Appendix G

Groundwater Impact Assessment

KENTBRUCK GREEN POWER HUB

Prepared for
Neoen Australia Pty Ltd
ABN: 31 117 519 570

AECOM

Groundwater Impact Assessment

Kentbruck Green Power Hub Project EES Technical Report

21-Jun-2024
Kentbruck Green Power Hub
Doc No. 60591699_GW_Draft rev0
Commercial-in-Confidence

Groundwater Impact Assessment

Kentbruck Green Power Hub Project EES Technical Report

Client: Neoen Australia Pty Ltd

ABN: 31 117 519 570

Prepared by

AECOM Australia Pty Ltd
Wurundjeri and Bunurong Country, Tower 2, Level 10, 727 Collins Street, Melbourne VIC 3008, Australia
T +61 1800 868 654 www.aecom.com
ABN 20 093 846 925

21-Jun-2024

Job No.: 60591699

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Quality Information

Document Groundwater Impact Assessment

Ref 60591699

Date 21-Jun-2024

Prepared by Breana McCartney and Mark Wakeman

Reviewed by Mark Wakeman and Bryan Chadwick

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	07-May-2020	Draft	David Knight Project Manager	
B	07-Jul-2021	Draft	Francesca Crossan Project Manager	
C	25-Aug-2022	Draft	Francesca Crossan Project Manager	
D	06-Feb-2024	Final	Jarred Winik Project Manager	
E	21-Jun-2024	Final	Jarred Winik Project Manager	

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Abbreviations

Abbreviation	Title
AECOM	AECOM Australia Pty Ltd
BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
DELWP	Department of Environment, Land, Water and Planning
EE Act	Environment Effects Act 1978
EES	Environment Effects Statement
EMF	Environmental Management Framework
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GDE	Groundwater dependent ecosystem
GDE Atlas	Groundwater Dependent Ecosystems Atlas
GIS	Geographic information system
GJ	Gigajoule
GWh	Gigawatt Hour
kW	Kilowatt
mAHD	Metres relative to Australian Height Datum
mbgs	Metres below ground surface
mbtoc	Metres below top of casing
m/day	Metres per day
mm	Millimetres
MW	Megawatt
PCV	Permissible Consumptive Volume
QA	Quaternary Aquifer
ROW	Right of way
SEPP	State Environment Protection Policy
SRW	Southern Rural Water
UMTA	Upper Mid Tertiary Aquifer
UTB	Upper Mid Tertiary Basalts

Glossary

Term	Definition
Construction	Includes all physical work required to construct the new structures of Project, for example, installing turbine foundations and laying cables.
Gaining stream	A stream that receives groundwater, which adds to its overall flow.
Groundwater dependent ecosystem (GDE)	A terrestrial or aquatic ecosystem that requires access to groundwater to meet all or some of its requirements.
Groundwater users	GDEs and users of existing registered bores
Hydraulic conductivity	The ease with which a fluid (usually water) can move through pore spaces or fractures.
Easement	A 'right of way' around infrastructure that allows access to authorised personnel for inspections, repairs and maintenance during operation. The establishment of an easement also restricts certain activities on the land that could endanger members of the public or impact on the safe operation of the infrastructure.
Effects	The consequences of the changes in airborne concentrations and/or dust deposition for a sensitive receptor.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
mAHD	Metres relative to Australian Height Datum is the datum that sets mean sea level as zero elevation, where mean seal level was determined by 30 tide gauges around the coast of Australia (1966-1968). This allows elevations to be compared relative to a common reference elevation.
Permissible Consumptive Volume	Determines the maximum volume of water that can be extracted from a groundwater management area.
Preferential flowpath	The uneven and often rapid movement of water and solutes through porous media.
Right of way (ROW)	A specific section of the Project area for carrying out Project construction activities such as trenching and excavation. Public access to the ROW would be restricted and may include associated activities such as traffic management measures.
Water table	The surface where the water pressure head is equal to the atmospheric pressure.

1.0 Introduction

1.1 Purpose of this report

The purpose of the groundwater technical report ('**this report**') is to assess the potential groundwater impacts associated with the Kentbruck Green Power Hub ('**the Project**') to inform the preparation of an Environment Effects Statement (EES) required for the Project.

On 25 August 2019, the Minister for Planning issued a decision confirming that an EES is required for the Project due to the potential for significant environmental effects.

The Project was also referred to the Commonwealth Government, on 7 November 2019, and declared a 'controlled action', requiring assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project is proposed to be comprised of wind turbines, associated infrastructure, transmission lines, quarry and groundwater supply. This report provides a groundwater impact assessment for the EES and proposes mitigation measures for potential impacts. This report assesses the potential for adverse effects to groundwater and groundwater receptors during construction and operation of the Project.

This will inform the development of an Environmental Management Framework (EMF) for the Project. The mitigation measures listed in the EMF will be implemented in the approvals and management plans for the Project.

1.2 Evolution of this report

A summary of revision changes to this report are provided in Table 1-1.

Table 1-1 Groundwater technical report evolution

Revision	Date	Description
rev A	7 May 2020	First draft for TRG 1st round review. Desktop assessment only.
rev B	7 July 2021	Second draft addressing comments from TRG 1st round review. Incorporated results and interpretation of fieldwork program that included installation, aquifer testing and monitoring of 12 shallow monitoring wells.
rev C	29 July 2022	Third draft addressing comments from TRG 2nd round review. Incorporates results and interpretation of fieldwork carried as part of groundwater supply investigation and impact assessment. Updated Project layout and Project description, including removal of proposed turbine locations in the vicinity of the Glenelg Estuary and Discovery Bay Ramsar site and GDEs on private land.
rev D	06 February 2023	Final version addressing comments from TRG 2nd round review. Updated Project layout and Project description, including a reduction in the number of turbines from 116 to 105. Incorporates results and interpretation of 7-day pumping test completed as part of additional groundwater supply investigation and impact assessment (CDM Smith, 2023).

Revision	Date	Description
		Includes groundwater level monitoring data collected at monitoring wells MW4 to MW8 between July 2022 and April 2023. Provides an assessment of transmission line options (Appendix G) and a change of preferred transmission line option.
rev E	19 June 2024	Minor updates to report text to address adequacy review comments and report finalisation

1.3 Why understanding groundwater is important

Some activities and infrastructure are anticipated to intersect shallow groundwater during construction and operation of the Project, which could potentially impact groundwater levels, flow and/or quality.

It is important to assess whether these activities could have a material impact on the beneficial uses of groundwater or groundwater users. Groundwater users include those people who pump water from existing registered groundwater bores, and groundwater dependent ecosystems (GDEs). GDEs are those ecosystems that require access to groundwater to meet all or some of their water requirements to maintain the communities of plants and animals and ecological processes they support, and ecosystem services they provide[1]. These can include streams, lakes or wetlands that groundwater flows into, vegetation with roots that access groundwater or biota living in cave systems.

This report documents the potential groundwater level and groundwater flow impacts that may arise from the Project, potential risks to groundwater users and mitigation measures.

Potential impacts on groundwater quality from the Project, including acid sulfate soils, are considered in *Environmental Site Investigation (Appendix I of the EES) (AECOM, 2023)*.

Potential impacts to groundwater dependent ecosystems (GDEs) are addressed in *Ecosystem Impact Assessment (Appendix H of the EES) (CDM Smith, 2024)*.

Linkages to other reports are described in Section 5.4.

[1] Definition from *Ministerial Guidelines for Groundwater Licensing and the Protection of High Value Groundwater Dependent Ecosystems*, dated 13 April 2015.

2.0 EES Scoping Requirements

2.1 EES evaluation objectives

The scoping requirements for the EES by the Minister for Planning set out the specific environmental matters to be investigated and documented in the Project's EES, which informs the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the Project.

The following evaluation objective is relevant to the groundwater assessment:

> **Catchment values and hydrology** – *To maintain the functions and values of aquatic environments, surface water and groundwater quality and stream flows and prevent adverse effects on protected beneficial uses.*

2.2 EES Scoping Requirements

The aspects from the scoping requirements relevant to the groundwater evaluation objective/s are shown in Table 2-1, as well as the location where these items have been addressed in this report.

Table 2-1 Scoping requirements relevant to groundwater

Aspect	Scoping requirement	Refer
Key issues	Potential for the Project to have significant impact on wetland systems, including, but not limited to, Glenelg Estuary and Discovery Bay Ramsar site and its associated aquatic environments, and the ability for wetland systems to support habitat for protected flora and fauna species.	Risk pathways associated with changes in groundwater levels and flow were identified, and a screening process completed in Section 6.0.
	The potential for adverse effects on nearby and downstream water environments (including Glenelg Estuary and Discovery Bay Ramsar site and listed Nationally Important Wetlands) due to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction.	Potential effects on groundwater during construction addressed in Section 8.1 . GDEs are addressed in *Groundwater Dependent Ecosystem Impact Assessment (Appendix H of the EES) (CDM Smith, 2024)* and surface water addressed in *Surface Water Impacts Assessment (Appendix F of the EES) (AECOM, 2024)*
	The potential for adverse effects on the functions, values and beneficial uses of groundwater due to the project's activities, including water extraction, interception or diversion of flows, discharges or seepage from quarrying areas, turbine foundations and other operational areas or saline water intrusion.	Potential effects on groundwater during operation are addressed in Section 8.2. GDEs are addressed in *Groundwater Dependent Ecosystem Impact Assessment (Appendix H of the EES) (CDM Smith, 2024)* and surface water addressed in *Surface Water Impacts Assessment*

Aspect	Scoping requirement	Refer
	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.	*(Appendix F of the EES) (AECOM, 2024)* Addressed in *Surface Water Impacts Assessment (Appendix F of the EES) (AECOM, 2024)*
	Potential for disturbance of contaminated or acid sulphate soils.	Addressed in *Environmental Site Investigation (Appendix I of the EES) (AECOM, 2023)*
Existing environment	Characterise the groundwater (including depth, quality and availability to licence/ use) and surface water environments and drainage features in the project area and its environs.	Section 7.0 describes the existing groundwater and surface water conditions in the Project Area and surrounds. The general environs are described in Sections 7.1 to 7.5. Sub-areas within the Project Area are detailed in Sections 7.6 to 7.8
	Characterise the wetland systems in the project area and its environs including the extent, types and condition of wetlands that could be impacted by the project, having regard to terrestrial and aquatic habitat, including as habitat corridors or linkages.	Addressed in *Groundwater Dependent Ecosystem Impact Assessment (Appendix H of the EES) (CDM Smith, 2024)*
	Characterise hydrological requirements for wetlands in the project area and its environs and their acceptable limits for change.	Addressed in *Surface Water Impacts Assessment (Appendix F of the EES) (AECOM, 2024)*
	Characterise soil types and structures in the study area and identify the potential location and disturbance of acid sulphate soils.	Addressed in *Environmental Site Investigation (Appendix I of the EES) (AECOM, 2024)*
Likely effects	Assess the potential effects of the project on surface water and groundwater environments and beneficial uses, including on permanent and ephemeral wetland systems in the project area and its environs and downstream, considering appropriate climate change scenarios.	Potential effects on the groundwater environment due to changes in groundwater levels, flow and saline intrusion are addressed in Sections 8.1 and 8.2 Climate change scenarios considered in Section 7.3.
	Assess the potential effects on Glenelg Estuary and Discovery Bay Ramsar site, due for example to changed water quality, flow regimes, impacts on groundwater or waterway conditions during construction considering appropriate climate change scenarios.	Addressed in *Groundwater Dependent Ecosystem Impact Assessment (Appendix H of the EES) (CDM Smith, 2024)* and *Surface Water Impacts Assessment (Appendix F of the EES) (AECOM, 2024)*

Aspect	Scoping requirement	Refer
	Identify and assess potential effects of the project on soil stability, erosion and the exposure and disposal of contaminants or hazardous soils (e.g. acid sulphate soils).	Erosion and sedimentation considered in *Surface Water Impacts Assessment (Appendix F of the EES) (AECOM, 2024)*, and contaminants and hazardous soils are considered in *Environmental Site Investigation (Appendix I of the EES) (AECOM, 2023)*
Mitigation measures	Identify proposed measures to mitigate any potential effects, including any relevant design features or preventative techniques to be employed during construction and operation.	Proposed mitigation measures are provided in Section 8.0 and Section 9.0
Performance objectives	Describe proposed measures to manage and monitor effects on catchment values and identify likely residual effects.	Mitigation and management measures are identified in Section 8.0, and recommended monitoring provided in Section 9.0
	Describe contingency measures for responding to unexpected but foreseeable impacts such as disturbance of acid sulphate soils.	Contingency measures are described in Section 10.0

3.0 Project Description

3.1 Overview

Neoen is proposing a renewable energy development, known as the Kentbruck Green Power Hub, comprising a wind energy facility (wind farm) with associated infrastructure. The Project would be mostly located in an actively managed and harvested pine plantation in southwest Victoria, between Portland and Nelson, in the Glenelg LGA.

The Project would involve two main components:

- A wind farm of up to 600 MW comprising up to 105 wind turbines and associated permanent and temporary infrastructure.
- A new 275 kV underground transmission line, which would connect the Project to the existing AusNet electricity transmission network. The transmission line would extend from the eastern boundary of the wind farm site to the existing 275/500 kV Heywood Terminal Station and would be approximately 26.6 km in length.

Further details about the main components of the Project are provided in Sections 3.3 to 3.6 and shown in **Figure F1, Appendix A.**

For the purposes of this EES, the following terminology is used to describe the Project site:

- Project Area: The total area in which the Project would be developed. It comprises the wind farm site and the transmission line corridor. The Project Area covers an area of approximately 8,350 hectares (ha).
- Wind farm site: The parcels of land on which the wind farm would be located. The wind farm site covers an area of approximately 8,318 ha.
- Transmission line corridor: The corridor of land in which the transmission line would be located. The exact location of the transmission line within this corridor will be determined during detailed design of the Project. The transmission line corridor covers an area of up to 21 ha.
- Construction footprint: The indicative area that would be directly impacted by the Project during construction, subject to changes based on the final construction design. The construction footprint is estimated to be approximately 455 ha.
- Operational footprint: The indicative area needed for operation of the Project, excluding land that may be used for unscheduled maintenance, subject to changes based on the final construction design. The operational footprint is estimated to be approximately 342 ha.

3.2 Study Area

The groundwater study area encompasses the wind farm site boundary (discussed in this report as two distinct sub-areas) plus an additional buffer zone and the transmission line plus an additional buffer zone. The groundwater study area is defined as the area within:

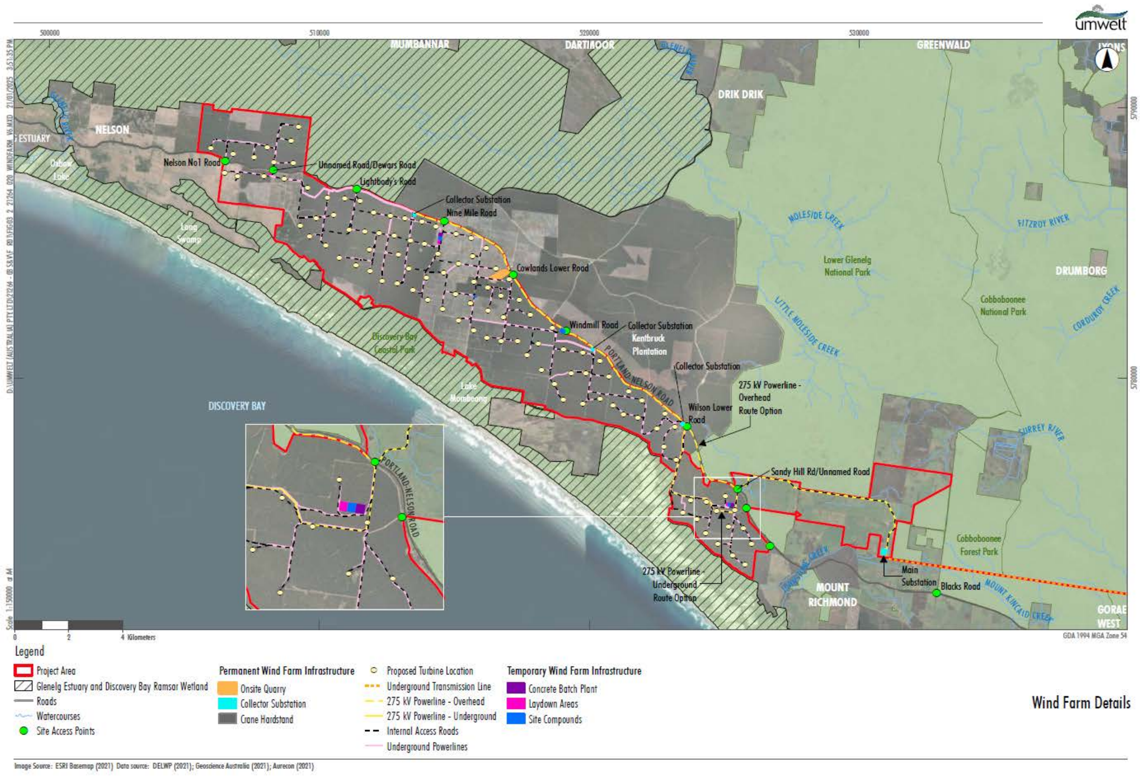
- Wind farm site boundary plus 500 metre buffer zone.
- This zone has been discussed in this report in terms of two distinct sub-areas:
  - the wind farm ‘plantation sub-area’ and
  - the wind farm ‘northeastern sub-area’ (noting that there are no turbines proposed in this sub-area)
- Underground transmission line towards Heywood plus 200 metre buffer zone.

The buffer zones around each component of the Project are based on existing conditions, the scale of each Project component and professional judgement. An iterative approach is used, and buffer zones are refined as required throughout the impact assessment. The final buffer zones reported here are considered adequate to capture existing conditions (including groundwater users) that may be affected by potential changes to groundwater levels and flow due to the proposed Project activities and infrastructure.

Potential impacts beyond the 500-metre buffer zone around the wind farm site boundary are considered separately for the groundwater supply assessment (included as **Appendix F** and considered in Section 8.1.7).

The groundwater study area and sub-areas are included in **Figures F2 to F12** (**Appendix A**) and the wind farm site is shown in Figure 3-1 below.

Figure 3-1 Wind farm site



3.3 Key construction activities

The Project would be constructed in either a single stage or over two stages. A single stage of construction would involve up to 350 workers, with construction occurring over a two-year period. If constructed over two stages, the construction period would be extended to 2.5 years and have a smaller peak workforce. The average workforce would be 250 workers for single stage construction and 190 workers for two stage construction. Construction would be restricted to a 12-hour window on Monday-Saturday, where possible.

Construction of the Project would involve two main components: the wind farm and the transmission line. The following key construction activities would be undertaken:

- Preliminary works including clearing of pine trees within the plantation, removal of vegetation from agricultural land, and removal and storage of topsoil for future use.
- Internal access road and public intersection upgrades.
- Construction of internal access tracks where needed.
- Establishment of concrete batching plants and construction of site buildings and construction compounds.

- Establishment of new onsite quarry to provide road-base material. Material would be extracted progressively throughout the Project construction period.
- Construction of hardstand and laydown areas.
- Excavation of turbine foundations and form work.
- Construction of cable trenches and power pole foundations; laying of bedding materials, cables and backfill; and replacement of topsoil.
- Construction of the main substation, collector substations and operation and maintenance building, involving excavation and pouring of building foundations and concrete pads at switchyard and transformer locations.
- Installation of wind turbines, collector substations, main substation, cabling and powerlines and other ancillary electricity infrastructure.
- Progressive rehabilitation of the site and landscaping.

3.4 Key operational activities

The operational life of the wind farm is expected to be between 25 and 30 years. During this period, operation, maintenance, and monitoring of the wind farm would include the following activities:

- Service of the wind turbines and associated infrastructure.
- Maintenance of internal access tracks and electrical infrastructure.
- Use and maintenance of buildings and plant, including the operations and maintenance building.
- Ongoing environmental monitoring in accordance with operational requirements and relevant approval conditions.

3.5 Key decommissioning activities

At the end of the operational life of the Project, the wind farm would either be decommissioned or upgraded with new turbines and ancillary infrastructure. Upgrading (repowering) the Project would extend the operational period of the Project and be subject to varied or additional approvals and permits.

Key decommissioning activities would include:

- Removal of all above-ground non-operational equipment.
- Removal and clean-up of any residual contamination.
- Rehabilitation of all storage areas, construction areas, access tracks and other areas affected by the Project, if those areas are not otherwise useful to the ongoing use or decommissioning of the wind farm and pine plantation. The site would be rehabilitated in consultation with the relevant landowners.

The Project would comply with any relevant requirements for decommissioning as prescribed under any planning approval or subsequent permit or licence.

3.6 Key activities relevant to groundwater

This groundwater impact assessment has considered the Project area as three distinct sub-areas (as described in Section 3.2); based on the proposed construction activities, and temporary and permanent infrastructure. The main activities and infrastructure relevant to potential impacts on groundwater are set out below.

Water supply

A source of water will be required during construction, which will primarily be used for road construction, dust suppression and turbine foundations.

Current water supply requirements for construction are estimated to be up to 250 megalitres over a 24-month construction period.

The preferred source of water supply for the Project is groundwater from a bore (or bores) within the wind farm site. Should other sources be needed to meet Project requirements, these may include onsite rainfall storages and tanks, offsite groundwater or trucking/carting water.

The use of existing bores and/or the construction of new bores will be subject to the licencing provisions administered by relevant regulators. A full assessment of potential impacts on groundwater users and beneficial uses will be carried out as part of any future groundwater take and use application if groundwater is to be used for construction of the Project.

A groundwater supply assessment was carried out in February and March 2022, and is provided as **Appendix F**. The findings of that assessment and results of the subsequent seven day pumping test (CDM Smith, 2023) have informed existing conditions in the wind farm plantation sub-area (described in Section 7.6) and allowed for an adequate assessment of potential impacts on the groundwater environment to appropriately respond to the Scoping Requirements (refer to Section 8.1.7).

The extraction of groundwater for Project purposes will need to be made as a temporary transfer of an existing licence allocation via a temporary trade. There is currently no Permissible Consumptive Volume (PCV) for the South West Limestone (SWL) according to the local management plan (SRW, 2023) but it is effectively capped. No further significant allocations are proposed, and trade is the primary mechanism to increase access to groundwater. There is currently 80,000 ML of groundwater entitlement in the SWL Groundwater Management Area with annual use typically between 40% and 50% of total entitlement and therefore a large volume of entitlement is available for trading (pers. communication SRW, April 2023).

All such applications would be in accordance with Section 40 of the *Water Act 1989* (the Water Act) and subject to the rules and limitations laid out in the relevant management plans. These may include restrictions on the siting of a new extraction bore (relative to existing users and GDEs) and the need to complete a detailed hydrogeological assessment.

The 24-hour (March 2022) and 7-day (April 2023) pumping tests, and associated assessments (**Appendix F** and CDM Smith, 2023) would help inform any such hydrogeological assessment required by Southern Rural Water and be used as part of a temporary transfer application for a take and use licence allocation.

Operational water requirements are expected to be limited to drinking water which is trucked in and stored on site.

Turbine foundations

Slab (gravity) foundations would involve the excavation of approximately 1600 cubic metres (m^3) of ground material to a depth of approximately 4 m (based on a 25 m diameter foundation). A slab foundation would involve the installation of shuttering and steel reinforcement, followed by the pouring of concrete.

Excavations may remain open for up to about a month and would require dewatering if groundwater is intersected. Any groundwater collected within the excavation area would be discharged immediately adjacent to the site subject to required licencing (refer to the Environmental Site Investigation report, AECOM 2023).

Much of the excavated material would, if suitable, be used as backfill around the wind turbine base. The remaining excavation material will be used for the onsite road infrastructure, where necessary.

The number of concurrent foundations in progress will be dependent on the final Project schedule, but is anticipated to be up to 15 at any one time. The level of completion would range from just starting the excavation, to backfilling the earthworks after concrete curing (that is, not all dewatering at the same time). Dewatering across the site due to foundation installation will therefore be at a limited number of locations at any given time.

Onsite wind farm powerlines

The Project would involve the installation of up to 190 km of underground powerlines (33 kV or 66 kV) connecting the wind turbines to the collector substations, and up to 27.8 km of high voltage powerline connecting the collector substations to the main wind farm substation.

The high voltage powerline would likely be 275 kV (subject to detailed design) and would run overhead along Portland-Nelson Road from the western collector substation to the eastern collector substation. From there two options are being considered:

- The powerline would continue overhead along Portland-Nelson Road to a transition station at the Portland-Nelson Road / Sandy Hill Road intersection.
- the powerline would transition to underground at the collector substation and run beneath existing roads in the GTFP pine plantation to the Portland-Nelson Road / Sandy Hill Road intersection.

From the Portland-Nelson Road / Sandy Hill Road intersection it would pass beneath Portland-Nelson Road then continue underground to the main substation. The proposed alignment of the powerline, including the options described above, is shown in **Figure F1, Appendix A**.

The underground route through the GTFP plantation is the preferred option for a range of reasons. Part of the underground route is located within land previously zoned Public Park and Recreation Zone (PPRZ), which recognises areas for public recreation and open space and provides for appropriate commercial uses. Glenelg Shire Council considered this PPRZ area to be an anomaly in the Glenelg Planning Scheme (the Planning Scheme), and it has since been rezoned to Farming Zone (FZ) through the gazettal of Amendment C96gelg occurred on 15 June 2023.

Transmission line

The Project would require a new 275 kV transmission line to connect the Project to the existing transmission network. The proposed transmission line route measures approximately 26.6 km in length and would extend underground from the main wind farm substation near the eastern boundary of the wind farm site to the existing Heywood Terminal Station (see **Figure F1, Appendix A**). The transmission line would bisect Cobboboonee National Park and Cobboboonee Forest Park for approximately 17.6 km, where it would be buried beneath an existing road (Boiler Swamp Road).

After exiting Cobboboonee Forest Park the underground line would continue for 1.2 km through freehold agricultural land. As shown on **Figure F1**, two options have been identified for this section of the transmission line. The slightly shorter southern route is the preferred option, but due to its proximity to a swampy area adjacent to the Surrey River it may not be feasible for underground construction. The viability of this option will be determined in response to geotechnical investigations undertaken during detailed design and only one option would ultimately be constructed. After crossing the Surrey River, the transmission line would continue underground until its connection point into the Heywood Terminal Station.

The underground route through Cobboboonee National Park / Forest Park has been delineated into a 6.5 m wide construction footprint to minimise impacts on native vegetation within the Boiler Swamp Road corridor. The cabling would be buried using a specialised machine that excavates, lays the cable and backfills the trench in a single pass, minimising the associated construction footprint through small trench widths and minimal spoil generation. Once the transmission line exits Cobboboonee Forest Park, the construction footprint would be approximately 9 m wide as it continues through freehold land until it reaches Heywood Terminal Station. Traditional open-cut trenching methods would be used for this section of the underground transmission line.

All transmission line options that have been considered for the Project, including those which are no longer being pursued by Neoen, are discussed in Chapter 4 of the EES and detailed in the options assessment report prepared by Umwelt (2024) (Appendix A of the EES). **Appendix G** of this report provides a summary of the impacts associated with three alternative transmission line options considered by Neoen to date, including a combined overhead-underground option to the Heywood Terminal Station, and overhead and underground options through freehold land southeast of the wind farm site. These options are referred to as Options 1A, 2A and 2B, respectively.

Quarry

A new limestone quarry is also proposed to be established in the wind farm site adjacent to the existing quarry operated by Green Triangle Forest Products (GTFP), on North Livingston Road (see **Figure F1, Appendix A**). The cemented “cap rock” quarry would operate during both construction and operation, with the extracted material to be used for hardstands and for upgrades to existing access roads or construction of new access roads.

The quarry would have a maximum footprint of 11 ha and be up to 15 m deep, with actual dimensions to be determined following a comprehensive drilling, sampling and testing program during detailed design of the Project. The total extracted volume is estimated to be up to 300,000 cubic metres (m3), with material to be extracted progressively during construction. The quarry would also be used throughout the Project’s lifetime for road maintenance and would be made safe and rehabilitated at the end of its use for the Project to a suitable landform.

4.0 Legislation

Table 4-1 summarises the relevant legislation that applies to the Project in the context of this groundwater impact assessment as well as the implications and required approvals.

Table 4-1 Primary environmental legislation and associated information on groundwater

Legislation/ policy	Key policies/strategies	Implications for the Project	Approvals required
State			
Water Act 1989	This Act is the primary legislation for the integrated management of Victoria's water resources. The Act applies to the management of groundwater and imposes licensing requirements in relation to the dewatering of groundwater. For groundwater in southern Victoria, the Department of Environment, Land, Water and Planning (DELWP) has delegated this responsibility (including licensing) to Southern Rural Water (SRW).	Liaison with SRW is required regarding the licensing of groundwater monitoring bores, extraction wells for construction water supply (if required) and removal of groundwater from trenches and excavations (if required to allow pipe installation). Glenelg Hopkins CMA (GHCMA) is also a referral authority for groundwater take and use (T&U) licences. GHCMA would consider potential impacts to GDEs and surface water as part of a T&U licence application	A Take and Use licence will be required if groundwater source(s) are required for construction purposes.
Environment Protection Act 2017 (Environment Protection Act)	The Environment Protection Act aims to protect Victoria's air, water and land by adopting a 'general environment duty' (GED) which imposes a broad obligation on entities and individuals to take proactive steps to minimise risks of harm to human health and the environment from pollution or waste. The Victorian Environment Protection Authority (EPA) administers the Environment Protection Act and subordinate legislation.	The Environment Protection Act regulates discharges to land, surface water or groundwater by a system of development and operating licences. Any discharge into a waterway or groundwater during the construction or operation of the project must be in accordance with the requirements of the Environment Protection Act. The GED requires all reasonably practicable steps be taken to minimise impacts from the construction and operation of the project.	No approvals required

Legislation/ policy	Key policies/strategies	Implications for the Project	Approvals required
Environment Reference Standard	This Environment Reference Standard (ERS) is made under section 93 of the *Environment Protection Act 2017*. It sets out the environmental values of the ambient air, ambient sound, land and water environments that are sought to be achieved or maintained in Victoria and standards to support those values. Environmental values are the uses, attributes and functions of the environment that Victorians value. Standards for the environmental values are comprised of objectives for supporting different uses of the environment and indicators that can be measured to determine whether those objectives are being met.	The project would seek to minimise the potential for impacts on groundwater to ensure that existing environmental values are protected, with priority given to maintaining environmental values of areas of high conservation value (Ramsar sites).	No approvals required but ERS used to inform EPA's decision making under Environment Protection Act.

5.0 Methodology

This section describes the method used to assess potential groundwater impacts of the Project. A risk-based approach was applied to prioritise key issues for assessment and inform measures to avoid, minimise and offset potential effects.

5.1 Desktop assessment

Key elements of the desktop assessment included:

- Characterise the nature and extent of groundwater systems which may be impacted by the construction and operation of the Project.
- Characterise the relevant groundwater environments, including the protected beneficial uses and values and behaviours, including nearby wetlands such as the Glenelg Estuary and Discovery Bay Ramsar site, and identifying any GDEs that might be affected by the Project.
- Characterise the interaction between surface water and groundwater within the Project site and the broader area.
- Characterise the physical and chemical properties of the Project area groundwater in relation to key infrastructure.
- Identify potential and proposed design options and measures which could avoid or minimise significant effects on beneficial uses of groundwater environments during Project construction and operation.
- Identify methods to manage and dispose of groundwater during construction.
- Identify and evaluate effects of the Project on groundwater near the Projects' works including the likely extent, magnitude and duration (short and long term) of changes to groundwater level or flow paths during construction and operation and changes to groundwater quality during construction including from sedimentation and downstream effects on ecological values.
- Describe and evaluate the approach to monitoring and the proposed contingency measures to be implemented in the event of adverse residual effects on water environmental including water quality and catchment values requiring further management.

5.2 Fieldwork program

5.2.1 Shallow monitoring bores

Based on findings of the desktop assessment, a focussed groundwater investigation was completed. Between 12 and 29 April 2021 to obtain site-specific groundwater data and to refine hydrogeological understanding within the study area. Twelve monitoring wells were installed, and manual groundwater level gauging, water quality sampling and aquifer testing was undertaken. Additional manual gauging and groundwater level monitoring with the use of data loggers has also been undertaken between April 2021 and April 2023. Refer to Table 5-1 for additional details.

In particular, the fieldwork program targeted areas where the Project had the potential to intersect groundwater in the proximity of mapped potential GDEs. Monitoring bores were installed close to the southern boundary of the Plantation sub-area adjacent to the complex of swamps and wetlands (including those within the Glenelg Estuary and Discovery Bay Ramsar site), and within the wind farm north-eastern sub-area due to the presence of mapped potential GDEs.

The scope and methodology of the fieldwork program are summarised in Table 5-1 below, and the location of the twelve installed groundwater monitoring wells are shown on **Figures F2** to **F12** (**Appendix A**).

Table 5-1 Groundwater investigation methodology

Activity	Details
Drilling method	Drilling was completed by South Western Drilling by Geoprobe drilling rig between 12– 16 April 2021. Twelve groundwater bores were advanced using push tube and auger techniques. The bores targeted the water table and shallow lithology, and were installed to: • depths of between 4 and 10 metres below ground surface (mbgs) in the Plantation sub-area (MW01 – MW09) and • A depth of 6mbgs at the north-eastern sub-area (MW10 – MW12). Construction summary information is provided in Table B1 (**Appendix B**).
Soil logging	Soil logging was conducted in general accordance with Australian Standard, AS1726. Lithology and monitoring well construction are presented on bore logs in **Appendix C**.
Monitoring Bore construction	Driller supplied PVC screen, casing and end caps were installed into the open hole. Washed rounded sand was then added to the annulus around the screen and extended to approximately 1.5 metres above the top of the well screen. A minimum 0.5 metre bentonite (clay) seal was installed above the filter pack by slowly adding bentonite pellets to the annular space between the borehole and the remaining space within the annulus was grouted from the top of the bentonite seal to the ground surface with a cement/bentonite grout. A slightly mounded concrete pad was constructed around the seven plantation bores with flush gatics at ground level to reduce the potential for surface flow ingress to the well, while the remaining five bores were finished with a lockable recycled PVC monument approximately 0.7 m above ground surface.
Well development	Post installation, the groundwater monitoring wells were developed by purging three bore volumes with a decontaminated stainless-steel bailer. Well development parameters are presented in Table B1 (**Appendix B**).
Survey	All monitoring bores were surveyed at ground surface using a handheld Trimble Geo 7x GPS during the gauging event on 26 – 27 April 2021. The casing height above/below ground was measured manually and top of casing calculated by manual adjustment. The water surface elevation in nine private dams and Lake Mombeong, and the approximate surface elevation at Black Swamp, was also surveyed. Vertical precision of the GPS unit was ±0.1 m, except for MW03 to MW09 and 101242 (EJ1) where precision was to ±0.5m where satellite access was affected by the plantation tree cover. Survey data is included in Table B1 (**Appendix B**).

Activity	Details
Groundwater gauging	All 12 newly installed groundwater wells, one State Observation Bore Network bore and six existing stock/domestic wells were gauged using a water level meter for depth to groundwater between 26 to 27 April 2021. Additional manual groundwater level gauging was carried out on 4 and 5 October 2021, and 23 March 2022. Data loggers were installed in monitoring wells MW04 – MW08 in April 2021 to allow continuous groundwater level monitoring at 30-minute intervals. Gauging results for the newly installed groundwater wells (MW0x series) presented in Table B2 (**Appendix B**), and existing groundwater well gauging results are presented in Table B3 (**Appendix B**).
Groundwater sampling	The 12 newly installed wells (MW01 - MW12) were sampled between 28 – 30 April 2021.
Groundwater sampling method	Groundwater samples were collected using the low-flow technique in accordance with EPA Victoria Publication 669: *Groundwater sampling guidelines (April 2000).* Ex-situ measurements of groundwater field chemistry (pH, electrical conductivity, dissolved oxygen, oxidation reduction potential, and temperature) were collected during low-flow purging. Field quality parameters collected during sampling are presented in Table B4 (**Appendix B**).
Surface water sampling	Field parameters were collected from grab samples at a total of eight locations.
Sample preservation	All samples were collected into the appropriately preserved bottles as provided by the laboratory. Samples were stored on ice in a cooler box while on site and in transit to the laboratory for analysis.
Sample analysis	All primary samples were submitted to Australian Laboratory Services for the following analysis: • major ions • total dissolved solids A select number of wells were also analysed for additional analysis as part of the soil contamination and acid sulfate soil scope and is discussed in the Environmental Site Investigation report (AECOM, 2021).
Quality control	The following samples were submitted for quality control purposes: • One duplicate sample, three equipment rinsate blanks, three field blanks and two trip blank to Australian Laboratory Services; and • One inter-laboratory samples (field triplicate) to Eurofins Environment Testing Australia. It should be noted that rinsate blanks and field blanks were only analysed for the contamination suite and not the major ions/total dissolved solids suite due to the limited rinsate water volume provided by the laboratory.
Decontamination procedure	The interface probe and low flow pump were washed in Decon90 solution and rinsed with potable water and deionised water between wells. Low flow bladders and low flow tubing were dedicated for each well.
Disposal of purged groundwater	Purged groundwater collected during sampling was discharged to ground given the minor volumes purged during sampling.

Activity	Details
Equipment calibration	The water quality meter used to collect groundwater parameters was calibrated daily prior to sampling.
Aquifer testing	Aquifer hydraulic testing (rising and falling head slug tests) was conducted from 26 to 29 April 2021 for all 12 newly installed wells.
Aquifer testing methodology	The slug testing methodology is summarised below: • Depth to groundwater from the top of casing reference point was measured prior to any disturbance within each of the wells. • An electronic pressure transducer was lowered into the well to monitor groundwater pressure head at intervals of 1 second during testing. • A 40mm diameter PVC slug of known volume was then lowered into the well, completely submerged where the water column was sufficient and then removed, displacing the water level. Slugs of 1.0, 1.5 and 2.0 m length were selected depending on the water column.at each bore. This was to achieve theoretical initial displacements of between 50 and 75cm, Water levels were monitored manually (as well as by transducer) until 90% recovery had occurred (that is, the water level recovered to within 10% of the static water level prior to displacement). Levels recovered within five minutes and the tests were repeated at least three times to obtain sufficient data. Data from the electronic transducers were compared to manual measurements as part of the data quality assessment.

5.2.2 Groundwater supply test bore and monitoring bore

A groundwater supply investigation was carried out in February and March 2022. The fieldwork scope of work included:

- Drilling and installation of a test production bore (TB01) and monitoring bore (MB01)
- Step and constant rate pumping tests at TB01

Results and interpretation of the fieldwork program are provided in **Appendix F** and the location of TB01 and MB01 are included in **Figures F2** to **F12** (**Appendix A**).

Relevant portions of **Appendix F** are used in describing existing conditions (Section 7.6) and to inform the impact assessment (Section 8.0).

A 7-day constant rate pumping test was subsequently carried out at TB01 in April 2023, with analysis and interpretation provided in *Factual Report – 7-day groundwater pumping test* (CDM Smith, 2023).

5.3 Limitations, uncertainties and assumptions

The following limitations, uncertainties and assumptions apply to this assessment:

- The desktop assessment was limited to publicly and readily available information. It is based on conditions that existed at the time assessment was conducted. Its findings and conclusions may be affected by the passage of time.
- The fieldwork program included the installation of 12 shallow monitoring wells, one deeper limestone monitoring bore, one deeper limestone test bore, aquifer testing, groundwater sampling and water level gauging. The assessment is limited to the conditions encountered at the locations investigated and the time over which the assessment was conducted but is considered appropriate and adequate to address the Scoping Requirements.
- Details of registered bores are described as provided in the WMIS database (such as mapped location, use and construction). The presence (or otherwise) of unregistered bores within the study has not been confirmed as part of this assessment. However, any bores observed during site investigation works were included in the assessment.

- The project will be constructed, operated, and decommissioned as assumed.
- Mitigation measures in Sections 8.0 and 9.0 will be employed as described.

5.4 Linkages to other reports

This report has interdependencies with the onshore ecology, surface water, and soil and waste reports in relation to the assessment of impacts associated with:

- Groundwater is extracted and released to the surface where it can enter and pollute receiving waterways (*Surface Water Impact Assessment Appendix F Kentbruck Green Power Hub EES Technical Report, AECOM 2024*).
- Intersection and/or extraction of groundwater affects groundwater quality and impacts groundwater users (*Environmental Site Investigation Appendix I Kentbruck Green Power Hub EES Technical Report, AECOM 2023*).
- Excavation or dewatering of acid sulfate soils affects groundwater quality and impacts groundwater users (*Environmental Site Investigation Appendix I Kentbruck Green Power Hub EES Technical Report, AECOM 2023*).
- Intersection of groundwater and dewatering activities result in mobilisation of contamination (including from ASS) which affects GDEs (*Appendix H Kentbruck Green Power Hub EES Technical Report Groundwater Dependent Ecosystem Impact Assessment, CDM Smith 2024).*
- Dewatering for turbine foundations or underground cabling impacts GDEs (*Appendix H Kentbruck Green Power Hub EES Technical Report Groundwater Dependent Ecosystem Impact Assessment, CDM Smith 2024).*
- Groundwater flow is impeded by turbine foundations and impacts GDEs (*Appendix I Kentbruck Green Power Hub EES Technical Report Groundwater Dependent Ecosystem Impact Assessment, CDM Smith 2024).*

The groundwater specialists undertaking this assessment worked collaboratively to evaluate these potential impacts and design suitable mitigation measures to be adopted by the project.

6.0 Risk Screening

6.1 Methodology

A risk-based screening approach was used for this assessment in accordance with the requirements outlined in the 'Ministerial guidelines for assessment of Environmental Effects under the Environment Effects Act 1978' (page 14). The risk screening was undertaken during the project scoping phase to ensure that the level of investigation was adequate to inform an assessment of the significance of the Project's potential environmental impacts.

A screening tool was used to prioritise and focus the proposed investigations, assessments, and approaches to avoiding, minimising or managing potential impacts. The issue screening process involved an evaluation of the potential environmental, social, and economic issues associated with the project based on the information collected through a series of initial assessments undertaken into the potential effects.

The purpose of the issues screening tool was to assist in identifying:

- Significant issues, uncertainties and/or potential impacts that require more detailed characterisation and/or assessment within the EES.
- Matters or potential impacts considered to be already well understood or less significant.

A high, medium, or low screening value was assigned to potential issues to determine the level of assessment required to identify and investigate impacts.

Each potential issue was given a score (1, 2 or 3) against the categories of:

- Community and stakeholder interest.
- Significance of assets, values and uses.
- Potential impact (spatial, temporal and severity).

The scores were added together, or the highest score across the three contributing categories were used, to give a 'screening value' of high, medium or low, which gives an indication of the level of impact assessment that is required. Issues that were assigned a screening value of high or medium required detailed assessment in the EES at a level commensurate with them being considered primary level issues.

Issues that were assigned a screening value of low were proposed to be documented and managed with some investigation and assessment in the EES at a level commensurate with them being considered secondary level issues.

6.1.1 Criteria and consequence ratings

Risks, issues, and potential impact pathways were identified for both construction and operation of the project. Table 6-1 defines the criteria and consequence ratings for each of the three categories that were used to inform the issues screening. The sum of the scores against each of the three categories gives the 'screening value'.

Table 6-1 Issues screening criteria and consequence ratings

Rating	Community and stakeholder interest	Significance of assets, values and uses	Potential impact (spatial, temporal and severity)
1	Low interest and perceived impact	Locally significant asset, value or use	Potential for localised, temporary impact
2	Some interest and targeted perceived impacts	Regionally significant asset, value or use	Potential for significant temporary, or localised permanent impact

Rating	Community and stakeholder interest	Significance of assets, values and uses	Potential impact (spatial, temporal and severity)
3	Broad community and stakeholder interest or impacts	State or nationally significant asset, value or use	Potential for significant permanent impact

The screening values are then used to determine the level of assessment required as shown in Table 6-2.

Table 6-2 Issue investigation categories

Screening score	Screening value	Potential consequences	Complexity of mitigation	Level of assessment
7, 8 or 9 or the highest rating across any one of the three contributing categories is 3	High	Potential for elevated, longer term impacts, significant assets or values may be affected with enduring changes. Considers both impacts and benefits, or Issue may not be well defined and insufficient information is available for the impact assessment, or High level of community interest.	Stringent management measures may be required	Detailed assessment required
4, 5 or 6 or the highest rating across any one of the three contributing categories is 2	Medium	Potential for moderate level impacts, significant assets or values may be affected over an extended time frame with some resultant changes. Considers both impacts and benefits, or Issue may be moderately understood, and some information is available, however more is required for the impact assessment, or Medium level of community interest.	Standard management measures are available that can be adopted with some modification	Moderate assessment required
3 or the highest rating across any one of the three contributing categories is 1	Low	Potential for short term and localised impact. Asset or values may be temporarily affected but recovery expected, or Issue is well understood and there is enough information available for the impact assessment, or Low level of community interest.	Standard management measures are available.	Some assessment required

Further information about the risk screening process is detailed in Chapter 6 *Assessment framework.*

Outcomes from the risk screening process are outlined in Section 6.2 below.

6.2 Results

Table 6-3 provides the key potential issues related to changes in groundwater level and flow identified as part of the risk screening process for the Project and presents the screening value for each issue.

These initial risk screening values have been used to prioritise and determine the level of assessment required for each of the issues identified.

A fieldwork program was designed and implemented, as described in Section 5.2, to assess those issues with high or medium screening values. The fieldwork program informed existing conditions (Section 7.0) with the objective of defining depths to groundwater and the potential for groundwater to be intersected by the Project. In particular, the field program focussed on low lying areas close to the Ramsar wetland complex (adjacent to the southern boundary of the plantation sub-area) and other areas of potentially shallow groundwater (including the wind farm northeastern sub-area). Aquifer testing was also carried out to inform dewatering estimates.

A groundwater supply investigation, including installation and testing of a test bore and monitoring bore, was carried out in February and March 2022. This was to assess the potential effect of groundwater extraction for Project supply during construction which identified as having a screening value of ‘high’. The findings of the assessment are provided as **Appendix F**, with relevant portions used in describing existing conditions (Section 7.6) and to inform the impact assessment (Section 8.0).

Potential impacts on groundwater quality from the Project, including acid sulfate soils, are considered in a separate EES Technical Report (Environmental Site Investigation; AECOM, 2023).

Table 6-3 Risk pathway screening results for groundwater

Risk pathway	Project area	Community and stakeholder interest	Significance of assets, values and uses	Potential impact (spatial, temporal and severity)	Screening score	Screening value
Construction						
Dewatering turbine foundations reduces groundwater levels and/or flows at GDEs or consumptive use bores	Plantation sub-area	3	3	2	8	High
Dewatering or groundwater supply extraction induces saline intrusion	Plantation sub-area	3	3	1	7	High
Cable trench dewatering reduces groundwater levels at existing consumptive use bore(s) or GDEs	Plantation sub-area	2	3	1	6	Medium
Cable trench dewatering reduces groundwater levels at existing consumptive use bore(s) or GDEs	Northeastern sub-area, and Heywood transmission line sub-area	1	2	1	4	Medium
Groundwater supply extraction reduces groundwater levels and/or flow at existing consumptive use bores or GDEs	Plantation sub-area	3	3	2	8	High
Existing bores become damaged, destroyed, or inaccessible thereby affecting bore user	All	1	2	1	4	Medium
Operation						
Turbine foundations impede groundwater resulting in changed groundwater levels and/or flow at existing bores or GDEs	Plantation sub-area	2	3	2	7	High
Trenched sections of underground cable impede groundwater resulting in changed groundwater levels and/or flows at existing bores or GDEs	Plantation sub-area	3	3	2	8	High
Trenched sections of underground cable impede groundwater resulting in changed groundwater levels and/or flows at existing bores or GDEs	Northeastern sub-area, and Heywood transmission line sub-area	1	2	2	5	Medium

7.0 Existing Conditions

7.1 Basin setting

The study area lies within the Otway Basin which extends offshore into Bass Strait, and onshore is bounded by the Goulburn Murray Basin to the north and the Central Coasts Basin to the east. The basin is around 3,000 metres thick beneath the study area[2], of mostly Cretaceous and Cainozoic sedimentary and volcanic rocks.

Table 7-1 Surface geology of the study area

Study area zone	Geological unit	Lithology
Wind farm site	Bridgewater Formation (Qxr) [predominant]	Calcarenite limestone (*calcareous dunes and dune limestone*)
	Coastal dune deposits (Qdl1) [very minor]	Silt, sands and clay (*beach ridge strandplain*)
	Swamp and lake deposits (Qm1) [very minor]	Silt, clay and peat (*still water – swamp marsh deposition*)
	Molineax Sand (Qxm) [very minor]	Sand and fine sand (*sand deposition – dunefield*)
Heywood transmission line	Newer Volcanic basalt (Neo) [predominant]	Basalt, tuff and scoria (*extrusive lava flow*)
	Swamp and lake deposits (Qm1) [very minor]	Silt, clay and peat (*still water – swamp marsh deposition*)

The aquifers within the basin sequence relevant to the groundwater impact assessment are the Quaternary Aquifer (QA) and Upper Tertiary/Quaternary Basalts (UTB), part of the Upper Aquifer Group (SRW, 2011). These overlie the Upper Mid-tertiary Aquifer (UMTA)[3], part of the Middle Aquifer, by thicknesses of typically upwards of 20 metres (SRW, 2011).

The Otway Basin extent and surface aquifer units are shown in Figure 7-1 and a summary of the study area hydrostratigraphy is provided in Table 7-2.

[2] based on information from https://www.water.vic.gov.au/groundwater/groundwater-resource-reports
[3] as defined in the Victorian aquifer framework

Figure 7-1 Otway Basin extent and surface aquifers

Table 7-2 Hydrostratigraphy of the study area

Study area zone	Aquifer	Hydrogeological Groundwater Unit (HGU)	Depth[1] (mbgs)
Wind farm site	QA	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0 – 30[2]
	UMTA	Port Campbell Limestone	30 - 250
Heywood transmission line (underground cable - west)	UTB	Newer Volcanics	0 - 50
Heywood transmission line (underground cable - east)	QA	Various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments	0 - 5
	UMTA	Port Campbell Limestone	5 - 200

NOTES: 1 - Approximated typical depths; 2 - Bridgewater Formation thickness reduces to around 10 metres beneath wind farm site at lower elevations (i.e. nearer the coast)

7.2 The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion

The Karst Springs and Associated Alkaline Fens of the Naracoorte Coastal Plain Bioregion Threatened Ecological Community (TEC) was listed as Endangered under the EPBC Act on 15 December 2020. The TEC is part of a once extensive system of wetlands that occurred on low lying areas over Gambier limestone bedrock near the coastal zone of the Otway Basin in South Australia and western Victoria.

The primary defining features of this community are the underlying limestone geology, karst fed (alkaline) freshwater springs, soaks, pools or streams and fringing fens which include herblands, peatlands, sedgelands and/or shrubland vegetation (TSSC 2020). Wetland dependent plants within the ecological community range from aquatic, emergent to fringing terrestrial species. Only fringing native vegetation that is hydrologically connected (at least intermittently) or dependent on the Tertiary limestone aquifer is part of the TEC.

Known occurrences within the study area include Lake Mombeong, which also forms part of the Glenelg Estuary and Discovery Bay Ramsar site.

Potential effects from the Project on these karst springs and associated alkaline fens are considered in CDM Smith (2024) (Appendix H of the EES).

Glenelg Estuary and Discovery Bay Ramsar site

A summary of the Glenelg Estuary and Discovery Bay Ramsar site is provided here and is described in more detail in the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith, 2024) (Appendix H of the EES), and the *Glenelg Estuary and Discovery Bay Ramsar Site: Ecological Character Description* report (DELWP, 2017).

The Glenelg Estuary and Discovery Bay Ramsar site has been designated a Wetland of International Significance under the Ramsar Convention since 2018; listed as internationally significant due to it providing seasonal habitat for many migratory birds. It consists of estuaries, a beach and dune system, and freshwater wetlands.

The Ramsar site is approximately 22,289 hectares and covers the western part of the Lower Glenelg National Park, most of the Discovery Bay Coastal Park and the Nelson Streamside Reserve. It borders the proposed wind farm component of the Project along the southern boundary and on the north western boundary.

The Ramsar site supports several different wetland types: freshwater wetlands, Glenelg Estuary and beach and dune system. A brief description of these wetland types is provided below, and their locations shown in **Figures F2a** and **F2b** (**Appendix A**). Further information on the Ramsar site wetland types is provided in the Ecological Character Description (DELWP, 2017) and discussed in *Hydrogeological processes and conceptualisation of the Glenelg River Estuary and Discovery Bay Ramsar sites* report (CDM Smith, 2020).

Freshwater wetlands

Freshwater wetlands in the Ramsar site consist of several complexes located behind (landward of) the dune system:

- The Long Swamp complex runs adjacent to the southern boundary of the proposed wind farm site and contains peatlands that support important fen wetlands (i.e. GDEs). The complex includes Sheepwash Lagoon, Cains Hut Swamp and several unnamed lagoons, Lake Mombeong, Black Swamp, McFarlanes Swamp and Eel Creek (connecting to Glenelg Estuary).
- The Lake Malseed complex, approximately 200 metres from the study area at its nearest point, consists of Malseed Lake, Swan Lake and Boomer Swamp.
- The Bridgewater Lakes are approximately 15 kilometres southeast of the wind farm site consisting of a sequence of five freshwater lakes at the southeastern end of the Ramsar site.

Glenelg Estuary

The Glenelg Estuary covers a surface area of around 510 hectares comprising the channel, Oxbow Lake, and a coastal lagoon extending from the channel (refer to Figure 7-2). It is linked to the Long Swamp complex via Eel Creek.

Figure 7-2 Glenelg Estuary

Source: Figure 9 of DELWP (2017)

The Glenelg Estuary is a salt wedge estuary formed by stratification of freshwater overlying denser saline water. The estuary closes seasonally as sediment deposited by wave action cannot be displaced by the low summer flows of the Glenelg River. When closed, the estuary fills with freshwater until the mouth is breached by wave action or higher river flow in spring or winter.

Freshwater inflows to the Glenelg Estuary are from direct rainfall, river inflows and groundwater. Most of the freshwater inflow to the estuary occurs in late winter and early spring. A water balance study, carried out when the estuary was closed for extended periods, indicated that groundwater inflow may account for up to 45% of total inflows (DELWP, 2017a). Marine water accounts for a large proportion of the total volume when the mouth of the estuary is open.

The Glenelg Estuary is not considered likely to be impacted by the Project based on the proposed Project activities, distance between Project and estuary (approximately 2.5 kilometres at its nearest point) and the hydrogeological setting of the groundwater study area that indicates groundwater flow is predominantly towards the coast.

Discovery Bay beach and dune system

The long sandy intertidal beach of Discovery Bay is formed by recently deposited, mobile sands and dunes that are sometimes broken by rocky limestone outcrops, such as Nobles Rocks (refer to Figure 7-3).

The dune system includes humid dune slacks which are damp or wet depressions in the dune system. Maintained by groundwater, they may be seasonally or permanently inundated depending on water table elevation and fluctuation. The ‘slack’ (that is, still or slow moving) water may also include a component of seawater from high tides.

Figure 7-3 Coast and dunes with Nobles Rocks in foreground and Long Swamp behind

Source: Figure 10 of DELWP (2017)

Ramsar site Limits of Acceptable Change

The *Glenelg Estuary and Discovery Bay Ramsar Site: Management Plan* (DELWP, 2017b) aims to '…*maintain, and where necessary, improve the ecological character*…' of the Ramsar site, and includes Limits of Acceptable Change (LAC) to provide a tool for measuring ecological change. The LAC relevant to groundwater is:

- Hydrology - Bridgewater Lakes, Lake Mombeong, Swan Lake, Malseed Lake and Cain Flat Swamp will not dry.

Possible impacts from the Project on the Ramsar wetlands are considered in CDM Smith (2024).

7.3 Climate

The study area has a temperate climate of warm, dry summers and cool, wet winters. Mean annual rainfall in the study area is in the order of 800 millimetres per year but ranges between approximately 750 and 970 millimetres per year (refer to Table 7-3).

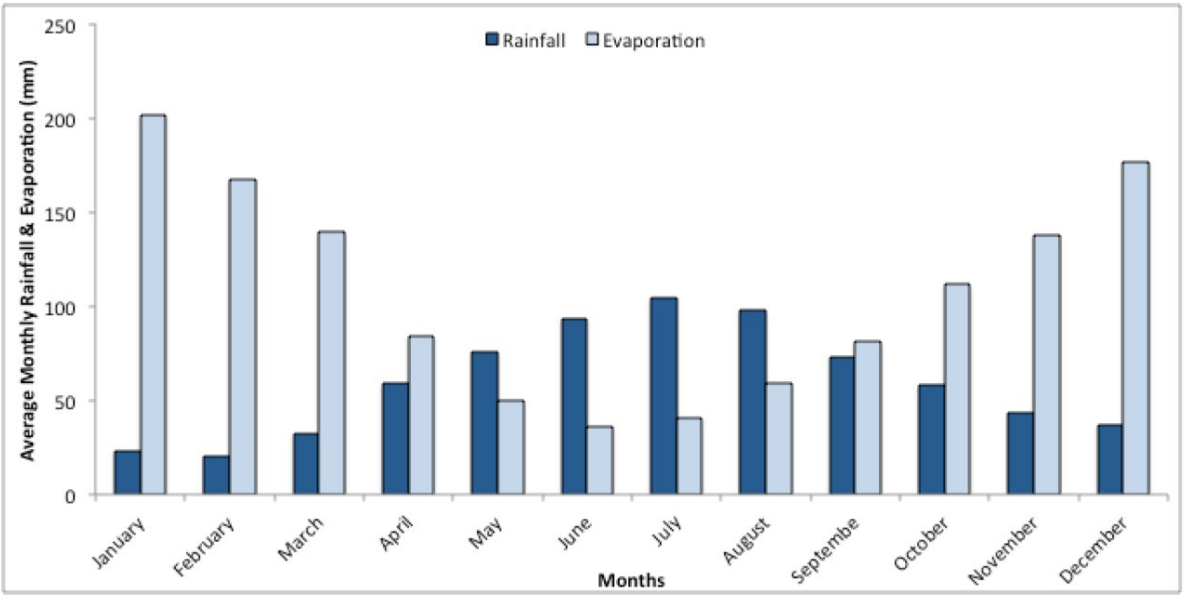
Table 7-3 Mean monthly and annual rainfall (in millimetres)

Month	Nelson[1] (BoM ID 90059) [1884 – 2019]	Mount Richmond[2] (BoM ID 90050) [1940 – 2013]	Cape Bridgewater (BoM ID 90013) [1905 – 2022]
January	29.8	38.5	33.4
February	29.0	35.2	32.6
March	37.5	53.0	41.5
April	59.9	73.9	63.4

Month	Nelson[1] (BoM ID 90059) [1884 – 2019]	Mount Richmond[2] (BoM ID 90050) [1940 – 2013]	Cape Bridgewater (BoM ID 90013) [1905 – 2022]
May	81.0	100.4	87.3
June	96.4	114.0	99.2
July	107.0	133.3	113.5
August	99.1	124.1	105.7
September	74.6	90.8	80.4
October	61.4	78.6	65.6
November	46.3	61.0	51.6
December	40.6	53.2	46.9
Annual	***765***	***971***	***829***
Notes: 1 – Nelson data only available up to 2019; 2 – Mount Richmond closed in January 2014			

The nearest Bureau of Meteorology (BOM) site with evaporation statistics is Mount Gambier in South Australia (BoM station ID 026021), located approximately 35 km northwest of the study area. The mean monthly evaporation at Mount Gambier was compared to the rainfall at Nelson in the *Glenelg Estuary and Discovery Bay Ramsar Site: Ecological Character Description* report (DELWP, 2017). This suggests that recharge of groundwater in the study area will be winter dominated, with monthly rainfall likely to exceed evaporation during winter months (for example, May to August), but be lower than monthly evaporation through other parts of the year (refer to Figure 7-4).

Figure 7-4 Mean monthly rainfall and evaporation



Source: Figure 21 of DELWP (2017)

Climate change is predicted to reduce rainfall in the Glenelg River catchment by between five and 17 per cent assuming two degrees of warming and predicted runoff to reduce by between 18 and 48 per cent (Post *et al.*, 2012). Decreased recharge of the unconfined aquifer may lead to lowered groundwater levels, and reduced discharge to springs and seeps (DAWE, 2020).

In terms of this groundwater assessment, climate change is not considered an issue during construction given the proposed construction timeline of two years. During operation, the potential reduction in recharge and lowering of groundwater levels would reduce the potential for, and depth of, groundwater intersection by Project infrastructure (such as turbines and trenches).

7.4 Groundwater management

Current water supply requirements for Project construction are estimated to be up to 250 megalitres over 24 months (refer to **Appendix F** for more details).

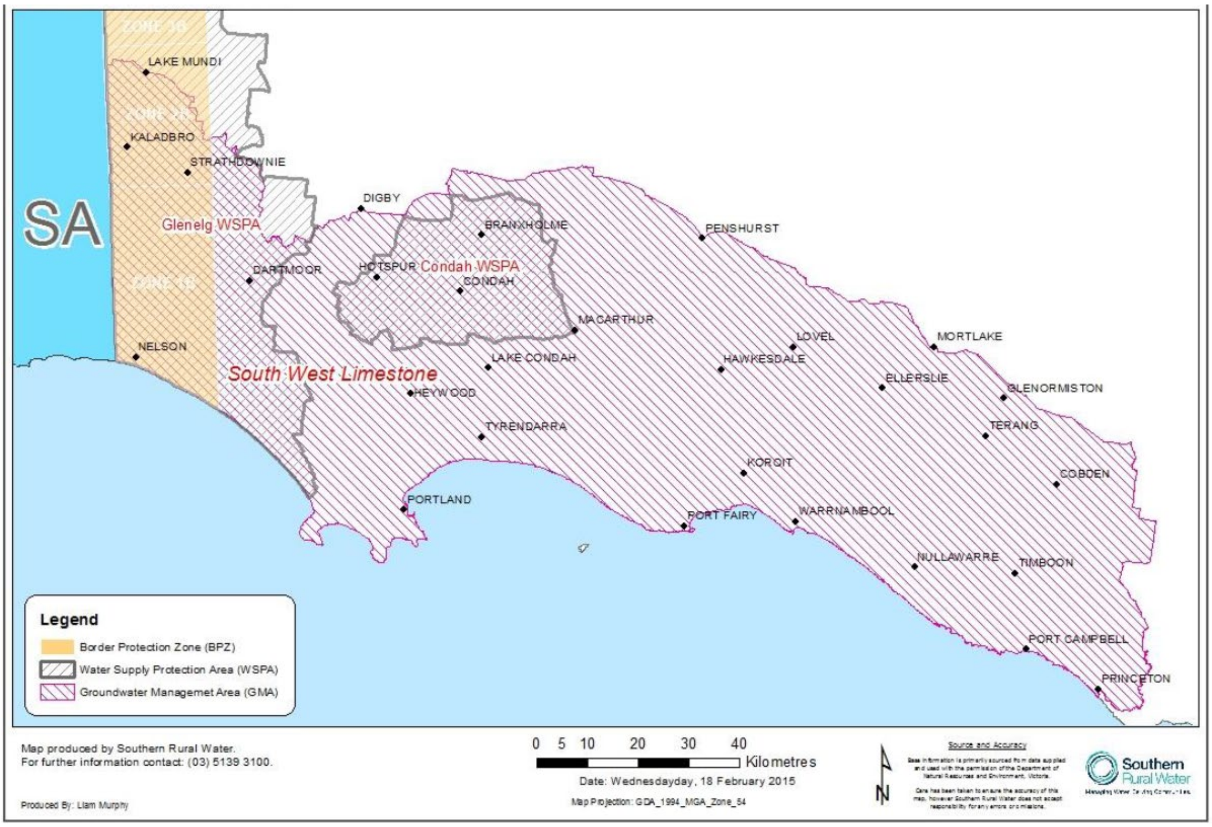
The extraction of groundwater for Project purposes will need to be made through transfer of an existing licence allocation via a temporary trade. There is currently no Permissible Consumptive Volume (PCV) for the South West Limestone (SWL) according to the local management plan (SRW, 2023) but it is effectively capped. No significant allocation is proposed, and trade is the primary mechanism to increase access to groundwater. There is currently 80,000 ML of groundwater entitlement in the SWL Groundwater Management Area with annual use typically between 40% and 50% of total entitlement (pers. communication SRW, April 2023). There is therefore a large volume of entitlement available for trading.

All such applications would be in accordance with Section 40 of the Water Act and subject to the rules and limitations laid out in the relevant management plans.

These may include restrictions on the siting of a new extraction bore (relative to existing users and GDEs) and the need to complete a detail hydrogeological assessment. Early liaison with Southern Rural Water is recommended.

The study area lies within several overlapping groundwater management precincts, listed below and shown in Figure 7-5.

Figure 7-5 Groundwater management



Source: Adapted from Map 1 (SRW, 2023)

South West Limestone Groundwater Management Area (SWL GMA):

Applies to the Upper Mid Tertiary limestone aquifer, but not the overlying Quaternary and upper Tertiary aquifers (including QA and UTB) which form the upper shallow aquifer within the study area.

There is currently no Permissible Consumptive Volume (PCV) for the South West Limestone (SWL) according to the local management plan (SRW, 2023). However, with no further significant allocations proposed, and trade being the primary mechanism to increase access to groundwater, the SWL is however effectively capped at the current entitlement of 80,000 ML (pers. communication SRW, April 2023).

South Australian-Victoria Border Groundwater Agreement (Zone 1B)

The South Australian – Victorian Border Agreement was enacted in 1985, establishing a Designated Area extending 20 km either side of the border. The Project is within Designated Zone 1B of the Designated Area.

The Designated Zone includes all aquifers, with extraction principally from the Tertiary Limestone Aquifer (the UMTA) and Tertiary Confined Sands (the Lower Tertiary Aquifer - LTA). Limits on extractions are referred to as Permissible Annual Volumes and apply to each aquifer and each zone.

7.5 Environmental values

The Environment Reference Standard (ERS) is promulgated under section 93 of the *Environment Protection Act 2017 (Vic)* (Environment Protection Act). It sets out the environmental values of the ambient air, ambient sound, land and water environments that are sought to be achieved or maintained in Victoria and standards to support those values.

The Environment Reference Standard (ERS) identifies environmental values that need to be achieved and maintained and provides a method to assess those environmental values in locations across the Victoria.

The ERS divides groundwater across Victoria into seven ‘segments’. These segments are defined by salinity ranges measured as total dissolved solids (TDS). Within each segment (or range of TDS) a number of environmental values are identified that need to be achieved and maintained.

The regional mapping of total dissolved solids (TDS), as presented in **Figure F3** (**Appendix A**), indicates that:

- groundwater beneath much of the plantation sub-area and all the northeastern sub-area is less than 600 mg/L, with the southern portion of the plantation sub-area (closer to the coast) being between 600 and 1,100 mg/L
- the TDS of groundwater is between 1,200 and 3,100 mg/L beneath the Heywood transmission line corridor.

All twelve groundwater monitoring bores were measured for field electrical conductivity (EC) and sampled for laboratory reported TDS.

Total dissolved solids and electrical conductivity values from the groundwater field program and DELWP’s Water Measurement Information System (WMIS) database are summarised in Table 7-4.

Table 7-4 Groundwater salinity in the study area

Area	Field measurements		Laboratory measurements		
	EC	Calc TDS[1]	EC	Calc TDS[1]	TDS
Groundwater Monitoring Well Sampling					
Wind farm - Plantation	1,047 – 2,586	712 – 1,758	-	-	658 – 1,860
	Mean: 1439	Mean: 978	-	-	Mean: 968
Wind farm - Northeastern area	452 – 817	307 – 556	-	-	592 – 1,540[2]
	Mean: 577	Mean: 393	-	-	Mean: 1,150
WMIS Database Results					
Wind farm site	625 – 844	425 – 574	219 – 3,870	149 – 2,632	390 – 802
	Mean: 735	Mean: 500	Mean: 941	Mean: 544	Mean: 641
Transmission line route	-	-	170 – 1,600	116 – 1,088	-
	-	-	Mean: 1,074	Mean: 730	-

Notes:

*1- TDS = EC*0.68; 2- Laboratory noted that TDS may be high due to the presence of fine particulate matter, which may pass through the prescribed filter. Samples were noted to be high turbidity and field EC should be used for accurate assessment; '–' : no data*

For the purposes of this groundwater report and identifying groundwater users to be protected, the groundwater salinity is considered to be:

- Segment A1 (0 – 600 mg/L TDS) across the northeastern sub-area
- Segment A2 (601 – 1,200 mg/L TDS) across the windfarm plantation sub-area and Heywood transmission line sub-areas

The environmental values that are to be protected based on the range of TDS identified (i.e. groundwater segments) are shown in Table 7-5.

Table 7-5 Environmental values of groundwater

Environmental values	Segment (TDS mg/L)						
	A1 (0-600)	A2 (601-1200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,000)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓		✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures;	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Note:

✓ (dark) Denotes segment adopted for the wind farm northeastern sub-area

✓ (light blue) Denotes segment adopted for the wind farm plantation, and the Heywood transmission line sub-areas

The key groundwater users that could be affected include users of groundwater bores for irrigation, stock watering and industrial/commercial uses, as well as groundwater dependent features that may support ecosystems or have cultural values to Traditional Owners.

Potential implications of the Project on groundwater bores are assessed in Section 8.0 and potential impacts to GDEs are assessed in CDM Smith (2024) (Appendix H of the EES).

7.6 Wind farm plantation sub-area

7.6.1 Physical geography and hydrology

The windfarm site boundary (as defined in Section 3.2) is within Glenelg Shire, approximately 30 kilometres northwest of Portland and five kilometres east of Nelson in southwest Victoria.

The windfarm sub-area is located on higher ground between the coastline and Ramsar wetlands to the south (at around 5 metres relative to Australian height datum (mAHD)) and the Glenelg River to the north.

The topography in this coastal region varies greatly, being characterised by calcareous sand ridges parallel to the coast that are separated by inter dune swales and closed limestone depressions. Ground surface elevation typically ranges from around 20 to 60 mAHD for much of the plantation sub-area, with some lower lying areas between 10 and 20 mAHD at the southern boundary of the site adjacent to the

Ramsar site, swamps and wetlands. At the eastern extent of the plantation sub-area the ground elevation rises to around 120 mAHD.

Topography of the study area and surrounds is shown in **Figure F4** (**Appendix A**).

The study area is located within the Glenelg Basin and Portland Coast Basin catchment regions. The largest watercourse within the catchment is the Glenelg River which is located north of the proposed wind farm site. There are no watercourses within the plantation sub-area due to the highly porous and transmissive soils and geology underlying the site.

The study area is wholly located within the Glenelg Hopkins Catchment Management Authority (GHCMA) boundary.

Land uses in the area include commercial forestry, agriculture (primarily grazing), Discovery Bay Coastal Park to the south, and the Lower Glenelg National Park and Cobboboonee National Park to the east and northeast.

The plantation sub-area is also located immediately north and adjacent to, the Ramsar site called the Glenelg Estuary and Discovery Bay Ramsar site, as described in Section 7.2.

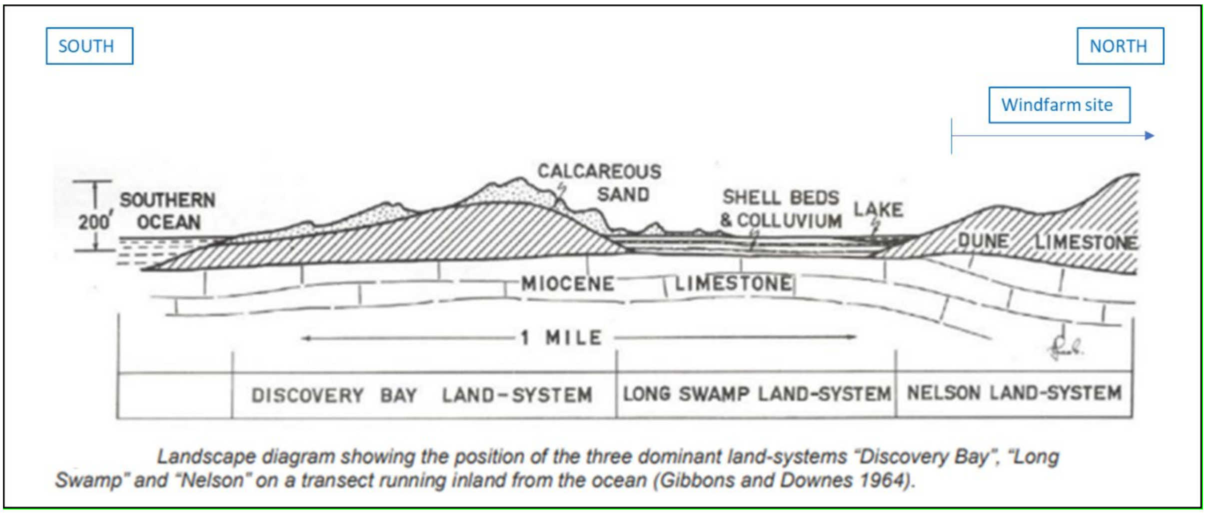
Surrounding land use and the declared Ramsar site are shown in **Figure F1** (**Appendix A**).

7.6.2 Geology and hydrostratigraphy

The geology of the wind farm site comprises predominantly aeolian, calcareous dunes and dune limestone (the Bridgewater Formation) overlying upper mid-Tertiary limestone (Port Campbell Limestone). Some coastal dunes and minor swamp deposits are present directly to the south of the wind farm site. These form the beach and dune systems and the Long Swamp wetlands that were described in Section 7.2.

A generalised cross section showing the key landforms and geology is provided in Figure 7-6, and the surface geology is provided in **Figure F5, Appendix A**.

Figure 7-6 Generalised landform cross section



Source: Adapted from Figure 24 of DELWP (2017a)

Drilling at monitoring bores MW01 to MW09, to depths of up to ten metres below ground surface, predominantly encountered loose to moderately cemented, fine to coarse grained sand, with occasional interbedded minor limestone layers and occasional shells. This has been interpreted as being the Bridgewater Formation, which overlies the Port Campbell Limestone to various thicknesses.

Monitoring well locations are shown in **Figure F5** (**Appendix A**) and borelogs are provided as **Appendix C**.

The key aquifers relevant to the Project within the plantation sub-area are the Quaternary Aquifer (QA) and Upper Mid-Tertiary Aquifer (UMTA).

The QA includes various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments. The predominant QA unit is the Bridgewater Formation which is present at surface across the plantation sub-area. The unit varies in thickness from less than five metres at the southern boundary to more than 30 metres as the depth of QA cover increases to the north.

Underlying the QA is the UMTA, known as the Port Campbell Limestone in southwest Victoria (equivalent to the Gambier Limestone in South Australia). The Port Campbell Limestone comprises a stack of thinly deposited repetitive cycles dipping to the south. It typically consists of grey unconsolidated to semi-consolidated, and rarely lithified, muddy carbonate sands and lesser sandy muds with minor quartz and clay (Radke et al, 2022). Although fractures and joints in the PCL can be widened over time by carbonate dissolution and form secondary porosity, karstification is not pervasively developed as in the Gambier Limestone to the west (Bush, 2009). Further, karst areas were not identified as being present within the study area based on work carried out as part upper Tertiary limestone aquifer groundwater resource appraisal (Jacob, 2016). This is consistent with drilling and testing carried out at MW01 – MW09, TB01 and MB01.

The UMTA is thought to be near surface at the southern boundary of the windfarm sub-area, being beneath a relatively thin sequence of QA (in the form of Bridgewater Formation or alluvial/swamp deposits[4]). To the north the UMTA is covered by a thicker sequence of QA in the order of up to 30 metres.

The water table is hosted by the QA or the UMTA, dependent on the groundwater elevation compared to the top of the UMTA elevation. There is no significant aquitard between the QA and UMTA, which are considered to be in direct hydraulic connection and to essentially act as one hydrogeological unit on a regional scale (SRW, 2023).

Refer to schematic cross sections provided as **Figures F6a** to 6**e, Appendix A**.

7.6.3 Groundwater occurrence

Regional scale mapping indicates that the depth to water table is greater than 10 mbgs across much of the plantation sub-area but reduces to less than 10 mbgs in some areas, including immediately north of the Ramsar site and associated swamps and wetlands (refer to **Figure F7a, Appendix A**).

Nine monitoring bores (MW01 to MW09) were installed between 12 and 16 April 2021 to refine the hydrogeological understanding of the site, including depths to groundwater, with a focus on those lower lying areas near the southern site boundary. A test bore (TB01) and monitoring bore (MB01) were installed in February 2022, approximately 3.5 km north of the southern site boundary as part of a groundwater supply assessment (refer to **Appendix F**). This has provided additional information on groundwater occurrence up hydraulic gradient of the lower lying areas and is referenced in the body of this report where relevant to conceptualising the hydrogeological setting in the context of the groundwater impact assessment.

Groundwater levels recorded during manual gauging on 27 April 2021 are summarised in Table 7-6, and were used to infer depths to groundwater (**Figures F8, Appendix A)** and groundwater elevation contours (**Figure F9, Appendix A**).

The groundwater elevation at bore 101241 (25.41 mAHD) is anomalously high compared to other groundwater levels and hydraulic gradients across the plantation sub-area. Bores MB01 and TB01 were drilled approximately 250 m south of bore 101241 and encountered groundwater at around 12 to 13 mAHD. The higher water level at 101241 is not considered representative of the regional water table beneath the site but has conservatively been used to develop **Figures F8** and **F9 (Appendix A)**.

[4] Based on top or aquifer unit mapping from Victorian Aquifer Framework

Table 7-6 Groundwater level data at the wind farm site

Bore ID	Ground level (mAHD)	Top of screen (mbgs)	Base of screen (mbgs)	Monitored lithology	Depth to water (mbgs)	SWL elevation (mAHD)
MW01	12.9	6	9	Sand	7.6	5.3
MW02	9.1	3.5	6.5	Sand	4.3	4.7
MW03	12.8	6	9	Sand	7.7	5.0
MW04	7.3	1	4	Sand	1.6	5.7
MW05	13.2	7	10	Sand	7.5	5.8
MW06	7.5	2	5	Sand	3.0	4.5
MW07	14.5	5.5	8.5	Sand	6.4	8.1
MW08	8.3	1	4	Sand	1.8	6.6
MW09	13.6	3	6	Sand	4.6	9.0
65058[1]	51.7	12	47.4	Limestone	40.9	10.8
65152 (MH1)	28.4	30.5	36.6	Limestone	23.5	4.9
101238	34.6	0	29	Not known	18 - 21	13 - 16
101241	39.9 (35.3)	Total depth 11.2 metres		Not known	10.79	24.51 (16.50[2])
101242 (EJ1)	39.9	27.4	30.5	Sand	26.5	13.4
101246	25.1	25.7	32	Sandstone	13 - 15	10 - 12
142176 (DJ1)	25.1	-	-	Not known	22.9	5.1
TB01[3]	41.1	54	144	Limestone	28.9	12.2
MB01[3]	41.1	100	130	Limestone	28.9	12.2

NOTES: 1 - State Observation Bore data between 6 June 2016 and 25 April 2021. 2 - Expected regional groundwater elevation of 16.5 mAHD based on nearby bores and groundwater hydraulic gradient for rest of site. 3 - data from 23/3/22

Except for bores TB01, MB01 and 101241 the groundwater levels in Table 7-6 represent the regional water table elevations (based on screened intervals), and hence provide an indication of depth at which groundwater would be intersected.

The considerable variation in depths to groundwater (from 1.6 to 40.9 mbgs) is due to the relatively flat water table compared to the undulating ground surface; as seen in schematic cross sections provided as **Figures 6a to 6e, Appendix A**.

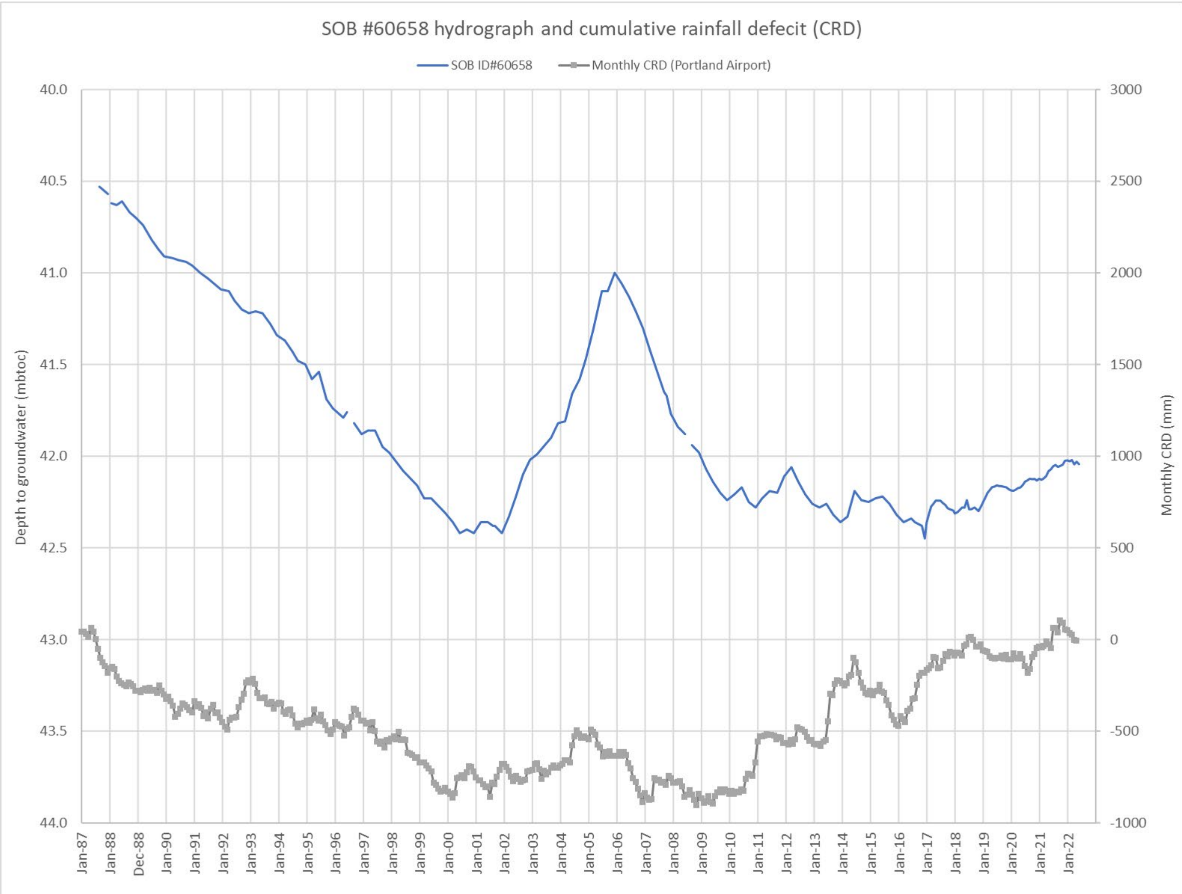
Groundwater level data from State Observation Bore 65058 were reviewed to assess longer term and seasonal fluctuations in groundwater levels beneath the site. Data from the WMIS database were used to produce the groundwater level hydrograph presented as Figure 7-7, together with the cumulative rainfall deficit (CRD) curve produced from rainfall data recorded at Portland (Cashmore Airport) [Bureau of Meteorology (BOM) site 090171].

The CRD curve compares monthly rainfall totals against long term monthly averages (1982 – 2022) for the rainfall station to produce a cumulative deficit curve over time. A falling CRD curve indicates ‘drier than average’ rainfall conditions, and a rising CRD curve indicates a ‘wetter than average’ rainfall conditions.

Groundwater levels generally correlate with the CRD curve. Falling groundwater levels occur during ‘drier’ conditions (falling CRD curve) and rising levels during wetter periods (rising CRD curve). Groundwater levels do not appear to have fully recovered during wetter conditions since the break of the Millennium Drought (in 2010/2011). This may reflect influences in addition to rainfall that could be impacting groundwater levels in the area, such as reduced rainfall infiltration/recharge through land use and/or increased abstraction. This is not considered a material issue in terms of the groundwater impact assessment given the temporary and short-term duration of the Project construction timeline.

Overall, the groundwater level is currently around 1.5 m lower than in 1987 but has remained stable since 2009 at between 42 and 42.5 mbtoc. Seasonal/short-term fluctuations are typically less than 20 cm.

Figure 7-7 Hydrograph for SOBN bore 65058 with cumulative rainfall deficit (CRD)



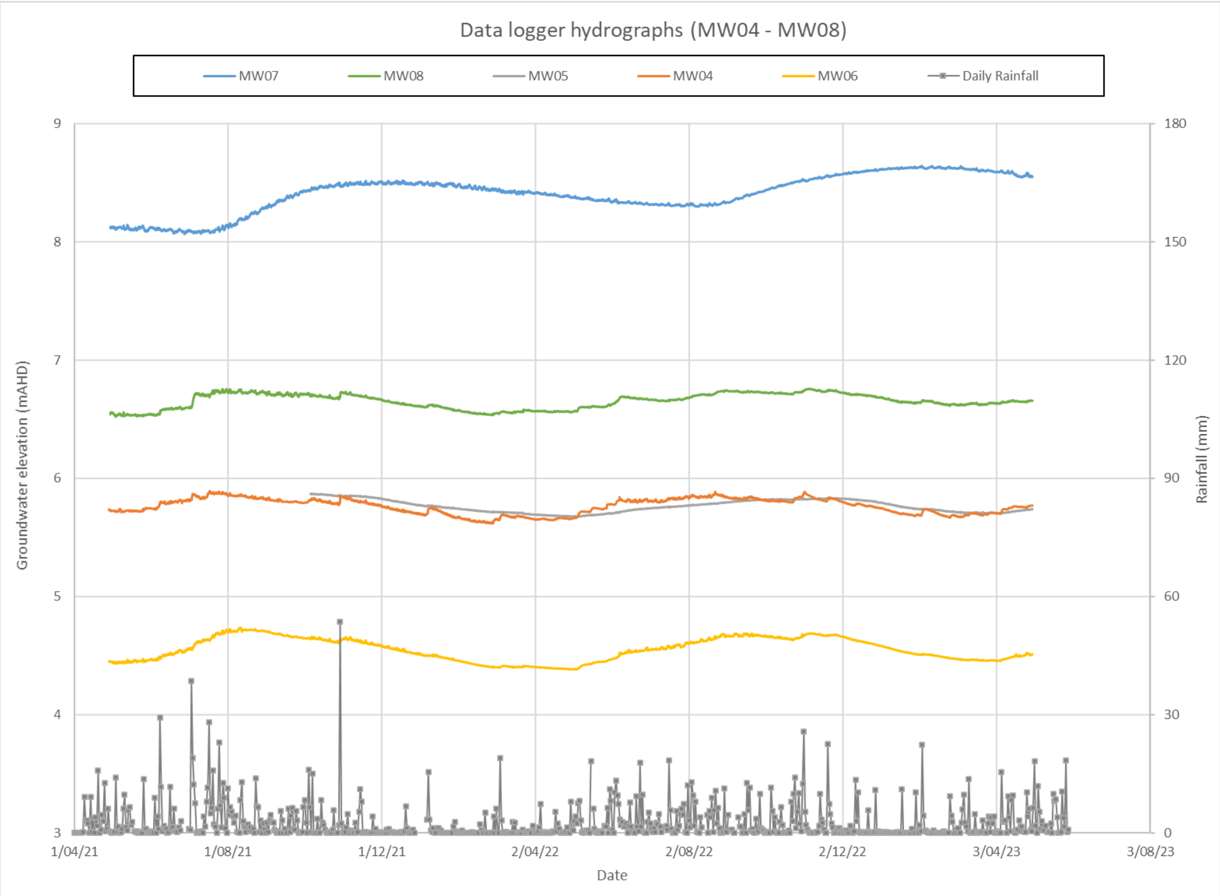
In April 2021 data loggers were installed in five shallow monitoring wells (MW04 – MW08) to measure groundwater levels at 30-minute intervals. A barometric logger was also installed in MW04 to allow groundwater data to be compensated for changes in atmospheric pressure. Manual gauging events were also undertaken at monitoring wells MW01 – MW09 in April and October 2021, and in March and June 2022. This has provided seasonal variations relative to the groundwater levels collected in April 2021 that are considered ‘baseline’ in this report.

A summary of the manual gauging is provided in Table 7-7, and data logger hydrographs are presented in Figure 7-8. Additional gauging data are provided in **Table B2, Appendix B.**

Table 7-7 Manual groundwater level summary for MW01 to MW08 (April 2021 to April 2023)

Bore ID	Minimum		Maximum		Range (m)
	Date	SWL elevation (mAHD)	Date	SWL elevation (mAHD)	
MW01	27/4/21	5.30	4/10/21	5.41	0.11
MW02	23/3/22	4.72	4/10/21	4.90	0.18
MW03	7/6/22	5.56	4/10/21	5.68	0.12
MW04	23/3/22	5.67	7/6/22	5.81	0.14
MW05	23/3/22	5.72	4/10/21	5.86	0.14
MW06	23/3/22	4.42	4/10/21	4.65	0.23
MW07	27/4/22	8.12	5/10/21	8.41	0.29
MW08	27/4/22	6.55	5/10/21	6.69	0.14
MW09	27/4/22	9.02	5/10/21	9.14	0.12

Figure 7-8 Data logger hydrographs for MW04 – MW08 (April 2021 to April 2023)



Groundwater elevation data from existing bores and monitoring wells MW01 to MW09, and surface water elevations at several waterbodies (including farm dams and wetlands) have been used to produce inferred groundwater elevation contours (refer to **Figure 9, Appendix A**).

Earlier iterations of the groundwater impact assessment had conservatively assumed an increase of up to two metres above baseline groundwater levels (April 2021) when considering the potential for groundwater intersection by the Project. This is greater than expected based on the hydrogeological setting, groundwater level data from MW04 - MW08 (refer to Figure 7-8) and the long-term hydrograph from SOBN bore 65058 (refer to Figure 7-7). The two-metre 'seasonal variation buffer' has been retained as a conservative methodology in this report when considering potential impacts associated with groundwater intersection by four-metre-deep turbine foundations (refer to Section 8.0).

In April 2021 groundwater elevations were generally between 4.5 and 6.5 mAHD at monitoring wells MW02, MW04, MW06 and MW08; located on the southern boundary of the site adjacent to the swamp and wetland areas. Moving north from the southern boundary the groundwater elevations increased slightly to between 5 and 9 mAHD at monitoring wells approximately 800 m to 1,000 m north.

The hydraulic gradient is relatively flat beneath the wind farm plantation sub-area, particularly within a kilometre of the southern boundary where the hydraulic gradient is in the order of 0.003 metres change in elevation per horizontal metre (m/m). The hydraulic gradient is inferred to increase to around 0.007 m/m further north based on the groundwater elevation of 24.51 mAHD at bore 101241. As discussed previously, this appears to be anomalously high compared to other groundwater data in the area but has been used to provide conservative estimates of depths to groundwater.

Water table levels of similar elevation are oriented approximately parallel to the coast and groundwater flow is seen to be towards the coast and Ramsar wetlands (refer to **Figure F9, Appendix A**). Groundwater elevations close to the southern boundary are at or higher than surface water elevations at various swamps and wetlands (such as Ewings Long Swamp, Small Patch Long Swamp, Lake Mombeong and the Sheepwash). Therefore, shallow groundwater discharge to these features is likely to be occurring, as shown in schematic cross sections (**Figures F6a – F6e, Appendix A**) and discussed further in Section 7.6.4.

It is inferred that there is a groundwater divide beneath the higher topography near the northern extent of the plantation sub-area, between the lower lying groundwater discharge areas of the coast to the south and Glenelg River to the north (refer to **Figure F6c, Appendix C**). The plantation sub-area site is generally on the southern side of the topographical high and groundwater flow within the upper portions of the aquifer is anticipated to flow south, providing a component of flow to wetland complexes that form part of the Glenelg Estuary and Discovery Bay Ramsar site.

The site-specific data are consistent with the water table being a subdued expression of topography, with the shape influenced by rainfall recharge, aquifer hydraulic characteristics (permeability and storage) and discharge mechanisms.

The steeply increasing ground surface elevation away from the southern boundary compared to the relatively flat water table leads to significant increases in depth to water immediately north of the southern site boundary. Overall, the site-specific groundwater data show limited potential for the proposed four-metre-deep turbine foundations to intersect groundwater across the plantation sub-area.

The potential for groundwater intersection and impacts to groundwater users are addressed in Sections 8.0, 9.0 and 10.0.

7.6.4 Hydraulic conductivity

Hydraulic conductivity is a measure of how readily groundwater can flow through the sub-surface. It is higher in a porous aquifer like sands and lower in fine-grained, clay dominant aquifers. If hydraulic conductivity is very low, the unit is often referred to as an aquitard rather than an aquifer.

Aquifer testing was undertaken at shallow monitoring bores MW01 to MW09 to estimate the hydraulic conductivity of the upper portion of the aquifer being screened, as described in Section 5.2. All monitoring wells were screened across the water table and therefore only rising head test results have been reported.

Corrections are applied to the analysis when the initial water level displacement observed is smaller than the theoretical displacement based on the slug volume inserted. This can be due to effects of screen and gravel pack being installed across the water table (Bouwer-Rice correction), and/or the transmissive nature of the aquifer (Butler correction).

For consistency, all straight-line approximations were fitted to data within the head ranges recommended by Butler (1998).

The results are summarised in Table 7-8, with the highest value reported where multiple tests were carried out at one location. The Aqtesolv outputs from all slug tests are provided in **Appendix D**.

The range of hydraulic conductivities at the shallow monitoring wells varied by an order of magnitude and were estimated at around 4 to 65 m/day. This broadly aligns with literature values for fine to coarse sands (Domenico and Schwartz, 1990), and is consistent with the lithology encountered by the monitoring bores tested.

Table 7-8 Summary of hydraulic conductivity estimates: Plantation sub-area

Well ID	Date	Geology at screen	Hydraulic conductivity (m/day)	
			Bouwer-Rice correction	Butler correction
MW01	28/04/2021	SAND: coarse grained	17.7	64.6
MW02	27/04/2021	SAND: fine to coarse grained	11.0	16.8
MW03	28/04/2021	SAND: fine to coarse grained	18.6	24.9
MW04	28/04/2021	SAND/GRAVEL: fine to coarse grained	25.6	47.2
MW05	28/04/2021	SAND: fine to medium grained	41.6	53.7
MW06	28/04/2021	SAND/silty SAND: fine to medium grained	11.6	15.9
MW07	29/04/2021	SAND: fine grained	6.4	5.5
MW08	29/04/2021	SAND: fine to medium grained	6.0	16.9
MW09	29/04/2021	SAND: fine grained	4.1	5.8
Minimum			**4.1**	**5.5**
Maximum			**41.6**	**64.6**
Geometric Mean			**12.4**	**20.3**

Aquifer parameters were also estimated from a 24-hour constant rate test completed on the deeper test bore TB01 (open hole completion from 54 to 144 metres). The test bore targets the deeper portion of the UMTA and encountered discrete fractures at depths of greater than 80 mbgs within the lower permeability limestone matrix. A bulk hydraulic conductivity in the order of 0.11 and 0.17 m/day was estimated from the transmissivity determined by analysis of the CRT.

Details of testing at TB01 are provided in **Appendix F** and informs the impact assessment discussed in Section 8.0.

7.6.5 Recharge

Soils in the area are typically free draining with no surface water features. Standing water is rarely seen and temporary even following high intensity rainfall events (pers. comm. with landowner). Rainfall recharge is also affected by land use, with much of the proposed wind farm area being forestry plantation that can intercept rainfall recharge and account for a large proportion of the water balance in some areas (CDM Smith 2020).

Under establishing plantation conditions, the recharge rates could be as low as 1% of rainfall and as high as 20% where land is used for crops or pastures (SKM, 2007); or 8 mm to 150 mm based on an annual rainfall of 765 mm at Nelson (refer to Table 7-3). Potential correlation between rising groundwater levels and plantation harvesting due to reduced interception of rainfall by vegetation was also noted by CDM Smith (2020).

Torkzaban et al (2020) includes reference to recharge rates to the water table being in the order of 10 to 25 mm for this area.

Although accurate recharge rates have not been determined, using the above values from others, a crude estimate of annual rainfall recharge would be in the order of upwards of 640 ML/yr; for the area directly adjacent to and upgradient of the Ramsar wetland complex. This is based on a catchment area of 42 km^2 (see Table 7-9) and a recharge rate of 15 mm/year (or 2% of 765 mm annual rainfall).

Figure 7-9 Rainfall recharge catchment area

7.6.6 Groundwater-surface water interaction

Surface water elevation from data loggers is available for several swamps of the Glenelg Estuary and Discovery Bay Ramsar site. Hydrographs are provided in Figure 7-10 (taken from CDM Smith, 2020) and elevation ranges included in **Figure F9, Appendix A**.

Figure 7-10 Surface water hydrographs for Long Swamp complex (sourced from CDM Smith, 2020)

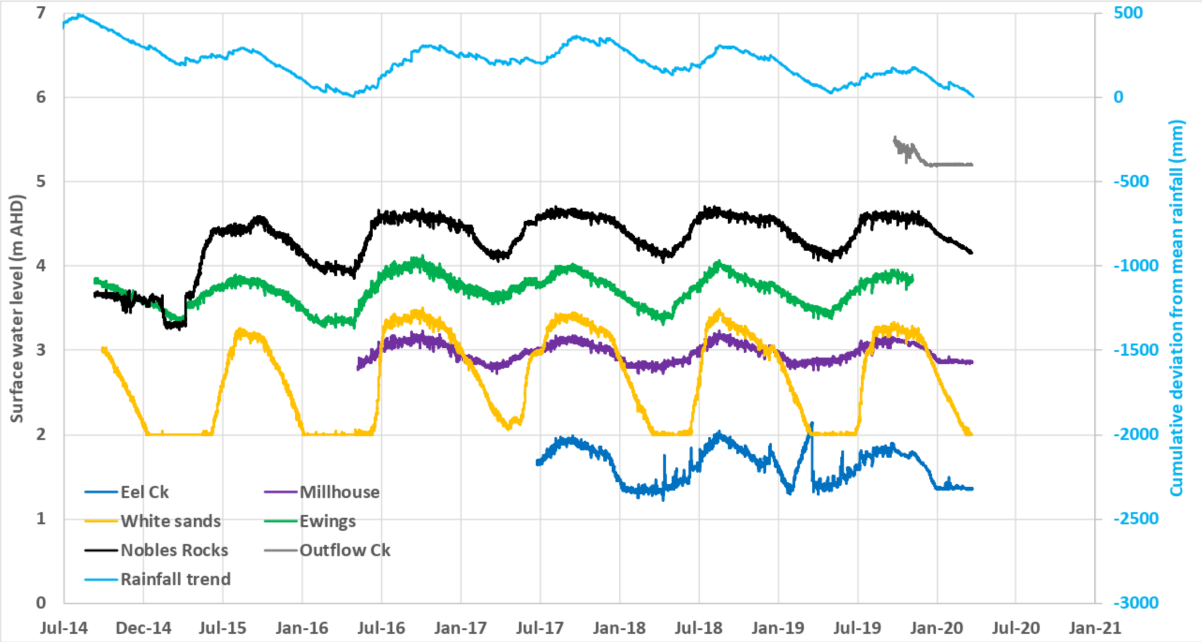
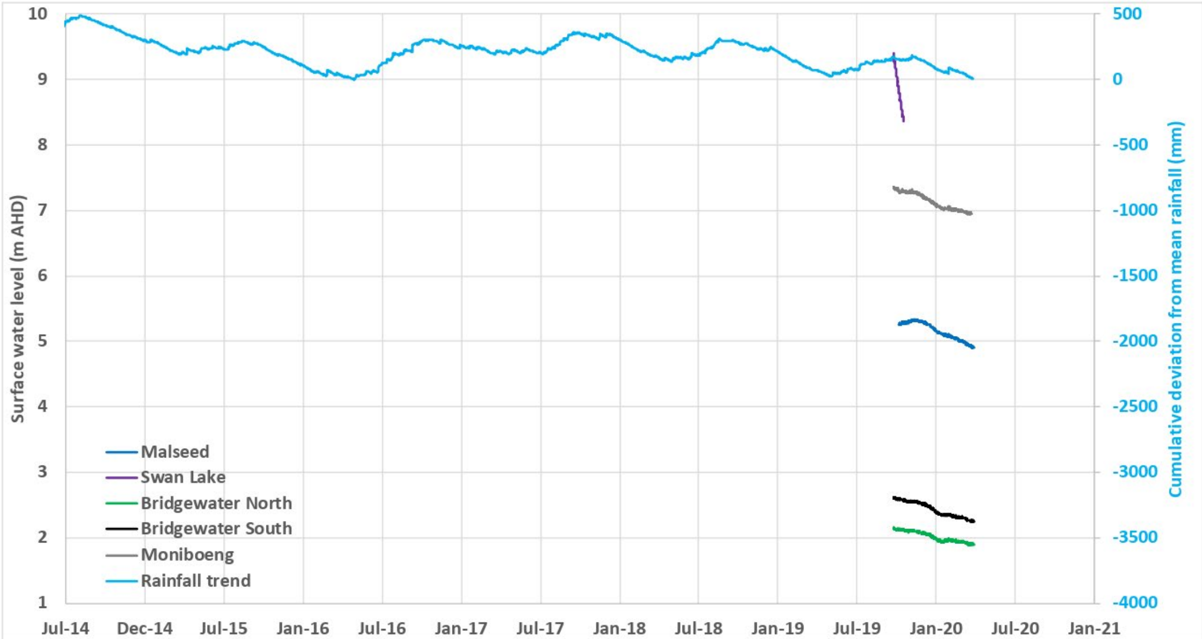


Figure 7-11 Surface water for deeper lake sites (sourced from CDM Smith, 2020)



A summary of surface water elevations (from west to east) and groundwater elevations at the nearest monitoring bores is provided in Table 7-9.

Table 7-9 Surface water and groundwater elevations

Swamp/wetland site	Surface water elevation range[1] (mAHD)	Nearest monitoring well	Groundwater elevation[2] (mAHD)
Ewings Long Swamp	3.5 – 4.0	MW04	5.7 – 5.8
Nobles Main Long Swamp	4.0 – 4.5	MW06	4.4 – 4.7
Small Patch Long Swamp	~6	MW08	6.5 – 6.7
Lake Mombeong	7.3 – 7.0	MW09	9.0 – 9.1
The Sheepwash	7.6 – 8.3		

Note: 1 – from CDM Smith hydrographs (Jul 2014 to Jan 2020); 2 – from data loggers and gauging (Apr 2021 to Jun 2022)

Temporal groundwater data collected from nearby monitoring wells between April 2021 and April 2023 confirms that the hydraulic gradient is typically from north to south; that is, towards the wetland complex.

Monitoring wells (MW01 - MW09) were installed in fine to coarse sand; interpreted as being the Quaternary Aquifer (Bridgewater Formation) rather than the UMTA (Port Campbell Limestone). Shallow groundwater within the QA therefore typically discharges across the southern site boundary to the various swamps and wetlands; based on the hydrogeological information currently available.

It is possible that localised and temporary reversal of shallow groundwater flow may occur at times (that is, from wetlands to the aquifer). This may occur in response to specific rainfall runoff events and/or tidal events. This could be confirmed with future monitoring and assessment of rainfall, surface water and groundwater levels; but is not considered a material data gap in terms of the EES Scoping Requirements.

The groundwater contribution from the underlying UMTA is not known but is anticipated to occur from the upper portions of the UMTA via the Bridgewater Formation and/or alluvial deposits underlying the swamps and wetlands. Some wetlands may receive groundwater flow directly from upper portions of the UMTA where it is intersected by deeper lake systems such as Lake Mombeong, Malseed Lake and Swan Lake.

Groundwater discharge from deeper sections of the confined to semi-confined UMTA targeted by TB01 is likely to be offshore based on findings from the groundwater supply assessment (refer to **Appendix F**). This discharge occurs near shore in the shallow submarine zone caused by density differences with fresher groundwater forced upwards by the denser 'saline wedge' (Bush, 2009).

7.6.7 Registered bores

A search of DELWP's WMIS database was carried out on 18 June 2021 (and confirmed as being current in April 2023). The results show 25 registered groundwater bores in the windfarm plantation study sub-area classified as 'used'.

Overall, 13 have been identified as being for consumptive use purposes, which includes domestic, stock and irrigation. A further eight are miscellaneous or of unknown use and have the potential to be for consumptive use. Consumptive bore depths are reported to range between 4.5 mbgs and 54 mbgs, with three bores noted to be screened in limestone, five screened in sand or gravel and one screened in sandstone.

Bore locations by use category are provided in **Figures F10a – F10b** (**Appendix A**). The bore search results are summarised in Table 7-10.

Potential impacts of the Project on consumptive use bores are discussed in Section 8.0.

Table 7-10 Registered groundwater bores (wind farm Plantation sub-area)

Wind farm plantation sub-area	
Use	**Bores**
TOTAL - unknown/miscellaneous	**8**
Monitoring/observation uses	
State Observation Network, Observation, groundwater investigation	
TOTAL – monitoring/observation	**4**
Consumptive uses	
Agro Industries, State Observation Network, Observation	1
Stock, State Observation Network	1
Stock and domestic	5
Stock	6
TOTAL - consumptive uses	**13**

7.6.8 Groundwater dependent ecosystems

The Groundwater Dependent Ecosystems Atlas (GDE Atlas) was developed as a national dataset of Australian GDEs (http://www.bom.gov.au/water/groundwater/gde/map.shtml).

The Atlas contains information about:

- aquatic ecosystems that rely on the groundwater that discharges to the surface, including rivers, springs and wetlands
- terrestrial ecosystems that rely on the subsurface presence of groundwater, including vegetation
- subterranean ecosystems that live in caves and underground aquifers.

The mapping is from two broad sources:

- national assessment: national scale assessment based on available geographic information system (GIS) data and a set of rules that describe the potential for groundwater and ecosystems to interact
- regional studies: more detailed assessment by state and/or regional agencies using field work, satellite imagery or application of conceptual models.

It is important to note that the identification of potential GDEs in the Atlas does not confirm that a particular ecosystem is groundwater dependent. Fieldwork is needed to verify whether an ecosystem is groundwater dependent.

A summary of GDEs is provided below and further detail is provided in CDM Smith (2024) (Appendix H of the EES).

Aquatic GDEs

There are 16 potential aquatic GDEs mapped as occurring within, or immediately adjacent to, the plantation sub-area. These mapped potential aquatic GDEs cover approximately 578 hectares, and are shown in **Figure F2a**, **Appendix A**.

High potential GDEs (from regional mapping) are located south of the plantation sub-area and are described as temporary freshwater marshes and meadows and temporary freshwater swamps according to the BoM GDE Atlas (http://www.bom.gov.au/water/groundwater/gde/). A number of these are named wetlands and are located within the Ramsar site, including Long Swamp (West), Long

Swamp (East), McFarlanes Swamp, Black Swamp, Lake Mombeong (also known as Lake Moniboeng and Lake Bongbong) and the Sheepwash Lagoon. The Ramsar site is discussed further in Section 7.2.

There are also a number of moderate potential GDEs (from regional mapping) located within the plantation sub-area, but outside of the Ramsar site. These include unclassified wetland type lacustrine/palustrine wetlands (including Dead Horse Swamp), and the permanent Cain Flat Swamp categorised as a permanent freshwater lake.

Possible impacts to potential GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Terrestrial GDEs

There are numerous high potential terrestrial GDEs (from national assessment) mapped as being present within the plantation sub-area, as shown in **Figures F11a**, **Appendix A**.

The main occurrences include small areas of coastline alkaline scrub and herb-rich woodland throughout the plantation sub-area.

Possible impacts to potential GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Subterranean GDEs

No potential or actual subterranean GDEs have been mapped as being present within the study area.

Possible impacts to potential GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

7.6.9 Conceptual hydrogeological model summary

Key aspects of the conceptual hydrogeological model for the plantation sub-area are summarised below, and schematic cross sections are provided in **Figures 6a** to **6e (Appendix A)**:

- Calcareous dunes and dune limestone of the Bridgewater Formation (BF) overlie the Port Campbell Limestone (PCL) to varying thicknesses
  - generally thicker to the north and becoming thinner southwards towards the coast where it forms a thin covering
- QA is thicker to the north and becomes thinner southwards towards the coast where it forms a thin covering over the UMTA
- The unconfined water table is hosted either by the QA or upper portions of the UMTA – dependent on water table elevation relative to the base of the QA
- Depth to water varies greatly across the site and increases quickly to the north away from the southern site boundary due the relatively flat water table compared to the undulating ground surface
- The depth to groundwater was less than 6 metres at some lower lying areas of the site, adjacent to the Ramsar wetlands (refer to **Figure F9, Appendix A**). At such locations there would be the potential for 4 m deep turbine foundations to intersect the water table, conservatively assuming groundwater levels up to 2 m higher than April 2021 baseline conditions. As discussed in Section 7.6.3, the longterm hydrograph for SOBN bore 65058, and the groundwater level monitoring data from site specific monitoring wells (MW01 to MW09) confirm this to be a suitably conservative assumption.
  - Turbines initially proposed in these lower lying areas close to the southern boundary were removed during Project layout refinement to mitigate the risk (refer to Section 8.1.1).
- There is no significant aquitard between the QA and UMTA, and they are considered to act as one unit on a regional scale; but connection between the two formations will vary at the local scale
- Recharge to the QA is via direct rainfall infiltration, which is reduced due to uptake by trees across the plantation area

- Recharge to the upper portions of the UMTA is via rainfall infiltration through the overlying unsaturated QA or leakage from the overlying QA where saturated and hydraulic gradients allow
- Recharge to lower portions of the UMTA (targeted by TB01) will occur via leakage from overlying portions of the UMTA or up-dip to the north where it outcrops or sub-crops towards the margins of the Basin
- Aquifer testing in the form of falling head tests (or slug tests) indicated hydraulic conductivities (K) of up to 65 m/day and a geometric mean of 20 m/day, which is consistent with the fine to medium/coarse sand lithology encountered during drilling
- Groundwater in the QA and upper portions of the UMTA (the shallow groundwater system) is discharged to the Ramsar wetland complex via relatively high transmissivity sediments; as indicated by on site hydraulic conductivity and shallow hydraulic gradient
- Flow in the lower UMTA occurs as throughflow beneath the site as part of intermediate and regional flow systems
  - these flowpaths are generally from regional scale recharge areas at the margins of the basin (north), to regional discharge areas beyond the coast (south)
- Significant discrete fractures were only encountered at depths of greater than 90 mbgs in the lower UMTA, and were overlain by a lower permeability limestone matrix
- The lower UMTA appears to be isolated from the shallow consumptive use bores and GDEs, with limited potential for vertical leakage between the lower UMTA and QA/upper UMTA (refer to **Appendix F**)
  - if the lower UMTA were to act as an unconfined or leaky confined (semi-confined) system due to longer term pumping the extent of drawdown would be much reduced, and the magnitude of water table drawdown would not be significant (refer to **Appendix F**)

7.7 Wind farm Northeastern sub-area

7.7.1 Physical geography and hydrology

The northeastern sub-area is located at a topographical high point, with lower lying areas towards the Glenelg River to the northwest (approximately 11 km distant), Fitzroy River to the northeast (approximately 7 km distant), and the coastline to the south (approximately 4 km distant).

The topography is relatively flat through the central portions of the site at an elevation of around 145 mAHD. The ground falls away to the west (approximately 130 mAHD) and east (approximately 135 mAHD). In the northeast portion of the site the land falls away to the north from around 155 mAHD (Piccaninny Mountain) to 120 mAHD at the northeastern sub-area site boundary.

Topography of the study area and river basin boundaries are shown in **Figure F4** (**Appendix A**).

The western and northern extents of the northeastern sub-area within the Glenelg River Basin with surface water draining to the north and northwest. The remainder of the site is within the Portland Coast Basin and drains to the east towards Portland Bay, and south towards Bridgewater Bay and Descartes Bay.

Johnstones Creek and its tributaries are located south of the northeastern sub-area and drain to Swan Lake, part of the Glenelg Estuary and Discovery Bay Ramsar site. Several unnamed drains and waterbodies (classified as flat areas subject to inundation) are also located within the southern and western portions of the wind farm northeastern sub-area and likely to drain south via the Johnstones Creek catchment.

Numerous dams and waterbodies are also mapped as being present within the northeastern sub-area, and a number were observed and surveyed during groundwater investigations carried out in March and April 2021.

The northeastern sub-area is located adjacent to the Lower Glenelg National Park on the northern boundary and land uses include commercial forestry and agriculture (primarily grazing).

The northeastern sub-area is wholly located within the Glenelg Hopkins Catchment Management Authority (GHCMA) boundary.

7.7.2 Geology and hydrostratigraphy

The surface geology of the northeastern sub-area consists of Quaternary age aeolian (windblown) coastal and inland dunes (Qdl1), and swamp deposits across the centre of the site (Qm1). Extrusive basalts of the Quaternary (Holocene) Newer Volcanics (Qn) are mapped in the eastern portion of the site, and a small eruption site known as Picaninny Mountain is present in the northeast part of the site (refer to **Figure F5, Appendix A**).

The geology encountered in groundwater monitoring wells MW10, MW11 and MW12 was generally consistent with regional mapping and is summarised below.

- 0 to 2.1 mbgs: black and grey silty sand/sand;
- 2.1 – 2.2 mbgs: dark brown clayey sand (in MW10 and MW12); and
- 2.2 – 6.0 mbgs: dark brown sand.

The underlying basalts of the Newer Volcanics were not encountered as part of the groundwater investigations.

The key hydrostratigraphic unit relevant to the northeastern sub-area is the Quaternary Aquifer (QA)[5] consisting of various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments. Due to the variable thickness of the overlying QA it is possible that the depth to Upper Tertiary Basalt Aquifer (UTBA) could be less than 6 metres in places, particularly close to eruption points such as Piccaninny Mountain.

Borelogs for MW10, MW11 and MW12 are provided in **Appendix C**.

7.7.3 Groundwater occurrence

Regional mapping indicates that the water table varies between less than 10 mbgs across much of the northeastern sub-area, to greater than 10 mbgs in localised areas beneath higher topography such as Piccaninny Mountain.

Monitoring wells MW10, MW11 and MW12 were gauged on 26 April 2021, with depths to water measured at between 0.74 metres and 1.93 mbgs. The depth to groundwater was also measured in existing bores at 2.36 mbgs (bore DG1) and 2.54 mbgs (bore DG2); refer to **Figure F12 (Appendix A)**.

Groundwater levels are typically between 1 to 3 mbgs in the summer, and near surface in winter (pers. comm. with landowner); dependent on the local variation in ground surface elevations.

Surface water elevation spot heights were also surveyed on 26 April 2021 and are included in **Figure F12 (Appendix A)**. These were at similar or slightly higher elevations than groundwater elevations measured in the newly installed monitoring bores (MW10 – MW12) and existing bores (DG1 and DG2).

It is unclear whether the QA forms a shallow perched groundwater system and/or to what extent it is interconnected with the underlying Upper Tertiary Basalt Aquifer (UTBA). This is not considered a material data gap in the context of the impact assessment, with potential effects on groundwater users due to intersection of the Project with the upper shallow groundwater system (i.e. less than five metres).

Groundwater flow in the QA appears to be radial and away from the central portion of the northeastern sub-area towards the southwest and southeast based on the topography, groundwater elevations and surface water elevations. In the northern section of the site it is anticipated that there will be a component of radial flow away from Piccaninny Mountain (a potentially higher recharge zone) and is seen to be northwards at the northern portion of the northeastern sub-area site.

Inferred groundwater flow directions are included in **Figure F12 (Appendix A)**.

[5] From the Victorian Aquifer Framework

7.7.4 Hydraulic conductivity

Hydraulic conductivity is a measure of how readily groundwater can flow through the sub-surface. It is higher in a porous aquifer like sands and lower in fine-grained, clay dominant aquifers. If hydraulic conductivity is very low, the unit is often referred to as an aquitard rather than an aquifer.

Aquifer testing was undertaken at monitoring bores MW10, MW11 and MW12 in order to estimate the hydraulic conductivity, as described in Section 5.2. The results are summarised in Table 7-11 for the northeastern sub-area and outputs provided in **Appendix D**.

The range of hydraulic conductivities was between 3.5 and 23 m/day. This broadly aligns with literature values for fine to coarse sands (Domenico and Schwartz, 1990), and is consistent with the lithology encountered by the monitoring bores tested.

It is noted that geology in some areas of the site could be more silty or clayey (such as in the centre of the site where regional mapping indicates swamp deposits). Literature values for lower hydraulic conductivity lithologies such as clays and silts are in the order of less than 0.0001 m/day to 2 m/day (Domenico and Schwartz, 1990).

The relevance and implications of hydraulic conductivities on the Project are discussed in Section 8.0.

Table 7-11 Summary of hydraulic conductivity estimates – wind farm northeastern sub-area

Well ID	Date	Geology at screen	Test type	Hydraulic conductivity (m/day)
MW10	26/04/2021	SAND: medium to coarse grained	FHT-1	6.7
			RHT-1	7.8
			FHT-2	5.5
			RHT-2	5.7
MW11	26/04/2021	SAND: medium to coarse grained	FHT-1	23
			RHT-1	10
			FHT-2	15
			RHT-2	13
MW12	26/04/2021	SAND: fine to coarse grained	FHT-1	3.9
			RHT-1	3.8
			FHT-2	3.5
			RHT-2	3.5
Minimum				**3.5**
Maximum				**23**
Geometric Mean				**7.6**

Notes:
FHT - falling head test; RHT – rising head test.
The Butler method was used to select appropriate time-period for analysis.

7.7.5 Groundwater-surface water interaction

Spot height survey data collected for several dams and water bodies within the northeastern sub-area, indicate that they are likely to be formed by depressions that intersect the water table when compared to groundwater elevation data from nearby monitoring bores.

It is anticipated that these dams would be reliant on groundwater during summer months but, may discharge into the shallow groundwater system locally following rainfall events when surface water elevations are higher relative to groundwater.

Based on the information available it is assumed that there is direct connection and interaction between groundwater and surface water.

7.7.6 Registered bores

A search of DELWP's WMIS database was carried out on 18 June 2021 (and confirmed as being current in April 2023). The results show 14 registered groundwater bores in the windfarm northeastern sub-area classified as 'used'. A further four are classified as 'unused'.

Overall, 8 have been identified as being for consumptive use purposes, which includes domestic and stock. A further 5 are unknown use and have the potential to be for consumptive use. Consumptive bore depths range between 4 mbgs and 70 mbgs, with two bores noted to be screened in basalt, with a further two bores screened in sand and clay.

Bore locations by use category are provided in **Figures F10a – F10c** (**Appendix A**). The bore search results are summarised in Table 7-12 below.

Table 7-12 Registered groundwater bores (wind farm northeastern sub-area)

Use	Bores
TOTAL - not known	**5**
Monitoring/observation uses	
TOTAL – monitoring/observation	**1**
Consumptive uses	
Stock and domestic	3
Stock	5
TOTAL - consumptive uses	**8**

7.7.7 Groundwater dependent ecosystems

A summary of GDEs is provided below and further detail is provided in CDM Smith (2024).

Aquatic GDEs

There are eight potential aquatic GDEs mapped as occurring within, or immediately adjacent to, the northeastern sub-area covering approximately 339 hectares, as shown in **Figure F2b**, **Appendix A**.

One high potential GDE (from national assessment) is Mount Kincaid Creek located to the southeast of the northeastern sub-area (refer to **Figure F12, Appendix A**). Six moderate potential GDEs and one low potential GDE (from regional mapping) are located across the western portion of the wind farm northeastern sub-area and described as lacustrine/palustrine wetlands according to the BoM GDE Atlas. All GDEs are unnamed wetlands.

Possible impacts to aquatic GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith, 2024) (Appendix H of the EES).

Terrestrial GDEs

There are 10 high potential terrestrial GDEs (from national assessment) mapped as being present within the northeastern sub-area, as shown in **Figures F11a (Appendix A)**. The main occurrences include wet heathy woodland and herb-rich foothill and woodland forests in eastern parts of the northeastern sub-area

Possible impacts to terrestrial aquatic GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith, 2024; Appendix H of the EES).

7.7.8 Conceptual hydrogeological model summary

The key aspects of the conceptual hydrogeological model for the northeastern sub-area are summarised below:

- surface geology of variable thickness of Quaternary age aeolian (windblown) coastal and inland dunes (Qdl1), and swamp deposits across the centre of the site (Qm1).
- shallow water table within the Quaternary Aquifer across the site.
- depths to groundwater are shallow, being typically between one to three metres, with higher groundwater levels in winter when they are close to surface.
- recharge to the shallow QA is via direct rainfall, and may be locally recharged by waterbodies (such as dams, watercourses, or drains) following rainfall events.
- it is unclear whether the QA forms a shallow perched groundwater system and/or to what extent it is interconnected with the underlying Upper Tertiary Basalt Aquifer (UTBA).
- shallow groundwater flow appears to be radial and away from slight mounding in the centre of the northeastern sub-area site. Local radial flow is also expected away from Piccaninny Mountain in the north of the site, with groundwater flow towards the northern boundary in the northeast of the site (refer to **Figure F12, Appendix A**).
- shallow groundwater levels and flow direction will also be locally influenced by the various table drains constructed across the site.
- hydraulic conductivity values in the order of 3.5 to 23 m/day are consistent with the fine to coarse grained sand encountered during monitoring bore installation, although lower hydraulic conductivities would be expected in areas of higher silt and clay content (for example in swamp areas).
- based on topography, groundwater elevations and surface water elevations it is assumed that there is direct groundwater-surface water interaction, with waterbodies formed by shallow depressions intersecting the water table.
- there are a number of existing consumptive use bores and potential aquatic and terrestrial GDEs within the northeastern sub-area.

7.8 Heywood transmission line sub-area

7.8.1 Physical geography and hydrology

The proposed 26.6 km long underground transmission line traverses the southern part of the Cobboboonee National Park and Forest Park beneath an existing road (Boiler Swamp Road), then continues beneath farmland to the Heywood Terminal Station. The ground elevation through Cobboboonee National Park and Forest Park falls from a high of around 140 mAHD in the west, to around 40 mAHD in the east. Further east, the topography initially falls gently from around 40 mAHD to 20 mAHD as the route follows west to east alongside the Surrey River. From a low point at approximately 6 km from the edge of the Cobboboonee National Park the ground rises more steeply over the final 2 km to an elevation of approximately 45 mAHD at Heywood Terminal Station (refer to **Figure F5, Appendix A**).

The Surrey River, Mount Kincaid Creek and Wild Dog Creek intersect the transmission line corridor, and several waterbodies/wetland areas are also mapped as being within the sub-area (refer to **Figure F2b, Appendix A**).

7.8.2 Geology and hydrostratigraphy

Regional geological mapping indicates basalts of the Quaternary age Newer Volcanics to be at surface between the windfarm northeastern sub-area and the eastern boundary of the Cobboboonee National Park, with some minor swamp deposits along a small reach of the transmission line corridor. Further east, the surface geology is mapped as being Quaternary age swamp and lake deposits consisting of silt, clay and peat (refer to **Figure F5b, Appendix A**).

Several registered bores are mapped as being located near to the proposed underground transmission line. The lithology is described as clay at shallow depths, consistent with weathered basalt and/or swamp deposits.

Lithological logs are summarised in Table 7-13 and corresponding bore locations provided in **Figure F10b, Appendix A**).

Table 7-13 Lithology at nearby registered bores

Bore ID	Depth (mbgs)	Lithology (from WMIS database)
WRK041192	0 to 6.8 6.8 to 18.0 18.0 to 34.0	Clay Decomposed basalt Limestone
WRK069031	0 to 27.0 27.0 to 122.0	Clay Basalt
67136	0 to 7.0 7.0 – 12.0	Clay Limestone

The key hydrostratigraphic units relevant to the Heywood transmission line sub-area are the Upper Tertiary Basalt Aquifer (UTBA) formed of the Newer Volcanics basalts, and the Quaternary aquifer comprising various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments.

7.8.3 Groundwater occurrence

Much of the transmission line corridor is mapped as having groundwater at less than ten metres below ground surface; based on regional scale interpretation and interpolation, as shown in **Figure F7b** (**Appendix A**).

There are no water level data available from DELWP's WMIS[6] database for existing bores within the transmission line corridor.

The regional groundwater flow direction is unclear, but local scale shallow flowpaths relevant to shallow trenching in this sub-area may be influenced by discharge to gaining streams, GDEs and groundwater extraction where these are present.

7.8.4 Groundwater-surface water interaction

This would be limited to local interaction between shallow groundwater in alluvial sediments of associated creeks (such as the Surrey River) and GDEs (such as wetlands). Waterbodies mapped as potential aquatic GDEs in or close to Heywood transmission line sub-area suggest the possibility of local surface water-groundwater interaction at these locations (refer to **Figure F2b, Appendix A**).

7.8.5 Registered bores

A search of DELWP's WMIS database was carried out on 18 June 2021 (and checked as current in August 2023). The results show 16 registered groundwater bores classified as 'used' in the transmission line sub-area. A further one is classified as 'decommissioned'.

Overall, 15 have been identified as being for consumptive use purposes, which includes domestic, stock and irrigation. One further bore is miscellaneous use and has the potential to be for consumptive use. Consumptive bore depths range between 6.1 mbgs and 122 mbgs.

[6] http://data.water.vic.gov.au/

Bore locations by depth are provided in **Figure F7b (Appendix A)** and by use category in **Figure F10b (Appendix A)**. The bore search results are summarised in Table 7-14.

Table 7-14 Registered groundwater bores (Transmission line sub-area)

Use	Bores
TOTAL - unknown/miscellaneous	**1**
Monitoring/observation uses	
TOTAL – monitoring/observation	**0**
Consumptive uses	
Domestic	3
Stock and domestic	5
Irrigation	1
Stock	5
Stock, domestic, miscellaneous	1
TOTAL - consumptive uses	**15**

7.8.6 Groundwater dependent ecosystems

A summary of GDEs is provided below and further detail is provided in CDM Smith (2024).

Aquatic GDEs

There are six potential aquatic GDEs mapped as occurring within, or immediately adjacent to, the transmission line corridor covering approximately 11 hectares, as shown in **Figure F2b**, **Appendix A**.

There are three waterways classified as high potential GDEs (from national assessment) located within the transmission line sub-area: the Surrey River, Mount Kincaid Creek and Wild Dog Creek. There are two unnamed high potential GDEs and one low potential GDE (from regional mapping) located across the central portion of the transmission line route which are described as palustrine wetlands according to the BoM GDE Atlas.

Potential effects on aquatic GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith, 2024) (Appendix H of the EES).

Terrestrial GDEs

There are 98 high potential terrestrial GDEs (from national assessment) mapped as being present within the transmission line corridor covering approximately 356 hectares, as shown in **Figure F11b**, **Appendix A**. These include herb-rich forest, sedgy riparian woodland and swamp scrub.

There also 24 smaller, moderate potential GDEs (from national mapping) within the transmission line corridor. These include damp sand heathy woodland and herb-rich forest.

Potential effects on potential terrestrial GDEs are discussed in the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith, 2024) (Appendix H of the EES).

8.0 Impact Assessment and Mitigation

This section of the report provides details on potential groundwater impacts for risks identified in Section 5.2.2, and focuses on potential impacts to consumptive use bores.

Groundwater contamination and acid sulfate soils are discussed in the *Environmental Site Investigation report* (AECOM, 2023) (Appendix I of the EES).

Potential impacts to GDEs and recommended mitigation measures are addressed in Sections 8, 9 and 10 of the *Groundwater Dependent Ecosystem Impact Assessment* (CDM Smith 2024) (Appendix H of the EES).

Potential groundwater impacts are associated with the construction and operation of the Project, and are based on key aspects of the Project description (Section 3.0) and existing conditions (Section 7.0).

8.1 Construction

8.1.1 Turbine foundation dewatering affects groundwater users

Dewatering of turbine foundation excavations would be required if groundwater is intersected. Turbine foundations would require dewatering for up to one month while open during construction.

When an excavation is dewatered a temporary, localised, ‘cone of depression’ (i.e. area of reduced groundwater levels) will be created radially away from the edge of the turbine foundation excavation. This has the potential to affect groundwater levels and groundwater flow to nearby receptors such as consumptive use bores and GDEs.

The magnitude of groundwater level reduction from dewatering will be influenced by the permeability of the saturated material, duration of dewatering, and the depth of groundwater intersected (and thus the rate of dewatering required).

The disposal of discharge from dewatering activities is addressed in Sections 8.3 of the *Environmental Site Investigation* report (AECOM, 2023) (Appendix I of the EES).

Plantation sub-area

Impact

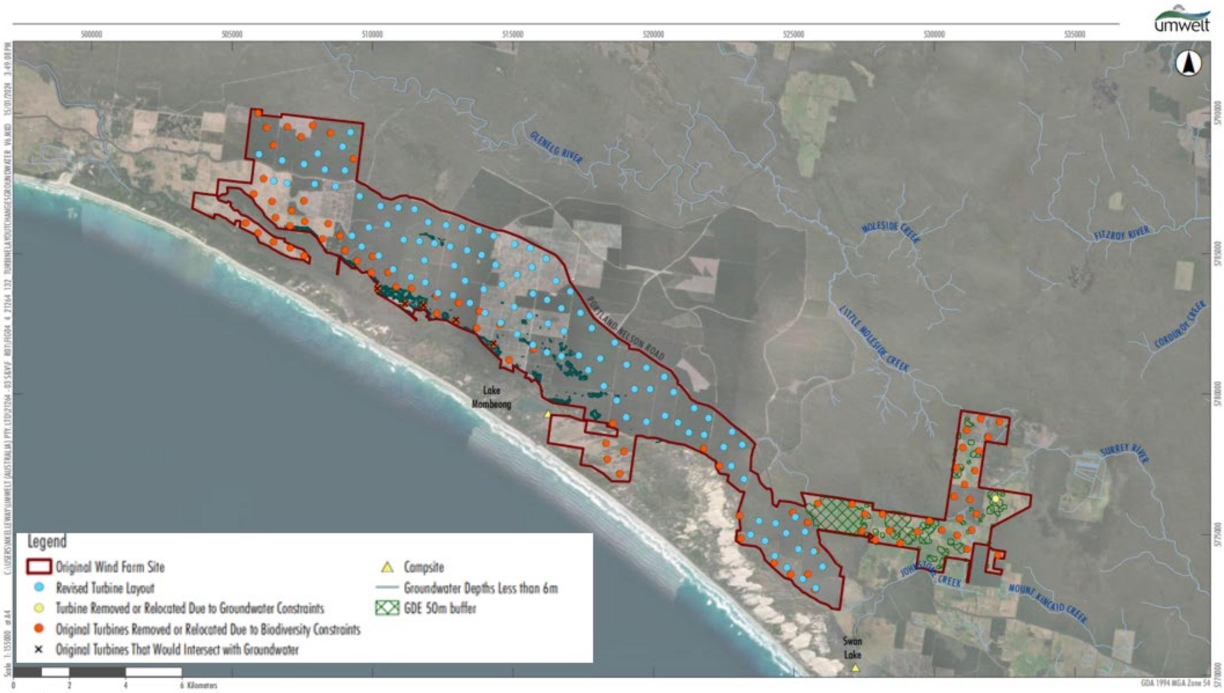
Groundwater level data from existing bores, shallow monitoring wells MW01 to MW09, and surface water elevations from selected wetlands and waterbodies have provided a good understanding of depths to groundwater beneath the plantation sub-area. In particular, the groundwater elevations and depths to groundwater are well understood within a kilometre of the wetland complex adjacent to the southern boundary which includes Long Swamp, Lake Mombeong, Sheepwash Swamp and Cain Hut Swamp.

The ground surface elevation increases away from the southern boundary compared to the relatively flat water table, leading to significant increases in depth to water immediately north of the southern site boundary (refer to schematic cross sections provided as **Figures F6a** to **F6e**, **Appendix A**).

As discussed in Section 7.6.3, four metre deep turbines are not expected to intersect the water table where depths to groundwater are greater than 6 mbgs (that is, two metres below the base of turbine foundations); which conservatively allows for accuracy of survey data and for seasonal variation against ‘baseline conditions’ of April 2021.

Figure F8 (**Appendix A**) shows those limited areas of the plantation sub-area, immediately north of the Ramsar site, where depth to groundwater is less than 6 mbgs and there is a greater potential for groundwater to be intersected during micro siting of turbines (when turbine locations can move by up to 100 metres). Turbines previously proposed in these areas of lower lying ground close to the Ramsar wetlands of Black Swamp, Nobles Main Long Swamp and Small Patch Long Swamp have been removed during Project design updates due to biodiversity constraints (refer to Figure 8-1). The constraints included buffers associated with brolga breeding habitat, Ramsar site wetlands and public land.

Figure 8-1 Changes Made to Turbine Layout



Source: Modified from Figure 4.4 EES Chapter 4: Project Development (Umwelt)

There remains very little potential for groundwater to be intersected by four metre deep slab (gravity) foundations at the proposed locations, and a foundation dewatering impact pathway has not been identified. However, mitigation measures have been provided below as a precautionary approach to minimise the potential for groundwater being intersected.

Contingency and monitoring measures have been included in Section 10.0 to address any unexpected intersection of groundwater due to changes in final turbine location micro-siting or changes to current baseline groundwater levels.

Mitigation

Although the intersection of groundwater is not anticipated within the plantation sub-area, it is recognised that the final location of turbines will be dependent on micro-siting, which typically provides for movement of up to 100 metres from the proposed locations.

To minimise the risk of final foundation locations intersecting groundwater in the plantation sub-area, it is recommended that wherever practicable:

- turbine locations should avoid areas with an inferred depth to groundwater of less than 6 mbgs (refer to **Figure F8, Appendix A**)

Contingency and monitoring measures are provided in Section 10.0 to address any unexpected intersection of groundwater at a turbine location.

Residual impact

With the removal of proposed locations within the lower lying areas north of the Ramsar wetland complex and the above recommended mitigation measure implemented, turbine foundations are not expected to intersect groundwater within the plantation sub-area and therefore no dewatering impact pathway exists; based on existing conditions described in Section 7.6 and proposed turbine locations (as shown in relevant figures throughout this report).

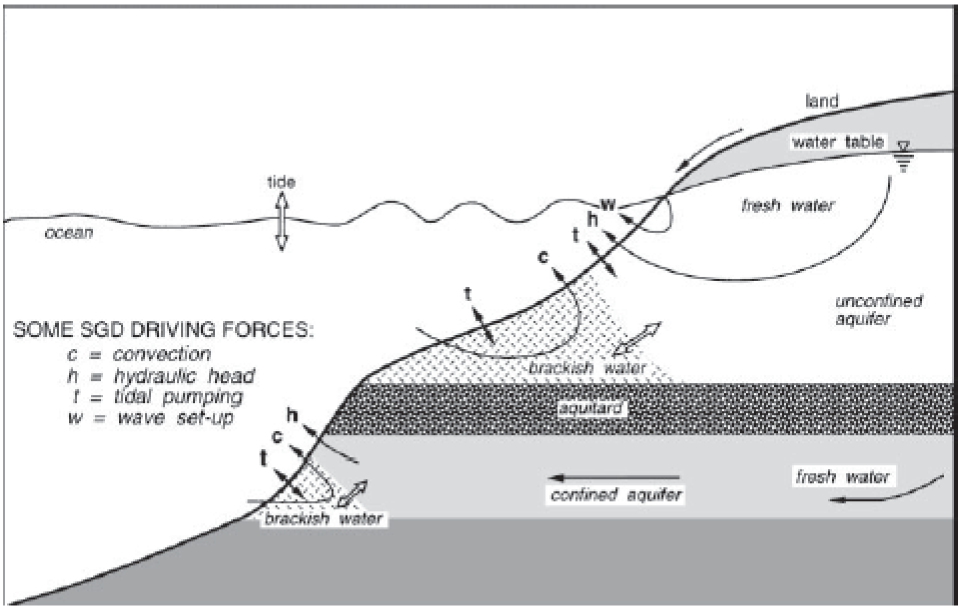
Contingency and monitoring measures are provided in Section 10.0 to address unexpected intersection of groundwater at a turbine location.

8.1.2 Dewatering activities or groundwater supply extraction induces saline intrusion

Impact

In coastal areas, fresher (less saline) groundwater, sometimes known as the 'freshwater lens', sits on top of more saline groundwater. This saline groundwater beneath coastal areas is in connection with seawater and is sometimes called the salt wedge (refer to Figure 8-2).

Figure 8-2 Schematic diagram of sea water and groundwater interaction (from Bush, 2009)



Pumping significant volumes of groundwater in coastal areas can induce reductions in groundwater levels in the fresher water, such that upward or lateral flow occurs from the salt wedge. This can then increase salinity within the freshwater lens and may impact on groundwater bores and/or GDEs.

The Ghyben-Herzberg relation states that for every metre of freshwater lens thickness above sea level (or above mAHD) the freshwater lens extends 40 metres below sea level. This is due to the relative density of freshwater and seawater.

The lowest recorded groundwater elevation was approximately 4.5 mAHD in MW06, located adjacent to Black Swamp (refer to **Figure F9, Appendix A**). This suggests a freshwater lens in the order of 180 metres below sea level (-180 mAHD) based on the simplified Ghyben-Herzberg approximation.

As discussed in Sections 7.6 and 8.1.1, the intersection of groundwater is not expected during construction activities at the plantation sub area; noting that proposed turbine locations were removed from lower lying areas close to the coast where the risk of intersection was higher. In the unlikely event that groundwater is intersected then lateral flow or upward leakage from the 'salt wedge' is not anticipated based on the distance of proposed turbine locations from the coast (at least 2 km), thickness of freshwater lens (in the order of 180 metres), depth of turbines (4 metres) and temporary nature of dewatering.

Groundwater extraction for construction supply will be from deeper portions of the UMTA and will occur from around 5 to 6 km from the coast (nominally along the Portland-Nelson Road); with final location(s) agreed through consultation with SRW at the time of a groundwater take and use licence. Lateral flow or upward leakage from the 'salt wedge' is not anticipated based on the depth of extraction, distance from the coast, the sea water and groundwater interaction model, and short-term, temporary extraction.

Although the risk of saline intrusion is low, it is anticipated that it would be further considered as part of a groundwater take and use licence.

Mitigation

No mitigation measures are proposed.

Residual Impact

Saline intrusion due to dewatering activities and groundwater supply has been assessed to be extremely unlikely. Any (unexpected) changes to groundwater quality would be localised, small in magnitude and temporary in nature; given the hydrogeological setting, locations and depths of excavations and production bores, and the limited duration of activities.

8.1.3 Onsite cable trench dewatering affects existing groundwater users

Cables between turbines will be laid in trenches up to 1.2 metres deep in 50 to 100 metre sections. If groundwater is intersected by the cable trenches it would need to be removed prior to the installation of underground cabling and placement of backfill, including thermally stable backfill in the form of flowable soft concrete (if required).

The shallow trenching depth for onsite cables will limit the potential to penetrate a significant depth below the water table, and dewatering (if required) would be carried out for a short duration only (hours rather than days) immediately prior to installation of the cable and backfill.

The disposal of discharge from dewatering activities is addressed in Sections 8.3 of the *Environmental Site Investigation* report (AECOM, 2023) (Appendix I of the EES).

Plantation sub-area

Impact

Based on existing conditions described in Section 7.6.3 it is not anticipated that groundwater will be intersected by the shallow cable trenches (up to 1.2 m deep) within the plantation sub-area, and no impact pathway exists.

In the very unlikely event that groundwater is intersected by cable trenching, it would be localised and of limited depth, and dewatering durations would be hours rather than days. Any changes to groundwater levels and flow would be negligible in extent, magnitude, and duration. Drawdown away from the trench section being dewatered would be negligible at distances beyond 10 to 20 metres and occur for less than a week.

Potential impacts to GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Mitigation

No additional mitigation measures recommended for existing consumptive use bores.

Mitigation measures for GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Residual impact

No material residual impact anticipated for existing consumptive use bores.

Wind farm northeastern sub-area

Impact

A limited depth of groundwater intersection may occur at the northeastern sub-area where groundwater was measured to be between one and three mbgs (in April 2021), and anticipated to be near surface during winter months.

The depth of any groundwater intersection during trenching would be limited (i.e. less than one metre) and along localised sections in lower lying areas. Also, dewatering durations would be in the order of hours (rather than days). Drawdown away from the trench section being dewatered would be negligible at distances beyond 10 to 20 metres and occur for less than a week[7].

[7] Based on Theis approximation with 1m drawdown at trench, hydraulic conductivity of 25 m/day, unconfined aquifer storage of 0.1 and 24hr continuous pumping

It is concluded that impacts (if any) would be negligible to consumptive use bores due to the shallow depth of trenching, limited extent and magnitude of drawdown away from trenches and short duration of trench dewatering.

Potential impacts to GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Mitigation

No additional mitigation measures recommended for existing consumptive use bores.

Residual impact

No material residual impact anticipated for existing consumptive use bores.

8.1.4 Transmission line trench dewatering affects existing groundwater users

Trenching for underground sections of the transmission line will be to a depth of approximately 1.25 metres.

If groundwater was intersected by the cable trench it would need to be dewatered prior to the installation of underground cabling and placement of backfill. However, the shallow depth will limit the potential to penetrate a significant depth below the water table, and dewatering (if required) would be carried out for a short duration only (hours rather than days) immediately prior to installation of the cable and backfill. It is possible that ASS management will be required along some sections of transmission line trenching where dewatering occurs (if required). The management of ASS is addressed in Section 8.2 of the *Environmental Site Investigation* report (AECOM, 2023) (Appendix I of the EES).

The disposal of discharge from dewatering activities is addressed in Sections 8.3 and 9.0 of the *Environmental Site Investigation* report (AECOM, 2023) (Appendix I of the EES).

Impact

The geology of the transmission line route is anticipated to be relatively low permeability clay/silty clay (i.e. completely weathered basalt or swamp and lake deposits) based on regional surface geology mapping and available bore logs (refer to Section 7.8.2). Literature values for the hydraulic conductivity of clay are up to 0.0004 m/day and for silt are up to 1 m/day (Domenico and Schwartz, 1990)

Regional mapping indicates depth to groundwater being less than 10 mbgs along much of the underground transmission line route through Cobboboonee National Park (refer to **Figure F7b, Appendix A**). Potential aquatic GDEs are mapped towards the eastern end of the underground cable route (refer to **Figure F2b, Appendix A**) which also suggests the possibility of shallow groundwater in these areas.

It is possible that groundwater could be intersected during trenching of some sections, with the depth of in-trench water variable based on small changes in relief. If groundwater is close to ground level, then up to 1.25 metres of water may need to be dewatered.

Given the low hydraulic conductivity of shallow soils likely to be encountered (clay or silty/clay), the limited depth of in-trench groundwater (less than 1.25 metres) and short duration of dewatering (in the order of hours rather than days), drawdown away from the trench would be very limited. Drawdown away from the trench section being dewatered would be negligible at distances beyond around 5 metres and occur for less than a week[8].

Impacts, if any, to nearby consumptive use bores would be negligible due to the shallow depth of trenching, limited extent and magnitude of drawdown away from trenches and short duration of trench dewatering.

Potential effects on GDEs are addressed in *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

[8] Based on Theis approximation with 2m drawdown at trench, hydraulic conductivity of 0.5 m/day, unconfined aquifer storage of 0.1 and 24hr continuous pumping

<u>Mitigation</u>

No additional mitigation measures recommended for existing consumptive use bores. [

Mitigation measures for GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024 (Appendix H of the EES)).

<u>Residual impact</u>

No material residual impact anticipated for existing consumptive use bores.

8.1.5 Quarry dewatering affects groundwater users

A new limestone quarry is proposed to be established in the northern central part of the wind farm plantation sub area, adjacent to the existing quarry owned by Green Triangle Forest Products (GTFP), on North Livingston Road (shown in **Figure F1, Appendix A**). The quarry footprint would have approximately 9 ha of extraction area and be a maximum depth of15 m, with actual dimensions to be determined following a comprehensive drilling, sampling and testing program during detailed design of the Project.

<u>Impact</u>

The adjacent existing quarry is at a depth of approximately 18 mbgs (current base of quarry surveyed to be 35.97 mAHD) and groundwater has not been intersected. The absence of groundwater ingress at the existing quarry is consistent with the inferred depth to groundwater at 36 metres below the rim of the quarry (that is, the groundwater elevation is inferred to be a at elevation of approximately 18 mAHD). Refer to **Figure F9, Appendix A**).

Based on conditions at the existing quarry and predicted groundwater levels at the location the maximum depth of the onsite quarry will be 21m above the groundwater table. There will be no requirement to dewater as part of the quarry operations. Any other hazard such as waste, fuels, or chemicals that presents a potential risk to groundwater will be managed in the work plan.

<u>Mitigation</u>

No mitigation measures recommended.

8.1.6 Existing bores become damaged, destroyed or inaccessible

<u>Impact</u>

Registered and unregistered bores within, or near, the construction footprint of the wind farm and transmission line corridor have the potential to be damaged, lost (i.e. destroyed), or to become inaccessible during construction. This could lead to a temporary or permanent loss of access to groundwater for the affected bore owner/user.

A total of 51 registered bores are mapped as being located within the groundwater study area, although many of these are beyond the immediate footprint of the proposed turbine, access track and trenching locations. Other bores, such as unregistered bores or registered bores mapped to the wrong location in the WMIS database, may also be affected during construction.

<u>Mitigation</u>

Following detailed design, the location of registered and unregistered bores should be visually confirmed on site relative to Project infrastructure (such as turbines, access tracks and trenching).

Prior to construction the potential for damage or loss of access to existing bores should be established in consultation with the landholder/bore owner.

In instances where a bore is deemed to be impacted by the Project, consultation should occur to facilitate an agreement between Neoen and the landholder/bore owner.

<u>Residual impact</u>

No material residual impact is anticipated following the implementation of the recommended mitigation measures.

8.1.7 Groundwater supply extraction affects groundwater users

Impact

The extraction of groundwater for the Project's construction phase water supply has the potential to affect groundwater users by reducing groundwater levels at existing consumptive use bores, as well as reducing groundwater levels and/or flow at GDEs. The current estimate is that approximately 250 ML of groundwater would be required during the construction period. This would be extracted from several production wells across the plantation sub-area based on logistical and hydrogeological constraints.

An impact assessment was carried out as part of the groundwater supply and hydrogeological assessment provided as **Appendix F**.

A test bore (TB01) and monitoring bore (MB01) were installed in the lower UMTA and intersected distinct fractures at depth, overlain by low permeability limestone matrix. A 24-hour pumping test (see **Appendix F**) and subsequent 7-day pumping test (see CDM Smith, 2023) were carried out to assess the sustainable yield of TB01 and to estimate groundwater level drawdowns at various distances and pumping durations. Aquifer testing showed that the limestone of the lower UMTA (targeted by TB01) behaves as a confined to semi-confined (leaky aquifer) system and is poorly connected to the overlying shallow groundwater system (that is, the upper UMTA and QA). Therefore, groundwater extraction from depth would not materially impact groundwater levels in existing groundwater bores; typically installed at depths of less than 50 metres within the upper UMTA .

Potential impacts to GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Mitigation

Groundwater supply bore(s) for the Project should target lower portions of the UMTA to reduce the potential for interaction with the shallow groundwater system. They should also be located away from existing consumptive use bores and GDEs (such as along the Portland-Nelson Road) to increase spatial separation and minimise the magnitude of drawdown in the underlying deeper UMTA, and hence the potential for vertical drainage effects on the overlying upper UMTA and QA.

Additional water supply investigations will be required in consultation with Southern Rural Water prior to any groundwater take and use licence application. The further investigations and the application process would reduce the risk of material impact to groundwater users, as well as identifying monitoring and contingency measures as part of groundwater licence conditions. A draft groundwater monitoring program is provided in Section 10.2.

Further, any groundwater licence granted would be a short term temporary transfer only, being in the order of two to three years to cover the construction phase of the Project.

Mitigation measures for GDEs are addressed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024) (Appendix H of the EES).

Residual impact

Any potential impact to consumptive use bores can be managed with the recommended mitigation measures and no material residual impacts are anticipated.

8.2 Operation

8.2.1 Turbine foundations impede groundwater affecting groundwater users

There is a conceivable risk that groundwater flow could be impeded to some extent by the presence of turbine foundations, leading to changes in groundwater levels and groundwater flow direction. If the change is sufficiently large it could result in impacts such as reduction of groundwater levels and flow to down hydraulic gradient bores and GDEs, or raising groundwater levels up hydraulic gradient leading to salinity issues from evaporative effects.

Measurable changes in groundwater levels or flow (if any) will be localised and small in magnitude, with groundwater readily flowing around and/or beneath the Project structures. This is based on the relatively shallow foundations and limited depth of groundwater intersected, the width of foundations relative to the regional flow systems, and the fact they are not being keyed into underlying lower permeability materials (i.e. aquitard).

To illustrate the materiality of any potential effects, the following analytical approach was adopted to consider the magnitude of potential changes in groundwater levels across a turbine foundation using the following underflow scenario:

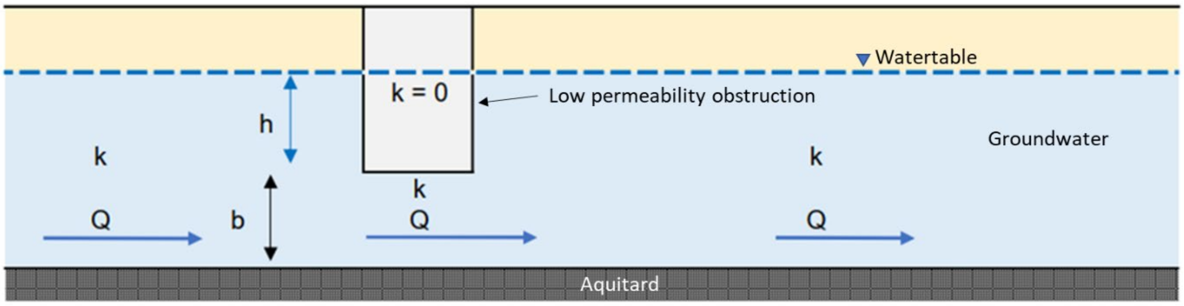
- flow through the shallow aquifer upgradient of the turbine is the same as the flow beneath the turbine, using the formula:

$$Q = k * i * A \qquad \text{(Equation 1)}$$

Where:
Q is flow through the aquifer (m^3/day)
k is the hydraulic conductivity of the aquifer (m/day)
i is the hydraulic gradient (m/m)
A is the cross-sectional area through which flow (Q) is occurring

- the hydraulic conductivity of the sediments adjacent to the trench is similar to that beneath the trench

Figure 8-3 Concept of underflow



Changes are made to the following inputs of Equation 1 to consider various scenarios:

- thickness of aquifer beneath the turbine foundation allowing underflow (b)
- initial/baseline hydraulic gradient without the foundation (i)
- depth of groundwater intersected by the turbine (h).

The increased gradient across the turbine is then calculated such that the upgradient flow (Q) is maintained beneath the reduced aquifer thickness beneath the turbine.[9]

Plantation sub-area

Impact

It is not anticipated that groundwater will be intersected by four metre slab (gravity) foundation, and groundwater flow being impeded is not considered a complete impact pathway within the plantation sub-area.

In the unlikely event that groundwater is intersected by completed turbine foundations, it would be limited in depth and localised to only a small number of turbines (if any). Impeded groundwater would readily flow around and beneath these foundations, and effects on groundwater levels would be negligible in magnitude and extent away from the foundations due to the highly transmissive nature of the QA and UMTA.

Mitigation

No additional mitigation measures recommended.

[9] The hydraulic conductivity value used does not affect result given k of zero for trench and same k up gradient and beneath trench. The change in gradient across the trench is due to changes in the initial hydraulic gradient, the head of water in the trench and thickness of aquifer beneath the trench.

8.2.2 Cable trenches impede groundwater affecting groundwater users

All sub-areas

Impact

There is the potential for shallow groundwater flow to be impeded by cable trenches following completion with thermally stable backfill if required (typically in the form of flowable concrete) followed by excavated backfill or crushed rock to surface.

Any such impacts on shallow groundwater levels due to the trench acting as a barrier (or partial barrier) to groundwater flow are not expected to be material given the size and scale of the trench relative to the aquifers and regional context of groundwater flow, and ability of groundwater to flow beneath the trench. Noting that groundwater intersection by cable trenching within the plantation sub-area is not anticipated.

No significantly lower permeability horizons were encountered directly below the base of trenching in the plantation sub-area and northeastern sub-area or are anticipated based on mapped geology. Groundwater flow beneath the backfilled trenches can therefore be expected to occur.

Estimated changes to groundwater levels adjacent to a trench are provided in Table 8-1; based on the concept of underflow and Equation 1 described in Section 8.2.1. These are provided for several hydraulic gradients (shallow, moderate and high) and below trench aquifer thicknesses scenarios (b) where the trench is submerged 1.5 metres below the water table.

Table 8-1 Summary of changes to hydraulic gradient across trench

Initial hydraulic gradient (i) (m/m)	Aquifer thickness beneath turbine, b (m)	New hydraulic gradient across turbine (m/m)	Increased head difference across turbine (m)	Groundwater level change [a] (cm)	
0.0001	1	0.0003	0.0002		0.01
	2	0.0002	0.0001		0.005
0.001	1	0.003	0.002		0.1
	2	0.002	0.001		0.05
0.01	1	0.025	0.023		1
	2	0.018	0.011		0.6

Note: a - assumes upgradient increase is equal to downgradient decrease across the trench

The results show that the increase in hydraulic gradient across the trench required to 'force' groundwater flow beneath the reduced aquifer thickness would result in a less than one-centimetre change to groundwater levels immediately up- and down-hydraulic gradient of the turbine.

Potential impacts to groundwater users would therefore be negligible due to changes in groundwater levels up- and down hydraulic gradient of the trench.

Mitigation

No additional mitigation measures recommended.

9.0 Recommended Mitigation Measures

The recommended mitigation measures listed in Table 9-1 are additional mitigation measures for the construction and operation of the Project. These mitigation measures were first identified throughout Section 8.0 and have been summarised here for ease.

The proposed design, construction and operational elements relevant to the groundwater impact assessment, as per the Project description (Section 3.0) have not been included but are considered integral elements of the Project (for example depth of cable trenching, turbine foundation design etc.) that inform initial risk rankings in Section 5.2.2 and potential impacts described in Section 8.0.

Table 9-1 Recommended mitigation measures

Mitigation measure ID	Recommended mitigation measures	Works area	Stage
MM-GW01	To minimise the risk of final foundation locations intersecting groundwater, it is recommended that wherever practicable, turbine locations should avoid areas with an inferred depth to groundwater of less than 6mbgs (refer to **Figure F8, Appendix A**).	Wind farm plantation sub-area	Detailed design/construction
MM-GW02	If groundwater is going to be intersected at a turbine foundation location, the turbine should be moved to higher ground, or a dewatering management plan should be developed specific to each turbine location (refer to Section 10.1)	Wind farm plantation sub-area	Detailed design/construction
MM-GW03	Additional water supply investigations as part of groundwater take and use application in consultation with SRW. Water supply extraction bores to be located along Nelson-Portland Road and within the deeper UMTA to reduce potential impacts to groundwater users; in consultation with SRW. Groundwater allocation to be short-term and temporary transfer only for construction phase (in the order of two to three years).	Wind farm plantation sub-area	Construction
MM-GW04	Visually confirm location of registered and unregistered bores. Prior to construction establish potential for damage or loss of access to existing bores in consultation with the landholder/bore owner. Agree to make good arrangements between Neoen and the landholder/bore owner if required.	All	Construction /operation
MM-GW05	A groundwater level monitoring program should be developed and included in the CEMP to assess for effects on groundwater levels from groundwater supply extraction (refer to Section 10.2 for draft monitoring plan).	Wind farm plantation sub-area	Pre-construction/ construction

10.0 Contingency measures and monitoring

10.1 Foundation dewatering

If groundwater were to be intersected at a turbine foundation location the following hierarchy of contingency measures is recommended:

- Move turbine location to higher ground to avoid groundwater intersection wherever practicable
- Develop a dewatering and monitoring plan specific to each location that could include but not be limited to:
  - assessment of drawdown and dewatering volumes
    - based on site specific information including depth to water, hydraulic conductivity, base of foundation elevation relative to GDEs and/or consumptive use bore groundwater level, and distance to GDE and/or consumptive use bore
  - monitoring well installation and groundwater level monitoring to be based on distance drawdown estimates
  - discharge of foundation dewatering to ground and down hydraulic gradient of the turbine to reduce drawdown and minimise loss of groundwater flow within the system (subject to groundwater quality and regulatory approvals)
  - triggers and actions such as cessation of dewatering and/or make good arrangements.

10.2 Draft groundwater monitoring plan

Potential Project water supply impacts to the shallow UMTA and QA groundwater levels due to groundwater extraction from the lower UMTA have been found to be negligible; as discussed in Section 8.1.7, **Appendix F** and CDM Smith (2024).

It is acknowledged however that ongoing groundwater monitoring will be required to verify the assessments that have been made based on the drilling and testing of test bore TB01 (in March 2022 and April 2023).

A final groundwater monitoring plan (GMP) should be developed and included in the CEMP. This would include engagement of appropriately qualified and/or experienced staff, contractors, or consultants to the undertake the necessary monitoring, assessment, and reporting.

Neoen should ensure that all personnel engaged in the works have a thorough understanding of the final groundwater monitoring plan and ensure they have adequate training, skills, and experience to undertake the works.

10.2.1 Draft Monitoring locations

A draft monitoring network summarising the rationale for each bore is provided in **Table** 10-1.

Table 10-1 Draft groundwater monitoring network

Monitoring bore ID	GW system	Easting	Northing	Bore type	Purpose
MW01	Shallow	506928.2	5786945.0	Background - inland	Background monitoring wells. Away from influence of deep UMTA production bore(s). Allows 'natural' changes in groundwater levels and hydraulic gradient to be assessed.
MW02	Shallow	506942.3	5785878.9	Background - wetland bore	
MW03	Shallow	509703.1	5785281.1	Trigger bore - inland	Measure changes in groundwater levels and hydraulic gradient. Allows comparison with other monitoring well pairs (including background MW01 and MW02).
MW04^	Shallow	509016.1	5784752.4	Trigger bore - wetland	
MW05^	Shallow	511868.2	5783703.7	Trigger bore - inland	Measure changes in groundwater levels and hydraulic gradient. Allows comparison with other monitoring well pairs (including background MW01 and MW02).
MW06^	Shallow	510974.3	5783327.7	Trigger bore - wetland	
MW07^	Shallow	514511.6	5782434.8	Trigger bore - inland	Measure changes in groundwater levels and hydraulic gradient. Allows comparison with other monitoring well pairs (including background MW01 and MW02).
MW08^	Shallow	514269.4	5781591.2	Trigger bore - wetland	
MW09	Shallow	517709.3	5780045.0	Background - inland	Background monitoring well. Away from influence of deep UMTA production bore(s). Allows 'natural' changes in groundwater levels to be assessed.
101246 (SOB*)	Shallow	517463.4	5781917.2	Background - inland	Background monitoring well. Away from influence of deep UMTA production bore(s). Allows 'natural' changes in groundwater levels to be assessed up hydraulic gradient of MW09.
65058 (SOB*)	Shallow	508134.2	5787701.9	Background - upper catchment	Background monitoring well. Away from influence of deep UMTA production bore(s). Allows 'natural' changes in groundwater levels to be assessed.

Monitoring bore ID	GW system	Easting	Northing	Bore type	Purpose
MB01	Deep UMTA	514512	5785224	Water supply observation bore	Allows comparison of groundwater level response to pumping TB01 versus modelled response.
Notes: SOB - State Observation Bore; * - a review of the condition and monitoring status of the SOBs should be carried out to confirm suitability for the monitoring network; ^ - bores with data logger installed for EES					

Surface water level data loggers were also installed in swamps and wetlands within the Ramsar wetland complex (CDM Smith, 2020). Liaison and sharing of groundwater level and surface water level between Neoen and Glenelg Hopkins Catchment Management Authority (GHCMA) is recommended.

Monitoring of existing consumptive use bores and/or installation of additional monitoring bores may need to be included in the final monitoring network if required by SRW as part of a groundwater take and use licence application. This will depend on the final agreed location of additional production bores (if required).

10.2.2 Draft Monitoring program

Baseline monitoring of groundwater levels should start 12 months prior to the commencement of water supply pumping and include:

- Continuous groundwater level monitoring (e.g. hourly) via data loggers at monitoring wells MW01 to MW09 and MB01
- Monthly download of data logger and manual gauging at MB01. Quarterly downloading of data loggers and manual gauging of groundwater levels at all other monitoring wells.
- Quarterly download of State Observation Bores 101246 & 65058 from WMIS website
- Quarterly collation of surface water/wetland data (available from Glenelg Hopkins Catchment Management Authority)
- Monthly download of water extraction rates and volumes from production bore(s) and pump run hours

It is anticipated that monitoring during the Project's construction phase would be similar in scope to the baseline monitoring. Construction phase monitoring would be finalised based on consultation with SRW and other stakeholders during the groundwater take and use licence application process.

Post construction groundwater monitoring is likely to be required to monitor the rebound of groundwater levels following the cessation of water supply extraction pumping. The scope and duration of monitoring would be determined based on results of the baseline and construction phase monitoring.

10.2.3 Draft triggers and contingencies

Final triggers and contingencies should be determined based on the data collected as part of the EES (between April 2021 and April 2023) and the proposed additional baseline monitoring (Section 10.2.2).

Triggers and contingencies would be determined prior to the commencement of groundwater pumping for Project's water supply. This should be carried out in consultation with Sothern Rural Water as part of the groundwater take and use licence application.

The key trigger will be changes to the hydraulic gradient within the shallow groundwater system which is typically towards the Ramsar Wetland beneath the Plantation Sub-area. Assessment of changes to the hydraulic gradient would need to be considered in terms of changes outside of natural variation (that is, outside of the 'baseline norm') and must be assessed in the context of the Project's pumping regime, groundwater hydrographs, climate, land use changes, tidal fluctuations, and wetland levels.

An additional trigger could also include the assessment of vertical gradients between the shallow (QA and upper UMTA) and deep (deeper UMTA) groundwater systems. This could include the installation of additional monitoring bores to supplement the existing monitoring network and would be determined in consultation with SRW during the groundwater take and use licence application.

Exceedances of trigger levels would result in contingency measures such as temporary cessation of pumping, reduction in pumping volumes, intermittent pumping schedule or ‘make good’ agreements to mitigate affected groundwater users.

10.2.4 Assessments and reporting

Baseline data should be collated and assessed to determine triggers and contingencies prior to commencement of pumping. Any additional testing required by SRW as part of a groundwater take and use licence application would also need to be incorporated in the baseline assessment reporting.

Monthly collation, review, and assessment of MB01 groundwater level responses to pumping during Year 1 of construction. Produce a report comparing actual fluctuations and predicted, with updates to conceptual model and groundwater monitoring plan if required. Monitoring and reporting requirements determined for Year 2 based on Year 1 outcomes.

Quarterly collation, review, and assessment of data from monitoring wells (except MB01) against triggers during construction phase.

Key inputs required for assessments and reporting will include (but not be limited to):

- Groundwater level data
- Surface water level data for wetlands and swamps (from GHCMA)
- Rainfall data
- Land use changes within the plantation and construction area
- Groundwater extraction data (instantaneous flows, cumulative volumes, and pumping run times)

11.0 Conclusions

This groundwater impact assessment has been undertaken to determine the potential impacts of the Project's construction and operational phases on groundwater levels and groundwater flow, and to identify recommended management and mitigation options where appropriate to reduce residual impacts from the Project.

Targeted groundwater field investigation were completed in April 2021 and February/March 2022 to obtain site-specific groundwater data and to refine hydrogeological understanding within the study area.

The initial fieldwork program targeted areas where the Project had the potential to intersect groundwater. Monitoring wells MW01 to MW09 were therefore completed in the plantation sub-area adjacent to the Ramsar site wetland complex, and monitoring wells MW10 to MW12 were installed in the wind farm north-eastern sub-area.

The fieldwork program in 2022 was carried out to investigate the potential for groundwater to meet the Project's construction supply requirements and to assess potential impacts to groundwater users due to groundwater extraction.

Results of the field programs identified areas of shallow groundwater (less than 6 mbgs) that might be intersected by turbine foundations. Four-metre-deep turbine foundations were assumed and an increase in groundwater levels of up to two metres above baseline levels measured in April 2011. Subsequent monitoring between April 2021 and April 2023 showed seasonal fluctuations were less than 0.5 metres and therefore a screening depth to groundwater of 6 mbgs was shown to be a conservative approach. Dewatering during construction of turbine foundations will be required where groundwater is intersected by foundation excavations, with the potential to effect nearby groundwater bores and groundwater dependent ecosystems (including Ramsar wetlands).

Changes to the Project design were made that removed higher risk turbine locations from the proposed Project layout. Groundwater is not expected to be intersected by the Project in the plantation sub-area, based on inferred depths to groundwater, turbine foundation depth of four metres, the proposed turbine locations, and flexibility during micro-siting turbines.

Turbine foundations were expected to intersect groundwater in the north-eastern sub-area with depths to groundwater ranging between approximately one and three metres below ground surface (in April 2021). Changes were made the Project design that removed all turbine locations from the north-eastern sub-area, therefore removing the potential for groundwater impact from turbine foundation dewatering in this sub-area.

Several potential construction impacts were related to the reduction in groundwater levels and/or flow from dewatering activities (turbine foundation construction and cable trenching), and from Project groundwater supply bore(s) that could possibly affect registered bore users and GDEs (including Ramsar wetlands).

The groundwater impact assessment found limited potential for material impacts on groundwater levels and flow during the operational phase of the Project.

Overall, construction and operation of the Project was found to present no unacceptable residual risks based on the Project description, existing conditions, and recommended mitigation measures (Section 9.0), and contingency measures (Section 10.0).

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Appendix A

Figures

DATUM GDA94 VICGRID94

0 3.5 7

Kilometers

1:175,000 (when printed at A3)

Legend

- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- Ramsar Gleneg Estuary and DIscovery Bay
- Work Exclusion Area
- Proposed Quarry
- Existing Quarry
- Existing Terminal Station
- Town
- Existing Transmission line
- Waterbodies

Existing Features

- National Park
- Forest Park
- Reserve

Type of Wetland

- Coastal saltmarsh
- Permanent freshwater
- Temporary freshwater
- Permanent saline
- Temporary saline
- Unknown

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

PROJECT OVERVIEW

PROJECT #:	60591699
CREATED BY:	JB
LAST MODIFIED:	JM: 12/10/2023
VERSION:	1

Figure F1

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\10\Groundwater\F1_Project_Overview.mxd

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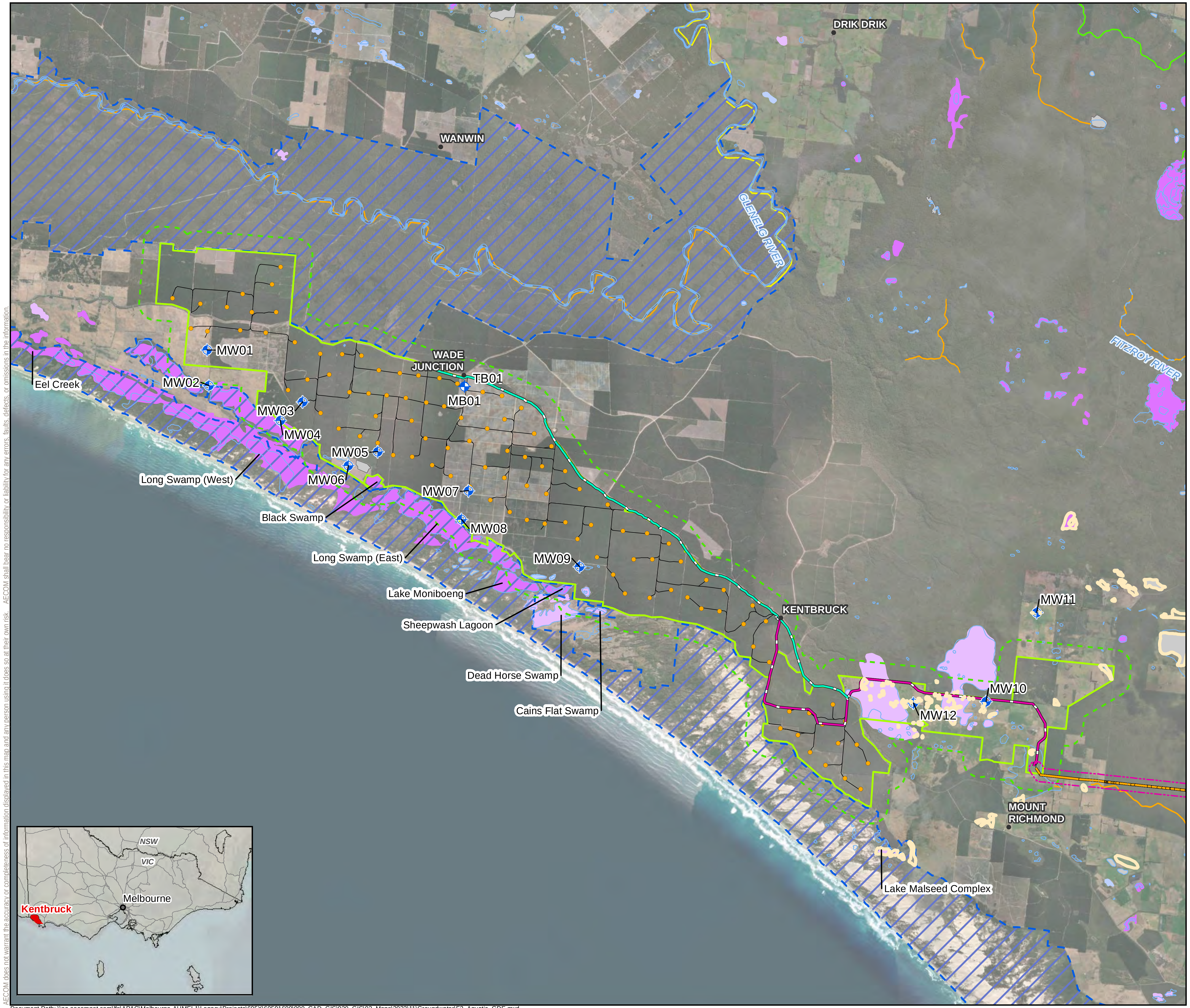

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 2 4

Kilometers

1:107,500 (when printed at A3)

Legend

- Turbine location
- MW0x series monitoring wells installed April 2021
- Watercourses
- Internal access roads
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Transmission Line - Underground
- 200m Alignment Buffer
- Wind Farm Site Boundary
- Wind Farm Boundary 500m -Buffer
- Wetlands from Biosis (2023)
- Waterbodies
- RAMSAR Gleneg Estuary and DIscovery Bay

Groundwater Dependent Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment

Kentbruck Green Power Hub

POTENTIAL AQUATIC GDES

PROJECT #: 60578607

CREATED BY: JB

LAST MODIFIED: stutta: 14/11/2023

VERSION: 1

Figure F2a

A3 size

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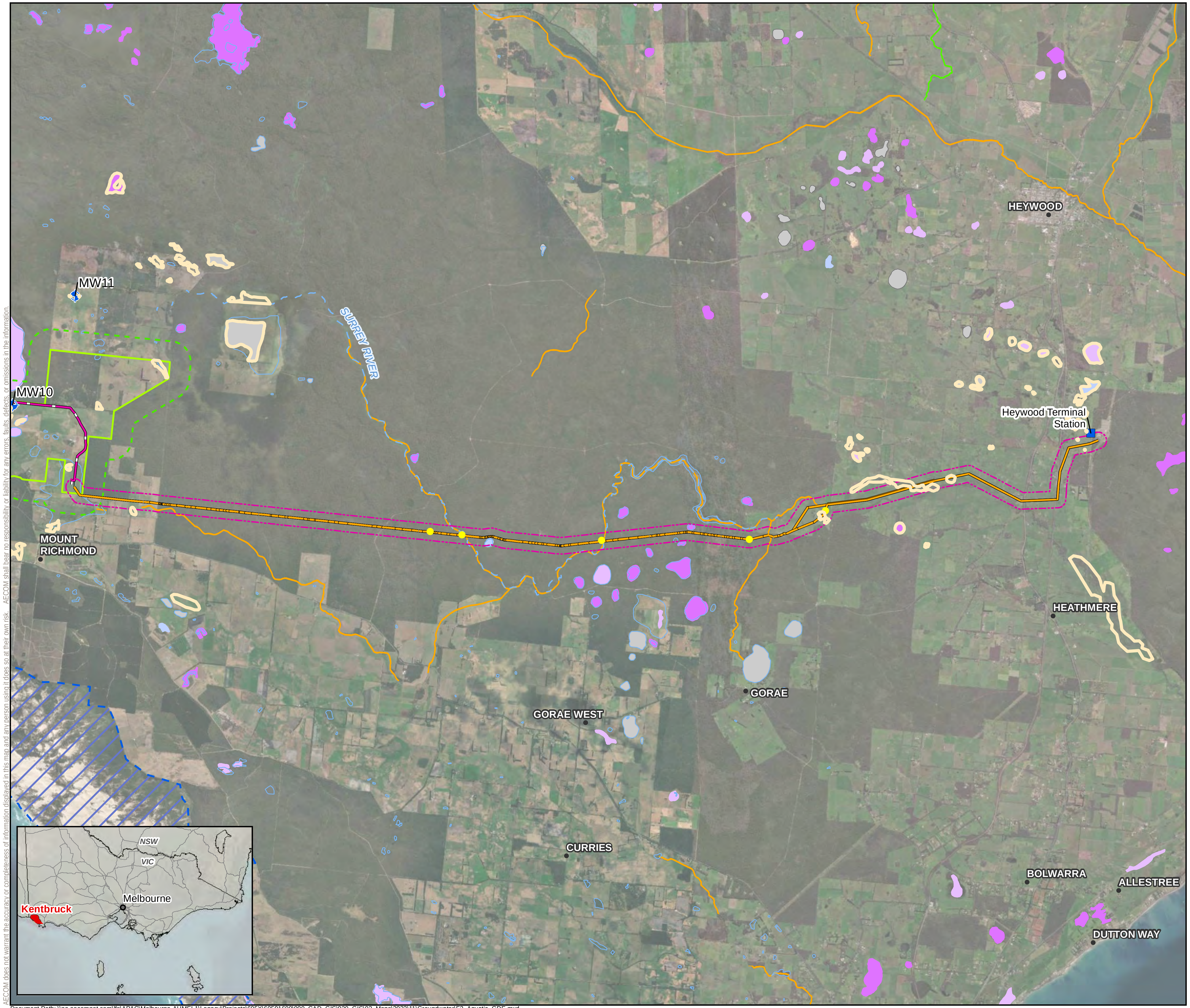

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3 Kilometers

1:87,500 (when printed at A3)

Legend

- Existing Terminal Station
- Horizontal Direction Drilling Locations
- MW0x series monitoring wells installed April 2021
- Watercourses
- Internal access roads
- 275 kV Powerline - Underground
- Transmission Line - Underground
- 200m Alignment Buffer
- Wind Farm Site Boundary
- Wind Farm Boundary 500m -Buffer
- Wetlands from Biosis (2023)
- Waterbodies
- RAMSAR Gleneg Estuary and DIscovery Bay

Groundwater Dependent Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub

POTENTIAL AQUATIC GDES

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F2b

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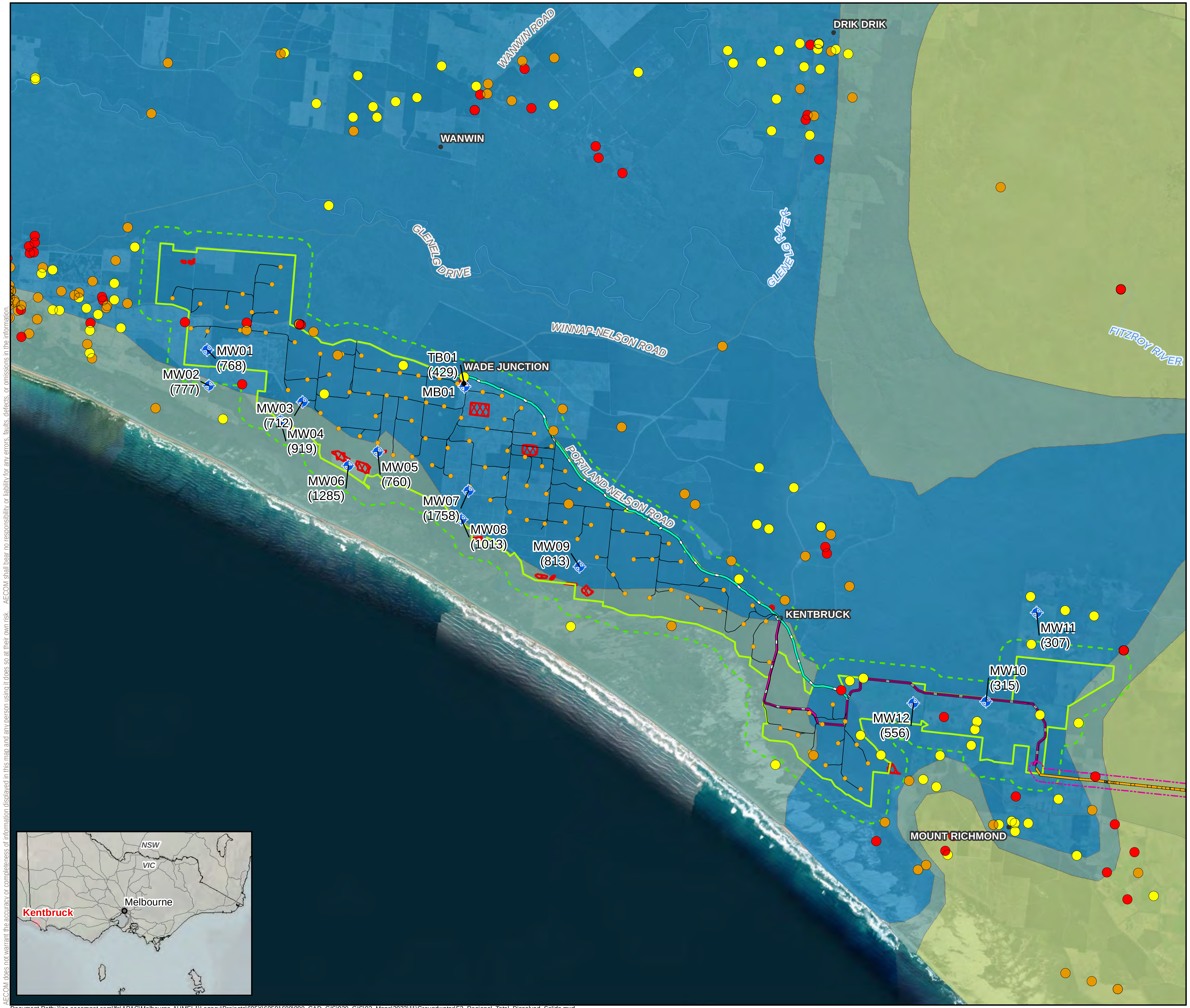

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 2 4

Kilometers

1:107,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021 (installed to < 10mbgs)
- Turbine location
- Internal access roads
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Transmission Line (Underground)
- 200m Alignment Buffer
- Wind Farm Site Boundary
- Windfarm Boundary 500m -Buffer
- Work Exclusion Area
- Roads
- Watercourses

Bore Depth (m)

- 0 - 20
- 21 - 50
- > 50

Total Dissolved Solids

- 0 - 600
- 600 - 1200
- 1200 - 3100

All TDS concentrations are in mg/L

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment

Kentbruck Green Power Hub EES

REGIONAL TOTAL DISSOLVED SOLIDS

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F3a

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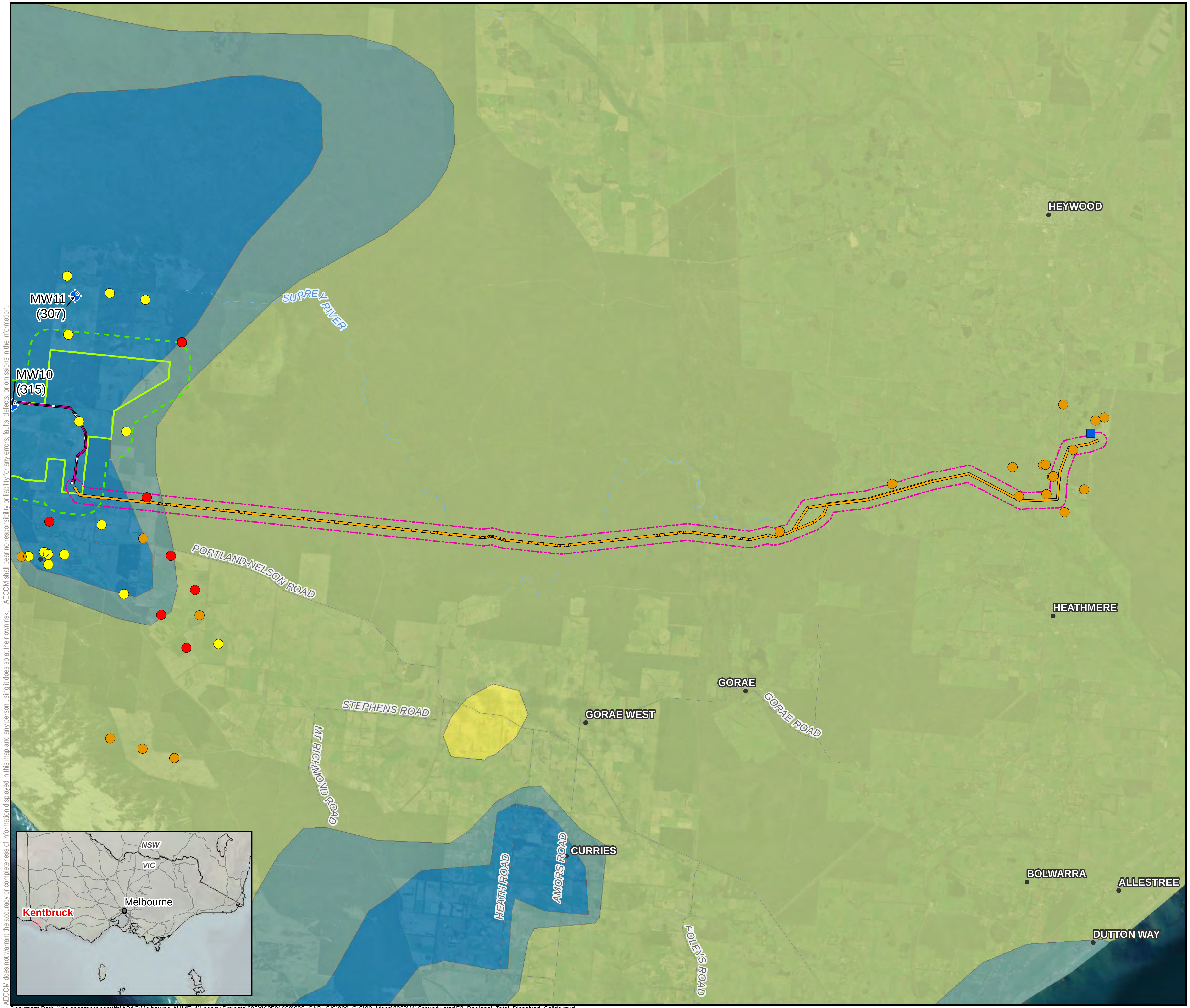

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:87,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021 (installed to < 10mbgs)
- Existing Terminal Station
- Internal access roads
- 275 kV Powerline - Underground
- Transmission Line (Underground)
- 200m Alignment Buffer
- Wind Farm Site Boundary
- Windfarm Boundary 500m -Buffer
- Roads
- Watercourses

Bore Depth (m)

- 0 - 20
- 21 - 50
- > 50

Total Dissolved Solids

- 0 - 600
- 600 - 1200
- 1200 - 3100
- 3100 - 5400

All TDS concentrations are in mg/L

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

REGIONAL TOTAL DISSOLVED SOLIDS

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F3b

A3 size

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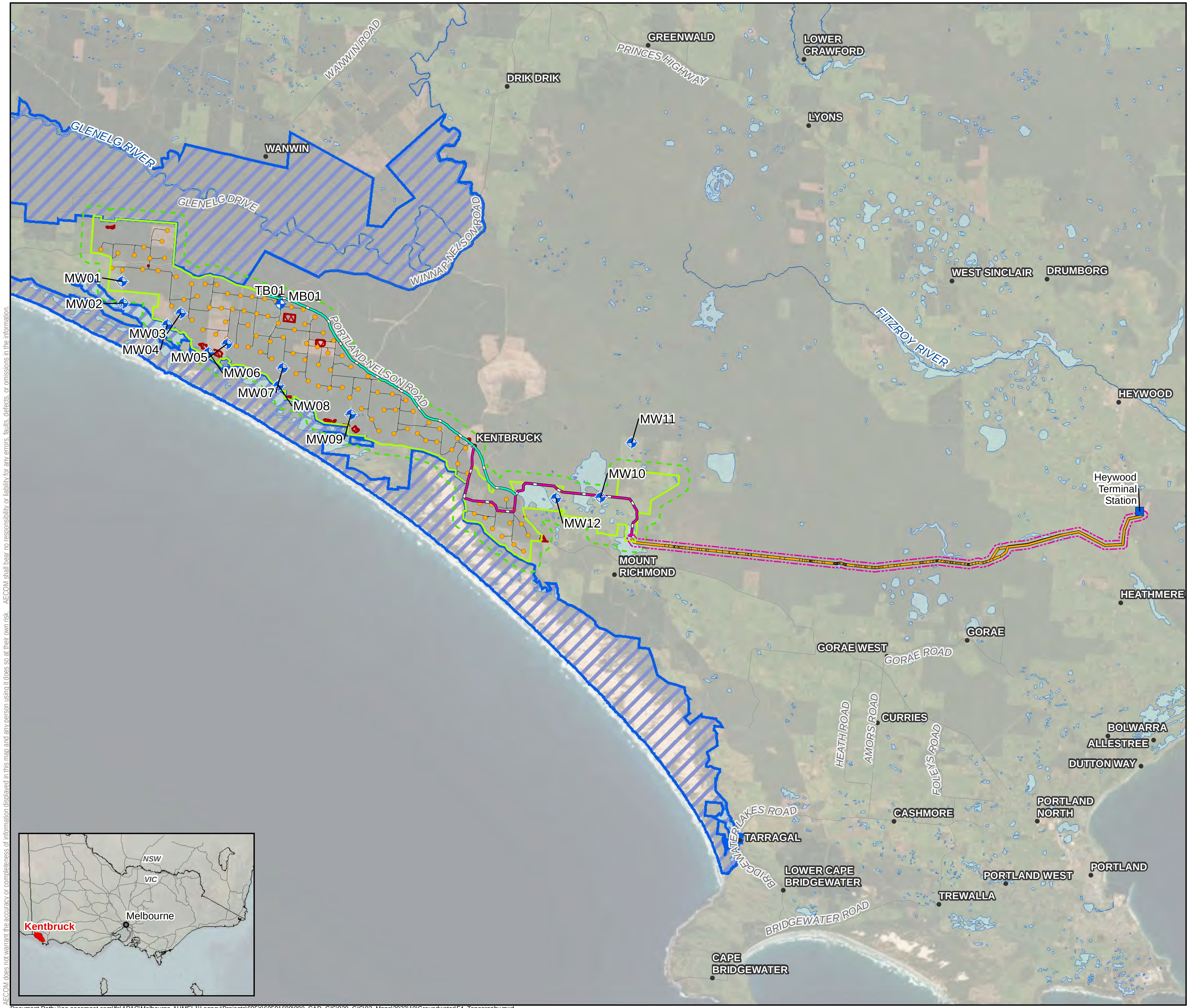

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 2.5 5
Kilometers

N

1:175,000 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Windfarm Boundary 500m -Buffer
- Work Exclusion Area
- RAMSAR Gleneg Estuary and Discovery Bay
- Town
- Roads
- Watercourse
- Waterbodies

Elevation (m)

- -33 - 0
- 0 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 50
- 50 - 60
- 60 - 80
- 80 - 100
- 100 - 120
- 120 - 140
- 140 - 160

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

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3. © Copyright Commonwealth of Australia (Geoscience Australia) 2016. The Commonwealth gives no warranty regarding the accuracy, completeness, currency or suitability for any particular purpose.

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

TOPOGRAPHY

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F4

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A3 size

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 2 4

Kilometers

1:107,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Indicative Wind Farm Boundary 500m - Buffer
- Work Exclusion Area
- Town
- Watercourses
- Roads

Geology

- Nh, Heytesbury Group
- Nxa, Whalers Bluff Formation
- Qa1, Unnamed alluvium
- Qdl1, Unnamed coastal dune deposits
- Qm1, Unnamed swamp and lake deposits
- Qn, Newer Volcanic Group
- Qns, Unnamed scoria deposits
- Qxr, Bridgewater Formation

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Disclaimer:

Groundwater Impact Assessment

Kentbruck Green Power Hub EES

SURFACE GEOLOGY

PROJECT #:	60591699
CREATED BY:	JB
LAST MODIFIED:	stutta: 14/11/2023
VERSION:	1

Figure F5a

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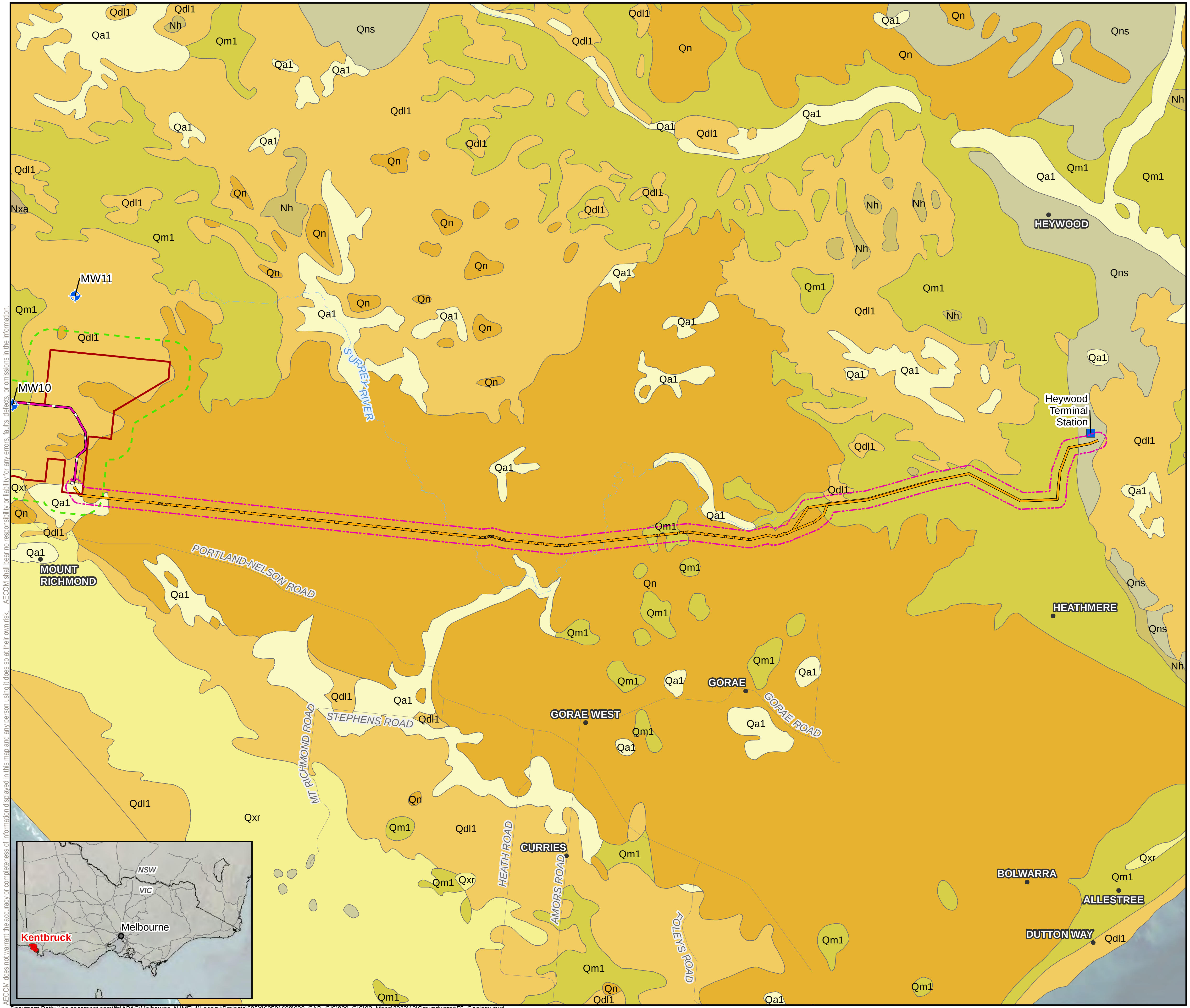

DATUM GDA94 VICGRID94

0 1.5 3 Kilometers

1:87,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Indicative Wind Farm Boundary 500m - Buffer
- Town
- Watercourses
- Roads

Geology

- Nh, Heytesbury Group
- Nxa, Whalers Bluff Formation
- Qa1, Unnamed alluvium
- Qdl1, Unnamed coastal dune deposits
- Qm1, Unnamed swamp and lake deposits
- Qn, Newer Volcanic Group
- Qns, Unnamed scoria deposits
- Qxr, Bridgewater Formation

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

SURFACE GEOLOGY

PROJECT #: 60591699
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F5b

A3 size

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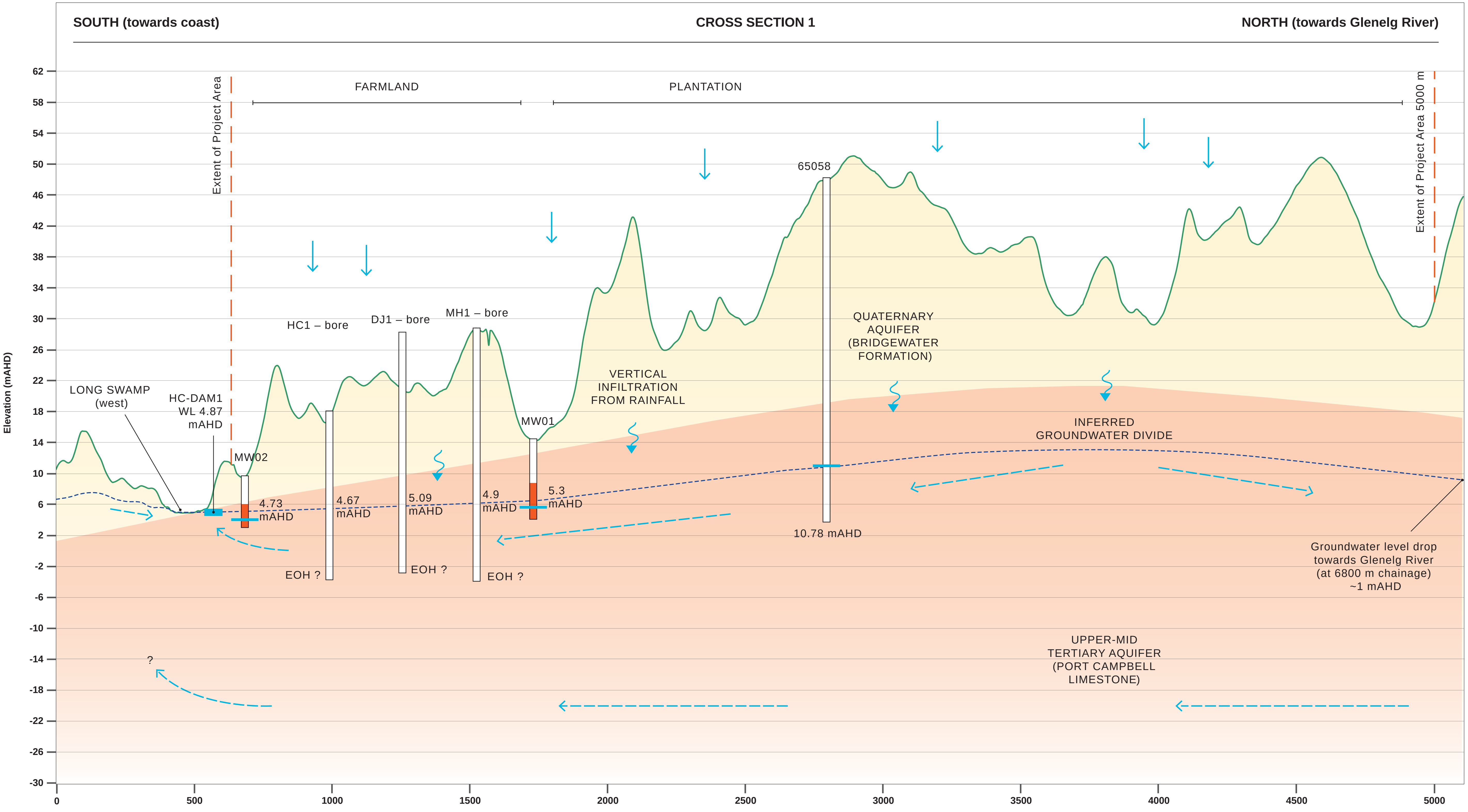


Not to scale

LEGEND

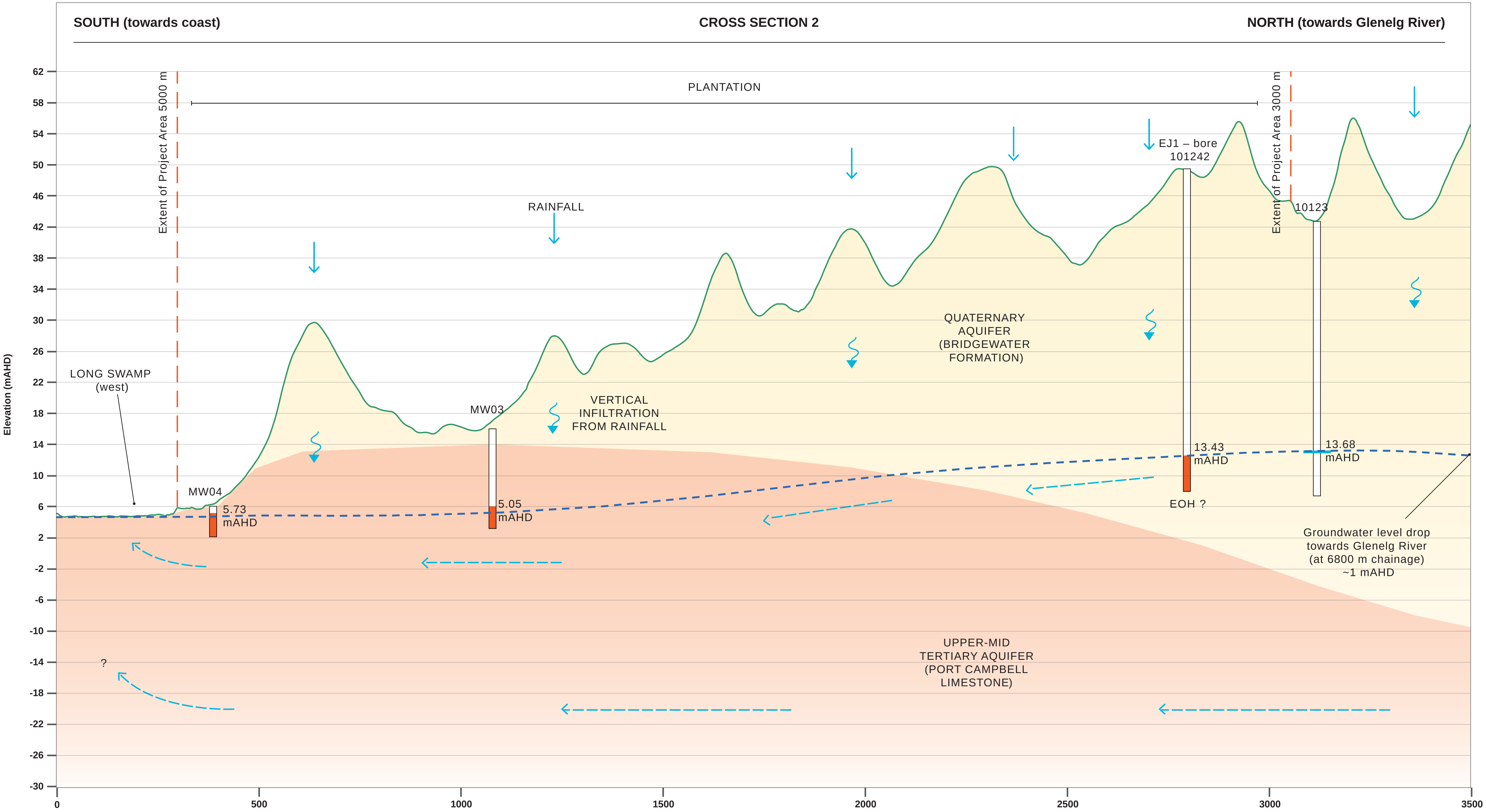
- Quaternary Aquifer
- Upper-Mid Tertiary Aquifer (Victorian Aquifer Framework)
- Inferred Water Table
- Dam Water Level
- Groundwater Bore
- Screen
- Rainfall
- Vertical Infiltration
- Inferred Groundwater Flow

EOH End of Hole

NOTE: Top of UMTA from Victorian Aquifer Framework data

27/07/2022 REV E

Figure F6a - Conceptual Hydrogeological Model



Not to scale

LEGEND

Quaternary Aquifer

Upper-Mid Tertiary Aquifer (Victorian Aquifer Framework)

Inferred Water Table

Groundwater Bore

Screen

Rainfall

Vertical Infiltration

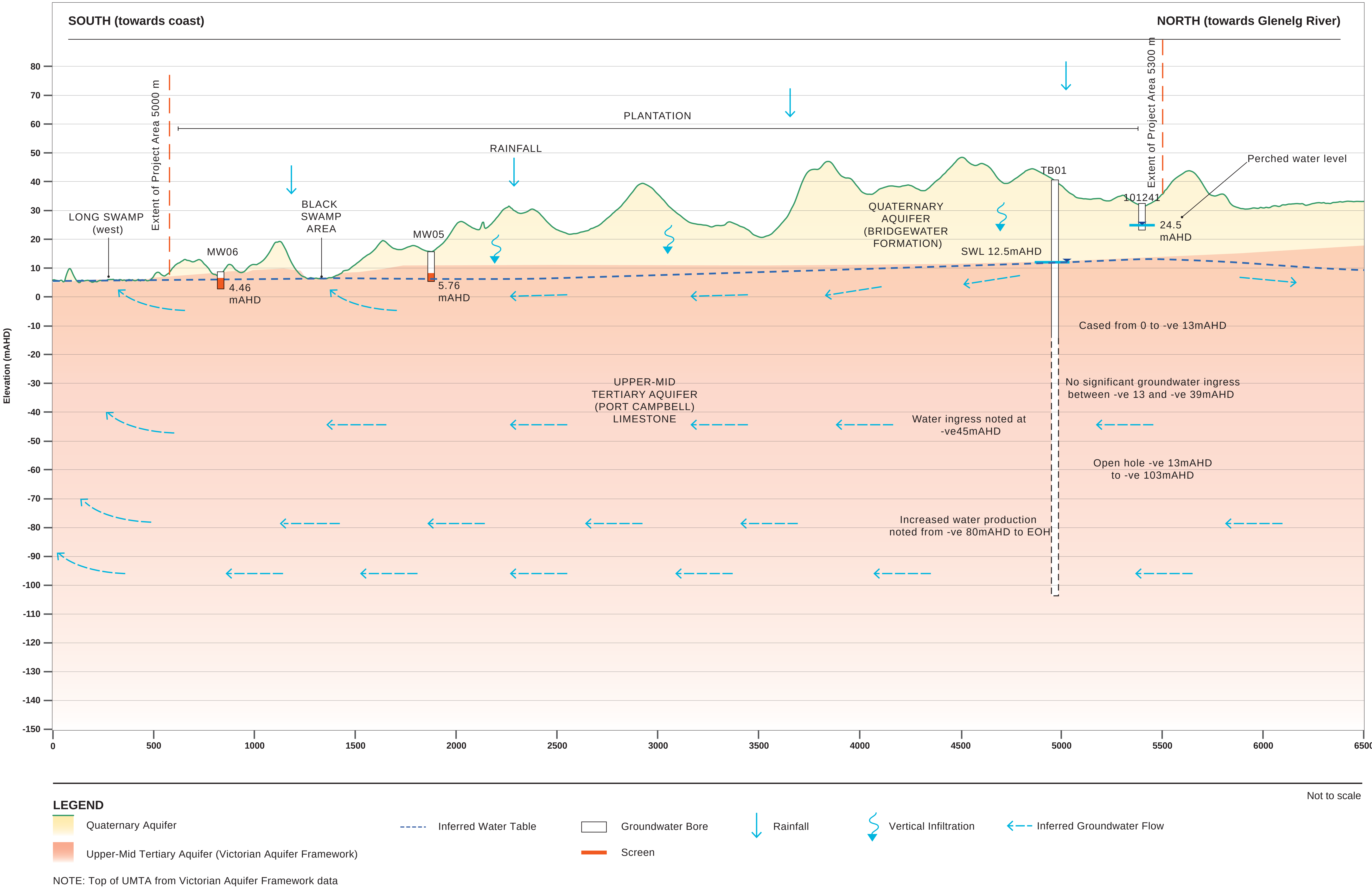
Inferred Groundwater Flow

NOTE: Top of UMTA from Victorian Aquifer Framework data

EOH End of Hole

27/07/2022 REV E

Figure F6b - Conceptual Hydrogeological Model



27/07/2022 REV E

Figure F6c - Conceptual Hydrogeological Model

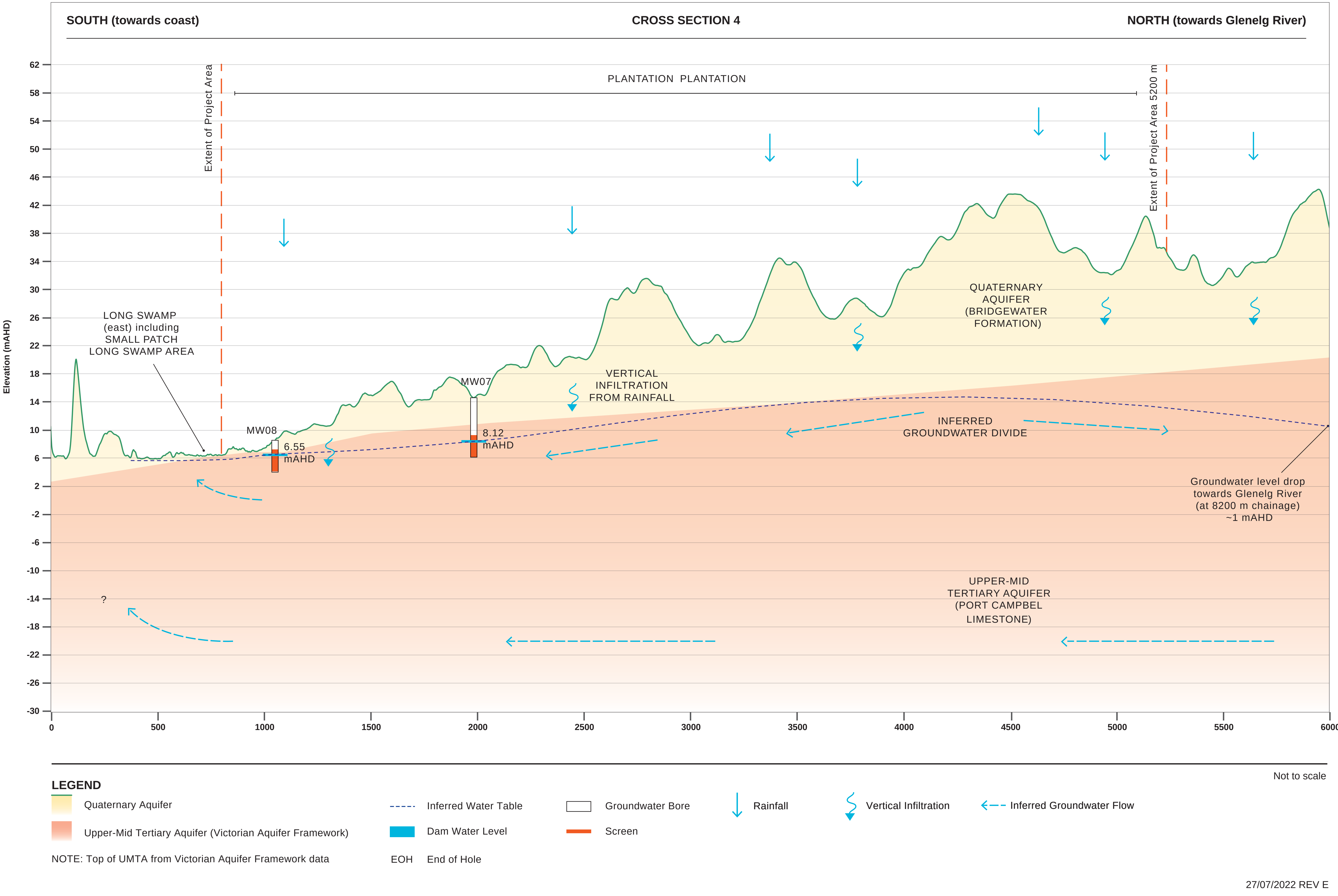
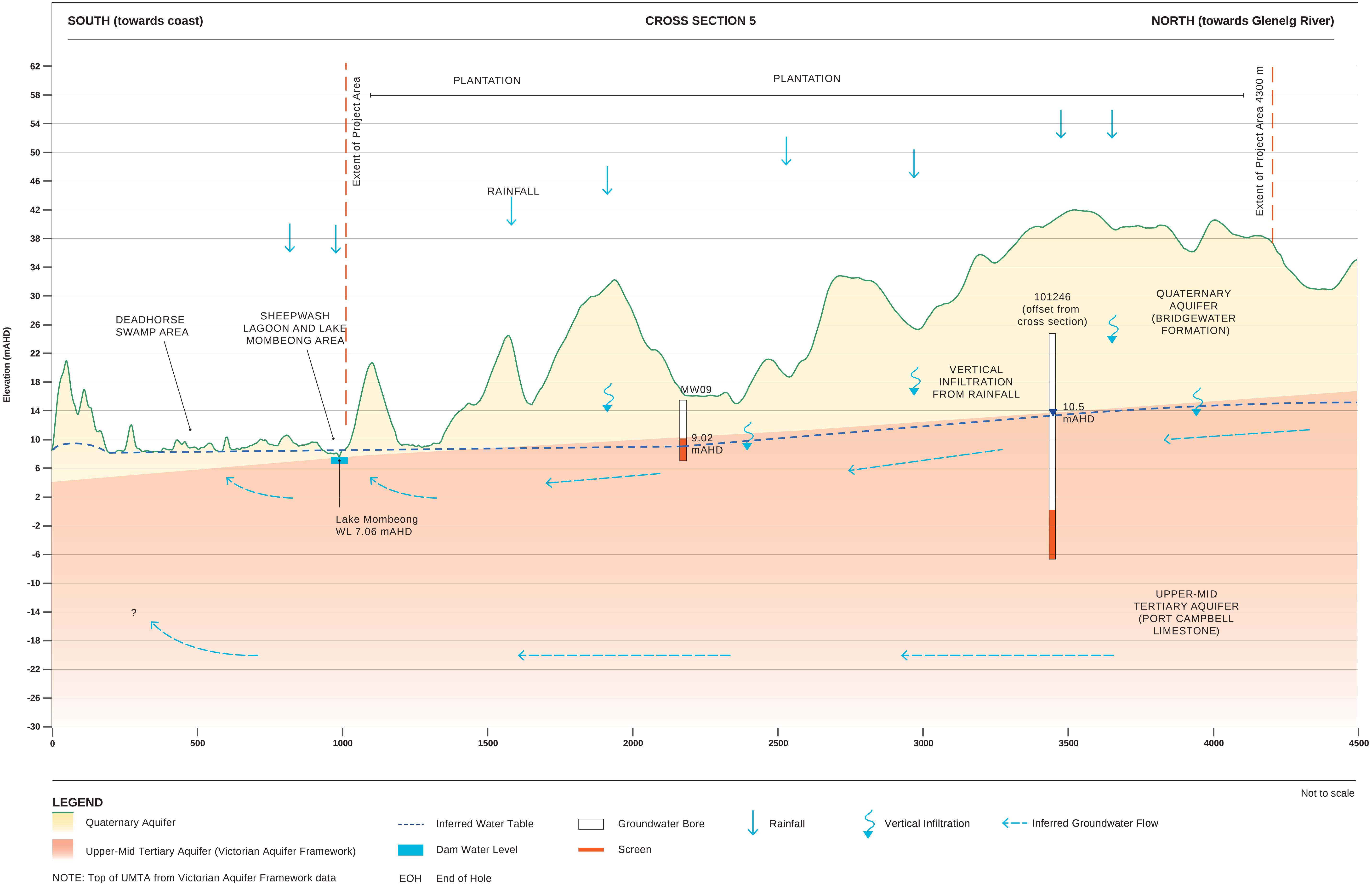


Figure F6d - Conceptual Hydrogeological Model

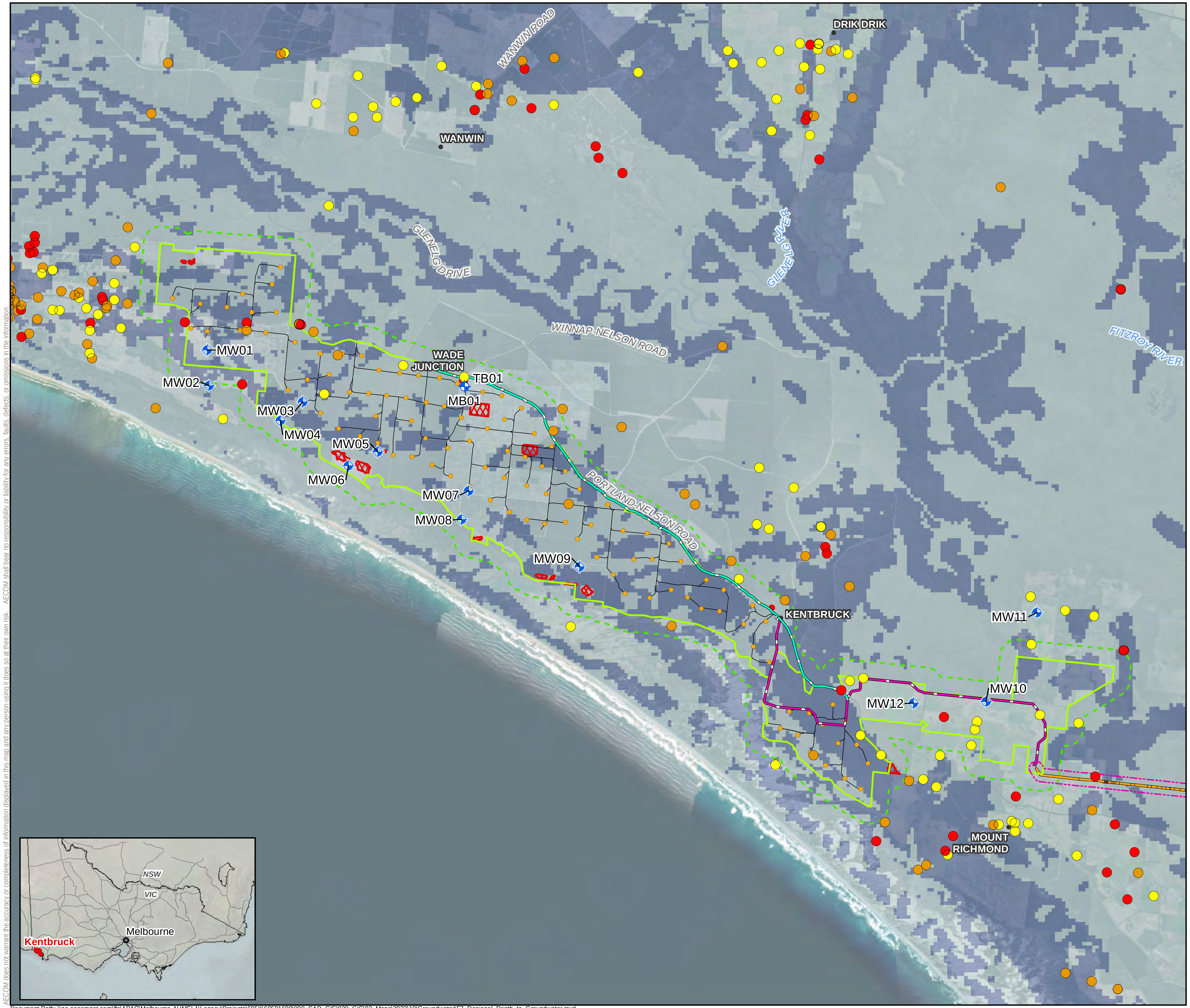


27/07/2022 REV E

Figure F6e - Conceptual Hydrogeological Model

Kentbruck Green Power Hub Project EES | Groundwater Impact Assessment

AECOM



DATUM GDA94 VICGRID94

0 2 4 Kilometers

1:107,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Windfarm Boundary 500m -Buffer
- Work Exclusion Area
- Town
- Roads
- Watercourses

Bore Depth (m)

- 0 - 20
- 21 - 50
- > 50

Depth to Groundwater (m bgs)

- 0 - 9.99
- > 10

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

REGIONAL DEPTH TO GROUNDWATER

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F7a

A3 size

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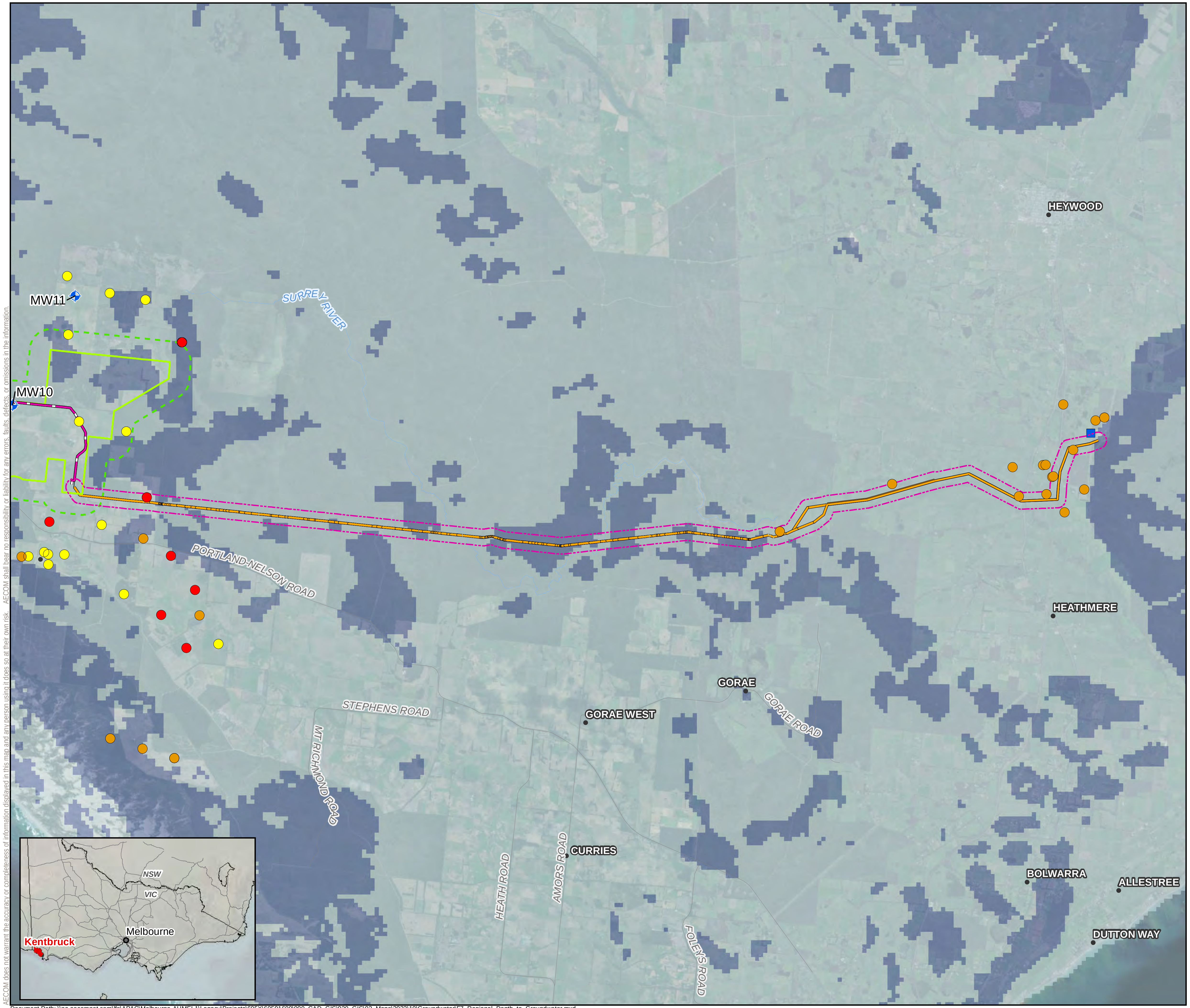

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3 Kilometers

1:87,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Windfarm Boundary 500m -Buffer
- Town
- Roads
- Watercourses

Bore Depth (m)

- 0 - 20
- 21 - 50
- > 50

Depth to Groundwater (m bgs)

- 0 - 9.99
- > 10

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

REGIONAL DEPTH TO GROUNDWATER

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 14/11/2023
VERSION: 1

Figure F7b

A3 size

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NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:120,000 (when printed at A3)

Legend

Locations

- Surface Water Locations
- AECOM Groundwater Monitoring Wells
- State Observation Bores
- Private Groundwater Bores
- Groundwater Bore
- Transmission Line - Underground
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Turbine location
- Internal access roads
- Town
- Roads
- Wind Farm Site Boundary
- Plantation Study Sub-area 500 m buffer
- Ramsar Gleneg Estuary and Discovery Bay
- Waterbodies

Proposed Infrastructure

- Crane Pad/Substation
- Potential Laydown

Depth to water below ground surface

- < 4 mbgs
- 4 - 6 mbgs
- > 6 mbgs

Groundwater Dependant Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

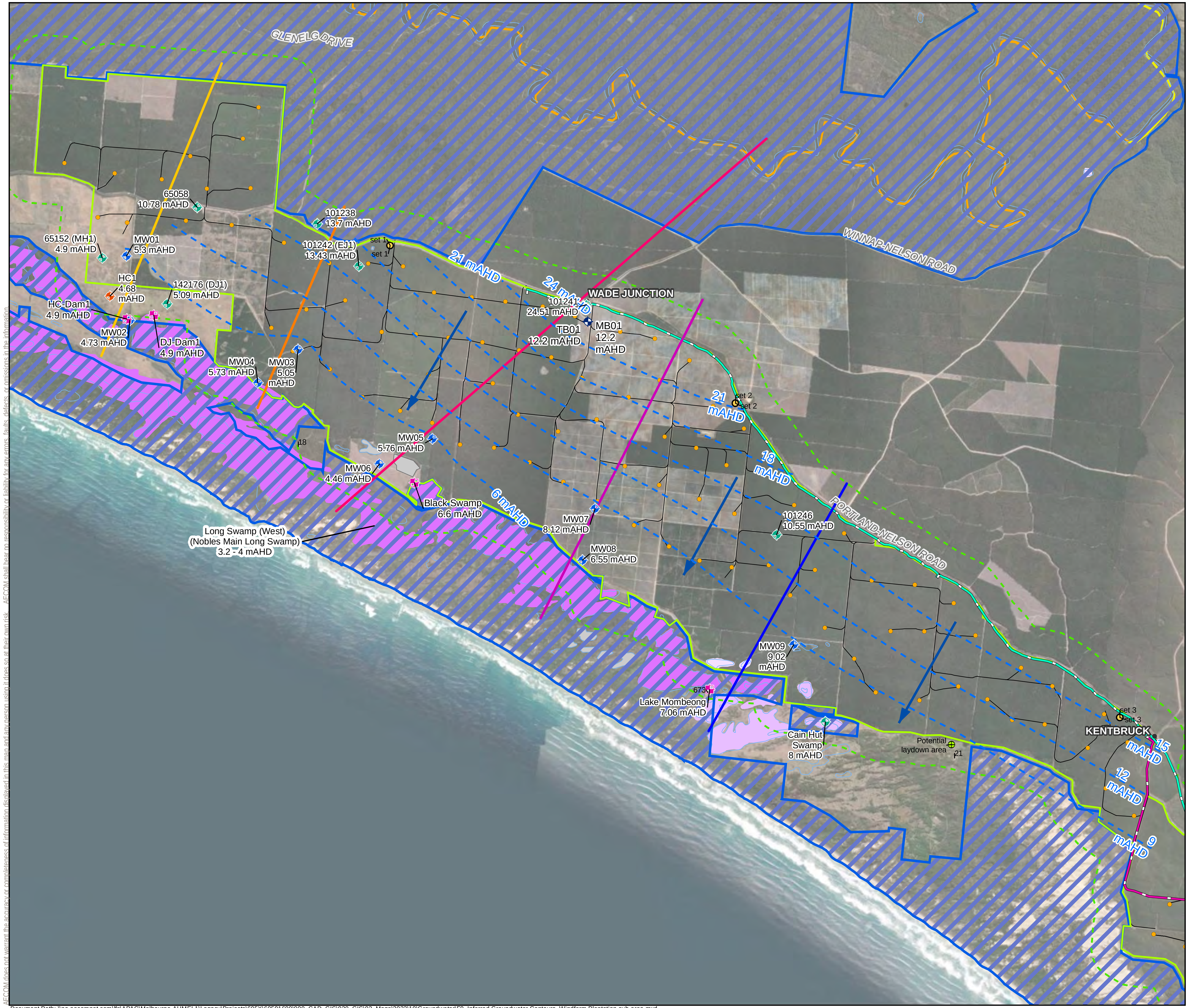
INFERRED DEPTHS TO GROUNDWATER
WINDFARM PLANTATION SUB-AREA

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: StuttA: 16/11/2023
VERSION: 1

Figure F8

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\10\Groundwater\F8_Inferred_Depths_to_Groundwater_Windfarm_Plantation_sub-area.mxd

A3 size



NEOEN
BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 0.95 1.9
Kilometers

1:60,000 (when printed at A3)

Legend

- Groundwater Bore

Locations

- AECOM Groundwater Monitoring Wells
- State Observation Bores
- Private Groundwater Bores
- Inferred Groundwater Contour (mAHD)
- Inferred Groundwater Flow Direction

Cross Section Transect Locations

- Cross Section 1
- Cross Section 2
- Cross Section 3b
- Cross Section 4
- Cross Section 5
- Town
- Roads

Proposed Infrastructure

- Crane Pad/Substation
- Potential Laydown
- Turbine location
- Internal access roads
- Wind Farm Site Boundary
- Plantation Study Sub-area 500 m buffer
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Ramsar Gleneg Estuary and Discovery Bay
- Waterbodies

Groundwater Dependant Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Low potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Note:
* - CDM Smith (2020) - surface water level data
State observation bore 101246 screened in underlying limestone and not considered representative of water table. Not used in inferred groundwater contours.

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
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Groundwater Impact Assessment
Kentbruck Green Power Hub EES

INFERRED GROUNDWATER CONTOURS
- WINDFARM PLANTATION SUB-AREA

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	McCartnb16/11/2023
VERSION:	1

Figure
F9

A3 size

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NEOEN Boundless Energy

AECOM

DATUM GDA94 VICGRID94

0 2 4 Kilometers

1:108,500 (when printed at A3)

Legend

- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Plantation Study Sub-area 500 m buffer
- Town
- Roads
- Watercourses

Bore Use - WMIS 18 June 2021

- DOMESTIC, STOCK, IRRIGATION, DAIRY
- STATE OBSERVATION NETWORK,GROUNDWATER INVESTIGATION,OBSERVATION,A... INDUSTRIES
- MISCELLANEOUS, UNKNOWN

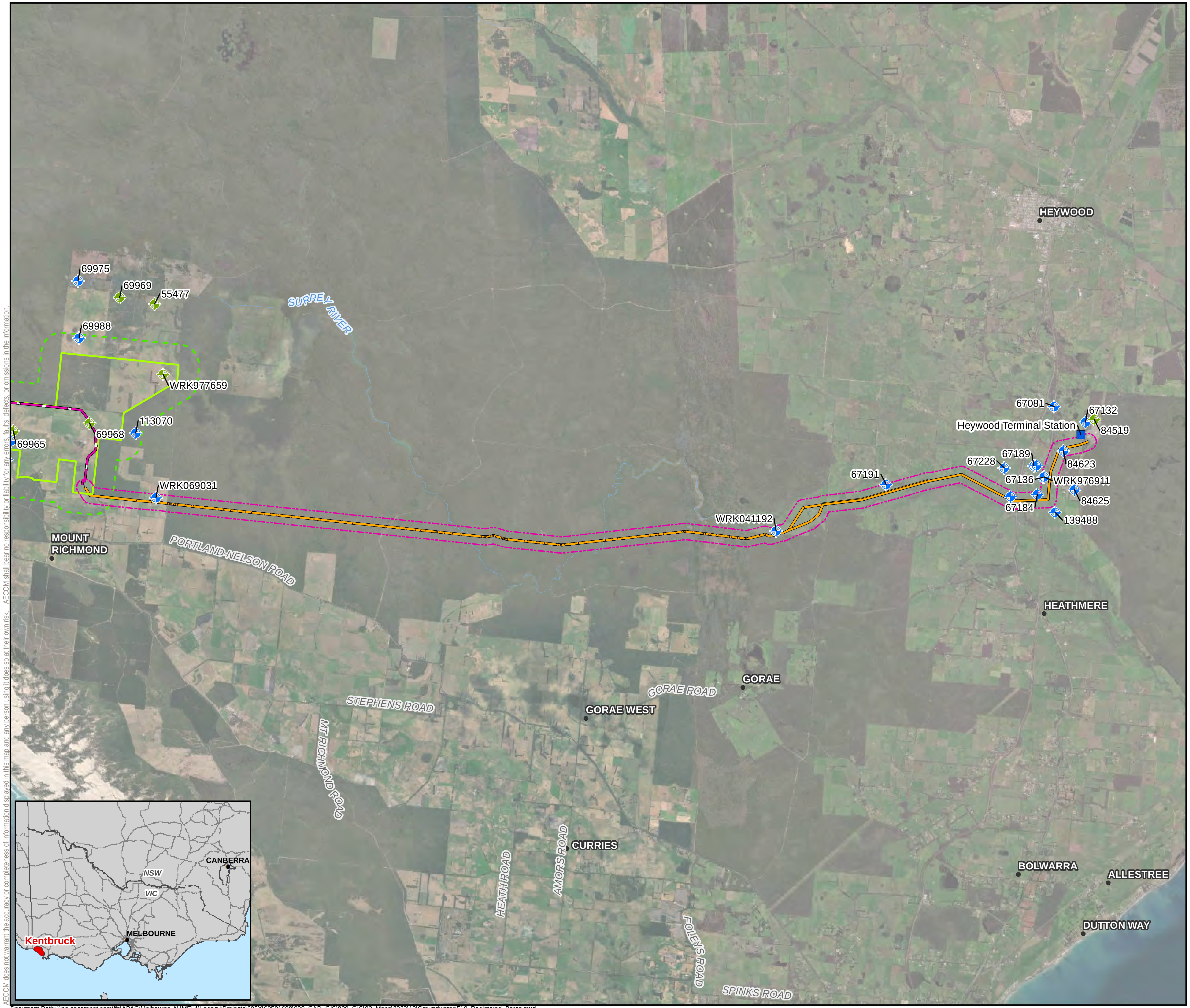
Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

REGISTERED GROUNDWATER BORE USERS

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	McMahonJ5: 12/10/2023
VERSION:	1

Figure F10a



NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:89,300 (when printed at A3)

Legend

- Existing Terminal Station
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Plantation Study Sub-area 500 m buffer
- Town
- Roads
- Watercourses

Bore Use - WMIS 18 June 2021

- DOMESTIC, STOCK, IRRIGATION, DAIRY
- MISCELLANEOUS, UNKNOWN

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

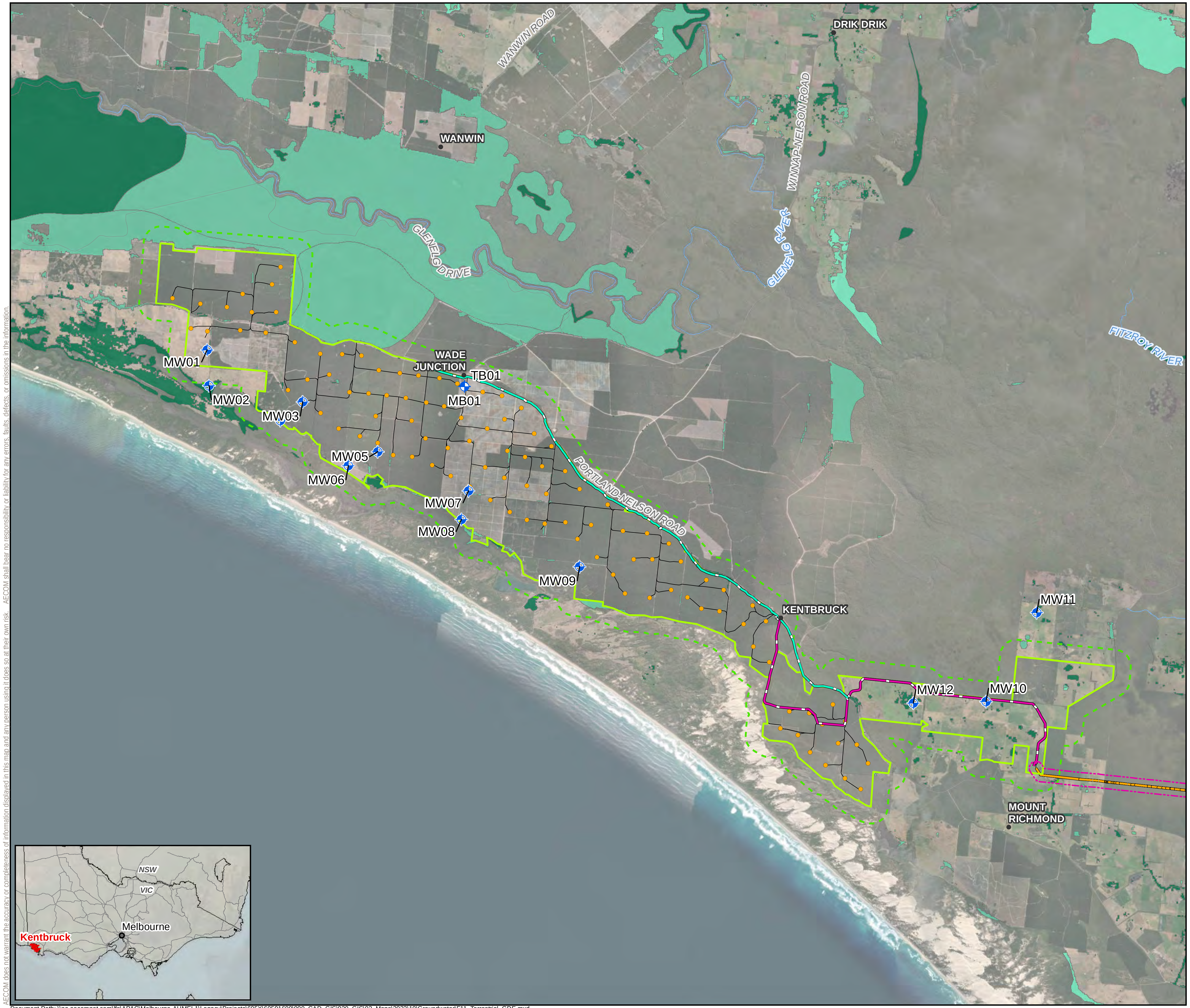
REGISTERED GROUNDWATER BORE USERS

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	McMahonJ5: 12/10/2023
VERSION:	1

Figure F10b

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\10\Groundwater\F10_Registered_Bores.mxd

A3 size



DATUM GDA94 VICGRID94

0 2 4 Kilometers

1:107,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Wind Farm Boundary 500m -Buffer
- Town
- Roads
- Watercourses

Groundwater Dependant Ecosystems - Terrestrial

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

POTENTIAL TERRESTRIAL GDES

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	stutta: 15/11/2023
VERSION:	1

Figure F11a

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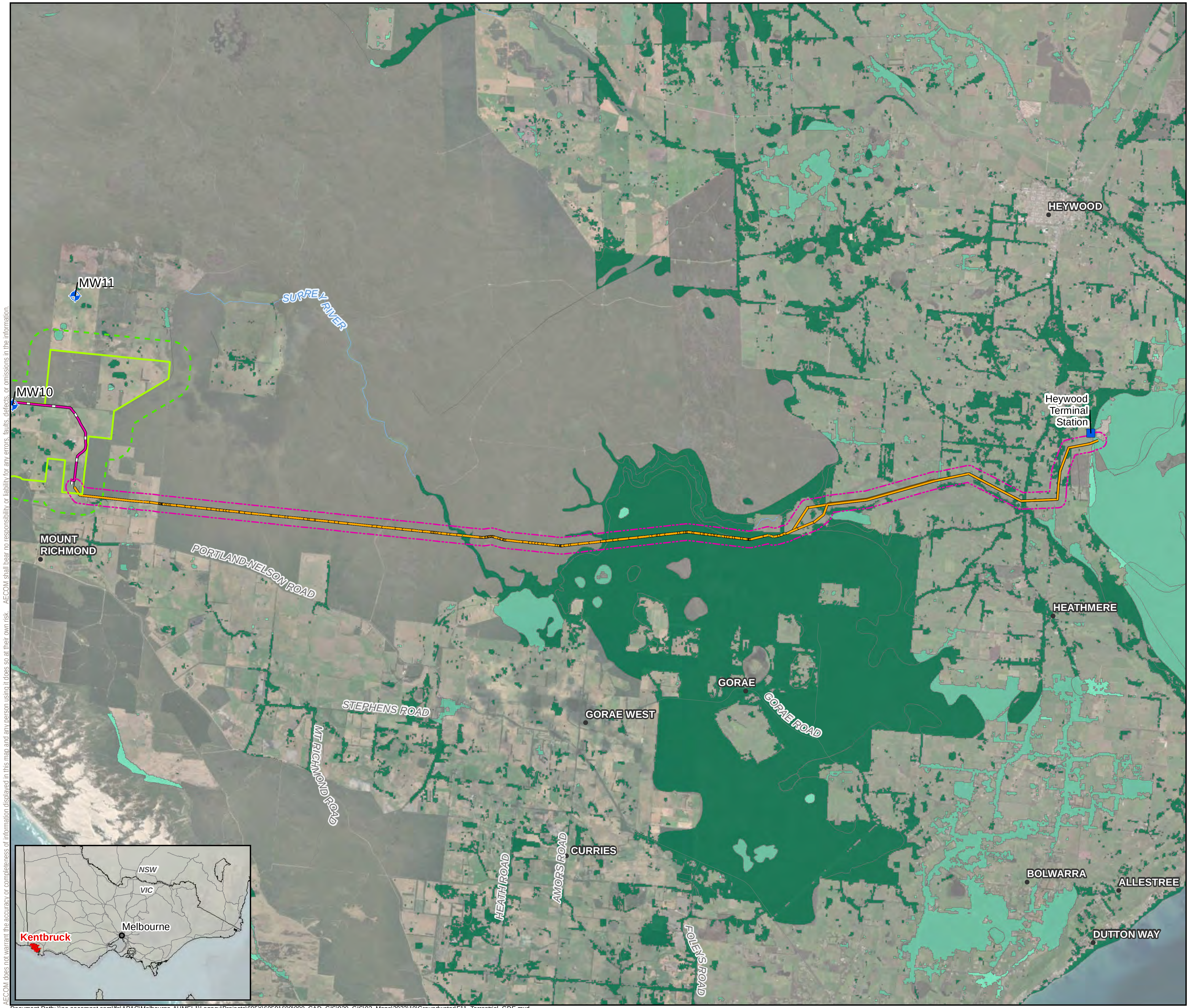
A3 size



NEOEN BOUNDLESS ENERGY | AECOM

DATUM GDA94 VICGRID94

0 1.5 3 Kilometers

1:87,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Wind Farm Boundary 500m -Buffer
- Town
- Roads
- Watercourses

Groundwater Dependant Ecosystems - Terrestrial

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

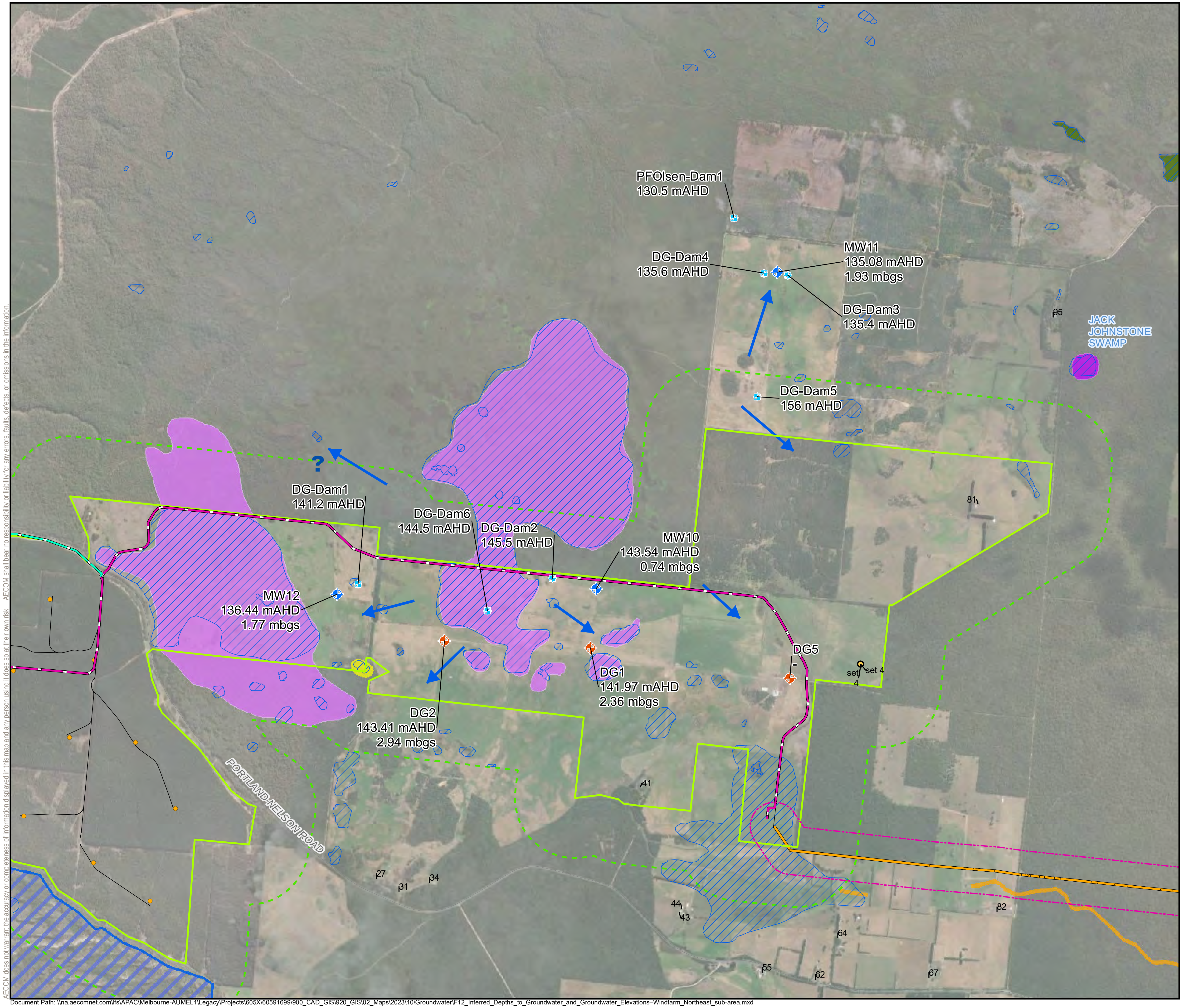
POTENTIAL TERRESTRIAL GDES

PROJECT #: 60578607
CREATED BY: JB
LAST MODIFIED: stutta: 15/11/2023
VERSION: 1

Figure F11b

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\10\Groundwater\F11_Terrestrial_GDE.mxd

A3 size



NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 0.45 0.9

Kilometers

1:30,000 (when printed at A3)

Legend

- AECOM Groundwater Monitoring Wells
- Private Groundwater Bores
- Surface Water Level (Dam)
- Crane Pad/Substation
- Turbine location
- Internal access roads
- Transmission Line (Underground)
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Inferred groumdwater flow direction
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Roads
- Ramsar Gleneg Estuary and Discovery Bay
- Wind Farm Boundary 500m -Buffer
- Waterbodies

Groundwater Dependant Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES

INFERRED DEPTHS TO GROUNDWATER AND GROUNDWATER ELEVATIONS WINDFARM NORTHEAST SUB-AREA

PROJECT #: 60591699
CREATED BY: JB
LAST MODIFIED: JM: 12/10/2023
VERSION: 1

Figure F12

A3 size

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\10\Groundwater\F12_Inferred_Depths_to_Groundwater_and_Groundwater_Elevations–Windfarm_Northeast_sub-area.mxd

Appendix B

Tables

Table B1. Well Construction and Development Record

Bore Construction Details												Bore Development										
Bore ID	Date Drilled	Easting	Northing	TOC (mAHD)	Ground Surface Elevation (mAHD)	Height relative to ground surface (m)	Drilling Method	Hole Diameter (mm)	Drilled Depth (mbgs)	Drilled Depth (mAHD)	Screen	Date Developed	SWL (mbtoc)	Volume Removed (L)	Temperature (ºC)	Dissolved Oxygen (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox Field (mV)	Total Dissolved Solids (TDS) 1 2	Redox Potential (Eh) 3	Comment
MW01	**15/04/21**	506928.18	5786944.96	13.78	12.94	0.84	Hollow Stem Auger	175	9.0	3.9	6 - 9 mbgs 50mm diameter uPVC	15/04/21	8.50	17	16.5	8.6	677	7.47	-100.0	440	112.7	Light brown, high turbidity, fine sand present (formation)
MW02	**15/04/21**	506942.27	5785878.86	9.84	9.07	0.77	Hollow Stem Auger	175	6.5	2.6	3.5 - 6.5 mbgs 50mm diameter uPVC	15/04/21	5.18	30	16.2	5.6	940	7.29	-407.0	611	-194.1	White, moderate turbidity
MW03	**15/04/21**	509703.07	5785281.13	12.68	12.78	-0.10	Solid Stem Auger	150	10.0	2.8	6 - 9 mbgs 50mm diameter uPVC	15/04/21	7.40	24	15.4	7.8	900	7.25	-242.0	585	-28.5	Light brown, high turbidity, fine sand present (formation)
MW04	**14/04/21**	509016.13	5784752.40	7.21	7.33	-0.12	Hollow Stem Auger	175	4.0	3.3	1 - 4 mbgs 50mm diameter uPVC	15/04/21	1.90	30	15.5	7.3	1332	7.21	-271.0	866	-57.6	Light brown, high turbidity, fine sand present (formation)
MW05	**14/04/21**	511868.24	5783703.69	13.13	13.24	-0.11	Hollow Stem Auger	175	10.0	3.2	7 - 10 mbgs 50mm diameter uPVC	14/04/21	7.40	35	16.5	7.6	936	7.21	-202.0	608	10.7	Light yellow, high turbidity
MW06	**14/04/21**	510974.27	5783327.65	7.39	7.48	-0.09	Hollow Stem Auger	175	5.0	2.5	2 - 5 mbgs 50mm diameter uPVC	14/04/21	3.00	30	16.8	3.8	1693	7.06	-219.0	1100	-6.5	Yellow-brown, high turbidity
MW07	**13/04/21**	514511.59	5782434.75	14.46	14.55	-0.09	Solid Stem Auger	150	10.0	4.5	5.5 - 8.5 mbgs 50mm diameter uPVC	13/04/21	6.60	18	15.3	8.9	2153	7.05	-28.5	1399	185.1	Light brown, high turbidity, fine sand present (formation), silt settling out
MW08	**13/04/21**	514269.44	5781591.18	8.24	8.33	-0.09	Hollow Stem Auger	175	4.0	4.3	1 - 4 mbgs 50mm diameter uPVC	13/04/21	2.09	25	17.0	3.3	1069	7.41	-32.0	695	180.3	Light yellow-brown, high turbidity, fine sand present (formation), silt settling out
MW09	**13/04/21**	517709.27	5780045.02	13.48	13.58	-0.10	Solid Stem Auger	150	7.0	6.6	3 - 6 mbgs 50mm diameter uPVC	13/04/21	4.40	21	15.7	6.8	1194	7.16	-113.3	776	100.0	Light brown, high turbidity, fine sand present (formation)
MW10	**12/04/21**	529605.66	5775533.02	145.03	144.28	0.75	Hollow Stem Auger	175	4.5	139.8	1.5 - 4.5 mbgs 50mm diameter uPVC	12/04/21	2.04	45	16.2	0.6	453	5.01	-117.9	294	95.0	Dark brown, high turbidity, no odour, fine sand present (formation)
MW11	**12/04/21**	531224.78	5778107.25	137.83	137.00	0.83	Hollow Stem Auger	175	6.0	131.0	3 - 6 mbgs 50mm diameter uPVC	12/04/21	2.83	50	15.6	2.04	420	5.30	-35	273	178.4	Dark brown, high turbidity, no odour, fine sand present (formation)
MW12	**16/04/21**	527445.28	5775579.30	138.81	138.21	0.60	Hollow Stem Auger	175	6.0	132.2	2.5 - 5.5 mbgs 50mm diameter uPVC	16/04/21	2.18	50	15.5	0.2	727	7.33	-830	473	-616.6	Dark brown, high turbidity, no odour, fine sand present (formation)
TB01	**7/02/22**	514521.94	5785544.67	41.58	41.11	0.47	Air and mud rotary	203	144.0	-102.9	54 - 144 mbgs 203mm openhole	7/02/22					660	8.25		429		Clear
MB01	**10/02/22**	514527.48	5785531.95	41.78	41.07	0.71	Air and mud rotary	150	132.0	-90.9	100 - 130 mbgs 50mm diameter uPVC	Not developed										

Notes
mAHD = metres above Australian Height Datum
mbgs = metres below ground surface
TOC = Top of Casing
mm = millimetres
* All wells constructed with 50 mm ND uPVC casing and screen
L = Litres
uS/cm = microsiemens per centimetre
mg/L = milligrams per litre
mV = millivolts
oC = degrees Celsius
(1) TDS = Total Dissolved Solids
(2) TDS approximated as Electrical Conductivity x 0.65
(3) Corrected Redox Potential = Field Redox Potential + (224.98 - 0.7443* Temperature) (Redox potential converted from Ag/AgCl electrode to H2 electrode)

Table B2. Groundwater Gauging: Shallow monitoring wells

Well ID	Top of Casing Elevation (mAHD)	Ground Surface Elevation (mAHD)	Height of casing (mbgs)	Installed Total Depth (mbgs)	Screened Interval (mbgs)	Date Gauged	Measured Total Depth (mbTOC)	Measured Total Depth (mbgs)	Measured Total Depth (mAHD)	Depth to Water (mbTOC)	Depth to Water (mbgs)	Groundwater Elevation (mAHD)
MW01	13.783	12.943	0.84	9.00	6 to 9	27/04/21	9.77	8.93	4.01	8.48	7.64	5.30
						4/10/21	9.75	8.91	4.03	8.37	7.53	5.41
						23/03/22	9.90	9.06	3.88	8.39	7.55	5.39
						7/06/22	NM	-	-	8.42	7.58	5.36
MW02	9.843	9.073	0.77	6.50	3.5 to 6.5	27/04/21	6.83	6.06	3.01	5.11	4.34	4.73
						4/10/21	6.78	6.01	3.06	4.94	4.17	4.90
						23/03/22	6.73	5.96	3.11	5.12	4.35	4.72
						7/06/22	NM	-	-	5.01	4.24	4.83
MW03	12.675	12.775	-0.10	9.00	6 to 9	27/04/21	8.80	8.90	3.88	7.03	7.13	5.65
						4/10/21	8.78	8.88	3.90	7.00	7.10	5.68
						23/03/22	8.78	8.88	3.90	7.10	7.20	5.58
						7/06/22	NM	-	-	7.12	7.22	5.56
MW04	7.213	7.333	-0.12	4.00	1 to 4	27/04/21	3.83	3.95	3.38	1.48	1.60	5.73
						4/10/21	3.82	3.94	3.39	1.41	1.53	5.80
						23/03/22	3.76	3.88	3.45	1.54	1.66	5.67
						7/06/22	NM	-	-	1.40	1.52	5.81
						1/05/23	NM	-	-	1.43	1.55	5.78
MW05	13.133	13.243	-0.11	10.00	7 to 10	27/04/21	9.44	9.55	3.69	7.37	7.48	5.76
						4/10/21	9.40	9.51	3.73	7.27	7.38	5.86
						23/03/22	9.36	9.47	3.77	7.41	7.52	5.72
						7/06/22	NM	-	-	7.41	7.52	5.73
						1/05/23	NM	-	-	7.40	7.51	5.73
MW06	7.386	7.476	-0.09	5.00	2 to 5	27/04/21	4.86	4.95	2.53	2.93	3.02	4.46
						4/10/21	4.84	4.93	2.55	2.74	2.83	4.65
						23/03/22	4.83	4.92	2.56	2.97	3.06	4.42
						7/06/22	NM	-	-	2.90	2.99	4.49
						1/05/23	NM	-	-	2.89	2.98	4.50
MW07	14.459	14.549	-0.09	8.50	5.5 to 8.5	27/04/21	7.76	7.85	6.70	6.34	6.43	8.12
						5/10/21	7.69	7.78	6.77	6.05	6.14	8.41
						23/03/22	3.62	3.71	10.84	6.07	6.16	8.39
						7/06/22	NM	-	-	6.16	6.25	8.30
						1/05/23	NM	-	-	5.94	6.03	8.52
MW08	8.241	8.331	-0.09	4.00	1 to 4	27/04/21	3.74	3.83	4.50	1.69	1.78	6.55
						5/10/21	3.67	3.76	4.57	1.55	1.64	6.69
						23/03/22	3.64	3.73	4.60	1.68	1.77	6.56
						7/06/22	NM	-	-	1.19	1.28	7.06
						1/05/23	NM	-	-	1.60	1.69	6.64
MW09	13.477	13.577	-0.10	6.00	3 to 6	27/04/21	5.88	5.98	7.60	4.46	4.56	9.02
						5/10/21	5.83	5.93	7.65	4.34	4.44	9.14
						23/03/22	5.69	5.79	7.79	4.43	4.53	9.05
						7/06/22	NM	-	-	4.46	4.56	9.02
MW10	145.029	144.279	0.75	4.50	1.5 to 4.5	26/04/21	5.16	4.41	139.87	1.49	0.74	143.54
						5/10/21	5.15	4.40	139.88	0.62	-0.13	144.41
						8/06/22	5.13	4.38	139.90	1.25	0.50	143.78
MW11	137.830	137.000	0.83	6.00	3 to 6	26/04/21	6.30	5.47	131.53	2.76	1.93	135.08
						5/10/21	6.31	5.48	131.52	1.11	0.28	136.72
						8/06/22	6.28	5.45	131.55	2.69	1.86	135.14
MW12	138.808	138.208	0.60	5.50	2.5 to 5.5	26/04/21	6.16	5.56	132.65	2.37	1.77	136.44
						5/10/21	6.15	5.55	132.66	1.10	0.50	137.71
						8/06/22	6.12	5.52	132.69	1.90	1.30	136.91

Notes
mAHD = metres above Australian Height Datum
mbgs = metres below ground surface
mbTOC = metres below Top of Casing
TOC = Top of Casing
L = Litres
Total measured depth of wells less than installation depth due to infiltration of fine sand through gravel pack and screen.
* - groundwater estimate based on water being below base of well
erroneous manual gauging result

Table B3. Groundwater Gauging: Registerd bores, TB01 and MB01

Well ID (Field)	Registered Bore ID	Easting	Northing	Top of Casing Elevation (mAHD)	Ground Surface Elevation (mAHD)	Height of casing (mbgs)	Drilled Total Depth (mbgs)	Screen interval (mbgs)	Base of well elevation - per construction info (mAHD)	Date Gauged	Measured Total Depth (mbTOC)	Base of well elevation - measured (mAHD)	Depth to Water (mbTOC)	Groundwater Elevation (mAHD)	Comments
DG1	-	529536.95	5775041.83	144.63	144.33	0.30	9.0	NK	135.63	26/04/21	12.00	132.630	2.66	141.97	Pump at bottom; pumping prior to dip
DG2	-	528323.62	5775151.40	146.35	145.95	0.40	6.5	NK	139.85	26/04/21	11.30	135.047	2.94	143.41	Stick up is the highest point on the farm
101241	**101241**	514514.56	5785818.42	35.88	35.30	0.58	11.2	NK	24.72	27/04/21	13.50	22.376	11.37	24.51	State Observation Bore network. Stick up; no cap
MH1	**65152**	506530.27	5786931.40	28.69	28.35	0.34	50.3	30.48 - 36.58	-21.59	27/04/21	-	-	23.79	4.90	Windmill bore; pump at bottom - bore not pumping
DJ1	**142176**	507572.01	5786125.32	28.07	27.95	0.12	54.0	42.0 - 54.0(?)	-25.93	27/04/21	-	-	22.98	5.09	Windmill bore; bore not pumping
HC1	**Not yet registered**	506630.01	5786292.29	30.30	30.12	0.18	4.0	NK	26.30	27/04/21	-	-	25.62	4.68	Bore under solar panel connected to water tank
EJ1	**101242**	510773.99	5786614.99	40.07	39.90	0.17	30.5	27.43 - 30.48	9.59	29/04/21		-	26.64	13.43	Windmill - not used; pump inside
65058	**65058^**	508134.20	5787701.90	52.88	51.70	1.18	53.7	12.0 - 47.7	-0.86	24/11/20	140.00	-87.124	42.12	11.90	State Observation Bore network - data from WMIS
101238	**101238**	510109.40	5787343.10	34.79	34.62	0.17	29.0	12.36 - 29.00	5.79	15/06/16^	29.17	5.620	21.09	13.70	State Observation Bore network - data from WMIS
101246	**101246**	517463.40	5781917.20	25.58	25.07	0.51	32.0	25.70 - 32.00	-6.42	15/06/16^	-	-	15.03	10.70	State Observation Bore network - data from WMIS
UK1	-	514492.42	5785787.76	36.90	36.80	0.10	NK	NK	-	22/03/22	21.97	15.510	11.09	25.81	Approx. 30m SW of SOB 101241. No database records.
TB01	**Not yet registered**	514521.94	5785544.67	41.58	41.11	0.47	144.0	54 - 144 (openhole)	-102.42	10/02/22		-	29.23	12.35	Neon water supply test bore
										22/03/22	-	-	29.13	12.45	
										23/03/22	-	-	29.34	7.57	
										1/05/23	-	-	29.33	12.25	
MB01	**Not yet registered**	514527.48	5785531.95	41.78	41.07	0.71	132.0	100 - 130	-90.22	10/02/22		-	28.87	12.91	Neon water supply monitoring bore
										22/03/22	130.97	-89.190	29.37	12.41	
										23/03/22		-	29.57	12.21	
										1/05/23		-	29.54	12.24	

Notes
mAHD = metres above Australian Height Datum
mbgs = metres below ground surface
mbTOC = metres below Top of Casing
TOC = Top of Casing
L = Litres
Total measured depth of wells less than installation depth due to infiltration of fine sand through gravel pack and screen. All groundwater bores constructed as per Australian standard bore construction requirements.
* - groundwater estimate based on water being below base of well
^ = Water level data electronically accessed from WMIS database. Not manually gauged on site

Table B4. Groundwater Sampling Stabilised Field Parameters

Bore ID	Date Sampled	Volume Removed (L)	Depth to Water (mbTOC)	Pump rate	Temperature (°C)	Dissolved Oxygen (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox Field (mV)	Total Dissolved Solids (TDS) [1 2]	Redox Potential (Eh) [3]	Comments
MW01	28/04/21	7.8	8.48	CPM3	16.2	5.46	1130	6.23	134.6	768	348	No odour, light brown, moderate turbidity; DO probe not reading due to sediment build up - cleaned YSI unit
MW02	28/04/21	7.8	5.11	CPM3	16.4	3.71	1142	6.33	12.9	777	226	No odour, white, moderate turbidity; DO probe not reading
MW03	28/08/21	11.1	7.07	CPM4	15.2	5.06	1047	5.96	155	712	369	No odour, light yellow-brown, low turbidity
MW04	28/04/21	6.0	1.49	CPM3	15.3	5.70	1352	7.32	24.7	919	238	No odour, light yellow-brown, moderate turbidity
MW05	28/04/21	8.9	7.37	CPM4	15.4	4.86	1118	6.23	114.2	760	328	No odour, light brown, clear
MW06	28/04/21	5.9	2.93	CPM3	17.0	4.98	1889	6.11	55.7	1285	268	No odour, orange-brown, moderate turbidity
MW07	29/04/21	6.8	6.34	CPM3	15.9	5.09	2586	6.2	117.9	1758	331	No odour, yellow-brown, low turibidity
MW08	29/04/21	5.9	1.70	CPM3	17.1	-	1490	6.41	-88.6	1013	124	Minor sulfur odour, yellow-brown, moderate turbidity; DO probe not reading
MW09	29/04/21	5.0	4.45	CPM3	15.1	6.07	1196	7.19	76.7	813	290	No odour, yellow-brown, low turbidity
MW10	29/04/21	5.0	1.50	CPM3	15.7	0.83	464	4.95	-143.5	315	70	Sulfur odour, dark brown, high turbidity; DO probe not reading so grab sample collected for DO
MW11	30/04/21	7.4	2.74	CPM3	15.5	0.04	452	4.23	149.6	307	363	No odour, dark brown, high turbidity
MW12	29/04/21	4.1	2.35	CPM3	16.1	-	817	4.67	-118.9	556	94	Strong sulfur odour, dark brown, high turbidity; DO probe not reading

Notes
(1) TDS = Total Dissolved Solids
(2) TDS approximated as Electrical Conductivity x 0.68
(3) Corrected Redox Potential = Field Redox Potential + (224.98 - 0.7443* Temperature) (Redox potential converted from Ag/AgCl electrode to H2 electrode)
L = Litres
uS/cm = microsiemens per centimetre
mg/L = milligrams per litre
mV = millivolts
oC = degrees Celsius
TOC = Top of Casing
"-" - not measured

Table B4. Surface Water Sampling Field Parameters

Bore ID	Easting	Northing	Water Level Elevation (mAHD)	Date Sampled	Temperature (ºC)	Dissolved Oxygen (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox Field (mV)	Total Dissolved Solids (TDS) [1 2]	Redox Potential (Eh) [3]	Comments
HC-Dam 1	506893.4	5785898.4	4.9	27/04/21	17.8	8.63	2,943	9.18	-13.7	2001	198	No odour, brown, moderate turbidity, minor suspended solids
DG-Dam 1	527624.2	5775655.2	141.2	27/04/21	-	-	-	-	-	-	-	Very small amount of water present. Water quality not measured
DG-Dam 2	529244.1	5775635.8	145.5	29/04/21	18.2	7.89	868	5.05	32.4	590	244	No odour, brown, high turbidity
DG-Dam 3	531311.6	5778078.0	135.4	30/04/21	14.1	-	691	6.7	86.1	470	301	No odour, clear, no turbidity
DG-Dam 4	531114.7	5778104.4	135.6	30/04/21	14.4	8.89	305	6.65	638	207	852	Slight organic odour, light brown-green, low turbidity
DG-Dam 5	531014.9	5777075.5	156.0	30/04/21	14.5	-	276	7.53	45.5	187	260	No odour, light brown, low turbidity
DG-Dam 6	528691.6	5775385.8	144.5	30/04/21	16.8	8.44	521	4.33	130.6	354	343	No odour, brown, high turbidity
DJ-Dam 1	507342.1	5785948.1	4.9	27/04/21	18.1	30.25	2,023	10.38	-12.3	1376	199	Manure odour, green, moderate turbidity, minor green algae
PFOlsen-Dam 1	530884.6	5778574.8	130.5	30/04/21	18.6	-	499	6.32	59.3	339	270	No odour, clear, no turbidity
Lake Mombeong	510421.5	5783795.1	7.057	29/04/21	-	-	-	-	-	-	-	Wharf ground surface surveyed. Level reduced by 0.54 m measured depth to water below wharf surface
Black Swamp	511540.4	5782990.1	6.649	28/04/21	-	-	-	-	-	-	-	Ground surface at edge of black swamp - not exact water level - vegetation very dense

Notes
(1) TDS = Total Dissolved Solids
(2) TDS approximated as Electrical Conductivity x 0.68
(3) Corrected Redox Potential = Field Redox Potential + (224.98 - 0.7443* Temperature) (Redox potential converted from Ag/AgCl electrode to H_2 electrode)
L = Litres
uS/cm = microsiemens per centimetre
mg/L = milligrams per litre
mV = millivolts
oC = degrees Celsius
TOC = Top of Casing
"-" - not measured due to dissolved oxygen probe not reading on 30/04/2021

Appendix C

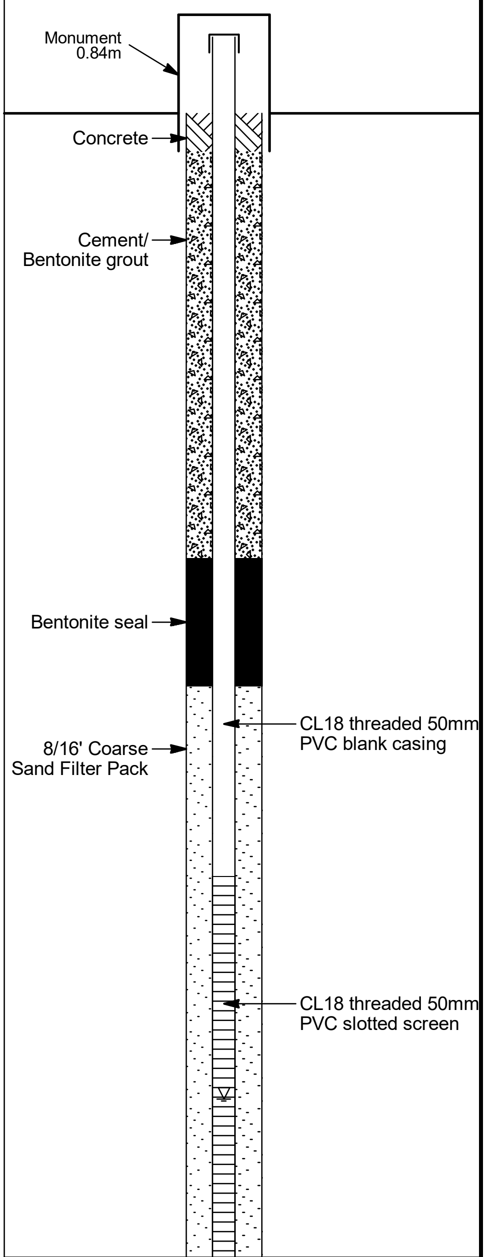
Borelogs (MW01 – MW12)

MONITORING WELL MW01

Drilling Contractor:	South Western Drilling	Project Name:	Kentbruck Green Power Hub Project
Logged By:	BM	Client:	Neoen
Checked By:	MW	Location:	Nelson, Victoria
Date Started:	15/04/2021	Project No:	60591699
Date Finished:	15/04/2021	Top of Casing:	13.78 mAHD
Bore Size:	175 mm	Coordinates:	506928.00 mE 5786945.00 mN
Total Depth:	9.00 m	Permit No:	WRK125931
Casing Size:	50 mm	Drill Type:	PT/SSA/HSA
		Drill Model:	Geoprobe 7822DT
		Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required		SW	SAND; fine grained, dark brown, loose minor rootlets	D	0
Hand Auger				SM	Silty SAND; fine grained, dark brown, weakly cemented	D	1
Push Tube/Solid Stem/Hollow Stem Auger				SP	SAND; light yellow-brown, fine grained, not cemented, fine to coarse grained sand with shell fragments At 2.0 mbgs becomes light yellow-white	D	2
				SM	Sandy SILT; grey brown, dense, firm, fine grained sand	D	
				SP	SAND; fine grained, light yellow-white, minor orange mottling, moderately cemented, calcareous sand as layer of limestone	M	3
				SP	SAND; very fine to fine grained sand, light yellow-white, weakly cemented, calcareous At 3.5m a 0.1m sandy limestone layer	M	
				SM	Sandy SILT; dark brown, grades to light brown, moist, fine grained sand	M	4
				SP	SAND; very fine to fine grained sand, light yellow-white, moderately cemented sand with alternating layers of limestone, moist	M	5
					Becomes coarse grained sands		6
					Becomes wet	W	7
							8
					End of hole at 9 m bgs. Target depth achieved - water observed at 7 mbgs.		9
							10

WELL CONSTRUCTION DETAILS



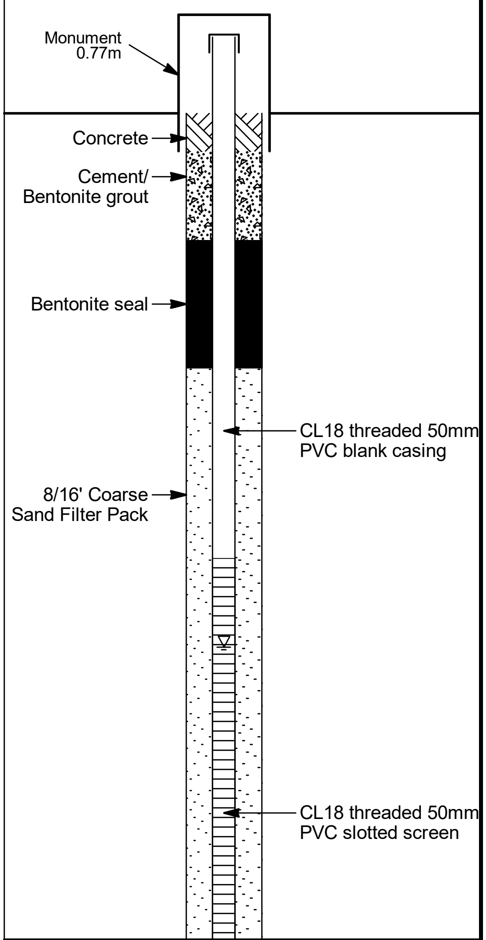
Remarks: Depth to water measured at 7.0 m bgs prior to casing installation on 15/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

MONITORING WELL MW02

Drilling Contractor:	South Western Drilling			Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
				Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	175 mm	Top of Casing:	9.84 mAHD	Drill Type:	PT/SSA/HSA
Checked By:	MW	Total Depth:	6.50 m	Coordinates:	506942.00 mE 5785879.00 mN	Drill Model:	Geoprobe 7822DT
Date Started:	15/04/2021	Casing Size:	50 mm				
Date Finished:	15/04/2021			Permit No:	WRK125856	Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required		SP	SAND; fine grained, dark brown, some silt, roots, dry, loose At 0.3 mbgs becomes light brown	D	0
				SP	SAND; very fine to fine grained, white, calcareous sand well cemented as limestone	D	1
Push Tube/ Hollow Stem Auger				SP	SAND; fine grained, lightly grey-brown, dry, loose, not cemented, minor limestone with subangular-subrounded clasts, trace roots	D	
					At 2.1 mbgs becomes white-brown, fine to medium grained, coarse grained sand with shell fragments	D	2
					Becomes yellow	D	4
					Becomes wet, light yellow to white, weakly cemented	W	
					Some subangular-subrounded fine to coarse grained limestone gravels	W	5
HSA							6
					End of hole at 6.5 m bgs. Target depth achieved - water observed at 4.2 m bgs.		6.5

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 4.2 m bgs prior to casing installation on 15/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

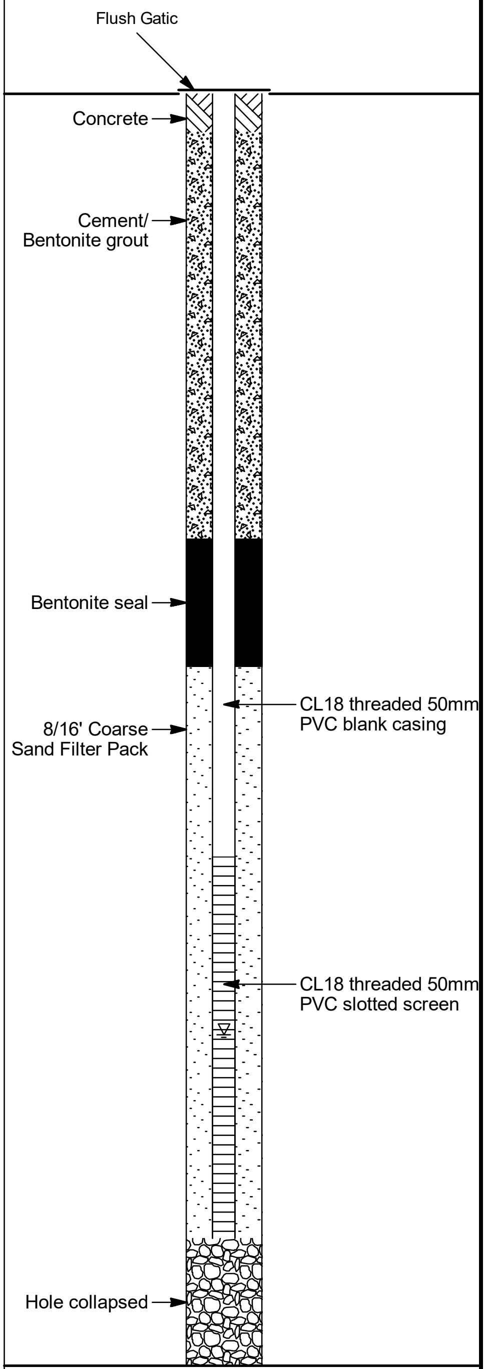
AECOM

MONITORING WELL MW03

Drilling Contractor:	South Western Drilling			Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
				Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	150 mm	Top of Casing:	12.68 mAHD	Drill Type:	PT/SSA/HSA
Checked By:	MW	Total Depth:	10.00 m	Coordinates:	509703.00 mE	Drill Model:	Geoprobe 7822DT
Date Started:	15/04/2021	Casing Size:	50 mm		5785281.00 mN		
Date Finished:	15/04/2021			Permit No:	WRK125850	Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required			SAND; fine grained, dark brown, minor subrounded fine gravels with organic black wood chips from 0.34 - 0.4 mbgs, some silt At 0.4 mbgs becomes light grey	D	0
				SP	SAND; fine grained, red brown, dry, loose, minor organic matter (wood)	D	
							1
Push Tube/Solid Stem/Hollow Stem Auger					Becomes fine to coarse grained sand, some shell fragments At 1.8 mbgs grades to light brown with trace black wood chips		
							2
					Becomes dry to moist	D/M	
							3
							4
					Becomes moist	M	5
				SW	At 6.0 mbgs becomes wet and fine to coarse grained sand	W	6
							7
							8
							9
					End of hole at 10 mbgs. Target depth achieved.		10

WELL CONSTRUCTION DETAILS



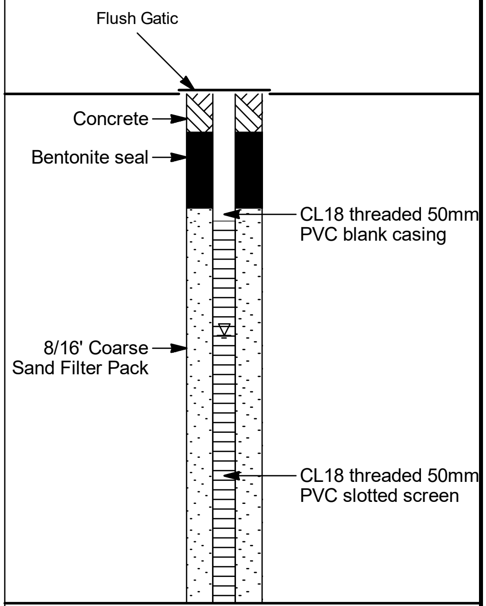
Remarks: Depth to water measured at 9.0 m bgs prior to casing installation on 15/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

MONITORING WELL MW04

Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
Drilling Contractor:	South Western Drilling	Location:	Nelson, Victoria
Project No:	60591699		
Logged By:	BM	Bore Size:	175 mm
Checked By:	MW	Total Depth:	4.00 m
Date Started:	14/04/2021	Casing Size:	50 mm
Date Finished:	14/04/2021		
Top of Casing:	7.21 mAHD	Drill Type:	PT/SSA/HSA
Coordinates:	509016.00 mE 5784752.00 mN	Drill Model:	Geoprobe 7822DT
Permit No:	WRK125849	Drill Fluid:	None

Drill Method	Sample Interval	PID (ppm)	Sample ID	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger			Samples not required	SP	SAND; fine grained, dark grey, loose, dry, some roots and bark At 0.2 mbgs becoming light grey with some coarse quartz grains	D D	0
Hand Auger				SC	Sandy CLAY; low plasticity, brown, hard, friable, dry From 0.6 m bgs increase in calcareous limestone grains up to 10 mm, fine to medium grained gravels	D M W	1
Hand Auger				SC	Becomes light brown mottled black (organic matter)	W	
Push Tube/ Hollow Stem Auger				SP	Clayey SAND; fine to medium grained sand, brown, weakly cemented with some limestone gravels At 1.4 mbgs 0.1m sandy limestone layer, well cemented SAND; fine grained, light yellow, moderately cemented; some white limestone subangular-angular fine to coarse gravel, wet	W	2, 3
					End of hole at 4 m bgs. Target depth achieved - water observed at 1.5 m bgs.		4

WELL CONSTRUCTION DETAILS



Depth (m): 0 1 2 3 4 5 6 7 8 9 10

Remarks: Depth to water measured at 1.5 m bgs prior to casing installation on 14/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

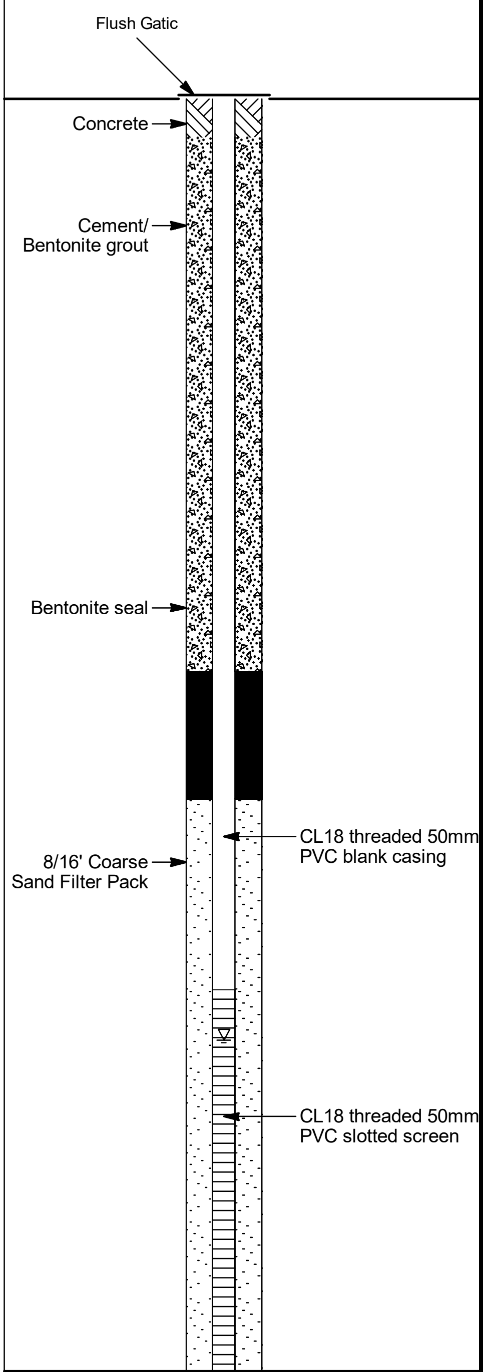
AECOM

MONITORING WELL MW05

Drilling Contractor:	South Western Drilling	Project Name:	Kentbruck Green Power Hub Project
Client:	Neoen	Location:	Nelson, Victoria
Project No:	60591699		
Logged By:	BM	Bore Size:	175 mm
Checked By:	MW	Total Depth:	10.00 m
Date Started:	14/04/2021	Casing Size:	50 mm
Date Finished:	14/04/2021		
Top of Casing:	13.13 mAHD	Drill Type:	PT/SSA/HSA
Coordinates:	511868.00 mE 5783704.00 mN	Drill Model:	Geoprobe 7822DT
Permit No:	WRK125852	Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required			SAND; fine to medium, dark brown, dense with trace rootlets	D	0
					At 0.4 mbgs becomes light red-brown, with some bark and black wood chips	D/M	
					Clayey SAND; fine to medium grained, orange-brown, moderately cemented, trace shell fragments	D/M D	1
					SAND; very fine to fine grained, light yellow-white, well cemented, some limestone bands, dry		
Push Tube/SSA/HSA					CLAY; high plasticity, brown, some roots and subangular-angular limestone clasts up to 20 mm	D	2
					Clayey SAND; red-brown, fine to medium grained, dry, weakly cemented, subangular-angular limestone clasts up to 20 mm	D/M M	
					SAND; very fine to fine grained, light yellow-white, dry, weakly cemented, calcareous sand with some limestone bands	M	3
					Becoming light yellow		
Solid Stem Auger/Hollow Stem Auger					Becoming dry/moist	D/M	4
					Becoming moist	M	5
							6
							7
							8
					Becoming fine to medium grained, yellow-white and wet	W	9
					End of hole at 10 m bgs. Target depth achieved.		10

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 7.4 m bgs prior to casing installation on 14/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

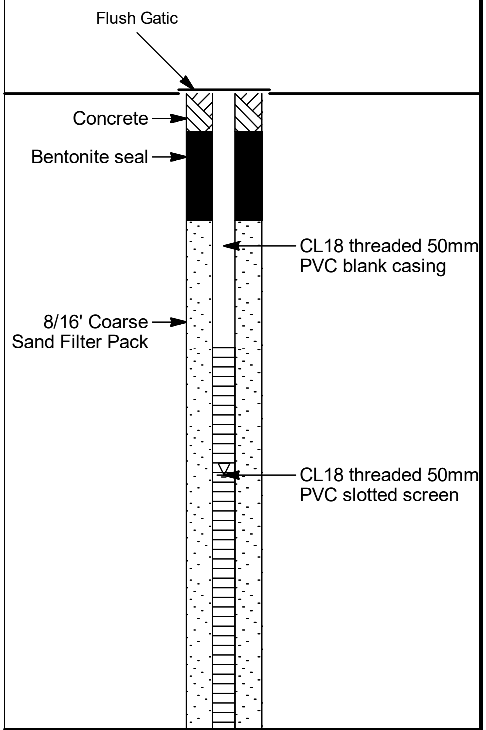
AECOM

MONITORING WELL MW06

Drilling Contractor:	South Western Drilling			Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
				Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	175 mm	Top of Casing:	7.39 mAHD	Drill Type:	PT/SSA/HSA
Checked By:	MW	Total Depth:	5.00 m	Coordinates:	510974.00 mE 5783328.00 mN	Drill Model:	Geoprobe 7822DT
Date Started:	14/04/2021	Casing Size:	50 mm				
Date Finished:	14/04/2021			Permit No:	WRK125851	Drill Fluid:	None

Drill Method	Sample Interval	PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger			Samples not required		SP	SAND; fine grained, black, dry, loose, some rootlets	D	0
						At 0.3 mbgs grades to light grey	D	
						At 0.6 mbgs grades to light brown, no rootlets, black wood chips	D	1
						At 1.4 mbgs becomes iron stained	D/M	
Push Tube/Solid Stem Auger/Hollow Stem Auger					SM	Silty SAND; fine grained, dark brown, dry, loose. Sharp contact with orange sand, minor roots	W	
					SP	SAND; fine to medium grained, yellow brown, dry to moist, well sorted, with some wood and rootlets, minor orange mottling		2
						Becoming wet		
					SM	Silty SAND; fine grained, light yellow brown		3
					SP	SAND; fine to medium grained, light brown, well sorted, wet, loose, some white shell fragments up to 5 mm	W	4
					SM	Sandy SILT; grey-brown, soft, wet	W	
						SAND; fine to coarse grained, orange-brown, weakly cemented, calcareous, large limestone clasts subrounded to subangular up to 30mm	W	5
						End of hole at 5 m bgs. Target depth achieved - water observed from 2.7 m bgs		
								6
								7
								8
								9
								10

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 2.9 m bgs prior to casing installation on 14/4/2021
Push tube to 4.8 m before refusal
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

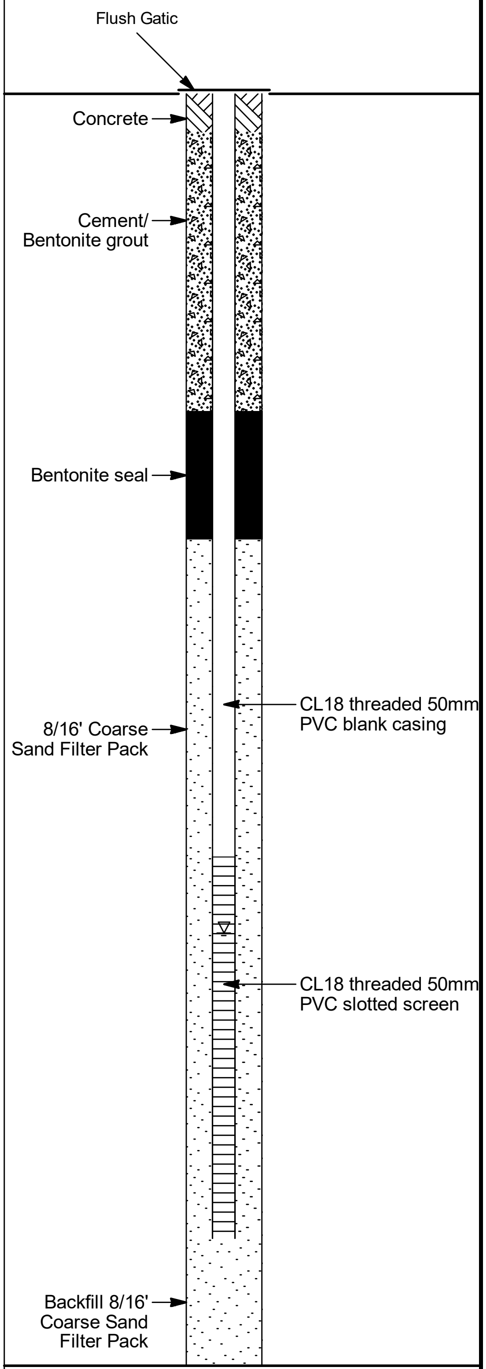
AECOM

MONITORING WELL MW07

Drilling Contractor:	South Western Drilling	Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
		Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	150 mm	Top of Casing:	14.46 mAHD
Checked By:	MW	Total Depth:	10.00 m	Coordinates:	514512.00 mE 5782435.00 mN
Date Started:	13/04/2021	Casing Size:	50 mm	Drill Type:	PT/SSA/HSA
Date Finished:	13/04/2021	Permit No:	WRK125855	Drill Model:	Geoprobe 7822DT
				Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger/Push tube		Samples not required		SP	SAND; medium to fine grained, dark brown, loose, poorly sorted, weakly cemented	D/M	0
				SP	SAND; fine grained, light yellow-white, moderately cemented with major limestone calcareous clasts and layers, dry	D	
							1
					Trace dark brown rootlets	D	
Solid Stem Auger					At 1.9 well cemented bands of limetstone for 0.4 m	D	2
					Becomes weakly cemented, fine to medium grained and light yellow	D	
					Becomes yellow-brown, dry to moist	D/M	3
					Becomes dry to moist	D/M	4
					From 4.3 mbgs subangular-subrounded limestone clasts		
					Becomes moist	M	5
					From 6.0 mbgs well cemented minor limestone clasts and layers present	M	6
							7
							8
							9
					End of hole at 10 m bgs. Target depth achieved.		10

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 6.7 m bgs prior to casing installation on 13/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

AECOM

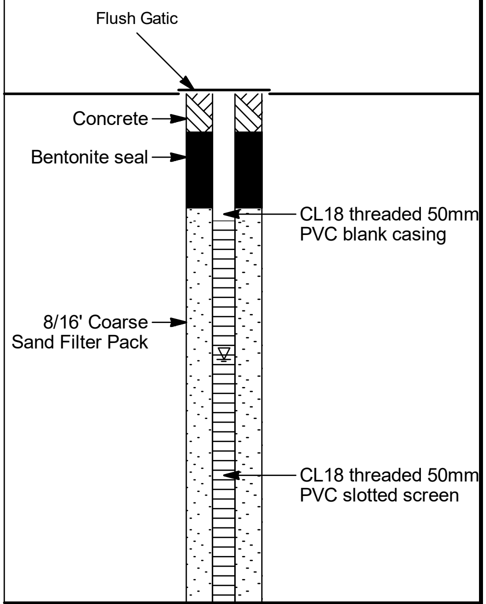
MONITORING WELL MW08

Drilling Contractor:	**South Western Drilling**			Project Name:	**Kentbruck Green Power Hub Project**	Client:	**Neoen**
				Project No:	**60591699**	Location:	**Nelson, Victoria**
Logged By:	**BM**	Bore Size:	**175 mm**	Top of Casing:	**8.24 mAHD**	Drill Type:	**PT/SSA/HSA**
Checked By:	**MW**	Total Depth:	**4.00 m**	Coordinates:	**514269.00 mE**	Drill Model:	**Geoprobe 7822DT**
Date Started:	**13/04/2021**	Casing Size:	**50 mm**		**5781591.00 mN**		
Date Finished:	**13/04/2021**			Permit No:	**WRK125853**	Drill Fluid:	**None**

Drill Method	Sample Interval	PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger			Samples not required			Silty SAND; fine to coarse grained, grey, coarse grained rounded quartz sand From 0.4 mbgs becomes grey-brown with black wood chips	D/M	0
Hand Auger / Push Tube/Hollow Stem Auger						Silty SAND; fine to coarse grained, dark brown, coarse grained quartz, moist Becoming medium to coarse grained q+z rounded	M	1
Push Tube/Hollow Stem Auger						SAND; fine to medium grained, light yellow, alternating limestone and poorly cemented sands layers, some minor shells. Well cemented layer 0.1 m thick at top of sand.	M	2
PT						From 4.5 mbgs white, subangular-angular fine to coarse limestone gravels, well cemented		4
						End of hole. Push tube to 4.8 mbgs, drilling to 4 mbgs due to water observed at 2 mbgs.		5

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

WELL CONSTRUCTION DETAILS



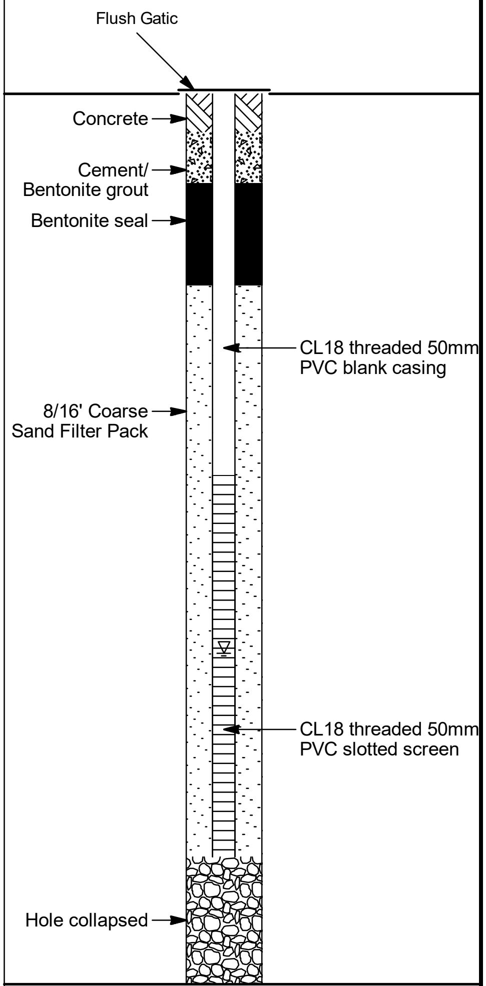
Remarks: Depth to water measured at 1.8 m bgs prior to casing installation on 13/4/2021
Push tube to 4.8 m bgs, drill to 4 m bgs due to shallow depth of observed water in push tube samples.
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

MONITORING WELL MW09

Drilling Contractor:	**South Western Drilling**	Project Name:	**Kentbruck Green Power Hub Project**	Client:	**Neoen**
		Project No:	**60591699**	Location:	**Nelson, Victoria**
Logged By:	**BM**	Bore Size:	**150 mm**	Top of Casing:	**13.48 mAHD**
Checked By:	**MW**	Total Depth:	**7.00 m**	Coordinates:	**517709.00 mE**
Date Started:	**13/04/2021**	Casing Size:	**50 mm**		**5780045.00 mN**
Date Finished:	**13/04/2021**			Permit No:	**WRK125854**
Drill Type:	**PT/SSA/HSA**	Drill Model:	**Geoprobe 7822DT**	Drill Fluid:	**None**

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required			Topsoil, dark brown, coarse grained, rootlets	D	0
					FILL; sandy limestone road base, fine to medium grained sand, yellow, subrounded-subangular limestone clasts	D	
					Silty SAND; fine grained, dark brown, loose, dry		1
					SAND; fine grained, brown, dry, weakly cemented At 0.8 mbgs some black wood chips At 1.3 mbgs grades to yellow-brown and moist At 1.4 mbgs becomes dense and tightly packed with some silt	M M M	
Push Tube/Hollow Stem Auger					SAND, fine grained, light yellow-white, alternating limestone and poorly cemented sands layers. From 2 mbgs becoming moderately cemented with some limestone clasts At 2.4 mbgs a well cemented limestone limestone layer Moist	M M	2 3
HSA							4
					At 4.8 mbgs a well cemented limestone limestone layer Moist to wet	M/W	5
					Becomes wet	W	6
					End of hole. Target depth - 2m of water saturated observed		7 8 9 10

WELL CONSTRUCTION DETAILS



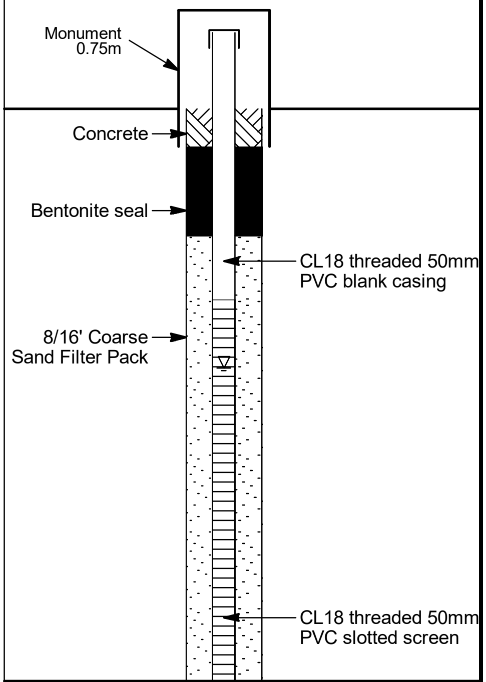
Remarks: Depth to water measured at 4.2 m bgs prior to casing installation on 13/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

MONITORING WELL MW10

Drilling Contractor:	South Western Drilling	Project Name:	Kentbruck Green Power Hub Project
Logged By:	BM	Project No:	60591699
Checked By:	MW	Client:	Neoen
Date Started:	12/04/2021	Location:	Nelson, Victoria
Date Finished:	12/04/2021	Top of Casing:	145.03 mAHD
Bore Size:	175 mm	Coordinates:	529606.00 mE 5775533.00 mN
Total Depth:	4.50 m	Permit No:	WRK125937
Casing Size:	50 mm	Drill Type:	PT/SSA/HSA
		Drill Model:	Geoprobe 7822DT
		Drill Fluid:	None

Drill Method	Sample Interval	PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger			Samples not required		SW	TOPSOIL; Silty SAND, fine to coarse grained, dark brown, loose	W	0
						SAND; medium to coarse grained, black, well graded; wet, loose		
						Becomes weakly cemented, minor clasts	W	1
Solid Stem/Hollow Stem Auger						Becomes red brown-black		
						Becomes dark brown with some clay		
					SC	Clayey SAND; coarse grained, brown, wet; loose	W	2
					SP	SAND; coarse grained, brown, wet, loose	W	
						Becomes grey and coarse grained with some quartz sand	W	
						Becomes black and medium to coarse grained	W	3
						Becomes red-black	W	
						Becomes light brown and fine to coarse grained	W	4
						End of hole at 4.5 mbgs. Potential sand collapse installed inside augers, stop and install.		5
								6
								7
								8
								9
								10

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 1.8 m bgs prior to casing installation on 12/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

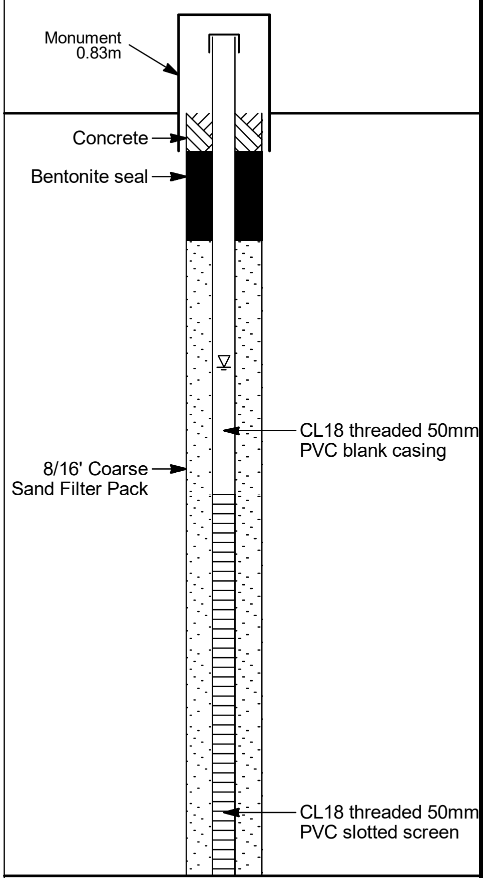
AECOM

MONITORING WELL MW11

Drilling Contractor:	South Western Drilling			Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
				Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	175 mm	Top of Casing:	137.83 mAHD	Drill Type:	PT/SSA/HSA
Checked By:	MW	Total Depth:	6.00 m	Coordinates:	531225.00 mE	Drill Model:	Geoprobe 7822DT
Date Started:	12/04/2021	Casing Size:	50 mm		5778107.00 mN		
Date Finished:	12/04/2021			Permit No:	WRK125938	Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Graphic Log	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required		SM	TOPSOIL; Silty SAND, fine to coarse grained, dark brown, loose, rootlets	D	0
Hand Auger				SW	SAND; fine to coarse grained, grey, dry, loose, rootlets		
Push Tube/Hollow Stem Auger				SP	Grades to light brown, medium to coarse grained and becomes moist	M	
Push Tube/Hollow Stem Auger					Grades to dark brown, becomes medium to coarse grained and wet with some large roots and rootlets	W	2
Push Tube/Hollow Stem Auger				SW	Becomes fine to coarse grained	W	
Push Tube/Hollow Stem Auger				SP	Grades to light brown, becomes medium to coarse grained	W	3
HSA							5
					End of hole at 6 mbgs. Target depth achieved.		6

WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 2.0 m bgs prior to casing installation on 12/4/2021
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

MONITORING WELL MW12

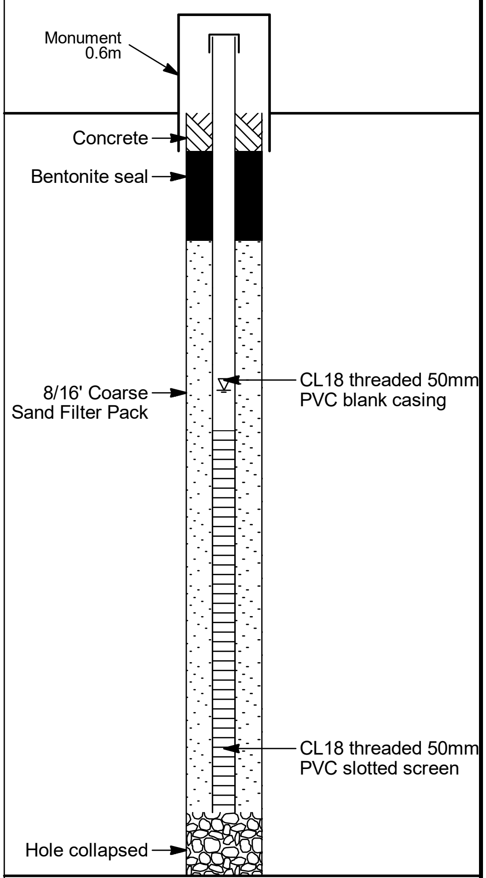
AECOM

Drilling Contractor:	South Western Drilling	Project Name:	Kentbruck Green Power Hub Project	Client:	Neoen
		Project No:	60591699	Location:	Nelson, Victoria
Logged By:	BM	Bore Size:	175 mm	Top of Casing:	138.81 mAHD
Checked By:	MW	Total Depth:	6.00 m	Coordinates:	527445.00 mE 5775579.00 mN
Date Started:	16/04/2021	Casing Size:	50 mm	Drill Type:	PT/SSA/HSA
Date Finished:	16/04/2021	Permit No:	WRK125936	Drill Model:	Geoprobe 7822DT
				Drill Fluid:	None

Drill Method	Sample Interval PID (ppm)	Sample ID	Classification	LITHOLOGICAL DESCRIPTION	Moisture	Depth (m)
Hand Auger		Samples not required	SM	Silty SAND; fine to coarse grained, dark brown, loose, roots, poorly sorted subangular-subrounded sands, dry	D	0
				Becoming light brown		
				Becoming moist, yellow-brown and no roots	M	
				Becoming wet		1
Push Tube/Hollow Stem Auger				Grades to light or brown-grey with minor roots and becomes wet	W	
			SC	Clayey SAND; fine to medium grained, dark brown, poorly sorted	W	2
			SP	SAND; fine to medium grained, dark brown, loose, wet	W	
				At 3.0 mbgs grades to grey-brown and becomes fine to coarse grained	W	3
				At 3.3 mbgs becomes light grey		
HSA						4–6
				End of hole at 6.0 m bgs. Target depth achieved.		6

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

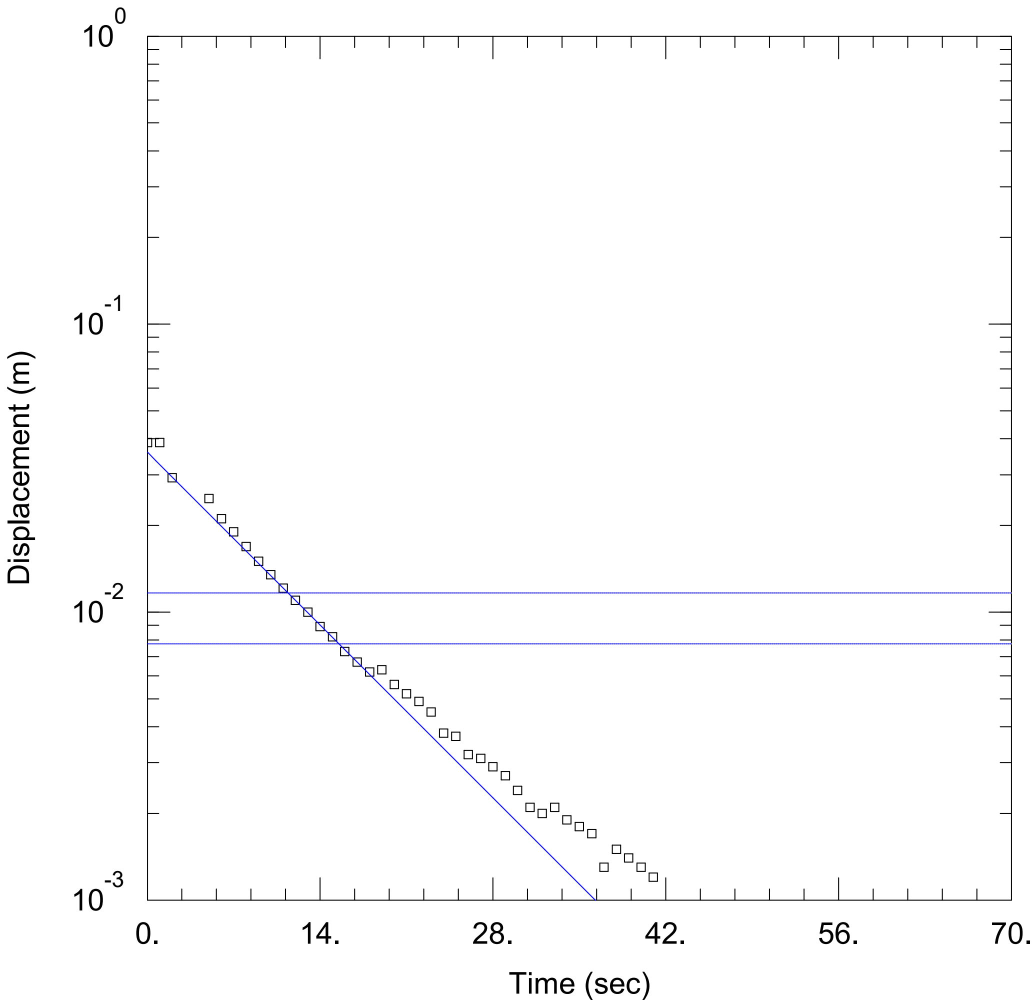
WELL CONSTRUCTION DETAILS



Remarks: Depth to water measured at 1.7 m bgs prior to casing installation on 16/4/2021
Bore installed to 5.5 mbgs due to hole collapse under sand pressure.
PT: Push Tube
SSA: Solid Stem Auger Drilling
HSA: Hollow Stem Auger Drilling

Appendix D

Slug test analysis outputs



MW01 RISING HEAD TEST

Data Set: D:\Kentbruck\40mm slug\MW01\MW01_RHT1 B-R correction.aqt
Date: 07/28/22 Time: 21:58:27

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neoen
Project: 60591699
Location: Plantation
Test Well: MB01
Test Date: 27/04/2021

AQUIFER DATA

Saturated Thickness: 1.295 m Anisotropy Ratio (Kz/Kr): 0.1

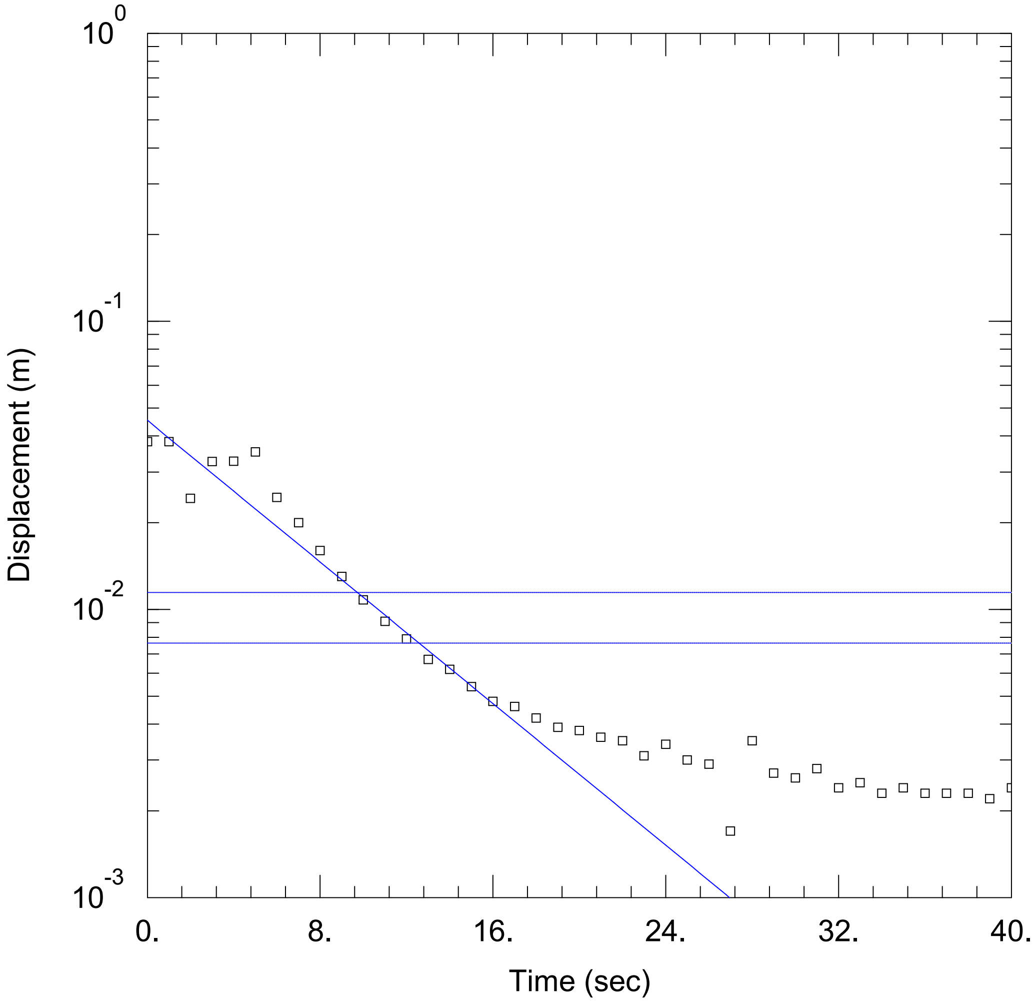
WELL DATA (MW01)

Initial Displacement: 0.0388 m
Total Well Penetration Depth: 1.295 m
Casing Radius: 0.025 m
Static Water Column Height: 1.295 m
Screen Length: 1.295 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 17.69 m/day y0 = 0.03594 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW04\MW04_RHT2 Butler correction.aqt
Date: 07/28/22 Time: 22:07:06

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 2.35 m Anisotropy Ratio (Kz/Kr): 0.1

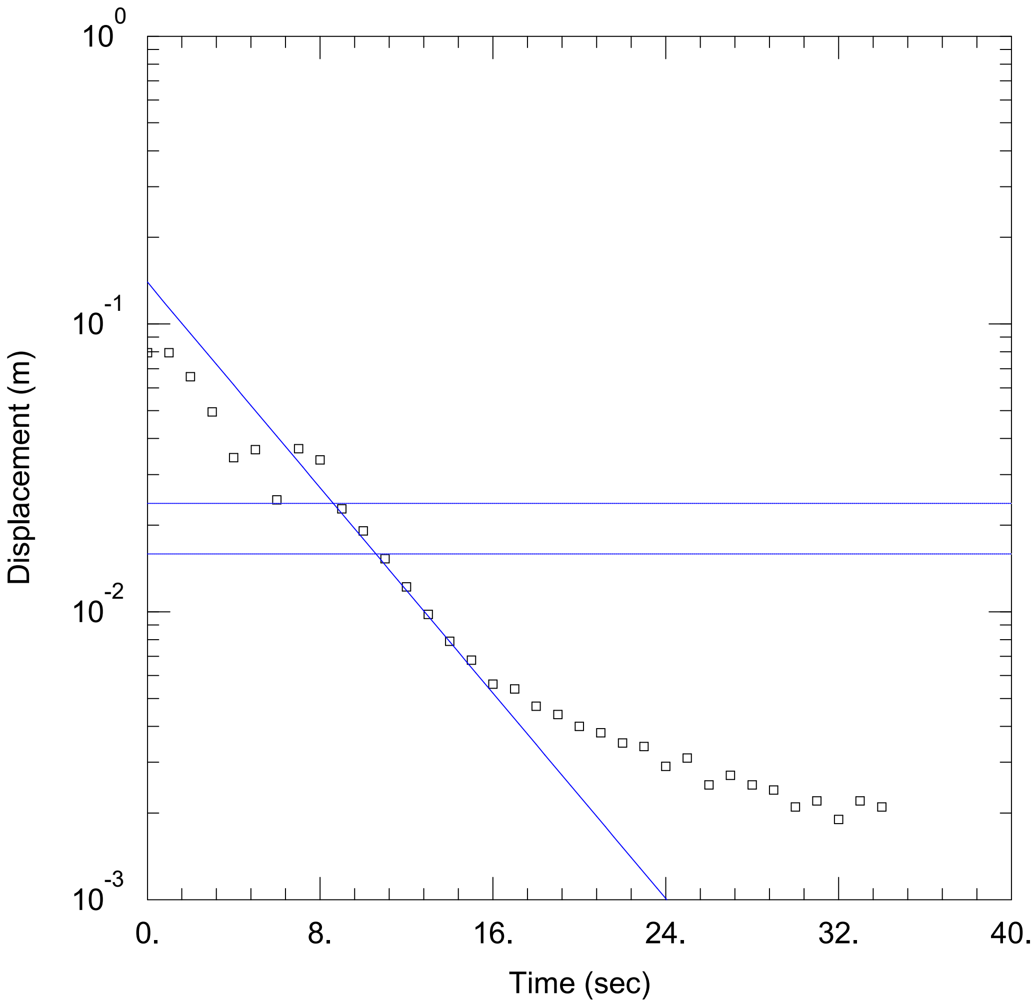
WELL DATA (MW04)

Initial Displacement: 0.0382 m
Total Well Penetration Depth: 2.35 m
Casing Radius: 0.025 m
Static Water Column Height: 2.35 m
Screen Length: 2.35 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 67.42 m/day y0 = 0.04533 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW05\MW05_RHT1 BR correction.aqt
Date: 07/28/22 Time: 22:09:55

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

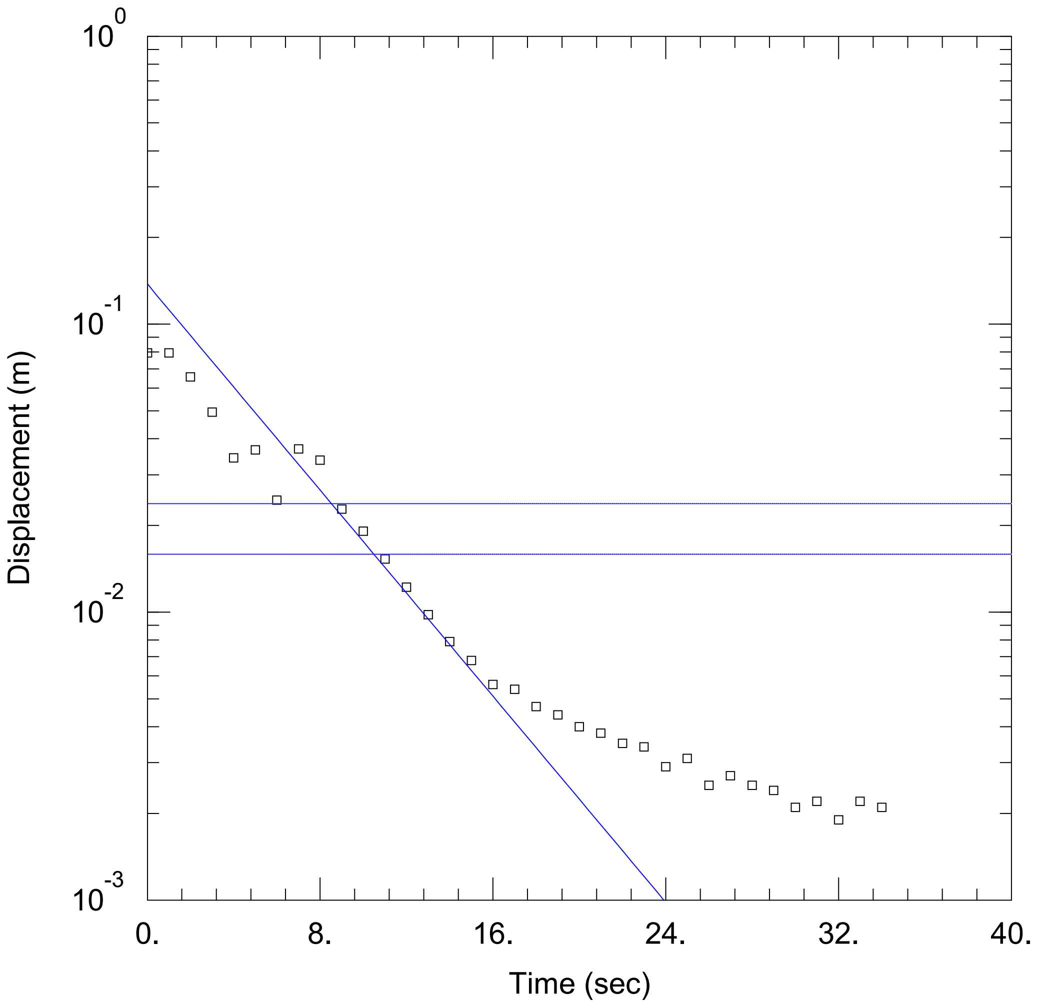
Saturated Thickness: 2.35 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW04)

Initial Displacement: 0.0794 m
Total Well Penetration Depth: 2.35 m
Casing Radius: 0.025 m
Static Water Column Height: 2.35 m
Screen Length: 2.35 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 25.57 m/day
y0 = 0.1398 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW05\MW05_RHT1 Butler correction.aqt
Date: 07/28/22 Time: 22:10:51

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 2.35 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW04)

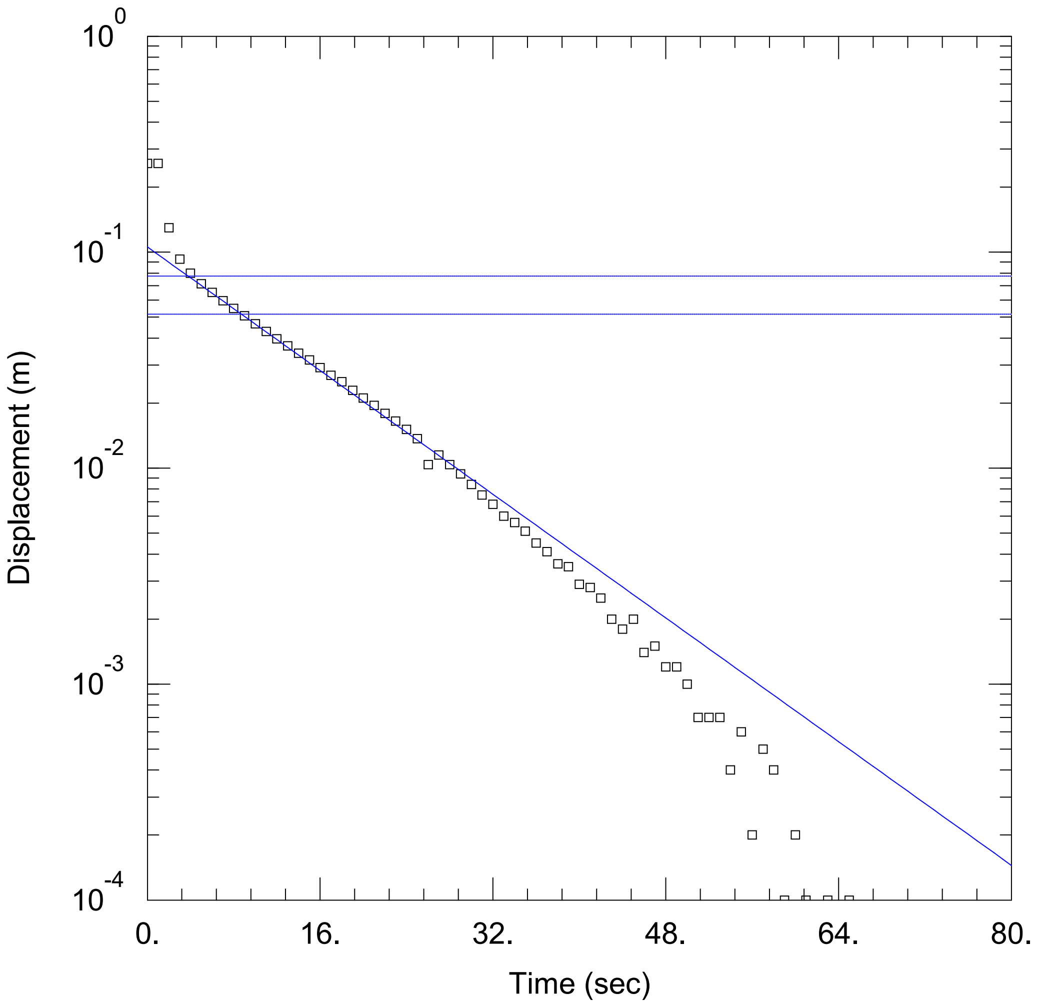
Initial Displacement: 0.0794 m
Total Well Penetration Depth: 2.35 m
Casing Radius: 0.025 m

Static Water Column Height: 2.35 m
Screen Length: 2.35 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 47.23 m/day y0 = 0.138 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW06\MW06_RHT1_BR correction.aqt
Date: 07/28/22 Time: 22:12:51

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.93 m
Anisotropy Ratio (Kz/Kr): 0.1

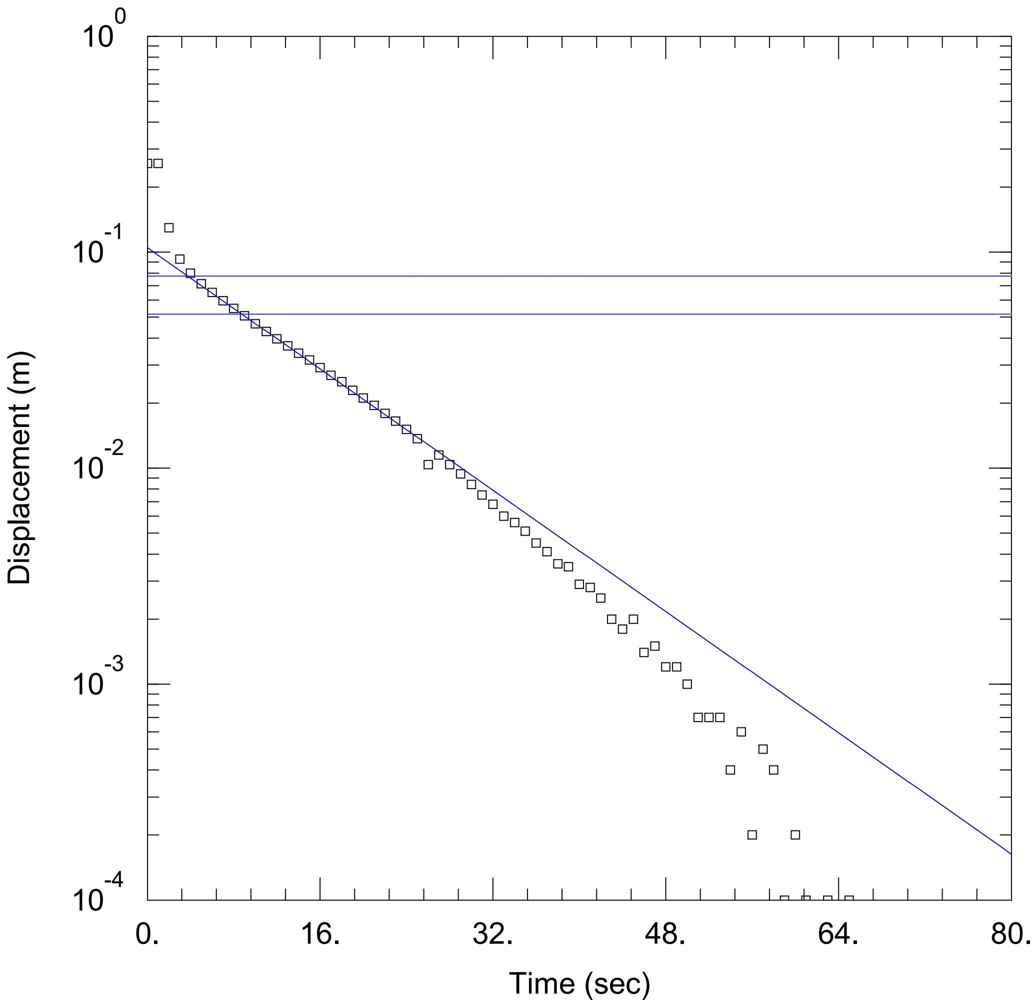
WELL DATA (MW06)

Initial Displacement: 0.2579 m
Total Well Penetration Depth: 1.93 m
Casing Radius: 0.025 m
Static Water Column Height: 1.93 m
Screen Length: 1.93 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 11.63 m/day
y0 = 0.1059 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW06\MW06_RHT1_Butler correction.aqt
Date: 07/28/22 Time: 22:13:43

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.93 m
Anisotropy Ratio (Kz/Kr): 0.1

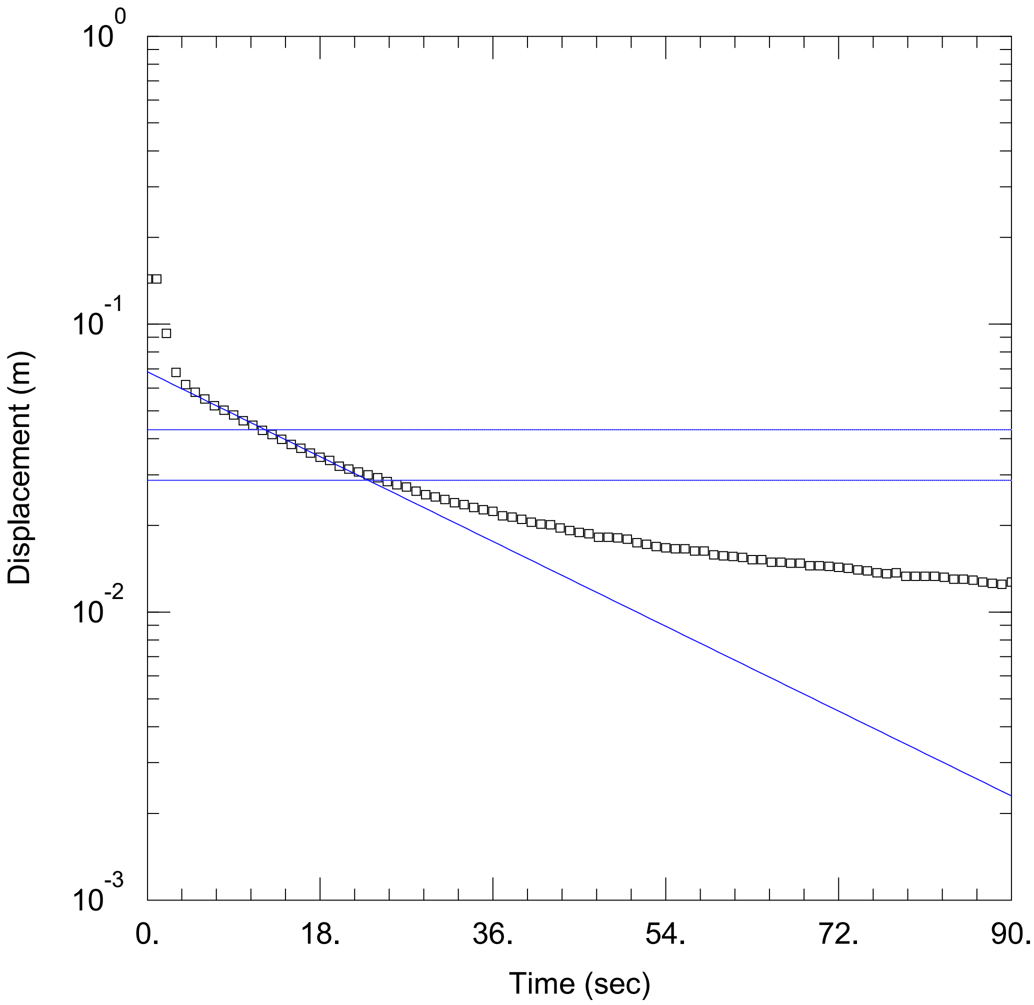
WELL DATA (MW06)

Initial Displacement: 0.2579 m
Total Well Penetration Depth: 1.93 m
Casing Radius: 0.025 m
Static Water Column Height: 1.93 m
Screen Length: 1.93 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 15.9 m/day
y0 = 0.1049 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW07\MW07_RHT2_BR correction.aqt
Date: 07/28/22 Time: 22:18:37

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.42 m Anisotropy Ratio (Kz/Kr): 0.1

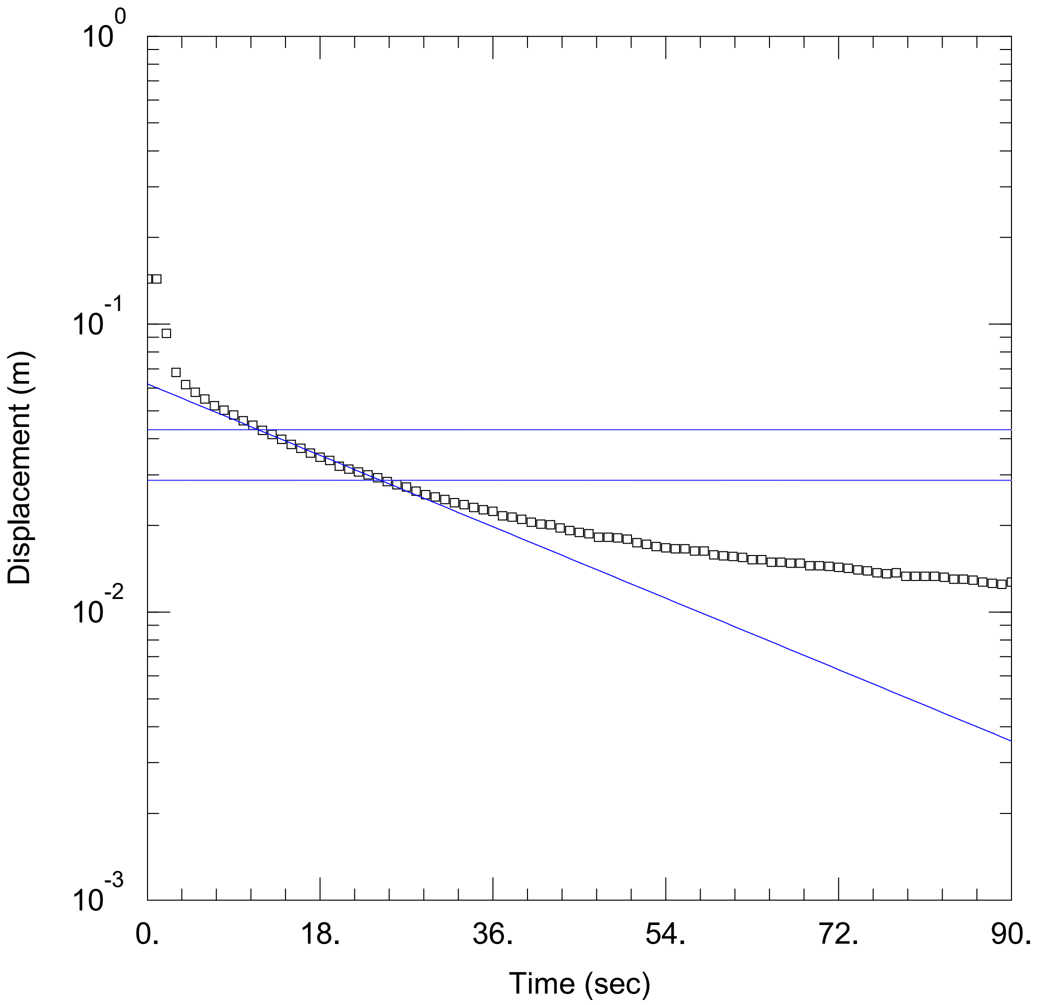
WELL DATA (MW07)

Initial Displacement: 0.1434 m
Total Well Penetration Depth: 1.42 m
Casing Radius: 0.025 m
Static Water Column Height: 1.42 m
Screen Length: 1.42 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.402 m/day y0 = 0.06833 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW07\MW07_RHT2_Butler correction.aqt
Date: 07/28/22 Time: 22:19:47

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.42 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW07)

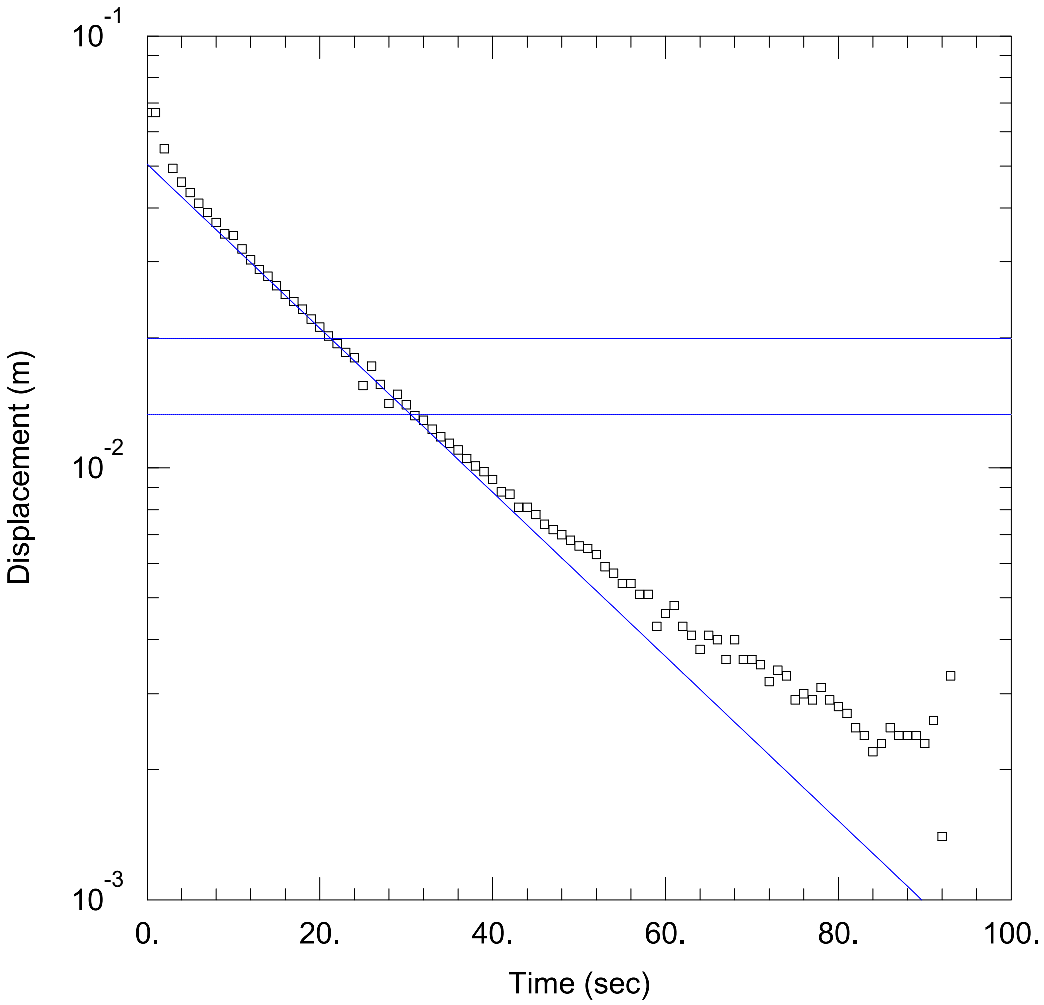
Initial Displacement: 0.1434 m
Total Well Penetration Depth: 1.42 m
Casing Radius: 0.025 m

Static Water Column Height: 1.42 m
Screen Length: 1.42 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.5 m/day y0 = 0.06204 m



WELL TEST ANALYSIS	
Data Set: D:\Kentbruck\40mm slug\MW08\MW08_RHT3_BR correction.aqt	
Date: 07/28/22	Time: 22:22:22

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

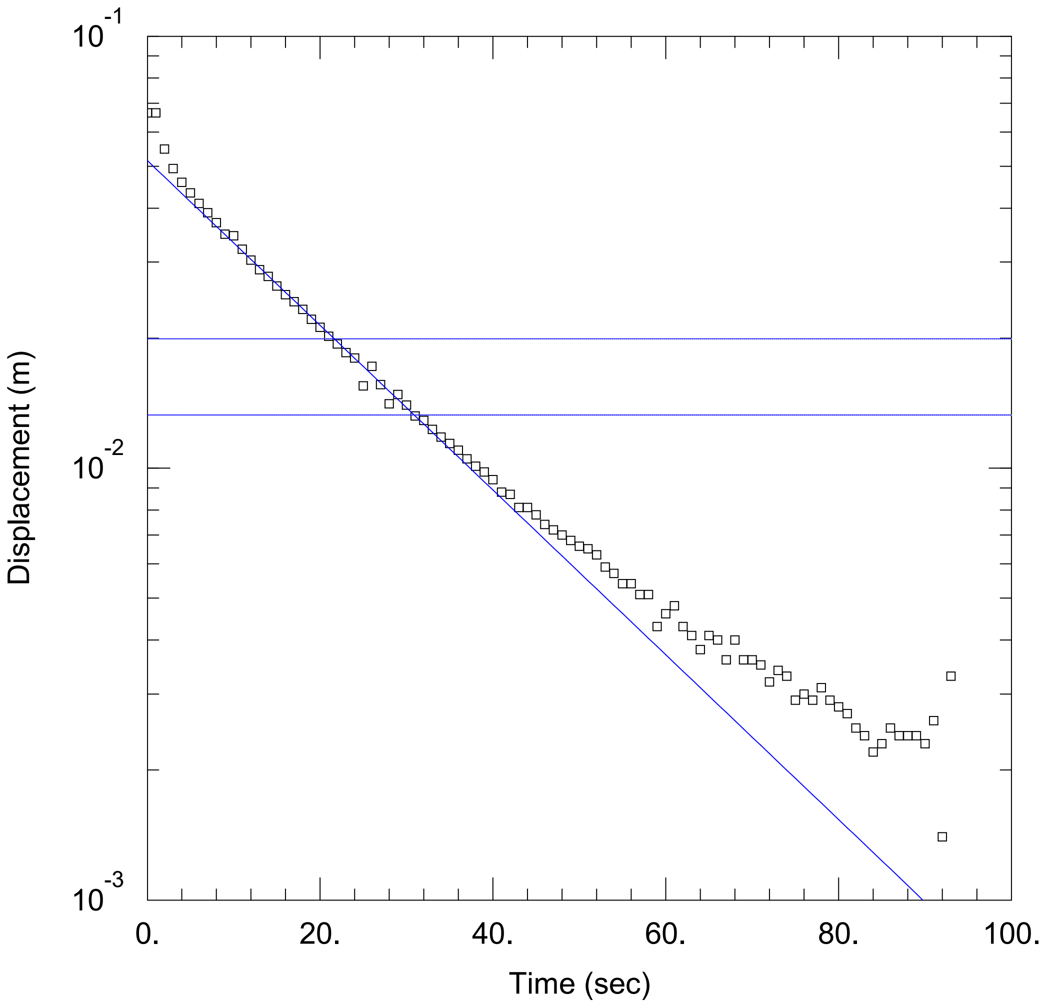
Saturated Thickness: 2.05 m	Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW08)

Initial Displacement: 0.0664 m	Static Water Column Height: 2.05 m
Total Well Penetration Depth: 2.05 m	Screen Length: 2.05 m
Casing Radius: 0.025 m	Well Radius: 0.0875 m
	Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined	Solution Method: Bouwer-Rice
K = 5.945 m/day	y0 = 0.05052 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW08\MW08_RHT3_Butler correction.aqt
Date: 07/28/22 Time: 22:23:00

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 2.05 m Anisotropy Ratio (Kz/Kr): 0.1

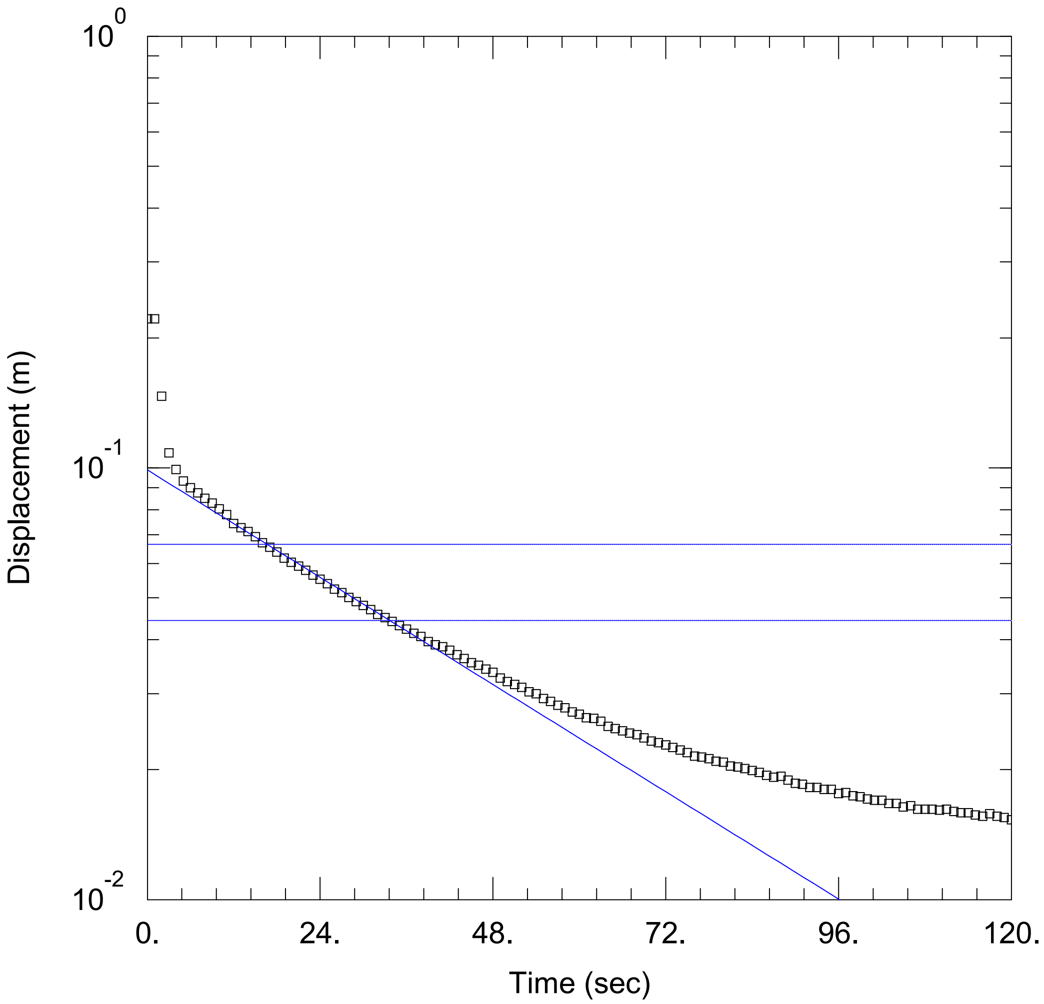
WELL DATA (MW08)

Initial Displacement: 0.0664 m
Total Well Penetration Depth: 2.05 m
Casing Radius: 0.025 m
Static Water Column Height: 2.05 m
Screen Length: 2.05 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 16.93 m/day y0 = 0.05155 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW09\MW09_RHT2_BR correction.aqt
Date: 07/28/22 Time: 22:24:18

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.42 m
Anisotropy Ratio (Kz/Kr): 0.1

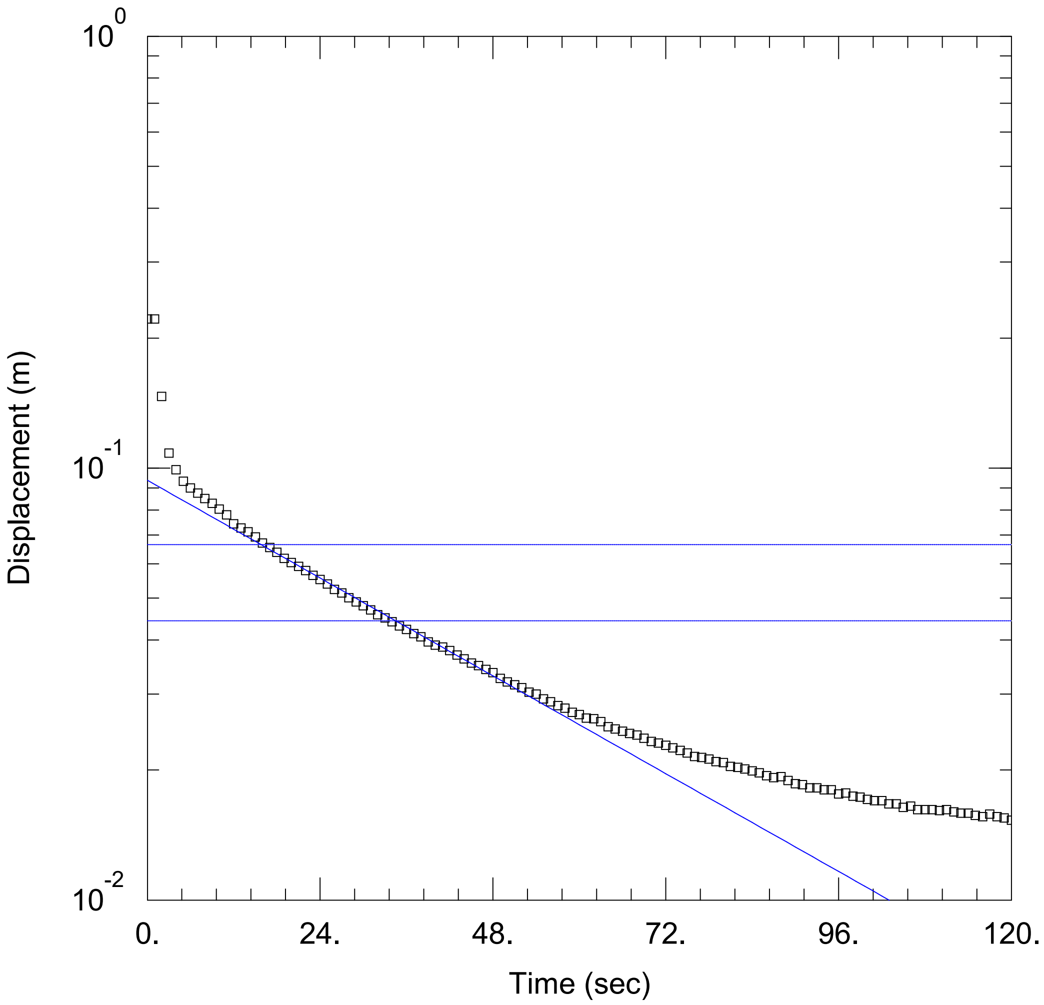
WELL DATA (MW09)

Initial Displacement: 0.2216 m
Total Well Penetration Depth: 1.42 m
Casing Radius: 0.025 m
Static Water Column Height: 1.42 m
Screen Length: 1.42 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.05 m/day
y0 = 0.09891 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW09\MW09_RHT2_Butler correction.aqt
Date: 07/28/22 Time: 22:25:05

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW05
Test Date: 29/04/2021

AQUIFER DATA

Saturated Thickness: 1.42 m Anisotropy Ratio (Kz/Kr): 0.1

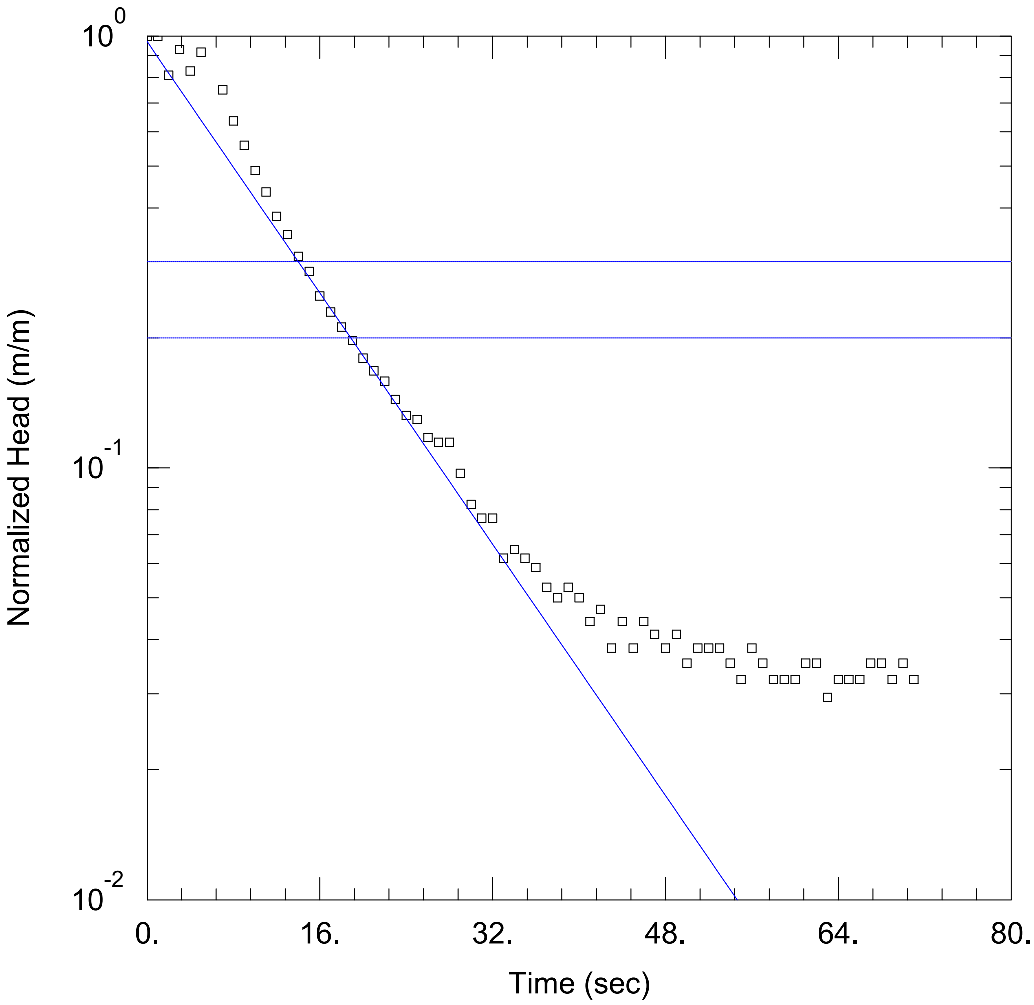
WELL DATA (MW09)

Initial Displacement: 0.2216 m
Total Well Penetration Depth: 1.42 m
Casing Radius: 0.025 m
Static Water Column Height: 1.42 m
Screen Length: 1.42 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.758 m/day y0 = 0.09377 m



MW01 RISING HEAD TEST 3

Data Set: D:\Kentbruck\40mm slug\MW01\MW01_RHT3 Butler correction.aqt
Date: 07/28/22 Time: 21:59:06

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neoen
Project: 60591699
Location: Plantation
Test Well: MB01
Test Date: 27/04/2021

AQUIFER DATA

Saturated Thickness: 1.295 m
Anisotropy Ratio (Kz/Kr): 0.1

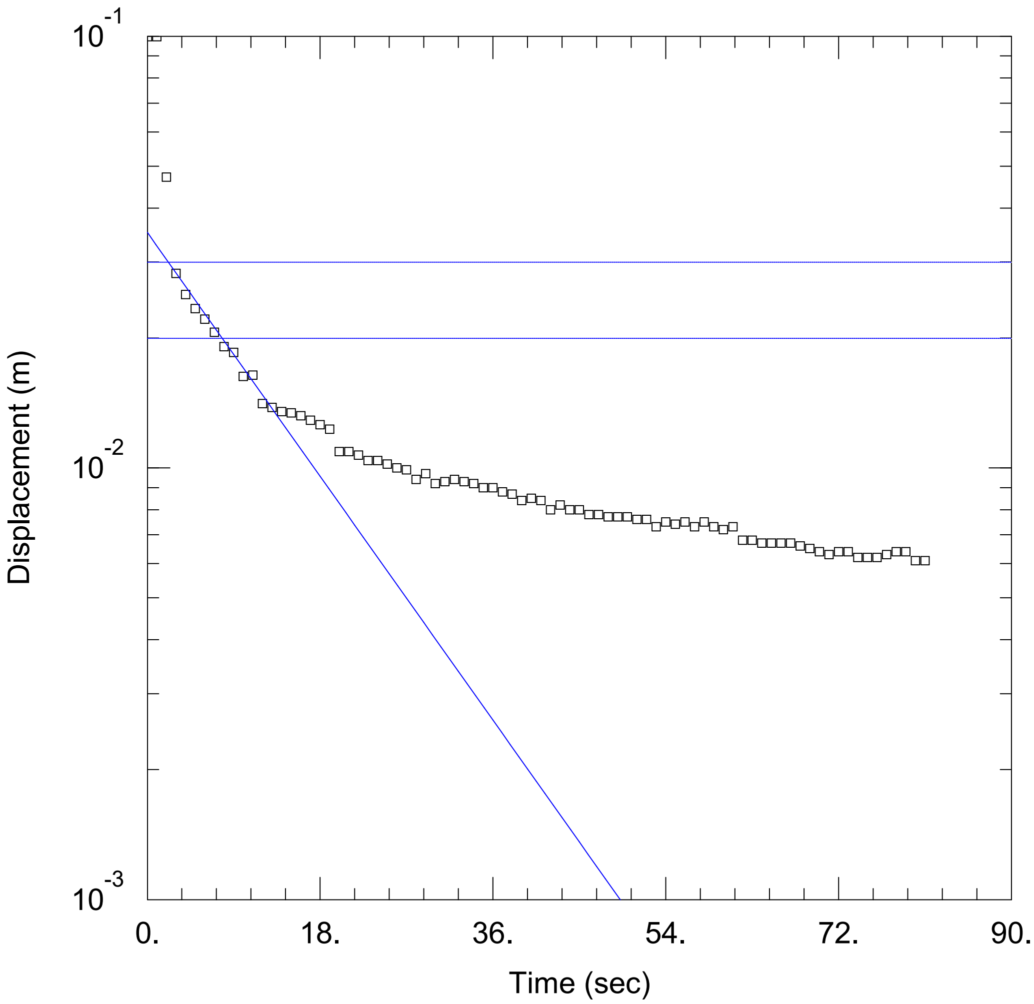
WELL DATA (MW01)

Initial Displacement: 0.034 m
Total Well Penetration Depth: 1.295 m
Casing Radius: 0.025 m
Static Water Column Height: 1.295 m
Screen Length: 1.295 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 64.57 m/day
y0 = 0.03299 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW02\MW02_RHT2 B-R correction.aqt
Date: 07/28/22 Time: 22:00:27

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 1.72 m Anisotropy Ratio (Kz/Kr): 0.1

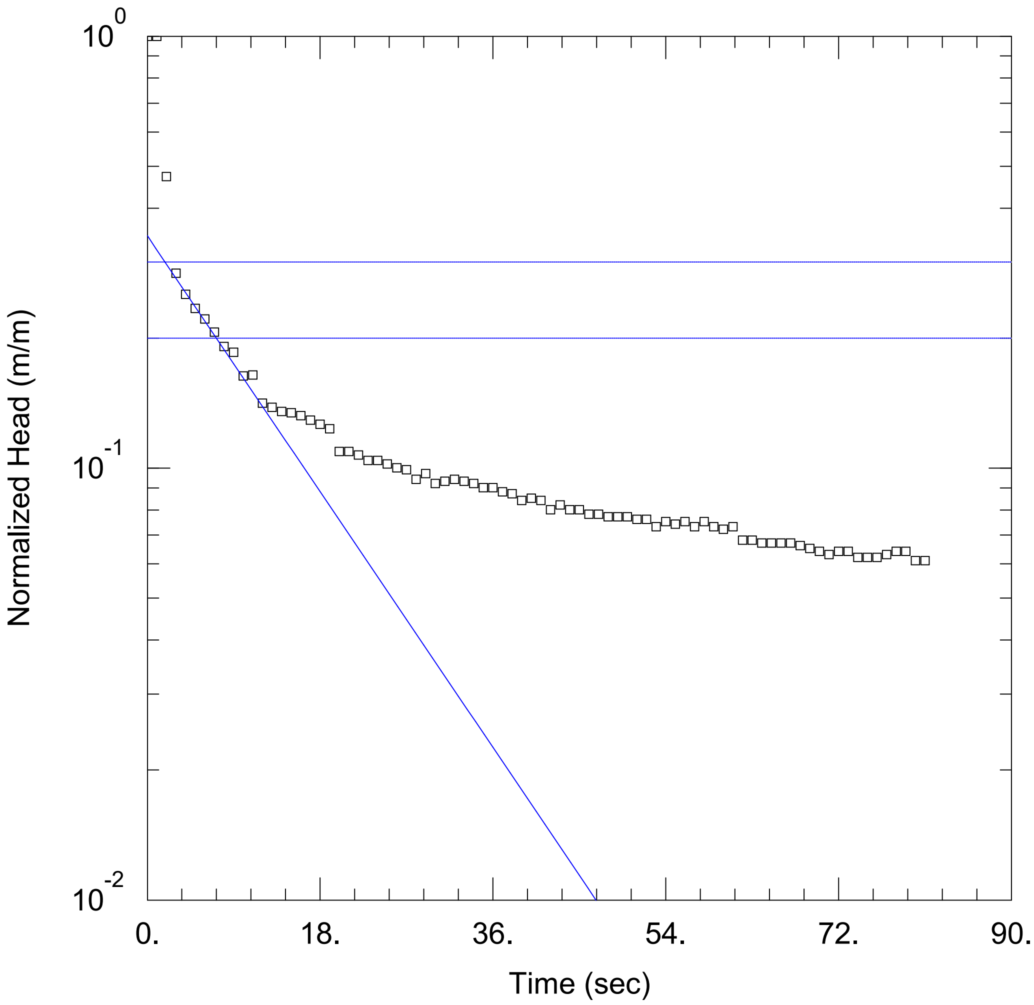
WELL DATA (MW02)

Initial Displacement: 0.0998 m
Total Well Penetration Depth: 1.72 m
Casing Radius: 0.025 m
Static Water Column Height: 1.72 m
Screen Length: 1.72 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 10.95 m/day y0 = 0.03511 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW02\MW02_RHT2 Butler correction.aqt
Date: 07/28/22 Time: 22:01:05

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 1.72 m Anisotropy Ratio (Kz/Kr): 0.1

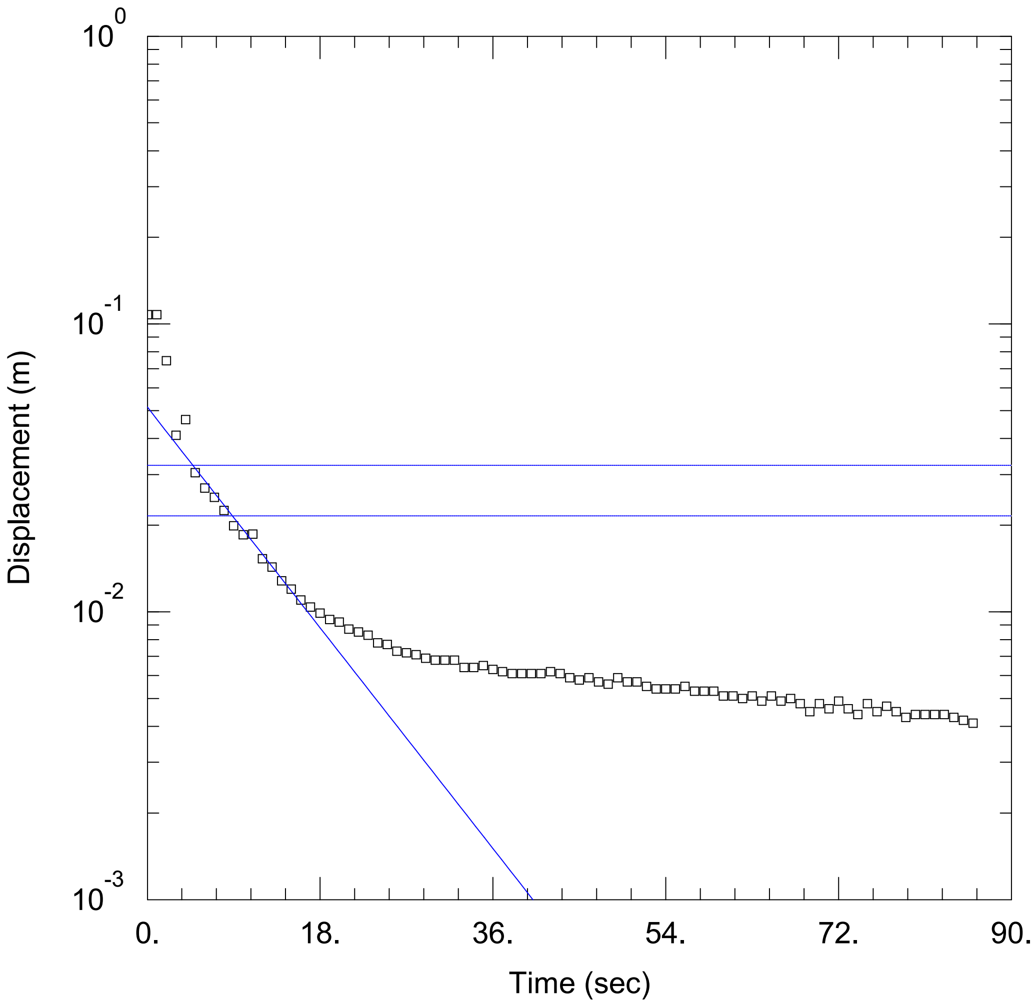
WELL DATA (MW02)

Initial Displacement: 0.0998 m
Total Well Penetration Depth: 1.72 m
Casing Radius: 0.025 m
Static Water Column Height: 1.72 m
Screen Length: 1.72 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 16.82 m/day y0 = 0.03443 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW03\MW03_RHT3 BR correction.aqt
Date: 07/28/22 Time: 22:02:07

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 1.17 m
Anisotropy Ratio (Kz/Kr): 0.1

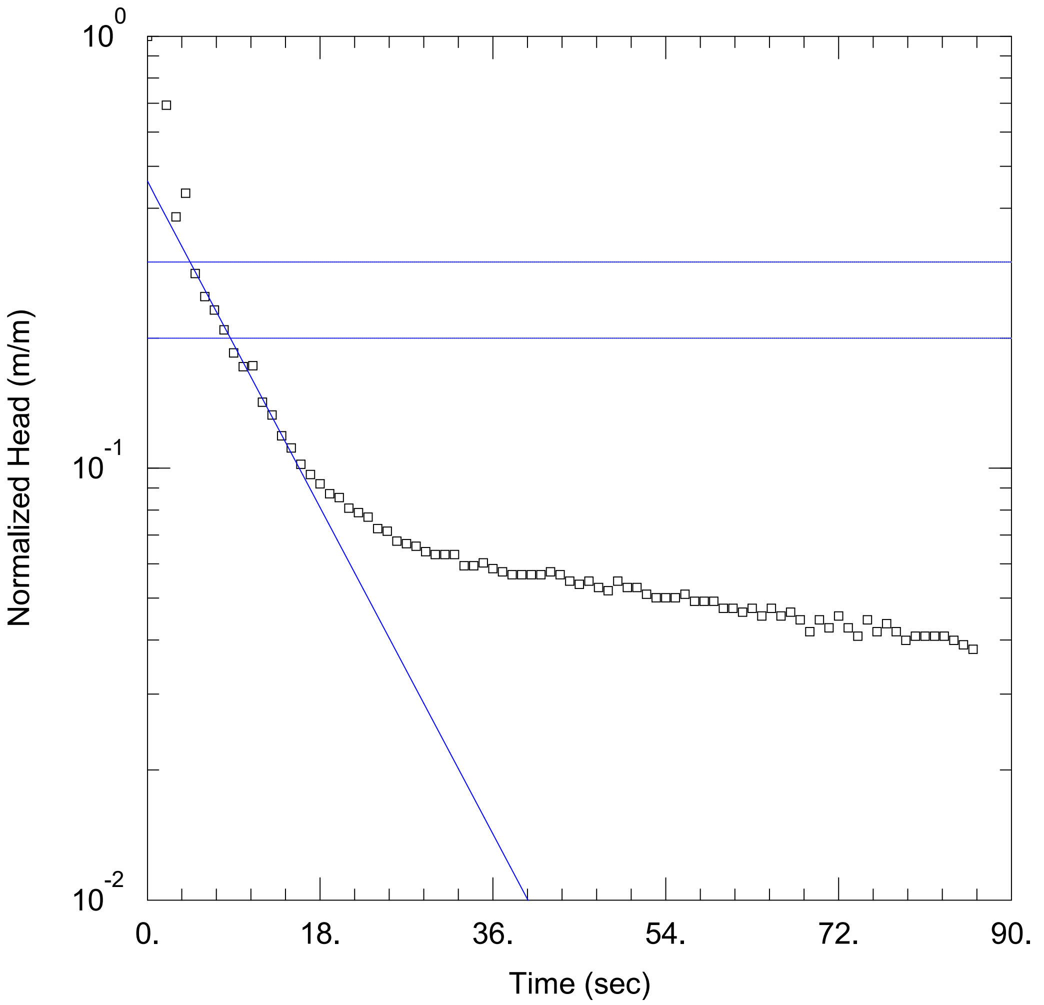
WELL DATA (MW03)

Initial Displacement: 0.1077 m
Total Well Penetration Depth: 1.17 m
Casing Radius: 0.025 m
Static Water Column Height: 1.17 m
Screen Length: 1.17 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 18.62 m/day
y0 = 0.05145 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW03\MW03_RHT3 Butler correction.aqt
Date: 07/28/22 Time: 22:03:14

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 1.17 m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW03)

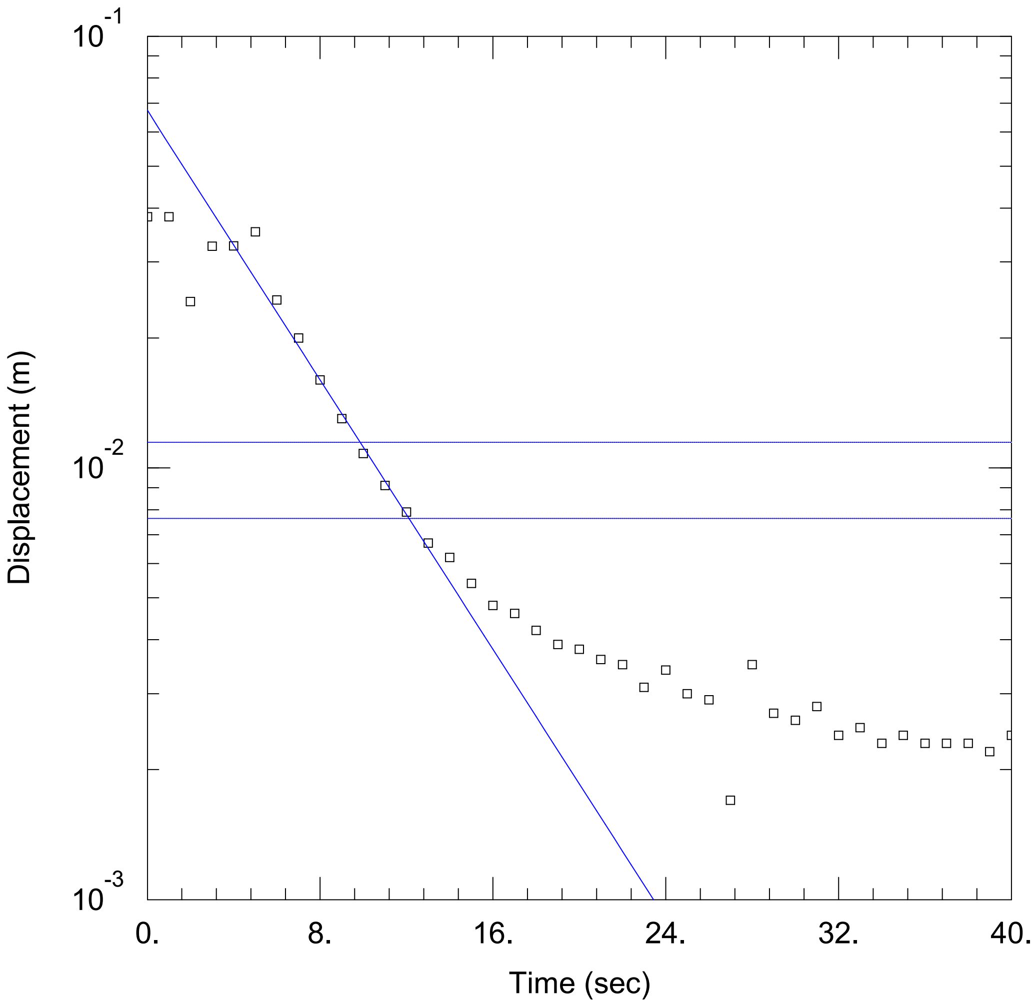
Initial Displacement: 0.1077 m
Total Well Penetration Depth: 1.17 m
Casing Radius: 0.025 m

Static Water Column Height: 1.17 m
Screen Length: 1.17 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 24.93 m/day y0 = 0.04975 m



WELL TEST ANALYSIS

Data Set: D:\Kentbruck\40mm slug\MW04\MW04_RHT2 BR correction.aqt
Date: 07/28/22 Time: 22:05:44

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon
Project: 60591699
Location: Plantation
Test Well: MW02
Test Date: 28/04/2021

AQUIFER DATA

Saturated Thickness: 2.35 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW04)

Initial Displacement: 0.0382 m
Total Well Penetration Depth: 2.35 m
Casing Radius: 0.025 m
Static Water Column Height: 2.35 m
Screen Length: 2.35 m
Well Radius: 0.0875 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 22.35 m/day
y0 = 0.06732 m

Appendix E

Dewatering estimates

Client :	**Neoen Australia Pty Ltd**	Location :	**Nr Nelson, Vic**
Project :	**Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**		

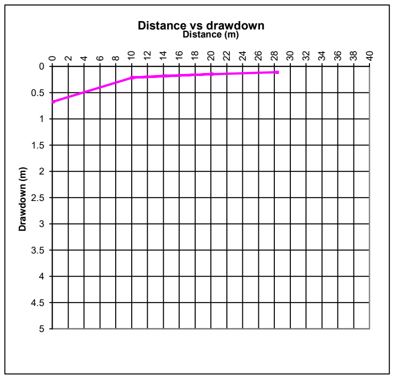
Calculate Drawdown (s) for known Discharge (Q) — THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	6.3
Corresponding pumping rate (L/s):	0.0729
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	10
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	189.00
(m3/hr)	0.26

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05, Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

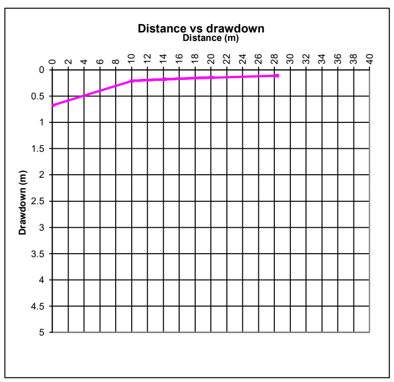
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	8.33E-07	1.34E+01	0.67
10.1	8.50E-03	4.20E+00	0.21
20.1	3.37E-02	2.85E+00	0.14
10.0	8.33E-03	4.22E+00	0.21
14.2	1.68E-02	3.52E+00	0.18
28.4	6.70E-02	2.19E+00	0.11



Drawdown at centre of foundation

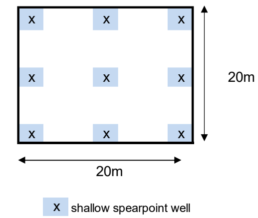
Distance (m)	u	W(u)	Drawdown (m)
0.1	8.33E-07	1.34E+01	0.67
10.0	8.33E-03	4.22E+00	0.21
14.1	1.67E-02	3.53E+00	0.18



9.0 bores
6.3 flow rate per bore (cu.m/day)
56.7 m3/day (total)
0.66 L/sec

aquifer thickness	2	
hydraulic conductivity	5	m/day
T	**10**	**m2/day**

Foundation dimensions
25 m diameter
12.50 m radius
490.874 Area
22 m : Eqvlnt square



Pit length 20 m — Pit width 20 m
No. Bores 9.0

Distance drawdown estimates

Drawdown at each perimeter well 0.1 — **Ddn 2.02 m**

	x1	x1	x1	x2	x2	x2
Distance	0.1	10.1	20.1	10.0	14.2	28.4
Ddn	0.67	0.21	0.14	0.21	0.18	0.11

Centre of foundation 11 — **Ddn 2.23 m**

	x1	x4	x4
Distance	0.1	10.0	14.1
Ddn	0.67	0.21	0.18

Distance from foundation edge (m) 25 — **Ddn 0.81 m**

	x1	x1	x1	x2	x2	x2
Distance	25.0	35.0	45.0	26.9	36.4	49.2
Ddn	0.12	0.09	0.07	0.11	0.09	0.06

Distance from foundation edge (m) 50 — **Ddn 0.41 m**

	x1	x1	x1	x2	x2	x2
Distance	50.0	60.0	70.0	51.0	60.8	72.8
Ddn	0.06	0.05	0.03	0.06	0.04	0.03

Distance from foundation edge (m) 150 — **Ddn 0.02 m**

	x1	x1	x1	x2	x2	x2
Distance	150.0	160.0	170.0	150.3	160.3	171.2
Ddn	0.00	0.00	0.00	0.00	0.00	0.00

Distance from foundation edge (m) 210 — **Ddn #NUM! m**

	x1	x1	x1	x2	x2	x2
Distance	210.0	220.0	230.0	210.2	220.2	230.9
Ddn	0.00	#NUM!	#NUM!	0.00	#NUM!	#NUM!

Client :	**Neoen Australia Pty Ltd**	Location :	**Nr Nelson, Vic**
Project :	**Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**		

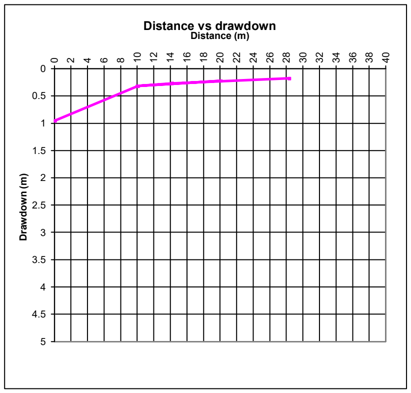
Calculate Drawdown (s) for known Discharge (Q) — THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	13
Corresponding pumping rate (L/s):	0.1505
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	15
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	390.00
(m3/hr)	0.54

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05, Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

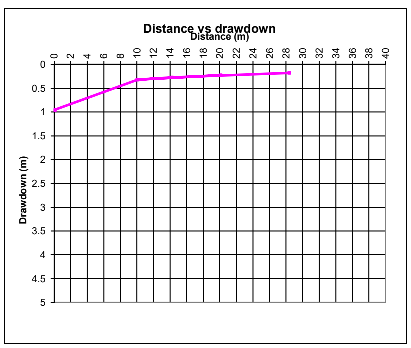
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	5.56E-07	1.38E+01	0.95
10.1	5.67E-03	4.60E+00	0.32
20.1	2.24E-02	3.24E+00	0.22
10.0	5.56E-03	4.62E+00	0.32
14.2	1.12E-02	3.92E+00	0.27
28.4	4.47E-02	2.58E+00	0.18



Drawdown at centre of foundation

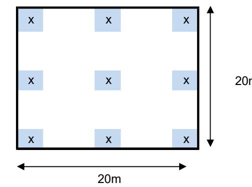
Distance (m)	u	W(u)	Drawdown (m)
0.1	5.56E-07	1.38E+01	0.95
10.0	5.56E-03	4.62E+00	0.32
14.1	1.11E-02	3.93E+00	0.27



9.0	bores
13	flow rate per bore (cu.m/day)
117.0	m3/day (total)
1.35	L/sec
aquifer thickness	3
hydraulic conductivity	5 m/day
T	**15 m2/day**

Foundation dimensions

25	m diameter
12.50	m radius
490.874	Area
22	m : Eqvlnt square



x shallow spearpoint well

Pit length 20 m — Pit width 20 m
No. Bores 9.0

Distance drawdown estimates

		Ddn		x1	x1	x1	x2	x2	x2
Drawdown at each perimeter well	0.1	**3.03**	m	0.1	10.1	20.1	10.0	14.2	28.4
				0.95	0.32	0.22	0.32	0.27	0.18

		Ddn		x1	x4	x4
Centre of foundation	11	**3.31**	m	0.1	10.0	14.1
				0.95	0.32	0.27

		Ddn		x1	x1	x1	x2	x2	x2
Distance from foundation edge (m)	25	**1.34**	m	25.0	35.0	45.0	26.9	36.4	49.2
				0.19	0.15	0.12	0.18	0.15	0.11

		Ddn		x1	x1	x1	x2	x2	x2
Distance from foundation edge (m)	50	**0.76**	m	50.0	60.0	70.0	51.0	60.8	72.8
				0.11	0.08	0.07	0.10	0.08	0.06

		Ddn		x1	x1	x1	x2	x2	x2
Distance from foundation edge (m)	150	**0.07**	m	150.0	160.0	170.0	150.3	160.3	171.2
				0.01	0.01	0.01	0.01	0.01	0.01

		Ddn		x1	x1	x1	x2	x2	x2
Distance from foundation edge (m)	210	**0.01**	m	210.0	220.0	230.0	210.2	220.2	230.9
				0.00	0.00	0.00	0.00	0.00	0.00

Client :	**Neoen Australia Pty Ltd**	Location :	**Nr Nelson, Vic**
Project :	**Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**		

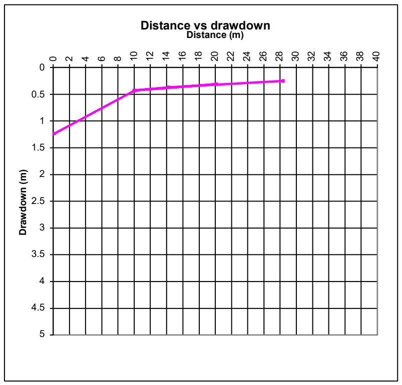
Calculate Drawdown (s) for known Discharge (Q) — THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	22
Corresponding pumping rate (L/s):	0.2546
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	20
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	660.00
(m3/hr)	0.92

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05, Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

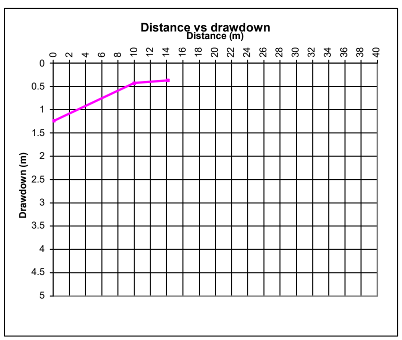
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	4.17E-07	1.41E+01	1.24
10.1	4.25E-03	4.89E+00	0.43
20.1	1.68E-02	3.52E+00	0.31
10.0	4.17E-03	4.91E+00	0.43
14.2	8.42E-03	4.21E+00	0.37
28.4	3.35E-02	2.85E+00	0.25



Drawdown at centre of foundation

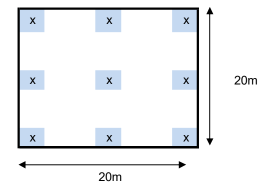
Distance (m)	u	W(u)	Drawdown (m)
0.1	4.17E-07	1.41E+01	1.24
10.0	4.17E-03	4.91E+00	0.43
14.1	8.33E-03	4.22E+00	0.37



9.0 bores
22 flow rate per bore (cu.m/day)
198.0 m3/day (total)
2.29 L/sec

aquifer thickness	4	
hydraulic conductivity	5	m/day
T	**20**	**m2/day**

Foundation dimensions
25 m diameter
12.50 m radius
490.874 Area
22 m : Eqvlnt square



x shallow spearpoint well

Pit length 20 m — Pit width 20 m
No. Bores 9.0

Distance drawdown estimates

Drawdown at each perimeter well 0.1 — **Ddn** **4.07** m

x1	x1	x1	x2	x2	x2
0.1	10.1	20.1	10.0	14.2	28.4
1.24	0.43	0.31	0.43	0.37	0.25

Centre of foundation 11 — **Ddn** **4.43** m

x1	x4	x4
0.1	10.0	14.1
1.24	0.43	0.37

Distance from foundation edge (m) 25 — **Ddn** **1.91** m

x1	x1	x1	x2	x2	x2
25.0	35.0	45.0	26.9	36.4	49.2
0.27	0.21	0.17	0.26	0.21	0.16

Distance from foundation edge (m) 50 — **Ddn** **1.15** m

x1	x1	x1	x2	x2	x2
50.0	60.0	70.0	51.0	60.8	72.8
0.16	0.13	0.11	0.15	0.13	0.10

Distance from foundation edge (m) 150 — **Ddn** **0.16** m

x1	x1	x1	x2	x2	x2
150.0	160.0	170.0	150.3	160.3	171.2
0.02	0.02	0.01	0.02	0.02	0.01

Distance from foundation edge (m) 210 — **Ddn** **0.04** m

x1	x1	x1	x2	x2	x2
210.0	220.0	230.0	210.2	220.2	230.9
0.01	0.00	0.00	0.01	0.00	0.00

Client :	**Neoen Australia Pty Ltd**	Location :	**Nr Nelson, Vic**
Project :	**Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**		

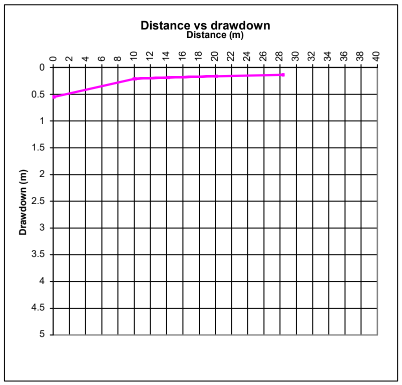
Calculate Drawdown (s) for known Discharge (Q) — THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	23
Corresponding pumping rate (L/s):	0.2662
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	50
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	690.00
(m3/hr)	0.96

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05, Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

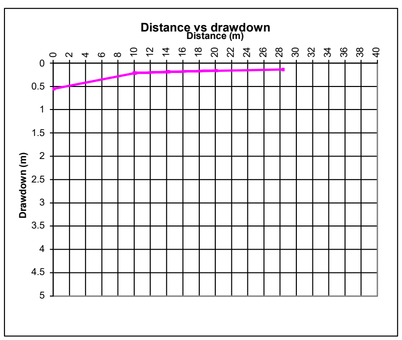
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	1.67E-07	1.50E+01	0.55
10.1	1.70E-03	5.80E+00	0.21
20.1	6.73E-03	4.43E+00	0.16
10.0	1.67E-03	5.82E+00	0.21
14.2	3.37E-03	5.12E+00	0.19
28.4	1.34E-02	3.75E+00	0.14



Drawdown at centre of foundation

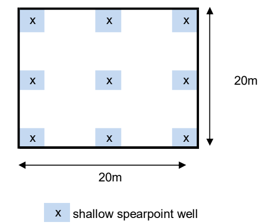
Distance (m)	u	W(u)	Drawdown (m)
0.1	1.67E-07	1.50E+01	0.55
10.0	1.67E-03	5.82E+00	0.21
14.1	3.33E-03	5.13E+00	0.19



9.0 bores
23 flow rate per bore (cu.m/day)
207.0 m3/day (total)
2.40 L/sec

Foundation dimensions
25 m diameter
12.50 m radius
490.874 Area
22 m : Eqvlnt square

aquifer thickness	2	
hydraulic conductivity	25	m/day
T	**50**	**m2/day**



Pit length 20 m — Pit width 20 m
No. Bores 9.0

Distance drawdown estimates

Drawdown at each perimeter well 0.1 — **Ddn 2.00** m

x1	x1	x1	x2	x2	x2
0.1	10.1	20.1	10.0	14.2	28.4
0.55	0.21	0.16	0.21	0.19	0.14

Centre of foundation 11 — **Ddn 2.15** m

x1	x4	x4
0.1	10.0	14.1
0.55	0.21	0.19

Distance from foundation edge (m) 25 — **Ddn 1.09** m

x1	x1	x1	x2	x2	x2
25.0	35.0	45.0	26.9	36.4	49.2
0.15	0.12	0.10	0.14	0.12	0.10

Distance from foundation edge (m) 50 — **Ddn 0.75** m

x1	x1	x1	x2	x2	x2
50.0	60.0	70.0	51.0	60.8	72.8
0.10	0.08	0.07	0.10	0.08	0.07

Distance from foundation edge (m) 150 — **Ddn 0.22** m

x1	x1	x1	x2	x2	x2
150.0	160.0	170.0	150.3	160.3	171.2
0.03	0.02	0.02	0.03	0.02	0.02

Distance from foundation edge (m) 210 — **Ddn 0.10** m

x1	x1	x1	x2	x2	x2
210.0	220.0	230.0	210.2	220.2	230.9
0.01	0.01	0.01	0.01	0.01	0.01

Client :	**Neoen Australia Pty Ltd**	Location :	**Nr Nelson, Vic**
Project :	**Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**		

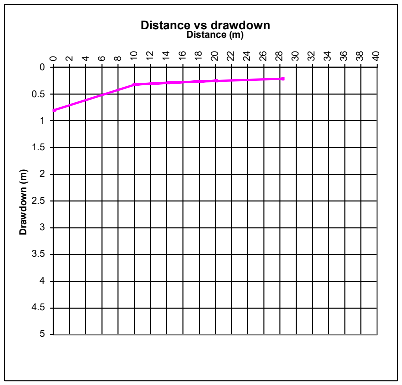
Calculate Drawdown (s) for known Discharge (Q) — THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	49
Corresponding pumping rate (L/s):	0.5671
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	75
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	1470.00
(m3/hr)	2.04

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give
hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05,
Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

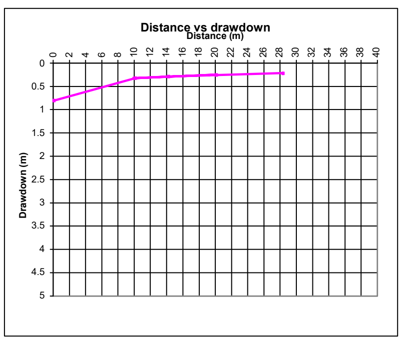
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	1.11E-07	1.54E+01	0.80
10.1	1.13E-03	6.21E+00	0.32
20.1	4.49E-03	4.83E+00	0.25
10.0	1.11E-03	6.23E+00	0.32
14.2	2.24E-03	5.52E+00	0.29
28.4	8.93E-03	4.15E+00	0.22



Drawdown at centre of foundation

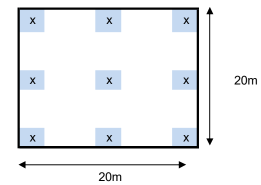
Distance (m)	u	W(u)	Drawdown (m)
0.1	1.11E-07	1.54E+01	0.80
10.0	1.11E-03	6.23E+00	0.32
14.1	2.22E-03	5.53E+00	0.29



9.0 bores
49 flow rate per bore (cu.m/day)
441.0 m3/day (total)
5.10 L/sec

Foundation dimensions
25 m diameter
12.50 m radius
490.874 Area
22 m : Eqvlnt square

aquifer thickness	3	
hydraulic conductivity	25	m/day
T	**75**	**m2/day**



Pit length 20 m — Pit width 20 m
No. Bores 9.0

x shallow spearpoint well

Distance drawdown estimates

Drawdown at each perimeter well 0.1 — **Ddn 3.03 m**

x1	x1	x1	x2	x2	x2
0.1	10.1	20.1	10.0	14.2	28.4
0.80	0.32	0.25	0.32	0.29	0.22

Centre of foundation 11 — **Ddn 3.25 m**

x1	x4	x4
0.1	10.0	14.1
0.80	0.32	0.29

Distance from foundation edge (m) 25 — **Ddn 1.73 m**

x1	x1	x1	x2	x2	x2
25.0	35.0	45.0	26.9	36.4	49.2
0.23	0.19	0.17	0.22	0.19	0.16

Distance from foundation edge (m) 50 — **Ddn 1.25 m**

x1	x1	x1	x2	x2	x2
50.0	60.0	70.0	51.0	60.8	72.8
0.16	0.14	0.12	0.16	0.14	0.12

Distance from foundation edge (m) 150 — **Ddn 0.44 m**

x1	x1	x1	x2	x2	x2
150.0	160.0	170.0	150.3	160.3	171.2
0.05	0.05	0.04	0.05	0.05	0.04

Distance from foundation edge (m) 210 — **Ddn 0.24 m**

x1	x1	x1	x2	x2	x2
210.0	220.0	230.0	210.2	220.2	230.9
0.03	0.03	0.02	0.03	0.03	0.02

Client : **Neoen Australia Pty Ltd** Location : **Nr Nelson, Vic**

Project : **Kentbruck GPH EES Project: Technical Report - Groundwater Impact Assessment**

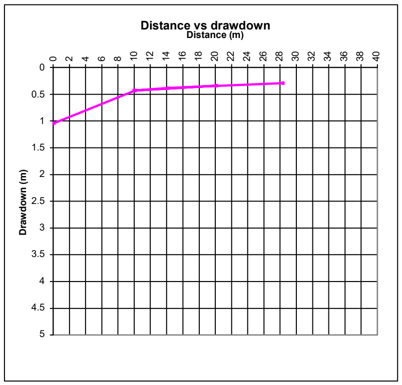
Calculate Drawdown (s) for known Discharge (Q) THEIS Analytical Solution (Theis, 1935)

	INPUTS
Pumping rate of well (m3/day):	83
Corresponding pumping rate (L/s):	0.9606
Storage coefficient (s) of aquifer:	0.1
Transmissivity (m2/day):	100
Time since pumping started (days):	30
time (hrs)	720.0
Volume produced during Test (KL):	2490.00
(m3/hr)	3.46

NOTE 1: Estimating 'T' from specific capacity data use:
[log t = -2.31 +0.81 log (spec cap)]
NOTE 2: If using 'T', divide by saturated thickness to give hydraulic conductivity (T=kB)
NOTE 3: Estimates of S (conservative): Unconfined=0.05, Semi=0.005, Confined=0.00005
NOTE 4: To convert Gallons/minute to litres/sec, divide by 13.2
NOTE 5: To convert litres/sec to cubic metres/day, multiply by 86.4

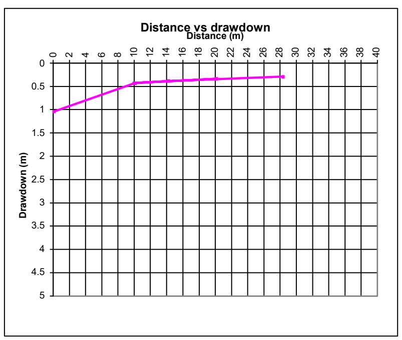
Drawdown at each shallow 'spearpoint'

Distance (m)	u	W(u)	Drawdown (m)
0.1	8.33E-08	1.57E+01	1.04
10.1	8.50E-04	6.49E+00	0.43
20.1	3.37E-03	5.12E+00	0.34
10.0	8.33E-04	6.51E+00	0.43
14.2	1.68E-03	5.81E+00	0.38
28.4	6.70E-03	4.44E+00	0.29



Drawdown at centre of foundation

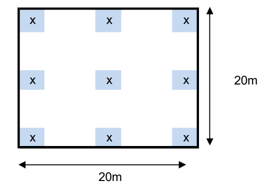
Distance (m)	u	W(u)	Drawdown (m)
0.1	8.33E-08	1.57E+01	1.04
10.0	8.33E-04	6.51E+00	0.43
14.1	1.67E-03	5.82E+00	0.38



9.0 bores
83 flow rate per bore (cu.m/day)
747.0 m3/day (total)
8.65 L/sec

Foundation dimensions
25 m diameter
12.50 m radius
490.874 Area
22 m : Eqvlnt square

aquifer thickness	4	
hydraulic conductivity	25	m/day
T	**100**	**m2/day**



x shallow spearpoint well

Pit length 20 m Pit width 20 m
No. Bores 9.0

Distance drawdown estimates

Drawdown at each perimeter well 0.1 — **Ddn** **4.02** m

x1	x1	x1	x2	x2	x2
0.1	10.1	20.1	10.0	14.2	28.4
1.04	0.43	0.34	0.43	0.38	0.29

Centre of foundation 11 — **Ddn** **4.30** m

x1	x4	x4
0.1	10.0	14.1
1.04	0.43	0.38

Distance from foundation edge (m) 25 — **Ddn** **2.37** m

x1	x1	x1	x2	x2	x2
25.0	35.0	45.0	26.9	36.4	49.2
0.31	0.27	0.23	0.30	0.26	0.22

Distance from foundation edge (m) 50 — **Ddn** **1.75** m

x1	x1	x1	x2	x2	x2
50.0	60.0	70.0	51.0	60.8	72.8
0.22	0.20	0.18	0.22	0.19	0.17

Distance from foundation edge (m) 150 — **Ddn** **0.70** m

x1	x1	x1	x2	x2	x2
150.0	160.0	170.0	150.3	160.3	171.2
0.08	0.08	0.07	0.08	0.08	0.07

Distance from foundation edge (m) 210 — **Ddn** **0.41** m

x1	x1	x1	x2	x2	x2
210.0	220.0	230.0	210.2	220.2	230.9
0.05	0.05	0.04	0.05	0.05	0.04

Appendix F

Groundwater supply assessment

Appendix F: Groundwater supply and hydrogeological assessment

1.0 Introduction

1.1 Objectives

The groundwater supply assessment was carried out as part of Neoen's Environment Effects Statement (EES) required for the Kentbruck Green Power Hub project ('**the Project**'). The purpose of the groundwater supply and hydrogeological assessment is to:

- assess the potential for groundwater to meet Project requirements
- inform the EES with respect to potential impact to groundwater users from a groundwater supply
- provide supporting information for any future groundwater take and use licence application

1.2 Scope of work

The scope of works carried out by AECOM included:

- field supervision for the drilling and installation of a test production bore (TB01) and monitoring bore (MB01)
- field supervision of the TB01 pumping tests
- collation of geological logging information, drilling observations, and pumping test data
- interpretation of pumping test data and estimates of aquifer parameters
- update EES groundwater technical report (AECOM, 2024) to include impact assessment of a groundwater supply
- completion of a hydrogeological assessment (this report) to:
  - inform the EES groundwater technical report (AECOM, 2024)
  - inform and support any future groundwater take and use application by Neoen in respect of the Project

1.3 Location

The site is in southwest Victoria to the east of Nelson, and generally refers to the wind farm plantation sub area described in AECOM (2024).

The test bore (TB01) and monitoring bore (MB01) are located on Nine Mile Road near the junction with Portland-Nelson Road, approximately 14 km east of Nelson. It is located within the Kentbruck Green Power Hub project area defined as part of the Environment Effects Statement (refer to **Figure 1, Attachment 1**).

The test bore location was chosen based on Neoen's anticipated logistical needs during Project construction, and the intent to locate it away from the potentially sensitive Ramsar wetland complex at the site's southern boundary. It is anticipated that this will allow the test bore to be used as one of the production bores for the Project, dependent on results of the assessment.

1.4 Project water supply requirements

Although the Project water supply requirements and daily extraction requirements are still to be finalised, the current conservative estimate is approximately 250 ML/yr of groundwater over a 24-month construction period.

Current estimates of the Project's construction phase water requirements are provided in Table 1, based on assumptions and estimates provided by Neoen. The maximum daily requirement will occur when dust suppression, soil moisture conditioning and foundation pouring is required. This could be in the order of 450,000 litres, or 5.2 L/sec based on a 24-hour pumping cycle.

No groundwater supply requirements are anticipated for the operational phase of the Project.

Table 1 Groundwater supply assumptions

Use	Rates	Totals (Megalitres)	Comments and assumptions
Dust suppression	100,000 litres per day	73	Over 24 months, assuming daily volume used for 730 days. Dust suppression usage likely to be far less during wetter months.
Concrete foundations	Up to 300,000 litres per foundation	35.4	For the proposed turbines. Half constructed in Year 1 and the remainder in Year 2. Foundations will be constructed in multiple pours over a number of days. Maximum daily requirement for foundations will be <150,000 litres
Soil moisture conditioning (roads, hardstand etc.)	Up to 200,000 litres per day	146	Over 24 months, assuming upper daily volume used for 730 days
TOTALS		254.4	Over project (24 months)
		127.2	Per year
Note: Concrete foundations requirements are conservative being based on the original 116 turbines rather than revised 105 turbines.			

Early liaison with SRW (in 2020/21) indicated that groundwater allocations would not be available from the Bridgewater Formation, which forms the Quaternary Aquifer, and is present at surface across the site. The target aquifer for the Project groundwater supply is therefore the Port Campbell Limestone which is part of the Upper Mid Tertiary aquifer (as defined in the Victorian Aquifer Framework).

The site location and target aquifer are within the South West Limestone Groundwater Management Area (SWL GMA):

- it applies to the Upper Mid Tertiary limestone aquifer, but not the overlying Quaternary and upper Tertiary aquifers
- no significant additional allocation is proposed under the South West Limestone Local Management Plan (SWL LMP) and trade will be the primary mechanism to increase access to groundwater (SRW, 2016).

The extraction of groundwater for Project construction will need to be made through temporary transfer of an existing licence allocation. At the time of writing there was approximately 80,000 ML/year of groundwater entitlement in the SWL GMA. With annual use typically between 40 and 50% there is currently a large pool of entitlement that is in theory available for temporary trading (SRW email dated 24 April 2023). All such applications would be in accordance with Section 40 of the Water Act and subject to the rules and limitations laid out in the relevant management plans.

2.0 Results of fieldwork

2.1 Drilling

Test bore (TB01) and monitoring bore (MB01) were drilled and installed between 3 February and 10 February 2022.

Bore construction logs are included as **Attachment 2**, and a summary of drilling observations is provided below:

<u>Test bore TB01</u>

- drilled using a tricone bit and air to 25 metres below ground surface (mbgs), with no water ingress noted
- from 25 to 54 mbgs the bore was drilled using mud rotary techniques to aid drill cuttings removal from the hole. No drilling mud losses were reported that would have indicated significant permeability through this section of the profile.
- cased from surface to 54 mbgs and a 200 mm diameter hole was drilled using tricone bit and air to 144 mbgs (total depth).
- water and drilling fluids were periodically injected to aid cuttings removal, with no significant water strikes or groundwater ingress observed between 54 and 80 mbgs
- water ingress was noted at approximately 90 mbgs and an increase in water production noted from around 120 mbgs

<u>Monitoring bore MB01</u>

- drilled approximately 15 metres south of TB01.
- mud rotary techniques were used to 24 mbgs, with loss of drill cuttings and drilling muds from approximately 11 mbgs due to a 'cavity' being intersected
- the hole was cased-off from surface to 24 mbgs
- a tricone bit with air was attempted from 24 to 34 mbgs but poor drill cutting returns required a change to mud rotary techniques from 34 to 130 mbgs (total depth)
- no significant water ingress was noted between 24 to 34 mbgs when drilling with air, and no significant mud loss was noted from 34 mbgs to total depth

The lithology encountered at TB01 and MB01 can be summarised as:

- 0 to 27 mbgs: silty sand and calcarenite (returned as sandy CLAY); interpreted to be Bridgewater Formation
- 27 to 144 mbgs: limestone (returned as pale grey CLAY with fine sand); interpreted to be Port Campbell Limestone

The geology encountered was consistent with regional geology that points to variable thicknesses of Bridgewater Formation (BF) overlying the Port Campbell Limestone (PCL) in this area (Section 4.2).

<u>Yield and water quality</u>

Bore TB01 was airlift developed for several hours. Although a steady airlift flow rate was not achieved, the yield was estimated to vary between 5 and 15 litres per second.

The airlifted groundwater from TB01 was measured in the field as having an electrical conductivity of 660 uS/cm, or approximately 450 mg/L as total dissolved solids[1].

2.2 Bore construction

A construction summary is provided in Table 2 and bore construction figures are included as **Attachment 2**.

[1] Where TDS is approximated as 0.68 x EC

Table 2 Bore construction summary

Bore name	Ground elevation (mAHD)	Casing	Screened interval	Airlift yield (L/sec)	TDS (mg/L)
TB01	41.11	203mm ND uPVC: +0.47 to 54mbgs	200mm open hole: 54 to 144mbgs [-12.89 to -102.89 mAHD]	5 – 10	450
MB01	41.07	150mm ND uPVC: +0.71 to 24mbgs 50mm ND uPVC: +0.71 to 100mbgs	50mm uPVC slotted screen: 100 to 130mbgs [-58.93 to -88.93 mAHD]	-	-

Note: mAHD – metres Australian Height Datum; ND – nominal diameter; mbgs – metres below ground level; L/sec – litres per second; TDS – total dissolved solids; mg/L – milligrams per litre

2.3 Pumping test

Agmek Ballarat Pty Lid was engaged as a specialist pumping test contractor and the pumping tests were supervised by AECOM Australia Pty Ltd.

A step test was attempted on 22 March 2022, and a constant rate test (CRT) was subsequently completed on the 24 and 25 March 2022.

Data loggers were installed in TB01 and MB01, together with one barometric logger to allow correction of water levels due to changes in atmospheric pressure. Data loggers were already installed in shallow monitoring wells MW04 to MW09 as part of ongoing EES and data for the pumping test period were reviewed as part of this hydrogeological assessment (refer to **Figure 1, Attachment 1** for monitoring well locations).

2.3.1 Step test

A step-drawdown test monitors pumping well performance by increasing the pumping rate through (typically) three to five steps for equal periods of between 30 and 60 minutes (typically). This allows the efficiency of the well to be determined as the yield is increased and to correctly size the pump for a constant rate test.

In consultation with the pumping test contractor and client it was agreed that the submersible pump should not be lowered beyond the cased section (approximately 54 mbgs) to protect the pump. This allowed the pumped water level in the bore to fall by approximately 23 metres (the available drawdown[2]) before it reached the pump inlet depth.

Based on airlift yields estimated in the field, it was proposed to carry out a step test (and subsequent constant rate test) using a 150 mm diameter submersible pump; capable of achieving rates in the order of 4 to 20 L/sec.

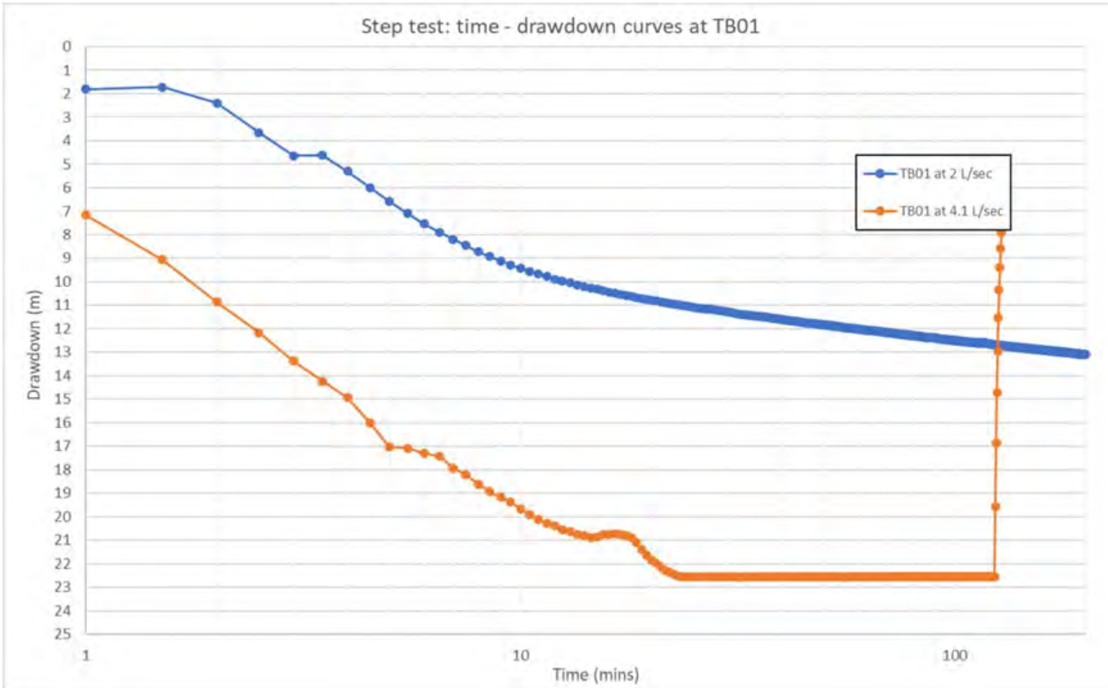
On 22 March 2022 a step test was started using an initial flow rate of at 4.1 L/sec. After 20 minutes the water level had fallen below the data logger and was close to the pump inlet depth leading to fluctuations in flow rates. Pumping was continued for a further 100 minutes to further develop the bore prior to the test being stopped.

The pumping test contractor demobilised and returned with a 100 mm diameter submersible pump. Due to time constraints a full step test was not attempted and instead a flow rate of 2 L/sec was selected and the 24-hour constant rate test began at 09:45 AM on 24 March 2022.

Although a full step test was not completed, the time-drawdown responses in TB01 have been compared in Plate 1 for pumping rates of 2 L/sec and 4.1 L/sec.

[2] Where the available drawdown is the distance between the initial water level (approx. 29 mbgs) and the pump inlet (52 mbgs).

Plate 1 TB01 distance-drawdown at 2 L/sec and 4.1 L/sec



The specific capacity of the bore is a measure of how readily a well can yield groundwater and is estimated by dividing the pumping rate by the drawdown (at a particular time). The specific capacity is expected to decrease as the extraction rate is increased, and so a doubling of yield produces greater than twice the drawdown in the pumping well.

The decrease in specific capacity with increased extraction rate is due to the increasing velocity of groundwater flow through discrete fracture sets in the limestone aquifer, leading to turbulent flow within the fractures and a reduced ability to readily transmit water to the bore. Greater additional drawdown occurs for a given increase in extraction rate due to these increased 'well losses'. The yield will finally be limited by the magnitude of the 'well losses', the aquifer parameters, and the available drawdown within the bore.

Although there is little change in the specific capacity of TB01 at 10 minutes due to an increase from 2 L/sec to 4.1 L/sec, a more meaningful comparison at 60 or 100 minutes is not possible. Changes in specific capacity cannot be made for higher extraction rates to determine a maximum sustainable bore yield.

A yield of 2 L/sec appears sustainable, however a full assessment of greater pumping rates was limited by the available drawdown; due to the pump being placed within the casing at 54 mbgs. A greater yield could be sustained if the pump was placed in the open hole section to provide greater available drawdown. The maximum sustainable yield would be confirmed as part of full-scale water supply investigation, in consultation with SRW, carried out during the groundwater take and use licence application process.

2.3.2 Constant rate test

A constant rate test (CRT) monitors groundwater level response in monitoring bores (and pumping well) as a constant extraction rate is maintained over a specified period. A comparison of the time-drawdown response with time-drawdown type curves (such as Theis, Neuman, and Hantush-Jacob) allows the hydrogeological setting to be determined in terms of a confined, unconfined, or leaky confined aquifer system.

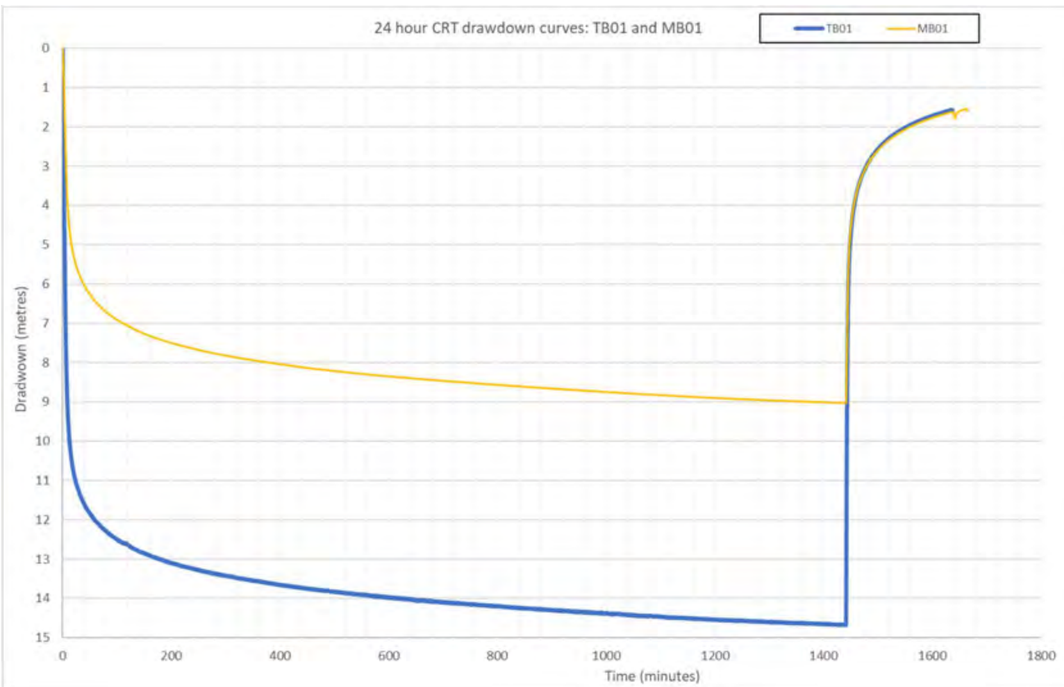
A 24-hour constant rate test was carried out at 2 L/sec and groundwater level responses were measured using data loggers at the test bore TB01, nearby monitoring bore MB01, and shallow monitoring bores MW05 and MW07.

The time-drawdown responses of groundwater levels in TB01 and MB01 are provided in Plate 2 for the pumping and subsequent recovery phase of the test. No responses occurred in monitoring bores MW05 or MW07 (the closest MW0x series of shallow bores). Groundwater level hydrographs for the test period are provided in **Attachment 3**.

After the initial steep drawdown response, the same stabilised rate of drawdown is observed at the pumping bore TB01 and nearby monitoring bore MB01. After 24-hours of pumping the drawdown was 14.7 m in TB01 and 9.0 m in MB01.

The time-drawdown responses are used to estimate aquifer parameters (Section 3.0) and subsequently used to estimate drawdowns at specified times and distances (Section 5.0).

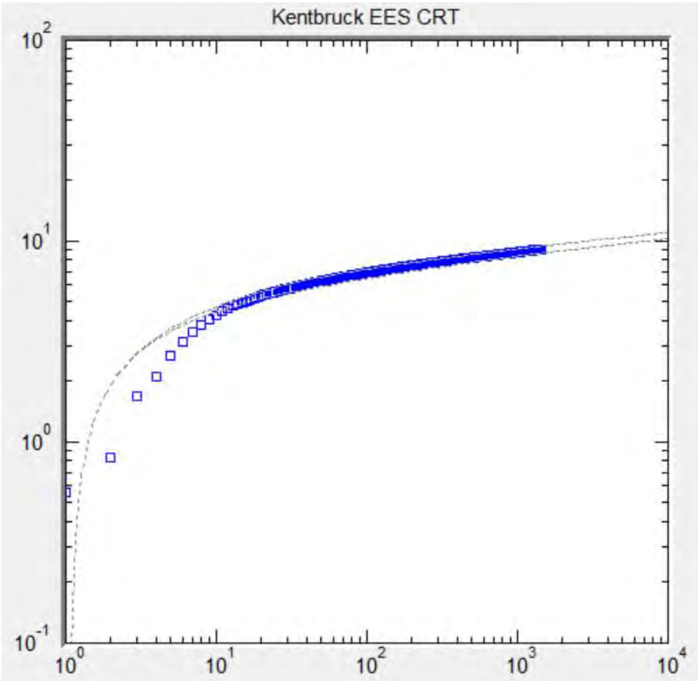
Plate 2 Constant rate pumping test: time-drawdown curves



3.0 Interpretation of aquifer parameters

The time-drawdown curves for TB01 and MB01 are indicative of a confined aquifer response for the 24-hour constant rate pumping phase (refer to Plate 3 showing late-time good fit for MB01 response compared to the Theis confined aquifer type curve). This is consistent with the lithology and water strike observations during drilling that suggest a lower permeability limestone matrix above and between distinct fractures/preferential flow horizons.

Plate 3 MB01 time-drawdown response (blue squares) compared to Theis type curves (black dashed)



The constant rate displacement and recovery data of the monitoring bore MB01 were therefore analysed in Aqtesolv Pro 4.0 using several confined aquifer solution methods. The analyses were undertaken to provide an estimate of the transmissivity (T) and storativity (S) of the targeted aquifer.

Results of the analyses are summarised in Table 3, and Aqtesolv output plots are provided as **Attachment 4**.

Table 3 Estimated aquifer parameters

Analytical solution	Comments	Transmissivity (m^2/day)	Storativity (-)
Theis	Pumping phase	16.4	4.9 x 10^{-5}
	Recovery phase	15.6	1.3 (S/S')#
Cooper-Jacob	Pumping phase	17.1	2.4 x 10^{-6}
Papadopulos-Cooper	Pumping phase	17.3	2.4 x 10^{-6}
	Pumping and recovery phase	18.8	1.2 x 10^{-6}
Upper value		18.8	4.9 x 10^{-5}
Lower value		15.6	1.2 x 10^{-6}
Geometric mean		17.0	4.3 x 10^{-6}
NOTE: # - Theis analysis of the recovery data provides a ratio between pumping S and recovery S. Ratio S/S' > 1 suggests a potential recharge mechanism.			

The transmissivity values are consistent with the 16 m^2/day estimated from the empirical relationship between the discharge rate and drawdown within a pumping well (Driscoll, 1989):

$$\frac{Q}{s} = \frac{T}{2000}$$

$$where\ Q\ is\ the\ yield\ of\ well\ in\ gpm;\ s\ is\ drawdown\ in\ feet\ and\ T\ is\ transmissivity\ in\ gpd/ft$$

Literature values for the hydraulic conductivity (K) of fractured carbonate rock include ranges in the order of 0.001 to 1 m/day (Kruseman & De Ridder, 2000). The site-specific bulk hydraulic conductivity (K) range estimate of between 0.11 to 0.17 m/day is consistent with this literature range[3].

The estimated storativity values (S) of between 1.2 x 10^{-6} and 4.9 x 10^{-5} are at the lower end of literature values for confined aquifers; reported to be between 5 x 10^{-5} and 5 x 10^{-3} in Kruseman & De Ridder (2000).

It is recognised that the hydraulics of a limestone aquifer can be complex with preferential flow via distinct fractures and/or fracture sets, and possible interporosity flow between the aquifer rock matrix and fractures. However, given the degree of fit with the solutions presented, the analysis is considered suitable for the purpose of estimating bulk hydraulic parameters and estimating future drawdowns (Section 5.0) and impacts from the extraction bore (Section 6.0).

3.1 Confined versus unconfined system

The drawdown at specified times and distances can be estimated using the aquifer parameters determined from the CRT and the Theis approximation for a confined aquifer.

As discussed in Section 2.3.2, the time-drawdown responses recorded over the 24-hour CRT pointed to a confined response with a low storativity value and (relatively low) transmissivity value.

A summary of predicted drawdowns is provided in Table 4 and detailed output files provided in **Attachment 5**; where the extraction rate is 2 L/sec, T is 17 m^2/d and S is 4.3 x 10^{-6}. Environmental Canterbury's excel drawdown analytical model of the University of Canterbury, Christchurch, New Zealand was used.[4]

Table 4 Drawdown estimates for confined system (at 2 L/sec continuous pumping)

Distance from TB01 (m)	Comment	Time (in days)			
		1	30	365	730
0.5	at TB01	14.1	16.8	18.8	19.4
14	at MB01	8.7	11.4	13.4	14.0
3200	at MW05 and MW07	0.3	2.7	4.7	5.2

The estimated drawdown responses at TB01 (14.1 m) and MB01 (8.7 m) are consistent with those measured at the end of the 24-hour CRT (refer to Plate 2). The estimated drawdowns at MW05 and MW07 were not evident in data logger measurements at those locations. This is because the estimated drawdowns represent a confined pressure response at depth within the limestone aquifer and these are not estimated changes to shallow groundwater pressures and/or water table levels.

Over time downward leakage from the overlying shallow system may be induced into the deeper system because of gravitational drainage (delayed yield) or changes in vertical hydraulic gradients. This would need to be assessed through groundwater monitoring during longer-term operational pumping (refer to Section 8.0).

It is important to note that if there was a good interconnection between shallow groundwater and the deep extraction well TB01, the system would begin to behave as an unconfined or a well-connected

[3] Where K is transmissivity divided by aquifer thickness; with aquifer thickness between 100 to 150m and geometric mean of 17m^2/day used for T.
[4] accessed via https://www.ecan.govt.nz/your-region/your-environment/water/tools-and-resources/)

leaky confined system (semi-confined). The greater storage available to meet extraction would lead to a much-reduced extent of drawdown compared to that of a confined aquifer.

As a simple example, drawdown in an unconfined system can be estimated by using an unconfined storativity (or specific yield). For a conservatively low S of 0.01[5] in the Theis approximation, the unconfined drawdown estimates are summarised in Table 5 and output files are provided in **Attachment 5**.

No water table drawdown would be anticipated at 3,200 m from TB01 (at MW05 and MW07) after 365 days of pumping at 2 L/sec; compare to the estimated 4.7 m of reduced pressure response in the deep, confined aquifer scenario (Table 4).

Table 5 Drawdown estimates for unconfined system (at 2 L/sec continuous pumping and specific yield of 1%)

Distance from TB01 (m)	Comment	Time (in days)			
		1	30	365	730
0.5	at TB01	7.8	10.5	12.6	13.1
14	at MB01	2.4	5.2	7.2	7.7
3200	at MW05 and MW07	0.0	0.0	0.0	0.0

4.0 Hydrogeological setting

The hydrogeological setting is detailed in *Kentbruck Green Power Hub Project EES: Groundwater Impact Assessment* (AECOM, 2024) and key aspects relating to the water supply assessment are summarised here.

4.1 Climate

The area has a temperate climate of warm, dry summers and cool, wet winters. Mean annual rainfall in the study area is in the order of 800 millimetres per year (refer to Table 6).

Table 6 Mean monthly and annual rainfall (in millimetres)

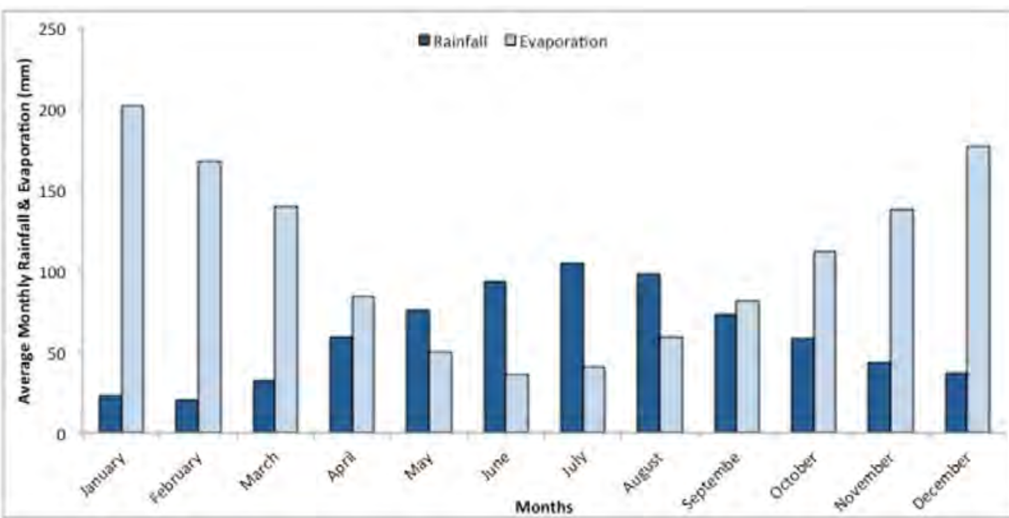
Month	Nelson (BoM ID 90059) [1884 – 2019]	Mount Richmond (BoM ID 90050) [1940 – 2013]	Cape Bridgewater (BoM ID 90013) [1905 – 2022]
January	29.8	38.5	33.4
February	29.0	35.2	32.6
March	37.5	53.0	41.5
April	59.9	73.9	63.4
May	81.0	100.4	87.3
June	96.4	114.0	99.2
July	107.0	133.3	113.5
August	99.1	124.1	105.7
September	74.6	90.8	80.4

[5] Literature values include an unconfined storativity (or specific yield) of 0.14 (Heath, 1983) and 0.18 (Morris and Johnson, 1967) for a limestone.

Month	Nelson (BoM ID 90059) [1884 – 2019]	Mount Richmond (BoM ID 90050) [1940 – 2013]	Cape Bridgewater (BoM ID 90013) [1905 – 2022]
October	61.4	78.6	65.6
November	46.3	61.0	51.6
December	40.6	53.2	46.9
Annual	***765***	***971***	***829***
Notes: 1 – Nelson data only available up to 2019; 2 – Mount Richmond closed in January 2014			

The nearest Bureau of Meteorology (BOM) site with evaporation statistics is Mount Gambier in South Australia (BoM station ID 026021), approximately 35 km to the northwest. The mean monthly evaporation at Mount Gambier was compared to the rainfall at Nelson in the *Glenelg Estuary and Discovery Bay Ramsar Site: Ecological Character Description* report (DELWP, 2017). This suggests that recharge of groundwater in the study area will be winter dominated, with monthly rainfall likely to exceed evaporation during winter months (for example, May to August), but be lower than monthly evaporation through other parts of the year (refer to Plate 4).

Plate 4 Mean monthly rainfall and evaporation



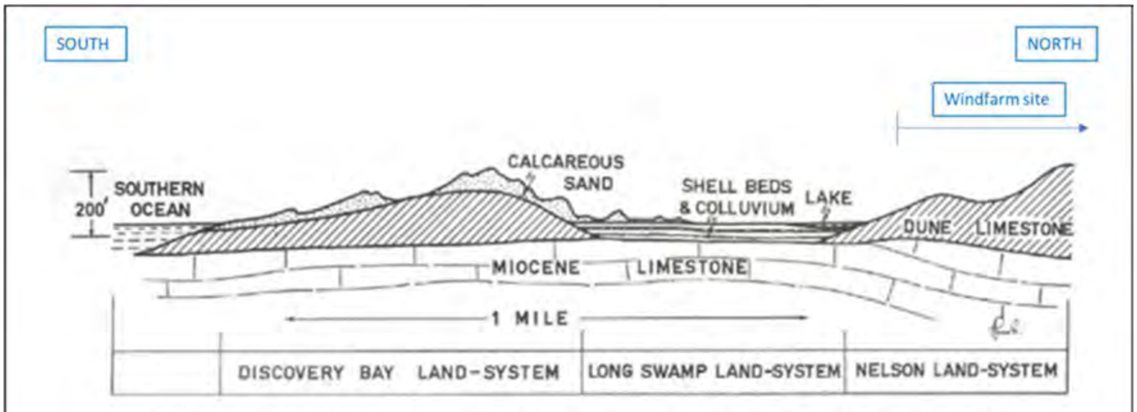
Source: Figure 21 of DELWP (2017)

4.2 Geology and hydrostratigraphy

The geology of the site comprises predominantly aeolian, calcareous dunes and dune limestone (the Bridgewater Formation) overlying Port Campbell Limestone. Some coastal dunes and minor swamp deposits are present directly to the south of the wind farm site.

A generalised cross section showing the key landforms and geology is provided in Plate 5.

Plate 5 Generalised landform cross section



Landscape diagram showing the position of the three dominant land-systems "Discovery Bay", "Long Swamp" and "Nelson" on a transect running inland from the ocean (Gibbons and Downes 1964).

Source: Adapted from Figure 24 of DELWP (2017a)

The key aquifers are the Quaternary Aquifer (QA) and Upper Mid-Tertiary Aquifer (UMTA).

The QA includes various aeolian deposits, fluvial, lacustrine, alluvial and colluvial sediments. The predominant QA unit is the Bridgewater Formation which is present at surface across the site. The unit varies in thickness from less than five metres at the southern boundary to more than 30 metres as the depth of QA cover increases to the north.

Underlying the QA is the Upper Mid Tertiary Aquifer (UMTA), which includes the Port Campbell Limestone (PCL) in southwest Victoria (equivalent to the Gambier Limestone in South Australia). The PCL comprises a stack of thinly deposited repetitive cycles dipping to the south. It typically consists of grey unconsolidated to semi-consolidated, and rarely lithified, muddy carbonate sands and lesser sandy muds with minor quartz and clay (Radke et al, 2022).

The UMTA is thought to be near surface at the southern boundary of the windfarm sub-area, being beneath a relatively thin sequence of QA[6]. To the north the UMTA is covered by a thicker sequence of QA in the order of up to 30 metres.

The water table is hosted by the QA or the UMTA, dependent on the groundwater elevation compared to the top of UMTA elevation. There is no significant aquitard between the QA and UMTA, which are in direct hydraulic connection and essentially act as one hydrogeological unit (SRW, 2011). Although on a regional scale the QA and UMTA are considered well connected, there will be variabilities in the degree of interconnection based on local scale changes in lithology and aquifer properties.

The geology encountered in shallow monitoring wells MW01 – MW09 (AECOM, 2024), and in TB01 and MB01 (Section 2.0) was consistent with the regional geology.

[6] Based on top of aquifer unit mapping from Victorian Aquifer Framework

4.3 Groundwater occurrence and flow

Groundwater levels gauged in on-site bores are summarised in Table 7 and locations shown in **Figure 1**, **Attachment 1**.

Table 7 Groundwater level data (27 April 2021) [based on AECOM, 2024]

Bore ID	Ground level (mAHD)	Top of screen (mbgs)	Base of screen (mbgs)	Monitored lithology	Depth to water (mbgs)	Groundwater elevation (mAHD)
MW01	12.9	6	9	Sand	7.6	5.3
MW02	9.1	3.5	6.5	Sand	4.3	4.7
MW03	12.8	6	9	Sand	7.7	5.0
MW04	7.3	1	4	Sand	1.6	5.7
MW05	13.2	7	10	Sand	7.5	5.8
MW06	7.5	2	5	Sand	3.0	4.5
MW07	14.5	5.5	8.5	Sand	6.4	8.1
MW08	8.3	1	4	Sand	1.8	6.6
MW09	13.6	3	6	Sand	4.6	9.0
65058[a]	51.7	12	47.4	Limestone	40.9	10.8
65152	28.4	30.5	36.6	Limestone	23.5	4.9
101238	34.6	0	29	Not known	18 - 21	13 - 16
101241	39.9	Total depth 11.2 metres		Not known	10.79	24.51 (16.50)[b]
101242	39.9	27.4	30.5	Sand	26.5	13.4
101246	25.1	25.7	32	Sandstone	13 - 15	10 - 12
142176	25.1	-	-	Not known	22.9	5.1
MB01	41.07	100	130	Limestone	29.57[c]	12.21
TB01	41.11	54	144	Limestone	29.34[c]	12.25

NOTES: mAHD is metres above Australian Height Datum; a - Data from State Observation Bore Network (SOBN) data between 6 June 2016 and 25 April 2021; b - Expected groundwater elevation of 16.5 mAHD based on nearby bores and groundwater hydraulic gradient for rest of site; c gauged on 23 March 2022.

The considerable variations in depths to the water table (from 1.8 to 40.9 mbgs) are due to the flat water table relative to the undulating ground surface. As seen in the conceptual cross section (**Figure 2, Attachment 1**), the depth to groundwater is shallow in the lower lying areas close to the Ramsar wetland complex and increases beneath higher topography away from the coast. This is consistent with the water table typically being a subdued expression of topography.

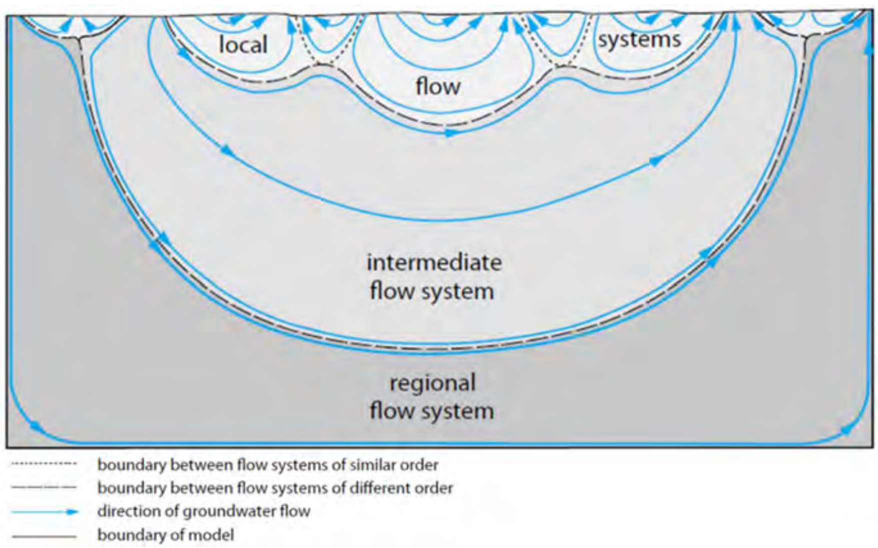
It is inferred that there is a groundwater divide in the shallow groundwater system beneath the higher topography; between the lower lying groundwater discharge areas to the south (i.e. the coast and Ramsar wetland complex), and the north (i.e. the Glenelg River).

Inferred groundwater elevation contours for the shallow local groundwater flow system are oriented approximately parallel to the coast, and groundwater flow beneath the site is towards the Ramsar wetlands and the coast (refer to **Figure 3, Attachment 1**). In the QA and shallow portions of the UMTA local groundwater flow systems dominate, with relatively short flow paths between recharge at topographically elevated areas and discharge at topographically depressed lakes, streambeds and springs (Jacobs, 2015). Aquifer testing at shallow monitoring bores MW01 - MW09 showed the hydraulic conductivity of the QA and upper most portions of the UMTA to be in the order of 4 to 65 m/day, and a geometric mean of 20 m/day (AECOM, 2024).

Groundwater movement within the deeper portions of the UMTA occurs as intermediate to regional scale flowpaths. These longer flowpaths are less influenced by local scale topographical highs and lows. This throughflow beneath the site is from regional scale recharge areas at the margins of the basin (north), to regional discharge areas at or beyond the coast (south).

A diagrammatic representation of groundwater flow systems is presented in Plate 6.

Plate 6 Regional, intermediate and local flow systems



Source: Figure 4.1 - Bush (2015)

4.4 Groundwater recharge and discharge

Recharge to the upper portions of UMTA (the Portland Limestone in this area) occurs directly as rainfall recharge where it outcrops or sub-crops beneath shallow depths of unsaturated permeable QA sediments (the Bridgewater Formation this area), or via downward leakage from overlying QA sediments where they are saturated, and vertical head gradients allow. Recharge to the deeper UMTA will occur via leakage from overlying portions of the UMTA or up-dip to the north where it outcrops or sub-crops towards the margins of the Basin.

In the QA and shallow portions of the UMTA local groundwater flow systems dominate, with relatively short flow paths between recharge at topographically elevated areas and discharge at topographically depressed lakes, streambeds and springs (Jacobs, 2015). At the proposed wind farm site, discharge of shallow groundwater in the QA and upper UMTA is to the Ramsar wetland complex at the southern boundary of the proposed windfarm site; approximately 3.5 km south of TB01 (AECOM, 2024).

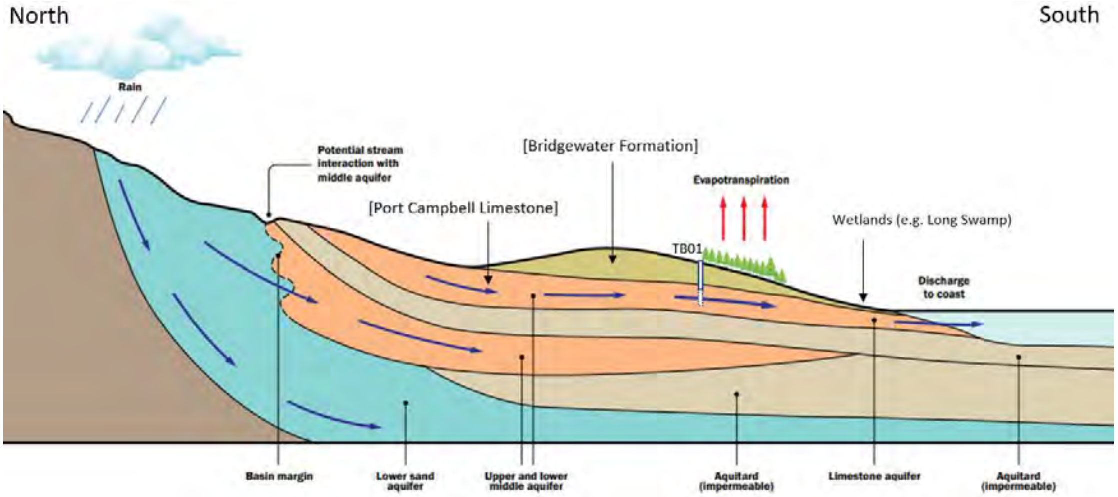
There appears to be limited potential for significant upward leakage from the deeper confined to semi-confined UMTA (targeted by TB01) into the Ramsar wetlands complex based on:

- generally low permeability limestone overlying and between distinct fractures intersected at depth in TB01
- significant water strikes/fractures in TB01 were approximately 40 m and >70 m below the elevation of the wetland complex

- UMTA dipping to the south indicates fractures targeted by TB01 unlikely to be directly connected to Ramsar wetland complex
- confined response during the CRT at TB01

Although groundwater-surface water interaction does occur between shallow groundwater in the QA and upper portions of the UMTA, discharge from deeper sections of the confined to semi-confined UMTA targeted by TB01 is likely to be offshore (refer to Plate 7). This occurs near shore in the shallow submarine zone caused by density differences with fresher groundwater forced upwards by the denser 'saline wedge' (Bush, 2009).

Plate 7 Regional scale cross section schematic



Source: Modified from South West Victoria Groundwater Atlas; cross section page 40 (SRW, 2011)

The limited connection anticipated between the deeper portions of the UMTA and Ramsar wetlands would be confirmed during full-scale water supply assessment, in consultation with SRW as part of a groundwater take and use application.This could include drilling monitoring well(s) into the UMTA between TB01 and the wetlands, and/or adjacent to the wetlands. The deeper monitoring bore(s) could be co-located with the existing MW0x series of shallow monitoring bores.

4.5 Groundwater salinity and environmental values

A groundwater sample was collected for laboratory analysis from bore TB01 on 22 March 2022, after 100 minutes of pumping at 4.1 L/sec (e.g. at the end of the aborted step test discussed in Section 2.3.1). The laboratory derived total dissolved solids concentration was 452 mg/L.

The groundwater salinity is therefore within Segment A1 (0 to 600 mg/L), as defined in the Environmental Reference Standard. The environmental values that need to be achieved and maintained for Segment A1 are highlighted in Table 8.

Table 8 Environmental values of groundwater

Beneficial Use	Segment (TDS mg/L)						
	A1 (0-600)	A2 (601-1200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,000)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓		✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures;	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

4.6 Groundwater management

The site lies within several overlapping groundwater management precincts:

- South West Limestone Groundwater Management Area (SWL GMA):

  Applies to the Upper Mid Tertiary limestone aquifer, but not the overlying Quaternary and upper Tertiary aquifers (including QA and UTB) which form the upper shallow aquifer within the study area.

  No significant additional allocation is proposed under the South West Limestone Local Management Plan (SWL LMP) and trade will be the primary mechanism to increase access to groundwater (SRW, 2016).

- South Australian-Victoria Border Groundwater Agreement (Zone 1B)

  The South Australian – Victorian Border Agreement was enacted in 1985, establishing a Designated Area extending 20 km either side of the border. The Project is within Designated Zone 1B of the Designated Area.

  The Designated Zone includes all aquifers, with extraction principally from the Tertiary Limestone Aquifer (the UMTA) and Tertiary Confined Sands (the Lower Tertiary Aquifer - LTA). Limits on extractions are referred to as Permissible Annual Volumes and apply to each aquifer and each zone.

4.7 Registered bores

A search of the WMIS database on 8 July 2022 identified nine 'used' bores mapped within 5 km of test bore TB01. Five are for consumptive use, and three are potentially for consumptive use (being designated as unknown or miscellaneous use). One is recorded as being an observation bore.

An additional bore with the status of 'not used' (ID 101245) was mapped at approximately 4.5 km from TB01.

A summary of the nine registered 'used' bores within 5 km of TB01 is provided in Table 9 and locations provided in Plate 8.

An unregistered bore was found approximately 250 metres north of TB01 by AECOM during the drilling program; nominated as bore UK01 in this report. Total depth was measured at 21.87 mbgs and the standing water level was 10.99 mbgs. The screened interval, condition and purpose of the bore is unknown (although no pumping equipment was present at the time of the TB01 pumping test).

The depth and screened interval of bore 101243 appears to be anomalous given its mapped location. Further, the bore could not be located by AECOM during various site visits and was not known to landholders.

No additional bores were located during various site visits conducted by AECOM as part of this water supply hydrogeological assessment and the broader groundwater impact assessment as part of the EES project.

Table 9 Registered bores within 5 km of TB01

WMIS bore ID	Ground elevation mAHD	Total depth mbgs [mAHD]	Screened interval mbgs [mAHD]	Standing water level[1] mbgs	Use	Distance from TB01 (metres)
101241	39.86	13.5 [26.16]	NK	~11.5	State Observation Network; Stock	275
101240	30.04	NK	NK	~17.5	Not known	1925
WRK974069	50.35	36 [14.35]	NK	-	Domestic and stock	2956
101244	39.76	25 [14.76]	21.4 – 25 [18.36 to 14.76]	-	Miscellaneous	2990
101242	40.56	30.48 [10.08]	27.43 - 30.48 [13.13 to 10.08]	~27	Stock	3877
101243	35.43	4.5 [30.87]	1 - 4.5 [34.43 to 30.93]	-	Stock	4176
101246	25.07	32 [-6.93]	25.7 – 32 [-0.63 to -6.93]	~14.5	Agro industries; Observation; State Observation Network	4670
101238	34.62	29 [5.62]	0 – 29 [34.62 to 5.62]	~21	Observation; Groundwater investigation; State Observation Network	4765

WMIS bore ID	Ground elevation mAHD	Total depth mbgs [mAHD]	Screened interval mbgs [mAHD]	Standing water level[1] mbgs	Use	Distance from TB01 (metres)
101234	49.68	30.48 [19.20]	NK	-	Not known	4820
NOTE: 1 – standing water levels have been approximated where possible based on a combination of WMIS database, gauging data (AECOM, 2024) and inferred contours (ref: Figure F9 of AECOM, 2024)						

Plate 8 Registered groundwater bores (modified from WMIS)

The registered consumptive use bores appear to target the upper groundwater system (QA and upper UMTA) when compared with the deeper open hole section of TB01 from -12.9 to -102.9 mAHD. This is consistent with domestic and stock bores generally being terminated following initial water strike and sufficient yield for the required low usage.

4.8 Groundwater Dependent Ecosystems

Potential effects on groundwater dependent ecosystems are assessed in the *Groundwater Dependent Ecosystem Impact Assessment report* (CDM Smith, 2024).

4.9 Conceptual hydrogeological model

Key aspects of the conceptual hydrogeological model are described below, and a conceptual cross section is provided in **Figure 2, Attachment 1**:

- calcareous dunes and dune limestone of the Bridgewater Formation (BF) overlie the Port Campbell Limestone (PCL) to varying thicknesses
  - generally thicker to the north and becoming thinner southwards towards the coast where it forms a thin covering
- the water table is hosted either by the BF (a Quaternary Aquifer) or the underlying PCL (part of the Upper-Mid Tertiary Aquifer)

  - dependent on water table elevation relative to the base of the QA
- a groundwater divide is inferred to be present in the shallow groundwater system beneath a topographic high (generally coincident with the Portland-Nelson Road)
  - shallow groundwater flow (in the QA and upper UMTA) discharges to the Glenelg River north of the divide, and south of the divide discharges to the Ramsar wetland complexes along the coast
- there is no significant aquitard between the QA and UMTA, and they are considered to act as one unit on a regional scale; but connection between the two formations will vary at the local scale
- recharge to the QA is via direct rainfall infiltration, which is reduced due to uptake by trees across the plantation area
- recharge to the upper UMTA is via rainfall infiltration through the overlying unsaturated QA or leakage from the overlying QA (where saturated) and vertical hydraulic gradients allow
- recharge to lower portions of the UMTA (targeted by TB01) will occur via leakage from overlying portions of the UMTA or up-dip to the north where it outcrops or sub-crops towards the margins of the Basin
- groundwater in the QA and upper UMTA (the shallow groundwater system) is discharged to the Ramsar wetland complex via relatively high transmissivity sediments; as indicated by on site hydraulic conductivity and shallow hydraulic gradient
- flow in the lower UMTA occurs as throughflow beneath the site as part of intermediate and regional flow systems
  - these flowpaths are generally from regional scale recharge areas at the margins of the basin (north), to regional discharge areas beyond the coast (south)
- significant discrete fractures were only encountered at depths of greater than 90 mbgs in the lower UMTA, and were overlain by lower permeability limestone matrix
- the lower UMTA targeted by the test bore TB01 behaved as a confined system during pumping tests, and is consistent with the lithology encountered during drilling
- the lower UMTA appears to be isolated from the shallow groundwater system and therefore the existing consumptive use bores, with limited potential for vertical leakage between the lower UMTA and QA/upper UMTA
- if the lower UMTA were to act as an unconfined or leaky confined (semi-confined) system during longer term pumping then the extent of drawdown would be much reduced (due to increased available storage), and the magnitude of water table drawdown would not be significant

5.0 Predicted drawdowns

5.1 Scenarios considered

5.1.1 Pumping

Although groundwater requirements for the Project's construction phase are not yet finalised, the estimates and assumptions outlined in Section 0 allow several extraction scenarios to be considered assuming a 130 ML/yr application:

- 'Average' flow rate of 4.12 L/sec based on 24 hr per day pumping for 365 days per year
  - giving daily total of 0.356 ML/day; and
  - annual total of 130 ML/yr
- 'High' flow rate of 10.4 L/sec over 144 days and 24-hour per day pumping
  - providing a daily maximum requirement of 0.9 ML/day; and

- annual total of 130 ML/yr used for construction over drier 5-month period in Year 1 and Year 2

5.1.2 Aquifer parameters

A range of T and S values have also been considered for the 'average' and 'high' pumping scenarios outlined in Section 5.1.1.

The T and S obtained from the CRT are at the lower end of literature values for limestone and considered a reasonably conservative base case. The following cases have therefore been considered in terms of a sensitivity analysis:

- 'Base' case using geometric means: T of 17 m^2/day and S of 4.3×10^{-6}
- 'High' case using 100% increase in geometric means: T of 34 m^2/day and S of 8.6×10^{-6}
- 'Unconfined' case: T of 17 m^2/day and S of 0.01

5.2 Bore interference

Drawdown estimates are provided for three aquifer parameter cases using the average extraction flow rate scenario (Table 10), and high extraction flow rate case (Table 11).

As discussed in Section 3.1, the estimated drawdowns for the base case and high case scenarios represent a confined pressure response at depth within the limestone aquifer and these are not estimated changes to shallow groundwater pressures and/or water table levels.

Table 10 Drawdown estimates after 2 years pumping at 4.1 L/sec

Bore ID	Distance from TB01 metres	Total depth mbgs	Available drawdown [1] metres	Drawdown estimates (metres)		
				Base case	High case	Unconfined case
TB01	-	144	-	45.0	22.5	32.2
101240	1925	NK	-	12.4	6.2	0.6
WRK974069	2956	36	31	11.0 [35%]	5.5 [18%]	0.1 [-]
101244	2990	25	20	11.0 [55%]	5.5 [23%]	0.1 [1%]
101242	3877	30.5	25.5	10.1 [40%]	5.0 [20%]	0.02 [-]
101243[2]	4176	4.5	-	9.8	4.9 [-]	0.01 [-]
101246	4670	32	27	9.5 [35%]	4.7 [17%]	- [-]
101234	4820	30.5	25.5	9.3 [36%]	4.7 [18%]	- [-]

NOTE: 1 – optimistically assuming that available drawdown is 5 metres less than a bore's total depth; 2 – construction and depth of 101243 appears anomalous and could not be found in the field

Table 11 Drawdown estimates after 144 days pumping at 10.4 L/sec

Bore ID	Distance from TB01 metres	Total depth mbgs	Available drawdown[1] metres	Drawdown estimates (metres)		
				Base case	High case	Unconfined case
TB01[3]	-	144	-	107.6	47.0	61.4
101240	1925	NK	-	24.6	12.3	0.02
WRK974069	2956	36	31	21.0 [68%]	10.5 [34%]	- [-]
101244	2990	25	20	20.9 [>100%]	10.4 [52%]	- [-]
101242	3877	30.5	25.5	18.7 [73%]	9.4 [37%]	- [-]

101243[2]	4176	4.5	-	18.1	9.0	- [-]
101246	4670	32	27	17.2 [64%]	8.6 [32%]	- [-]
101234	4820	30.5	25.5	16.9 [66%]	8.5 [33%]	- [-]

NOTE: 1 – optimistically assuming that available drawdown is 5 metres less than a bore's total depth; 2 – construction and depth of 101243 appears anomalous and could not be found in the field; 3 – the predicted drawdown in TB01 suggests 10.4 L/sec may not be a sustainable yield.

A simple assessment of the percentage reduction in available drawdown has been attempted at the registered bores based on limited data. Optimistically, if it is assumed the available drawdown is 5 metres less than a bore's total depth, there is still a significant drawdown at all bores for a confined aquifer response using base case and high case aquifer parameters (refer to Table 10 and Table 11).

<u>However, direct connection between extraction from TB01 and the registered consumptive use bores is not anticipated, and drawdown estimates at the bores are not considered representative</u> given that:

- shallow consumptive use bores appear to be screened across the water table and/or target the upper portions of the groundwater system (refer to Section 4.6)
- lithology and water strikes encountered during drilling of TB01 and MB01 indicated distinct fractures/fracture sets overlain by a competent limestone matrix (refer to Section 2.0)
- the groundwater level responses at TB01 and MB01 indicate the targeted aquifer was confined in nature during the CRT (refer to Section 3.0)

A higher storage scenario was therefore used to provide a simple assessment of the potential distance-drawdown response should there be direct connection between the upper and lower systems; such that it behaves as an unconfined or leaky confined aquifer. The estimated drawdowns are seen to be negligible with respect to impacting the registered consumptive use bores (Table 10 and Table 11).

Groundwater monitoring during operational pumping would be required to confirm longer term drawdown extents within the shallow and deeper system (refer to Section 8.0).

5.3 Potential GDEs

Potential effects on groundwater dependent ecosystems are assessed in the *Groundwater Dependent Ecosystem Impact Assessment* report (CDM Smith, 2024).

6.0 Impact assessment

6.1 Bores

As discussed in previous sections:

- groundwater from TB01 occurs from discrete fracture/fracture sets at depths of greater than 90 mbgs which were overlain by a low permeability limestone matrix
- results from the constant rate pumping test showed a confined response with a low storativity value
- consumptive use bores are shallow in comparison to TB01, and are thought to access groundwater from the unconfined upper portions of the UMTA

Existing consumptive use bores are therefore considered to be essentially isolated from the lower portions of the confined UMTA targeted by TB01. Under this scenario, the reduction in confined pressures estimated in Section 5.2 would not be experienced at the shallower consumptive use bores.

Drawdown estimates were also considered using a higher (unconfined) storage value (of 1%) to represent the scenario where the lower UMTA exhibits unconfined to leaky-confined response in the longer-term. Drawdowns were found to be insignificant at neighbouring bores in this case.

Overall, there is a low risk of a material impact being realised at the registered consumptive use bores identified from the WMIS database and site visits during AECOM' groundwater investigations.

6.2 Groundwater Dependent Ecosystems

Potential impacts on groundwater dependent ecosystems are assessed in the Groundwater Dependent Ecosystem Impact Assessment report (CDM Smith, 2023).

7.0 Conclusions

The following conclusions are drawn from this preliminary water supply assessment:

The sustainable yield of 2.1 L/sec at TB01 was limited by the 24 m of available drawdown within the cased section of the hole (from surface to 54 mbgs).

A yield of greater than 4 L/sec is likely achievable if the pump intake level is placed within the open hole section above the first significant water strike (at 90 mbgs). This would need to be assessed with additional testing to confirm (as part of a groundwater take and use licence application). Several extraction bores will likely be required to meet the Project demand and/or provide back-up capacity. The size of the site is such that there is adequate access and flexibility (for example along the Portland-Nelson Road to allow production bore locations and spacing to minimise potential impacts on groundwater users.

TB01 intersected distinct fractures at depth overlain by low permeability limestone matrix. Testing showed the lower UMTA targeted by TB01 behaves as a confined system, and therefore isolated from the water table and shallow groundwater system with no impact pathway between a groundwater supply bore in the deeper UMTA and the registered bores (and GDEs – as discussed in CDM Smith, 2023).

Should the lower UMTA behave as an unconfined or leaky confined aquifer with longer term pumping, the extent of drawdown would be much reduced due to increased available storage. Under this scenario, no measurable drawdown is estimated to occur at the water table, and hence no material drawdown impact is predicted to occur at existing bores and GDEs.

The temporary (up to 2 years) extraction of groundwater from TB01, and the lower UMTA, has limited potential to impact existing shallow registered bores and GDEs.

8.0 Recommendations

The following recommendations are provided based on results of the initial water supply assessment:

8.1 Water supply investigation program

Additional water supply investigations should be undertaken in consultation with SRW prior to any future groundwater take and use licence application. This could include, but not be limited to:

- installation of deeper monitoring bore (or bores) within the lower UMTA and co-located with existing shallow monitoring wells. These would provide details on:
  - limestone between the shallow groundwater system (QA and upper UMTA) and deeper UMTA to be targeted by Neoen
  - baseline vertical hydraulic gradients between the shallow and deeper groundwater systems
  - changes in groundwater level pressure and vertical hydraulic gradients during operational use
- the final location and construction of deeper monitoring well (or wells) should be determined in consultation with SRW, but nominally could include 40 to 50 m deep monitoring wells co-located with MW05 and MW06
- additional step testing at TB01 with pump lowered into open hole section. Intake level to be determined but it is noted that first significant water strike noted at ~85 mbgs and increased water production observed from 120 mbgs
- additional constant rate test at TB01 to confirm sustainable yield and
- clarification on the number of extraction bores needed to meet final Neoen water supply requirements and logistical needs. It is understood that several extraction bores will be required across the site to meet firefighting and dust suppression requirements
- installation of additional water supply bores, monitoring bores and aquifer testing of water supply bores

8.2 Monitoring

The current monitoring of groundwater levels using data loggers at MW04, MW05, MW06, MW07 and MW08 should continue. This will provide ongoing information on baseline (pre-construction) conditions.

An additional data logger should also be installed in the deeper monitoring bore MB01 to provide continuous baseline data to provide ongoing information on baseline (pre-construction) conditions within the deeper UMTA.

Specific monitoring requirement during additional water supply investigations and testing should be confirmed with SRW at the time of those works being carried out.

Groundwater monitoring should continue during the construction phase of the Project, with details included in a monitoring plan to be provided as part the groundwater take and use licence. An indicative monitoring plan has been provided in Section 10.2 of the Groundwater Impact Assessment (AECOM, 2023). Full details of a monitoring plan would be agreed with SRW at the time of a groundwater take and use application and would likely form part of any licence conditions.

8.3 Licence application

The process of applying for a groundwater take and use licence should commence as soon as practicable following Project approval.

A temporary transfer of groundwater allocation within the South West Limestone Groundwater Management Area (SWL GMA) should be sought in consultation with SRW. Correspondence with SRW to date has confirmed that a temporary transfer of groundwater in the order of 150 ML/year is available within the SWL GMA.

Early liaison with SRW would be beneficial to clarify the additional investigations that may be required to satisfy the take and use application process.

9.0 References

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SRW (2011). *South West Victoria Groundwater Atlas.* Southern Rural Water. December 2011

SRW (2016). *South West Limestone Local Management Plan*. Southern Rural Water. 5 May 2016

SRW (2017). *Glenelg Groundwater Catchment Statement*. Southern Rural Water. 4 May 2017

CDM Smith (2023). *Kentbruck Green Power Hub EES Technical Report: Groundwater Dependent Ecosystem Impact Assessment.* Revision 5, 2024.

Attachment 1 – Figures

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 2 4 Kilometers

1:107,500 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Turbine location
- Internal access roads
- 275 kV Powerline - Overhead
- 275 kV Powerline - Underground
- Transmission Line (Underground)
- Wind Farm Site Boundary
- Wind Farm Boundary 500m -Buffer
- 200m Alignment
- Watercourses
- Waterbodies
- RAMSAR Gleneg Estuary and DIscovery Bay

Groundwater Dependent Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment
Kentbruck Green Power Hub

SITE LOCALITY MAP

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	stutta: 29/11/2023
VERSION:	1

Figure 1

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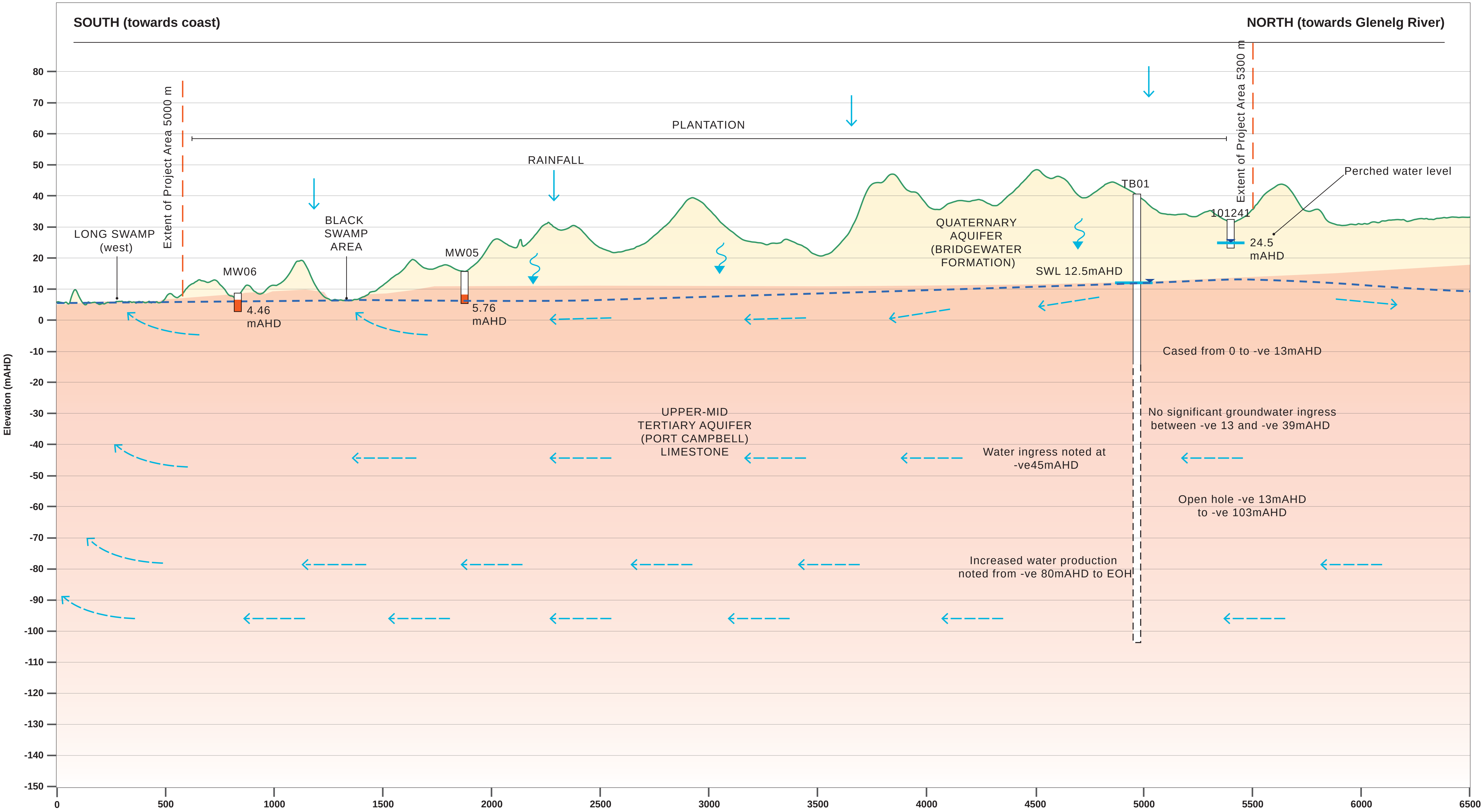
A3 size



LEGEND

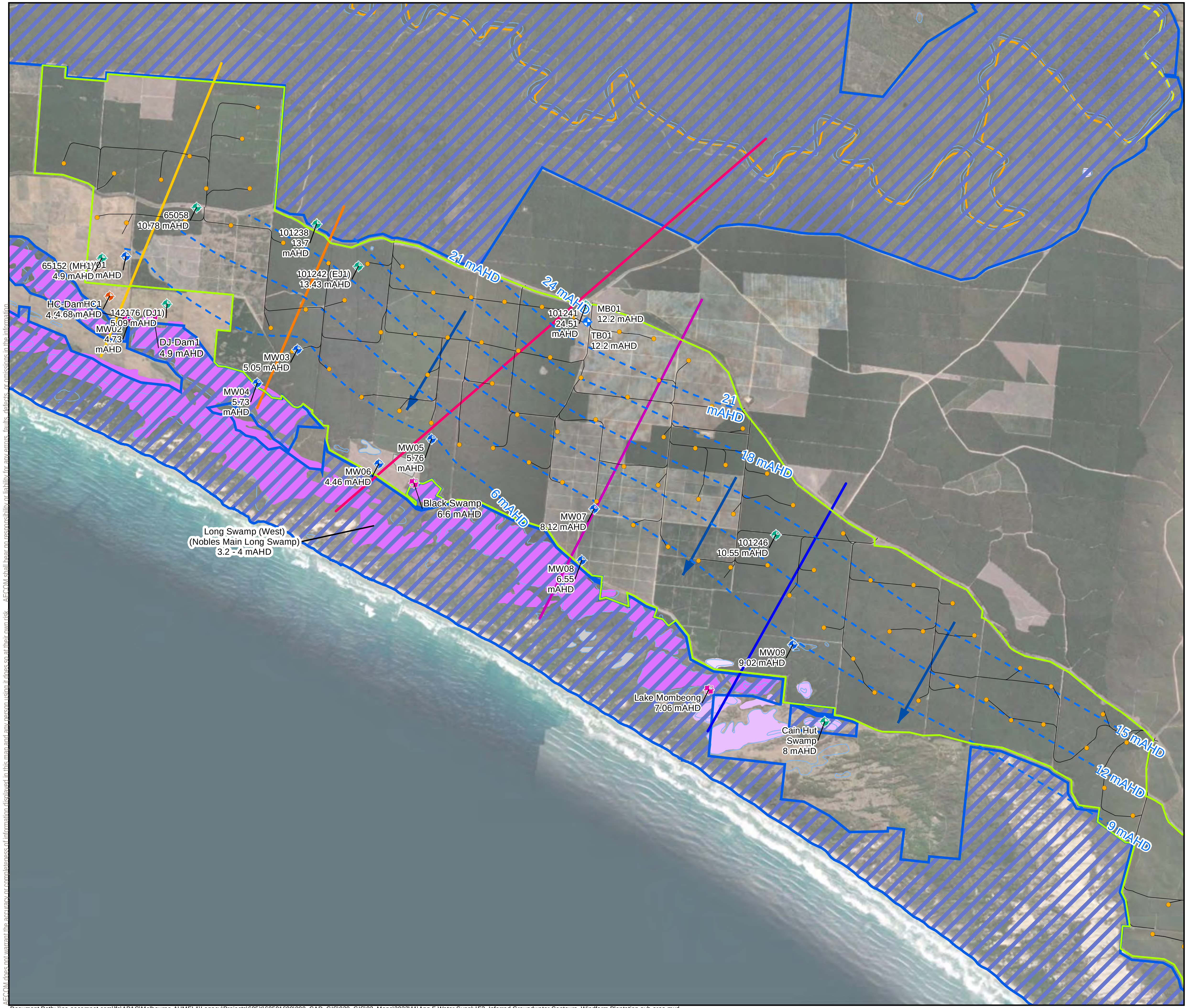
Not to scale

- Quaternary Aquifer
- Upper-Mid Tertiary Aquifer (Victorian Aquifer Framework)
- Inferred Water Table
- Groundwater Bore
- Screen
- Rainfall
- Vertical Infiltration
- Inferred Groundwater Flow

NOTE: Top of UMTA from Victorian Aquifer Framework data

27/07/2022 REV E

Figure 2 - Conceptual Hydrogeological Model



NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 0.95 1.9

Kilometers

1:60,000 (when printed at A3)

Legend

Locations

- AECOM Groundwater Monitoring
- State Observation Bores
- Private Groundwater Bores
- Wind Farm Site Boundary
- Turbine location
- Internal access roads
- Inferred Groundwater Flow Direction

Cross Section Transect Locations

- Cross Section 1
- Cross Section 2
- Cross Section 3b
- Cross Section 4
- Cross Section 5
- Ramsar Gleneg Estuary and Discovery
- Waterbodies

Groundwater Dependant Ecosystems -

- High potential GDE - from regional
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional
- High potential GDE - from national assessment
- Low potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Note:
* - CDM Smith (2020) - surface water level data
State observation bore 101246 screened in underlying limestone and not considered representative of water table. Not used in inferred groundwater contours.

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Environmental Effects Statement
Kentbruck Green Power Hub
Indicaitve layout

INFERRED GROUNDWATER CONTOURS
- WINDFARM PLANTATION SUB-AREA

PROJECT #:	60578607
CREATED BY:	JB
LAST MODIFIED:	stutta: 29/11/2023
VERSION:	1

Figure 3

A3 size

Document Path: \\na.aecomnet.com\lfs\APAC\Melbourne-AUMEL1\Legacy\Projects\605X\60591699\900_CAD_GIS\920_GIS\02_Maps\2023\11\App F Water Supply\F3_Inferred Groundwater Contours_Windfarm Plantation sub-area.mxd

Attachment 2 – Bore construction logs

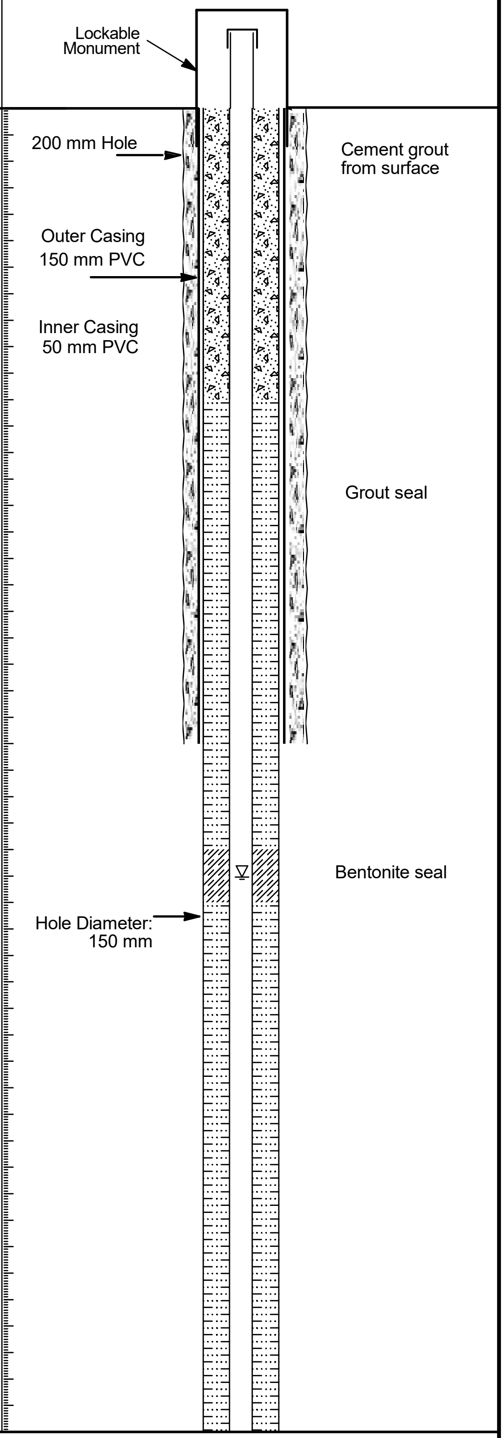
AECOM Imagine it. Delivered.

MB01
Observation Well

AECOM Australia Pty Ltd Level 10, 727 Collins Street, Docklands VIC 3006	Collar Stickup: Casing Stickup:	Location: **Kentbruck Plantation**	Client: **Neoen** Project: **Kentbruck GPH EES**
Project No.: **60591699** Logged By: **CA** Checked By: Date Started: **8-2-22** Date Finished: **10-2-22**	Drilled Depth: **m** Cased Depth: **m** Airlift Yield: EC: pH: Water level: **28.87 m (10/02/2022)**	Coordinates: **59161 mE** **14310676 mN** Datum: **GDA 94/Zone54/AHD** Relative Level (TOC): **40 mAHD** BCL No: **WRK130592**	Drilling Contractor: **Sims Drilling** Driller: **AS** Drill Type: **ROTARY** Drill Model: **Bournedrill Custom Rig** Drill Fluid: **MUD/AIR/WATER**

Depth (m)	USC DESCRIPTION OF STRATA (Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations)	Stratigraphy	Yield (L/s)	Water Quality and Comments (pH and EC (uS/cm) with description)
0 – 3	Silty SAND. Fine to medium, red-brown well-sorted grains with clay.	Bridgewater Fm		
3 – 7	Silty SAND. Fine to medium, pale yellow-brown well-sorted sub-angular grains with clay.	Bridgewater Fm		
7 – 11	CALCARENITE. Returned as GRAVEL. Medium, pale yellow and white, angular grains.	Bridgewater Fm		
11 – 28	Cavity intersected at 11m. No returns to 28 m. (CORE LOSS)	Bridgewater Fm		
28 –	LIMESTONE. Returned as CLAY, grey, trace fine to medium sand. 42-44 m with pale brown CLAY	Port Campbell Limestone		

WELL CONSTRUCTION DETAILS



REMARKS:

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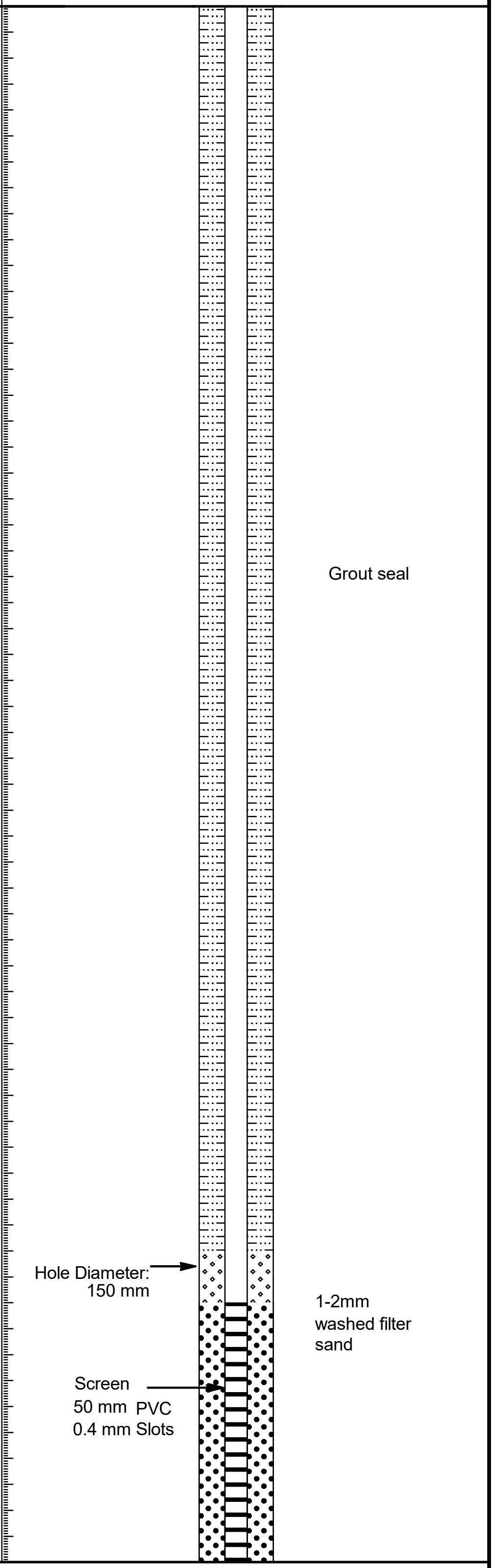
MB01
Observation Well

AECOM Australia Pty Ltd
Level 10, 727 Collins Street, Docklands VIC 3006

Project No.: **60591699**

Project Reference: **Kentbruck GPH EES**

Depth (m)	Legend	Moisture	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Stratigraphy	Yield (L/s)	Water Quality and Comments pH and EC (uS/cm) with description	WELL CONSTRUCTION DETAILS
50				Port Campbell Limestone			
55							
60							
65							
70							Grout seal
75							
80							
85							
90							
95							
100							Hole Diameter: 150 mm; 1-2mm washed filter sand
			102 - 108 m with medium sub-angular sand.				Screen 50 mm PVC 0.4 mm Slots
105							
			Dark grey at 108 m				



MELB_PRODWELL 60591699 PRODUCTION BORE FEB 2022.GPJ WCC_AUS.GDT 16/2/22

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MB01

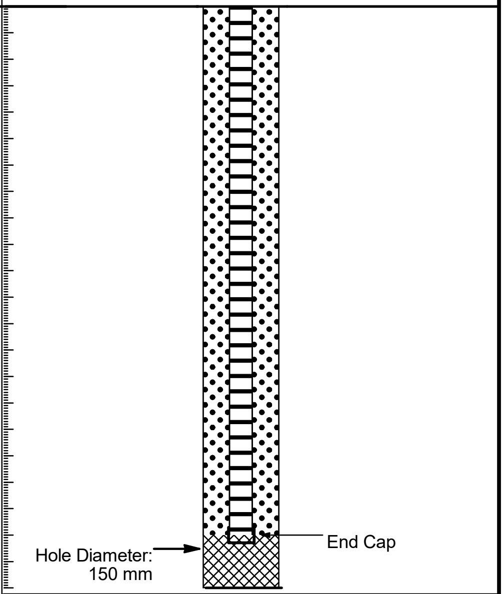
Observation Well

AECOM Australia Pty Ltd
Level 10, 727 Collins Street, Docklands VIC 3006

Project No.: **60591699**

Project Reference: **Kentbruck GPH EES**

Depth (m)	Legend	Moisture	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Stratigraphy	Yield (L/s)	Water Quality and Comments pH and EC (uS/cm) with description	WELL CONSTRUCTION DETAILS
110				Port Campbell Limestone			
115							
			118 - 120 m with medium sub-angular sand.				
120							
			122 - 128 m trace fossil shell fragments				
125							
			Sand trace only from 128 m				
130							
			EoH at 132 m				
135							
140							
145							
150							
155							
160							
165							



AECOM Imagine it. Delivered.

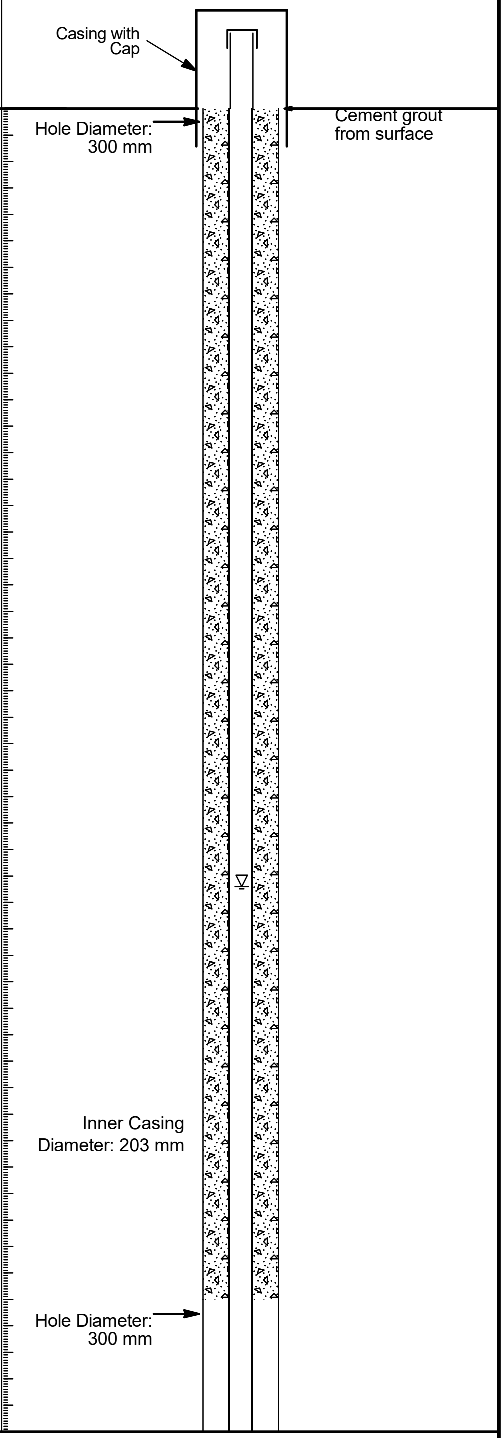
TB01
Test Bore

AECOM Australia Pty Ltd
Level 10, 727 Collins Street, Docklands VIC 3006

Project No.: **60591699**	Collar Stickup: **0.4 m**	Location: **Kentbruck Plantation**	Client: **Neoen**
Logged By: **CA**	Casing Stickup: **0.5 m**	Coordinates: **59166 mE**	Project: **Kentbruck GPH EES**
Checked By:	Drilled Depth: **144.00 m**	**14310681 mN**	Drilling Contractor: **Sims Drilling**
Date Started: **31-1-22**	Cased Depth: **54.00 m**	Datum: **GDA 94/Zone54/AHD**	Driller: **AS**
Date Finished: **7-2-22**	Airlift Yield: **10 L/s @ 1 hr**	Relative Level (TOC): **40 mAHD**	Drill Type: **ROTARY**
	EC: **660 uS/cm**	BCL No: **WRK130591**	Drill Model: **Bournedrill Custom Rig**
	pH: **8.25**		Drill Fluid: **MUD/AIR/WATER**
	Water level: **29.23 m (10/02/2022)**		

Depth (m)	Legend	Moisture	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Stratigraphy	Yield (L/s)	Water Quality and Comments pH and EC (uS/cm) with description
0			Silty SAND. Fine to medium, brown-grey well-sorted grains.	Bridgewater Fm.		
			Silty SAND. Fine, red-brown loosely packed grains.	Bridgewater Fm.		
5			CALCARENITE returned as Sandy CLAY. Low plasticity, pale grey, fine sand.	Bridgewater Fm.		
28			LIMESTONE returned as CLAY. Pale grey with fine sand.	Port Campbell Limestone		
39			Harder drilling noted 39 - 40 m	Port Campbell Limestone		
43			Harder drilling noted at 43 m	Port Campbell Limestone		

WELL CONSTRUCTION DETAILS



REMARKS: Target Depth

AECOM Imagine it. Delivered.

TB01
Observation Well

AECOM Australia Pty Ltd
Level 10, 727 Collins Street, Docklands VIC 3006

Project No.: 60591699

Project Reference: Kentbruck GPH EES

Depth (m)	Legend	Moisture	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Stratigraphy	Yield (L/s)	Water Quality and Comments pH and EC (uS/cm) with description	WELL CONSTRUCTION DETAILS
50							
55							200 mm diameter open hole
60							
65							
70							
75							
80				Port Campbell Limestone			
85			Increase in water to approximate 1 L/s				
90					1 - 2		
95							
100							
105							

AECOM Imagine it. Delivered.

TB01

Observation Well

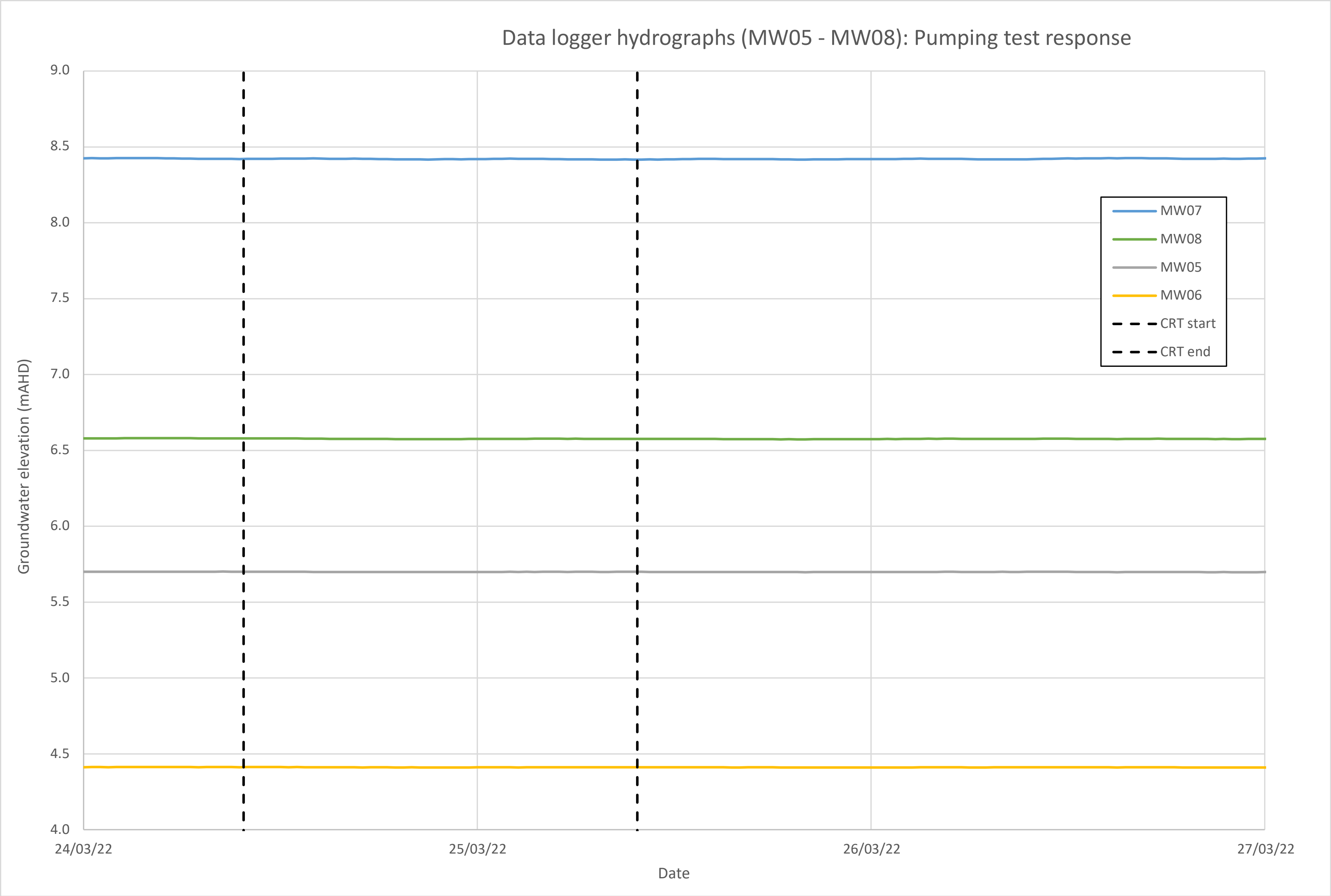
AECOM Australia Pty Ltd
Level 10, 727 Collins Street, Docklands VIC 3006

Project No.: **60591699**

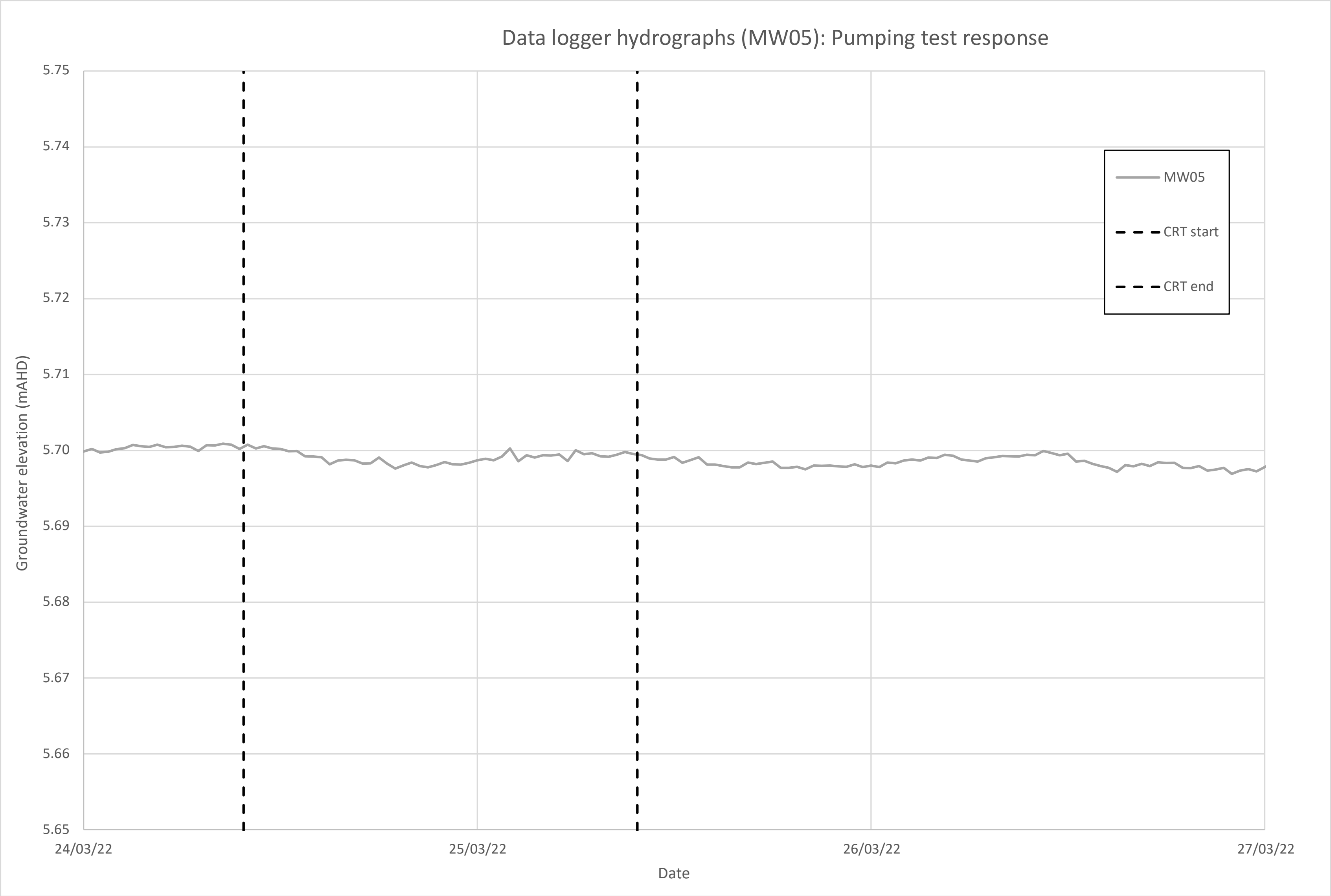
Project Reference: **Kentbruck Production Bore**

Depth (m)	Legend	Moisture	USC DESCRIPTION OF STRATA Type, plasticity / particle size, colour, secondary / minor components (e.g., "trace"), moisture content, consistency / density, and additional observations	Stratigraphy	Yield (L/s)	Water Quality and Comments pH and EC (uS/cm) with description	WELL CONSTRUCTION DETAILS
110				Port Campbell Limestone			
115							200 mm diameter open hole
120			Increase in water production from 120 m				
125							
130							
135							
140			Harder drilling at 139 - 142 m		5 - 10	EC = 660	
145			EoH at 144 m				
150							
155							
160							
165							

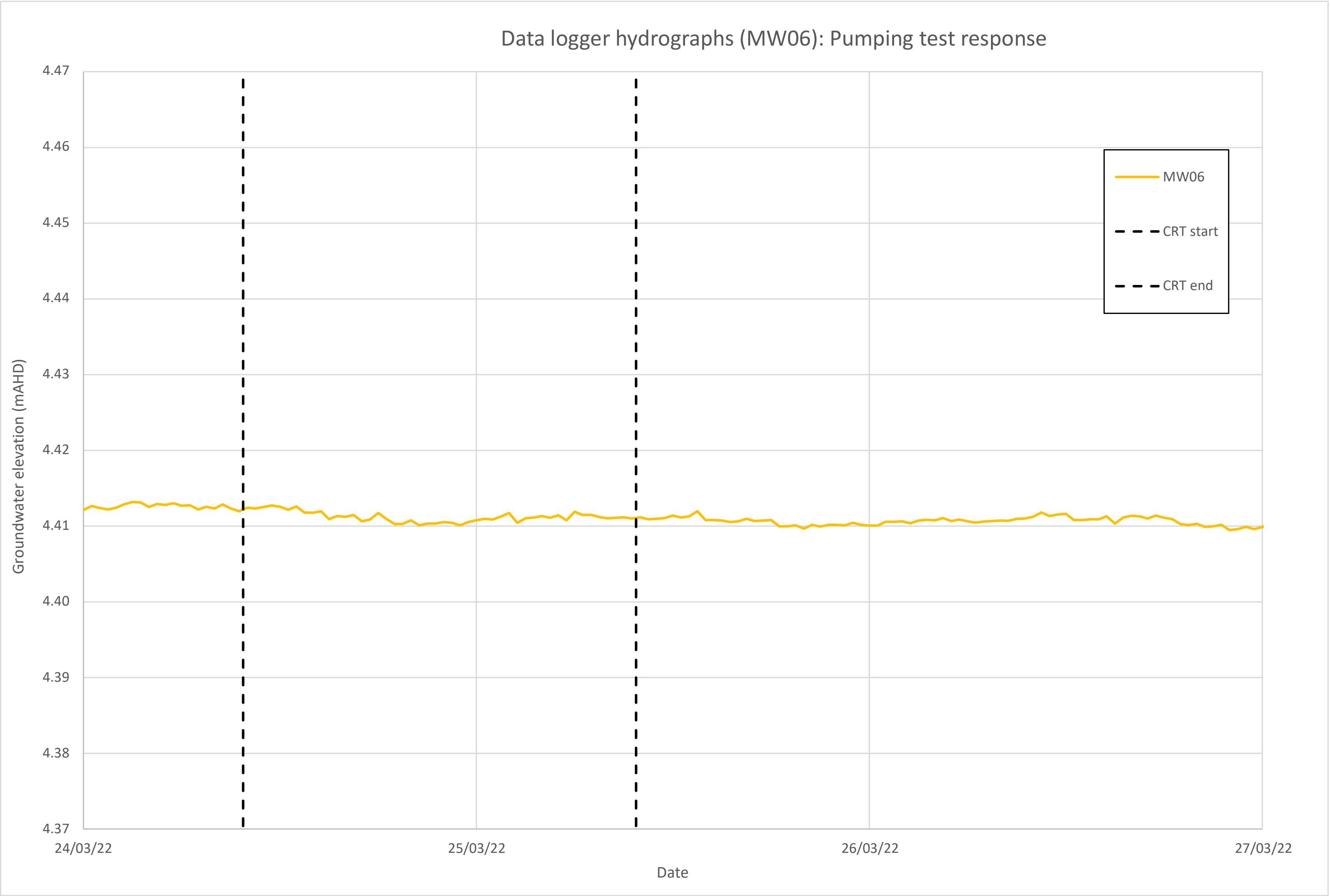
Attachment 3 – Data logger hydrographs



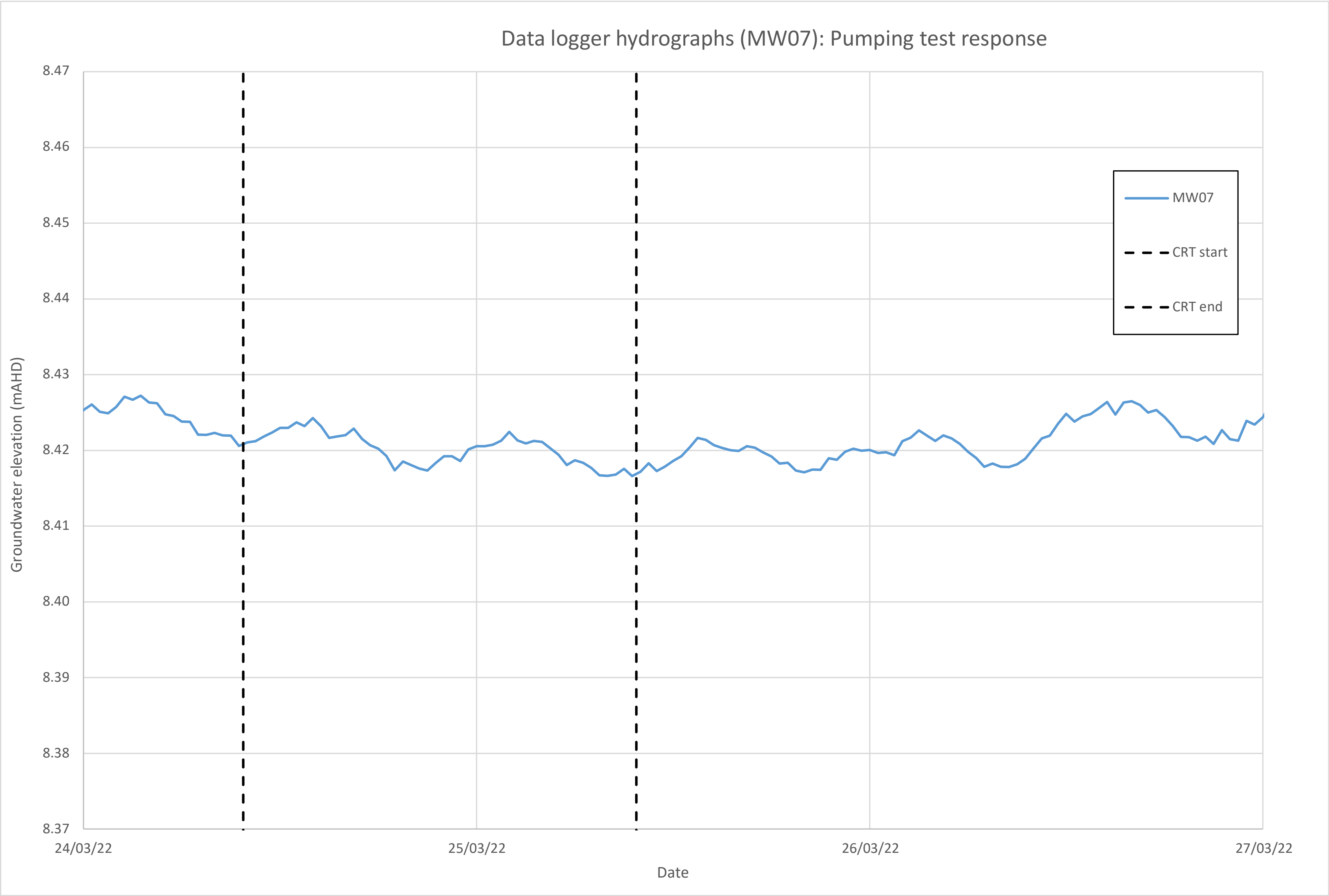
Data logger hydrographs (MW05 - MW08): Pumping test response
Groundwater elevation (mAHD)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
24/03/22
25/03/22
26/03/22
27/03/22
Date
MW07
MW08
MW05
MW06
CRT start
CRT end



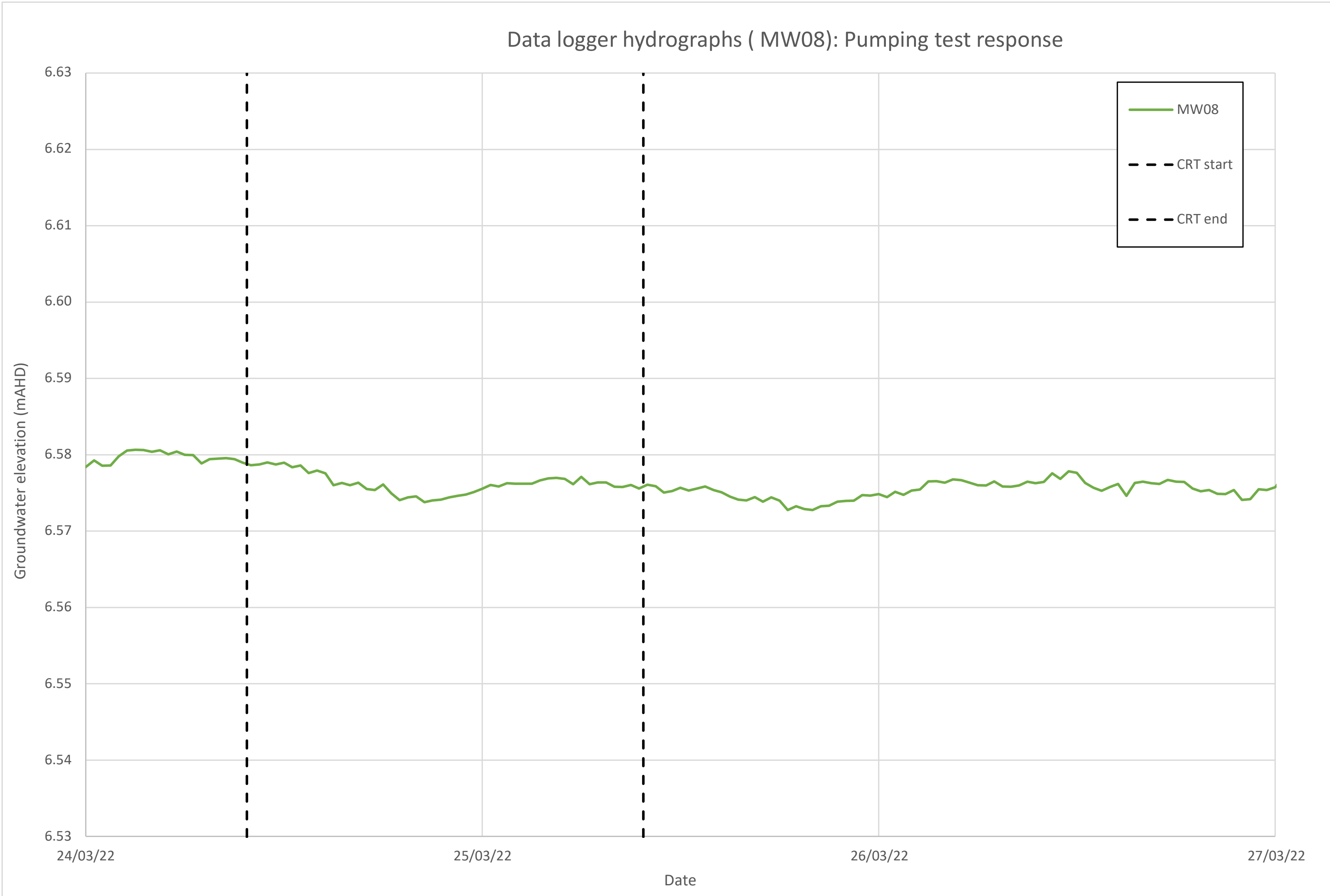
Data logger hydrographs (MW05): Pumping test response
Groundwater elevation (mAHD)
5.75
5.74
5.73
5.72
5.71
5.70
5.69
5.68
5.67
5.66
5.65
24/03/22
25/03/22
26/03/22
27/03/22
Date
MW05
CRT start
CRT end



Data logger hydrographs (MW06): Pumping test response
Groundwater elevation (mAHD)
4.47
4.46
4.45
4.44
4.43
4.42
4.41
4.40
4.39
4.38
4.37
24/03/22
25/03/22
26/03/22
27/03/22
Date
MW06
CRT start
CRT end



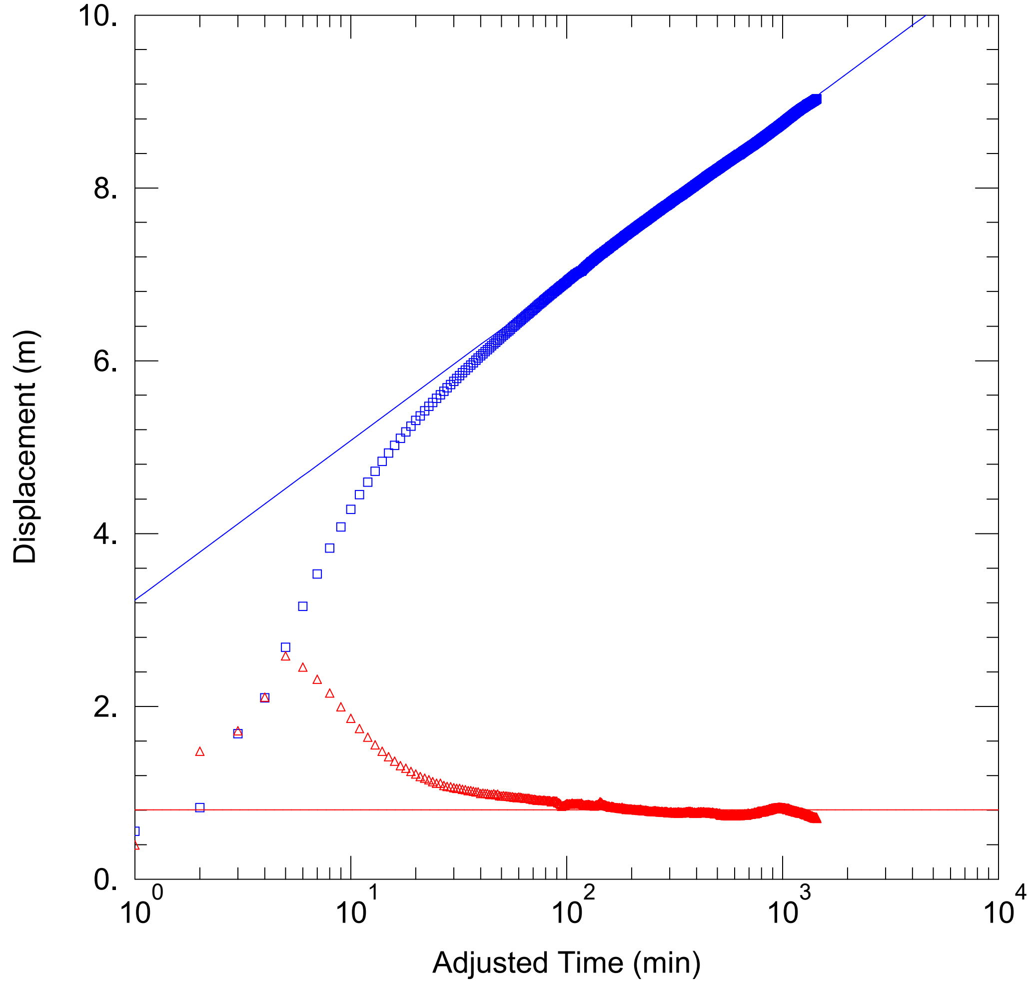
Data logger hydrographs (MW07): Pumping test response
8.47
8.46
8.45
8.44
8.43
8.42
8.41
8.40
8.39
8.38
8.37
Groundwater elevation (mAHD)
24/03/22
25/03/22
26/03/22
27/03/22
Date
MW07
CRT start
CRT end



Data logger hydrographs (MW08): Pumping test response
Groundwater elevation (mAHD)
6.63
6.62
6.61
6.60
6.59
6.58
6.57
6.56
6.55
6.54
6.53
24/03/22
25/03/22
26/03/22
27/03/22
Date
MW08
CRT start
CRT end

Attachment 4 – Aqtesolv pumping test outputs

Attachment 4 – Aqtesolv pumping test outputs



KENTBRUCK EES CRT

Data Set: D:\Kentbruck\Water supply\Pumping test\Aqtesolv\MB01 CRT CooperJacob pumping.aqt
Date: 07/11/22 Time: 10:36:26

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon Australia Pty Ltd
Project: 60591699
Location: Nr Nelson, VIC
Test Well: TB01
Test Date: Feb 2022

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

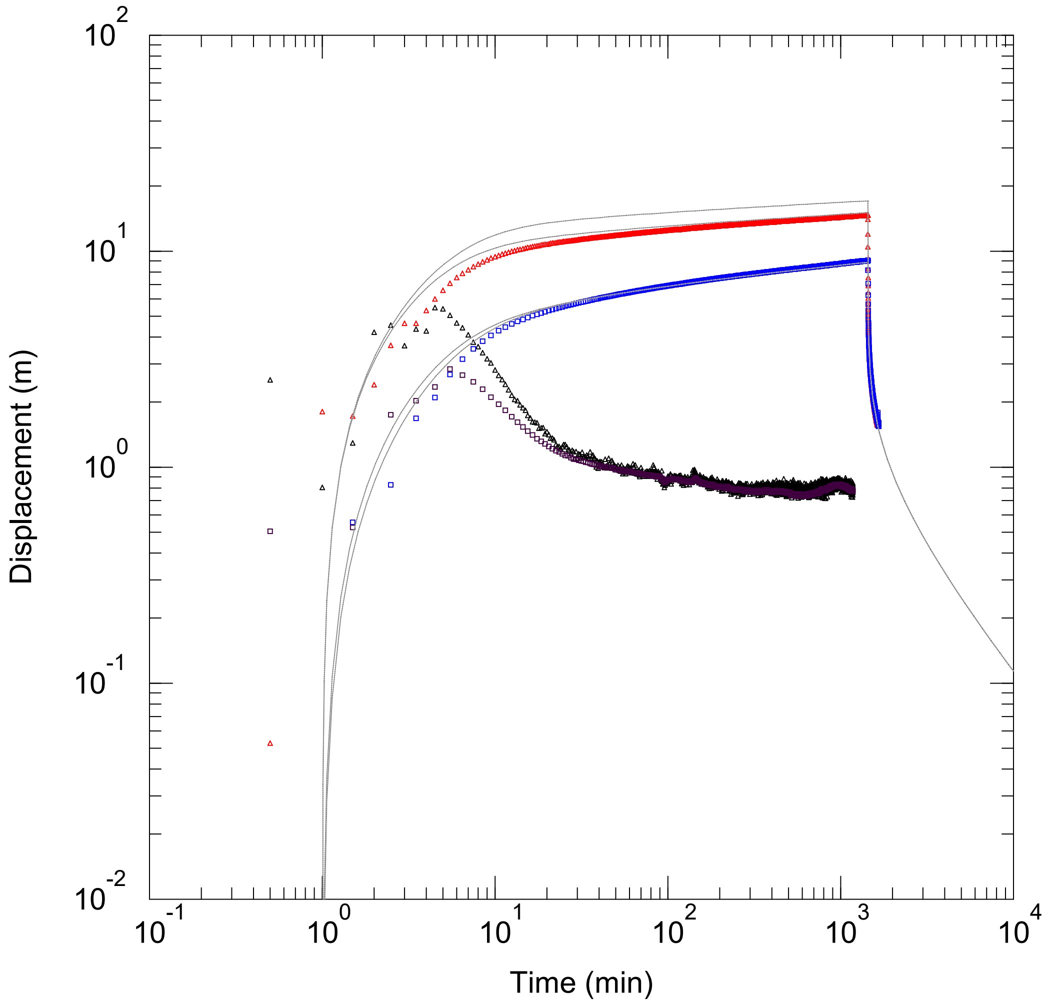
Observation Wells

Well Name	X (m)	Y (m)
□ MB01	14	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 17.14 m^2/day S = 2.438E-6



KENTBRUCK EES CRT

Data Set: D:\Kentbruck\Water supply\Pumping test\Aqtesolv\MB01 CRT Pap&Coop ALL.aqt
Date: 07/11/22 Time: 10:37:48

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon Australia Pty Ltd
Project: 60591699
Location: Nr Nelson, VIC
Test Well: TB01
Test Date: Feb 2022

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

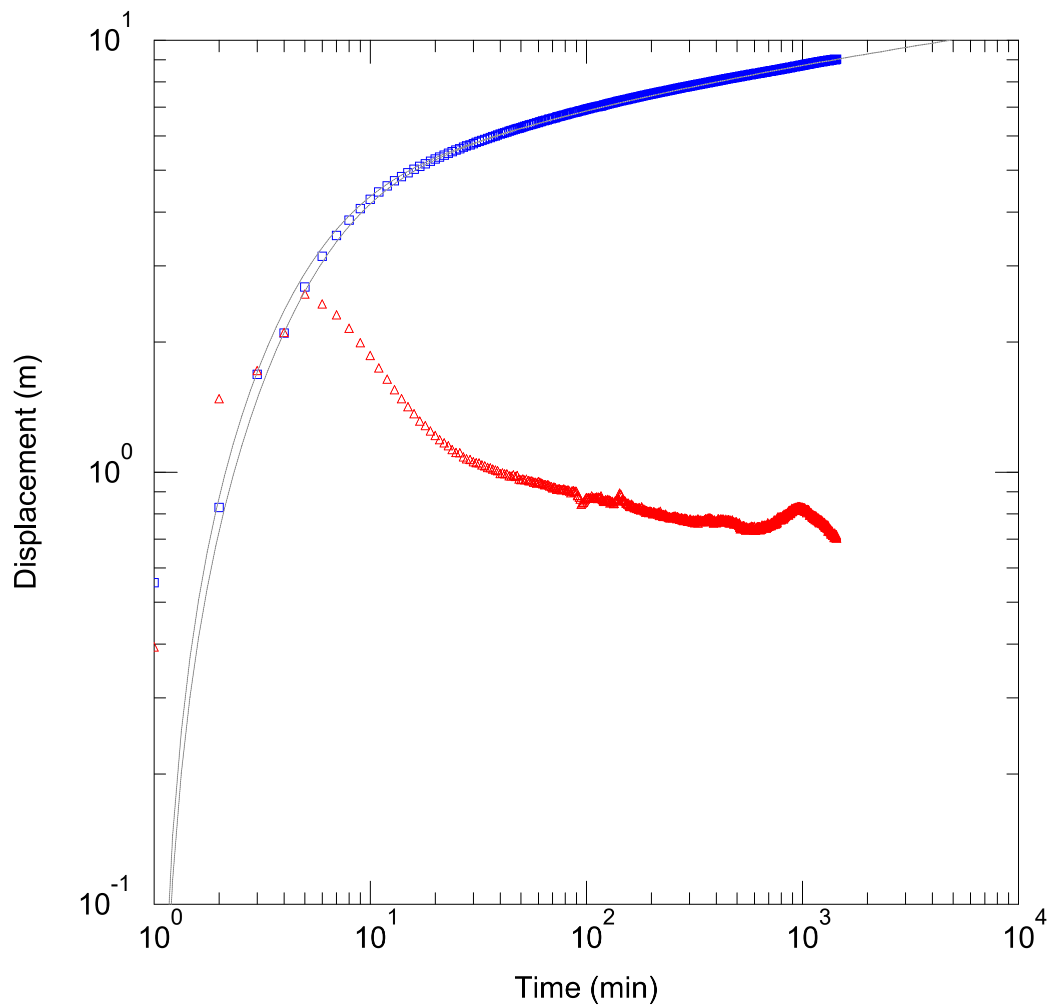
Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Papadopulos-Cooper

T = 18.84 m^2/day S = 1.155E-6
r(w) = 0.1 m r(c) = 0.1 m



KENTBRUCK EES CRT

Data Set: D:\Kentbruck\Water supply\Pumping test\Aqtesolv\MB01 CRT Pap&Coop pumping.aqt
Date: 07/11/22 Time: 10:33:35

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon Australia Pty Ltd
Project: 60591699
Location: Nr Nelson, VIC
Test Well: TB01
Test Date: Feb 2022

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

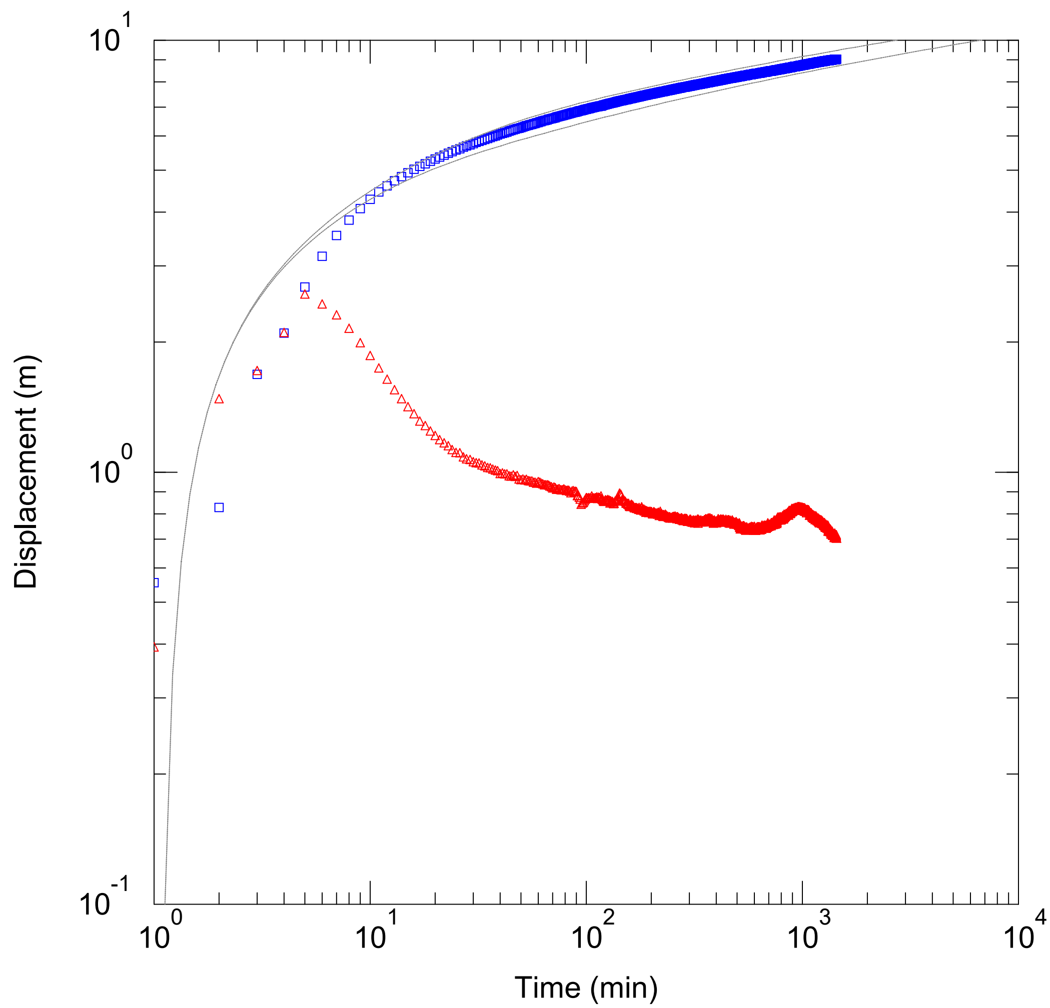
Observation Wells

Well Name	X (m)	Y (m)
□ MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Papadopulos-Cooper

T = 17.3 m^2/day S = 2.36E-6
r(w) = 0.1 m r(c) = 0.1 m



KENTBRUCK EES CRT

Data Set: D:\Kentbruck\Water supply\Pumping test\Aqtesolv\MB01 CRT analysis Theis pumping.aqt
Date: 07/11/22 Time: 10:31:55

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon Australia Pty Ltd
Project: 60591699
Location: Nr Nelson, VIC
Test Well: TB01
Test Date: Feb 2022

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ MB01	13.87	0

SOLUTION

Aquifer Model: Confined

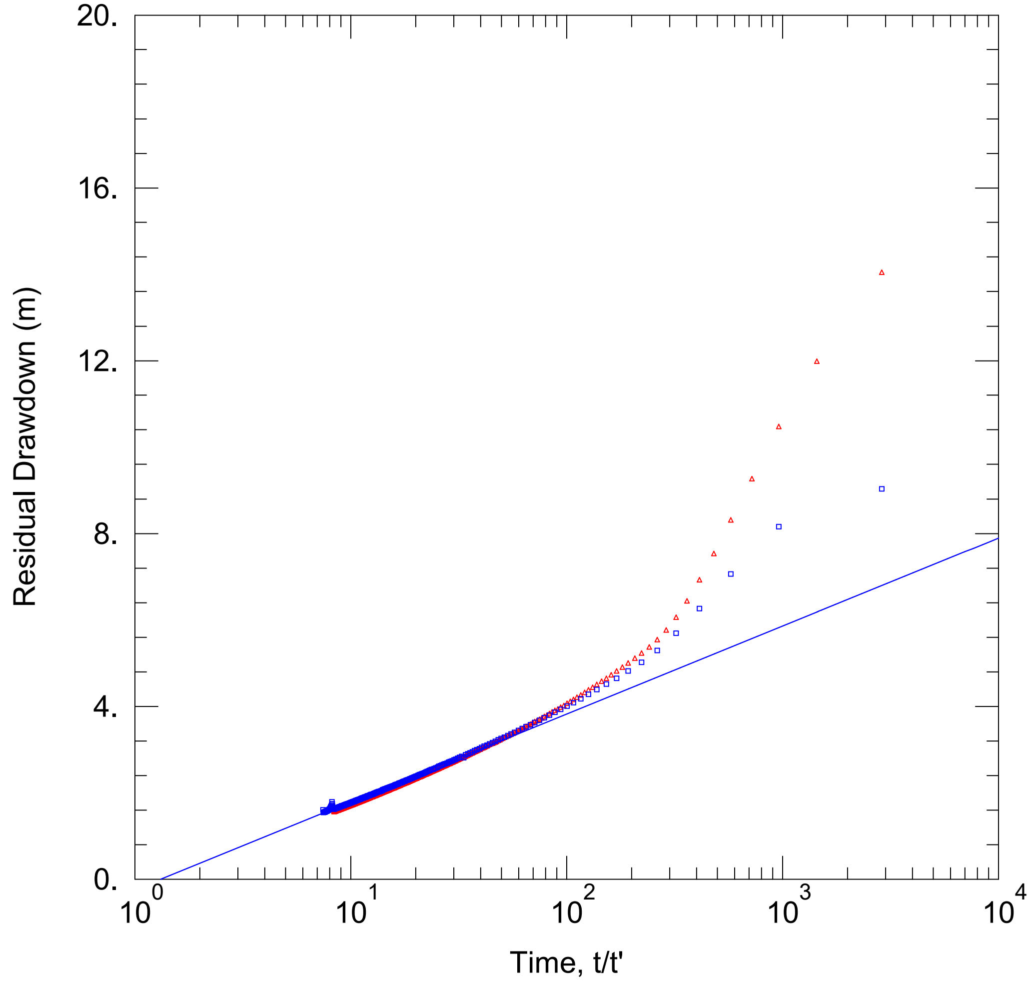
Solution Method: Theis

T = 16.4 m^2/day

S = 4.884E-5

Kz/Kr = 0.1

b = 150. m



KENTBRUCK EES CRT

Data Set: D:\Kentbruck\Water supply\Pumping test\Aqtesolv\MB01 TB01_CRT Theis recovery.aqt
Date: 07/11/22 Time: 10:41:30

PROJECT INFORMATION

Company: AECOM Australia Pty Ltd
Client: Neon Australia Pty Ltd
Project: 60591699
Location: Nr Nelson, VIC
Test Well: TB01
Test Date: Feb 2022

AQUIFER DATA

Saturated Thickness: 150. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TB01	0	0

Observation Wells

Well Name	X (m)	Y (m)
TB01	0	0
MB01	13.87	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

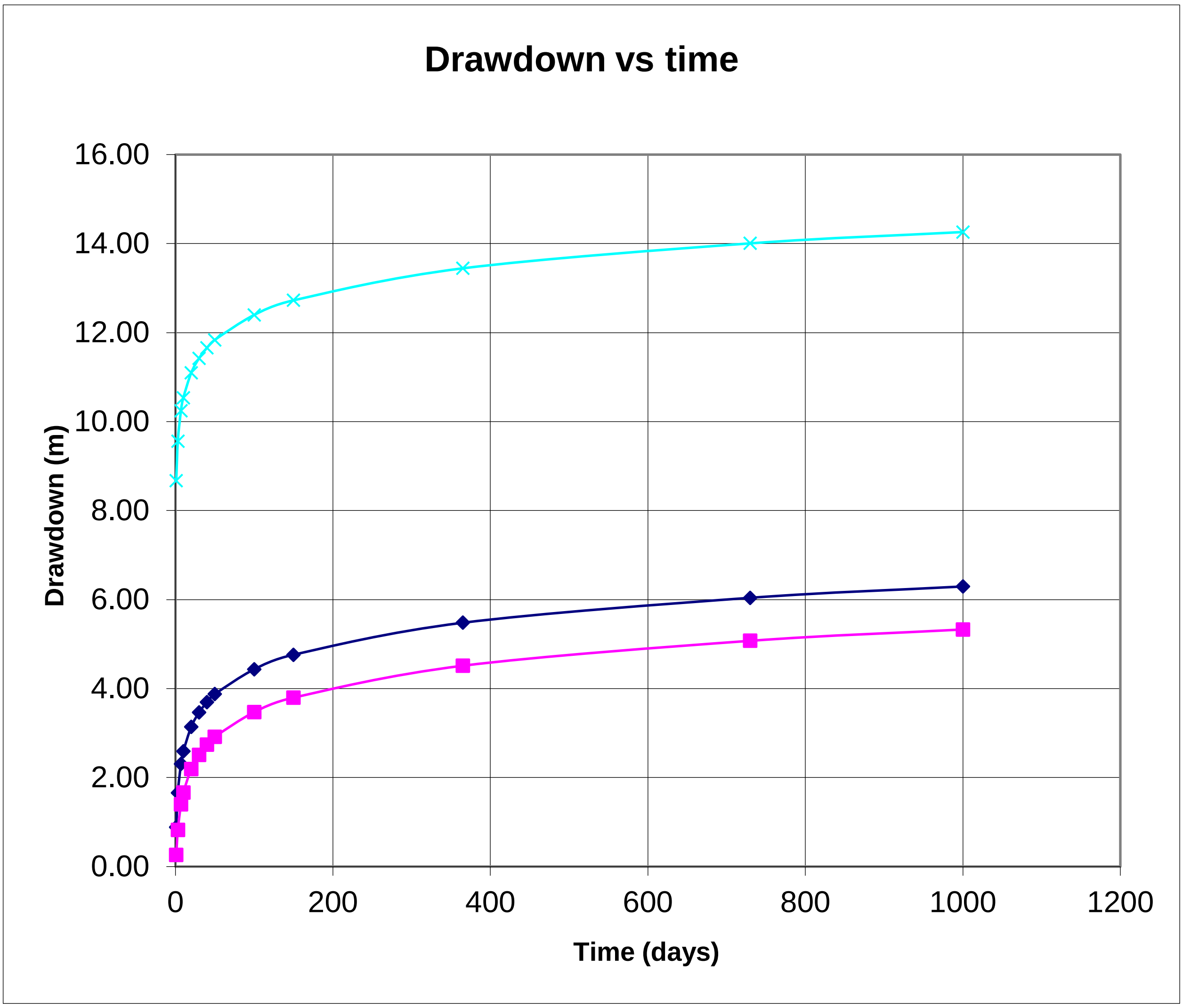
T = 15.56 m^2/day S/S' = 1.321

Attachment 5 – Environment Canterbury drawdown estimate outputs

Time-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	4.30E-06	
B		
Pumping rate		
Q	2	l/s

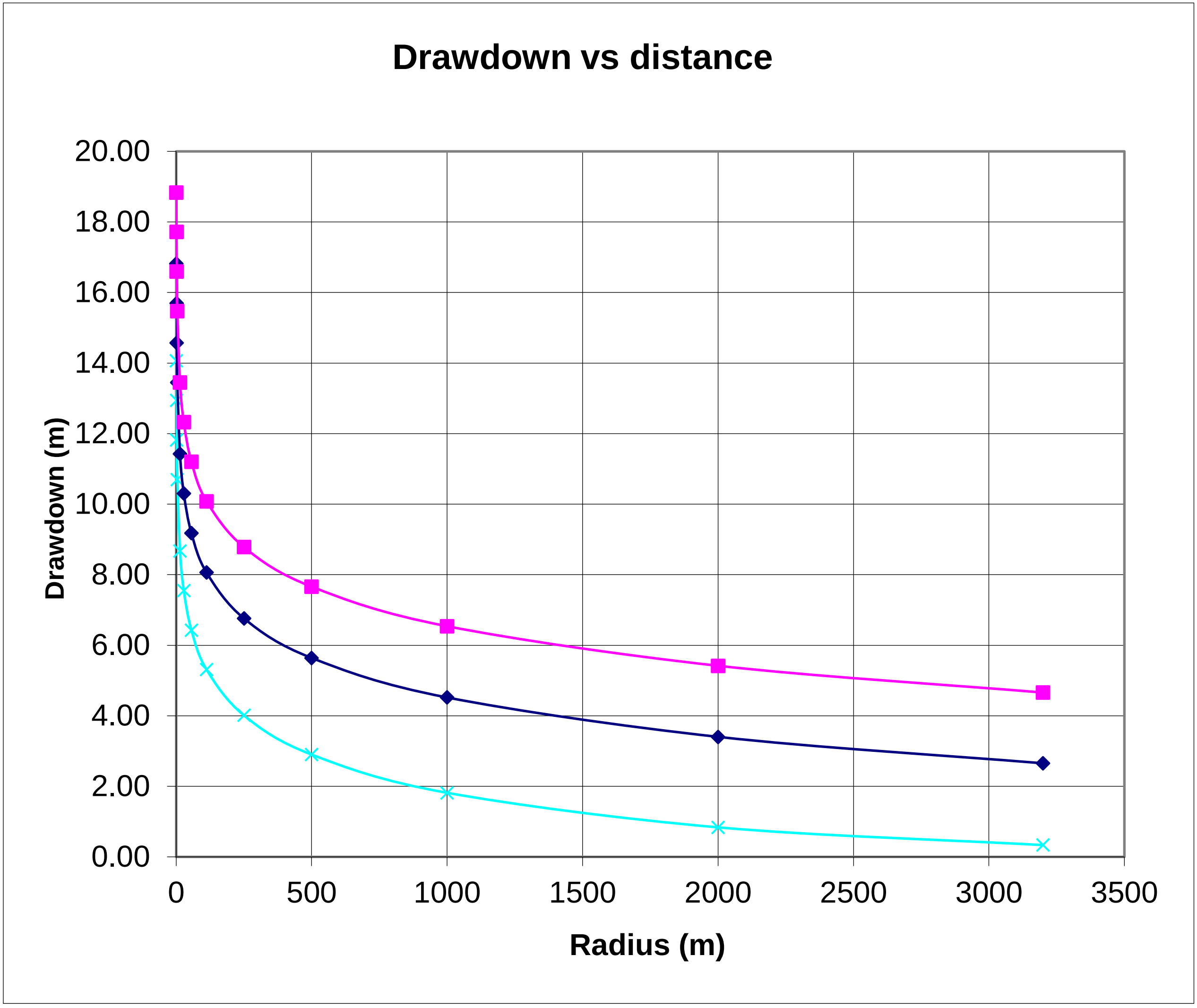
Radius (m)	14	1925	3500
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
1	8.672	0.886	0.263
3	9.561	1.657	0.824
7	10.246	2.308	1.401
10	10.535	2.588	1.664
20	11.095	3.139	2.194
30	11.423	3.464	2.512
40	11.656	3.695	2.739
50	11.836	3.875	2.917
100	12.397	4.434	3.471
150	12.725	4.761	3.797
365	13.444	5.480	4.514
730	14.005	6.040	5.074
1000	14.260	6.295	5.328



Distance-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.0000043	
B		
Pumping rate		
Q	2	l/s

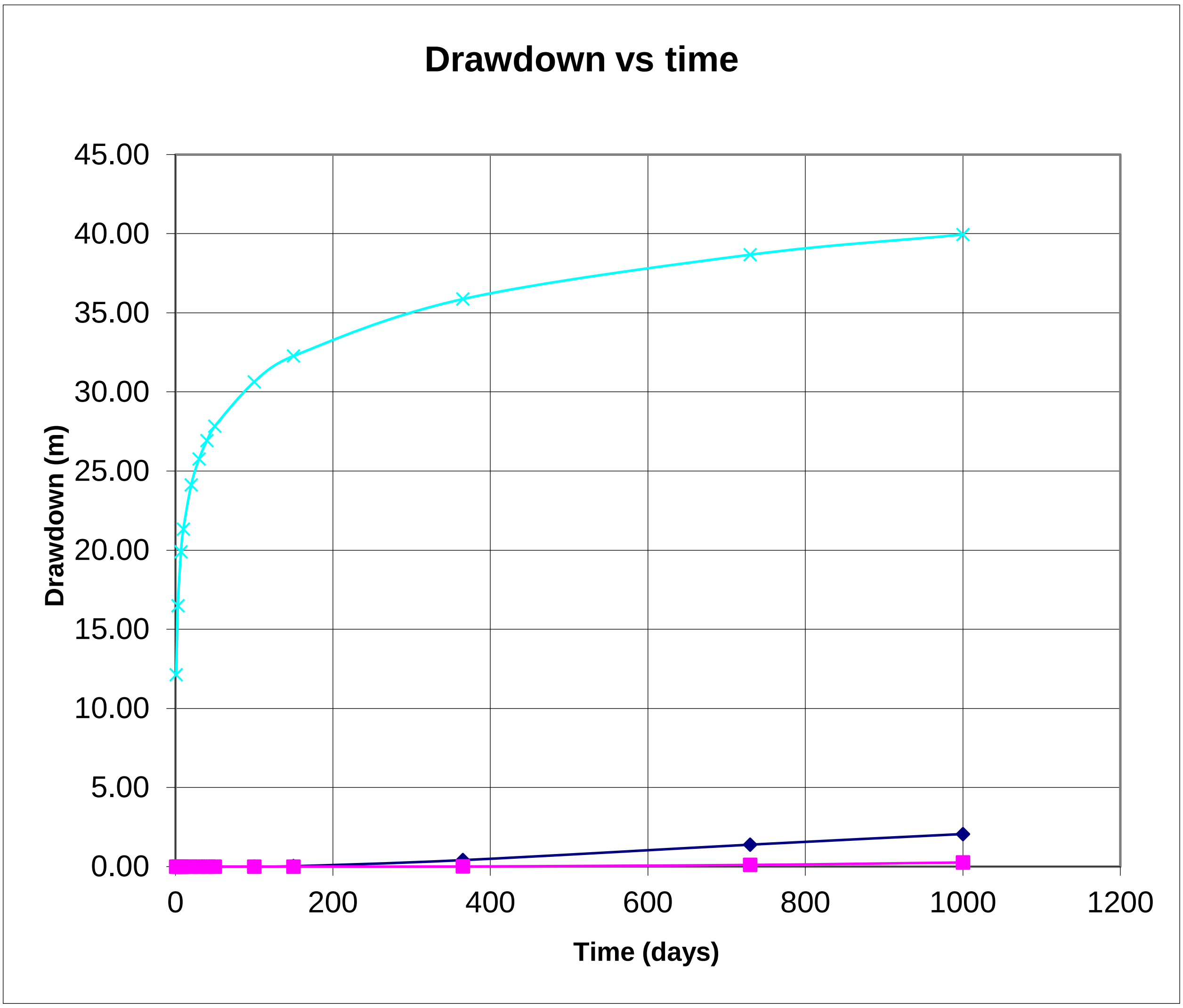
Time (days)	1	30	365
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.5	14.063	16.814	18.835
1	12.941	15.693	17.714
2	11.820	14.571	16.592
4	10.699	13.450	15.471
14	8.672	11.423	13.444
28	7.551	10.302	12.323
56	6.430	9.181	11.202
112	5.309	8.059	10.080
250	4.012	6.760	8.781
500	2.900	5.639	7.660
1000	1.817	4.519	6.539
2000	0.837	3.403	5.418
3200	0.334	2.653	4.658



Time-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	10	l/s

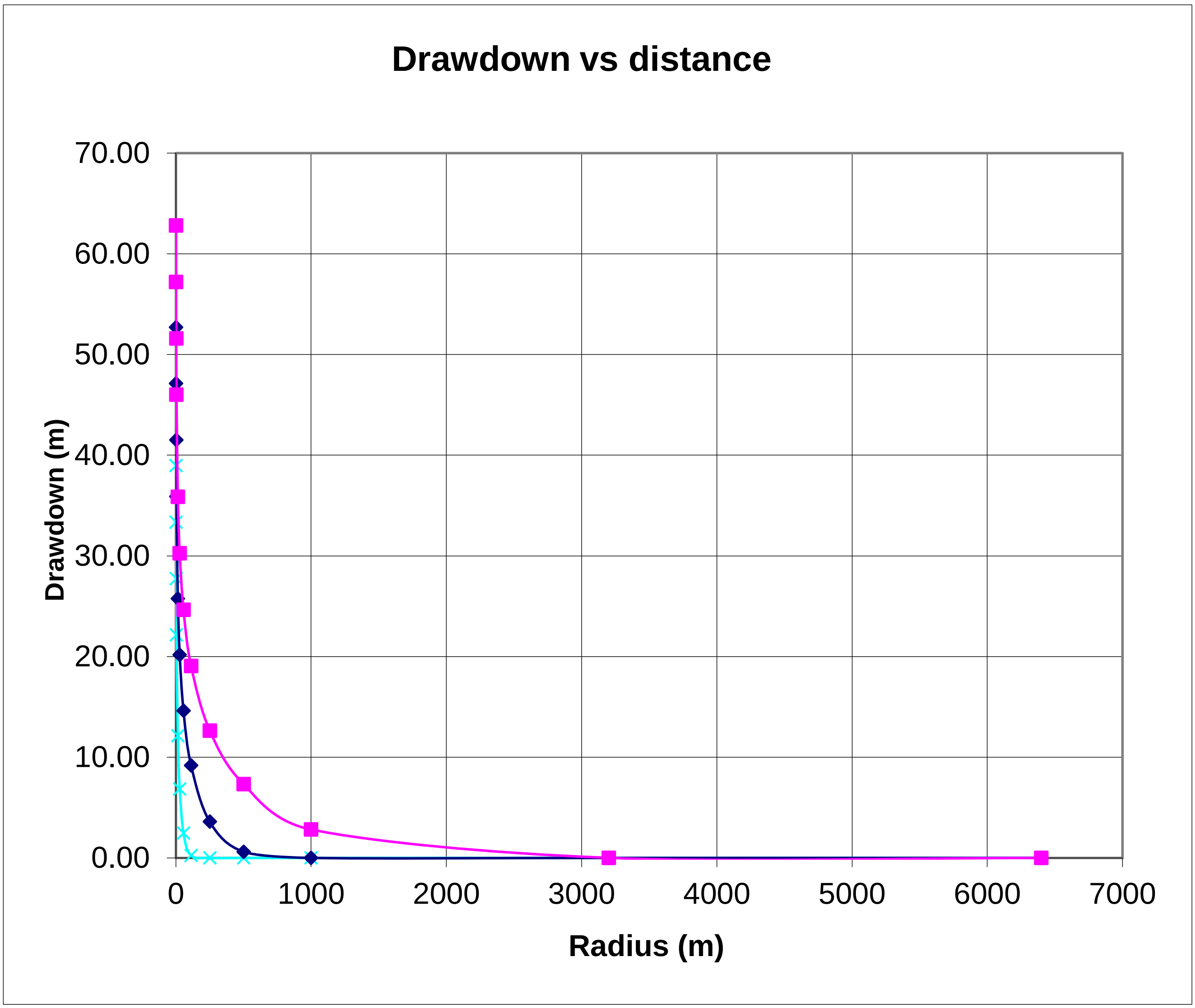
Radius (m)	14	1925	3500
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
1	12.125	-	-
3	16.491	-	-
7	19.896	-	-
10	21.334	-	-
20	24.131	-	-
30	25.769	-	-
40	26.932	0.000	-
50	27.833	0.000	-
100	30.636	0.003	-
150	32.275	0.024	0.000
365	35.871	0.409	0.005
730	38.674	1.385	0.105
1000	39.947	2.057	0.261



Distance-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	10	l/s

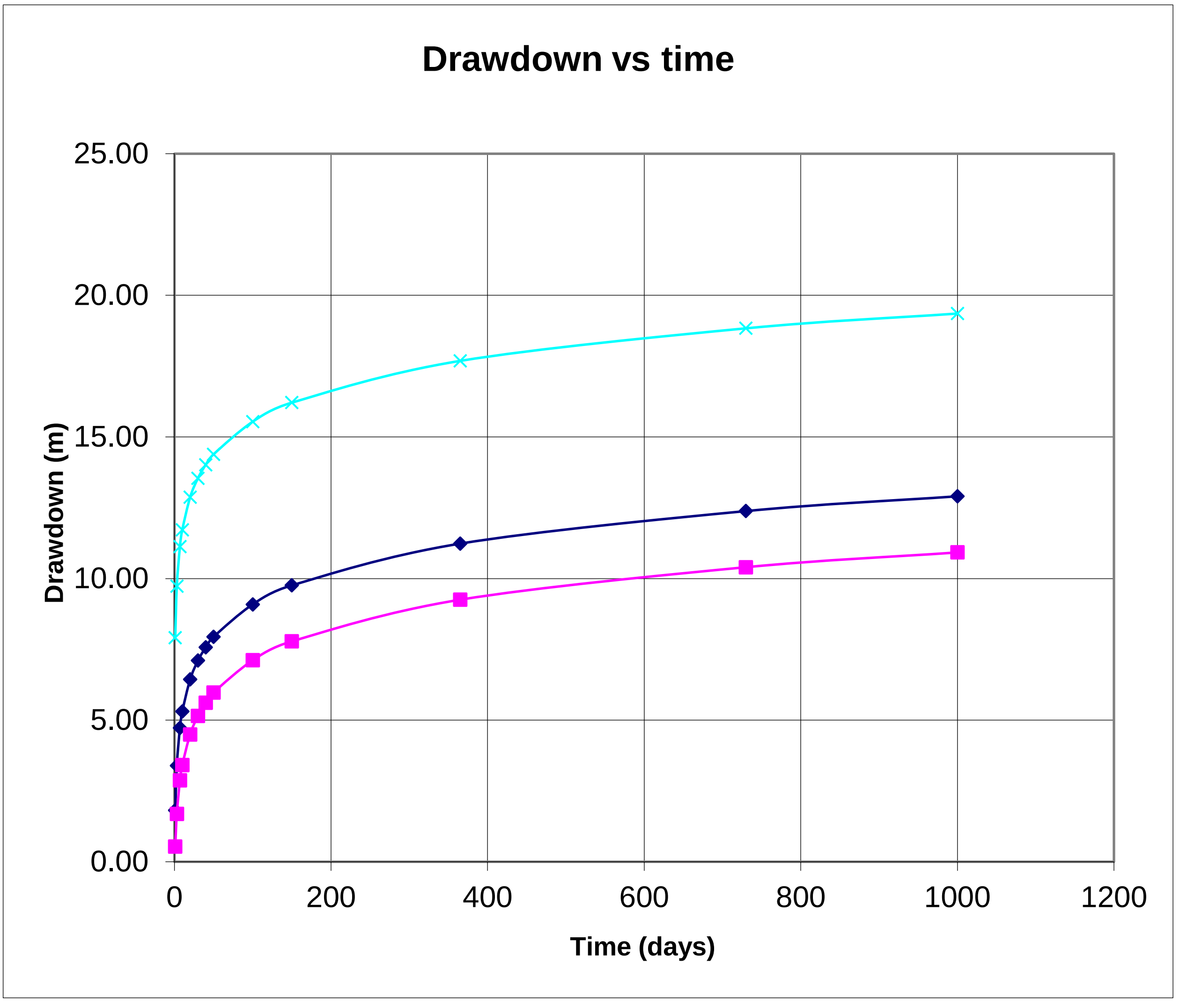
Time (days)	1	30	365
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.5	38.963	52.719	62.824
1	33.357	47.112	57.218
2	27.752	41.505	51.611
4	22.152	35.899	46.004
14	12.125	25.769	35.871
28	6.856	20.174	30.265
56	2.466	14.614	24.662
112	0.246	9.190	19.071
250	0.000	3.600	12.657
500	-	0.615	7.346
1000	-	0.005	2.821
3200	-	-	0.013
6400	-	-	-



Time-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.0000043	
B		
Pumping rate		
Q	4.1	l/s

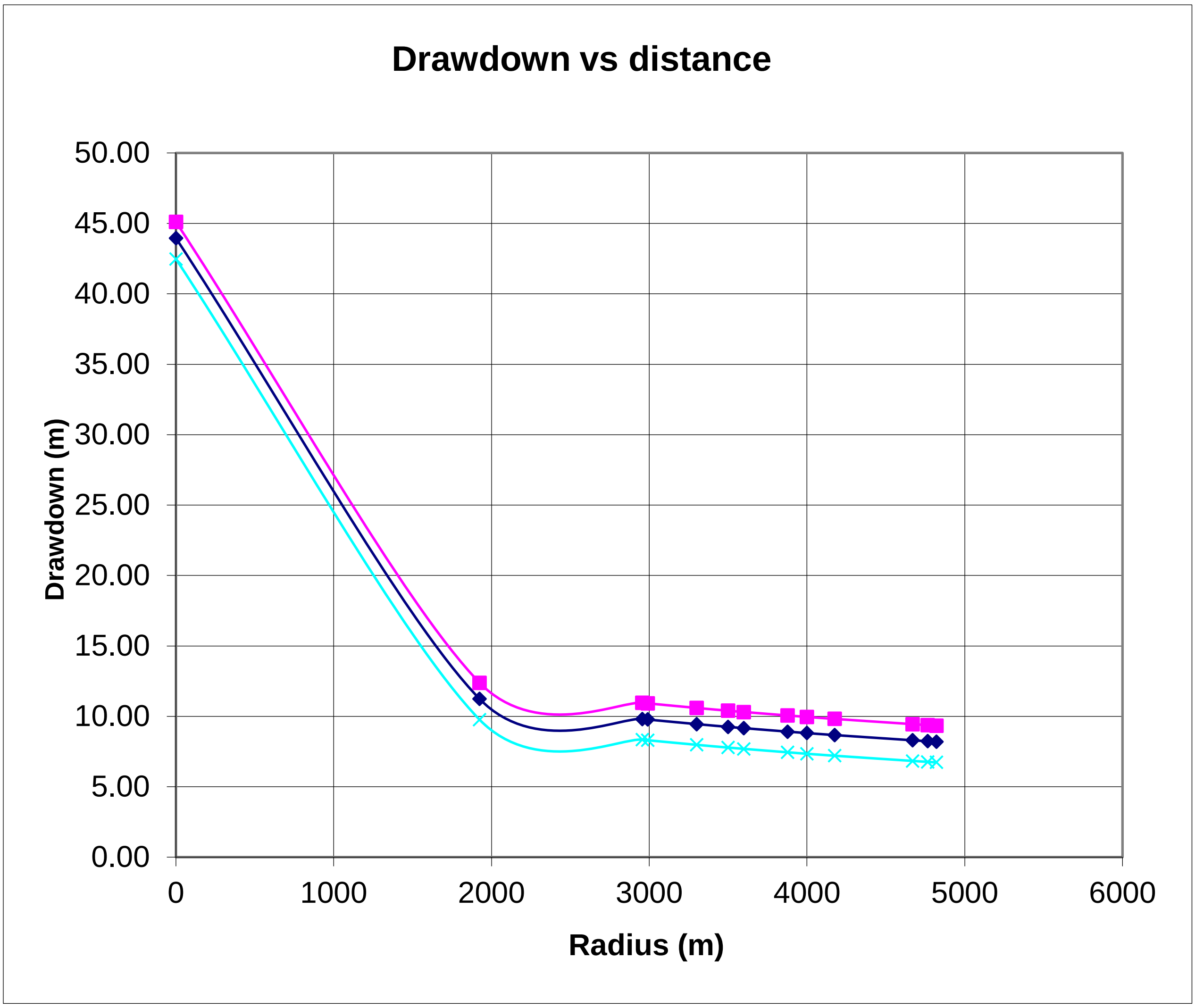
Radius (m)	275	1925	3500
Time (days)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
1	7.910	1.816	0.539
3	9.727	3.398	1.690
7	11.130	4.731	2.872
10	11.721	5.306	3.410
20	12.870	6.436	4.497
30	13.543	7.102	5.149
40	14.020	7.576	5.615
50	14.390	7.944	5.979
100	15.539	9.089	7.115
150	16.211	9.760	7.784
365	17.686	11.233	9.253
730	18.835	12.382	10.401
1000	19.357	12.904	10.922



Distance-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.0000043	
B		
Pumping rate		
Q	4.1	l/s

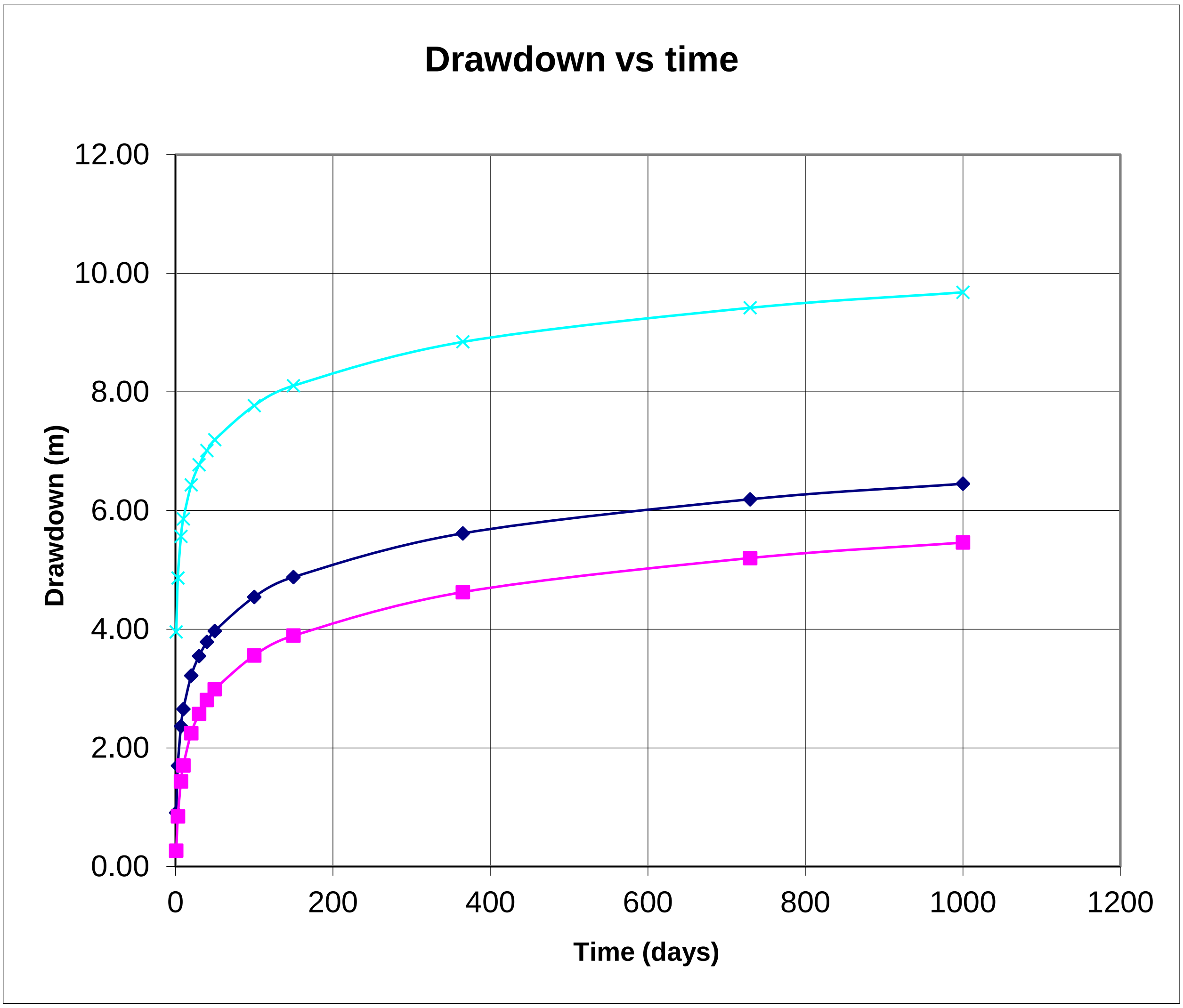
Time (days)	150	365	730
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.1	42.475	43.950	45.099
1925	9.760	11.233	12.382
2956	8.341	9.812	10.960
2990	8.304	9.774	10.923
3300	7.978	9.448	10.596
3500	7.784	9.253	10.401
3600	7.691	9.160	10.307
3877	7.446	8.915	10.062
4000	7.343	8.811	9.958
4176	7.202	8.669	9.816
4670	6.834	8.299	9.446
4765	6.768	8.233	9.379
4820	6.730	8.195	9.341



Time-drawdown calculations
using Theis equation

Aquifer parameters		
T	34	m2/d
S	8.60E-06	
B		
Pumping rate		
Q	4.1	l/s

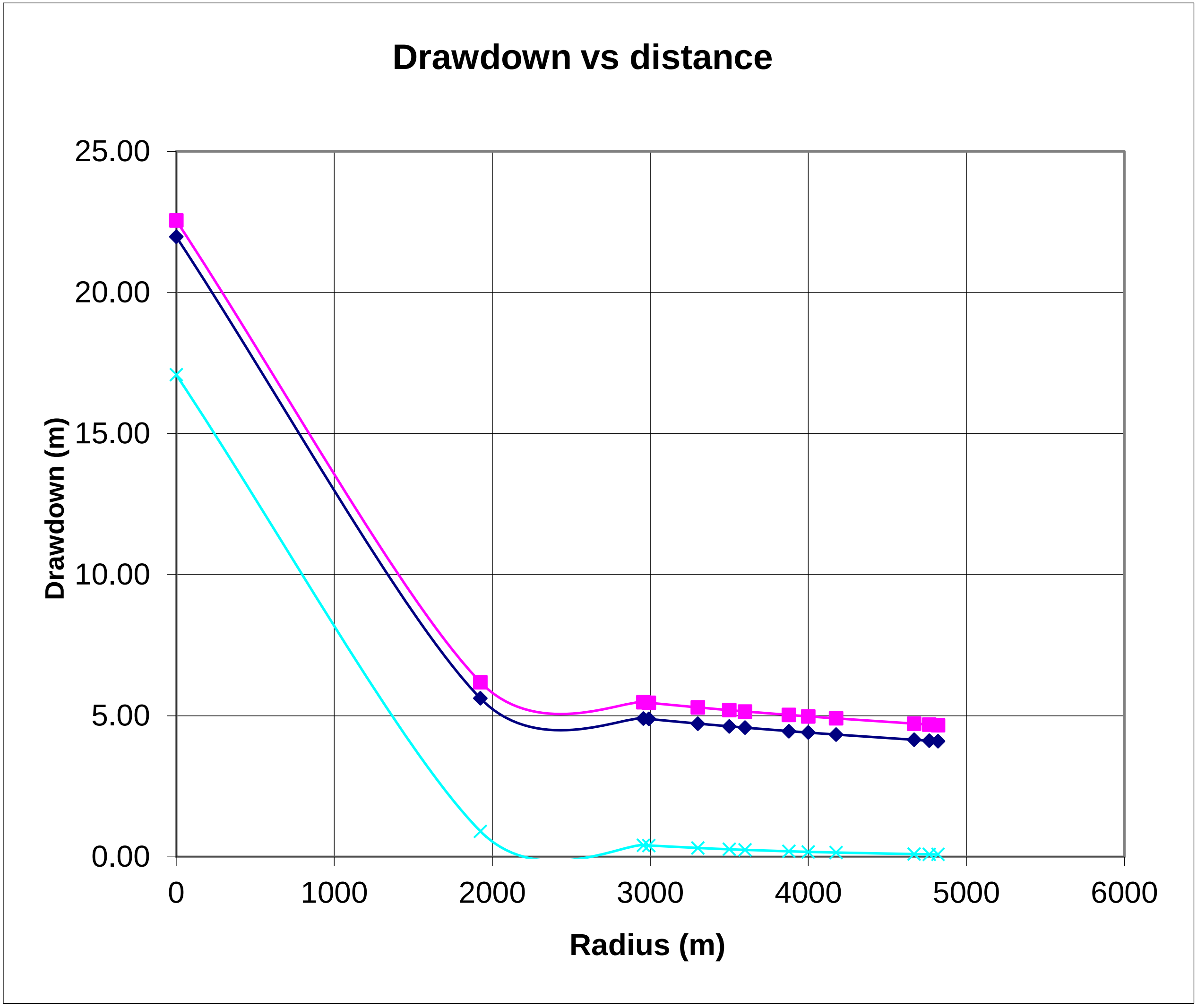
Radius (m)	275	1925	3500
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
1	3.955	0.908	0.270
3	4.863	1.699	0.845
7	5.565	2.365	1.436
10	5.861	2.653	1.705
20	6.435	3.218	2.249
30	6.771	3.551	2.574
40	7.010	3.788	2.808
50	7.195	3.972	2.989
100	7.769	4.545	3.558
150	8.106	4.880	3.892
365	8.843	5.617	4.627
730	9.418	6.191	5.200
1000	9.678	6.452	5.461



Distance-drawdown calculations
using Theis equation

Aquifer parameters		
T	34	m2/d
S	8.60E-06	
B		
Pumping rate		
Q	4.1	l/s

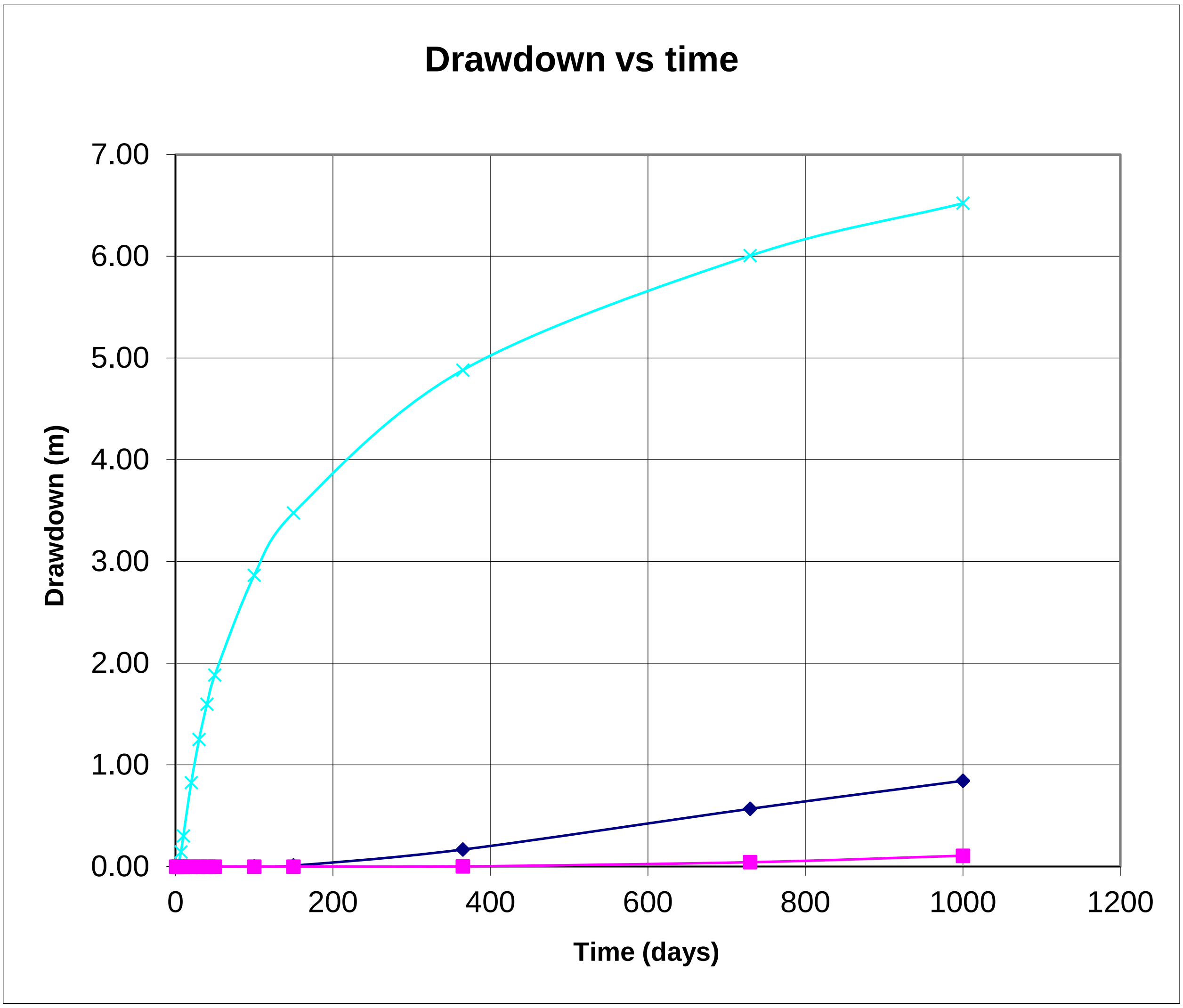
Time (days)	1	365	730
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.1	17.083	21.975	22.549
1925	0.908	5.617	6.191
2956	0.415	4.906	5.480
2990	0.404	4.887	5.461
3300	0.317	4.724	5.298
3500	0.270	4.627	5.200
3600	0.249	4.580	5.154
3877	0.198	4.457	5.031
4000	0.178	4.406	4.979
4176	0.154	4.334	4.908
4670	0.099	4.150	4.723
4765	0.091	4.116	4.689
4820	0.087	4.097	4.670



Time-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	4.1	l/s

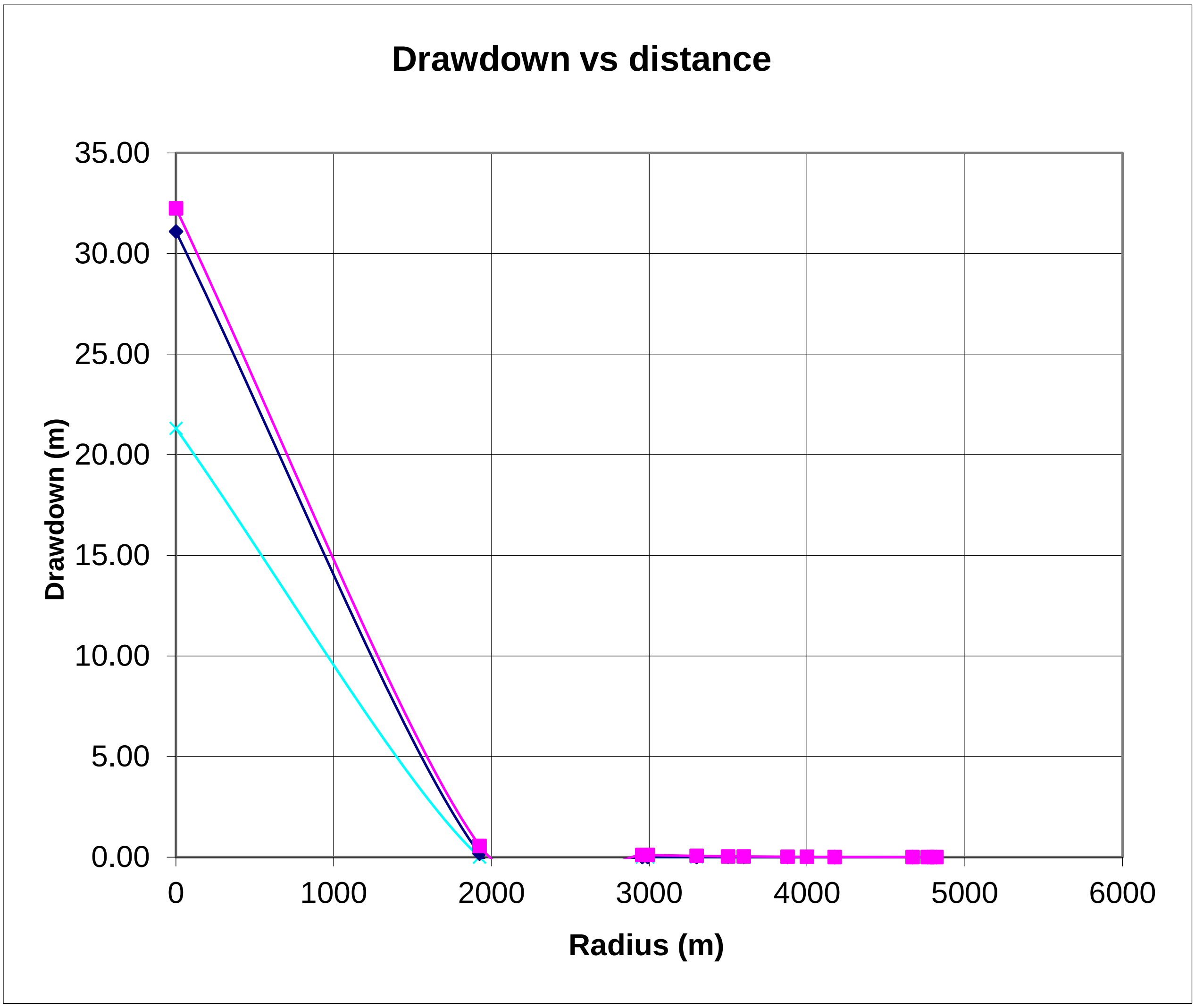
Radius (m)	275	1925	3500
Time (days)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
1	0.000	-	-
3	0.009	-	-
7	0.145	-	-
10	0.302	-	-
20	0.824	-	-
30	1.250	-	-
40	1.596	0.000	-
50	1.885	0.000	-
100	2.864	0.001	-
150	3.478	0.010	0.000
365	4.882	0.168	0.002
730	6.006	0.568	0.043
1000	6.521	0.844	0.107



Distance-drawdown calculations
using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	4.1	l/s

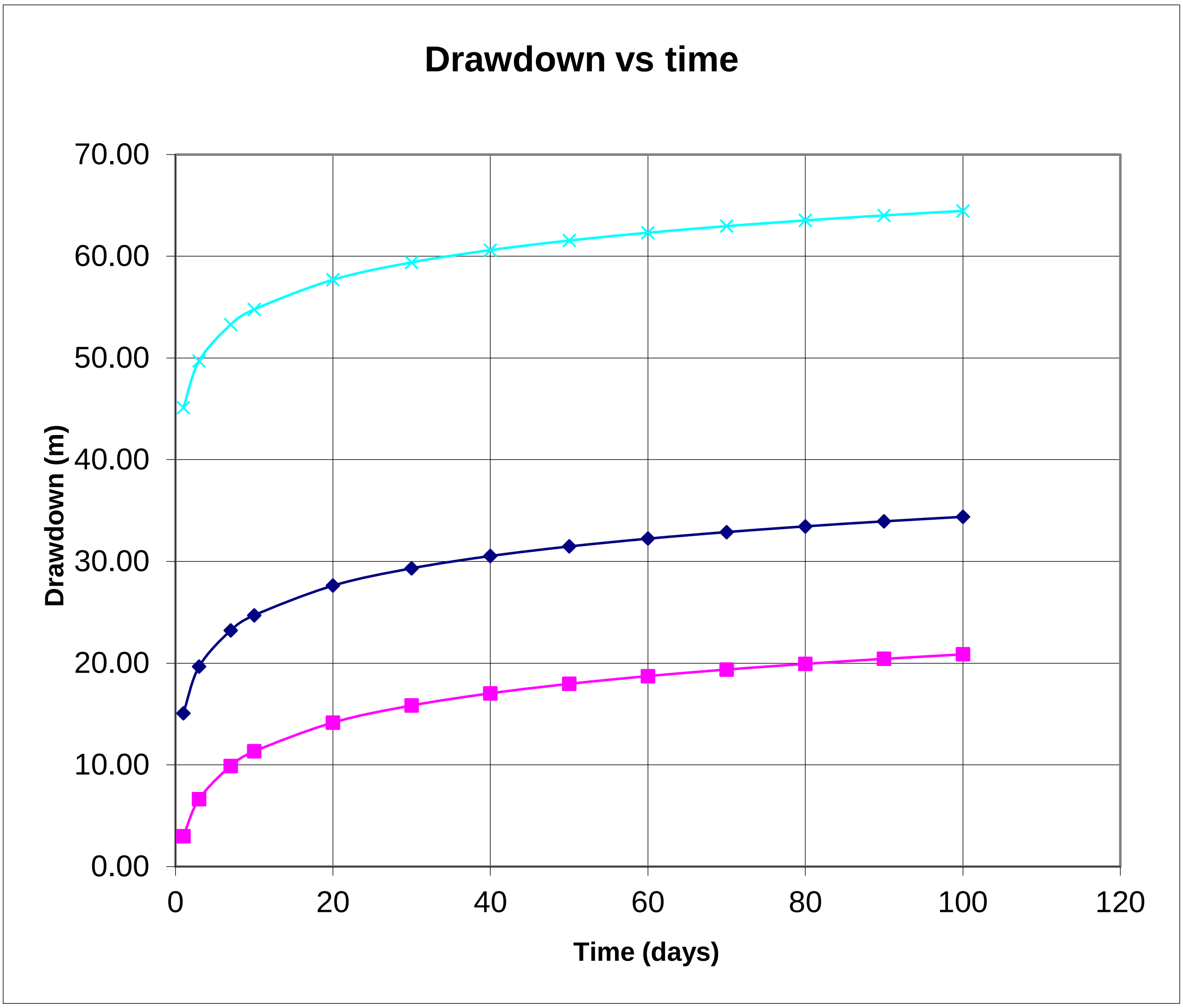
Time (days)	1	365	730
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.1	21.312	31.096	32.245
1925	-	0.168	0.568
2956	-	0.011	0.114
2990	-	0.010	0.107
3300	-	0.004	0.062
3500	-	0.002	0.043
3600	-	0.001	0.036
3877	-	0.001	0.021
4000	-	0.000	0.016
4176	-	0.000	0.011
4670	-	0.000	0.004
4765	-	0.000	0.003
4820	-	0.000	0.003



Time-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	4.30E-06	
B		
Pumping rate		
Q	10.4	l/s

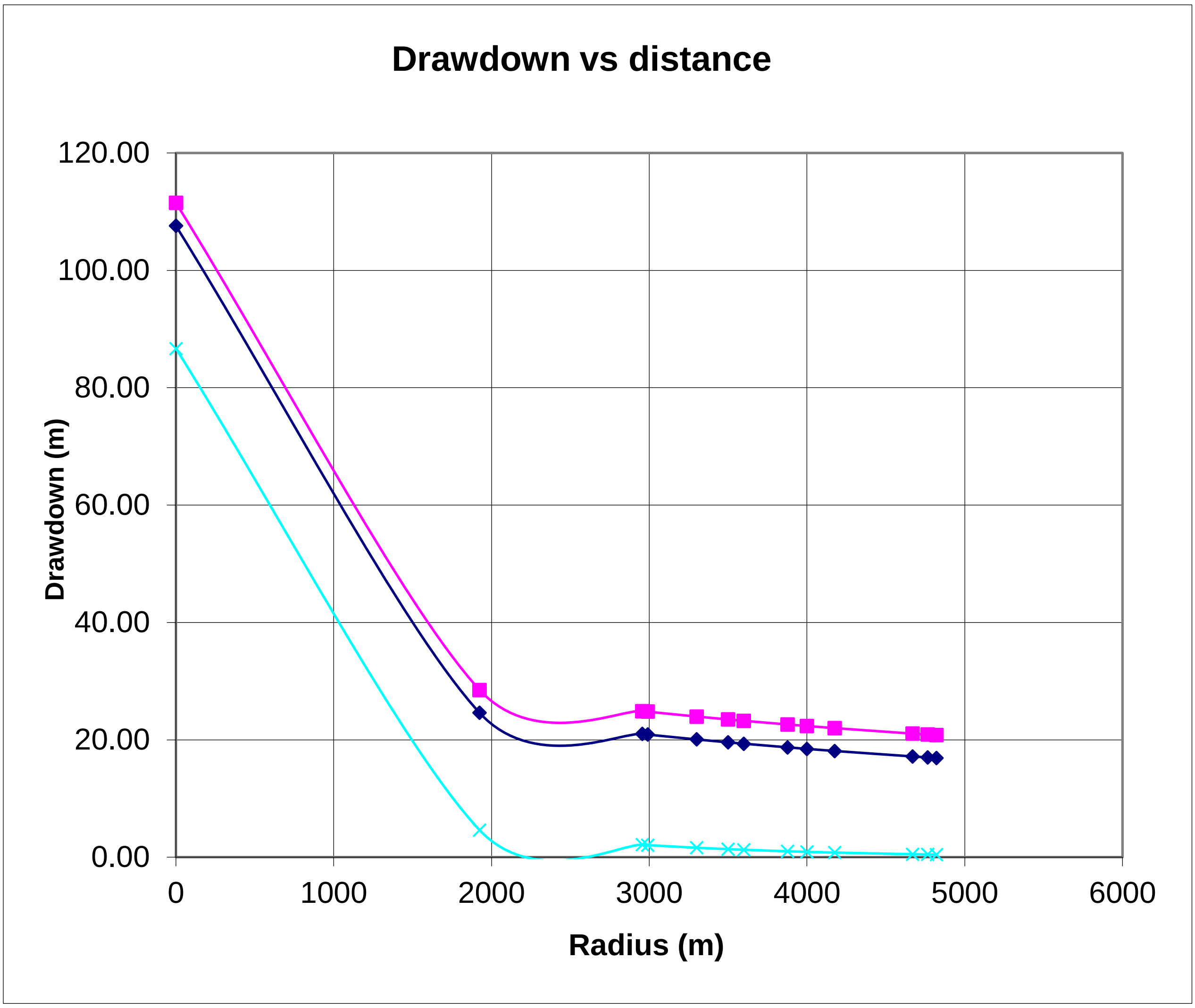
Radius (m)	14	500	2500
Time (days)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
1	45.095	15.082	2.988
3	49.716	19.659	6.634
7	53.280	23.210	9.896
10	54.780	24.708	11.326
20	57.695	27.620	14.160
30	59.401	29.324	15.838
40	60.611	30.534	17.034
50	61.550	31.472	17.965
60	62.316	32.239	18.726
70	62.965	32.887	19.370
80	63.526	33.448	19.929
90	64.022	33.944	20.422
100	64.465	34.387	20.864



Distance-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	4.30E-06	
B		
Pumping rate		
Q	10.4	l/s

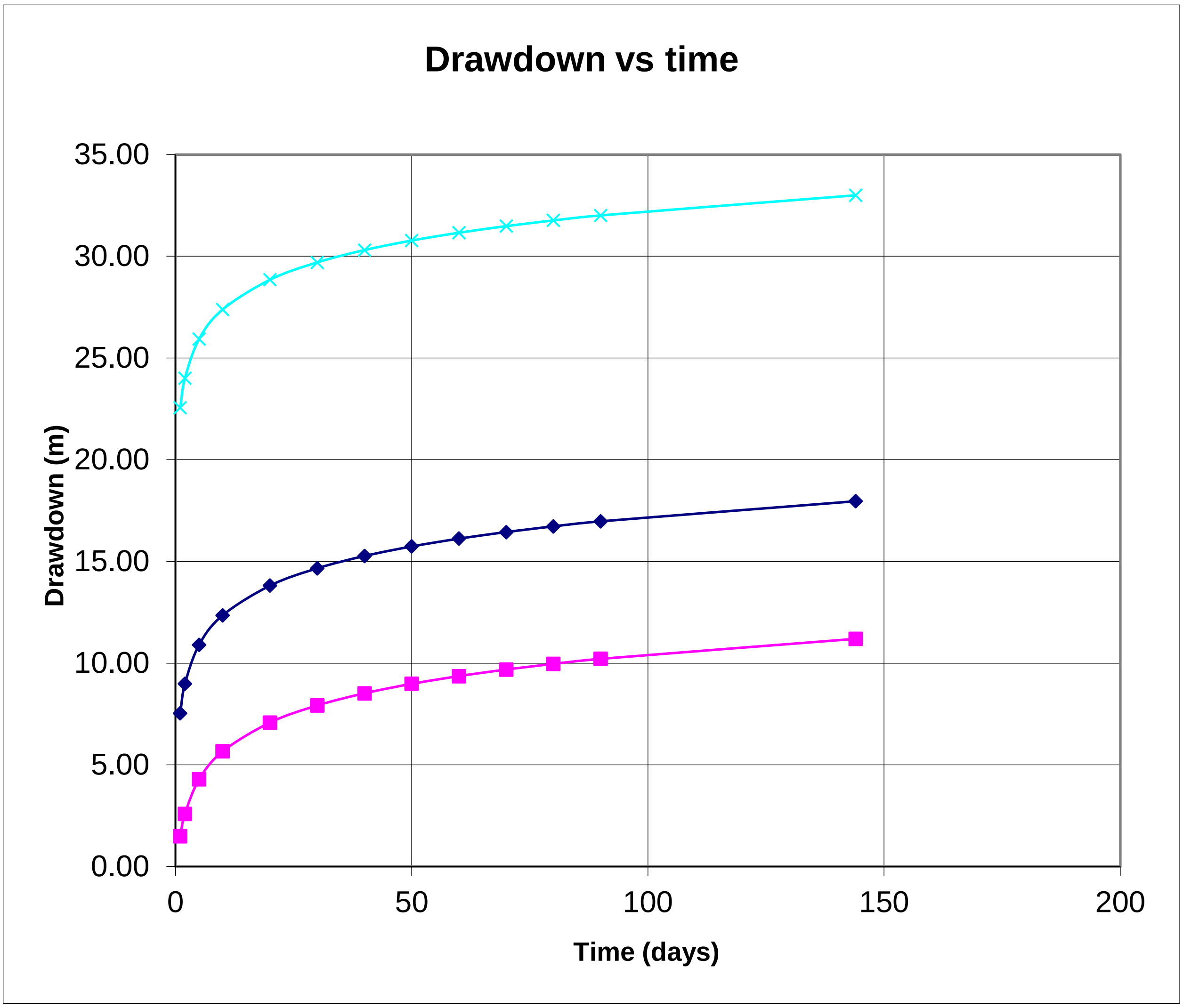
Time (days)	1	144	365
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.1	86.666	107.570	111.482
1925	4.606	24.586	28.494
2956	2.106	20.987	24.890
2990	2.051	20.892	24.794
3300	1.607	20.065	23.965
3500	1.368	19.573	23.471
3600	1.261	19.337	23.235
3877	1.003	18.717	22.613
4000	0.905	18.456	22.351
4176	0.779	18.097	21.989
4670	0.505	17.164	21.052
4765	0.463	16.997	20.883
4820	0.441	16.901	20.787



Time-drawdown calculations
using Theis equation

Aquifer parameters		
T	34	m2/d
S	8.60E-06	
B		
Pumping rate		
Q	10.4	l/s

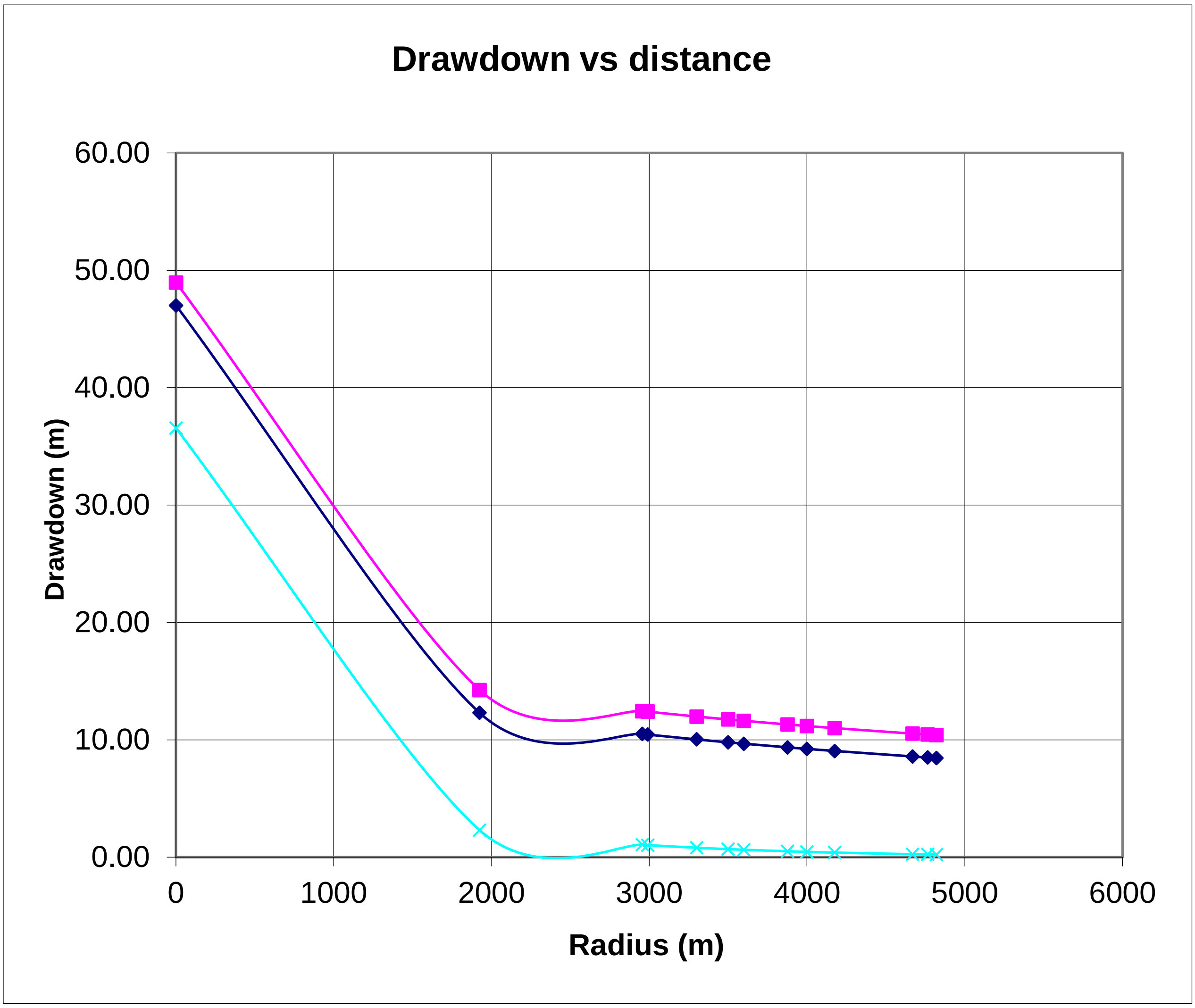
Radius (m)	14	500	2500
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
1	22.547	7.541	1.494
2	24.005	8.982	2.592
5	25.932	10.899	4.286
10	27.390	12.354	5.663
20	28.848	13.810	7.080
30	29.700	14.662	7.919
40	30.305	15.267	8.517
50	30.775	15.736	8.982
60	31.158	16.119	9.363
70	31.482	16.443	9.685
80	31.763	16.724	9.965
90	32.011	16.972	10.211
144	32.999	17.960	11.196



Distance-drawdown calculations using Theis equation

Aquifer parameters		
T	34	m2/d
S	8.60E-06	
B		
Pumping rate		
Q	10.4	l/s

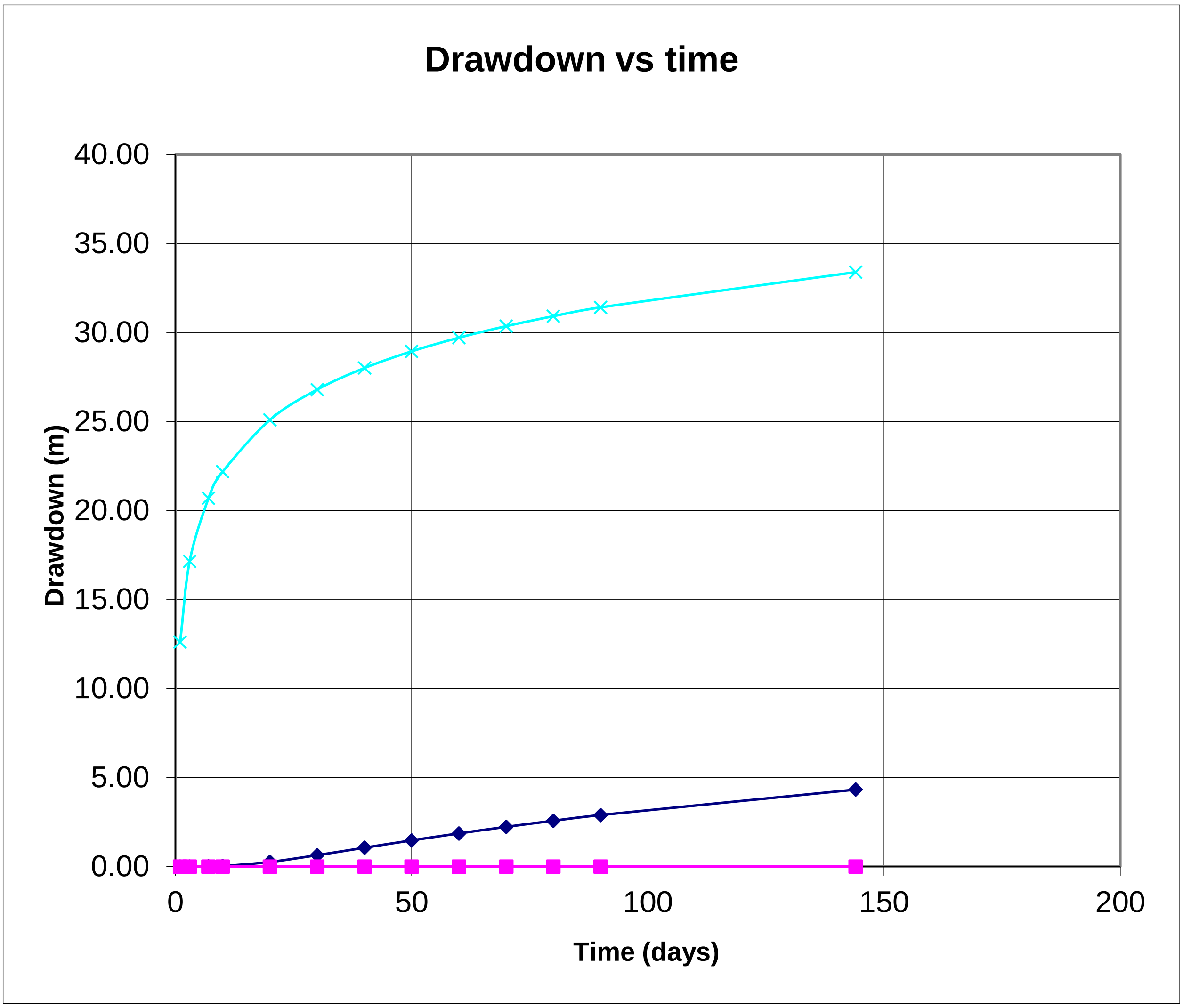
Time (days)	1	144	365
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.5	36.563	47.015	48.971
1925	2.303	12.293	14.247
2956	1.053	10.494	12.445
2990	1.026	10.446	12.397
3300	0.803	10.033	11.983
3500	0.684	9.786	11.736
3600	0.631	9.669	11.617
3877	0.502	9.359	11.306
4000	0.452	9.228	11.175
4176	0.389	9.048	10.995
4670	0.252	8.582	10.526
4765	0.232	8.498	10.442
4820	0.220	8.450	10.394



Time-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	10.4	l/s

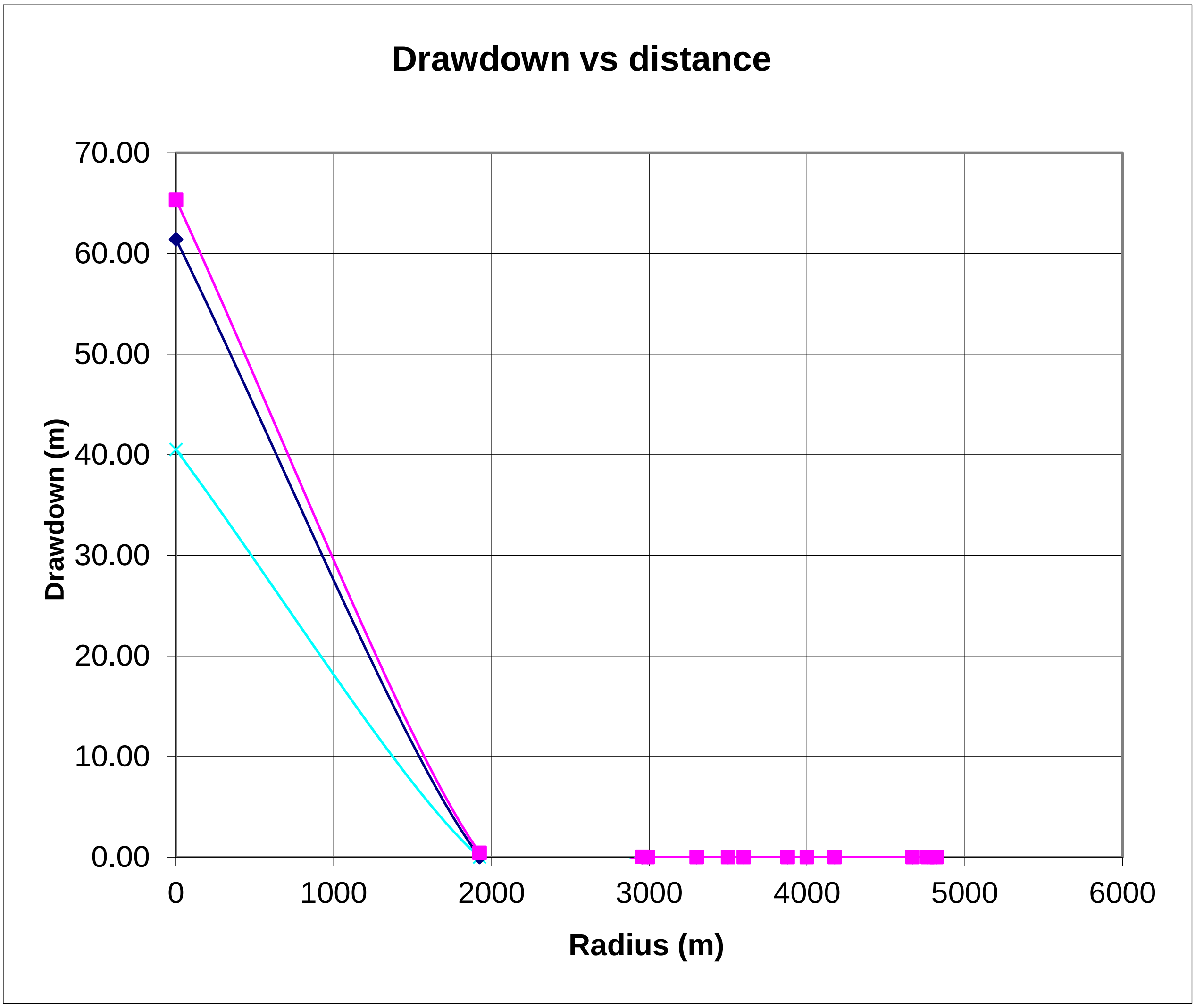
Radius (m)	14	500	2500
Time (days)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
1	12.610	-	-
3	17.151	0.000	-
7	20.692	0.004	-
10	22.187	0.024	-
20	25.096	0.258	-
30	26.800	0.640	-
40	28.009	1.059	-
50	28.947	1.471	-
60	29.713	1.863	-
70	30.361	2.231	0.000
80	30.923	2.574	0.000
90	31.418	2.895	0.000
144	33.394	4.324	0.001



Distance-drawdown calculations using Theis equation

Aquifer parameters		
T	17	m2/d
S	0.01	
B		
Pumping rate		
Q	10.4	l/s

Time (days)	1	144	365
Radius (m)	**Drawdown (m)**	**Drawdown (m)**	**Drawdown (m)**
0.5	40.522	61.425	65.337
1925	-	0.021	0.425
2956	-	0.000	0.029
2990	-	0.000	0.026
3300	-	0.000	0.010
3500	-	0.000	0.005
3600	-	0.000	0.004
3877	-	-	0.001
4000	-	-	0.001
4176	-	-	0.000
4670	-	-	0.000
4765	-	-	0.000
4820	-	-	0.000



Appendix G

Assessment of transmission line options

Appendix G Assessment of transmission line options

Background

Section 3.4 of the Scoping Requirements for Kentbruck Green Power Hub Environment Effects Statement requires that the Project's EES document the likely environmental effects of the Project's feasible alternatives, including routes and configurations for the transmission line. The depth of investigation should be proportionate to the potential of the alternatives to minimise potentially significant adverse effects and to meet the Project objectives.

This appendix describes the feasible transmission line alternatives that have been considered by Neoen for this Project, and the potential groundwater effects of each alternative. The preferred option for the Project, referred to as "Option 1B", has been assessed in detail in this report, so is not subject to any further assessment in this appendix. Instead, this appendix considers the potential environmental effects of the following transmission line alternatives (see Figure A1, Attachment A):

- Option 1A ("Heywood Underground and Overhead": Follows the same route as Option 1B (the preferred option) underground through Cobboboonee National Park / Forest Park and then overhead to the existing Heywood Terminal Station.
- Option 2A ("Portland Overhead"): A wholly overhead option that connects to the existing Heywood-Portland 500 kV line north of Portland. Runs southeast from the wind farm site through rural landholdings. No final route was determined for this option as landowner agreements were unable to be secured for the entire length of transmission line. This option therefore includes several route options.
- Option 2B ("Portland Underground"): Follows the same route as Option 2A but is wholly underground.

A full description of each option is provided in Section 3.0.

Transmission line Project objectives

The fundamental objective of the Project is to provide a source of clean, renewable energy to help power homes and businesses in Victoria and throughout eastern Australia which are connected to the National Electricity Market (NEM). Neoen's environmental and social objectives for the Project, as described in Section 2.2 of the EES, stem from the need to develop the Project in accordance with the principles of ecologically sustainable development. Neoen's objectives relating specifically to the transmission line component of the Project are to:

- Deliver renewable electricity from the Project to the NEM
- Seek opportunities to co-locate infrastructure with existing compatible land uses such as existing easements and transport routes
- Avoid or minimise potential adverse impacts on the natural environment
- Avoid or minimise potential adverse impacts on Aboriginal and historical heritage
- Avoid or minimise potential adverse impacts on nearby residents associated with visual amenity, noise, traffic, and air quality
- Avoid impacts to business and commercial operations
- Avoid or minimise potential impacts on productive agricultural land
- Avoid or minimise the risk of bushfire
- Ensure an appropriate land use outcome by avoiding areas of sensitivity and potential land use conflicts
- Be able to obtain necessary agreements with landowners and land managers to install and operate infrastructure.

- Be able to obtain planning and environmental approvals from all necessary authorities.
- Provide a constructable and cost-effective grid connection.

Umwelt (2024) has prepared a Transmission Line Options Assessment which describes all the transmission line options considered by Neoen to date, including those which were not found to be viable and were removed from the Project before the EES process commenced or very early in the EES process. The Options Assessment uses an objective, criteria-based approach to assessing each option. The assessment criteria and scoring metrics were developed in accordance with the transmission line objectives provided above.

This appendix describes the potential groundwater impacts of the feasible transmission line options identified in the options assessment report, providing information for use by Umwelt in the options assessment in relation to the groundwater related criteria.

Description of the alternative transmission line options

The Project being pursued by Neoen, and subject to full impact assessment in this report, comprises a preferred transmission line route and configuration as described in Section 3.6 of this report (underground through Cobboboonee National Park and Forest Park and through farmland to the Heywood Terminal Station – Option 1B). A feasible alternative is for this alignment to be underground through Cobbobooneed National Park and Forest Park and overhead through farmland to the Heywood Terminal Station (Option 1A).

Two other options which were identified as being feasible in the Transmission Line Options Assessment but are no longer being pursued by the Project due to a lack of landowner and community support, are Options 2A and 2B which run southeast from the wind farm site and connect to the Heywood-Portland 500 kV line north of Portland. Option 2A is wholly overhead, while Option 2B is wholly underground.

The three transmission line options are described as follows:

- Option 1A: The underground transmission line would extend east from the main wind farm substation and traverse Cobboboonee National Park and Forest Park beneath an existing road, and then continue overhead through freehold rural landholdings to reach the Heywood Terminal Station.
- Option 2A: The overhead transmission line would extend southeast from the main wind farm substation and traverse several freehold rural landholdings used primarily for grazing. This option would require development and construction of a new terminal station adjacent to the existing Heywood-Portland 500 kV line north of Portland.
- Option 2B: The underground transmission line would extend southeast from the main wind farm substation and traverse several freehold rural landholdings used primarily for grazing. This option would require development and construction of a new terminal station adjacent to the existing Heywood- Portland 500 kV line north of Portland.

The three options are shown in Figure A1, Attachment A

Summary of the assessment methodology

This section describes the method used to assess potential groundwater impacts of the Project. A risk-based approach was applied to the desktop assessment to prioritise key issues for assessment and inform measures to avoid, minimise and offset potential effects.

Key elements of the impact assessment for the transmission line options included:

- Characterise the nature and extent of groundwater systems which may be impacted
- Identify relevant groundwater environments, values and users that might be affected
- Identification of potential impact pathways and risk-based screening to identify key potential issues
- Identify and evaluate potential effects of the transmission line options on groundwater including the likely extent, magnitude, and duration (short and long term) of changes to groundwater level, flow paths and quality during construction and operation

- Describe and evaluate any monitoring and contingency measures to be implemented in the event of adverse residual effects on the groundwater environment

The western portion of Option 1A is the same as Option 1B – both being a proposed 17 km of underground transmission line traversing the southern part of the Cobboboonee National Park. Therefore, the underground section of Option 1A is addressed in Sections 7.9, 8.1 and 8.2 of the groundwater impact assessment report. The eastern above ground section of Option 1Ais not considered as part of this assessment as no potential impact pathways were identified for groundwater.

The wholly above ground option, Option 2A, is not considered as part of this assessment as no potential impact pathways were identified for groundwater.

The assessment provided in this appendix therefore addresses:

- Option 2B in its entirety: being approximately 24 km of underground transmission line from the main wind farm substation to an area adjacent to the existing Heywood-Portland 500 kV line

The groundwater study area includes the transmission line option plus a 200-metre buffer zone. This is consistent with the main report and appropriate to capture existing conditions that may be affected by potential changes to groundwater levels and flow due to the proposed Project activities and infrastructure.

Existing conditions

Option 2B

The topography falls steadily from northwest to southeast, with the ground elevation decreasing from around 150 mAHD to 50 mAHD along the approximately 24 km route (refer to Figure A2, Attachment A).

Near surface geology along Option 2B transmission line route is predominantly mapped as Quaternary age coastal and inland dunal deposits, consisting of sand or fine sand (also known as the Molineaux Sands - VVG website). Some swamp deposits (typically including clay, silt, and peat) are also mapped in several areas along the alignment. The eastern end of the alignment is mapped as being underlain by basalt of the Newer Volcanics. This is broadly consistent with the limited borelog information from registered bores within the study area (refer to Table 12-1 and Figures A3 and A5, Attachment A).

The Option 2B transmission line is mapped as having groundwater at less than ten metres below ground surface; based on regional scale interpretation and interpolation (Figure A4, Attachment A). According to Visualising Victoria's Groundwater (VVG) website, the depth to water is mapped as being less than five metres (again based on limited regional scale data).

There are no water level data available from DELWP's WMIS[10] database for existing bores within or close to the transmission line study area.

The regional groundwater flow direction is unclear, but local scale shallow flowpaths relevant to shallow trenching in this sub-area may be influenced by discharge to gaining streams, GDEs and groundwater extraction where these are present.

Groundwater - surface water interaction would be limited to local interaction between shallow groundwater in sediments of associated creeks and GDEs. There is one low potential aquatic GDE (from regional studies) mapped within the study area and high potential terrestrial GDEs (from national assessment) are mapped along some minor waterways within the study area (Figures A6 & A7, Attachments A).

A search of the WMIS database was carried out in July 2023. There are a total of 11 bores mapped within 200 m of the transmission line (one listed as decommissioned).

Bore locations are provided in Figure A5 (Attachment A), and pertinent information summarised in Table 12-1.

[10] http://data.water.vic.gov.au/

Table 12-1 Registered bores mapped within 200m of Option 2B

Bore ID	Status	Use	Total depth (mbgs)	Screened interval (mbgs)	Lithology
82004	Used	NK	NK	NK	NK
82045	Used	D & S	51.82	39.6 - 51.8	21.3 - 51.8: basalt
132651	Used	Stock	99.06	NK	0 - 13.4: sand 13.4 - 18.3: clay 18.3 - 99.1: basalt
WRK046629	Used	D & S	16.76	NK	NK
WRK968678	Used	D & S	14.93	NK	NK
WRK985654	Decom.	Stock	9.14	NK	NK
66081	Used	Stock	19.2	NK	NK
65980	Used	D & S	51.82	33.5 - 51.8	44.8 - 51.8: fractured basalt
66034	Used	D & S	85.34	84 - 85.3	0 - 15: mottled clay 15 - 84: basalt 84 - 85.3: limestone
96835	Used	D & S	12	11 - 12	2 - 12: sand
66035	Used	D & S	65.53	65 - 65.5	0 - 9: mottled clay 9- 65: basalt 65 - 65.5: limestone
NOTES: mbgs – metres below ground surface; Decom. – decommissioned; NK – not known; D&S – domestic and stock					

Identification of impact pathways

Possible transmission line risk pathways related to changes in groundwater levels and flow were identified and rated in Section 6 of the main groundwater impact assessment. Results from the risk assessment that are relevant to Option 2B are summarised in Table 12-2.

Table 12-2 Risk pathway screening results for groundwater

Impact pathway	Project area	Risk screening score	Risk screening value
Construction			
Cable trench dewatering reduces groundwater levels at existing consumptive use bore(s) or GDEs	Option 2B	4	Medium
Existing bores become damaged, destroyed, or inaccessible thereby affecting bore user	Option 2B	4	Medium
Operation			
Trenched sections of underground cable impede groundwater resulting in changed groundwater levels and/or flows at existing bores or GDEs	Option 2B	5	Medium

Potential impacts on groundwater quality from the Project, including acid sulfate soils, are considered in a separate EES Technical Report (Environmental Site Investigation; AECOM, 2023) (Appendix I of the EES).

Potential impacts on GDEs are considered in a separate EES Technical Report (Groundwater Dependent Ecosystem Impact Assessment; CDM Smith, 2024) (Appendix H of the EES).

Impact assessment

Construction phase

Transmission line trench dewatering

Impact

Trenching for underground sections of the transmission line Option 2B will be to a depth of approximately 1.25 metres.

It is possible that groundwater could be intersected during trenching of some sections, with the depth of in-trench water variable based on small changes in relief, but up to 1.25 metres of water may need to be dewatered if groundwater is close to ground surface.

If groundwater were to be intersected it would need to be dewatered prior to the installation of underground cabling and placement of backfill. The shallow depth of the trench will limit the potential to penetrate a significant depth below the water table, and dewatering (if required) would be carried out for a short duration only (hours rather than days) immediately prior to installation of the cable and backfill.

Swamp and lake deposits, and weathered basalt may be intersected along alignment Option 2B. The lithology will be predominantly clays, silts, and peat with relatively low hydraulic conductivity (that is, limited capacity to readily transmit groundwater). Literature values for the hydraulic conductivity of clay are up to 0.0004 m/day and for silt are up to 1 m/day (Domenico and Schwartz, 1990). The reduction in groundwater levels (drawdown) away from the trench sections through these clays and silts would be negligible (<0.1 m) at distances beyond around 5 metres and would occur for less than a week[11].

Trenching along some sections of Option 2B may also intersect the fine to medium grained sands of the dunal systems mapped in some areas. Literature values for the hydraulic conductivity of fine to medium grained clean sand is between 0.02 and 35 m/day (Domenico and Schwartz, 1990). The greater hydraulic conductivity of these sediments would be less than 0.1 m at distances beyond 20 metres away from the trench and occur for less than a week[12].

[11] Based on Theis approximation with 1m drawdown at trench, K of 0.5 m/day, unconfined S of 0.1 and 24 hrs pumping
[12] Based on Theis approximation with 1m drawdown at trench, K of 25 m/day, unconfined S of 0.2 and 24 hrs pumping

Impacts, if any, to nearby consumptive use bores would be negligible due to the shallow depth of trenching, limited extent and magnitude of drawdown away from trenches, and short duration of trench dewatering.

Potential effects on GDEs are addressed in Groundwater Dependent Ecosystem Impact Assessment report (CDM Smith, 2024) (Appendix H of the EES).

Mitigation

No additional measures are recommended to mitigate existing consumptive use bores.

Mitigation measures for GDEs are addressed in the Groundwater Dependent Ecosystem Impact Assessment report (CDM Smith, 2024) (Appendix H of the EES).

Residual impact

No material residual impact is anticipated for existing consumptive use bores.

Existing bores become damaged, destroyed or inaccessible

Impact

Registered and unregistered bores within, or near, the construction footprint of the transmission line corridor have the potential to be damaged, lost (i.e. destroyed), or to become inaccessible during construction. This could lead to a temporary or permanent loss of access to groundwater for the affected bore owner/user.

A total of 11 registered bores (plus two decommissioned bores) are mapped as being located within the groundwater study areas for transmission line Option 2B. Many of these are beyond the immediate footprint of the proposed turbine, access track and trenching locations. Other bores, such as unregistered bores or registered bores mapped incorrectly in the WMIS database, may also be affected during construction.

Mitigation

Following detailed design, the location of registered and unregistered bores should be visually confirmed on site relative to Project infrastructure (such as turbines, access tracks and trenching).

Prior to construction the potential for damage or loss of access to existing bores should be established in consultation with the landholder/bore owner.

In instances where a bore is deemed to be impacted by the Project, consultation should occur to facilitate an agreement between Neoen and the landholder/bore owner.

Residual impact

No material residual impact is anticipated following the implementation of the recommended mitigation measures.

Operational phase

Transmission line cable trenches impede groundwater affecting groundwater users

Impact

There is the potential for shallow groundwater flow to be impeded by cable trenches following completion with thermally stable backfill if required (typically in the form of flowable concrete) followed by excavated backfill or crushed rock to surface.

Any such impacts on shallow groundwater levels due to the trench acting as a barrier (or partial barrier) to groundwater flow are not expected to be material given the size and scale of the trench relative to the aquifers and regional context of groundwater flow, and ability of groundwater to flow beneath the trench.

No significantly lower permeability horizons directly below the trench depth (of approximately 1.25 m) are anticipated and groundwater flow beneath the backfilled trenches can therefore be expected to occur.

Estimated changes to groundwater levels adjacent to a trench, to provide a change in driving head to produce underflow, are provided in Table 12-3; based on the concept of underflow (described in Section 8.2.1 of the groundwater impact report).

These are provided for several hydraulic gradients (shallow, moderate and high) and below trench aquifer thicknesses scenarios (b) where the trench is submerged 1.25 metres below the water table.

Table 12-3 Summary of changes to hydraulic gradient across trench

Initial hydraulic gradient (i) (m/m)	Aquifer thickness beneath turbine, b (m)	New hydraulic gradient across turbine (m/m)	Increased head difference across turbine (m)	Groundwater level change [a] (cm)
0.0001	1	0.0003	0.0002	0.01
	2	0.0002	0.0001	0.005
0.001	1	0.003	0.002	0.1
	2	0.002	0.001	0.05
0.01	1	0.025	0.023	1
	2	0.018	0.011	0.6

Note: a - assumes upgradient increase is equal to downgradient decrease across the trench

The results show that the increase in hydraulic gradient across the trench required to 'force' groundwater flow beneath the reduced aquifer thickness would result in a less than one-centimetre change to groundwater levels immediately up- and down-hydraulic gradient of the turbine.

Potential impacts to groundwater users would therefore be negligible due to changes in groundwater levels up- and down hydraulic gradient of the trench.

Potential effects on GDEs are addressed in Groundwater Dependent Ecosystem Impact Assessment report (CDM Smith, 2024) (Appendix H of the EES).

Mitigation

No additional mitigation measures recommended.

Residual impact

No material residual impact is anticipated for existing consumptive use bores.

References

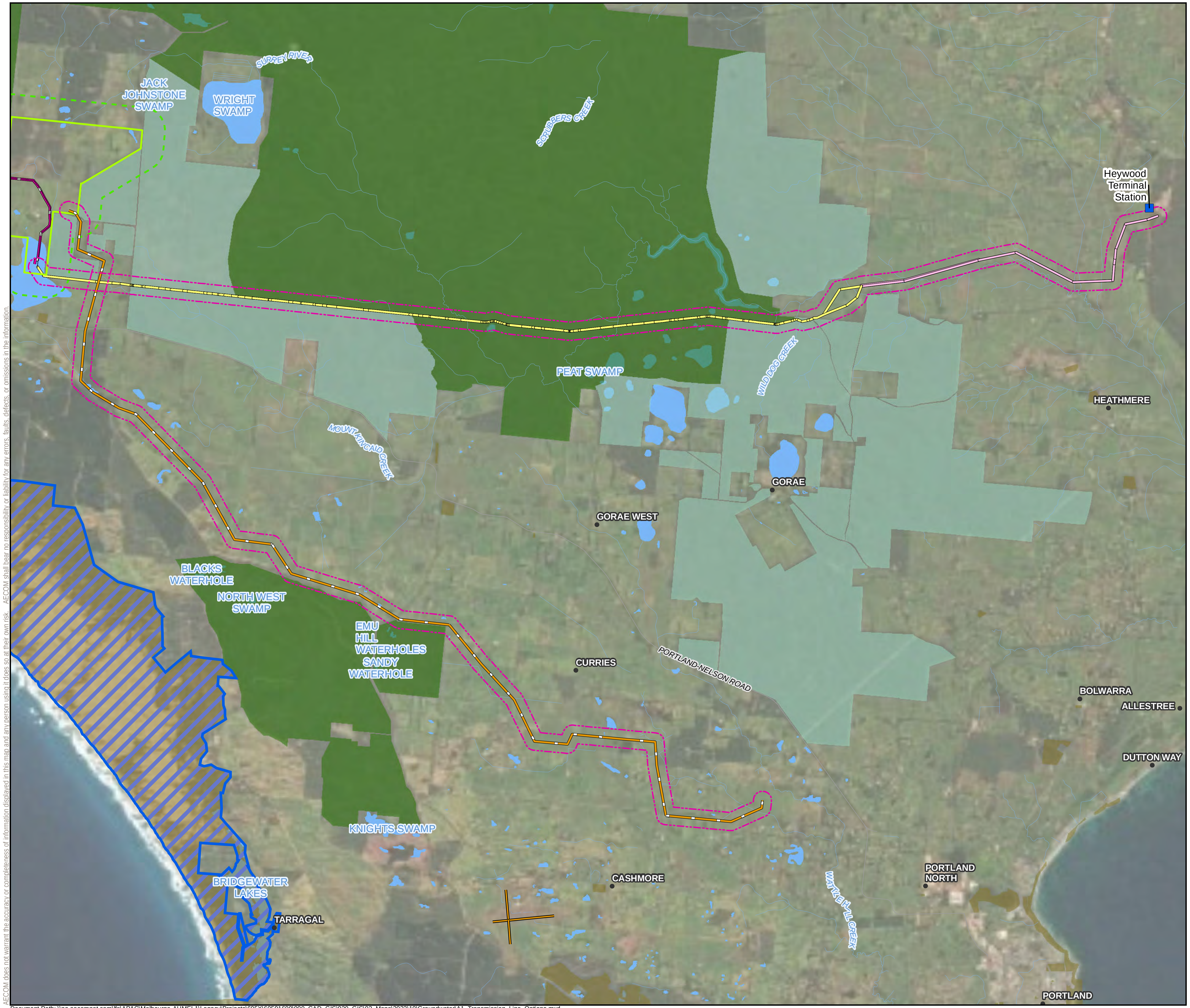
AECOM (2023). *Environmental Site Investigation. Kentbruck Green Power Hub Project EES Technical Report*. Revision 5, October 2023.

CDM Smith (2024). *Kentbruck Green Power Hub EES Technical Report Groundwater Dependent Ecosystem Impact Assessment*. Revision 5, January 2024

Domenico, P.A. and F.W. Schwartz (1990). *Physical and Chemical Hydrogeology*

Umwelt (2024). *Transmission Line Options Assessment. Kentbruck Green Power Hub*. Revision 5, January 2024.

Attachment A – Figures



DATUM GDA94 VICGRID94

0 1.5 3
Kilometers

1:80,000 (when printed at A3)

Legend

- Existing Terminal Station
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Windfarm Boundary 500m -Buffer
- Town
- Roads
- Airstrips
- Watercourses
- Waterbodies
- Ramsar Gleneg Estuary and Discovery Bay
- National Park
- Forest Park
- Reserve

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

Groundwater Impact Assessment
Kentbruck Green Power Hub EES
(Appendix G)

TRANSMISSION LINE OPTIONS

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VERSION:	1

Figure A1

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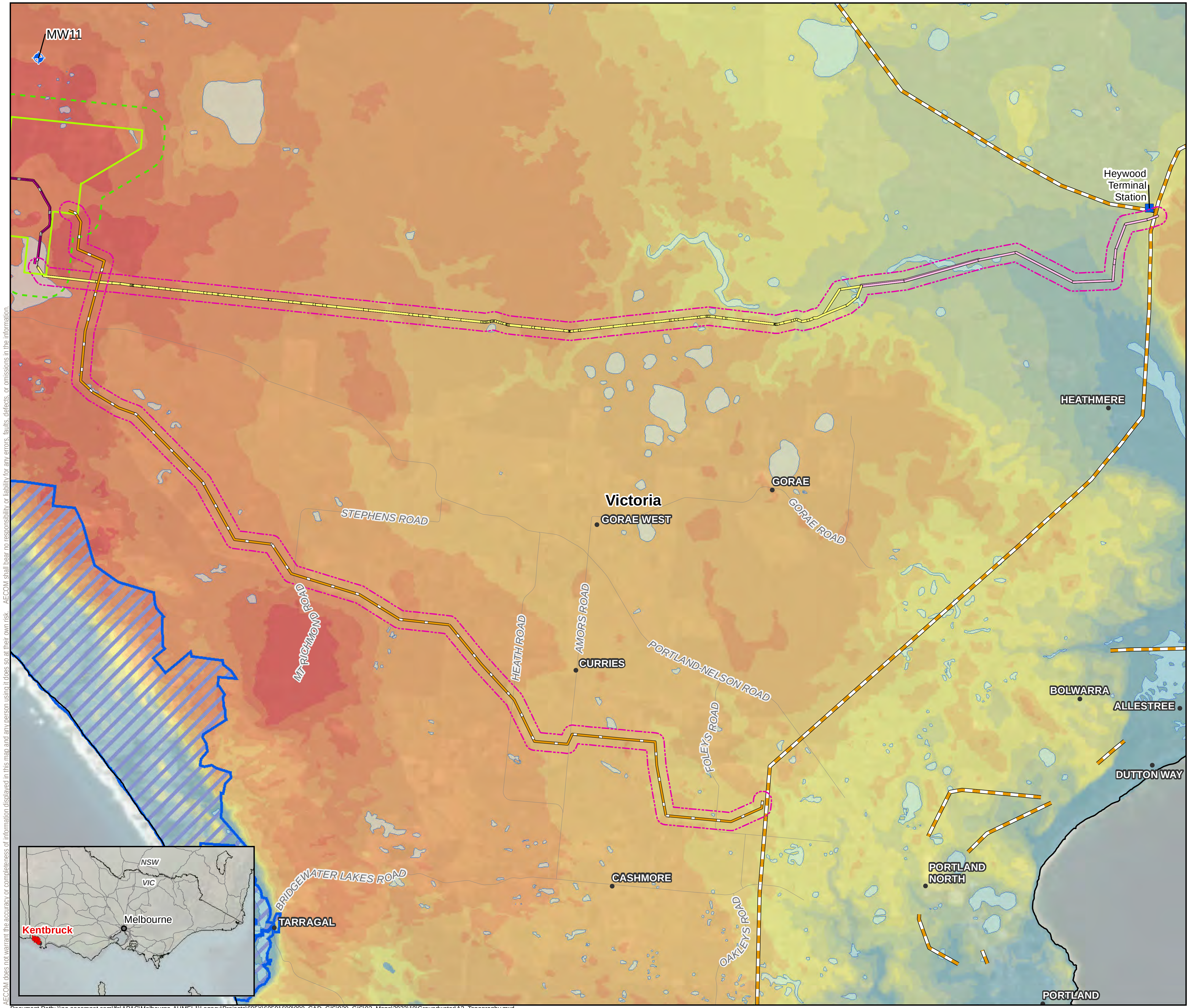

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1 2 Kilometers

1:80,000 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- Windfarm Boundary 500m -Buffer
- 200m Alignment Buffer
- Existing 500 kV transmission line
- RAMSAR Gleneg Estuary and Discovery Bay
- Town
- Roads
- Waterbodies

Elevation (m)

-33 - 0	40 - 50
0 - 20	50 - 60
20 - 25	60 - 80
25 - 30	80 - 100
30 - 35	100 - 120
35 - 40	120 - 140
	140 - 160

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

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TOPOGRAPHY

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VERSION:	1

Figure A2

A3 size

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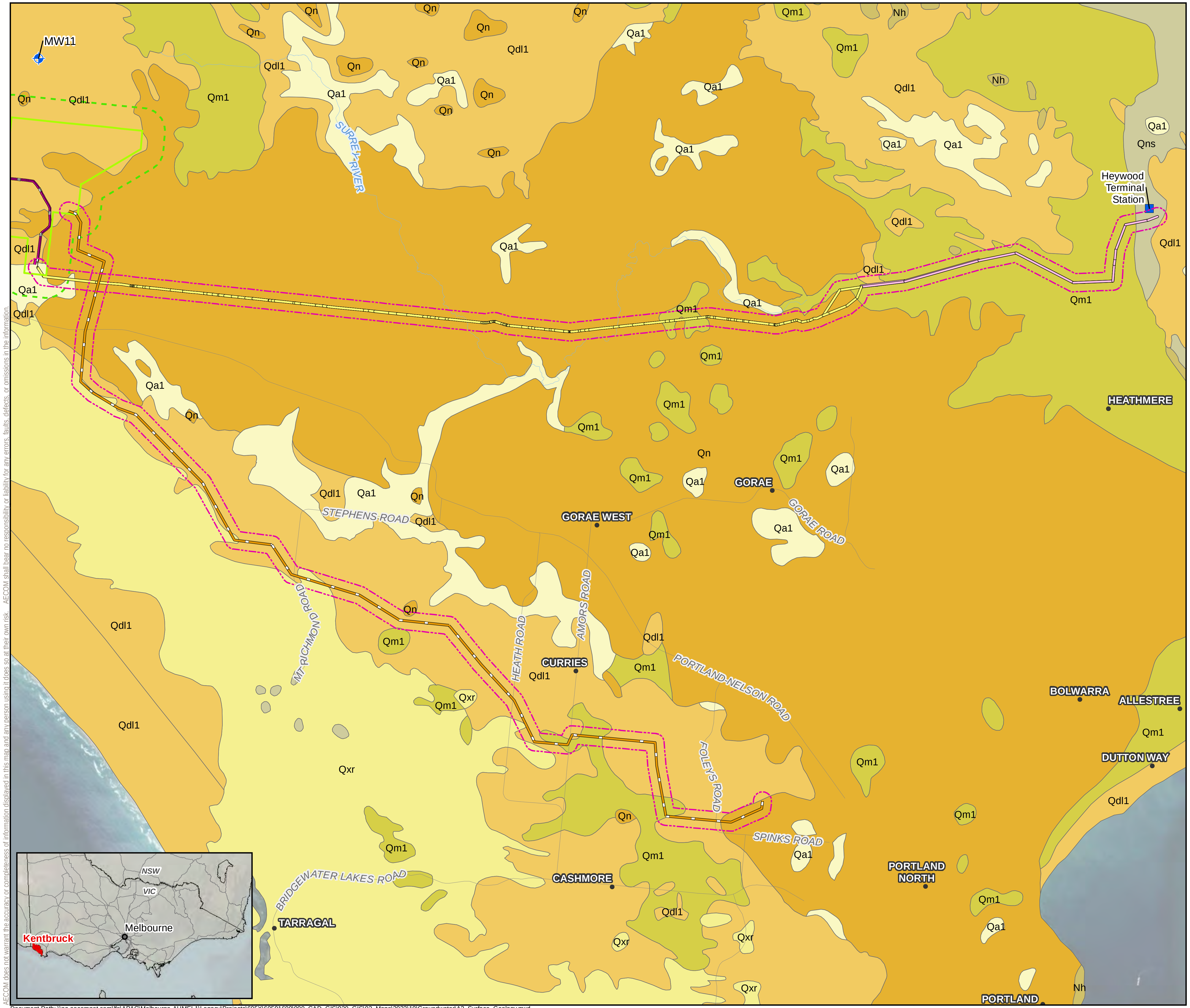

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:80,000 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- Wind Farm Site Boundary
- Indicative Wind Farm Boundary 500m - Buffer
- 200m Alignment Buffer
- Town
- Watercourses
- Roads

Geology

- Nh, Heytesbury Group
- Qa1, Unnamed alluvium
- Qdl1, Unnamed coastal dune deposits
- Qm1, Unnamed swamp and lake deposits
- Qn, Newer Volcanic Group
- Qns, Unnamed scoria deposits
- Qxr, Bridgewater Formation

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

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SURFACE GEOLOGY

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Figure A3

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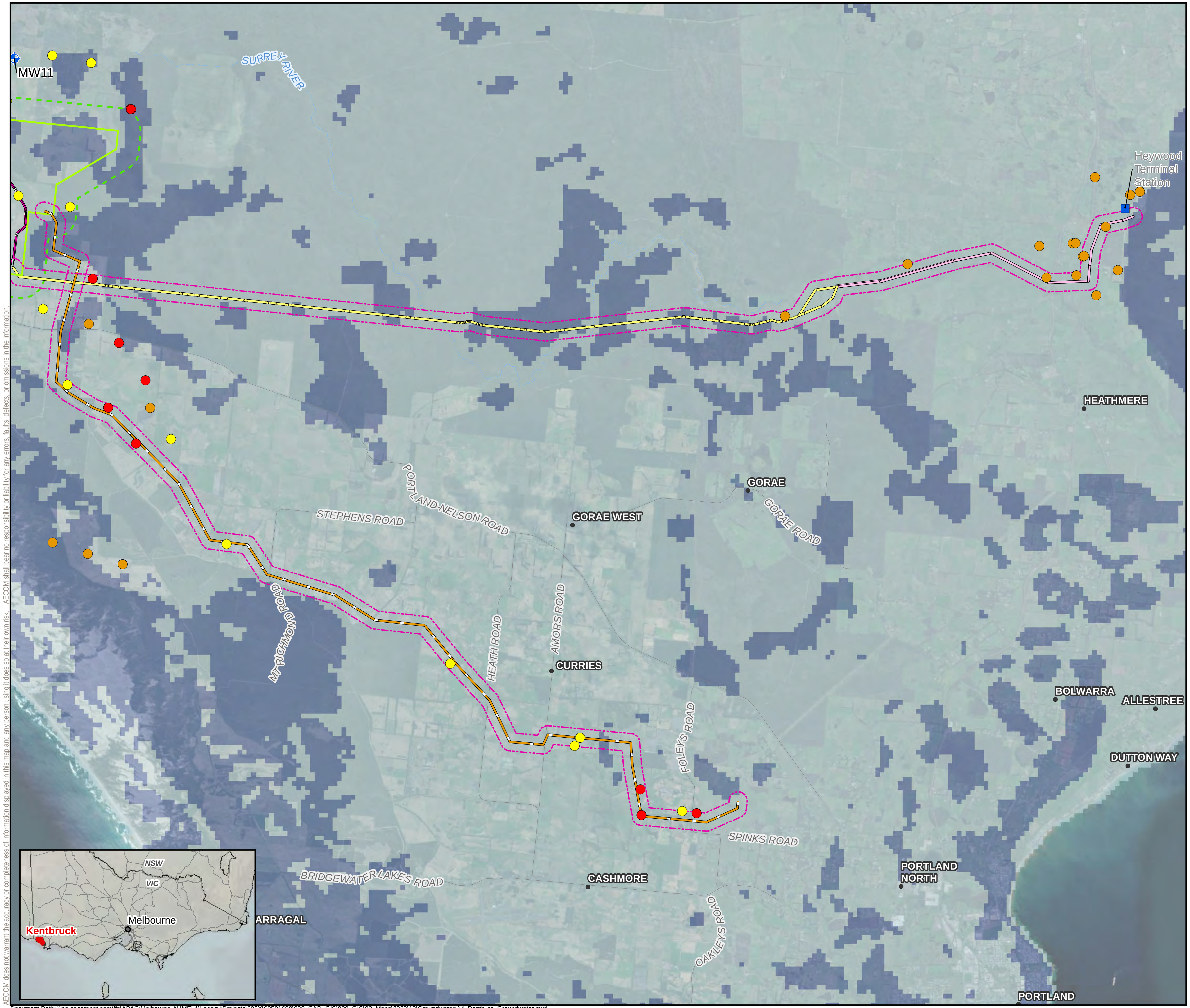

NEOEN Boundless Energy | AECOM

DATUM GDA94 VICGRID94

0 1.5 3 Kilometers

1:80,000 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- Windfarm Boundary 500m -Buffer
- 200m Alignment Buffer
- Town
- Roads
- Watercourses

Bore Depth (m)

- 0 - 20
- 21 - 50
- > 50

Depth to Groundwater (m bgs)

- 0 - 9.99
- > 10

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

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DEPTH TO GROUNDWATER

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VERSION: 1

Figure A4

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NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:80,000 (when printed at A3)

Legend

Bore use - WMIS July 2023

- DOMESTIC, STOCK, IRRIGATION, DAIRY
- MISCELLANEOUS, UNKNOWN
- Domestic & Stock
- Not known
- Stock
- Existing Terminal Station

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Internal access roads
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Plantation Study Sub-area 500 m buffer
- Town
- Roads
- Watercourses

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

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REGISTERED GROUNDWATER BORES

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VERSION: 1

Figure A5

A3 size

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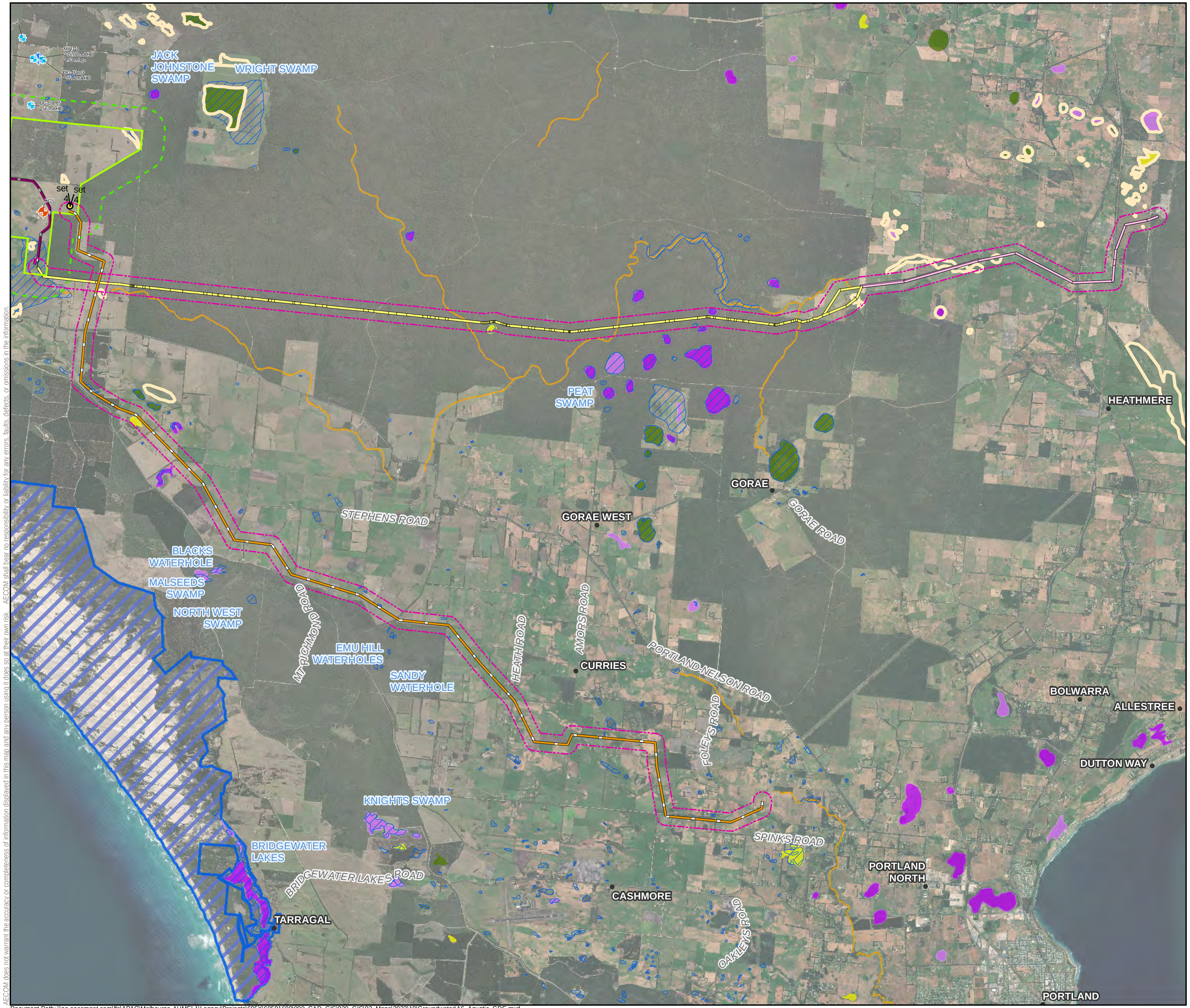

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1 2 Kilometers

1:80,000 (when printed at A3)

Legend

- AECOM Groundwater Monitoring Wells
- Private Groundwater Bores
- Surface Water Level (Dam)
- Crane Pad/Substation
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- Windfarm Boundary 500m -Buffer
- 200m Alignment Buffer
- Town
- Roads
- Ramsar Gleneg Estuary and Discovery Bay
- Waterbodies
- Wetlands from Biosis (2023)

Groundwater Dependant Ecosystems - Aquatic

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies
- High potential GDE - from national assessment
- Unclassified potential GDE - from regional studies

Data Sources:
1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018

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POTENTIAL AQUATIC GDES

PROJECT #: 60591699
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Figure A6

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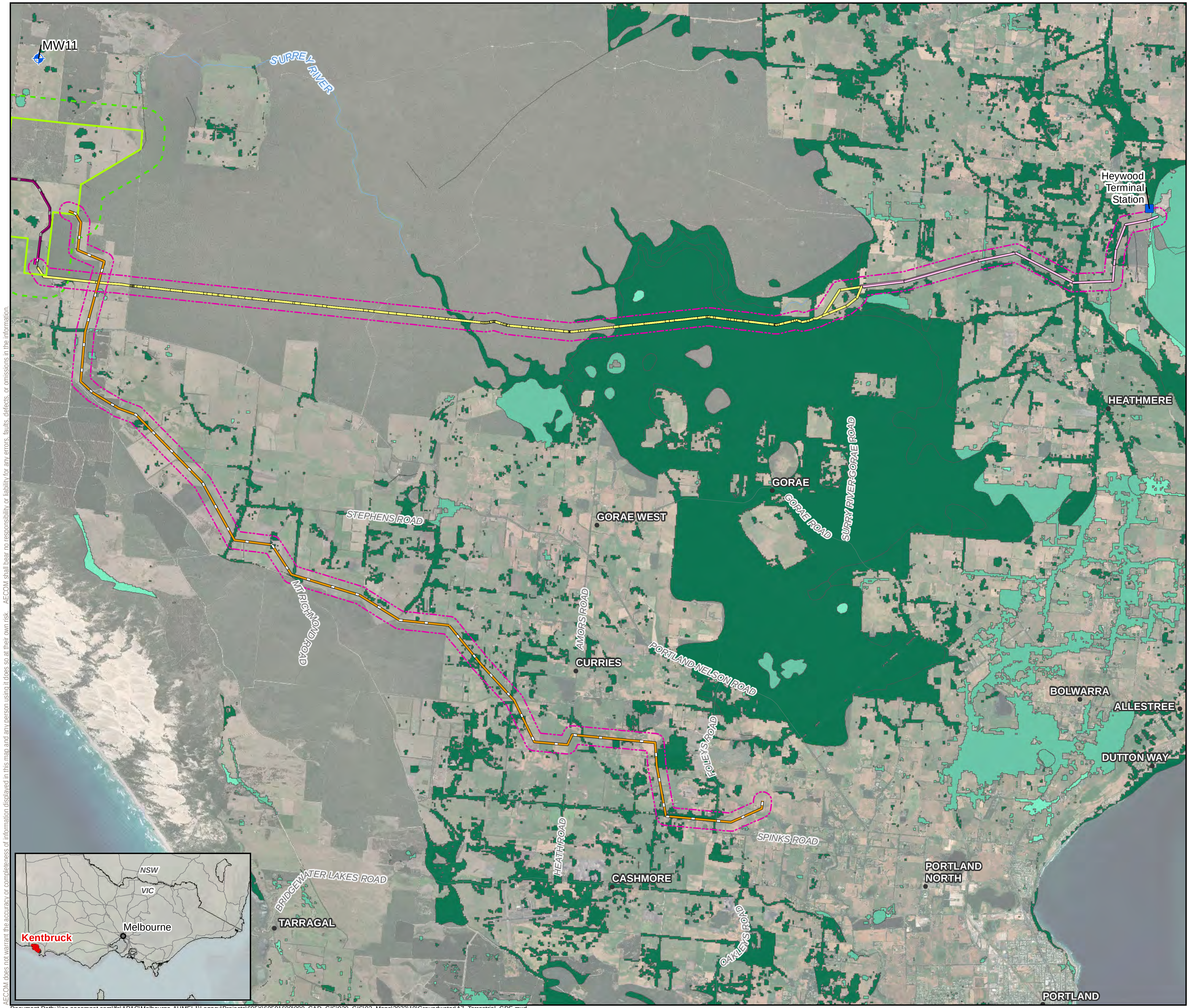

NEOEN BOUNDLESS ENERGY

AECOM

DATUM GDA94 VICGRID94

0 1.5 3

Kilometers

1:80,000 (when printed at A3)

Legend

- MW0x series monitoring wells installed April 2021
- Existing Terminal Station
- Internal access roads

Option 1A (Underground-overhead combination)

- Overhead Transmission Line
- Underground Transmission Line
- Alignment Option 2 (2A Overhead, 2B Underground)
- 275 kV Powerline - Underground
- Wind Farm Site Boundary
- 200m Alignment Buffer
- Wind Farm Boundary 500m -Buffer
- Town
- Roads
- Watercourses

Groundwater Dependant Ecosystems - Terrestrial

- High potential GDE - from national assessment
- Moderate potential GDE - from national assessment
- Low potential GDE - from national assessment

Data Sources:

1. Locality, Railway, Drainage Line, Streets, Features © StreetPro 2014
2. State Controlled Roads © (VICMAP) 2018
3. Essential Habitat © (VICMAP) 2018
4. Conservation Areas © (VICMAP) 2018
5. Protected Area © (VICMAP) 2018
6. Regional Ecosystems v8 © (VICMAP) 2018
7. Protected Plants Flore Survey Trigger © (VICMAP) 2018
8. Waterway Barrier Works© (VICMAP) 2018
9. Water Measurement Information System (WMIS) Accessed 14 April 2020

Groundwater Impact Assessment

Kentbruck Green Power Hub EES

POTENTIAL TERRESTRIAL GDES

PROJECT #:	60578607
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VERSION:	1

Figure A7

A3 size

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