Hexham Wind Farm

# Chapter 12

## Surface water

WIND PROSPECT

## 12.1 Overview

This chapter describes the surface water environment within and surrounding the project site and defines key surface water features and environmental values. It describes potential construction and operational impacts of the project on these values, and measures that have been taken to avoid and minimise these impacts. This chapter is based on the findings of the ***Surface Water and Groundwater Impact Assessment*** (Appendix B), prepared by Water Technology Pty Ltd.

The surface water investigation area includes the project site and surrounding areas, comprising of the Hopkins River catchment (north and central portions of the project site) and Mustons Creek catchment (upstream of the confluence of Mustons Creek and the Hopkins River). Mustons Creek is a tributary of Hopkins River, located along the eastern boundary of the project site, and Drysdale Creek is a tributary of Merri River, located more than 20 kilometres south of the project site. These waterways and their tributaries are the main surface water features within the project site. Other surface water features within the project site include wetlands, smaller drainage systems and dams. Wetlands within the project site generally capture localised runoff from isolated catchment areas, however some receive flood overflows from Mustons Creek or its tributaries.

Due to the relative flat topography, most depressions within the project site are inundated during winter and spring (during some years) but largely dry out during summer. The larger swampy areas are known to hold water for approximately three to four months, then dry (through both natural flow paths and artificial drains) and form modified grasslands, which are grazed by sheep and cattle. During drier years, these wetlands do not fill and remain modified grasslands.

Key impact pathways to surface water features during project construction and operation include physical disturbance from watercourse crossings, reduced water quality from surface water runoff and sedimentation during periods of high rainfall, and accidental spills of hazardous materials such as fuels and oils. Construction of project infrastructure also has the potential to alter the existing hydrology of the site.

Potential flooding from surface water values within the project site was assessed using hydrologic and hydraulic modelling to inform the siting of infrastructure to avoid areas of potential flooding. Other design mitigations include designing the project with buffers around all mapped wetlands, and minimisation of watercourse crossings through siting of access tracks.

With the implementation of management controls, impacts to Hopkins River and Mustons Creek catchments were assessed to range from negligible to low.

## 12.2 EES objectives and key issues

The EES scoping requirements specify the evaluation objective and key issues, outlined in Table 12.1, relevant to surface water that have guided this assessment.

Table 12.1 EES evaluation objective and key issues

| **Evaluation objective** | |
|---|---|
| **Catchment values and hydrology:** *To maintain the functions and values of aquatic environments, surface water and groundwater quality and stream flows and avoid adverse effects on protected environmental values* | |
| Key issues | • Potential for the project to have a significant effect on hydrology and affect existing sedimentation and erosion processes leading to land and aquatic habitat degradation.<br>• Potential for the project to have a significant effect on surface water and/or groundwater and its environmental values, including through the temporary on-site quarry.<br>• Potential for the project to have significant impact on wetland systems, including, but not limited to, Seasonal Herbaceous Wetlands (EPBC Act listed community), and the ability for wetland systems to support habitat for flora species listed under the FFG Act and EPBC Act. |

## 12.3 Legislation, policy and guidelines

Key legislation, policies and guidelines relevant to the ***Surface Water and Groundwater Impact Assessment*** (Appendix B), and specifically surface water, are summarised in Table 12.2.

Table 12.2 Relevant legislation, policies and guidelines

| Legislation and guidelines | Description | Relevance to project |
|---|---|---|
| **Commonwealth** | | |
| Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2018) | The Australian and New Zealand Guidelines for Fresh and Marine Water Quality were prepared as part of Australia's National Water Quality Management Strategy, and contain guidelines for water and sediment chemical and physical parameters, and biological indicators to assess water quality. | Where indicators and objectives are not prescribed in the Environment Reference Standard, made under the *Environment Protection Act 2017*, trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems (lowland rivers) contained within these guidelines were used in the assessment of water quality. |
| Australian Rainfall and Runoff (ARR2019) (Ball et al., 2019) | The Australian Rainfall and Runoff includes guidelines, data and software for estimating design flood characteristics in Australia. It helps to ensure development does not occur in high flood risk areas and that infrastructure is designed to withstand flood events. | The recommendations set out in ARR2019 were used in undertaking the hydrologic and hydraulic modelling. |
| **State** | | |
| *Environment Protection Act 2017* | The *Environment Protection Act 2017* establishes the legislative framework for protecting the environment in Victoria. The subsequent *Environment Protection Amendment Act 2018* introduced the general environmental duty in relation to risks of harm to human health and the environment from pollution or waste. | The project is being developed under the provisions of the *Environment Protection Act 2017* that relate to the project's general environmental duty, and is required to demonstrate it is implementing measures so far as 'reasonably practicable' to meet the general environmental duty. |
| | Environment Reference Standard | The Environment Reference Standard (ERS), identifies environmental values to be achieved and maintained, and how these values are to be assessed. The ERS is comprised of many 'reference standards', including water (surface water and groundwater) (Part 5 of the ERS).<br><br>The project design and construction would need to consider and apply the ERS relevant to the project. This is further discussed in Section 12.3.1 below. |
| *Catchment and Land Protection Act 1994* | The *Catchment and Land Protection Act 1994* defines requirements to avoid land degradation, conserve soil, protect waste resources, and to eradicate and prevent the establishment and spread of noxious weeds and pest animals.<br><br>The *Catchment and Land Protection Act 1994* integrates management and protection of catchments through catchment management authorities. | The project is located within the Glenelg Hopkins Catchment Management Authority boundary.<br><br>Weeds listed as noxious under the *Catchment and Land Protection Act 1994* were recorded during the flora and fauna assessment. Weed and pest management are discussed in Chapter 8 – ***Biodiversity and habitat***. |

| Legislation and guidelines | Description | Relevance to project |
|---|---|---|
| *Planning and Environment Act 1987* | The purpose of the *Planning and Environment Act 1987* is to establish a framework for planning the use, development and protection of land in Victoria. The Act sets out the process for obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes and permits, and other administrative procedures.<br><br>The Moyne Planning Scheme contains Victoria Planning Provisions within the Planning Policy Framework relevant to surface water. | The land within the project site is subject to the requirements of the Moyne Planning Scheme.<br><br>The Moyne Planning Scheme contains the following Clauses relevant to surface water:<br>• 12.03-1S River and riparian corridors, waterways, lakes, wetlands and billabongs: objective is *"to protect and enhance waterway systems including river and riparian corridors, waterways, lakes, wetlands and billabongs"*.<br>• 14.02-1S Catchment planning and management: objective is *"to assist the protection and restoration of catchments, waterways, estuaries, bays, water bodies, groundwater, and the marine environment"*.<br>• 14.02-2S Water quality: objective is *"to protect water quality"*, with a key strategy to *"ensure that land use activities potentially discharging contaminated runoff or wastes to waterways are sited and managed to minimise such discharges and to protect the quality of surface water..."*. |
| *Water Act 1989* | Victoria's *Water Act 1989* promotes the orderly, equitable and efficient use of water resources to make sure that water resources are conserved and properly managed for sustainable use for the benefit of present and future Victorians. The *Water Act 1989* regulates the impacts on and use of surface water and groundwater.<br><br>Under the *Water Act 1989*, works and activities on or near a designated waterway require a licence from the relevant catchment management authority. The *Water Act 1989* defines a 'designated waterway' as "*a natural channel in which water regularly flows, whether or not the flow is continuous*". | The project is located within the Glenelg Hopkins Catchment Management Authority boundary. The Glenelg Hopkins Catchment Management Authority has statutory responsibilities under the *Water Act 1989*.<br><br>The project would require 56 waterway crossings over designated waterways associated with access tracks and electrical cables (Figure 12.16 and Figure 12.17). This includes crossings over Mustons Creek (two crossings), Tea Tree Creek (one crossing), Lyall Creek (one crossing) and Drysdale Creek (three crossings).<br><br>A licence to construct works across designated waterways or to construct a bore as part of the project would be required from the Glenelg Hopkins Catchment Management Authority. |

| Legislation and guidelines | Description | Relevance to project |
|---|---|---|
| Glenelg Hopkins Catchment Management Authority | The Glenelg Hopkins Catchment Management Authority has developed the following relevant strategies:<br>• Glenelg Hopkins Waterway Strategy 2014-2022, which provides a single planning document for river, estuary and wetland management in the region.<br>• Glenelg Hopkins Regional Floodplain Management Strategy 2017, which seeks to improve management and reduce flood risks across the region.<br>• Glenelg Hopkins Regional Catchment Strategy 2021-2027, which provides an overarching plan for integrated catchment management, and outlines policy directions, challenges and opportunities for the community, water, biodiversity, land, and marine and coast. | The project is located within the Glenelg Hopkins Catchment Management Authority boundary.<br>Works would be undertaken in accordance with Glenelg Hopkins Catchment Management Authority Works on a Waterway permit licence requirements. |
| EPA Victoria Publication 1834.2: *Civil construction, building and demolition guide* | Outlines controls for civil construction and earthworks to manage risks and obligations under the general environmental duty in relation to air, noise, land and water. This includes controls regarding the management of stormwater flows, stockpiles, works within waterways, and storage and handling of chemicals. | Measures for the management of surface water were developed in accordance with controls contained in EPA Victoria Publication 1834.2. |
| EPA Victoria Publication 1893: *Erosion, sediment and dust: treatment train* | Outlines measures to eliminate or reduce the risk of harm from erosion, sediment and dust using a treatment train approach. | Measures to limit erosion and sedimentation of surface water, considering the treatment train approach, have been proposed. |
| EPA Victoria Publication 1894: *Managing soil disturbance* | Provides information about managing soil disturbance and how to eliminate or reduce the risk of harm from erosion, sediment and dust. | Measures to reduce the risk of harm from erosion, sediment and dust from ground disturbance have been proposed. |
| EPA Victoria Publication 1895: *Managing stockpiles* | Provides information about managing stockpiles and how to eliminate or reduce the risk of harm from erosion, sediment and dust generated by stockpiles. | Measures for managing stockpiles to reduce the risk of harm from erosion, sediment and dust have been proposed. |
| EPA Victoria Publication 1896: *Working within or adjacent to waterways* | Provides information about how to eliminate or reduce the risk of harm from erosion, sediment and dust when working within or adjacent to waterways. | Measures for conducting works within or adjacent to waterways have been proposed. |

### 12.3.1 Environment Reference Standard

The ERS is a legislative tool that identifies the environmental values that the Victorian community want to achieve and maintain. and provides a way to assess those environmental values in locations across Victoria.

The ERS identifies four types of surface waters: rivers and streams, wetlands (including lakes and swamps), estuarine, and marine. To define the environmental values relevant to water, each of these surface water types are comprised of 'segments' in the ERS. For surface water, these segments are based on geographical regions or characteristics.

Surface water within the project site falls within the 'Murray and Western Plains' segment of the 'rivers and streams' surface water type. The 'Murray and Western Plains' segment comprises river and stream reaches of lowlands that are generally below 200 metres in altitude, including the Hopkins basin.

Environmental values applicable to these segments and considered relevant to the project are:

- Water dependent ecosystems and species – water quality that is suitable to protect the integrity and biodiversity of water dependent ecosystems.
- Agriculture and irrigation – 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.
- Traditional Owner cultural values – water quality that protects the cultural values of Traditional Owners, which may include traditional aquaculture, fishing, harvesting, cultivation of fresh water and marine foods, fish, grasses, medicines and filtration of water holes.

Water quality indicators and objectives are defined in the ERS to protect these environmental values. The regionalisation of environmental water quality indicators and objectives for different landscape segments is due to natural variations in soils, topography, meteorology and vegetation. Indicators are parameters that can be measured and used to understand the existing conditions of waterways and waterbodies, and to assess impacts both via modelling and water testing. Objectives are the level, load, concentration, amount benchmark or character of an indicator against which the achievement, maintenance of, or risk to, an environmental value is assessed.

The water dependent ecosystems and species of the Murray and Western Plains segment are classified as being 'slightly to moderately modified' and have a different set of indicators and objectives to segments that are 'largely unmodified' (e.g., aquatic reserves) and 'highly modified' (e.g., urban waterways).

The water quality indicators and objectives of the Murray and Western Plains segment for the river and stream reaches of the Hopkins basin are listed in Table 12.3. The 25$^{th}$ and 75$^{th}$ percentiles refer to the values below which 25% and 75% of observations fall, respectively.

Table 12.3 Water quality indicators and objectives (rivers and streams) for the Hopkins basin

*(Source: Environment Reference Standard, Victorian Government Gazette no. S 245, May 2021)*

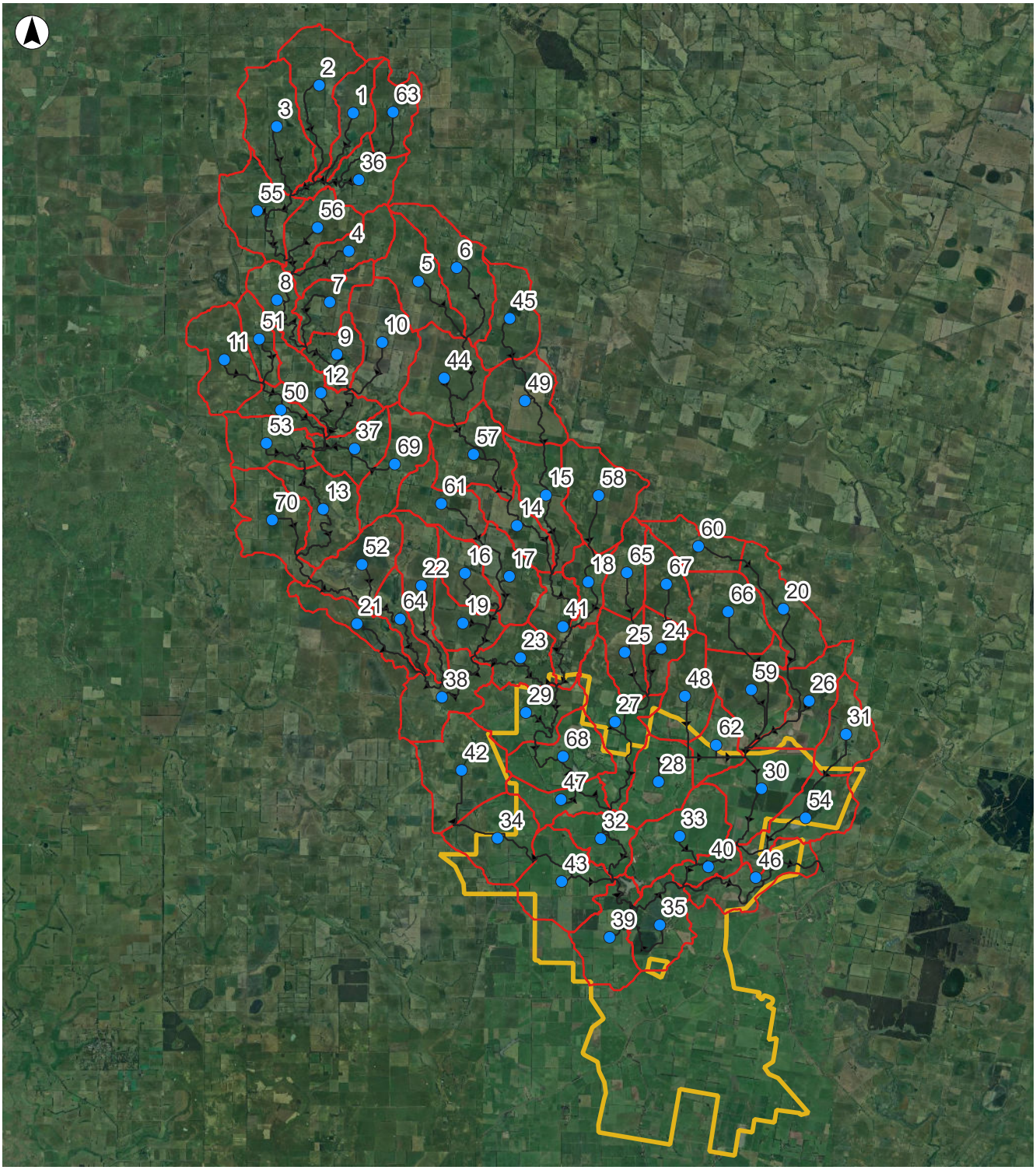
| Indicator | Objective | | |
|---|---|---|---|
| | 25th percentile | 75th percentile | Maximum |
| Total phosphorus (µg/L) | - | ≤55 | - |
| Total nitrogen (µg/L) | - | ≤1,000 | - |
| Dissolved oxygen (percent saturation) | ≥65 | - | 130 |
| Turbidity (nephelometric turbidity units) | - | ≤20 | - |
| Electrical conductivity (µS/cm@ 25°C) | - | ≤2,000 | - |
| pH | ≥7.0 | ≤8.0 | - |

Water quality indicators

- **Total Phosphorus and Total Nitrogen:** refers to the total organic and inorganic phosphorus and nitrogen in a water sample. High nutrient levels can lead to water quality issues such as toxic algal blooms, which can consume oxygen and block light for aquatic plants.
- **Dissolved oxygen:** a measure of how much oxygen is dissolved in water. Low levels of dissolved oxygen (hypoxia) can lead to fish kill events.
- **Turbidity:** refers to the cloudiness of water caused by suspended sediment. High levels of turbidity can block light for aquatic plants and may contain contaminants.
- **Electrical conductivity:** measure of salinity. Depending on their tolerance thresholds, salinity levels above their preferred range can be harmful to aquatic species.
- **pH:** measure of acidity. Changes in pH can affect the toxicity of chemicals and heavy metals present in the water, which can harm aquatic species.

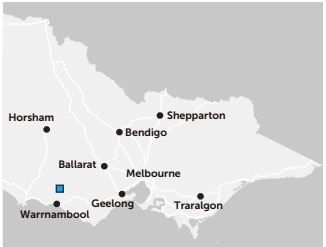
## 12.4 Investigation area

The surface water investigation area includes the project site and surrounding areas, comprising of the Hopkins River catchment (north and central portions of the project site) and Mustons Creek catchment (upstream of the confluence of Mustons Creek and the Hopkins River) (Figure 12.1). While most of the project site is within the Hopkins River catchment, the Hopkins River only comprises a small part of the eastern project site boundary.




**Legend**

- Site boundary
- Subareas of the investigation area
- Subarea nodes
- Reaches




Scale
0 2 4 6 km

Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed.


Figure 12.1 Regional catchments

## 12.5 Method

A combination of desktop information, modelling and field-based surveys were used to characterise surface water within the investigation area. The assessment methods are described below.

### 12.5.1 Desktop assessment

A desktop review of the following databases, maps and reports was undertaken to develop an understanding of the surface water environment within the project site:

- water quality data from relevant DEECA stream flow gauges on Hopkins River (from 1975 to 2005). Due to the age of available water quality records, it was decided to conduct further sampling during the site visit (refer to Section 12.5.3)
- historical flood records
- VicMap Hydro (DEECA) – Watercourse Rivers, which provides a visual representation of drains, channels, creeks, rivers and water storages in Victoria
- Glenelg Hopkins Catchment Management Authority mapping of designated waterways
- DEECA Victorian Wetland Inventory ('current wetlands') database
- Appendix D – ***Flora and Fauna Assessment***
- Glenelg Hopkins Region 3rd Index of Stream Condition Report for 2004–2010 (DEPI, 2013).

### 12.5.2 Surface water modelling

#### Hydrologic and hydraulic modelling

To determine the potential flooding impacts, flood behaviour within the project catchments was assessed using hydrologic and hydraulic modelling:

- **Hydrologic modelling** (rainfall runoff) of the Mustons Creek catchment, upstream of the confluence of Mustons Creek and the Hopkins River, for the 10% and 1% Annual Exceedance Probability (AEP) events using modelling software RORB. A flood with a 1% AEP has a one in a hundred chance of being exceeded in any year, whereas a flood with a 10% AEP has a ten in a hundred chance of being exceeded. This modelling is used to define the existing flood conditions within a catchment by estimating the runoff generated during a rainfall event, and takes into consideration the land cover, topography and soil types within the catchment.

  The RORB model covered the Mustons Creek catchment upstream of the confluence of Mustons Creek and the Hopkins River (Figure 12.1), and was used to produce hydraulic model inflows for Mustons, Burchett and Tea Tree Creeks, as well as smaller local catchments located just outside the project site boundary but that still generate runoff to the site.
- **Hydraulic modelling** (rain-on-grid, or direct rainfall) using hydraulic modelling software TUFLOW, developed to represent flows from Mustons Creek, tributaries and local catchments surrounding the project site, as well as storm events across the project site. A second TUFLOW hydraulic assessment was undertaken to model inundation from the Hopkins River. The Hopkins River 1% AEP streamflow was determined using data from the Hopkins River at Framlingham gauge (236210).

  This modelling is used to establish the extent of the floodplain and streamflow characteristics for different flood events by simulating runoff generated, including:
  - flood level (referred to as afflux) – how high the flood waters get
  - velocity – how fast the water is flowing
  - duration – how long the flood event lasts.

  This model considers factors such as vegetation, floodplain geometry (e.g., topography) and structures (e.g., bridges, culverts) within the catchment. For the project, this model was used to identify how wetlands and other depressions are filled, their maximum size and their interconnectivity.

The modelling software used in the ***Surface Water and Groundwater Impact Assessment*** (Appendix B), are preferred modelling packages for the Glenelg Hopkins Catchment Management Authority and are often used in the flood modelling projects they manage (e.g., Upper Mt. Emu Creek Flood Investigation (Water Technology, 2020), Ararat Flood Investigation (Water Technology, 2017)).

Data used in the model development included:

- Topography based on one-metre resolution Light Detection and Ranging (LiDAR) topographic data specifically captured for the project site in 2020, and 2009-2010 Victorian State-wide Rivers LiDAR and VicMap 10-metre Digital Terrain Model (DEECA) for areas outside the project site.
- Aerial imagery and land use types (to define the hydraulic roughness).
- ARR 2019 to determine rainfall input and losses, and rainfall data from the Bureau of Meteorology
- Intensity Frequency Duration curve data from the Bureau of Meteorology, which show the relationship between rainfall duration and intensity for each AEP event. These curves are used to determine the likelihood of rainfall (and therefore inundation) and define design rainfall depths for the rain-on-grid modelling.
- Streamflow gauge data from the following gauges, used to determine RORB parameters for the hydrology model:
  - Mustons Creek at Hexham (236214), from 1975 to 1982
  - Hopkins River at Wickliffe (236202), from 1964
  - Hopkins River at Framlingham (236210), from 1955.
- Streamflow gauge data from the Hopkins River at Framlingham gauge (236210) from 1955 to 2022, used to determine the 1% AEP streamflow and total flood event volume for Hopkins River for the hydraulic model.

The following studies were also reviewed to determine RORB parameters used in the hydrology modelling:

- Wickliffe Flood Study (Cardno, 2013)
- Port Fairy Regional Flood Study (Water Technology, 2008)
- Upper Mt. Emu Creek Flood Investigation (Water Technology, 2020)
- South Warrnambool Flood Study (Water Technology, 2007).

### Climate change modelling

Climate projection modelling indicates the future impacts of climate change. While it is uncertain how quickly the world would be able to mitigate greenhouse gas emissions, a set of 40 global climate projection models are used around the world to analyse and represent future temperature, evaporation and rainfall. The project's hydrologic and hydraulic modelling used Representative Concentration Pathway (RCP) 8.5 scenario. This scenario represents little curbing of emissions, with carbon dioxide concentrations continuing to rapidly rise and reaching 940 parts per million by 2100. This scenario provides the most conservative assessment of the available RCP scenarios.

Predicted climate change rainfall used in the hydrologic and hydraulic modelling was obtained from ARR2019. The effect of climate change on flood levels for the existing topography of the project site was assessed by comparing results for the current climatic conditions with those for the RCP8.5 climate change scenario.

### On-site quarry modelling

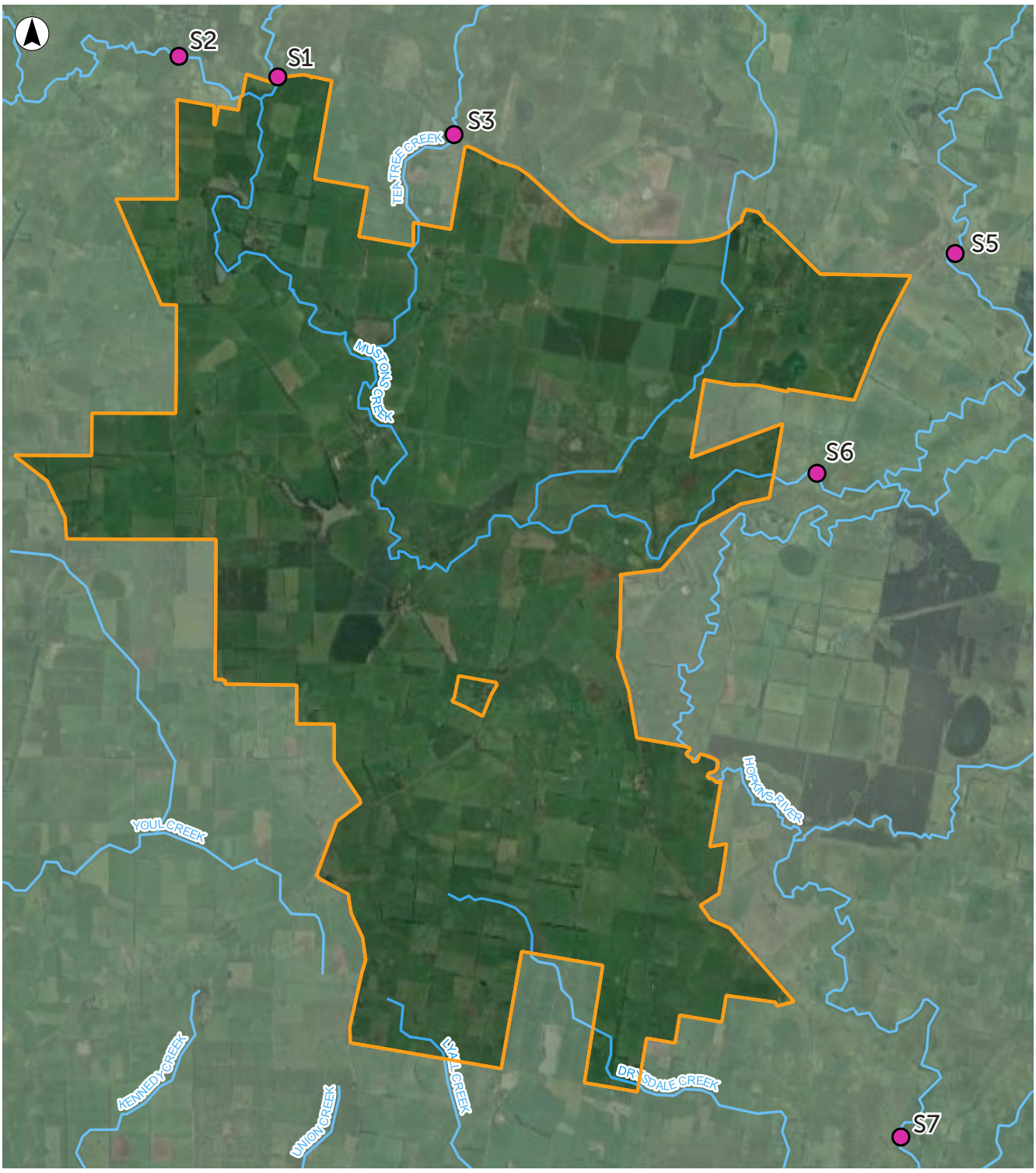
A conceptual water balance model for the proposed on-site quarry site was developed using eWater Source to estimate catchment run-off volume and behaviour. This model considered the required on-site storage during quarry operation (during project construction) and the likelihood of the rehabilitated quarry pit surface water overtopping after decommissioning.

## 12.5.3 Field surveys

As part of the ***Flora and Fauna Assessment*** (provided in Appendix D), field surveys were undertaken to survey fish and identify potential aquatic and semi-aquatic habitats. Water quality and waterbody types (i.e., permanent or temporary) were considered in the assessment of suitable aquatic habitat. A site visit was undertaken by Water Technology on 31 January 2023. During this site visit water quality sampling was undertaken at six locations, as listed in Table 12.4 and shown in Figure 12.2.

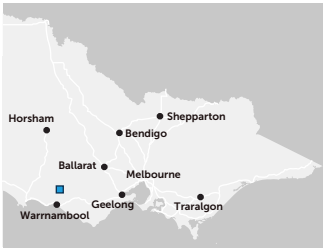
Table 12.4 Water quality sample locations

| Sample ID | Location |
|---|---|
| S1 | Burchett Creek (northern boundary of project site) |
| S2 | Mustons Creek, upstream (northwest of project site) |
| S3 | Tea Tree Creek (northern boundary of project site) |
| S5 | Hopkins River, upstream (northeast of project site) |
| S6 | Mustons Creek, downstream (east of project site) |
| S7 | Hopkins River, downstream (southeast of project site) |




**Legend**

- Water quality sample
- Major watercourse
- Site boundary




Scale

0 1 2 3 4 km

Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed.


Figure 12.2 Water quality sampling locations

### 12.5.4 Impact assessment

Potential impacts to water flow and quality from the construction, operation and decommissioning of the project were assessed for each identified surface water feature (i.e., watercourses, drainages and ephemeral wetlands) within the investigation area. The assessment was based on the flood modelling results and the ***Flora and Fauna Impact Assessment*** (provided in Appendix D) in relation to existing aquatic habitats.

The significance of surface water impacts was assessed against the impact ratings outlined in Table 12.5

Table 12.5 Impact significance criteria for surface water impacts

| Very low/ negligible | Low | Moderate | High | Very high |
|---|---|---|---|---|
| Project results in negligible changes to waterway flow and/or quality.<br><br>Negligible reduction in the extent of a water resource that:<br>• Has a negligible impact on the current or future use of the water resource for third-party users; and/or<br>• Results in negligible or temporary adverse effect on aquatic ecosystems. | Project results in minor (isolated) changes to waterway flow and/or quality.<br><br>Minor reduction in the extent of a water resource that:<br>• Results in a short-term (temporary) reduction of the current or future use of the water resource for third-party users; and/or<br>• Results in short-term adverse effect on aquatic ecosystems. | Project results in changes to waterway flow and/or quality in a local area.<br><br>Reduction in the extent of a water resource that:<br>• Results in a medium-term (temporary) reduction of the current or future use of the water resource for a number of third-party users; and/or<br>• Results in medium-term adverse effect on aquatic ecosystems. | Project results in significant changes to waterway flow and/or quality in local and downstream areas.<br><br>Significant reduction in the extent of a water resource that:<br>• Results in a long-term reduction of the current or future use of the water resource for a number of third-party users; and/or<br>• Results in long-term adverse effect on aquatic ecosystems. | Project results in extensive changes to waterway flow and/or quality in the catchment.<br><br>Significant reduction in the extent of a water resource that:<br>• Results in a permanent reduction of the current or future use of the water resource for a number of third-party users; and/or<br>• Results in permanent adverse effect on aquatic ecosystems. |

## 12.6 Existing conditions

### 12.6.1 Catchments

The project site is within the Glenelg Hopkins Catchment Management Authority management area. Bound by the Great Dividing Range to the north and coastline to the south, the region supports agriculture, supplies water to neighbouring regions, and includes national parks and state forest. Three river basins form the Glenelg Hopkins region: Hopkins, Portland Coast and Glenelg basins. The project is located within the Hopkins basin, where large areas have been cleared for agriculture (primarily for sheep and cattle grazing).

The Hopkins basin is comprised of the Hopkins River catchment, which covers a rural area of approximately 10,000 square kilometres (including all its tributaries). The catchment is comprised largely of agricultural land dominated by dryland sheep and cattle grazing, as well as dryland cereal cropping. The north and central areas of the project site are within the Hopkins River catchment (Figure 12.3)

The Victorian government, in conjunction with the catchment management authorities, have undertaken a state-wide benchmark of the environmental condition of Victoria's major rivers and streams. This is referred to as the Index of Stream Condition, and it is a benchmarking process that provides a measure of river condition. The Index of Stream Condition considers five key aspects (or sub-indices) of river condition:

- hydrology – refers to the amount of water within the river channel at a specific location and point in time. It considers seasonality and variability of flows
- streamside zone – measures characteristics of woody vegetation within 40 metres of the river's edge, including fragmentation, tree cover and presence of weeds
- physical form – considers the condition of the riverbank and in-stream habitat, including presence of artificial barriers
- water quality – considers total phosphorus, turbidity, salinity (electrical conductivity) and pH levels
- aquatic life – based on the number and type of aquatic macroinvertebrates in the river.

Each sub-index is scored out of 10, with higher scores indicating better river condition. These scores are combined to give an overall Index of Stream Condition Score between 0 and 50, which are then categorised into five broad condition bands (i.e., excellent, good, moderate, poor or very poor) for sections of rivers in Victoria, referred to as 'reaches'.

The latest Index of Stream Condition report found that the majority of stream lengths within the Hopkins basin were in poor condition (38%) or very poor condition (56%). A small portion (6%) of stream lengths were in moderate condition.

A summary of the latest Index of Stream Condition report findings for reaches within the Hopkins basin (DEPI, 2013) is provided in Table 12.6 below. The Index of Stream Condition report information for reaches directly relevant to the project is contained in Section 12.6.2

Table 12.6 **Summary of stream reach sub-indices assessed within the Hopkins basin** *(Source: DEPI, 2023)*

| Sub-indices | Summary |
|---|---|
| Hydrology | Natural flow regimes in the Hopkins basin were highly altered, indicating extended periods of low flow, zero flow and summer stress. Two-thirds of reaches in the Hopkins basin had extremely modified flow regimes. The lower reaches of the Hopkins River, Merri River and Mount Emu Creek recorded extended periods of low flow. |
| Physical Form | Physical condition of reaches varied greatly, with excellent (52%) conditions in the south of the basin while also having the poorest reach recorded for the entire Glenelg Hopkins region – reach 28 on Fiery Creek, which scored poorly for fish passage and very poorly for bank stability. |
| Streamside Zone | All reaches were in poor (70%) or moderate (30%) condition.<br><br>Poor condition of streamside vegetation and a lack of large trees along most reaches. |
| Water Quality | The five reaches tested were found to be in poor condition with highly elevated results for phosphorus and salinity. All five reaches were located in the lower area of the basin where land is cleared of vegetation. |
| Aquatic Life | Approximately 24% of reaches were in good or excellent condition. This reflects the extent of land cleared for agriculture and urban development. |

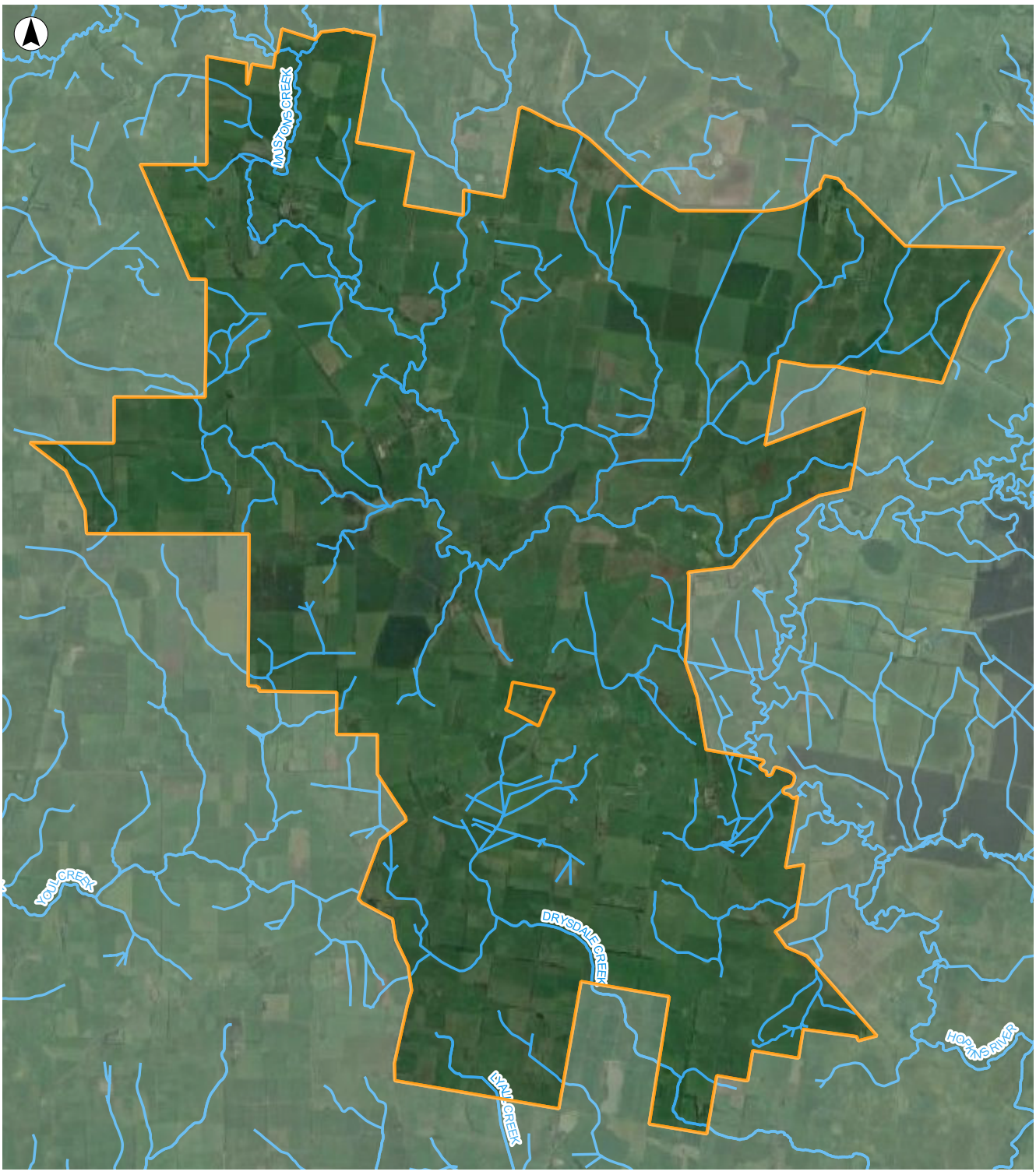
### 12.6.2 Watercourses

A number of watercourses of various size intersect the investigation area. These include:

- Hopkins River
- Mustons Creek and its tributaries, including Burchett Creek and Tea Tree Creek
- Drysdale Creek and its tributaries, including Lyall Creek
- drainage channels and dams.

Surface water in the investigation area generally flows towards Mustons Creek, which joins the Hopkins River east of the project site. In the southern portion of the project site, surface water either flows south to Drysdale Creek and Lyall Creek or south-east to the Hopkins River.

The existing condition of rivers, creeks, wetlands and surface water drainage systems within the project site is discussed in the following sections, and the location of these surface water systems is shown in Figure 12.3 While key fauna habitat within these watercourses is summarised below, further discussion is contained in Chapter 8 – ***Biodiversity and habitat***.




**Legend**

Site bounday

Major and Minor watercourse


Scale

0 1 2 3 4 km

Data: State of Victoria (DECCA/Land Use Victoria), Commonwealth of Australia, Wind Prospect, and specialist studies/reports. Data is indicative only; accuracy and completeness are not guaranteed. © State of Victoria and other data providers

Figure 12.3 Local watercourses in relation to the project site

### Hopkins River

The Hopkins River, mapped by the Glenelg Hopkins Catchment Management Authority (Waterway 36/1), forms a small portion of the eastern project site boundary (Figure 12.3) The Hopkins River originates north of Ararat, being fed by various tributaries before discharging into the ocean at Warrnambool. Example images of Hopkins River east of the project site are provided in Figure 12.4 and Figure 12.5 below.

Figure 12.4
Hopkins River at Hexham (east of the project site)
*(Source: Water Technology)*

Figure 12.5
Hopkins River at Ellerslie (east of the project site)
*(Source: Water Technology)*

#### *Physical form and hydrology*

Large floods on the Hopkins River, have occurred in 1960, 1975, 1978, 1983, 1986, 2010, 2011 (largest on record) and 2016. There are two stream flow gauges on the Hopkins River: Hopkins River at Wickliffe (236202) and Hopkins River at Framlingham (236210), which provide water quality data as well as stream flow. The Wickliffe gauge (located 45 kilometres north (upstream) of the project site) has recorded flow data from 1964 to present day, while the Framlingham gauge (located 21 kilometres south-east (downstream) of the project site) has flow data spanning from 1955 to present day.

The hydraulic model for the Hopkins River shows that in a 1% AEP flood event, the floodplain inundation is wider than one kilometre in some sections near the project site. However, most of the project site is outside the modelled flood extent (Figure 12.6).