Hexham Wind Farm

Chapter 11

Groundwater

WIND PROSPECT

11.1 Overview

This chapter describes the groundwater within and surrounding the project site and defines key values associated with it. It assesses potential project impacts on these values, and measures to be 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. Aspects relating to Groundwater Dependent Ecosystems (GDEs) are also considered the ***Flora and Fauna Assessment*** by Nature Advisory Pty Ltd (Appendix D). Surface water impacts are discussed separately in Chapter 12 – ***Surface Water***.

Groundwater refers to a water resource beneath the surface of the earth that forms when water seeps into the ground and is collected within aquifers (permeable rock).

Groundwater supplies around 30% of Australia's total water needs (DCCEEW, 2016).

The geology across most of the project site consists of Upper-Tertiary/Quaternary Basalts, the Upper-Tertiary Aquifer and the Quaternary Alluvium. Groundwater level measurements taken from 15 groundwater bores within and near the project site ranged from 3.25 to 13.75 metres below ground level, while measurements taken from four investigation bores within the boundary of the proposed on-site quarry and three existing bores near the quarry site ranged from 9.38 to 13.30 metres below ground level. Groundwater flow in the water table aquifer is influenced by recharge which occurs via infiltrating rain (during winter and spring). Groundwater depletes through evapotranspiration as well as through discharge via extraction from bores and at the edge of geological formations and topographic lows where surface expressions of groundwater occur (e.g., springs).

The Visualising Victoria's Groundwater database maps 59 bores within the project site, most of which are listed as being used for stock and domestic purposes. A field survey conducted in July 2023 identified three bores near the proposed on-site quarry. There are also potential aquatic and terrestrial groundwater dependent ecosystems (GDEs) that occur within the project site, including those that have a high potential of being supported by groundwater.

Construction and operation of the project has the potential to result in localised lowering of the water table and reduced groundwater availability due to groundwater dewatering during wind turbine foundation excavations, altered groundwater recharge, or barriers to water movement related to infrastructure foundations and hardstands. Reduced groundwater quality from accidental spills of hazardous chemicals or fire water may also potentially occur.

Management measures have been proposed for the construction, operation and decommissioning phases of the project to further manage potential groundwater impacts. With these measures in place, the impacts to groundwater users and groundwater quality were assessed to be very low to low.

11.2 EES objectives and key issues

The EES scoping requirements specify the following evaluation objective and key issues, outlined in Table 11.1, relevant to groundwater that have guided this assessment.

Table 11.1 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. • 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. • 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.

11.3 Legislation, policy and guidelines

Key legislation, policies and guidelines relevant to the *Surface Water and Groundwater Impact Assessment* (Appendix B), and specifically groundwater, are summarised in Table 11.2.

Table 11.2 Relevant legislation, policies and guidelines

Legislation and guidelines	Description	Relevance to project
State		
Extractive Industries Development Act 1995	Requires extractive industry to meet safe operating standards and ensures rehabilitation of quarried land to an appropriate, stable landform. This includes measures to protect and manage groundwater resources.	A Rehabilitation Plan will be developed to address the requirements of the *Extractive Industries Development Act 1995*.
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), made under the *Environment Protection Act 2017*, 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). The project design and construction would need to consider and apply the ERS relevant to the project. This is further discussed in Section 11.3.1.
Environment Protection Regulations 2021	These regulations support the *Environment Protection Act 2017* by detailing prescribed activities, permissions, and conditions. Schedule 1 defines activities requiring EPA Victoria permission, including discharges to aquifers.	Infiltration from proposed retention basins, including at the proposed on-site quarry, may result in discharge to an aquifer. As such, an A18 permit may be required under the Environment Protection Regulations 2021. The project will assess whether the activity constitutes a discharge of waste to groundwater and obtain appropriate permissions from EPA Victoria as required in accordance with final designs.

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. The Moyne Planning Scheme contains clauses within the Planning Policy Framework and Particular Provisions relevant to groundwater.	The land within the project site is subject to the requirements of the Moyne Planning Scheme. The Moyne Planning Scheme contains the following Clauses relevant to the groundwater assessment for the project: • 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"* • 14.02-2S Water quality: objective is *"to protect water quality"*, with a key strategy to *"Avoid detrimental impacts on groundwater resources and minimise risk of harm to human health and the environment from proposed land use or development"*.
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. The Act includes provisions for various licences, including a Take and Use Licence for extracting groundwater and a Section 76 Licence for the underground disposal of matter via a bore or similar structure.	Southern Rural Water is the delegated authority under the *Water Act 1989*. A Take or Use Licence for groundwater is not required from Southern Rural Water for dewatering where groundwater will not be intentionally encountered (e.g., in foundations). Permits and any associated investigations will be required if groundwater is targeted as a water supply. As the project will intercept groundwater at the proposed on-site quarry, the project will apply for a Take and Use Licence to dewater the quarry site, should water be used outside the quarry site. Additionally, if infiltration from retention basins results in the underground disposal of matter, a Section 76 licence may be required. This licence ensures that the disposal does not adversely affect groundwater quality or aquifer integrity. Appropriate licencing will be obtained from Southern Rural Water as required in accordance with final designs.
Mineral Resources (Sustainable Development Act) 1990	The purpose of the *Mineral Resources (Sustainable Development Act) 1990* is to encourage mineral exploration and extraction to occur in a way that aligns with the economic, social and environmental objectives of Victoria.	Following the finalisation of the EES, a work plan and work authority will need to be submitted to the regulator for approval under the *Mineral Resources (Sustainable Development Act) 1990.*

11.3.1 Environment Reference Standard

The ERS (see Table 11.2) specifies potential environmental values based on the background water quality of groundwater, specifically the concentration of total dissolved solids (TDS). Seven 'segments' of groundwater are defined depending on the concentration of TDS in groundwater, with Segment A1 having a TDS concentration of 0–600 milligrams per litre and Segment F having a TDS concentration of more than 10,001 milligrams per litre .

Based on groundwater salinity measurements taken from 15 groundwater bores in June 2019 and Visualising Victoria's Groundwater water table salinity mapping, groundwater within the project site is classified as falling within Segments A2 to D (TDS range of 1,000–7,000 milligrams per litre. Environmental values applicable to these segments are indicated in Table 11.3.

Groundwater is suitable for all but potable water across most of the project site, although fresher water is possible in some areas. Groundwater higher than 3,100 milligrams per litre is unsuitable for some agriculture purposes and irrigation.

Table 11.3 Environmental values that apply to the groundwater segments relevant to the project

Environmental value	Segment (TDS milligrams per litre)			
	A2 (601 – 1,200)	B (1,201 – 3,100)	C (3,101 – 5,400)	D (5,401-7,100)
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	✓	✓	✓	✓

** Environmental values relevant to the project*

11.4 Investigation area

The investigation area includes the project site and immediate surrounding areas that may have hydrogeological connectivity with site activities. An area extending five kilometres from the project boundary was used for the hydrogeological data capture and review process. This area was included to provide geological context and to identify potential groundwater users.

11.5 Method

11.5.1 Existing conditions

Desktop information and field-based survey techniques were used to characterise groundwater within the project site. The assessment included the:

- Review of legislation and policies relevant to the assessment of groundwater impacts
- Review of existing land and water use, including the identification of:
  - registered groundwater bores via the Visualising Victoria's Groundwater website
  - GDEs as shown in the Bureau of Meteorology GDE Atlas
- Characterisation of the surface and underlying geology, informed by:
  - 25 resource investigation drillholes (drilled to depths of up to 18 metres) within the area of the proposed on-site quarry (Figure 11.1)
  - borelogs from existing bores drilled near the proposed on-site quarry (Figure 11.1)
  - geological and hydrogeological spatial layers available through Visualising Victoria's Groundwater online portal
- Review of the Victorian Aquifer Framework (GHD, 2012) to identify hydrostratigraphic units within the project site
- Development of a hydrogeological conceptual model and groundwater level maps, based on Visualising Victoria's Groundwater mapped depth to groundwater level, Water Measurement Information System available data, and groundwater level measurements taken from 15 groundwater bores within and surrounding the project site in June 2019
- Estimation of inflow rates and drawdown around the proposed on-site quarry, based on hydraulic testing, water level monitoring and groundwater quality sampling undertaken at four groundwater monitoring bores (P23-04, P23-12, P23-14 and P23-22) established in April 2023 (Figure 11.1).

Hydrostratigraphic units are geologic layers that share similar hydrologic characteristics or properties associated with groundwater flow. These units can be classified into aquifer or aquitard units.

A **hydrogeological conceptual model** represents the hydrogeological (groundwater) setting, including:

- movement of groundwater
- groundwater-surface water interactions
- groundwater receptors (users and receiving environments).

The location of the proposed on-site quarry in relation to the project site is detailed in Figure 6.2, shown in Chapter 6 – ***Project description***.

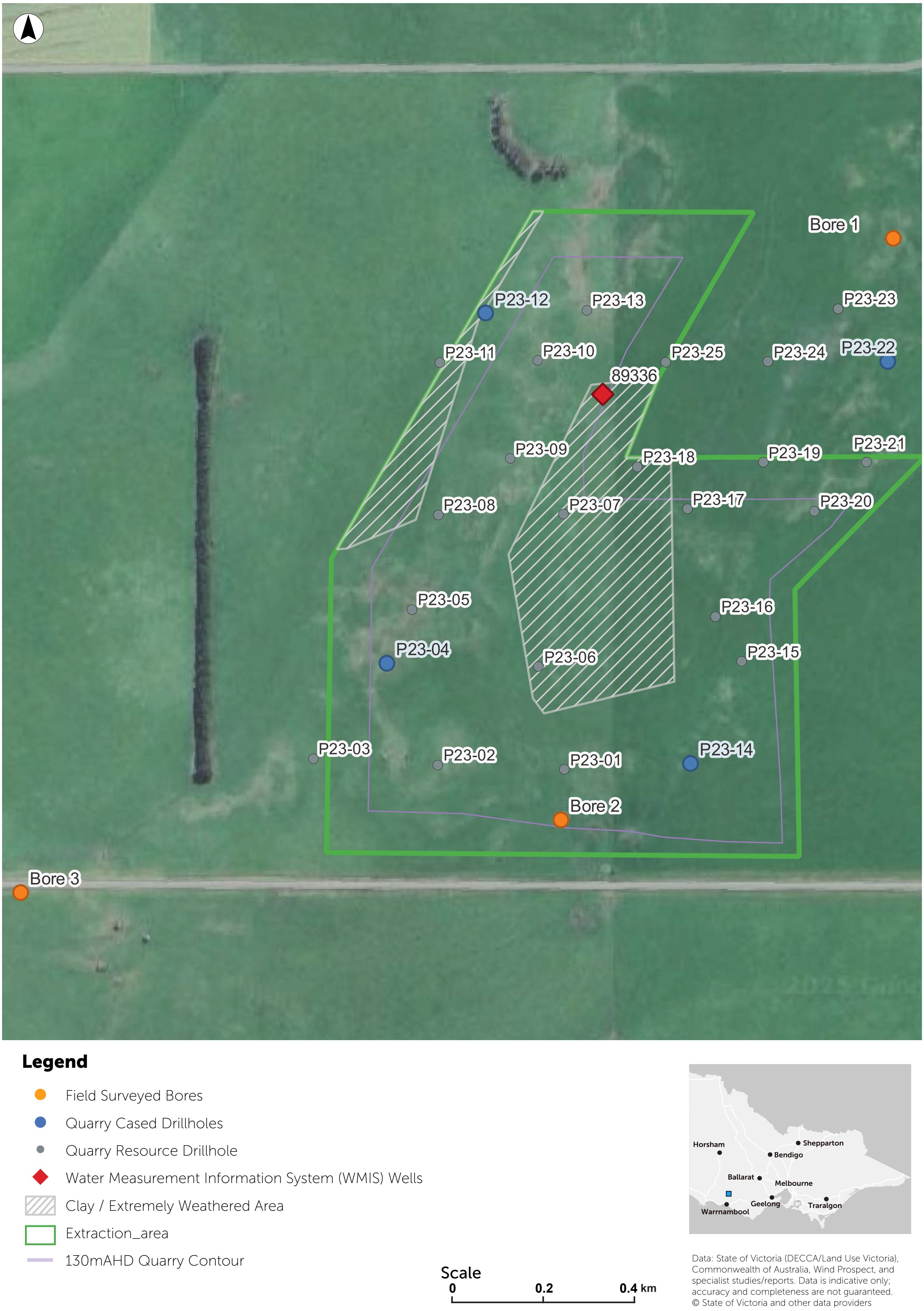


Figure 11.1 Drillholes and proposed on-site quarry extent

11.5.2 Impact assessment

A qualitative assessment of impacts associated with the wind turbine foundation and cable trench excavation sites, and the proposed on-site quarry has been undertaken. The significance of groundwater impacts was assessed against the impact ratings outlined in Figure 11..

Table 11.4 Significant rating criteria for groundwater impacts

Very low/ negligible	Low	Moderate	High	Very high
Project results in negligible groundwater drawdown. Negligible reduction in the extent of the groundwater resource and/or quality that: • has a negligible impact on the current or future utility of the water resource for third-party users; and/or • results in negligible or temporary adverse effect on aquatic ecosystems.	Project results in minor (highly localised) groundwater drawdown. Minor reduction in the extent of the groundwater resource and/or that: • results in a short-term (temporary) reduction of the current or future utility of the water resource for third-party users; and/or • results in short-term adverse effect on aquatic ecosystems.	Project results in groundwater drawdown in a local area. Reduction in the extent of the groundwater resource and/or that: • results in a medium-term (temporary) reduction of the current or future utility of the water resource for a number of third-party users; and/or • results in medium-term adverse effect on aquatic ecosystems.	Project results in groundwater drawdown that extends into the regional area. Significant reduction in the extent of the groundwater resource and/or that: • results in a long-term reduction of the current or future utility of the water resource for a number of third-party users; and/or • results in long-term adverse effect on aquatic ecosystems.	Project results in groundwater drawdown on a regional scale. Significant reduction in the extent of the groundwater resource and/or that: • results in a permanent reduction of the current or future utility of the water resource for a number of third-party users; and/or • results in permanent adverse effect on aquatic ecosystems.

11.6 Existing conditions

11.6.1 Geology

The project site is in the south of the Western Volcanic Plain. This volcanic region is part of a broad basaltic lava province active during the past six million years and referred to as the Newer Volcanic Province, a major geological unit of southern Australia. Further discussion of the local geology relevant to the region is contained within Chapter 13 – ***Landform and soils***.

The surface geology within the project site primarily consists of the Newer Volcanic Group basalt flows, with outcrops of Whalers Bluff / Hanson Plain sand in the north and to the east of the project site, and alluvial deposits scattered across the landscape, mainly in, and adjacent to, drainage lines. Alluvium refers to material (e.g., clay, silt, sand) deposited by running water. At the proposed on-site quarry site, weathering of basalt material to clay was observed in several drillholes. Twenty-three of the 25 drillholes terminated in basalt, which means that basalt is likely to extend to at least 18 metres in depth at most locations. The surface geology of the project site is illustrated in Figure 11.2.

Within the Newer Volcanic Province, several geological units form aquifers that have different depths and quality. The primary aquifer units within project site are associated with the following geological layers:

- unconsolidated alluvium and colluvium deposits (Quaternary Aquifer)
- Newer Volcanic Group basalts (Upper Tertiary/Quaternary Basalt)
- Whalers Bluff / Hanson Plain (Upper Tertiary Aquifer)
- Port Campbell Limestone (Upper mid-Tertiary Aquifer).

A cross-section of the aquifer layers shown in Figure 11.3.

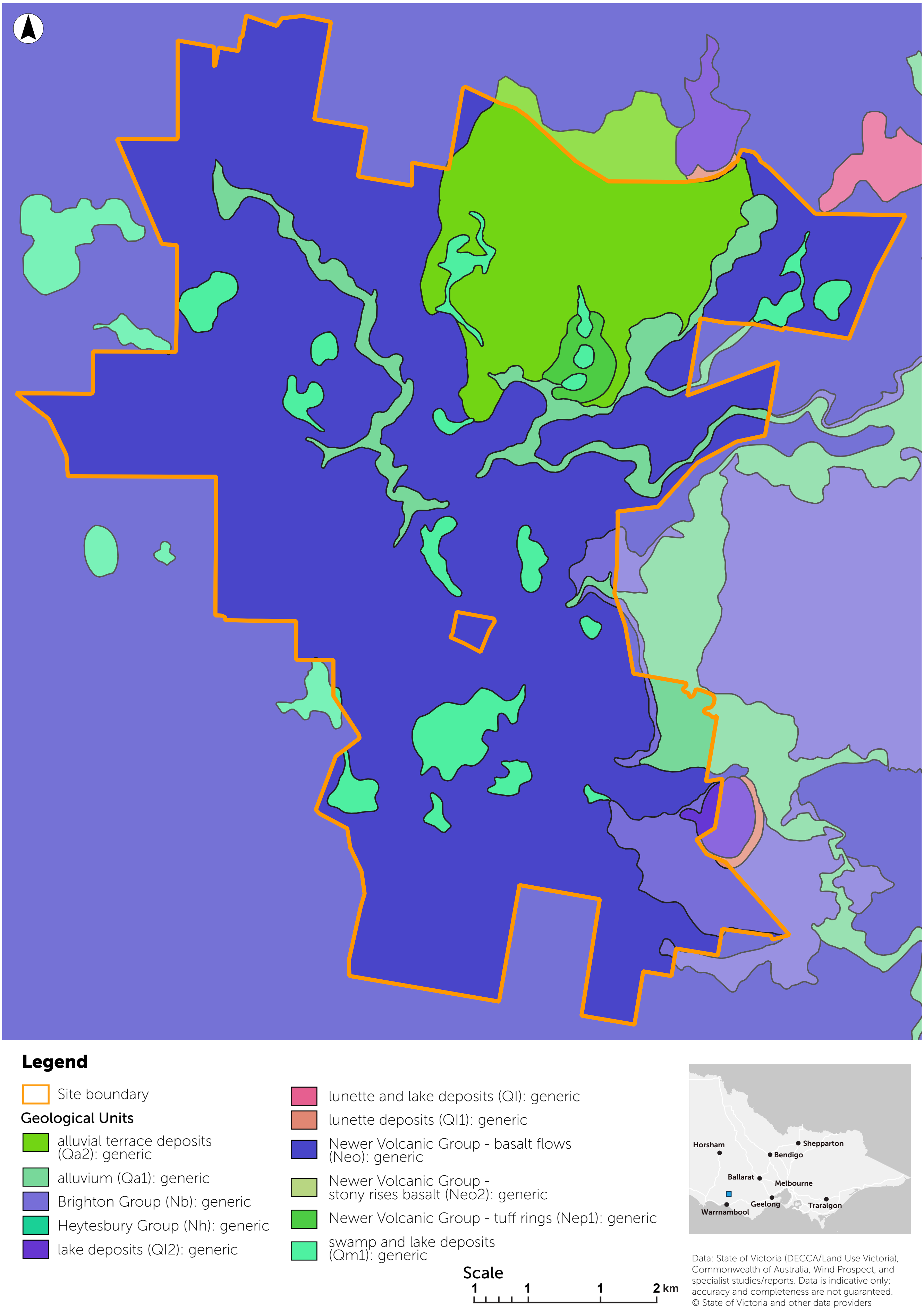


Figure 11.2 Surface geology

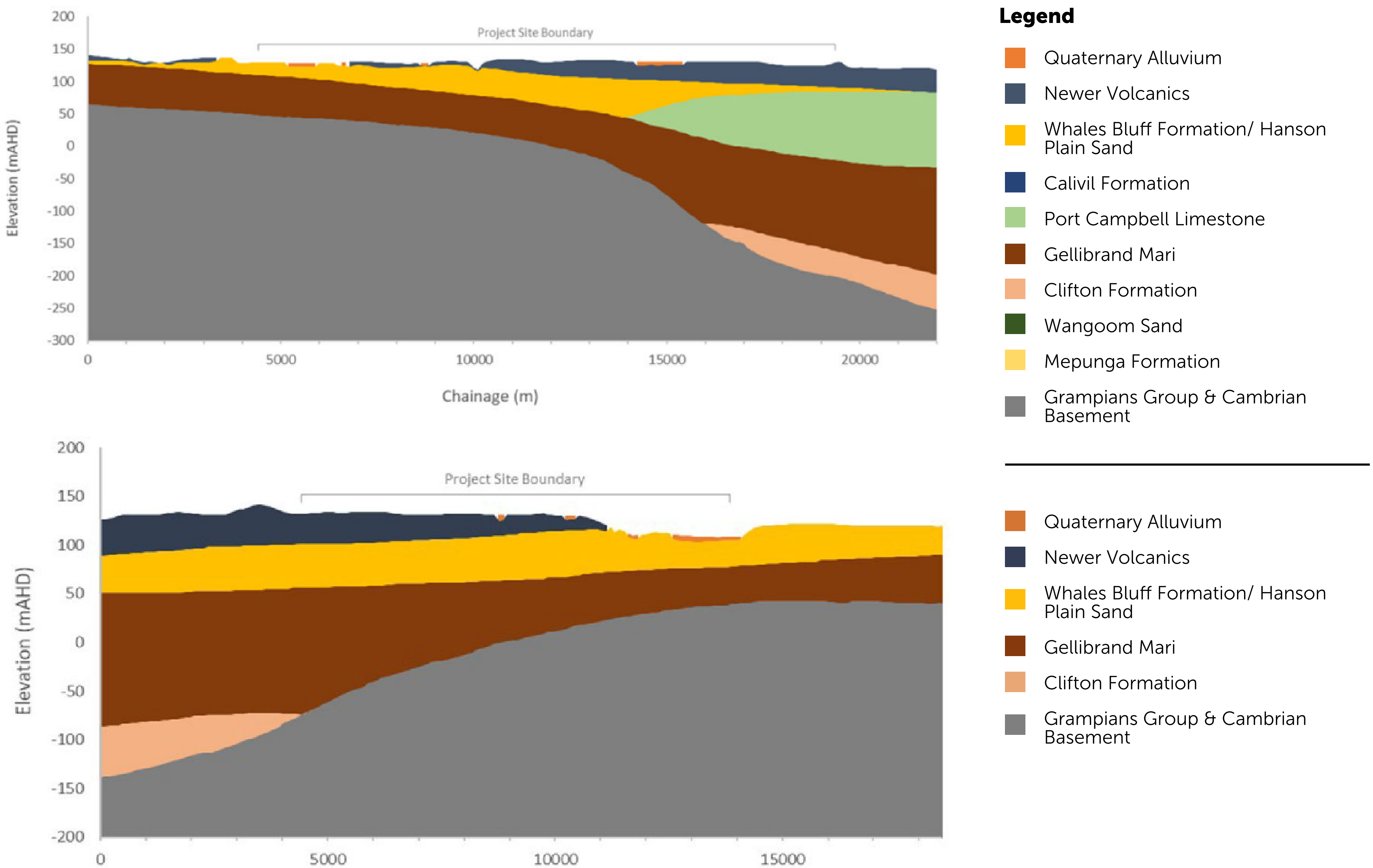


Figure 11.3 Illustrative north-south (top) and west-east (bottom) cross section views of the hydrostratigraphic layers within the project site

Unconsolidated alluvium/colluvium deposits (Quaternary Aquifer)

The local Quaternary Aquifer is comprised of gravels, sands and silts, forming a thin layer of alluvial material in low-lying areas near drainage channels and on the base of hillslopes. These deposits are found between the natural surface to a depth of around five metres.

Within the project site, unconsolidated alluvium and colluvium surface deposits are found near Mustons Creek, Tea Tree Creek and Drysdale Creek (Figure 11.2). The unconsolidated alluvium and colluvium surface deposits overlie the Newer Volcanic Group basalts.

Newer Volcanic Group basalts (Upper Tertiary/Quaternary Basalt)

The local Upper Tertiary/Quaternary Basalt comprises the Newer Volcanic Group basalt flows, overlain locally by stony rises and scoria. These basalt flows and stony rises comprise the majority of the project site surface geology, except in the north and to the east of the project site (Figure 11.2). The Newer Volcanic Basalts occur between the natural surface to a depth of around 40 metres. At the proposed on-site quarry location, basalt is interpreted to extend to a depth of 24 metres below ground level based on the drill log from an existing bore, which is around 6 metres below the proposed based on the quarry.

Stony rises occur in areas within the project site where lava flows buried soil that was present on previous lava flows, and are reported to be less weathered and more fractured.

Across the project site the Newer Volcanic Group basalt and stony rises provide unconfined fractured rock aquifer. In these aquifers, groundwater flow is controlled by fracture zones through which groundwater infiltrates and flows. Groundwater flow is also controlled by the rock type, level of rock deformation and undulations of the land surface.

Whalers Bluff Formation / Hanson Plain Sand (Upper Tertiary Marine and Fluvial Aquifer)

Whalers Bluff Formation and the Hanson Plain Sand aquifer is comprised of Pliocene-age marine and fluvial deposits, composed mostly of quartz sand, silty sand, shelly sand and basal reworked gravels. This aquifer is present across the project site as a continuous layer and reaches a combined thickness of up to 50 metres.

Port Campbell Limestone (Upper mid-Tertiary Aquifer)

Beneath the Newer Volcanic Group basalts is the Port Campbell Limestone, comprised of marine silts and clays from depths of around 50 to 200 metres below the natural surface. This Upper mid-Tertiary Aquifer is typically around 100–200 metres thick across the South-west Coast sub-region and is a major aquifer in the region. Outcropping of Port Campbell Limestone occurs in some areas and overlain by Newer Volcanic Group basalts in others. The Port Campbell Limestone aquifer is classified as 'partially (or semi) confined' in areas where it is overlain by Newer Volcanic Group basalts.

Gellibrand Marl (Upper Mid-Tertiary Aquitard)

The Gellibrand Marl forms a regionally extensive, low permeability aquitard located at depths around 50 to 100 metres below the project site. Due to this low permeability, this unit is not used as a water source. This aquitard forms a barrier between the above hydrostratigraphic units, and the deeper aquifer units of the Otway Basin described below.

Other regional geological units

Other aquifer units that occur in the vicinity of the project site include:

- Clifton Formation (Lower mid-Tertiary Aquifer): a confined limestone aquifer, typically 15 to 25 metres thick, located throughout most of the Otway Basin. It is considered the Clifton Formation is not hydraulically connected to the Port Campbell Limestone aquifer as it is separated by the Gellibrand Marl aquitard.
- Dilwyn formation (Lower Tertiary Aquifer): up to 1,000 metres below the surface in some areas, this aquifer is used to supply the townships of Portland, Port Fairy, Heywood and Dartmoor. Due to the depth of this aquifer, it is not extensively used (unlike the limestone and basalt aquifers).

11.6.2 Depth to groundwater

The depth to groundwater differs across the region, and it is influenced by seasonal rainfall and longer-term climatic changes. Across the project site, groundwater may be within five metres of ground level areas in areas associated with topographic lows and drainage lines. Away from drainage lines, groundwater is estimated to be between five and 20 metres below the natural surface level.

Groundwater level measurements taken from the 15 groundwater bores across the investigation area ranged from 3.25 to 13.75 metres below ground level. Based on groundwater level measurements taken from the four investigation bores within the boundary of the proposed on-site quarry, and observed levels in three existing bores (bores 1, 2 and 3), groundwater levels range from 9.38 to 13.30 metres below ground level. A regional interpretation of average depth to groundwater, based on data from Visualising Victoria's Groundwater and the bore measurements taken for the project, is shown in Figure 11.4.

Seasonally, groundwater levels vary by about 0.2 metres, with the highest levels generally observed around spring, and the lowest levels around autumn. Similar trends are observed in bores located outside the project site boundary, with the seasonality in some bores being higher at around 0.5 metres.

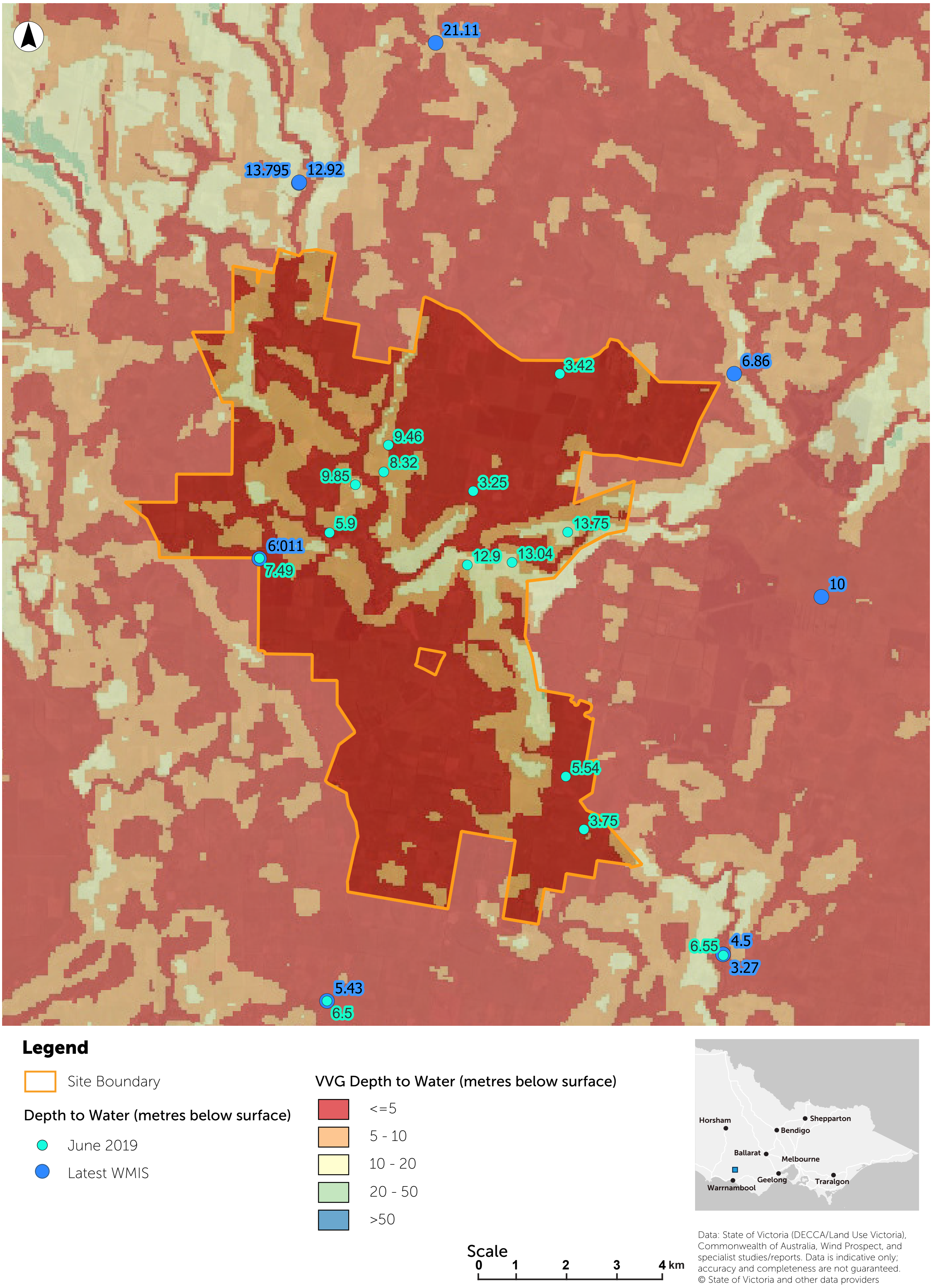


Figure 11.4 Predicted depth to water table, and groundwater levels from 15 bores (June 2019) and available Water Measurement Information System (WMIS) data *(Source: Visualising Victoria's Groundwater www.vvg.org.au and groundwater measurements)*

11.6.3 Groundwater flow, recharge and discharge

Groundwater flow in the water table aquifer has been interpreted from the Visualising Victoria's Groundwater database of water table elevation. The elevation change follows a regional groundwater gradient from north (higher elevation) to south (lower elevation). Groundwater flow is driven by recharge which occurs from infiltrating rain (during winter and spring), with estimates of between 10 to 40 millimetres per annum reported by Dahlhaus et al. (2002). In areas of stony rises, groundwater recharge may be higher than within the basalt flows because they are more permeable and fractured. The underlying Whalers Bluff Formation / Hanson Plain sand aquifer is recharged by direct rainfall infiltration where the aquifer is reaches the surface.

Discharge from the Newer Volcanic Group basalt aquifer and the Whalers Bluff Formation / Hanson Plain sand aquifer occurs through evapotranspiration, groundwater extraction from bores and at the edge of formations and topographic lows where groundwater reaches the surface (e.g., springs). Local groundwater information provided by landowners indicates that most springs in the area fill during winter and dry up during summer. Groundwater may also discharge into streams (as baseflow) and into unconsolidated alluvium/colluvium deposits (Quaternary Aquifer).

Hydraulic conductivity represents the ease in which water can move through the pore spaces and fractures in the rock.

The Newer Volcanic Group basalt is the main aquifer within the project site. Groundwater flow within this aquifer is variable because aquifers of volcanic origin have variable hydraulic parameters. The parameter of interest is hydraulic conductivity. Hydraulic conductivity values range from 0.001 to 100 metres per day for the Newer Volcanic basalt. The lower estimate represents tight fractures, and the upper estimate represents open fractures and lava tubes. The hydraulic conductivity range is consistent with the description that groundwater moves through the fractured rocks at highly variable rates (Dahlhaus et al., 2002). Quaternary deposits exhibit a wider hydraulic conductivity range from 1×10^{-6} to 100 metres per day, while the Pliocene Sands (Whalers Bluff / Hanson Plain) range from 0.01 metres per day to 100 metres per day .

11.6.4 Groundwater quality

The geology, water-rock interactions and local groundwater flow systems can influence groundwater quality and recharge. Groundwater salinity (measured as electrical conductivity or as TDS) is generally used as a measure of quality due to its implications for groundwater use and land management.

Using the Visualising Victoria's Groundwater database, groundwater salinity in the water table aquifer is expected to be in the range of 1,000 to 3,500 milligrams per litre in the south of the project site, and 3,500 to 7,000 milligrams per litre in the north. The salinity ranges correspond to Segments A2 to C in the Environment Reference Standard (see Section 11.3.1).

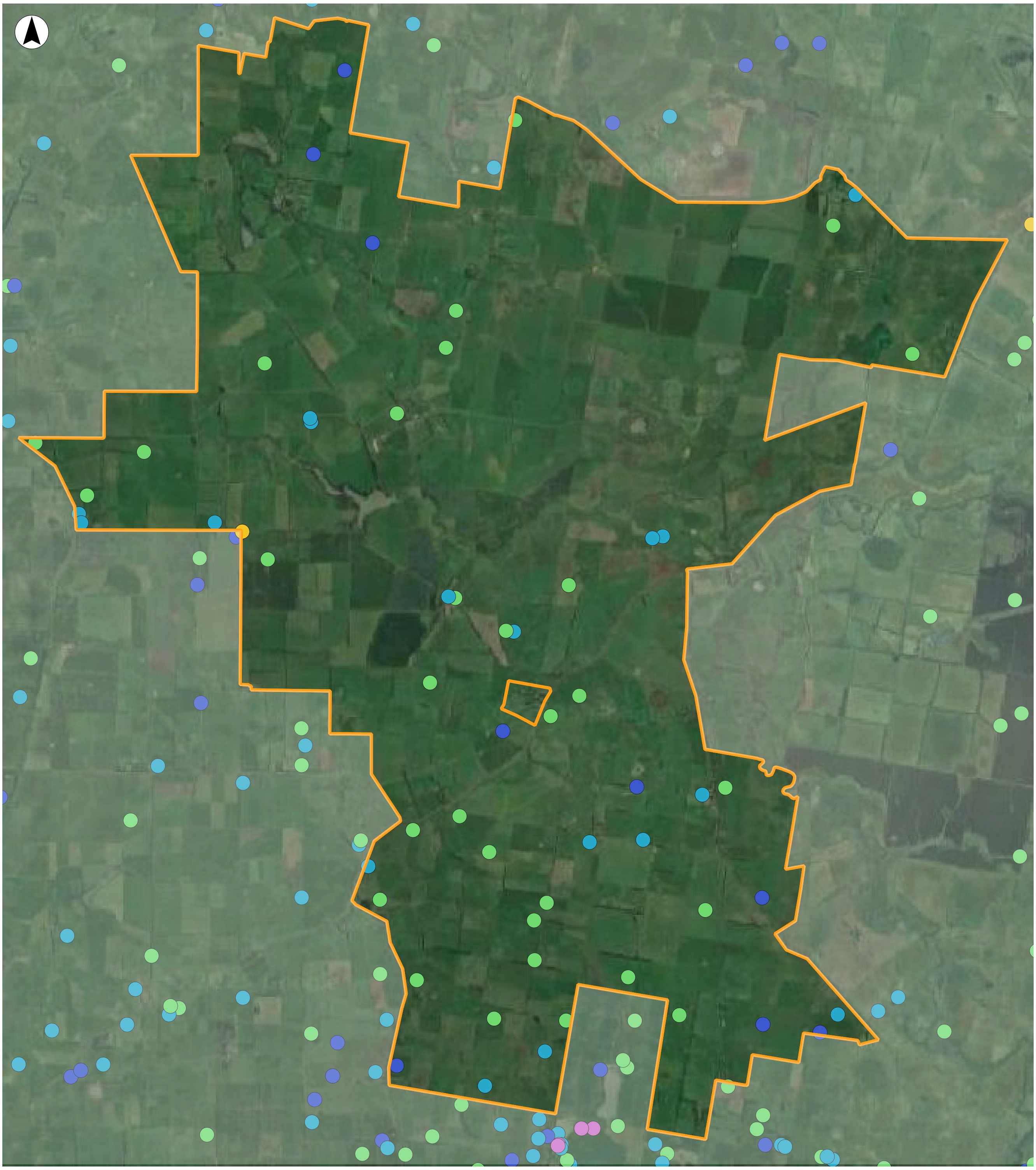
Groundwater salinity measurements taken from the 15 groundwater bores in June 2019 ranged from 528 to 5,874 milligrams per litre, which generally correlate with the Visualising Victoria's Groundwater salinity classifications. Groundwater salinity measurements taken from the bores within the proposed on-site quarry were found to range from 962 to 3,330 milligrams per litre, which is less than the salinity estimate in Visualising Victoria's Groundwater of 3,500 to 7,000 milligrams per litre for this site.

11.6.5 Groundwater users

Groundwater Management Areas in Victoria are established where groundwater has been intensively developed or has the potential to be developed.

The project site lies within the South West Limestone Groundwater Management Area. Within this management area, groundwater extraction from the Gambier Limestone, Port Campbell Limestone and Portland Limestone is regulated. There are no Water Supply Protection Areas, declared under the *Water Act 1989*, within the project site.

Based on a review of Visualising Victoria's Groundwater database, there are 59 bores within the project site. Most of these bores are listed as being used for stock and domestic purposes, as the region has a history of pastoral and cropping land uses. Unregistered bores in operation may also be present within the project site. Two state observation bores (ID 110107 and 110108) are located on the western boundary of the project site (Figure 11.5). A field survey conducted in July 2023 identified two bores within 305 metres of the proposed on-site quarry (Bore 1 and 3), and one bore within the quarry site (Bore 2).



Legend

Site Boundary

NGIS Bore - Usage

- Commercial and Industrial
- Irrigation
- Monitoring
- Stock and Domestic
- Unknown
- Water Supply

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 11.5 Groundwater bores in relation to the project site

11.6.6 Groundwater dependent ecosystems

Groundwater Dependent Ecosystems (GDEs) refer to ecosystems that rely on groundwater (either permanently or intermittently) to meet some or all of their water requirements to maintain the flora and fauna, ecological processes and ecosystem services they support. There are three classes of GDEs:

- aquifer and cave ecosystems
- ecosystems dependent on the surface expression of groundwater (e.g., wetlands), and;
- ecosystems dependent on subsurface (subterranean) groundwater (Richardson et al., 2011).

The Bureau of Meteorology's GDE Atlas maps aquatic and terrestrial GDEs in the project site (Figure 11.6). These ecosystems are rated as having moderate to high likelihood of receiving groundwater inflows.

Aquatic GDEs with a high potential of being supported by groundwater are located along creek lines such as Mustons Creek, Tea Tree Creek and Drysdale Creek. Surface water modelling suggests these systems are strongly influenced by surface water, with inundation only occurring during winter months (refer to Chapter 12 – ***Surface water***). In summer, these systems are dry, which indicates that groundwater does not provide a permanent water source.

Other moderate and low potential aquatic GDEs within the project site include small and isolated temporary freshwater marshes and meadows, as well as unclassified GDEs listed as Palustrine or Lacustrine Lakes.

Terrestrial vegetation communities mapped to have a moderate to high potential of being supported by groundwater are:

- Creekline Grassy Woodland
- Lunette Woodland
- Plains Grassy Woodland
- Riparian Woodland
- Swampy Riparian Woodland.

These communities are limited, and occur as isolated patches in paddocks, along creek lines and along road verges.

The GDE Atlas modelling of potential terrestrial GDEs also considers depth to groundwater. Groundwater less than 10 metres below surface allows for tree root penetration if the soil conditions are suitable. The GDE Atlas displays ecosystem polygons where groundwater interaction may occur, but it does not suggest that vegetation within the polygon is dependent on groundwater (Doody et al., 2017).

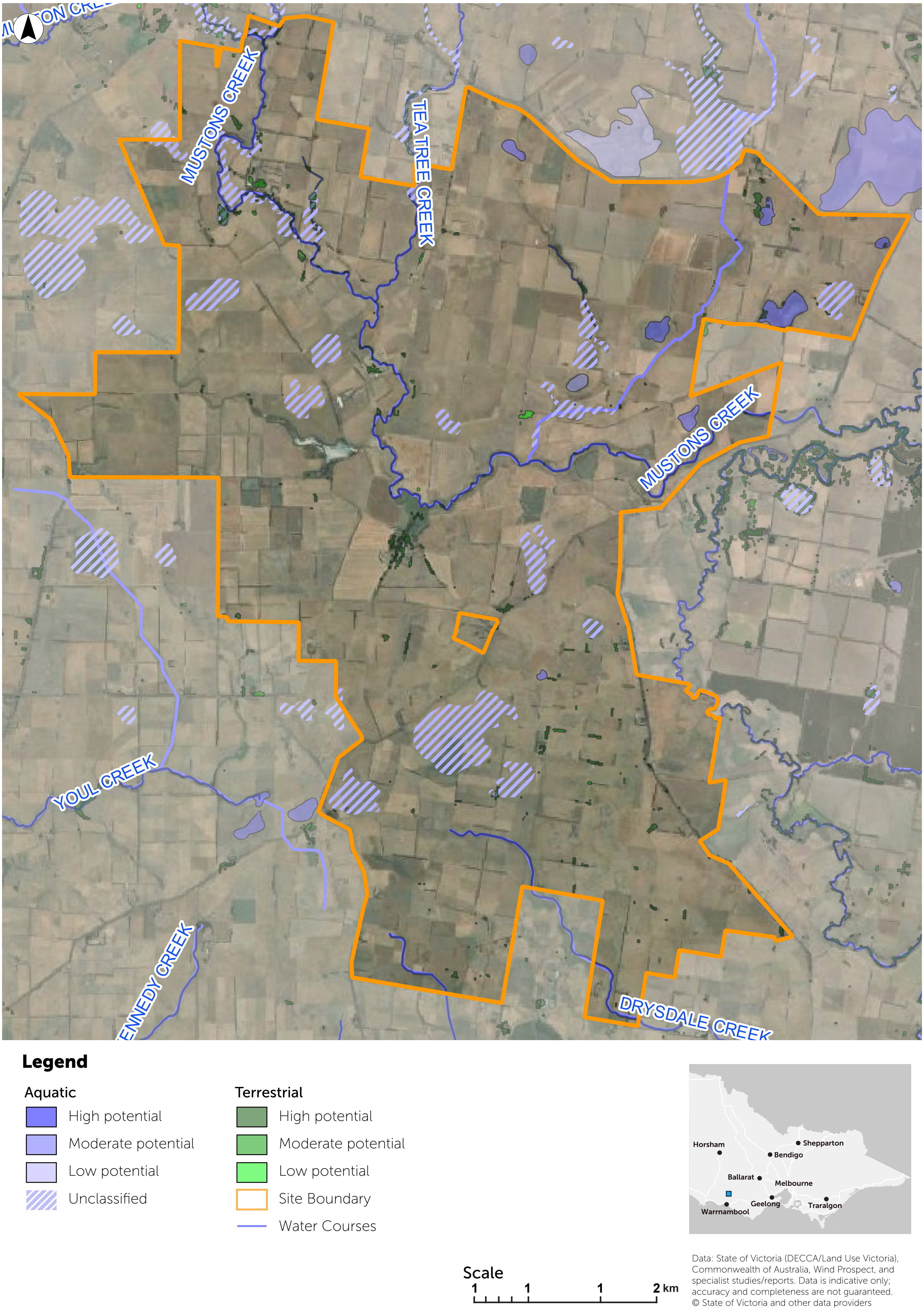


Figure 11.6 Mapped Groundwater Dependent Ecosystems in relation to the project site

11.6.7 Stygofauna

Stygofauna are aquatic animals that inhabit groundwater for their entire life cycle. In Australia, stygofauna exist within alluvial, karstic, calcrete and certain fractured rock aquifers (Bold et al., 2020).

A regional baseline survey of stygofauna was undertaken in the Otway Basin in 2020, with samples taken from 80 groundwater bores. The survey identified 149 individual animals from five stygofauna taxa at six groundwater bores (Bold et al., 2020). One of the bores (110108) is located on the western boundary of the project site located three kilometres south of the proposed on-site quarry location. The other two bores are located approximately 45 kilometres northeast of the site. In this area, there is a cluster of eight Upper Tertiary Basalt bores, of which only two recorded stygofauna.

11.7 Impact assessment

11.7.1 Impact pathways

The potential for groundwater-related issues associated with the project relates to the potential for adverse impacts to existing users of groundwater and to GDEs (including stygofauna) due to reduced groundwater levels or impacts to groundwater supply. Impacts may also occur due to reduced groundwater quality.

Impacts can occur through the following potential impact pathways:

- dewatering of groundwater during construction and lowering the water table resulting in groundwater drawdown that affects water availability
- disruption of groundwater recharge and flow, such as from introduction of less permeable surfaces and physical barriers in the form of wind turbine foundations
- disruption of groundwater discharge to watercourses or waterbodies by intersecting groundwater discharge features (e.g., natural springs) or from a reduction in groundwater availability (e.g., due to dewatering)
- groundwater contamination, including from accidental spills and the discharge of fire water.

The degree of impact would depend on the reliance that existing users and GDEs (including stygofauna) have on groundwater and the extent, timing and duration of impacts resulting from project activities.

Cumulative Impacts

The surface water and groundwater environments within the investigation area are connected by infiltration/ groundwater recharge (surface water contributing to groundwater) and plant transpiration, groundwater extraction from wells and groundwater expressing in springs and waterways (groundwater contributing to surface water). Given this connection, there is the potential for cumulative groundwater and surface water impacts. The potential impacts include:

- reduced groundwater recharge in areas already impacted by groundwater extraction, exacerbating the potential reduction in groundwater levels
- contaminated surface water entering the groundwater system impacted by reduced water levels
- reduced groundwater expression in waterways caused by groundwater extraction in areas with already reduced surface water inflows.

The design mitigation measures outlined in Section 11.7.2 and and the management controls outlined in Section 11.7.3 provide a framework for how the potential impact associated with these impact pathways can be reduced.

Dewatering and disposal of extracted groundwater (drawdown)

Excavation of turbine foundations and trenches during construction would be to depths of less than 3.5 metres. This means that groundwater extraction will be limited to locations where perched or very shallow aquifers are present. If shallow groundwater is intercepted during construction of turbine foundations and trenches, localised groundwater from the uppermost zones may seep into the excavated area. Under this scenario, groundwater abstraction via pumping (termed 'dewatering' of the excavation) may be required to create a safe work area. Dewatering may temporarily lower the water table until the works are complete. As the construction period for turbine foundations and trenches is short (i.e., up to two weeks for turbine foundations and three hours for open trenches), impacts are unlikely to materially affect groundwater users.

As the proposed on-site quarry excavation depth is 14 metres, and the depth to groundwater is estimated to range from nine to 13 metres, it is expected that dewatering of the quarry pit would be required during operation.

A summary of the proposed excavation depths for project infrastructure is provided in Table 11.5.

Table 11.5 **Proposed project excavation depths of one metre or more, and approximate depth to groundwater at these locations**

Project activity / infrastructure	Proposed excavation depth	Approximate depth to groundwater
Quarry excavation	14 metres	Estimated to range from 9 to 13 metres, based on water level measurements taken at the proposed site in seven bores.
Excavation for foundations	3.5 metres	Foundations may intercept shallow groundwater less than 3.5 metres below the natural surface. This would be most likely to occur during winter and early spring when levels are expected to be highest.
Underground cabling	One metre	Cable trenches may intercept very shallow groundwater less than one metre below the natural surface during winter and early spring in isolated areas.

During operation of the proposed on-site quarry, groundwater inflows in the excavation pit are expected to be around 19.0 megalitres per year. However, inflows of up to 37.2 megalitres per year may be possible if hydraulic conductivity is greater than anticipated.

Drawdown as a result of pit inflow is predicted to extend up to 189 metres from the centre of the pits for the base case scenario, and up to 226 metres for the low-recharge scenario. For the purposes of assessing potential impacts on existing users, the low-recharge drawdown extent was used as it provides the largest predicted drawdown extent. For excavations for turbine foundations and cables, the potential radius of influence indicates a drawdown of six to 18 metres from the edge of the excavation may occur.

Disruption of groundwater recharge and flow

Infrastructure foundations can alter the permeability of the ground surface, making it less permeable. This can then impact infiltration and groundwater recharge. Once foundations are in place, they can influence the lateral flow of groundwater, however, this influence would be localised and is unlikely to affect groundwater availability and levels at the project site.

Vegetation removal can also influence groundwater recharge rates, however this is not expected as most of the native vegetation has been avoided and would be retained (see Chapter 8 – ***Biodiversity and habitat***).

Disruption of groundwater discharge

Impacts to groundwater discharge may occur if project infrastructure intersects groundwater discharge features, such as springs. Earthworks or watercourse crossings have the potential to intersect the groundwater table. This would potentially change groundwater availability and baseflow, resulting in indirect impacts to groundwater discharge features.

Groundwater contamination

During the project's construction and operation, the use of fuels and chemicals can pose a threat to groundwater quality if they are not managed appropriately. Bulk liquid chemicals, including fuels and lubricants, would also be stored on site. Contamination could occur if fuels, chemicals or other substances are accidentally released onto the ground.

Groundwater contamination may also occur from exposure and oxidation of potential acid sulfate soils, which may arise during excavation of trenches in potential acid sulfate soils zones (see Chapter 13 – ***Landform and soils***). The release of acidic waters may adversely impact groundwater quality and downgradient receiving environments or users.

The disposal and management of abstracted groundwater can result in potential impacts as well. A reduction in groundwater quality, due to contamination, may extend to existing users or GDEs depending on the aquifers affected. The quality of abstracted groundwater would determine the required management method.

11.7.2 Design mitigation

To avoid potential groundwater impacts to local groundwater users and environmental values, design measures have been implemented. These include:

- Applying a 100-metre buffer around all mapped aquatic GDEs to exclude turbine foundations within the buffered area except crossing of waterways where this cannot be avoided. This area was selected as a means of avoiding physical disturbance to the GDEs and their fringes, and to limit surface water runoff and entrained sediment loads reaching these GDEs from construction work zones.
- Applying 100-metre buffer around all mapped DEECA wetlands to exclude turbine foundations within the buffered area.
- Applying a 25-metre buffer around all mapped terrestrial GDEs to exclude to exclude turbine foundations within the buffered area. This area was selected as a means of limiting potential physical disturbance and deposition of eroded sediments.
- Minimised construction time for turbine foundations, therefore reducing the time required to manage groundwater (if intersected).

Because aquatic GDEs have a high likelihood of being inflow systems (i.e., they receive local surface water inflows), hydrological modelling of the site was considered during the project design to ensure natural flow paths (hydrological connectivity) are not interrupted by the project (see Chapter 12 – ***Surface water***).

Specific design mitigation measures relating to the development of the proposed on-site quarry include:

- positioning the quarry on topographic high where the water table is deep, therefore minimising dewatering requirements
- positioning the quarry greater than 500 metres from nearest potential aquatic GDE, terrestrial GDE and DEECA wetland
- developing the quarry in stages with progressive backfill to minimise dewatering requirements and operational impact
- backfilling the quarry to one metre above the seasonally high water table level to minimise ongoing losses of groundwater and promote groundwater level recovery.

The proposed on-site quarry has been designed as a ‘zero discharge’ site, with all surface water and groundwater to be managed within the quarry site using retention basins, either infiltrating or evaporating stored water. Infiltration through a basin may require approval under an A18 permit in accordance with the Environmental Protection Regulations 2021, and a Section 76 licence in accordance with the *Water Act 1989*. To minimise impacts to groundwater recharge and flow, turbine foundations are shaped to allow rainwater runoff and to re-establish natural recharge adjacent to these features.

11.7.3 Environmental management measures

To further manage potential impacts to groundwater, the management measures outlined in Table 11.6 have been proposed for project construction, operation and decommissioning.

Management and disposal of water extracted from excavations during project construction (including dewatering) is discussed in Chapter 12 – ***Surface water***.

Table 11.6 Groundwater management measures

Groundwater impact	Project phase	Management measures	Number
Excavation and dewatering leads to lowering of groundwater level	Construction	Work Authority 1. Prior to the development of an on-site quarry, obtain a Work Authority through approval by Resources Victoria (Department of Energy, Environment and Climate Action for the temporary quarry construction and operation and adhere to its requirements.	EMM06
	Construction	Quarry Work Plan 1. Prior to the development of an on-site quarry, the draft Quarry Work Plan (provided in Attachment II) will be finalised and submitted to Resources Victoria (Department of Energy, Environment and Climate Action) for approval. 2. The Quarry Work Plan will include measures to: a. manage and monitor surface water impacts b. manage noise emissions, in accordance with a Quarry Noise Management Plan (NV02) c. control emissions of dust or other particulates d. manage the carriage and deposition of dust, silt and clay by vehicles existing the work authority area e. manage erosion from topsoil and overburden stockpiles f. manage site rehabilitation. 3. Prior to blasting, the affected areas will be pre-wet to minimise dust emissions. Blasting would occur when winds are blowing away from the nearest sensitive receptors (i.e. from the north, south or west) and are consistent enough to encourage movement of dust away from the nearest receptors, but light enough to minimise emission generation and transport of dust off-site.	EMM07

Groundwater impact	Project phase	Management measures	Number
	Pre-construction	**Construction Environmental Management Plan - Groundwater assessment** 1. Prior to the commencement of construction, assess the likely occurrence of groundwater in foundations and trenches and potential dewatering volumes. The findings of this assessment, and management implications, will be documented in the Construction Environmental Management Plan (EMM01).	GW01
	Pre-construction	**Targeted micro-siting to avoid unmapped springs and watercourses** 1. Prior to the commencement of construction, micro-site turbine foundation excavations and trenches to avoid any unmapped springs and watercourses identified during detailed design works.	GW02
	Pre-construction	**Community and Stakeholder Engagement Plan - Impacts to groundwater bores** 1. Prior to the commencement of construction, consult with relevant landowners about potential impacts to groundwater bores to limit disruption to water access and support identification of mitigation measures or alternative supply options. This will be undertaken in accordance with the Community and Stakeholder Engagement Plan (EMM02).	GW03

Groundwater impact	Project phase	Management measures	Number
	Construction	**Water Management Plan** 1. Prior to the commencement of construction, develop and implement a Water Management Plan approved by the Responsible Authority as a sub-plan of the Construction Environmental Management Plan (EMM01). The Water Management Plan will detail groundwater management approaches required to identify, avoid and minimise impacts to groundwater levels, flow and quality as far as reasonably practicable. It will also respond to any final design details and ensure all risks are appropriately managed. 2. The Water Management Plan would include, but not be limited to: a. baseline groundwater level and quality (pH and salinity) monitoring at the four cased quarry investigation bores and three existing bores at the proposed quarry site prior to construction, undertaken quarterly for up to two years to determine the seasonally high water table elevation which will be used to guide the quarry backfill level b. stygofauna monitoring at the quarry c. quarry and foundation excavation dewatering activities: i. the purpose of dewatering (an explanation of why dewatering is necessary). ii. a description of dewatering technique to be employed. iii. The anticipated dewatering flow rate, duration and total volume. iv. water collection and storage options. v. monitoring of water quality of captured water (e.g. pH, salinity and suspended solids). vi. disposal options and requirements in accordance with the Environment Protection Regulations 2021, to be undertaken in accordance with EMM SW05. d. operational groundwater monitoring requirements including locations, frequency and parameters and method for assessing against baseline conditions and predicted impacts. e. management requirements of unmapped springs/seeps f. management of changes in surface permeability and groundwater discharge from construction activities, discussed further in EMM GW04-1 g. guidance provided in EPA Publication 668: Hydrogeological Assessment (Groundwater Quality) Guidelines. 3. The stygofauna monitoring program, captured within the Water Management Plan, will be prepared in consultation with the Department of Energy, Environment and Climate Action.	GW04

Groundwater impact	Project phase	Management measures	Number
	Construction	**Construction Environmental Management Plan - Discharge of collected water** 1. To minimise the risk of surface water contamination, water collected during quarry and foundation excavation dewatering activities will only be discharged to the environment in accordance with the Environment Protection Regulations 2021 and the following management measures, which would be documented in the Construction Environmental Management Plan (EMM01): a. assessing the quality of groundwater to be disposed (in accordance with GW04) b. assessing the baseline quality of waterways that have the potential to receive collected water to determine the potential impact (in accordance with SW04) c. conducting a risk assessment in accordance with EPA Publication 1287: Guidance for environmental and human health risk assessment of wastewater discharges to surface waters, identifying management controls to prevent impacts to the environmental values of the waterway so far as reasonably practicable d. applying for EPA permission, if required under the Environment Protection Regulations 2021 e. implementing sediment control devices, where required.	SW05
Foundation excavations intersect shallow water table and alters groundwater flow and recharge Disruption of groundwater discharge	Construction	**Water Management Plan - Minimise impacts to groundwater discharge, recharge and flow** 1. Include construction activities and temporary works that may impact on groundwater discharge, surface permeability and groundwater flow within the Water Management Plan (GW04). 2. Measures to minimise groundwater discharge, recharge and flow related impacts will include, but not be limited to: a. revegetation of disturbed areas b. backfilling cabling trenches using excavated material where possible, or a material of a similar permeability where this is not possible c. micro-siting turbine foundation excavations and trenches to avoid unmapped springs and watercourses.	GW04-1

<table>
<tr><th>Groundwater impact</th><th>Project phase</th><th>Management measures</th><th>Number</th></tr>
<tr><td rowspan="2">Accidental spills of hazardous materials reduce water quality</td><td>Construction
Operation
Decommissioning</td><td>Retain and manage firefighting water
1. The battery energy storage system will be designed to include a retention basin to capture firefighting water to prevent uncontrolled release of water to the environment.
2. Contaminated water captured within the retention basin will be disposed at a lawful place in accordance with the Environment Protection Regulations 2021.</td><td>EMM08</td></tr>
<tr><td>Construction
Operation
Decommissioning</td><td>Environmental Management Plan - Storage and handling of hazardous substances
1. Develop and implement measures in accordance with EPA Publication 1698: Liquid handling and storage guidelines and EPA Publication 1700: Preventing liquid leaks and spills from entering the environment to manage potential pollutants from entering the environment. These measures will be documented in the Construction Environmental Management Plan (EMM01), Operational Environmental Management Plan (EMM09), and Decommissioning Plan (EMM10), and include:
a. measures for the use, storage, transfer and disposal of hydrocarbons and chemicals
b. a site-specific risk assessment and spill response procedure for hazardous materials (batteries, explosives, etc.)
c. requirements for the storage of liquid fuels and chemicals, including:
i. containment within bunded areas or equivalent facilities
ii. being located more than 50 metres from waterways
iii. placement within designated areas of the project site.
d. requirements for spill response kit(s) to be located at waterway crossings, at locations where machinery/plant are operating, and refuelling and fuel/chemical storage areas during construction
e. incorporation of spill containment measures into the drainage design.</td><td>EMM11</td></tr>
</table>

11.7.4 Residual impacts

The residual groundwater impacts resulting from the project construction, operation and decommissioning were assessed for each groundwater asset within the investigation area, after the development of design mitigation measures. The significance of groundwater impacts was assessed against the impact ratings outlined in Table 11.4.

Quaternary aquifer

Three crossings for access tracks and underground cables would intersect with the Quaternary Alluvium near Mustons Creek and two crossings on the upper reaches of Drysdale Creek. Several other crossings for accessways and cables exist across minor unnamed watercourses in the Quaternary Aquifer.

Surface disturbance is the key impact pathway for the Quaternary Aquifer. Implementation of the Water Management Plan [EMM GW04], informed by pre-construction assessments will determine the likely occurrence of groundwater in foundations and trenches [EMM GW01]. Disturbance in the access tracks and cable crossing areas would be minimal and temporary, due to the short construction timeframe for these crossings. Disturbance would occur only in the localised area. Targeted micro-siting to avoid unmapped springs and watercourses during detailed design works [EMM GW02]. If saturated, direct disturbance may need dewatering to enable construction for a short period (i.e., up to two weeks), which would temporarily lower the water table while construction activities were undertaken.

Disturbed areas would be rehabilitated after completion of works to the satisfaction of the Glenelg Hopkins Catchment Management Authority, and work would be in accordance with the Work Authority [EMM06] and Quarry Work Plan [EMM07]. Consultation will also be undertaken with groundwater bore uses to limit disruption to water access [EMM GW03]. No permanent impacts to existing bores, potential aquatic and terrestrial GDEs, springs, wetlands or stygofauna communities are anticipated.

Dewatering and disposal of extracted groundwater

Quarry

In-pit sump pumping (i.e., in-pit dewatering) and storage on-site retention basins are proposed to manage groundwater inflows in the proposed on-site quarry excavation site.

One groundwater bore (Bore 2), located within the boundary of the proposed on-site quarry, is within the predicted extent of drawdown. An alternate water source may need to be provided to replace this bore. Bore 1 and 3 located close to the quarry are not predicted to be impacted, however, it is recommended that these bores are monitored during and after quarry operations. All potential aquatic and terrestrial GDEs are located outside the predicted drawdown extent. As such, impacts to GDEs are not expected due to quarry pit dewatering.

As quarrying activities progress, each stage will be backfilled to at least one metre above the water table to prevent the ongoing loss of groundwater from the quarry pit. The four quarry bores will require monitoring to determine the seasonally high water table elevation, which will be used to guide the quarry backfill level [EMM GW04].

Once the quarry is backfilled, the water table is expected to recover to its pre-quarrying level. Impacts to stygofauna are therefore expected to be temporary. Overall, potential impacts to stygofauna are considered to be low.

Turbine foundations and cable excavations

To create the foundation base necessary for turbine foundation construction, water (if present) will be pumped out using a sump at the base of the excavation. Shallow groundwater may flow into wind turbine foundations, particularly during winter and early spring. If dewatering is required, this may temporarily lower the water table before the concrete foundations are laid.

The occurrence of groundwater in foundation excavations and potential dewatering volumes (should this be required) will be assessed during the pre-construction works [EMM GW01], which will include on-site geotechnical works and soil testing/profiling to determine the foundation conditions at each site. The findings of this assessment and management implications will be detailed in the Construction Environmental Management Plan.

If active pumping is needed for the construction of foundations, groundwater inflow monitoring would be required as part of the Water Management Plan [EMM GW04]. This would include monitoring of water quality (e.g., pH, salinity, suspended solids) and seeking the necessary approval to discharge water at a suitable site. Water collected during dewatering of excavations would be managed in accordance with the Environment Protection Regulations 2021. Potential impacts of water extracted from excavations during project construction is discussed further in Chapter 12 – ***Surface water***. After dewatering, the water table is predicted to recover quickly over several weeks.

With the application of buffer distances, the impact of groundwater drawdown near potential aquatic GDEs, DEECA wetlands and potential terrestrial GDEs is considered to be very low. If unmapped springs and watercourses are found to exist near turbine locations, micro-siting will be used to avoid these areas [EMM GW02].

Impacts to groundwater bore water levels are considered to be very low due to the limited drawdown extent and temporary nature of the works. Potential impacts to stygofauna as a result of foundation excavations are expected to be highly localised and temporary. If cable excavations are required where groundwater levels are less than one metre below the natural surface, this would be limited to isolated areas, and the excavations for the underground cables would be open for less than three hours. As a result, impacts to groundwater levels from these works are considered low.

Disruption of groundwater recharge and flow

Turbine foundations have been shaped to allow rainwater runoff, and to re-establish natural recharge to the nearby aquifer. As the surface area for foundations and hardstands is small, the estimated reduction in groundwater recharge would be minimal and can be offset by appropriate drainage design.

Any impacts to groundwater flow around infrastructure foundations are anticipated to be localised and minor and would only occur when groundwater levels are high. With design buffers of 100 metres around wetlands, impacts to groundwater flow and recharge caused by infrastructure foundations are unlikely to affect ephemeral wetlands and springs.

If cable trench backfill material has a higher hydraulic conductivity than the surrounding undisturbed soils, groundwater may flow faster through the backfill material than in surrounding material. To mitigate this impact, excavated material would be used to backfill the trench [EMM GW04-1]. As such, there would be no change to surface permeability and recharge rates in these areas.

Disruption of groundwater discharge

To reduce the likelihood of impacts associated with groundwater discharge to watercourses and wetlands, design buffers will be applied around potential aquatic GDEs and DEECA wetlands. Additionally, turbine locations have been positioned to avoid watercourses and areas which may receive overland flows. If unmapped springs and watercourses are found to exist near turbine locations, micro-siting of turbine locations can be used to avoid these areas. [EMM GW02].

Groundwater contamination

Accidental spills of hydrocarbons or other chemicals can contaminate the groundwater system, impacting surrounding groundwater users including GDEs, wetlands, stygofauna and groundwater bores. Contaminated firefighting water could also impact surrounding groundwater. The battery energy storage system will be designed to include a retention basin to capture firefighting water to prevent uncontrolled release of water to the environment [EMM08]. This water would be disposed at a lawful place in accordance with the Environment Protection Regulations 2021 [EMM08]. Should an uncontrolled release of hazardous material occur, which is unlikely with best-practice construction and operational management approaches in place (outlined in Section 11.7.3), it would be highly localised near the spill. The Construction Environmental Management Plan outlines measures to prevent, manage and contain spills [EMM11]. The potential impact is considered to be low.

The exposure of potential acid sulfate soils can acidify water and impact groundwater quality and resources. The potential impact from acid sulfate soils is further discussed in Chapter 13 – ***Landform and soils***.

Port Campbell Limestone aquifer

Impacts to groundwater drawdown, flows, recharge and contamination are not predicted for this aquifer due to the anticipated lack of connectivity with the Newer Volcanic Group basalt aquifer and the depth to the Port Campbell Limestone aquifer.

11.7.5 Impact assessment summary

A summary of the *Surface Water and Groundwater Impact Assessment* (Appendix B) is provided in Table 11.7, and a summary of cumulative impacts is provided in Table 11.8. Potential impacts of water extracted from excavations during project construction (including dewatering), and the management and disposal of this water, is discussed in Chapter 12 – ***Surface water***.

Table 11.7 Groundwater impact assessment summary

Aquifer	Environmental value	Impact pathway	Project phase	Mitigation and management	Likely effect (magnitude, extent and duration)	Residual impact significance
Quaternary aquifer	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Direct disturbance and dewatering leads to lowering of groundwater level	Construction	• Implementation of the Water Management Plan [EMM GW04], informed by pre-construction assessments determining the likely occurrence of groundwater in foundations and trenches [EMM GW01]. • Targeted micro-siting to avoid unmapped springs and watercourses during detailed design works [EMM GW02]. • Consultation with groundwater bore uses to limit disruption to water access [EMM GW03]. • Work in accordance with the Work Authority [EMM06] and Quarry Work Plan [EMM07].	Three crossings for access tracks and underground cables are proposed in Quaternary Alluvium and two proposed on the upper reaches of Drysdale Creek. Several other crossings for accessways and cables exist across minor unnamed watercourses in Quaternary Alluvium. Disturbance and potential impacts on groundwater levels would be minimal, highly localised and temporary.	Very low

Aquifer	Environmental value	Impact pathway	Project phase	Mitigation and management	Likely effect (magnitude, extent and duration)	Residual impact significance
Water table aquifer (Newer Volcanic Group basalt aquifer and Whalers Bluff Formation / Hanson Plain sand aquifer	GDEs (including potential unmapped springs)	Quarry excavation and dewatering leads to lowering of groundwater level.	Construction	• Quarry greater than 500 m from potential aquatic and terrestrial GDEs / DEECA wetlands. • Quarry positioned on topographic high • Quarry to be progressively backfilled [EMM GW04-1] • Post quarrying land surface rehabilitated to one metre above water table [EMM GW04] • Implementation of Water Management Plan [EMM GW04]	All aquatic and terrestrial GDEs and DEECA wetlands are located outside of the predicted drawdown extent. The presence of potential unmapped springs is considered unlikely due to the elevated topography and lack of areas which are conducive to spring flow. Impacts to GDEs and wetlands are not expected due to quarry pit dewatering.	Low
	Stygofauna			• Quarry positioned on topographic high • Quarry to be progressively backfilled [EMM GW04-1] • Post quarrying land surface rehabilitated to one metre above water table [EMM GW04] • Implementation of Water Management Plan [EMM GW04]	Localised disturbance to stygofauna may occur during 2-year quarrying period due to excavation of the basalt material and localised drawdown around the quarry. Quarry backfill will prevent ongoing evaporative losses from the quarry and promote groundwater level recovery. The Newer Volcanic Group basalts in which the quarry will be excavated are not highly conducive environments for stygofauna.	Low
	Groundwater bore users			• Quarry positioned on topographic high • Quarry to be progressively backfilled [EMM GW04-1] • Post quarrying land surface rehabilitated to one metre above the water table [EMM GW04] • Implementation of Water Management Plan [EMM GW04]	An alternate water source may required to replace the one bore in the quarry area, depending on the reliance that the landowner has on this well. Two other bores located close to the quarry are not predicted to be impacted.	Low

Aquifer	Environmental value	Impact pathway	Project phase	Mitigation and management	Likely effect (magnitude, extent and duration)	Residual impact significance
	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Foundation excavation and dewatering leads to lowering of groundwater level.	Construction	• 100-metre buffer around potential aquatic GDEs. • 100-metre buffer around all mapped DEECA wetlands. • 25-metre buffer around potential terrestrial GDEs • Assess likely occurrence of groundwater in foundation excavations and potential dewatering volumes [EMM GW01] • Consult with landholders in relation to potential impacts to bores [EMM GW03] • Water Management Plan, including procedures for dewatering [EMM GW04]	This impact is temporary due to short duration of turbine excavation. Groundwater levels will recover after foundation excavations are filled. Drawdown from foundation excavations is not expected to impact on existing groundwater bores given the distance to the nearest bore. The buffer between foundation excavations and potential aquatic GDEs would limit drawdown at these receptors. Potential unmapped springs to be avoided by micro-siting turbine locations. Some highly localised and temporary disturbance to stygofauna may occur if dewatering is required.	**Very low**
	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Foundation excavations intersect shallow water table and alters groundwater flow and recharge.	Construction	• Turbine foundations would be shaped to allow rainwater runoff and to re-establish natural recharge • Measures to minimise groundwater recharge and flow related impacts, contained with the Water Management Plan [EMM GW04-1] • Manage water collected from dewatering of excavations in accordance with Environment Protection Regulations 2021 [EMM SW05]	Impacts to groundwater flow around infrastructure foundations would be localised and minor Reduction in groundwater recharge would be localised and mitigated by appropriate drainage design. Changes to groundwater flow and recharge are unlikely to affect bores, potential GDEs, wetlands, springs and stygofauna communities.	**Very low**

Aquifer	Environmental value	Impact pathway	Project phase	Mitigation and management	Likely effect (magnitude, extent and duration)	Residual impact significance
	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Accidental spills of hazardous materials or fire contaminated water reduce water quality.	Construction, operation, decommissioning	• Measures outlined in the CEMP to prevent, manage and contain spills [EMM11] • The battery energy storage system will be designed to include a retention basin to capture firefighting water to prevent uncontrolled release of water to the environment [EMM08]. • Contaminated water captured within the retention basin will be disposed at a lawful place in accordance with the Environment Protection Regulations 2021 [EMM08].	Spills of fuels and chemicals could result in localised contamination of the groundwater system. Uncontrolled release of fire water at the battery energy storage system could cause localised contamination of the groundwater system. With the implementation of best-practice measures this is unlikely.	Low
Port Campbell Limestone aquifer	Groundwater bore users	No linkage.	N/A	N/A	Due to the shallow nature of the proposed works, the limited connectivity with the Newer Volcanic Group basalt aquifer and the depth to the Port Campbell Limestone aquifer, no impact is anticipated.	N/A

Table 11.8 Groundwater cumulative impact assessment summary

Aquifer	Environmental value	Impact pathway	Combined surface water and groundwater residual impact significance
Quaternary Aquifer (QA) Water Table Aquifer (Newer Volcanic Group Basalts Aquifer (UTB) / Whalers Bluff Formation / Hanson Plain Sand (UTAM))	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Reduced groundwater recharge in locations impacted by alterations of existing drainage patterns through diversion of flow, caused by the project components	Low
	Stygofauna	Reduced groundwater recharge in locations impacted by alterations of existing drainage patterns through diversion of flow, caused by the project components	Low
	Groundwater bore users	Reduced groundwater recharge in locations impacted by alterations of existing drainage patterns through diversion of flow, caused by the project components	Low
Water Table Aquifer (Newer Volcanic Group Basalts Aquifer (UTB) / Whalers Bluff Formation / Hanson Plain Sand (UTAM))	GDEs (including potential unmapped springs), stygofauna and groundwater bore users	Groundwater contamination caused by infiltration of contaminated surface water, caused during construction	Low
Hopkins River and tributaries (other than Mustons Creek)	Water dependent ecosystems and species	Reduced waterway flows caused by groundwater extraction during construction	Low
Mustons, Tea Tree, Lyall, Drysdale and other Creeks/designated waterways	Agriculture and irrigation (including stock watering).	Reduced waterway flows caused by groundwater extraction during construction	Low
Ephemeral wetlands	Water dependent ecosystems and species	Reduced waterway flows caused by groundwater extraction during construction	Low
Hopkins River and tributaries (other than Mustons Creek)	Water dependent ecosystems and species	Waterway contamination caused by contaminated groundwater entering waterways through e.g. springs	Low
Mustons, Tea Tree, Lyall, Drysdale and other Creeks/designated waterways	Agriculture and irrigation (including stock watering).	Waterway contamination caused by contaminated groundwater entering waterways through e.g. springs	Low
Ephemeral wetlands	Water dependent ecosystems and species	Waterway contamination caused by contaminated groundwater entering waterways through e.g. springs and baseflow	Low

11.8 Conclusions

Construction and operation of the project has the potential to impact groundwater and supporting environmental values in the water table aquifer, which includes Upper-Tertiary/Quaternary, the Upper-Tertiary Aquifer, and the Quaternary Alluvium. Possible impact pathways include localised lowering of the water table from groundwater dewatering during wind turbine foundation and quarry excavations, altered groundwater recharge, flows and discharge from infrastructure foundations and hardstands creating barriers to water movement or from a reduction in groundwater availability (e.g. due to dewatering), and/or reduced water quality from accidental spills of hazardous chemicals.

To minimise the potential for the project to impact local aquatic GDEs and wetlands, the design has incorporated a minimum 100-metre buffer from these features and a 25-metre buffer from potential terrestrial GDEs to proposed turbine foundations, however this excludes crossing of waterways where this cannot be avoided. Micro-siting of turbine locations is used to avoid any unmapped springs. The proposed on-site quarry is proposed to be a 'zero discharge' site, with all surface water and groundwater to be managed within the quarry site using retention basins. All GDEs and wetlands are located outside of the predicted quarry drawdown extent.

Management measures have been proposed for the construction, operational and decommissioning phases of the project to further manage potential groundwater impacts. Any proposed dewatering activities are to be captured in a Water Management Plan. With these measures in place, the impacts to groundwater users and groundwater quality are considered to be very low to low.