table aquifer and therefore influenced by the prevailing climate. However, the depth to groundwater is generally over 20 m, potentially rendering it somewhat insensitive, i.e. takes considerable time for recharge to migrate through the unsaturated zone to become a groundwater accession. During this time it can evaporate, runoff or be transpired by plants.

Given the negligible interaction of the Project on the groundwater environment, climate change is not expected to affect the risk profile.

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# 10. Summary of mitigation measures

Once the potential impacts that require mitigation measures are identified, mitigation measures can be developed and added to the impact assessment register. Mitigation measures consider the ‘mitigation hierarchy’ as part of the design of mitigation measures to reduce/mitigate the significance of effects on the existing environment. As part of this process, where a mitigation measure from lower in the hierarchy is preferred, there must be justification for why controls from higher in the hierarchy cannot be applied. This mitigation hierarchy is illustrated in Figure 19 **Error! Reference source not found.**

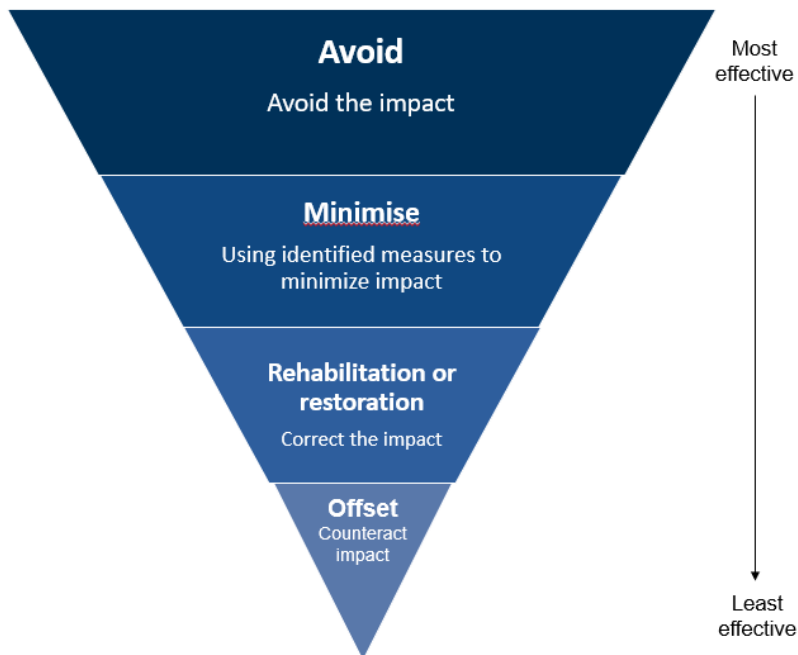


Figure 19 Mitigation hierarchy

Mitigation and contingency measures have been developed in accordance with the mitigation hierarchy and consideration of the level of potential impact. A summary has been provided in Table 18 **Error! Reference source not found.** The focus of these mitigation measures is firstly avoiding impacts where possible (building upon the avoidance measures included in the design), and secondly, implementing project-specific measures to achieve acceptable outcomes for the environment. Where it was deemed necessary, mitigation measures include monitoring of environmental performance and implementation of contingency actions should standards be exceeded.

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Table 18 Mitigation measures

| Risk No.      | Mitigation or contingency measure  | Stage                      |
|---------------|--|----------------------------|
| SW2           | <p><b>Erosion and sediment management</b></p> <p><b>Objective:</b> To reduce erosion of soil and the amount of sediment in surface water runoff to reduce the impact on receiving waterways.</p> <p>Follow EPA publication 1894 Managing soil disturbance (EPA 2020c).</p> <p>Erosion monitoring: Monitoring or areas with significant soil disturbance and overland flow to identify areas within the site boundary that experience erosion and contribute to sediment in surface water runoff.</p> <p>Areas where erosion is likely to occur should be avoided during construction. Sediment traps should be implemented where possible and necessary to reduce the amount of sediment in surface water runoff impacting receiving waterways.</p> <p>Install rock armouring when significant overland flow paths or channels are present (but no other indication of waterway as per <i>Water Act 1989 definition</i>).</p> <p>Install rock armouring if there are signs of wet/unstable soil or changes to vegetation that signal higher water concentration that is likely to impact trail surface stability</p> <p>Review all crossing points identified.</p>   | Construction               |
| SW1, SW3, SW6 | <p><b>Spill management</b></p> <p><b>Objective:</b> Minimise the likelihood and impact of a spillage and establishing controls to contain and clean-up.</p> <p>Follow EPA publication 1698 Liquid storage and handling guidelines (EPA 2018).</p> <p>Implement the CEMP to manage chemical spills and leaks:</p> <ul style="list-style-type: none"> <li>– Australian Standard AS 1940- Storage and handling of flammable and combustible liquids to be adhered to</li> <li>– All storage and transport of chemicals will be undertaken in accordance with the relevant Australian standards</li> <li>– Current safety data sheets (SDS) would be kept on site wherever hazardous materials are being stored</li> <li>– A register of all chemicals and SDS for these chemicals would be held on site</li> <li>– Spill kits would be present on site during these works</li> <li>– All personnel would be trained in spill response procedures and in the use of spill kits</li> <li>– If a spill occurs works would stop immediately, and emergency procedures enacted if required</li> <li>– All regulated and hazardous waste would be stored in a bunded area as far as practical from the waterways</li> <li>– The quantity of materials being stored on site would be minimised</li> </ul> <p>Vehicles will be washed down as part of Biosecurity management and runoff to be contained (treated and managed) to avoid release into any waters.</p> <p>Plant shall not undergo maintenance or cleaning where contaminants could be released to any waters.</p> <p>Refuelling of machinery shall conform with the following:</p> <ul style="list-style-type: none"> <li>– Occur away from waterways unless for tracked machinery and contingency plan management measures are available in the immediate area</li> <li>– Fuelling activity to be supervised at all times</li> <li>– Hoses to be fitted with a stop valve at the nozzle end</li> <li>– Machinery shall be maintained to minimise the leakage of oil, fuel, hydraulic and other fluids. During the servicing of machinery, the Contractor shall use management measures to capture and contain oils, fuels, hydraulic and other fluids so as to minimise contamination of the servicing area</li> </ul> <p>All waste material would be removed from the site before removing any erosion and sediment control measures.</p> <p>All hazardous materials would be removed from site and disposed of appropriately.</p> | Construction and Operation |

| Risk No.        | Mitigation or contingency measure  | Stage  |
|-----------------|--|--|
| SW4, SW5        | <p><b>Drainage paths and surface water runoff</b></p> <p><b>Objective:</b> Reduce changes to overland flow paths and surface water runoff. Significant overland flow paths and drainage channels (as well as irrigation channels, diversions and storages) within the Project area should be avoided during the construction phase of the Project. Commence works away from major overland flow paths within the site boundary.</p> <p>Local drainage and storage should be implemented around construction areas that are located around drainage paths. Local drainage flooding assessment should be undertaken in detailed design to inform micro siting and sizing of drainage infrastructure.</p> <p>Where land elevation has changed during construction and drainage paths disrupted, surface water will be redirected to local channels or flow paths that discharge to their original outlets, e.g. Lake Bael Bael.</p> | Construction and Operation   |
| GW1/GW5         | <b>Spill Management (as per SW3)</b>   | Construction   |
| GW2             | <b>Operation Environmental Management Plan</b>   | Operation  |
| GW3/GW4/GW5/GW6 | <p>GMW licensing process (hydrogeological assessment/groundwater pumping impact assessment)</p> <p>Adoption of directional drilling techniques along transmission line chainages that may intersect waterways</p>  | Construction and Operation (if used for long term water supply for fire suppression) |

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# 11. Conclusions

Based on a desktop review of available information relating to existing surface water and groundwater conditions at the proposed NMEP, GHD has identified the potential impacts of the proposed NMEP (during construction and operation) to surface water and groundwater and potential controls to minimise the potential for site activities to adversely affect the water environment. The following conclusions are made regarding the surface water and groundwater assessment for NMEP:

## **Surface Water**

- Surface water risks associated with flooding or impacting the downstream receiving waterway environments are generally low with recommended mitigation measures
- Surface water risks associated with the Project can be appropriately managed through standard construction management measures such as selective siting, bunding, spill control and sediment and erosion controls
- Any direct disturbance to overland flow paths or drainage paths due to construction of infrastructure associated with wind turbines or the of transmission line and terminal station may require surface protection works to prevent erosion

## **Groundwater**

- Direct interaction with the groundwater environment would be limited based on existing designs (which indicate excavations would generally be above the water table elevation), and related risks are generally low
- Risks associated with buried transmission line construction were classified as low
- Groundwater risks associated with the Project can be appropriately managed through standard construction environmental management measures such as selective siting, bunding, trench breakers, and spill control
- It is possible that future geotechnical investigations undertaken for the Project call for groundwater site investigations to assess groundwater level and/or quality conditions to inform subsurface designs

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## 12. Recommendations

Based on the surface water and groundwater assessment for NMEP, GHD recommends the following:

### **Surface water**

Relevant controls to protect surface water during construction and operation of the Project include:

- Preparation and implementation of a construction environment management plan

### **Groundwater**

Relevant controls to protect groundwater during construction and operation of the Project include:

- Preparation and implementation of a construction environment management plan.
- Where the alignment of transmission lines is to cross under waterways, further investigation should be carried out to confirm the potential for groundwater intersection, and to inform design of directional drilling construction approaches. This would eliminate risks related to conventional trenching within a waterway.
- Existing controls under the *Water Act 1989* regarding the requirement of a technical hydrogeological assessment to support the licensing of groundwater take and use.
- Inferred groundwater conditions are verified during future geotechnical site investigations.

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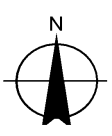
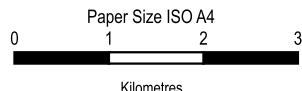
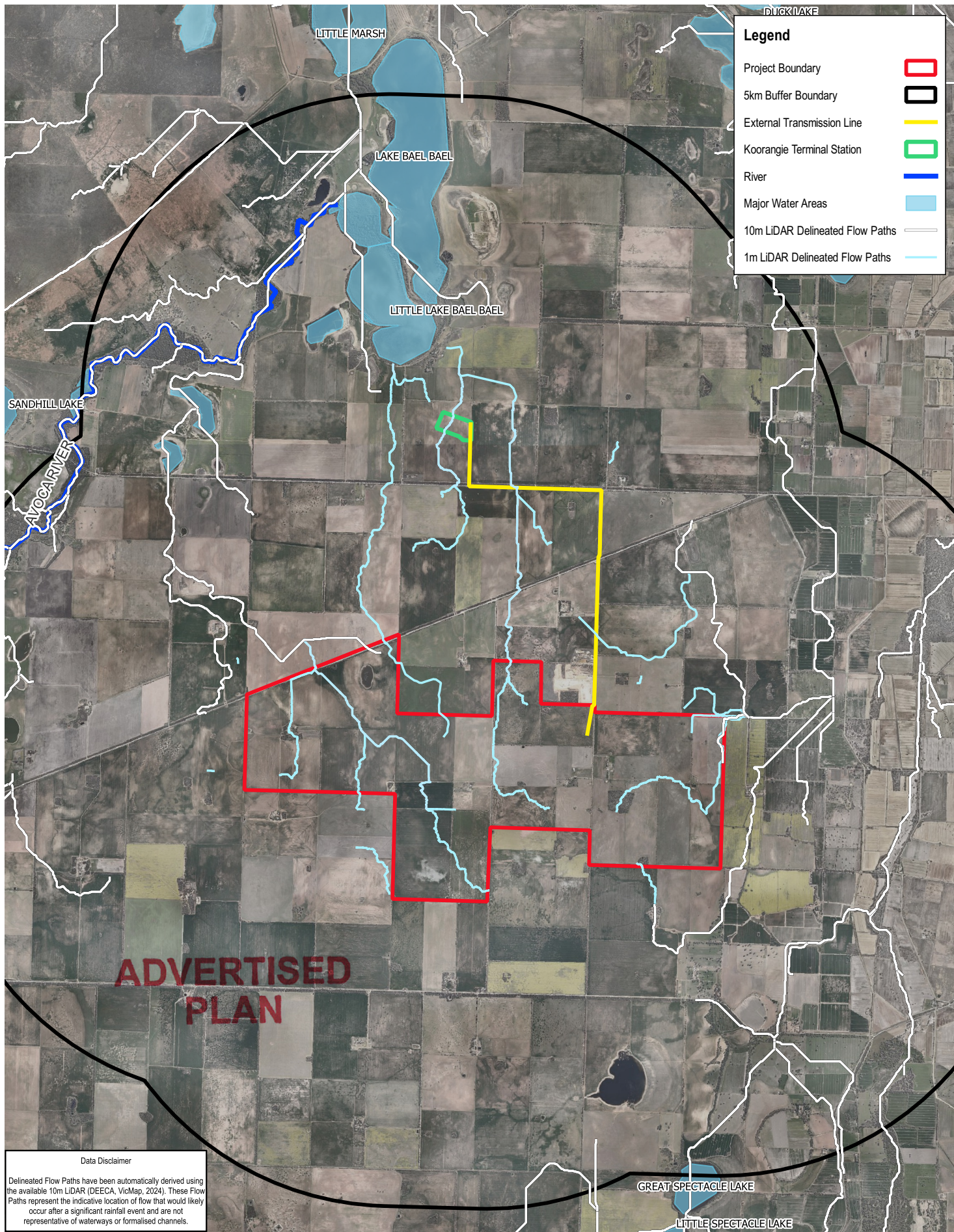
# Appendices

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# Appendix A

## Delineated Flow Paths

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Normanville Energy Park Pty Ltd (NMEP)  
 Surface water and groundwater assessment  
 of the Normanville Energy Park

Project No. 31-12601890  
 Revision No. 5  
 Date 11/20/2024

**Surface Water  
 LIDAR Delineated Flow Paths**

**FIGURE A.1**



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