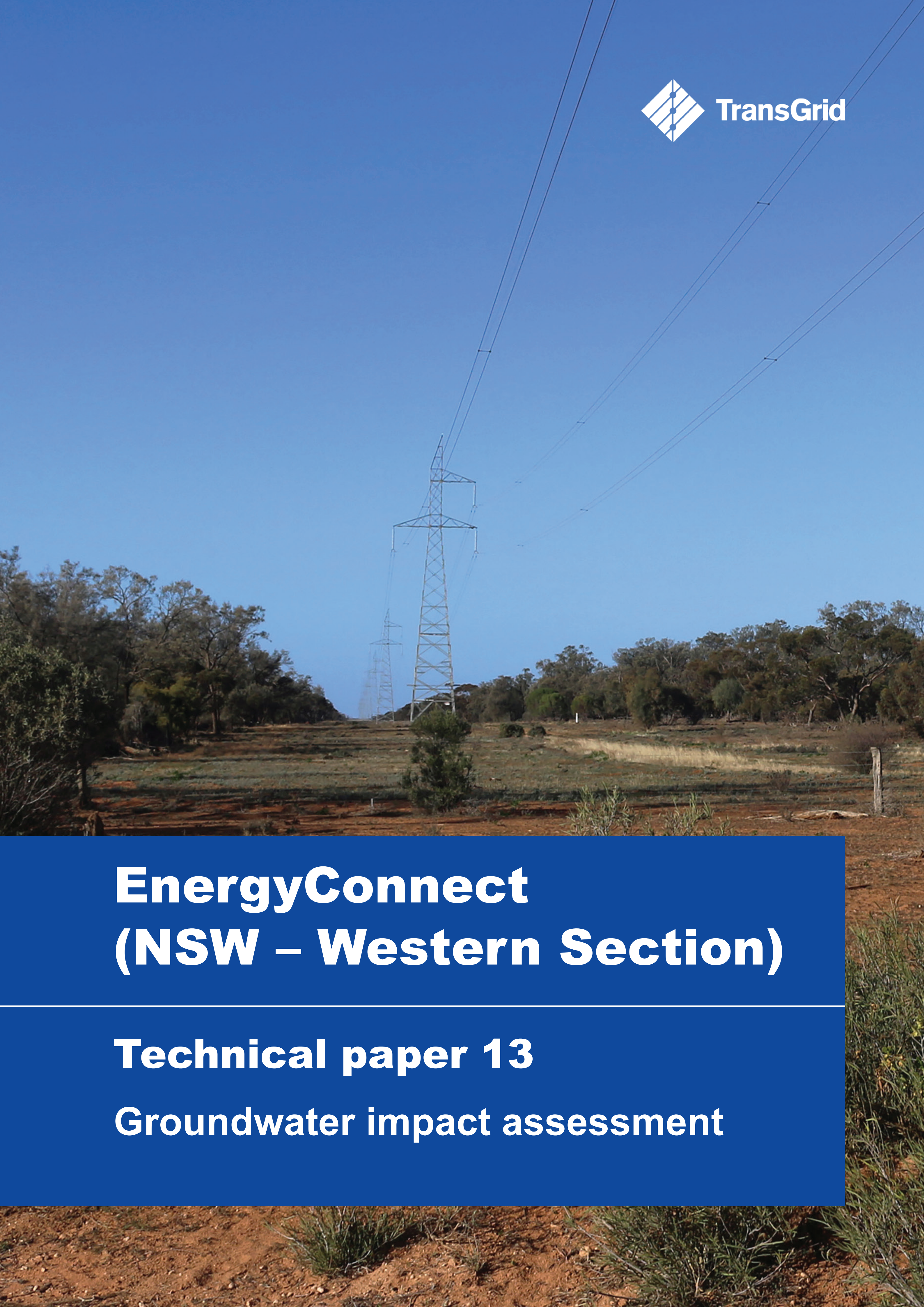

TransGrid

EnergyConnect (NSW – Western Section)

Technical paper 13

Groundwater impact assessment

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Technical paper 13 – Groundwater impact assessment

TransGrid

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REV	DATE	DETAILS
Final	21/10/2020	Final

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GLOSSARY

Aeolian	Sediments deposited by the action of wind, such as dunes.
Alluvial	Sediments deposited by flowing water.
Alluvium	General term for unconsolidated deposits of inorganic materials (clay, silt, sand, gravel, boulders) deposited by flowing water.
Aquifer	Rock or sediment in a formation, group of formations or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
Beneficial use	A resource management tool to protect groundwater resources. It is a general categorisation of groundwater uses based on water quality and the presence or absence of contaminants. It is typically based on salinity concentrations.
Bore	Artificially constructed or improved groundwater cavity used for the purpose of accessing or recharging water from an aquifer. Interchangeable with borehole, piezometer.
Borehole	Includes a well, excavation, or other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer. Interchangeable with bore, well, piezometer.
Catchment	The land area draining through the main stream, as well as tributary streams, to a site. It always relates to an area above a specific location.
Clay	Deposit of particles with a diameter of less than 0.002 mm, typically contains variable amounts of water within the mineral structure, and exhibits high plasticity.
Compaction halo	The area of compaction influence resulting from the compaction force.
Conceptual model	A simplified and idealised representation of the physical hydrogeologic setting and the hydrogeological understanding of the essential flow processes of the system. This includes the identification and description of the geologic and hydrologic framework, media type, hydraulic properties, sources and sinks, and important aquifer flow and surface-groundwater interaction processes.
Confined aquifer	An aquifer bounded above and below by impervious (confining) layers. In a *confined aquifer*, the water is under sufficient pressure so that when wells are drilled into the aquifer, measured water levels rise above the top of the aquifer.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second. Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving (e.g. metres per second).
Drawdown	The change in groundwater level in a bore, or the change in water table elevation in an unconfined groundwater system, due to the extraction of groundwater.
Detailed design	The stage of design where proposal elements are designed in detail, suitable for construction.

Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
Fluvial	Synonymous with alluvial. Refer to alluvial for definition.
Formation	General term used to describe a sequence of soil or rock layers.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Groundwater flow	The movement of water through openings and pore spaces in rocks below the water table i.e. in the saturated zone.
Groundwater quality	Groundwater quality relates to the condition of groundwater within a groundwater source and its suitability for different purposes.
Groundwater resource	Groundwater available for beneficial use, including human usage, aquatic ecosystems and the greater environment.
Groundwater study area	The area includes an additional two-kilometre extension from the proposal study area boundary on either side of the corridor. This has been applied for assessment of impacts to potential sensitive users, including groundwater dependent ecosystems (GDEs), registered groundwater bores, culturally significant groundwater related sites and noted waterways with groundwater connectivity. The additional two kilometres does not extend beyond the Murray River border into Victoria (VIC) or South Australia (SA), with the project boundary ceasing at the state borders.
Hydraulic conductivity	Measure of the ease with which water will pass through earth material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (metres per day).
Hydraulic gradient	The gradient between two or more groundwater level measurements.
Hydrogeology	The study of the interrelationships of geological materials and processes with water, especially groundwater.
Impact	An event that disrupts ecosystem, community, or population structure and alters the physical environment, directly or indirectly.
Monitoring bore	A bore used to monitor groundwater levels or quality.
Permeability	The ease with which a fluid can pass through a porous medium and is defined as the volume of fluid discharged from a unit area of an aquifer under unit hydraulic gradient in unit time (metres per day).
Pressure heads	The new height of the groundwater level resulting from a particular pressure exerted on the groundwater.
Proposal study area	Comprises a one kilometre wide corridor between the SA/New South Wales (NSW) border near Chowilla and Buronga and a 200 metre wide corridor between Buronga and the NSW/VIC border at Monak, near Red Cliffs. This study area for the Environmental Impact Statement has been devised to provide a broader understanding of constraints and environmental conditions. Some access tracks (construction and operation) could be located within this region. Not to be confused with the groundwater study area.

Recharge	*Recharge* is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation.
Runoff	All surface and subsurface flow from a catchment, but in practice refers to the flow in a river i.e. excludes groundwater not discharged into a river.
Semi-confined aquifer	An aquifer that is partly confined by layers of lower permeability material through which recharge and discharge may occur, also referred to as a leaky aquifer.
Sensitive receptors	Groundwater dependent ecosystems, registered groundwater extraction bores and connected surface water and groundwater systems that are sensitive to changes in the hydrogeological environment such as groundwater quality and groundwater levels.
Standing water level	The height to which groundwater rises in a bore after it is drilled and completed, and after a period of pumping when levels return to natural atmospheric or confined pressure levels.
Transmission line corridor	A 200 metre wide corridor along transmission line sections of the proposal. The final easement, transmission line construction activities and infrastructure are expected to be contained within this corridor.
Water table	The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric; it can be measured by installing a well into the zone of saturation and then measuring the water level in the well.
Yield	The quantity of water removed from a water resource e.g. *yield* of a borehole.

ABBREVIATIONS

AER	Australian Energy Regulator
AHIP	Aboriginal Heritage Impact Permit
BOM	Bureau of Meteorology
CEMP	Construction and Environment Management Plan
CLPoM	Cultural Landscape Plan of Management
EIS	Environmental impact statement
GDE	Groundwater dependant ecosystem
GIS	Graphical information systems
GWIA	Groundwater impact assessment
HCM	Hydrogeological conceptual model
K	Hydraulic conductivity
LTAAEL	Long-term average annual extraction limit
MDBA	Murray Darling Basin Authority
MDBPR	Murray Darling Basin Porous Rock
MLDRR	Murray and Lower Darling Regulated Rivers
MNES	Matters of national environment and significance
NGIS	National groundwater information system
NSW	New South Wales
OPGW	Optical Ground Wire
QLD	Queensland
SA	South Australia
SEARs	Secretary's Environmental Assessment Requirements
RIT-T	Regulatory Investment Test for Transmission
VIC	Victoria

EXECUTIVE SUMMARY

ENERGYCONNECT (NSW – WESTERN SECTION)

TransGrid (electricity transmission operator in New South Wales (NSW)) and ElectraNet (electricity transmission operator in South Australia (SA)) are seeking regulatory and environmental planning approval for the construction and operation of a new High Voltage (HV) interconnector between NSW and SA, with an added connection to north-west Victoria. Collectively, the proposed interconnector is known as EnergyConnect.

The proposal, focusing on the western section of EnergyConnect in NSW (and the subject of this technical paper), would involve the construction and operation of new 330kV transmission lines between the SA/NSW border and Buronga, a significant upgrade and expansion of the existing Buronga substation from an operating voltage of 220kV to 330kV, and an upgrade of the existing 220kV transmission line between Buronga substation and the border of NSW and Victoria.

GROUNDWATER IMPACT ASSESSMENT OVERVIEW

The groundwater impact assessment has been prepared to address the Secretary's environmental assessment requirements issued for the proposal. It establishes the existing groundwater environment and assesses the potential for the proposal to impact groundwater aquifers, sensitive users and groundwater dependent ecosystems, having regard to the *NSW Aquifer Interference Policy* and relevant water sharing plans.

A qualitative desktop review was undertaken using publicly available information on the legislation and existing environment, and the results from recent geotechnical field investigations.

CONSTRUCTION AND OPERATIONAL IMPACTS

The construction and operation phases of the proposal are anticipated to have similar types of groundwater impacts (changes to groundwater levels and groundwater quality), however the potential impacts are greater in the construction phase due to greater activity and larger impact footprint.

Groundwater is unlikely to be intercepted during construction from shallow earthworks. Where groundwater may be encountered, design and construction methodology will be adopted in order to avoid groundwater inflows, such as during foundation design of the transmission line structures, where construction methodology would adopt bored, helical screw anchor and/or driven steel piles. Groundwater impacts associated with piling can be mitigated through the implementation of appropriate piling procedures that will maintain the groundwater levels (such as a tremie system).

During construction and operation of the proposal, changes to groundwater levels are expected due to reduced recharge from impervious areas, and compaction of sediments causing groundwater mounding. The significance of potential impact to groundwater levels is considered low due to the proposed construction methodologies, small footprint of the activities, small magnitude of the compaction halos and typical depth to groundwater.

No groundwater take is anticipated during construction or operation of the proposal.

The potential impacts to groundwater quality during construction and operation of the proposal may occur through contaminant infiltration to the underlying aquifers and mobilisation of salts through groundwater mounding or increased groundwater levels through vegetation clearing. These impacts would be limited due to the localised and small footprint of the activities that would cause the potential impacts, such as:

- contamination through the use and maintenance of vehicles, machinery, structures and plant equipment during construction and operation of the proposal
- increase in salinity through the mobilisation of salts in areas of groundwater level rise (mounding) from compaction of the aquifer due to piling or filling during construction. Whilst compaction activities would not be present during operation of the proposal, the aquifers would likely continue to experience the impacts from compaction throughout the operation of the proposal
- contamination from leakage to the water table from concrete slurry and wastewater from mobile concrete batching plants during construction of the proposal.

Groundwater quality across the majority of the proposal study area is likely to be saline to hyper saline, limiting its beneficial use. Groundwater quality near connected surface water features is expected to be fresh to brackish, however the risk of saline groundwater intrusion was assessed as low. Therefore, the beneficial water use category for the groundwater aquifers are not anticipated to be impacted. The significance of potential impact to groundwater quality is considered low.

The risk to sensitive receptors of registered groundwater extraction bores and connected surface water and groundwater systems from the above listed potential impacts is considered low. An assessment of impacts to identified groundwater dependent ecosystems (GDEs), including high potential GDEs, during construction and operation of the proposal was undertaken with impacts considered to be low. However a review of additional GDEs, including high priority GDEs, would need to be undertaken when graphical information systems data from the latest water sharing plans enacted on 1 July 2020 becomes publicly available. It is anticipated that there will be no change in the potential impacts or low risk rating currently assigned to GDEs, following the review.

An assessment of the proposals impacts on aquifers and GDEs in regard to the minimal impact considerations of the NSW Aquifer Interference Policy was undertaken. The outcome of the assessment indicates the proposal complies with Level 1 minimal impact considerations. Further review of the GDEs is required when information becomes available.

Potential groundwater impacts to the Riverland RAMSAR wetland, located within SA, approximately 3.5 kilometres south west of the proposal are considered negligible.

The potential for cumulative impacts with other nearby projects (Copi Mineral Sands Mine, Buronga Solar Farm and Buronga – Gol Gol residential expansion) is considered low from assessment of the preliminary development information available, depth to groundwater and distance to the projects.

MITIGATION AND MANAGEMENT

Mitigation and management measures have been identified to inform the proposals design and for both the construction and operation phases of the proposal. It is anticipated the correct implementation of appropriate mitigation and management measures would result in low residual risk to groundwater. Mitigation and management measures would occur in three phases and include:

1. Design and pre-construction: the selection of appropriate foundation designs and construction materials; limiting the extent of earthworks and vegetation clearing; and reassessment of the likely groundwater level in the areas of construction.
2. Construction: appropriate collection and bunding of wastewater, spoil and construction chemicals; limiting over compaction of soils; make good provisions for any existing groundwater bores that are damaged or destroyed; and managing any unexpected groundwater inflows.
3. Operation: control measures would be developed and implemented as part of the operations environment management procedures relating primarily to minimisation of potential spills. Additionally, removed vegetation cover would be rehabilitated with ecologically suitable vegetation types.

CONCLUSION

This groundwater impact assessment has identified the key potential impacts during construction and operation of the proposal with consideration to the wider groundwater study area. The potential impacts, subject to review of priority GDEs within the groundwater study area, are low during both the construction and operation of the proposal. With suitable management and mitigation measures, the proposal is expected to result in minimal impacts to the hydrogeological environment.

1 INTRODUCTION

1.1 OVERVIEW OF ENERGYCONNECT

TransGrid (electricity transmission operator in New South Wales (NSW)) and ElectraNet (electricity transmission operator in South Australia (SA)) are seeking regulatory and environmental planning approval for the construction and operation of a new High Voltage (HV) interconnector between NSW and SA, with an added connection to north-west Victoria. Collectively, the proposed interconnector is known as EnergyConnect.

EnergyConnect comprises several components or ‘sections’ (shown on Figure 1.1). The Western Section (referred to as ‘the proposal’) is the subject of this technical paper.

EnergyConnect aims to secure increased electricity transmission between SA, NSW and Victoria, while facilitating the longer-term transition of the energy sector across the National Electricity Market (NEM) to low emission energy sources.

EnergyConnect has been identified as a priority transmission project in the NSW Transmission Infrastructure Strategy (Department of Planning and Environment, 2018), linking the SA and NSW energy markets and would assist in transporting energy from the South-West Renewable Energy Zone to major demand centres.

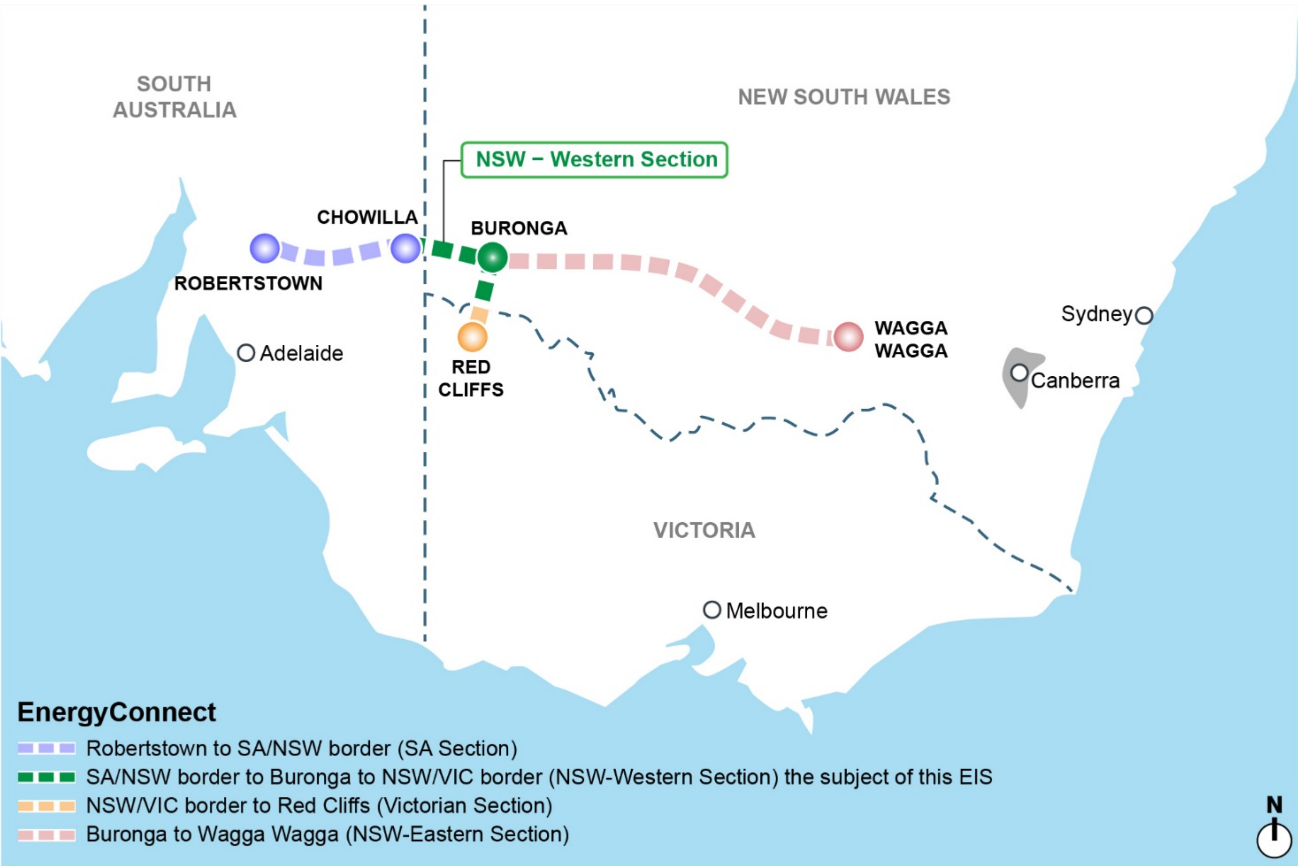


Figure 1.1 Overview of EnergyConnect

1.2 THE PROPOSAL

TransGrid is seeking approval under Division 5.2, Part 5 of the *Environmental Planning and Assessment Act 1979* (the EP&A Act) to construct and operate the proposal. The proposal has been declared as Critical State significant infrastructure under Section 5.13 of the EP&A Act.

The proposal was also declared a controlled action on 26 June 2020 and requires a separate approval under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999*. The proposal is subject to the bilateral assessment process that has been established between the Australian and NSW governments.

The proposal is located in western NSW within the Wentworth Local Government Area (LGA), approximately 800 kilometres west of Sydney at its nearest extent. The proposal spans between the SA/NSW border near Chowilla and Buronga and the NSW/Victoria border at Monak, near Red Cliffs. It traverses around 160 kilometres in total.

1.2.1 KEY PROPOSAL FEATURES

The key components of the proposal include:

- a new 330 kilovolt (kV) double circuit transmission line and associated infrastructure, extending around 135 kilometres between the SA/NSW border near Chowilla and the existing Buronga substation
- an upgrade of the existing 24 kilometre long 220kV single circuit transmission line between the Buronga substation and the NSW/Victoria border at Monak (near Red Cliffs, Victoria) to a 220kV double circuit transmission line, and the decommissioning of the 220kV single circuit transmission line (known as Line 0X1)
- a significant upgrade and expansion of the existing Buronga substation to a combined operating voltage 220kV/330kV
- new and/or upgrade of access tracks as required
- a minor realignment of the existing 0X2 220kV transmission line, in proximity to the Darling River
- ancillary works required to facilitate the construction of the proposal (e.g. laydown and staging areas, concrete batching plants, brake/winch sites, site offices and accommodation camps).

An overview of the proposal is provided Figure 1.2. The final alignment and easement of the transmission line would be confirmed during detailed design and would be located within the transmission line corridor as shown in Figure 1.2.

Subject to approval, construction of the proposal would commence in mid-2021. The construction of the transmission lines would take approximately 18 months. The Buronga substation upgrade and expansion would be delivered in two components and would be initially operational by the end of 2022, with site decommissioning and rehabilitation to be completed by mid-2024.

The final construction program would be confirmed during detailed design.

The proposal is further described in Chapter 5 and Chapter 6 of the Environmental Impact Statement (EIS).

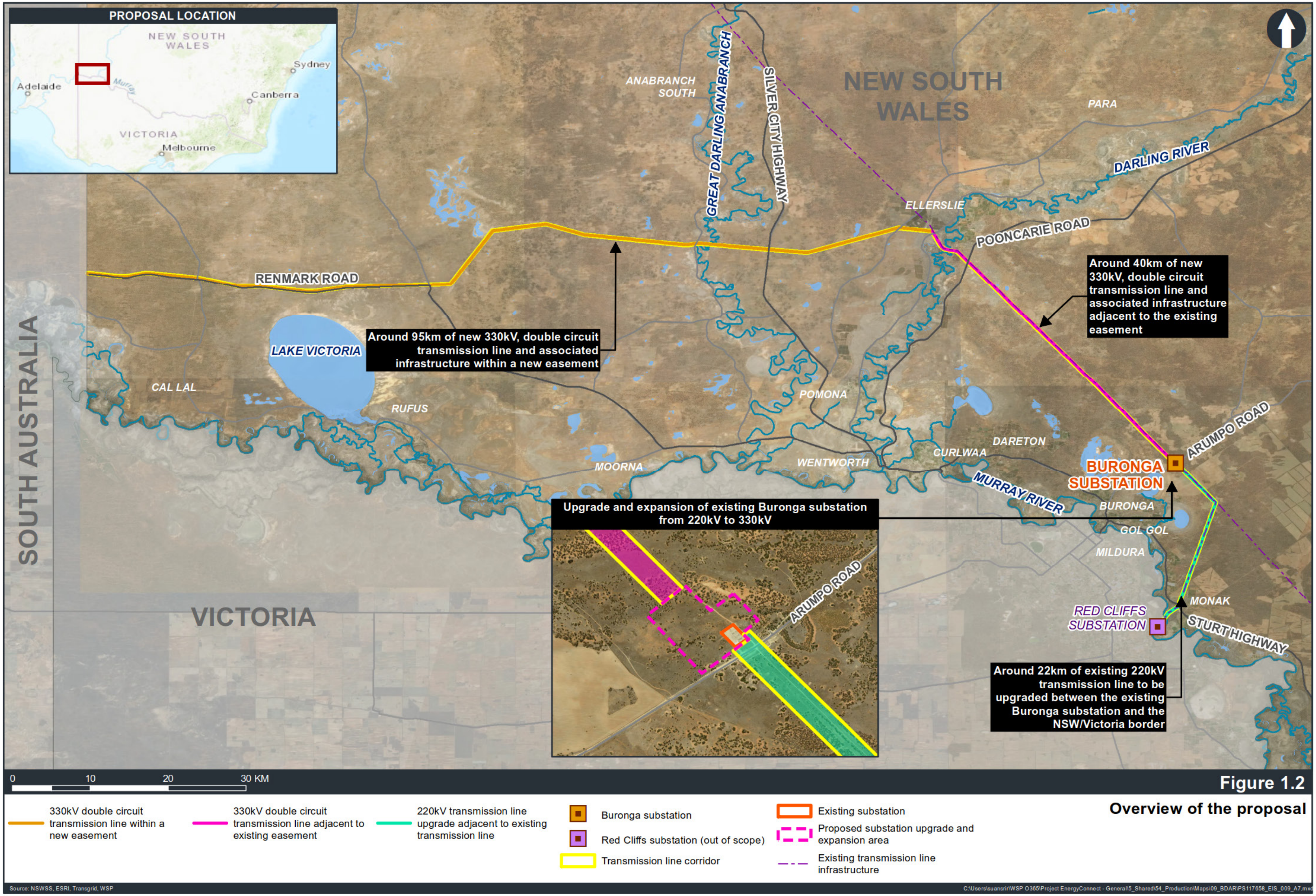


Figure 1.2
Overview of the proposal

1.2.2 PROPOSAL NEED

The proposal is required to complete the missing transmission link between SA and NSW transmission networks. The upgrade to the existing transmission line between Buronga and Red Cliffs would also enhance the capacity of the network to provide electricity between NSW and Victoria.

This connection would relieve system constraints and allow for NSW, SA and Victorian consumers to benefit from significant amounts of low-cost, large-scale solar generation in south-west NSW. The proposal is an essential component of EnergyConnect.

1.3 PURPOSE OF THIS TECHNICAL REPORT

This technical paper is one of a number of technical papers that form part of the EIS for the proposal. The NSW Department of Planning, Industry and Environment (DPIE) has provided the Secretary's Environmental Assessment Requirements (SEARs) for the EIS.

The purpose of this technical paper is to identify and assess the potential impacts of the proposal in relation to groundwater. It responds directly to the Secretary's environmental assessment requirements (SEARs) (refer to section 1.3.1). This report has the following objectives:

- provide context and information pertaining to relevant groundwater legislation
- describe the existing hydrogeological environment that may be impacted by the proposal
- identify and assess the potential proposals impacts to the existing hydrogeological environment
- provide suitable mitigation measures to reduce identified potential impacts.

Further details on the methodology applied in this assessment are provided in Chapter 3 of this technical paper.

1.3.1 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The NSW Department of Planning, Industry and Environment (DPIE) has provided the SEARs for the EIS. The requirements specific to this assessment and where these aspects are addressed in this technical report are outlined in Table 1.1.

Table 1.1 Secretary's environmental assessment requirements – Groundwater

REFERENCE	SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS	WHERE ADDRESSED
Water	An assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the *NSW Aquifer Interference Policy* and relevant Water Sharing Plans	Chapter 7

1.4 STRUCTURE OF THIS REPORT

The structure and content of this report is as follows:

- *Chapter 1 – Introduction:* Outlines the background, need for the proposal, and the purpose of this report.
- *Chapter 2 – Legislative and policy context:* Provides an outline of the key legislative requirements and policy guidelines relating to the proposal.
- *Chapter 3 – Methodology:* Provides an outline of the methodology used for the preparation of this GWIA.
- *Chapter 4 – Existing environment:* Describes the existing hydrogeological environment.
- *Chapter 5 – Assessment of construction impacts:* Describes the potential construction impacts associated with the proposal.
- *Chapter 6 – Assessment of operational impacts:* Describes the potential operational impacts associated with the proposal.
- *Chapter 7 – Compliance:* Assessment of the proposal against legislative requirements.
- *Chapter 8 – Cumulative impacts:* Outlines the potential cumulative impacts with respect to other known developments within the vicinity of the proposal.
- *Chapter 9 – Mitigation measures:* Outlines the proposed mitigation measures for the proposal.
- *Chapter 10 – Conclusion:* Provides a conclusion of the potential impacts of the proposal on groundwater.
- *Chapter 11 – References*: Identifies the key reports and documents used to generate this report.

Appendices to this report includes:

- **Appendix A** – Registered groundwater bore search results and information.
- **Appendix B** – WaterNSW (2020b) published hydrographs.

1.5 REPORT TERMINOLOGY

The following terms are used throughout this report and are defined as:

- **Groundwater study area** – to adequately characterise the hydrogeological conditions for the proposal, a regional scale understanding is required. Therefore, a larger area termed the groundwater study area has been used to enable understanding and assessment of the potential area of influence of potential impacts to the existing groundwater environment. An additional two-kilometre extension from the proposal study area boundary on either side of the corridor has generally been applied for assessment of impacts to potential sensitive users, comprising of groundwater dependent ecosystems (GDEs), registered groundwater bores, culturally significant groundwater related sites and waterways with groundwater connectivity. The additional two kilometres does not extend beyond the Murray River border into VIC or SA.
- **Proposal study area** – the proposal, including transmission line corridor, Buronga substation upgrade and expansion, access tracks, and the main construction compounds and accommodation camps at Buronga and Anabranch South would be contained within the proposal study area. The proposal study area comprises of a one kilometre wide corridor between the SA/NSW border near Chowilla and Buronga and a 200 metre wide corridor between Buronga and the NSW/VIC border at Monak, near Red Cliffs, and is used in the environmental assessment to provide a broader understanding of the constraints and conditions of the locality.
- **Transmission line corridor** – the corridor in which the final easement and transmission line is expected to be contained within. It would consist of a 200 metre corridor along the transmission line component of the proposal. Transmission line construction activities would be contained within this area, but some access tracks may extend beyond this corridor.

1.6 LIMITATIONS

The preparation of this technical report has involved a desktop exercise that has relied upon information from the proponent, together with freely available reports, data, figures and existing investigations. Freely available data and reports included the available background water sharing plan documents published by NSW Department of Primary Industries – Office of Water, and hydrograph figures, groundwater level and registered bore data published by WaterNSW and Bureau of Meteorology. Existing investigation include the latest geotechnical reports by Douglas Partners (2020a & 2020b) which were used to obtain information on the existing environment within the proposal study area, predominantly the geology, with groundwater observations also noted when intersected. The impact assessment is limited to a qualitative assessment which is based upon the concept design and proposed construction methodology at the time of preparation of this report.

The level of characterisation of hydrogeological conditions and potential impacts are limited to the data available and the preliminary nature of the proposal design. Assumptions have been reasonably applied in areas of limited data based on *expected* hydrogeological conditions derived from the interpretation of field data and information sourced during the desktop review. The impact assessment conclusions may differ from those reported within this study if encountered conditions differ from those assumed.

This assessment is adequate to assess typical environmental impacts and provide recommendations for mitigation measures. Recommendations would be subject to refinement as the proposal progresses through the detailed design stage and validation is undertaken during construction.

2 LEGISLATIVE AND POLICY CONTEXT

2.1 LEGISLATION, POLICY AND GUIDELINES

A review of Commonwealth and state legislation, policy and guidelines relevant to the proposal has been completed. Table 2.1 to Table 2.3 lists the relevant legislation, policies and guidelines and a summary of their relevancy to the proposal. Further details on the key legislation and policy are provided in sections 2.2 and 2.3.

Table 2.1 Overview of relevant groundwater Commonwealth legislation

COMMONWEALTH LEGISLATION	SUMMARY AND RELEVANCE
Environment Protection and Biodiversity Conservation Act 1999	— Guides environmental assessment, biodiversity conservation and the management of protected areas and species, population and communities, and heritage items. — Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an action will require approval from the Australian Government Department of the Environment if the action has, will have, or is likely to have, a significant impact on Matters of National Environmental Significance (MNES). In the context of the GWIA, the EPBC Act is not triggered.
Water Act 2007 Basin Plan 2012	— The legislative framework for ensuring Australia's largest water resource—the Murray-Darling Basin—is managed in the national interest. — The Basin Plan 2012 is an instrument of the *Water Act 2007* that enables the Commonwealth, in conjunction with the Basin States, to manage the Basin water resources. — The Basin refers to water resources within or beneath the Murray-Darling Basin that extends across Australian Capital Territory (ACT), NSW, Queensland (QLD), SA and VIC. However, it excludes any groundwater that forms part of the Great Artesian Basin. — The Basin Plan provides limits on the quantity of water that may be taken from the Basin water resources as a whole and from the water resources of each water resource plan area. — Water Resource Plans for the water resources within the proposal study area are currently under review. — Further details are provided in Section 2.2.

Table 2.2 Overview of relevant groundwater State legislation

STATE LEGISLATION	SUMMARY AND RELEVANCE
Water Act 1912	— Water resources are administered under the *Water Act 1912* and the *Water Management Act 2000*, with the *Water Act 1912* is being progressively phased out and replaced with the *Water Management Act 2000*. — Approximately five per cent of extracted water in NSW is still governed under the *Water Act 1912* and does not include the groundwater resources within the proposal study area.
Water Management Act 2000	— Groundwater resources within the proposal study area are governed under the *Water Management Act 2000.* — The *Water Management Act 2000* separates land and water rights, which were previously combined within the *Water Act 1912*. — The provision for the sustainable and integrated management of the state's water sources for the benefit of present and future generations. — It defines an aquifer interference activity as that which involves any of the following: — the penetration of an aquifer — the interference with water in an aquifer — the obstruction of flow in an aquifer — the taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations — the disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations. — Governs the issue of water access licences and approvals for those water sources (including groundwater) in NSW where water sharing plans have commenced (see below). — Four water sharing plans exist within the proposal study area: — Darling Alluvial Groundwater Sources 2020 — NSW Murray Darling Fractured Rock Groundwater Sources 2020 — NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 — NSW Murray and Lower Darling Regulated Rivers Water Sources 2016. — The proposal is a Critical State Significant Infrastructure (CSSI) project and therefore is exempt from the following approvals in regard to the *Water Management Act 2000*: — a water approval under section 89 — a water use approval confers a right on its holder to use water for a particular purpose at a particular location — a water use approval may authorise the use within NSW of water taken from a water source outside NSW

STATE LEGISLATION	SUMMARY AND RELEVANCE
	— a water management work approval under section 90. There are three kinds of water management work approvals, namely, water supply work approvals, drainage work approvals and flood work approvals: — a water supply work approval authorises its holder to construct and use a specified water supply work at a specified location — a drainage work approval confers the right on its holder to construct and use a specified drainage work at a specified location — a flood work approval confers a right on its holder to construct and use a specified flood work at a specified location — an activity approval under section 91 (other than an aquifer interference approval). There are two kinds of activity approvals, namely, controlled activity approvals and aquifer interference approvals: — a controlled activity approval confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land — an aquifer interference approval confers a right on its holder to carry out one or more specified aquifer interference activities at a specified location, or in a specified area, in the course of carrying out specified activities. — Further details are provided in section 2.3.
Water Management (General) Regulation 2018	— Specifies procedural, technical and licence requirements and exemptions under the *Water Management Act 2000.* — Defines the function and powers of water supply authorities. — The proposal is generally not exempt from requiring Water Access Licences. However, the proposal would be exempt during construction if up to three megalitres of groundwater from a groundwater source was taken in a water year due to any excavation required for the construction of a building, road or infrastructure.

Table 2.3 Overview of relevant guidelines and policies

GUIDELINES AND POLICIES	SUMMARY AND RELEVANCE
Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 revision (ANZG 2018)	— Provides guidance on the management of water quality in Australia and New Zealand. — Incorporates setting water quality and sediment quality objectives designed to sustain current, or likely future, community values for natural and semi-natural water resources, including groundwater. — Refers to Australian and New Zealand Environment and Conservation Council guidelines (ANZECC, 2000) for default trigger values where updated values are currently being devised.
NSW Aquifer Interference Policy	— Clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation. — Includes a set of minimal impact considerations for assessing the impacts of all aquifer interference activities. — All NSW groundwater sources have been categorised as being either highly productive or less productive, based on the general character of the water source meeting or not meeting the criteria of 1,500 mg/L total dissolved solids and a bore yield rate of greater than 5 L/s. — Defines considerations on whether more than minimal impacts might occur to key water-dependent assets. — The proponent of an activity that may result in aquifer interference needs to provide sufficient information to enable the assessment of the activity against the minimal impact considerations. — Due to the likely depth of transmission line structure footings, it is expected the proposal would intercept groundwater sources, triggering the controls and requirements of the policy.
NSW Groundwater Quality Protection Policy	— Provides a framework for the protection of groundwater quality against pollution. — The detailed design and construction methodology for the proposal would need to consider any potential groundwater quality impacts that may arise.
NSW Groundwater Dependent Ecosystems Policy	— Designed to protect valuable ecosystems which rely on groundwater for survival, and where possible, the ecological processes and biodiversity of these ecosystems are maintained or restored. — No high priority GDEs were identified in the previous water sharing plans that were replaced on 1 July 2020 within the proposal study area. GIS data regarding identified GDEs from the new water sharing plans are currently not available, and thus there is no available information on whether any high priority GDEs occur within the groundwater study area. However, potential GDEs were identified from National Groundwater Information Systems database and their locations were assessed against the proposals potential impacts.

GUIDELINES AND POLICIES	SUMMARY AND RELEVANCE
NSW Groundwater Quantity Management Policy	— Aims to achieve the efficient, equitable and sustainable use of the state's groundwater. Includes a number of principles, such as the identification and protection of significant GDEs, the management of groundwater so there are no unacceptable impacts, and basic rights to groundwater. — The proposal needs to identify and protect significant GDEs and minimise groundwater impacts.

The legislation, policies and guidelines listed above in Table 2.1 to Table 2.3 have been incorporated into the assessment, findings and conclusions provided within this report.

2.2 BASIN PLAN 2012

The Murray–Darling Basin Plan 2012 (referred to as the Basin Plan in this assessment) aims to provide a coordinated approach to water use across the Murray–Darling Basin's four states and the ACT. It provides a framework to balance environmental, social and economic considerations for water use and water quality to an environmentally sustainable level. The Basin Plan addresses both surface water and groundwater use and quality. Elements of the Basin Plan include:

- overall environmental management objectives and outcomes
- sustainable diversion limits on how much surface water and groundwater can be taken from the Basin and a mechanism for adjustments to these limits
- an environmental watering plan – to protect and restore the Basin's rivers and wetlands
- a water quality and salinity management plan that sets objectives and targets
- identifying the risks to continued water availability in the Basin, and strategies to manage them
- a monitoring and evaluation program, including an annual report on the effectiveness of the Basin Plan.

The Basin Plan also required the preparation of water resource plans for various areas in the Murry-Darling Basin, which include water quality management plans.

2.2.1 WATER RESOURCE PLANS

Water resource plans are an integral tool for implementing the Basin Plan. They set rules on how much water can be taken from the Basin, ensuring that the sustainable diversion limit is not exceeded over time. The Murray-Darling Basin Authority (MDBA) is responsible for monitoring and enforcing compliance with water resource plans. The MDBA is working in close consultation with the state governments to outline how each region aims to achieve community, environmental, economic and cultural outcomes and state water management rules to meet the Basin Plan objectives. Importantly, state governments have had to revise current water management rules, including water sharing plans within NSW, to ensure they comply with the Basin Plan, including sustainable diversion limits rules on the delivery, protection and monitoring of water for the environment; licence conditions on water access rights; and critical human water needs in extreme circumstances (when triggered).

There are 33 water resource plans (WRPs) within the Basin Plan, covering surface water, groundwater, or both. The states and territory are at various stages of accrediting their component of WRPs. In April 2020, NSW submitted its 11 WRPs to the MDBA for assessment, with the remaining nine surface water WRPs to be submitted by 30 June 2020 (MDBA, 2020a). The MDBA and NSW have agreed to a new bilateral agreement that will cover the 2020–21 water year as the NSW WRPs were not accredited before 1 July 2020. Once the NSW submitted WRPs are accredited, groundwater within the proposal will likely be governed by the Murray-Darling Fractured Rock WRP or the NSW Murray-Darling Basin Porous Rock WRP or the Darling Alluvium WRP.

2.3 WATER MANAGEMENT ACT 2000

2.3.1 WATER SHARING PLANS

Water sharing plans are established under the *Water Management Act 2000* and are the primary tool for defining water-sharing arrangements in NSW. The plans establish rules for sharing water between water users and the environment, and rules for water trading. Water sharing plans describe the annual surface and groundwater recharge volumes for each identified water source and the volumes of water that are available for sharing. Available water volumes are based on calculated long-term average annual extraction limit (LTAAEL). Provisions are made for environmental water allocation, basic landholder rights, domestic and stock rights and native title rights. Water sharing plans are typically in place for ten years, however they may be suspended in times of severe water shortages.

Due to the MDBA bilateral agreement (refer to section 2.2.1) multiple new water sharing plans have commenced across NSW from 1 July 2020, even though the corresponding Basin Plan WRPs have not been accredited. Since the update to certain water sharing plans in July 2020, three water sharing plans, covering both surface water and groundwater, are in force within the groundwater study area (NSW DPIE, 2020a). However, all the plans are currently under review to ensure compliance with the Basin Plan. Currently the plans are either awaiting assessment from the MDBA, final amendments or Australian Government accreditation. Summary and comments on the development and status of the water sharing plans that exist within the groundwater study area are provided in Table 2.4.

Table 2.4 Status and development of water sharing plans within the groundwater study area (NSW DPIE 2020a & 2020b)

WATER SHARING PLAN	STATUS	START / CEASE DATE	COMMENT
Lower Murray – Darling Unregulated and Alluvial Water Sources 2011	Amended	2012/2020	Alluvial water resources removed from the water sharing plan and governed under the water sharing plan for the Darling Alluvial Groundwater Sources 2020. The remaining water resources are governed by the water sharing plan for the Lower Murray – Darling Unregulated River Water Sources 2011.
Murray Alluvial Groundwater Sources 2019	Replaced	2020/2020	This water sharing plan briefly replaced the water sharing plan for the Lower Murray-Darling Unregulated and Alluvial Water Sources 2011, but it has since been replaced by a 2020 version that governs water resources located east of the proposal study area.
NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011	Replaced	2012/2020	Replaced by the 2020 version of the water sharing plan.
NSW Murray Darling Basin Porous Rock Groundwater Sources 2011	Replaced	2012/2020	Replaced by the 2020 version of the water sharing plan.
Lower Murray – Darling Unregulated River Water Sources 2011	Amended – in force	2012/2022	No longer within the proposal study area after the amendment to remove alluvial water sources from within the water sharing plan.

WATER SHARING PLAN	STATUS	START / CEASE DATE	COMMENT
NSW Murray and Lower Darling Regulated Rivers Water Sources 2016	In force	2016/2026	Current water sharing plan within the proposal study area.
NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011	In force	2020/2030	Current water sharing plan within the proposal study area, which has recently come into force, effective from 1 July 2020.
Darling Alluvial Groundwater Sources 2020	In force	2020/2030	Current water sharing plan within the proposal study area, which has recently come into force, effective from 1 July 2020.
NSW Murray Darling Basin Porous Rock Groundwater Sources 2020	In force	2020/2030	Current water sharing plan within the proposal study area, which has recently come into force, effective from 1 July 2020.

2.3.1.1 WATER SHARING PLANS RELATING TO RELEVANT GROUNDWATER SOURCES

Three water sharing plans relating to groundwater exist within the groundwater study area. The Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020 (Kanmantoo Fold Belt Murray-Darling Basin Groundwater Source) is at significant depth within the groundwater study area, underlying groundwater sources governed in the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020. Due to the significant depth, it will not be intersected by the proposal and therefore will not be discussed further.

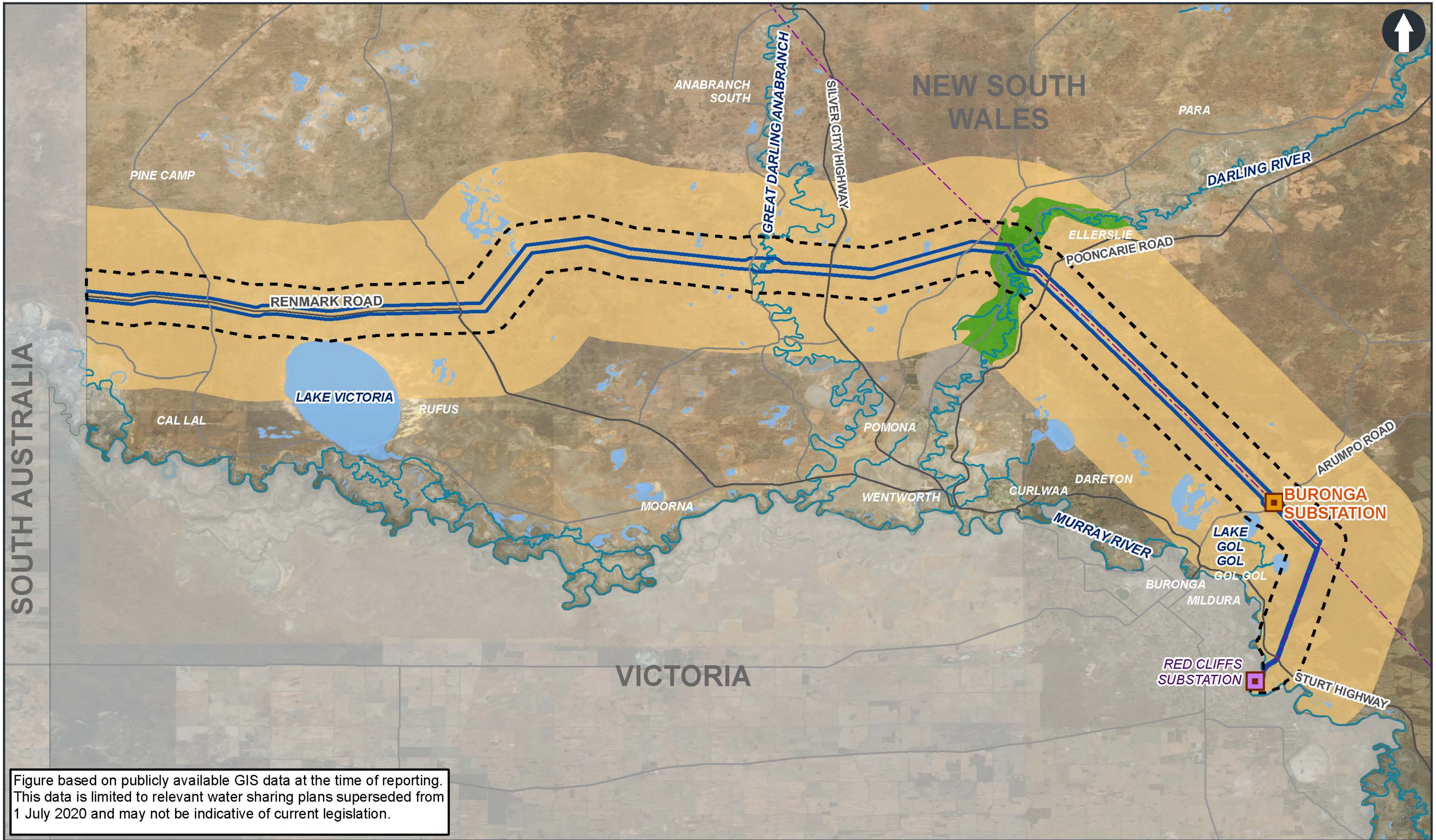
The two remaining water sharing plans that currently legislate the groundwater sources within the proposal study area are the *Darling Alluvial Groundwater Sources 2020* and *NSW Murray Darling Basin Porous Rock Groundwater Sources 2020*. The location and extent of these water sharing plans (clipped to a 10 kilometre range) are presented in Figure 2.1. It is noted that the extent of the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2020 water sharing plan is not shown, as it underlies both of these plans. Graphical Information Systems data and the background documents for the latest water sharing plans have not been publicly released by DPIE. It is expected that the updated water sharing plans contain negligible alterations to their geographical extent and any adjustments between the depicted water sharing plan boundaries in Figure 2.1 would be minor.

2.3.1.2 DARLING ALLUVIAL GROUNDWATER SOURCES 2020

The water sharing plan for the Darling Alluvial Groundwater Sources governs the groundwater sources located within alluvial sediments along the Darling River. The water sharing plan contains rules for four groundwater sources, the Lower Darling Alluvial Groundwater Source, the Paroo Alluvial Groundwater Source, the Upper Darling Alluvial Groundwater Source and the Warrego Alluvial Groundwater Source. Within the proposal study area, the Lower Darling Alluvial Groundwater Source is in the alluvial sediments surrounding the Darling River (Figure 2.1). The water sharing plan covers all water within alluvial sediments of Quaternary age below the surface of the ground within the boundaries of the groundwater source. It does not include the groundwater source located in the alluvium alongside the Anabranch, often referred to as the Great Darling-Anabranch, as it falls outside of the water sharing plan boundary. The alluvial sediments associated with the Lower Darling Alluvial Groundwater Sources around the Darling River extend for approximately four and a half kilometres along the alignment corridor, extending north and south out of the groundwater study area (refer to Figure 4.1, section 4.6.2).

2.3.1.3 NSW MURRAY DARLING BASIN POROUS ROCK GROUNDWATER SOURCES 2020

The water sharing plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources (MDBPR) governs all porous rock groundwater sources that are not included in other water sharing plans. Within the water sharing plan, four groundwater sources exist, being the Western-Murray Porous Rock, the Oaklands Basin, the Gunnedah – Oxley Basin Murray-Darling Basin, and the Sydney Basin Murray-Darling Basin. From these four, the Western-Murray Porous Rock groundwater source covers the majority of the proposal study area. It includes groundwater located within all rocks of Tertiary and Quaternary age within the outcropped and buried areas of the water sharing plan and all alluvial sediments within the outcropped areas.



0 10 20 30 KM

Figure 2.1

Groundwater study area
Proposal study area
Buronga substation
Red Cliffs substation (out of scope)
Existing transmission line infrastructure
Major road
Minor road
Watercourses

Water sharing area - groundwater (clipped to 10km either side of proposal study area)

Lower Murray-Darling Unregulated and Alluvial Water Sources 2011
NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

Location of governing water sharing plans within the groundwater study area

Source: NSWSS, ESRI, Transgrid, WSP

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3 METHODOLOGY

To understand the hydrogeological environment within the proposal study area, a desktop review of available data was undertaken, including from national and state databases, reports, and existing site-specific field investigations. The review included determining the existing hydrogeological environment and identifying sensitive receptors, including waterways, GDEs and registered groundwater bores. From this, a hydrogeological conceptual model (HCM) was developed, which is a summary of the current understanding of the groundwater system and the influences on it. Once developed, an assessment of the potential impacts of the proposal on the aquifers and GDEs, in accordance with the SEARs, was carried out. Where potential adverse effects to the groundwater systems were identified, mitigation measures were provided to minimise the potential impacts. The key methodology implemented for this groundwater impact assessment is summarised below.

3.1 EXISTING ENVIRONMENT

3.1.1 CLIMATE

Climate data was sourced from the Bureau of Meteorology (BOM, 2020a). Weather stations at Lake Victoria (station number: 047016), Irymple (station number: 076015), Wentworth Post Office (station number: 047053), Wamberra (station number: 47040) and Toora (station number: 47099) were analysed to determine the climatic conditions within the groundwater study area.

3.1.2 SOILS AND GEOLOGY

Information pertaining to soils within the groundwater study area was obtained from publicly available data from CSIRO (2016) and NSW Soil and Agriculture Victoria (2020).

Outcropping geological data within the proposal study area was obtained from the Seamless Geology Project (Colquhoun, Hughes & Deyssing et al., 2019). Additional information was compiled from geotechnical investigations (Douglas Partners, 2020a; 2020b), readily available governmental studies and published scientific journal papers.

3.1.3 HYDROGEOLOGY

An assessment on the hydrogeological conditions and development of the HCM incorporated results from existing geotechnical investigations within the proposal study area by Douglas Partners (2020a & 2020b), and a wider regional review of governmental hydrogeological studies and information provided in water sharing plan documents, published scientific journal papers and data obtained from the National Groundwater Information System (NGIS) (BOM, 2020b). Groundwater quality was assessed against the beneficial use categories outlined in the Draft Murray-Darling Basin Porous Rock Water Resource Plan: Schedule F - Water Quality Management Plan (NSW DPIE, 2019a).

3.1.4 REGISTERED BORE SEARCH

A registered bore search was conducted by downloading data provided from the NGIS database (BOM, 2020b). The database was filtered to only include registered bores within the defined groundwater study area. The NGIS data was then quality checked against the WaterNSW (2020a) Real-time data website, with discrepancies highlighted. In addition, where the NGIS data was missing, information relevant to this assessment, such as registered function, an additional search through the WaterNSW (2020a) Real-time data website was completed. Available hydrographs were assessed from registered monitoring bores located within the groundwater study area (WaterNSW, 2020b).

3.1.5 GROUNDWATER DEPENDENT ECOSYSTEMS

The GDE search was conducted by reviewing the relevant water sharing plan documents and their additional appendices that list identified high priority GDEs. A second search involving GDE data downloaded from the NGIS database (BOM 2020b) was graphically presented and data confined to the groundwater study area using GIS software. A search through the Department of Agriculture, Water and the Environment (2020) Protected Matters Search Tool was conducted to identify any Ramsar wetlands within 25 kilometres of the proposal study area.

3.2 IMPACT ASSESSMENT

A qualitative assessment of the potential groundwater impacts from the proposal was conducted and considers:

- the existing hydrogeological environment
- the potential impacts to groundwater from construction and operations activities
- the effectiveness of identified mitigation measures
- any residual impacts post-mitigation.

The construction impact assessment aims to identify potential impacts to groundwater based on the current understanding of the likely construction approach and construction methods.

The operational impact assessment identifies potential impacts to groundwater during the current understanding of the operation of the proposal.

The significance of the potential impact to groundwater was assessed against the potential consequence and extent of the potential impact on the hydrogeological environment. For the purpose of this assessment, two potential impact significance rating categories were assessed with respect to potential impacts relating to the proposal. These two categories are:

- negligible – indicating the impact was considered to cause no perceptible change to the local or regional hydrogeological environment
- low – indicating a potential for limited (in extent and/or time) impact to the hydrogeological environment may exist. However, the potential impact would cause no perceptible change to the regional hydrogeological environment.

The impact assessment allows for the development of mitigation measures to inform future stages of the design, the construction and operation of the proposal.

4 EXISTING ENVIRONMENT

4.1 CATCHMENT

The proposal is located in the Murray-Darling Basin. The Murray-Darling Basin captures over one million square kilometres of land in QLD, NSW, ACT, VIC and SA. Within the Murray-Darling Basin, there are a number of sub-catchments, with the proposal located in the Lower Murray-Darling catchment (Murray Darling Basin Authority, 2020).

The Lower Murray Darling region covers an area of 6.3 million hectares, incorporating the entire local government areas of Wentworth and Broken Hill City, the majority of the Balranald Shire Council area, a section of the Central Darling Shire Council and the southern portion of the Unincorporated Area administered by NSW Land and Property Management Authority.

There are three major river systems in the Lower Murray Darling region. The Murray River is the longest at 598 kilometres, followed by the Darling River at 530 kilometres and then the Great Darling Anabranch at 460 kilometres. The Darling River and the Great Darling Anabranch supply water to a number of large lakes, some of which are used as water storages.

The Lower Murray Darling River system has been modified with a weir system that is highly regulated, making it difficult to return flow to pre-development conditions. Threats to the river system include flow regulation, over extraction of water for consumptive purposes, and the construction of structures that impede flooding. These threats are leading to a decline in the health of floodplain, wetland, lake and riverine ecosystems.

Named waterways crossed by the proposal study area in the Lower Murray Darling catchment include:

- Darling River
- Great Darling Anabranch
- Murray River.

The Darling River begins in northern NSW and continues to its confluence with the Murray River at Wentworth. Below the Menindee Lakes, the river travels as two main channels, the lower Darling River and the Darling Anabranch, an anabranch and ancestral channel of the Darling River. The Darling Anabranch is an ephemeral system but has a number of overflow lakes that can hold water for prolonged periods following a flood. It branches from the main channel of the river about 55 kilometres south of Menindee and joins the River Murray downstream of Wentworth.

The proposal would pass over the Murray River at the NSW – Victorian border upstream of Mildura where it would connect to a section of the proposal being progressed under applicable Victorian planning processes. The proposal would pass over the central portion of the Murray upstream of its confluence with the Darling River and Darling Anabranch. At the proposal crossing location, the river is wide, flows strongly and steadily, and has an extensive floodplain on both sides, which is evidenced by billabongs and dry anabranches.

The proposal study area also passes near (approximately three kilometres away) Lake Victoria, a naturally occurring shallow freshwater lake about 60 kilometres downstream of the Murray and Darling Rivers. In the 1920s, Lake Victoria was modified by the then River Murray Commission to its current state as a regulated off-river storage. The lake assists in regulating flow and salinity in the Murray River, by intercepting high flows from upstream or by releasing extra water when required. Lake Victoria is located in a flat, semi-arid region of the Basin and does not have a local catchment of any significance. Its inflows are dependent on diversions from the River Murray. Under natural conditions, the lake would likely only receive inflows during times of flooding along the Murray or when sufficiently heavy rain fell at or close to the lake.

The proposed Buronga substation upgrade is located about one and a half kilometres north-east of the Gol Gol Swamp and Gol Gol Lake. These are large freshwater ephemeral systems. Lake Gol Gol is 494 hectares in size and is situated north-east of Gol Gol Swamp. Prior to 1950s, the lake and swamp would have received water from the Murray River via Gol Gol Creek, however a number of flow control structures were installed in the 1950s and the waterbodies are now disconnected from the Murray River. The last significant flooding of Lake Gol Gol occurred during the 1974 and 1975 flood events (Murray Darling Wetland Working Group, 2020).

4.2 SALT INTERCEPTION SCHEMES

Salt interception schemes are significant groundwater pumping and drainage projects that help intercept hypersaline groundwater flows before they enter the Murray River (NSW DPIE, 2020d). A salt interception scheme exists around Buronga, where groundwater mounding has occurred under neighbouring irrigation areas due to the construction of the Mildura Weir and Lock (NSW DPIE, 2020e). Grounding mounding is the phenomenon of localised increased groundwater levels due to changes in the groundwater flow regime. It can also lead to decreased groundwater levels on the down-gradient side of the mound. The scheme uses a series of eight groundwater bores along the Murray River that removes groundwater from the Loxton-Parilla Sands aquifer before it reaches the Murray River (refer to Table 4.2 and section 4.7.1 for aquifer description). Generally, groundwater sources with water quality containing salinity concentrations greater than 50,000 microsiemens per centimetre are targeted for salt interception schemes (NSW DPIE, 2019a).

4.3 TOPOGRAPHY

The catchments of the proposal are largely flat but generally slope towards the existing large watercourses of the Darling River and the Darling Anabranch and then to the south to the Murray River. The catchment has a very shallow grade with the average grade of four to six centimetres per kilometre in the Darling River catchment. Additionally, there are large flat areas around the Darling River and Lake Victoria. The elevation across the proposal study area is about 35 to 80 metres above sea level, with lower elevation located within the vicinity of the river systems and claypans.

4.4 LAND USE

Agricultural land uses dominate the proposal study area. Livestock, cropping and horticultural enterprises comprise 97 per cent of the proposal study area, with the vast majority being used for grazing livestock. Sheep and cattle account for almost all grazing livestock (OEH, 2013).

There are some irrigated grape vines on and adjacent to the proposal study area near the Darling River, and adjacent to the proposal study area near the Murray River. Further information on agricultural land use and potential impacts are provided in Technical Report 10 Agricultural Impact Assessment (TIA, 2020).

4.5 CLIMATE AND RAINFALL

The region has a semi-arid climate with hot summers and cool winters. The average temperature range is around 16–33°C in summer and around 4–15°C in winter.

The closest weather station to Buronga at the eastern end of the proposal (Irymple, station number: 076015) records an average annual rainfall of 271 millimetres (1908–2020). Rainfall is typically fairly evenly spread across the year, with higher peak rainfall values from November to April. The Wentworth Post Office (Station number 047053) near the proposal has recorded rainfall data since 1868. The average rainfall at the Wentworth Post Office between 1868 and 2020 has been 286 millimetres per annum. There is a slight seasonal dominance from late autumn to late spring, with summer and early autumn being the driest period, on average.

The Lake Victoria Storage weather station (station number: 047016) records an annual average rainfall of 259.1 millimetres (1922–2020). The average monthly rainfall is slightly higher from May to November, however as at Buronga, recorded peak rain values are higher in the month from November to April.

Other average rainfall does not vary greatly across the proposal study area. The average annual rainfall at other recording stations near the proposal study area include 260 millimetres at Wentworth (Wamberra Station – 47040), 269 millimetres at Wentworth (Toora – 47099) and 259 millimetres at Lake Victoria Storage.

Mean daily evaporation averages 5.6 millimetres with a peak of 10.0 millimetres in January falling to 1.8 millimetres in June and 1.9 millimetres in July.

4.6 SOILS AND GEOLOGY

4.6.1 SOILS

Most soils of the proposal study area have low to moderately low inherent fertility (OEH, 2017) and low plant available water holding capacity. The main exceptions are areas adjacent to the Murray River, the Darling River and the Darling Anabranch, and an area to the north of Lake Victoria which have moderate inherent soil fertility.

The dominant soil in the proposal study area are calcarosols according to Australian Soil Classification (CSIRO, 2016). These have moderately low inherent fertility and are formed on calcareous aeolian sediments of variable texture. They generally have a small, gradual increase in clay content with depth. The soil profile is alkaline throughout, and sodicity and salt levels are often high in the deeper subsoils (Agriculture Victoria, 2020).

Rudosols are also quite common, having low inherent fertility and a sandy, weekly developed profile. Other soils of low to moderately low inherent fertility found in the proposal study area include tenosols and kandosols.

The main soil of moderate inherent fertility are vertisols found along the main watercourses. They have a clay texture throughout the profile, display strong cracking when dry, and shrink and swell considerably during wetting and drying phases (Agriculture Victoria, 2020). Other soils of moderate inherent fertility include kurosols and chromosols north of Lake Victoria.

4.6.2 MAPPED GEOLOGY

Published geological mapping data from the Seamless Geology Project (Colquhoun, Hughes & Deyssing et al, 2019) indicates that Quaternary aged transported soils cover most of the proposal study area. This material includes alluvial flood plains, dune sands and swamp and lake deposits. The geological unit, origin and their corresponding dominant soil type are listed in Table 4.1, with mapped geology shown in Figure 4.1.

Table 4.1 Dominant regional geology within the proposal investigation area

NSW SEAMLESS GEOLOGY CODE	GEOLOGICAL UNIT[1]	ORIGIN	DOMINANT SOIL TYPE
Q_acm	Alluvial channel	Alluvial	Sand or silt
Q_af	Alluvial floodplain	Alluvial	Sand, silt or clay
Q_ath	Alluvial terrace	Alluvial	Sand, silt or clay
Q_av	Alluvial valley	Alluvial and fluvial	Gravel, sand, silt or clay
Q_ddl	Aeolian sand plain	Aeolian	Sand
Q_dds	Bordering dunes	Aeolian	Sand
QH_w_x	Woorinen Formation	Aeolian	Sand
QH_w	Woorinen Formation	Aeolian	Sand, silt or clay
QH_s	Molineaux Sand (formerly Lowlan Formation)	Aeolian	Sand
Q_l	Claypan and lacustrine deposits	Alluvial	Clay or silt
CZwua	Blanchetown Clay	Fluvial	Clay

(1) Not in stratigraphic order.

Approximately 70 per cent (about 108 kilometres) of the proposal study area is covered by a surficial layer of aeolian sediments of the Woorinen Formation. This dominant geology changes near surface water systems, where alluvial sediments near creeks and river tributaries dominate, including in areas surrounding the Darling River and Great Darling-Anabranch. In the proposal study area, the alluvium laterally extends up to 14 kilometres across the Darling River and five kilometres across Great Darling-Anabranch. There are also small, minor areas of other alluvial, fluvial and aeolian deposits in the groundwater study area.

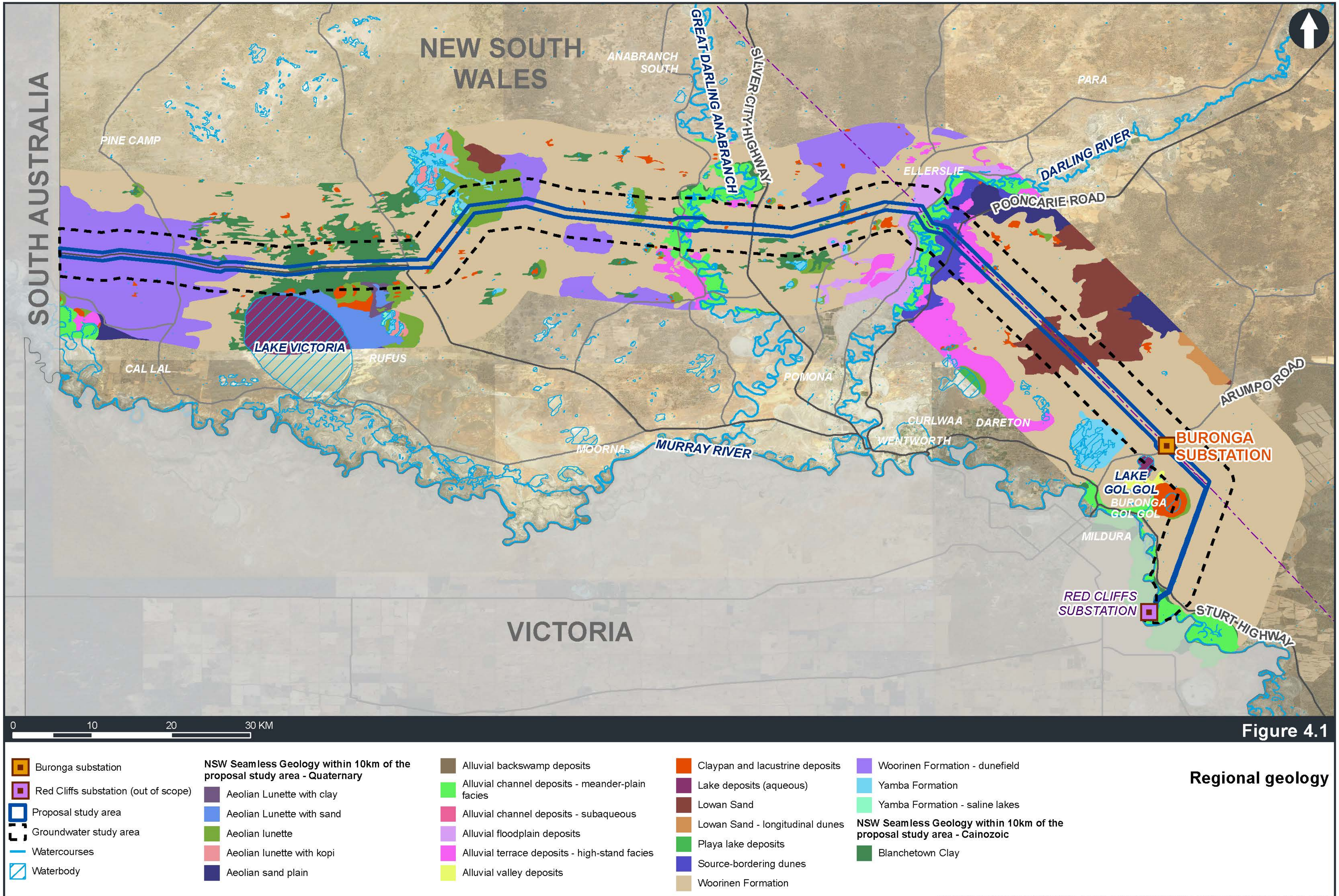

Figure 4.1

Regional geology

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP

4.6.3 BASIN STRATIGRAPHY

The underlying regional geology that exists within the defined Murray-Darling Basin stratigraphy can be separated into three distinct groups based on age (Brown, 1985) that extend up to 600 metres thick (Evans & Kellet, 1989). These are shown in Figure 4.2 and are as follows (in decreasing age):

- The base of the Basin is the Renmark Group, a sequence of unconsolidated medium to coarse quartz sands overlain by a widely distributed sequence of unconsolidated carbonaceous sand, silt, clay and peaty coal. The Renmark Group is approximately 35 to 60 million years old.
- Overlying the Renmark Group is the Murray Group, a sequence of deposited marl, limestone and clay that exists within the western portion of the Basin and is 12 to 30 million years old. The Murray Group is enveloped by the Ettrick Formation, Geera Clay and Winnambool Formation of marls and clay.
- The third distinct group consists of the:
  - Bookpurnong Formation that consists of clays and occasional sandy, silty and calcareous beds
  - overlying the Bookpurnong Formation is the Loxton-Parilla Sands (sands) and the Calivil Formation (coarse grain sands) that occur in the eastern portion of the Basin
  - overlying the Loxton-Parilla Sands in the west is a broad sequence of clay known as the Blanchetown Clay
  - where the Blanchetown Clay does not outcrop, it can be overlain by the fluvial sediments of the Shepparton Formation which underlies a sequence of aeolian dunes that dominate the western Basin geology, known as the Woorinen Formation
  - recent alluvial deposits restricted to proximity to the major rivers within the region comprise the Coonambidgal Formation (GA, 2020a) as well as scattered gypsum (calcrete) of the Yamba Formation and clay lunettes.

Basin-wide borehole compilation data undertaken by Wilford (2017) indicates that the Basin sediments within the proposal study area may extend to depths of up to 600 metres.

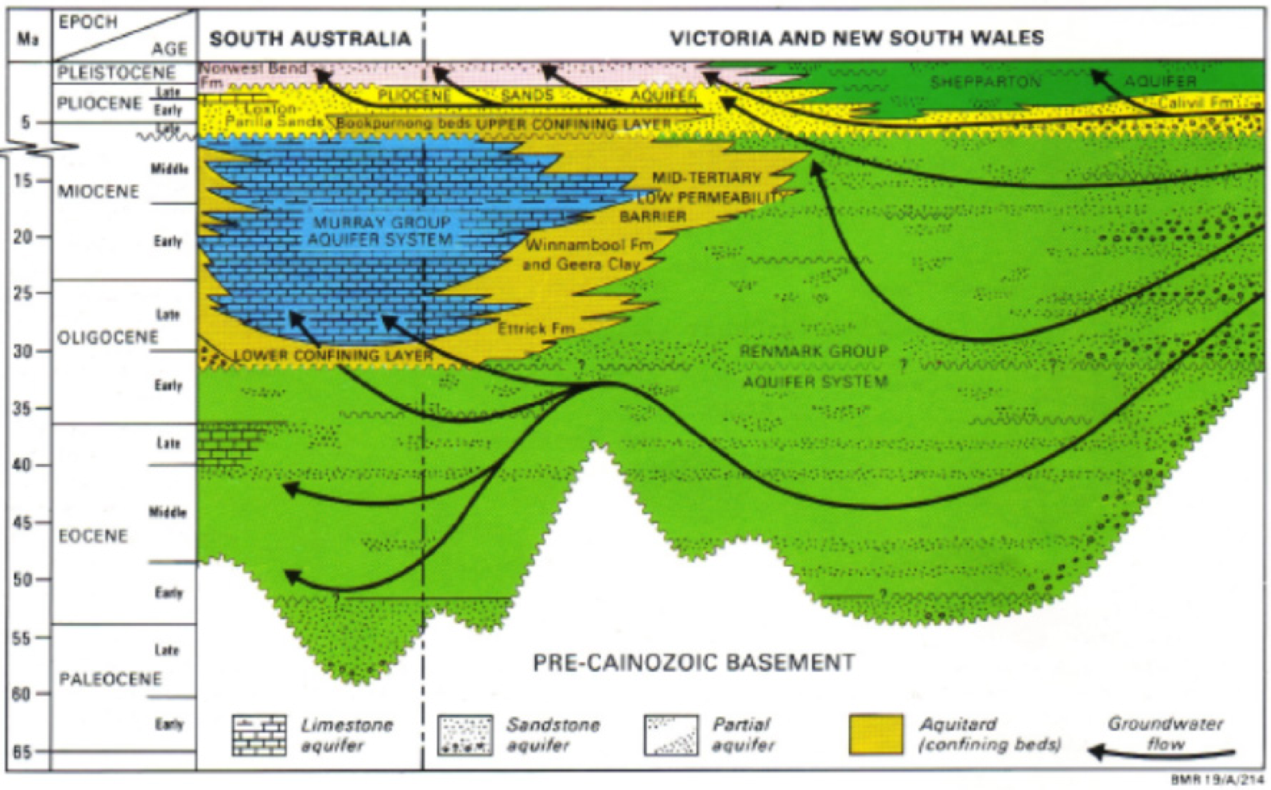

Figure 4.2 Simplified hydrostratigraphic section of the Murray Basin (Evans & Kellet, 1989, cited by Middlemis et al, 2005)

4.6.4 STRATIGRAPHY WITHIN THE GROUNDWATER STUDY AREA

Based on readily available Basin information, the following geology, in stratigraphic order and estimated thickness, is anticipated to occur within the groundwater study area:

- The Woorinen Formation, Blanchetown Clay, Yamba Formation and Coonambidgal Formation can outcrop within the groundwater study area and collectively range in thickness from 10 metres to approximately 30 metres. The Shepparton Formation may exist near the surface within the eastern portion of the groundwater study area.
- Loxton-Parilla Sands, underlying the above formations, with anticipated thickness of 40 to 60 metres.
- Bookpurnong Beds, possible Gera Clay and Winnambool Formation, of 10 to 40 metres thickness.
- Underlying the above mostly clay units is the Murray Group with considerable thickness, potentially in excess of 100 metres.
- The Ettrick Formation and Renmark group are likely to occur at depth and to a considerable thickness.

4.7 HYDROGEOLOGY

Whilst there are only two relevant water sharing plans associated with groundwater resources within the groundwater study area, the hydrogeology is considerably more complex. This is because the water sharing plans have been designed for simplicity; to make the legislative process more transparent and easier to read, whilst maintaining legislative accuracy (NSW DPIE, 2019b).

Evans and Kellet (1989) identified several regional hydrogeological systems within the Murray-Darling Basin, which have been incorporated into the NGIS database (BOM, 2020b). The NGIS database has the regional hydrogeological systems grouped into four aquifer types; upper, middle-upper, middle-lower, and lower. These aquifers and additional interpreted hydrogeological units and type are provided in Table 4.2.

Table 4.2 Anticipated hydrogeological units within the proposal study area, adapted from BOM (2020b)

AQUIFER GROUP	HYDROGEOLOGICAL UNIT	HYDROGEOLOGICAL TYPE
Upper[1]	Quaternary sediments[2]	Perched, unconsolidated aquifer
Upper[1]	Coonambidgal Formation	Unconsolidated aquifer
Upper[1]	Shepparton and Yamba Formations	Aquitard[3]
Upper	Blanchetown Clay	Aquitard
Upper	Loxton-Parilla Sands	Typically an unconfined aquifer, however likely to be semi-confined in the proposal study area
Middle – upper	Bookpurnong Formation	Aquitard
Middle – upper	Winnambool Formation	Aquitard
Middle – upper	Murray Group Limestones	Confined aquifer
Middle – lower	Ettrick Formation	Aquitard
Lower	Renmark Group	Confined aquifer

(1) Hydrogeological unit not identified by BOM (2020b); adapted for this GWIA.

(2) Includes relevant recent sedimentary deposits of the Woorinen Formations.

(3) Based on the dominant soil type identified during fieldworks undertaken by Douglas Partners (2020a).

Selected hydrogeological units, their positioning and processes are depicted in a hydrogeological conceptual model illustrated by Viezzoli, Auken and Munday (2009) in Figure 4.3.

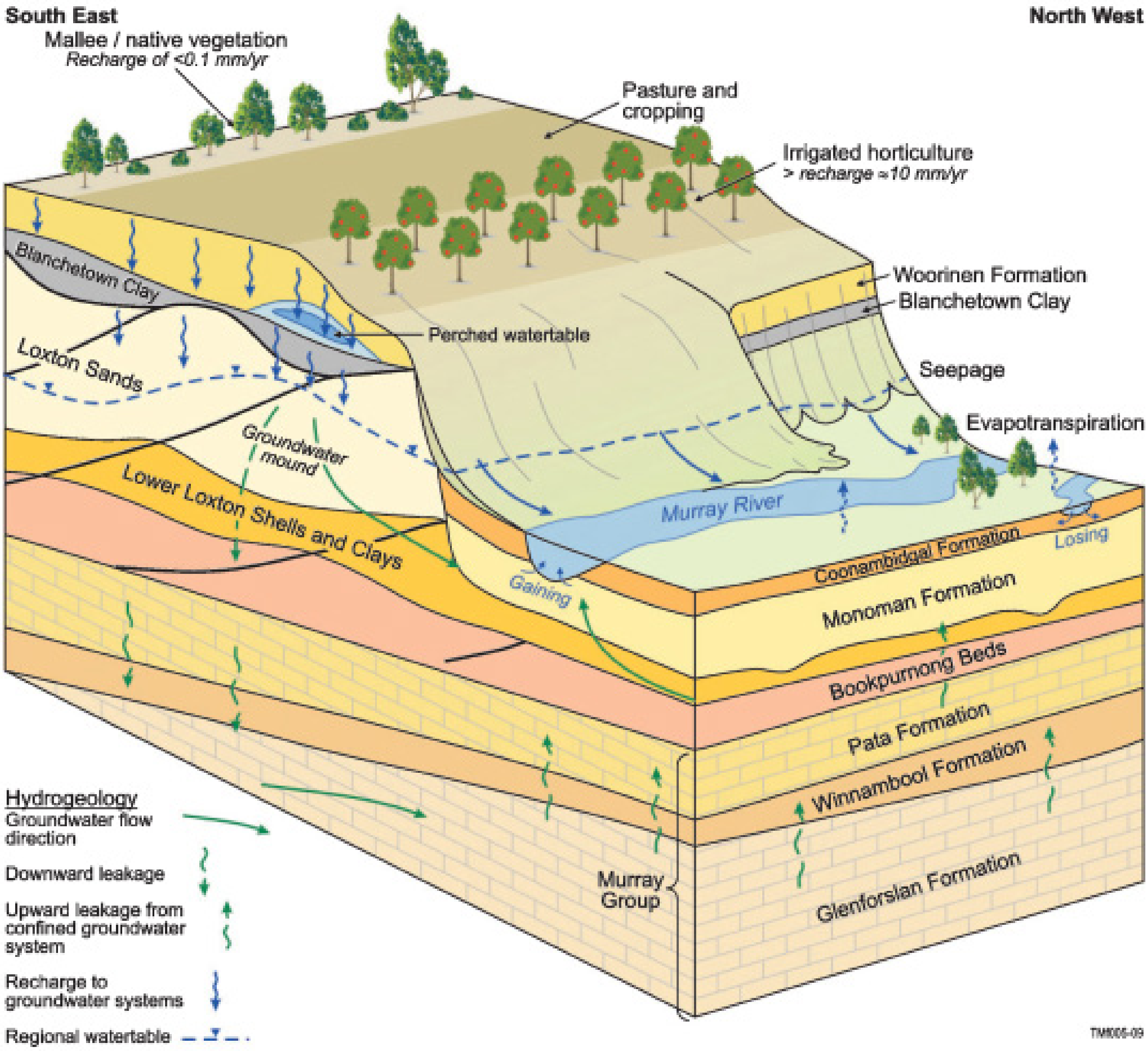

Figure 4.3 Simplified hydrogeological conceptual model from Viezzoli, Auken and Munday (2009)

4.7.1 UNCONFINED AND SEMI-CONFINED AQUIFERS

The unconfined aquifers are heavily influenced by climatic conditions, such as rainfall, and surface water features, such as rivers and lakes (MDBA, 2014). Three distinguishable types of unconfined aquifers exist within the groundwater study area and are described below:

- *Unconfined alluvial aquifers associated with surface water features*:
  - In areas proximal to surface water features, groundwater levels can be quite shallow, located in the associated alluvial sediments (e.g. Coonambidgal Formation), where they are recharged by the surface water features. The groundwater levels can be less than two metres below the ground surface immediately adjacent to these features. However, groundwater levels within these aquifers deepen with distance from the surface water feature, as the surface water features typically represent areas of lower elevation and with distance from the recharge source of the surface water feature. The distance and associated change in groundwater levels will depend on factors such as:
    - the size and volume of the surface water feature
    - permanent or ephemeral nature of the surface water feature
    - local topography
    - underlying geological controls, such as the extent of the alluvial soils and depth to aquitards.
  - Groundwater quality relating to electrical conductivity (EC), is expected to be less than 3,000 microsiemens per centimetre (fresh to brackish) within 500 metres from connected fresh surface water features.
  - Groundwater flow will generally follow surface water flow directions.
- *Perched aquifers*:
  - There is potential for groundwater to perch atop the Blanchtown Clay, claypans and lacustrine deposits (aquitards). The groundwater is likely to be limited in extent, being dependent upon the presence, continuity and extent of the aquitards. The depth to groundwater encountered within these perched systems will vary across the groundwater study area and be related to the depth of the underlying aquitards of the Blanchtown Clay, claypans and lacustrine deposits.
  - Groundwater quality will vary, but predominately the salinity is expected to be high (saline to hyper saline).
- *Semi-confined aquifer of the Loxton-Parilla Sands*:
  - Where groundwater is not encountered in the unconfined perched aquifers or the aquifers highly connected to surface water features, it will be encountered within the Loxton-Parilla Sands. The Loxton-Parilla Sands is likely a semi-confined aquifer within the groundwater study area. Groundwater level maps of the Loxton-Parilla Sands aquifer suggests that regional groundwater levels within this aquifer lie between 20 to 30 metres below ground level (Ife & Skelt, 2004).
  - Groundwater quality is saline to hypersaline with typical EC values between 30,000 and 150,000 microsiemens per centimetre (sea water is approximately 50,000 microsiemens per centimetre). Groundwater within the Loxton-Parilla Sands is a significant contributor to salinity for the Darling River and Murray River.
  - Hydraulic conductivity and groundwater chemistry will be locally influenced by the presence of clays and gypsum.
  - Groundwater within the Loxton-Parilla Sands, typically flows towards the west within the groundwater study area.

Groundwater quality regarding potential contaminants from land uses and areas of potential concern are documented in the Contaminated Land Management Impact Assessment (WSP, 2020) (refer to Technical Report No. 5).

Refer to section 4.7.6 for further information regarding groundwater levels within the groundwater and proposal study areas.

4.7.2 CONFINED AQUIFERS

The primary confined aquifers underlying the groundwater study area are the Murray Group and the Renmark Group. Groundwater within these deeper aquifers generally flows towards the west. Based on the anticipated Basin stratigraphy within the groundwater study area (refer to section 4.6.4), it is unlikely that the proposal would interfere with these confined aquifers and therefore they have not been considered further in the assessment.

4.7.3 AQUITARDS

The Blanchetown Clay has been mapped to locally occur within the groundwater study area and geophysical modelling indicates the likely presence of the Bookpurnong Formation and Winnambool Formation underlying the groundwater study area (McLennan, 2016). These lithologies are considered aquitards that will restrict the downward flow of groundwater. Groundwater within the Woorinen Formation will perch atop the Blanchetown Clay.

4.7.4 REGISTERED GROUNDWATER BORES

A search of the BOM's NGIS registered groundwater bore database (BOM, 2020b) within the groundwater study area identified 53 registered bores. Nine of these bores are part of three nested installations and are registered as GW03685 (set of five screened intervals), GW087756 (set of two screened intervals) and GW088454 (set of two screened intervals). It could not be determined from the available information if the nested bores are contained as a single bore set-up or additional bores in close proximity.

One (GW087592) of the registered bores status was listed as abandoned, with the remaining bores listed as unknown (38), functioning (13) and one (GW088199) in use.

The location of all recorded registered bores within the groundwater study area from the NGIS database (BOM, 2020b) are shown in Figure 4.4. Lists of registered bores, their status, registered purpose, construction depth and any information relating to groundwater are provided in Appendix A. Published hydrographs from WaterNSW (2020b), are provided in Appendix B. Groundwater level information is also provided in section 4.7.6, and other general information (such as bore purpose) is provided in section 4.8.3.

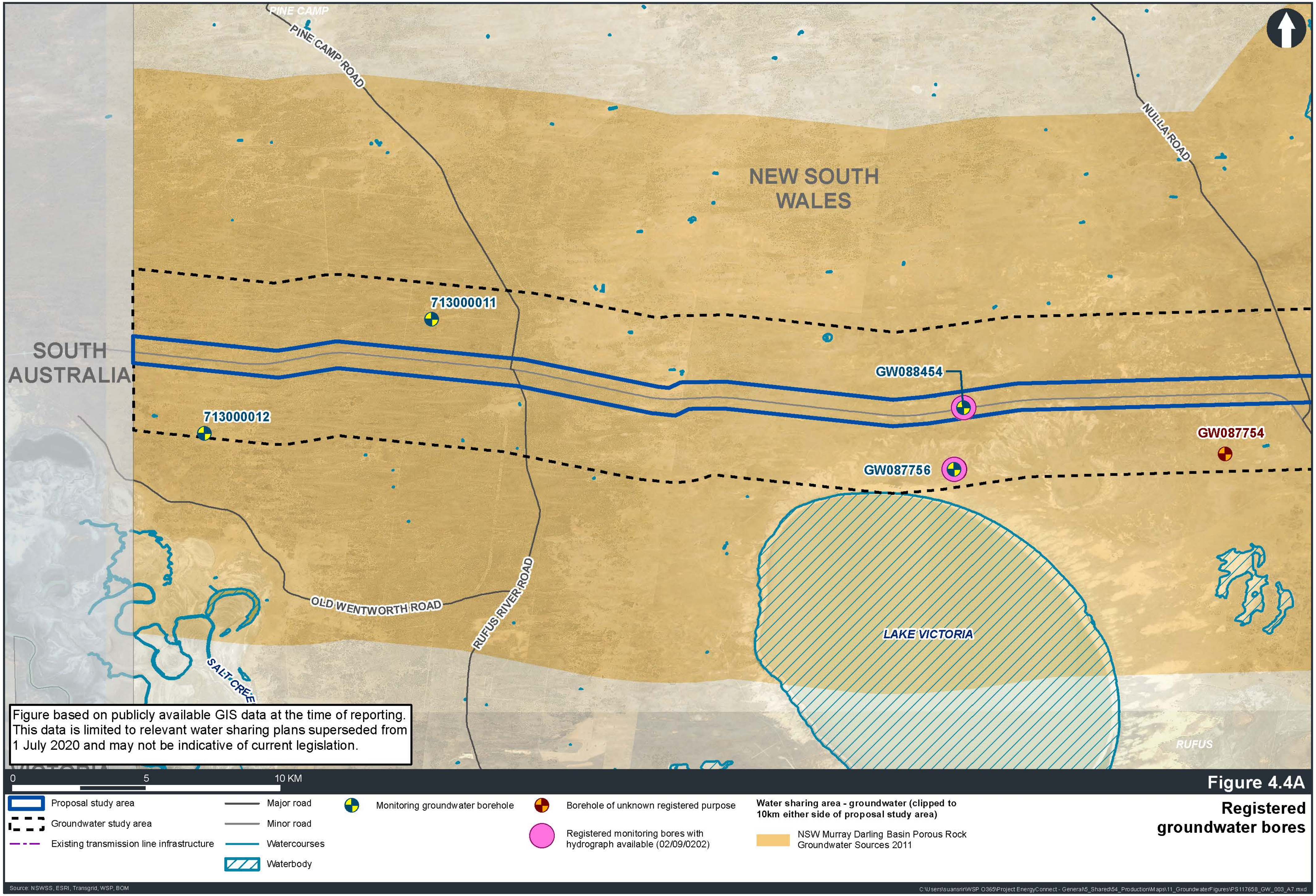

Figure 4.4A
Registered groundwater bores

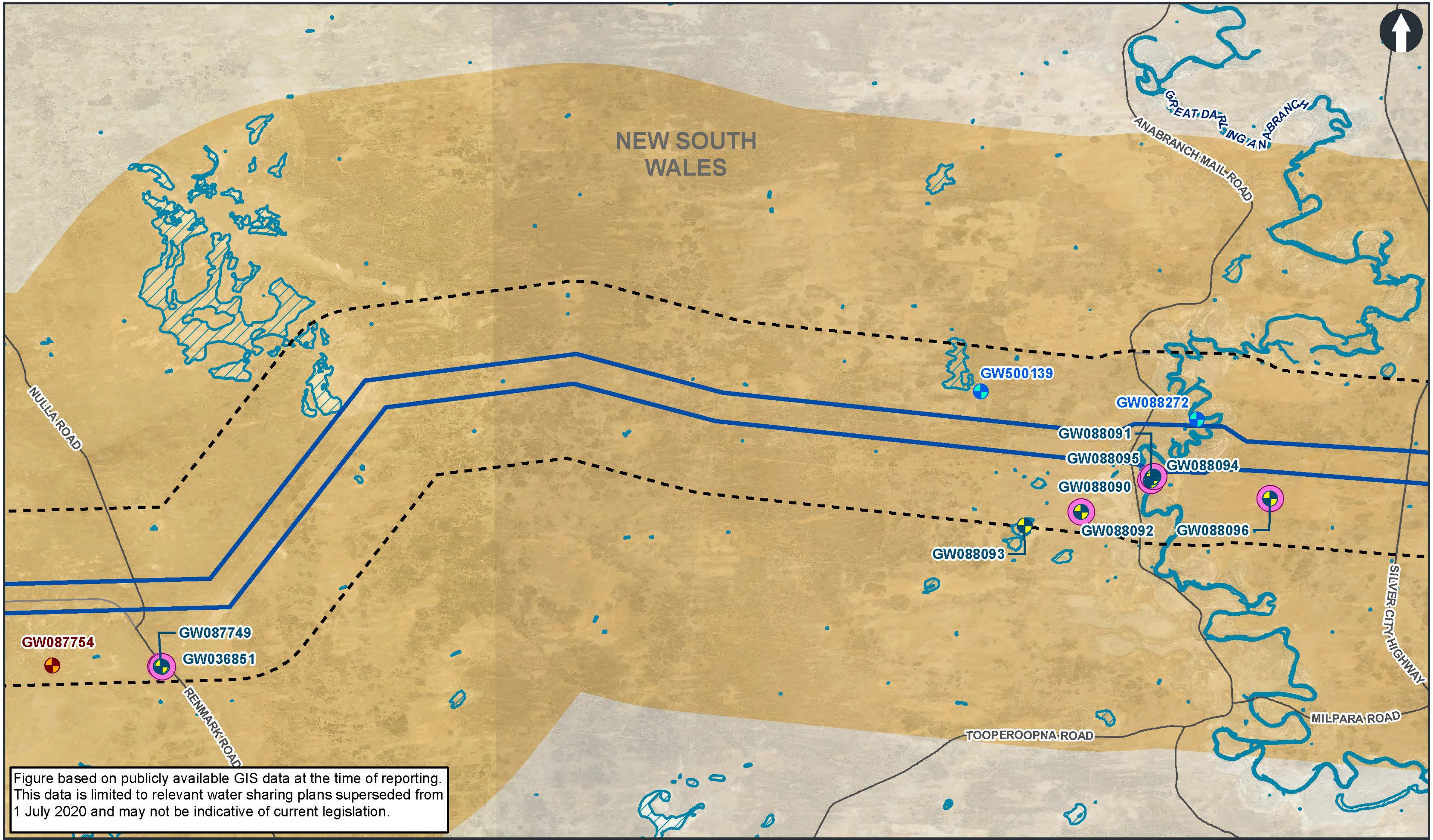

Figure 4.4B

Registered groundwater bores

- Proposal study area
- Groundwater study area
- Existing transmission line infrastructure
- Major road
- Minor road
- Watercourses
- Waterbody
- Monitoring groundwater borehole
- Water supply groundwater borehole
- Borehole of unknown registered purpose
- Registered monitoring bores with hydrograph available (02/09/0202)

Water sharing area - groundwater (clipped to 10km either side of proposal study area)

- NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

Source: NSWSS, ESRI, Transgrid, WSP, BOM

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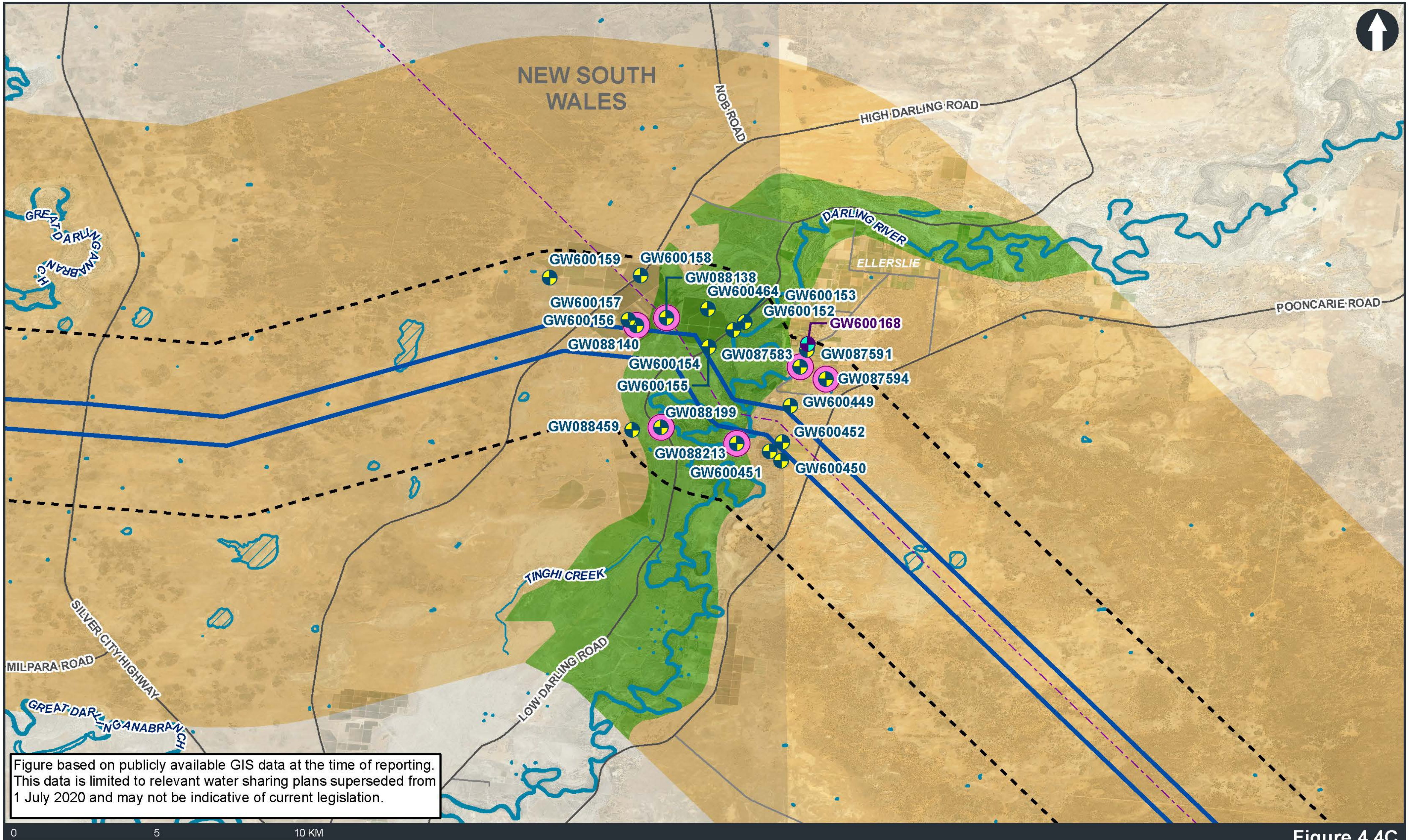

Figure 4.4C

Registered groundwater bores

- Proposal study area
- Groundwater study area
- Existing transmission line infrastructure
- Major road
- Minor road
- Watercourses
- Waterbody
- Irrigation groundwater borehole
- Monitoring groundwater borehole
- Registered monitoring bores with hydrograph available (02/09/0202)

Water sharing area - groundwater (clipped to 10km either side of proposal study area)

- Lower Murray-Darling Unregulated and Alluvial Water Sources 2011
- NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

Source: NSWSS, ESRI, Transgrid, WSP, BOM

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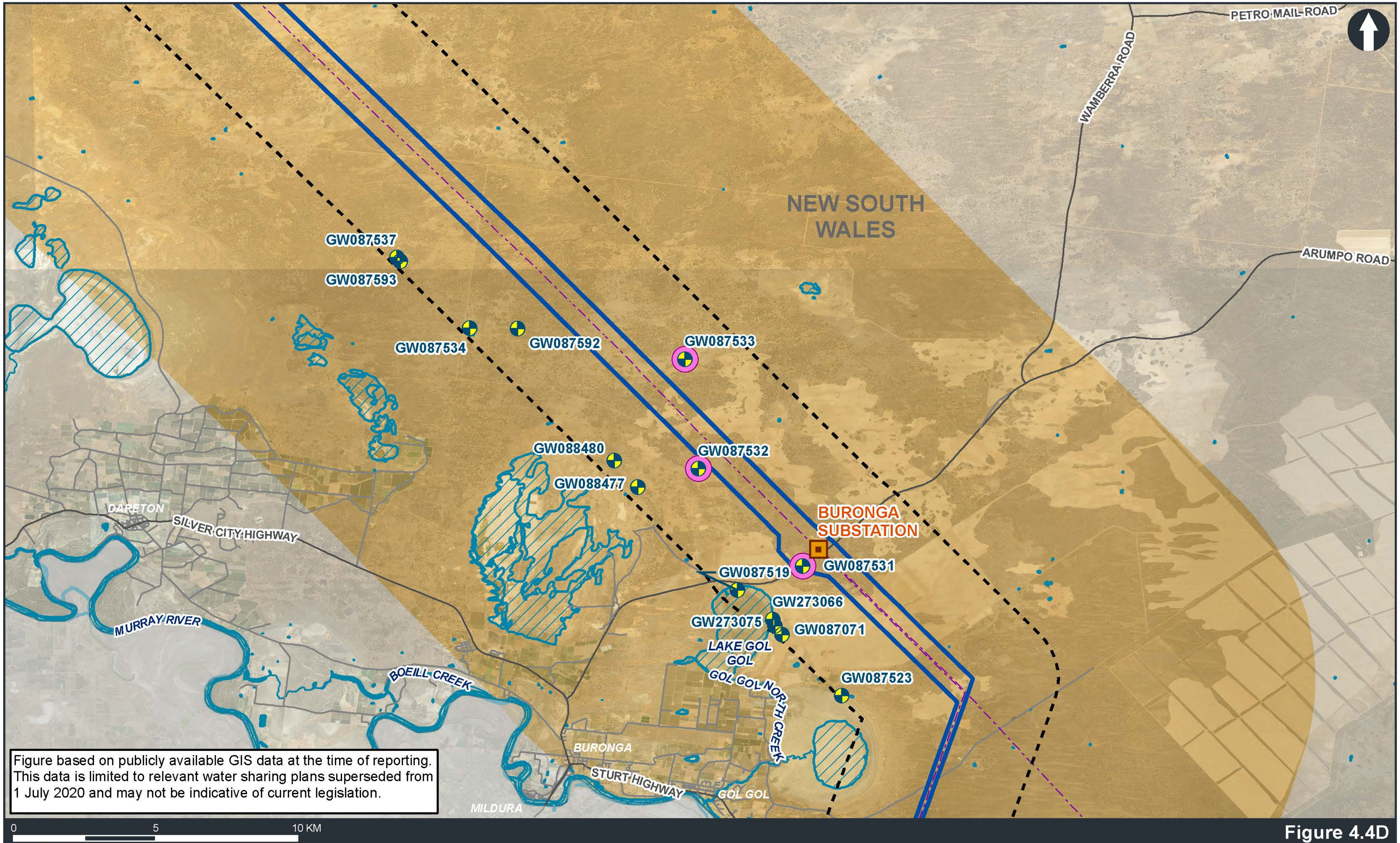
Figure 4.4D

Registered groundwater bores



- Proposal study area
- Groundwater study area
- Buronga substation
- Existing transmission line infrastructure
- Major road
- Minor road
- Watercourses
- Waterbody
- Monitoring groundwater borehole
- Registered monitoring bores with hydrograph available (02/09/0202)

Water sharing area - groundwater (clipped to 10km either side of proposal study area)

- NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

Source: NSWSS, ESRI, Transgrid, WSP, BOM

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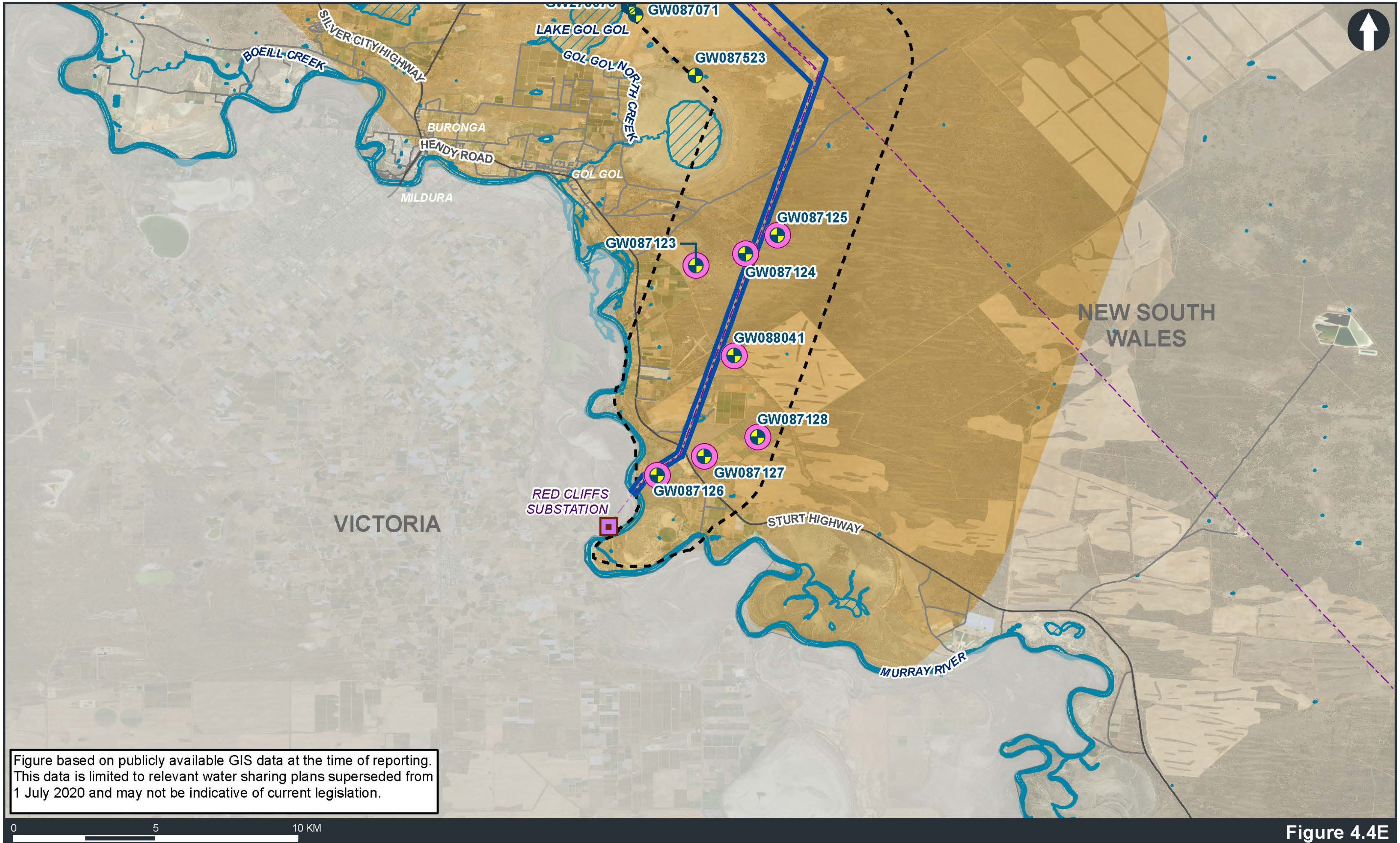

Figure based on publicly available GIS data at the time of reporting. This data is limited to relevant water sharing plans superseded from 1 July 2020 and may not be indicative of current legislation.

Proposal study area
Groundwater study area
Red Cliffs substation (out of scope)
Existing transmission line infrastructure
Major road
Minor road
Watercourses
Waterbody
Monitoring groundwater borehole
Registered monitoring bores with hydrograph available (02/09/0202)

Water sharing area - groundwater (clipped to 10km either side of proposal study area)

NSW Murray Darling Basin Porous Rock Groundwater Sources 2011

Figure 4.4E

Registered groundwater bores

Source: NSWSS, ESRI, Transgrid, WSP, BOM

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4.7.5 SURFACE WATER AND GROUNDWATER CONNECTED SYSTEMS

The following have been identified as major connected surface water and groundwater systems within the groundwater study area:

- A freshwater lens that developed within the alluvial aquifer adjacent to the Darling River (NSW Office of Water 2012a). Recharge from the Darling River has resulted in a freshwater lens that extends approximately 500 metres from the Darling River into the associated alluvial sediments. Where this freshwater lens is present, the groundwater system has been classified as a 'highly connected system' in which '70 per cent or more of the groundwater extraction volume is derived from stream flow within a single irrigation season' (NSW Office of Water 2012a). Outside of this freshwater lens, groundwater is considered to not be highly connected to the river.
- The groundwater below and surrounding Lake Victoria, particularly the shallow unconfined aquifers, which consistently show strong groundwater level and water quality relationships to the surface water level and quality in Lake Victoria (Parsons Brinckerhoff, 2013; MDBA, 2014; MDBA, 2019a).
- The Murray River, which receives groundwater from the Loxton-Parilla Sands aquifer (NSW Office of Water, 2012c). The highly saline inflows of the Loxton-Parilla Sands aquifer into the Murray River is partly managed by salt interception schemes (refer to section 4.2).

4.7.6 GROUNDWATER LEVELS

Permanent groundwater levels vary locally due to influences from surface water features, climatic conditions and localised geological controls, such as topography and the presence of perched shallow aquitards such as the Blanchtown Clay, claypans or gypsum. The hydrogeological controls and expected groundwater levels across the groundwater study area have been briefly discussed above in sections 4.7.1 and 4.7.2.

4.7.6.1 HYDROGRAPHS FROM REGISTERED MONITORING BORES

Twenty-five hydrographs are available from registered monitoring bores within the groundwater study area through WaterNSW (2020b). Table 4.3 provides a summary of the information obtained from the hydrographs. The location of registered monitoring bores with available hydrographs is shown on Figure 4.4, with hydrographs presented in Appendix B.

Table 4.3 Summary of available hydrographs for registered monitoring bores within the groundwater study area

REGISTERED BORE ID[1]	MONITORED LENGTH (YEAR)	SCREEN DEPTH (MBGL[3])	GROUNDWATER LEVEL RANGE[2] (MBMP[3])	TYPICAL GROUNDWATER LEVEL[2] (MBMP[3])	GROUNDWATER LEVEL TREND[2]
GW036851	1990–2019	30.0–42.0	20.4–22.5	20.5–21.0	declining
GW087123	1977–2018	30.0–31.8	22.7–26.0	25.0–26.0	declining
GW087124	1977–2018	25.0–26.8	23.7–24.4	23.7–24.4	declining
GW087125	1977–2018	22.6–23.8	19.8–20.5	20.0–20.4	declining
GW087126	1977–2019	5.0–6.8	2.8–4.6	3.4–4.6	declining
GW087127	1977–2019	30.0–28.8	23.6–24.7	23.7–24.4	declining
GW087128	1977–2010	30.6–32.4	28.8–30.0	28.9–29.1	no trend
GW087531	1988–2019	10.3–11.3	9.2–11.7	10.9–11.5	no trend
GW087532	1988–2019	10.8–11.8	5.6–10.0	9.0–10.0	no trend
GW087533	1988–2019	24.9–25.9	25.2–25.5	25.3–25.4	no trend

REGISTERED BORE ID[1]	MONITORED LENGTH (YEAR)	SCREEN DEPTH (MBGL[3])	GROUNDWATER LEVEL RANGE[2] (MBMP[3])	TYPICAL GROUNDWATER LEVEL[2] (MBMP[3])	GROUNDWATER LEVEL TREND[2]
GW087583	1990–2019	8.2–9.2	8.4–9.9	8.8–9.8	declining
GW087594	1990–2019	14.8–15.8	14.5–15.8	14.8–15.6	declining
GW087749	1995–2019	27.3–28.3	18.6–19.9	19.6–19.9	no trend
GW087756[4]	1995–2019	19.5–21.0	14.9–17.8	16.2–17.2	no trend
GW088041	1998–2019	23.0–26.0	15.9–16.4	16.0–16.3	no trend
GW088091	2000–2019	0.0–0.0	2.8–7.2	4.2–6.2	no trend
GW088092	2000–2019	0.0–0.0	5.4–6.1	5.5–6.1	declining
GW088094	2000–2019	13.0–14.0	2.5–6.4	4.0–5.8	declining
GW088095	2000–2019	33.5–34.5	4.0–4.6	4.4–4.6	declining
GW088096	2000–2019	0.0–0.0	11.7–12.4	12.0–12.4	declining
GW088138	2000–2008	8.0–9.0	6.6–6.9	6.6–6.9	declining
GW088140	2000–2006	13.0–14.0	9.1–9.3	9.1–9.3	declining
GW088199	2000–2019	11.5–12.5	6.9–7.6	6.9–7.4	declining
GW088213	2000–2019	10.7–11.7	6.1–7.8	6.6–7.6	declining
GW088454	2000–2019	36.0–42.0	30.7–31.3	31.0–31.3	no trend

(1) Monitoring bores screened in aquifers identified in section 4.7.1 listed. Screened intervals and corresponding water level records located at depths deeper than 50 meters have not been assessed. It is unlikely that the proposal would interfere with these aquifers.

(2) Numbers are approximate and based on assessment of WaterNSW (2020b) published hydrographs.

(3) MBGL = metres below ground level; MBMP = metres below measuring point. The measuring point is usually from ground surface (0 m) to 1.5 m above ground surface, thus the corresponding groundwater levels may be shallower when converted to metres below ground level, by approximately 0 m to 1.5 m.

(4) Bore replaced during monitoring period. Values represent range of data encountered in original and replaced bore.

Seven of the registered monitoring bores listed in Table 4.3 contained groundwater levels potentially within approximately 5 metres of the ground surface. Further assessment, including searching for additional bore details, was conducted and comments on the groundwater levels presented in the corresponding hydrographs are provided in Table 4.4.

Table 4.4 Registered monitoring bores with recorded groundwater levels potentially within 5 metres of surface

REGISTERED BORE ID[1]	GROUNDWATER LEVEL RANGE (mBMP[1,2,3])	GROUNDWATER LEVEL RANGE (mBGL/mAHD[4])	REVIEW OF HYDROGRAPHS AND GROUNDWATER LEVEL COMMENTS
GW087126	2.8–4.6	2.8–4.6/33.8–35.5	— The bore is located approximately 700 metres east of the Murray River. — The shallowest groundwater level reading of 2.8 metres below ground level was recorded in March 1994; groundwater levels have generally since declined. — A localised response to recharge is indicated, with groundwater levels increasing by up to a metre in response to such events. — The most recent groundwater level (recorded in October 2018) was 4.5 metres below ground level. — There is a low risk that groundwater levels are currently within two metres of the ground surface at this monitoring point.
GW087532	5.6–10.0	5.6–10.0/30.0–34.2	— The bore is located approximately four kilometres north of Lake Gol Gol. — There is a low risk of groundwater within two metres of the surface at this monitoring point.
GW088091	2.8–7.2	2.8–7.2/26.2–30.4	— The bore is located approximately 10 metres south of the Great Darling Anabranch. — Groundwater levels have been declining since monitoring began in 2000. This declining trend was interrupted by a spike in groundwater level, rising from approximately 7 metres below ground level to 2.9 metres below ground level between 2010 and 2012, potentially in response to the end of the Millennium drought. — The most recent groundwater level was 6.6 metres below ground level, recorded in October 2018. — There is a low risk that groundwater levels are currently within two metres of the ground surface at this monitoring point.

REGISTERED BORE ID[1]	GROUNDWATER LEVEL RANGE (mBMP[1,2,3])	GROUNDWATER LEVEL RANGE (mBGL/mAHD[4])	REVIEW OF HYDROGRAPHS AND GROUNDWATER LEVEL COMMENTS
GW088092	5.4–6.1	5.4–6.1/28.3–29.0	— The bore is located approximately 1.2 kilometres west of the Great Darling Anabranch, within its floodplain. — There is a low risk of groundwater within two metres of the ground surface at this monitoring point.
GW088094	2.5–6.3	2.5–6.3/26.6–30.4	— The bore is located approximately 30 metres north east of the Great Darling Anabranch. — Groundwater levels have been declining since monitoring began in 2000. This declining trend was interrupted by a spike in groundwater level, rising from approximately 6.4 metres below ground level to 3.4 metres below ground level between 2010 and 2012, potentially in response to the end of the Millennium drought. — The most recent groundwater level was 6.0 metres below ground level, recorded in October 2018. — There is a low risk that groundwater levels are currently within two metres of the ground surface at this monitoring point.
GW088095	4.0–4.6	4.0–4.6/28.3–28.9	— The bore is located approximately 60 metres northwest of the Great Darling Anabranch. — There is a low risk of groundwater within two metres of the ground surface at this monitoring point.
GW088213	6.1–7.8	6.1–7.8/29.4–31.0	— The bore is located approximately 300 metres south and 350 metres west of the Darling River. — There is a low risk of groundwater within two metres of the surface at this monitoring point.

(1) The bores listed in this table have been selected based on an assumed measurement point of 1.5 m above ground level. MBMP = metres below measuring point. Values rounded to one decimal place.

(2) Numbers are approximate and based on assessment of WaterNSW (2020b) published hydrographs.

(3) WaterNSW (2020b) lists the measuring point as equal to the ground level, indicating that the numbers provided do not need adjustment.

(4) MBGL = metres below ground level; MAHD = metres Australian height datum. Data obtained from published excel spreadsheets (WaterNSW, 2020b).

4.7.6.2 GROUNDWATER LEVELS NEAR LAKE VICTORIA

The Lake Victoria 2018 annual compliance report (MDBA, 2019a) noted the following information regarding groundwater levels:

- Groundwater levels adjacent to the lake or under the lake itself fluctuate in unison with the volume of water held in the lake. Groundwater depths within these regions fluctuated from approximately 1.24 to 6.24 metres below ground level within the alluvial sediments and 3.24 to 5.50 metres below groundwater level within the Loxton-Parilla Sands.
- Recorded groundwater levels varied spatially and are influenced by the groundwater network coverage (the majority of the monitoring network bores are focused in the vicinity of Lake Victoria, particularly the shoreline and on adjacent land to the east and south). However, shallow groundwater (less than two metres below ground level) extended approximately 1.25 kilometres to the northwest, up to seven and a half kilometres to the east and five kilometres to the south and south east from the top of bank.
- The extent of shallow groundwater surrounding Lake Victoria is due to the topographic low towards the east of the lake, with elevations of approximately 29 to 30 metres Australian Height Datum to the east up to 55 metres Australian Height Datum to the north.

Hydrographs from registered monitoring bore GW087756, located approximately one kilometre north of the lake towards the proposal study area, indicates groundwater has fluctuated between 14.9–17.8 metres below the measuring point from 1995 to 2019. In addition, registered monitoring bore GW088454, located approximately three kilometres north of the lake and within the transmission line corridor, has recorded groundwater levels of 30.7–31.3 metres below measuring point from 2000 to 2019. Further information regarding hydrographs is discussed in section 4.7.6.1.

Further information on Lake Victoria is provided in sections 4.7.6.2 and 4.8.2.

4.7.6.3 INTERSECTED GROUNDWATER LEVELS FROM FIELD INVESTIGATIONS

Field investigations undertaken by Douglas Partners (2020a) intersected groundwater at only 11 of the 113 tested proposed transmission line structure locations within the proposal study area. Field investigations included borehole drilling and cone penetration tests (CPTs) and were conducted to termination depths typically ranging between 15 to 25 metres below ground level, indicating that at the vast majority of locations, the water table was below these depths. Where groundwater was encountered, it was intersected between 2.8 to 12.5 metres below ground level. Table 4.5 presents the groundwater levels and a discussion on the potential cause for the encountered groundwater levels that were intersected from the proposal specific field investigations. Investigation locations, depths and observed groundwater levels are shown in Figure 4.5.

Table 4.5 Intersected groundwater levels during field investigations (Douglas Partners, 2020a)

LOCATION	EASTING	NORTHING	INTERSECTED GROUNDWATER LEVEL (mBGL/mAHD)[1]	COMMENT
BH-4-063	597198	6248405	4.0/32.4	Mapped geology is claypan/lacustrine deposit that transitioned from alluvial terraces in an area of low elevation.
BH-4-076	593217	6253090	10.7/32.8	Located ~750 m east of the Darling River and ~1 km south of irrigation fields.
BH-4-089	589221	6255873	7.2/34.4	Located ~2.5 km west of the Darling River and ~50 m to the north are irrigation fields.
BH-4-091	588283	6255982	12.5/30.4	Located ~3.5 km west of the Darling River and ~50 m to the north are irrigation fields.

LOCATION	EASTING	NORTHING	INTERSECTED GROUNDWATER LEVEL (mBGL/mAHD)[1]	COMMENT
BH-4-139	566459	6254524	8.0/30.5	Near CPT-4-139. Located ~400 m down gradient of the Great Darling Anabranch, in an area of low elevation
BH-4-187	543561	6255996	6.2/26.4	Located at the edge of mapped Yamba Formation (aquitard) and aerial photography (Google Earth) indicates the presence of a claypan or gypsum in an area of low elevation.
BH-4-204	539073	6249232	2.8/27.9	Mapped geology is claypan/lacustrine deposit in an area of low elevation.
CPT-4-138	566912	6254327	5.0/32.7	Located <100 m from the Great Darling Anabranch, in an area of low elevation.
CPT-4-139	566464	6254522	4.4/34.1	Near BH-4-139. Located approximately 400 m down gradient of the Great Darling Anabranch, in an area of low elevation.
CPT-4-195	541483	6252887	9.6/29.9	Location is situated between Lake Victoria to the south west and clay plan deposits to the north east, in an area of typically lower elevation.
CPT-4-200	540138	6250843	5.6/31.0	Location is ~2 km northeast of BH-2-204 and mapped geology indicates claypan and lacustrine deposits, in an area of low elevation.
CPT-4-200A	540135	6250825	6.8/29.8	Location is ~2 km northeast of BH-2-204 and mapped geology indicates claypan and lacustrine deposits, in an area of low elevation.

(1) mBGL = metres below ground level; mAHD = metres Australian Height Datum; mAHD obtained from Douglas Partners (2020a).

Groundwater intersected during field investigations was at approximately 26.4–34.4 metres Australian Height Datum. These groundwater levels correspond to groundwater levels reviewed in the literature (section 4.7.1 to 4.7.3) and WaterNSW (2020b) hydrographs (section 4.7.6.1), indicating the intersected groundwater within the proposal study area is likely part of the regional Loxton-Parilla Sands aquifer or the unconfined alluvial aquifers associated with surface water features. However, groundwater may exist as limited perched aquifers above claypans and lacustrine deposits.

4.7.6.4 GROUNDWATER LEVELS SUMMARY

In summary, the dominant regional groundwater aquifer of the Loxton-Parilla Sands is anticipated to have groundwater levels within the groundwater study area of approximately 26–35 metres Australian Height Datum. Groundwater levels around the major surface water features of the Great Darling Anabranch and Darling River are of a similar elevation, at 26.2–34.1 metres Australian Height Datum and 29.4–34.4 metres Australian Height Datum (respectively). The highest groundwater level elevation was recorded at GW087126, located in the Murray River floodplain, approximately 700 metres east of the Murray River, at 33.8–35.5 metres Australian Height Datum between 1977 and 2019.

In terms of the groundwater levels below ground surface across the groundwater study area, the following generalisations can be made based on the viewed information:

- Within the majority of the proposal study area, groundwater levels are anticipated to be between 20 to 30 metres below ground level and occurring within the Loxton-Parilla Sands aquifer. This includes regions within the proposal study area east of the Great Darling Anabranch and west of Lake Victoria, provided the locations are not situated in the alluvial sediments of the Great Darling Anabranch or Darling River.
- Groundwater is likely to be approximately 2.5 to 10 metres below ground surface near the Douglas Partners (2020b) field investigation locations BH-4-204 and BH-4-187, at around 26 to 31 metres Australian Height Datum, due to a lower elevation within this region of the proposal study area. Intersected groundwater may be perched, but is likely to be from the Loxton-Parilla Sands aquifer.
- Groundwater is approximately 2.5 to five metres below ground surface within 500 metres of the Great Darling Anabranch and generally five to 10 metres of the ground surface within its floodplain, up to 1.2 kilometres away from the river.
- Groundwater was deeper than five metres below ground surface within the Darling River floodplain.
- Groundwater is approximately 2.5 to five metres below ground surface within the Murray River floodplain (within the groundwater study area). However, this is based on limited information at greater than 500 metres from the Murray River and thus shallower groundwater levels may occur at closer distances to the river.
- Groundwater north of Lake Victoria, within the proposal study area, was generally greater than 15 metres below ground surface.

Exceptions to the above are likely caused by factors and controls discussed earlier, within section 4.7.

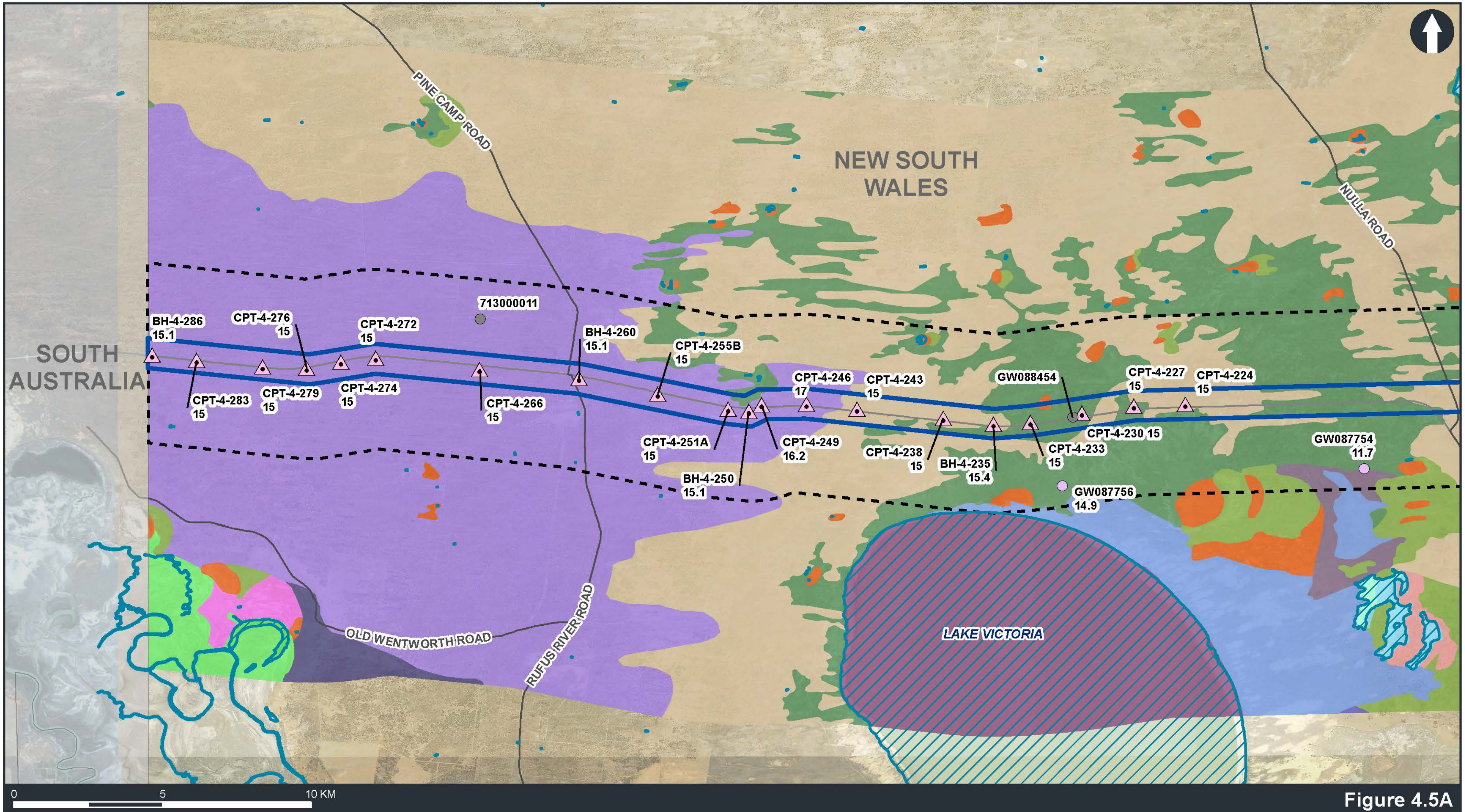

Figure 4.5A

Proposal study area
Waterbody

BOM (2020b) Registered bores (mbmp)
- No recorded water level data (BOM, 2020b)
- 10-14.9

Douglas Partners (2020) testing locations
- 15+
- Groundwater not observed; termination depth listed

NSW Seamless Geology within 10km of the proposal study area - Quaternary
- Aeolian Lunette with clay
- Aeolian Lunette with sand
- Aeolian lunette
- Aeolian lunette with kopi
- Aeolian sand plain
- Alluvial channel deposits - meander-plain facies
- Alluvial terrace deposits - high-stand facies
- Claypan and lacustrine deposits
- Lake deposits (aqueous)
- Source-bordering dunes
- Woorinen Formation
- Woorinen Formation - dunefield
- Yamba Formation
- Yamba Formation - saline lakes

NSW Seamless Geology within 10km of the proposal study area - Cainozoic
- Blanchetown Clay

Minimum recorded standing water levels identified within the groundwater study area

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP, BOM, Douglas Partners

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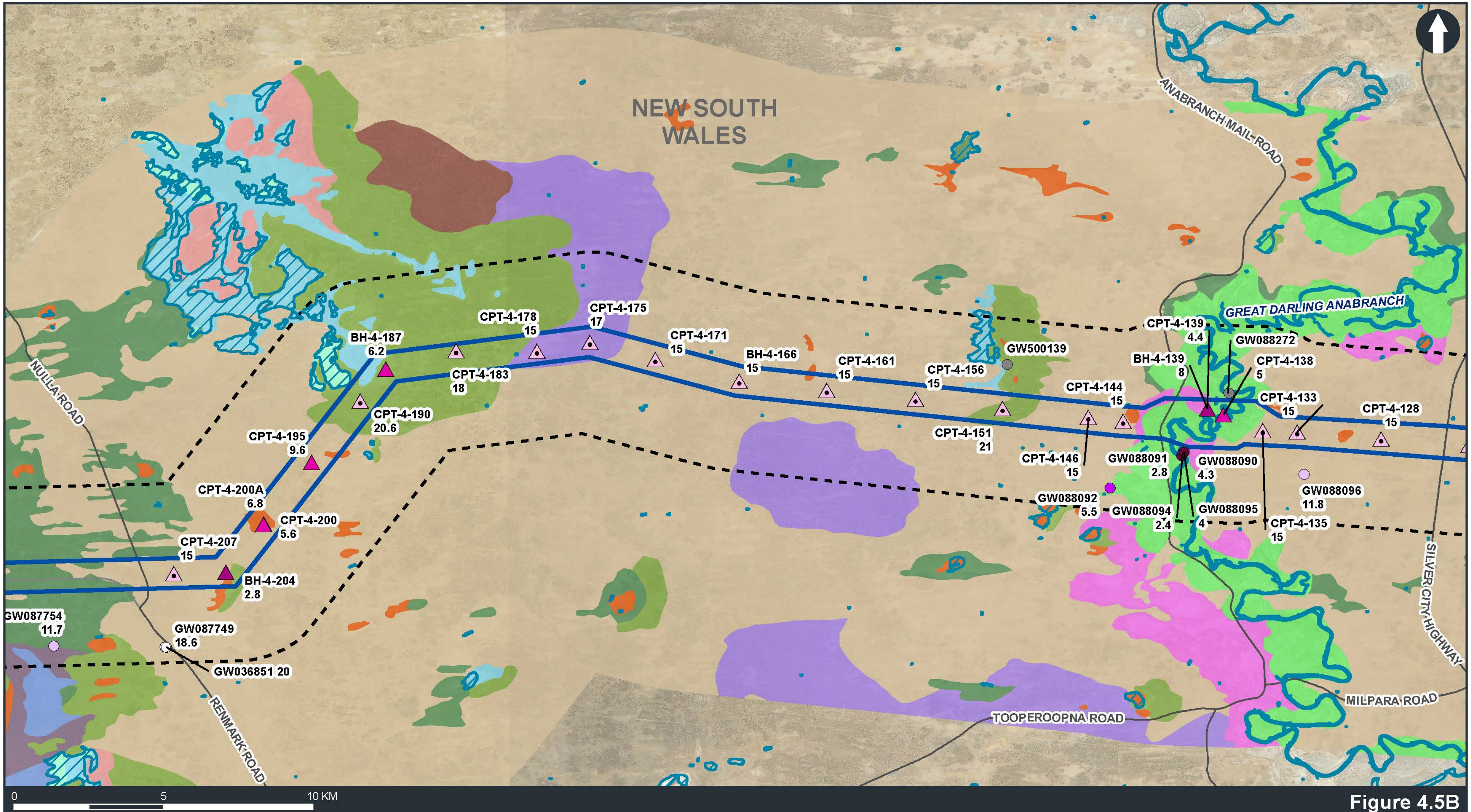

Figure 4.5B

Proposal study area
Waterbody

BOM (2020b) Registered bores (mbmp)

- No recorded water level data (BOM, 2020b)
- 0-4.9
- 5-9.9
- 10-14.9
- 15+

Douglas Partners (2020) testing locations

- 0-4.9
- 5-9.9
- 15+
- Groundwater not observed; termination depth listed

NSW Seamless Geology within 10km of the proposal study area - Quaternary

- Aeolian Lunette with clay
- Aeolian Lunette with sand
- Aeolian lunette
- Aeolian lunette with kopi
- Alluvial channel deposits - meander-plain facies
- Alluvial terrace deposits - high-stand facies
- Claypan and lacustrine deposits
- Lowan Sand
- Woorinen Formation
- Woorinen Formation - dunefield
- Yamba Formation
- Yamba Formation - saline lakes

NSW Seamless Geology within 10km of the proposal study area - Cainozoic

- Blanchetown Clay

Minimum recorded standing water levels identified within the groundwater study area

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP, BOM, Douglas Partners

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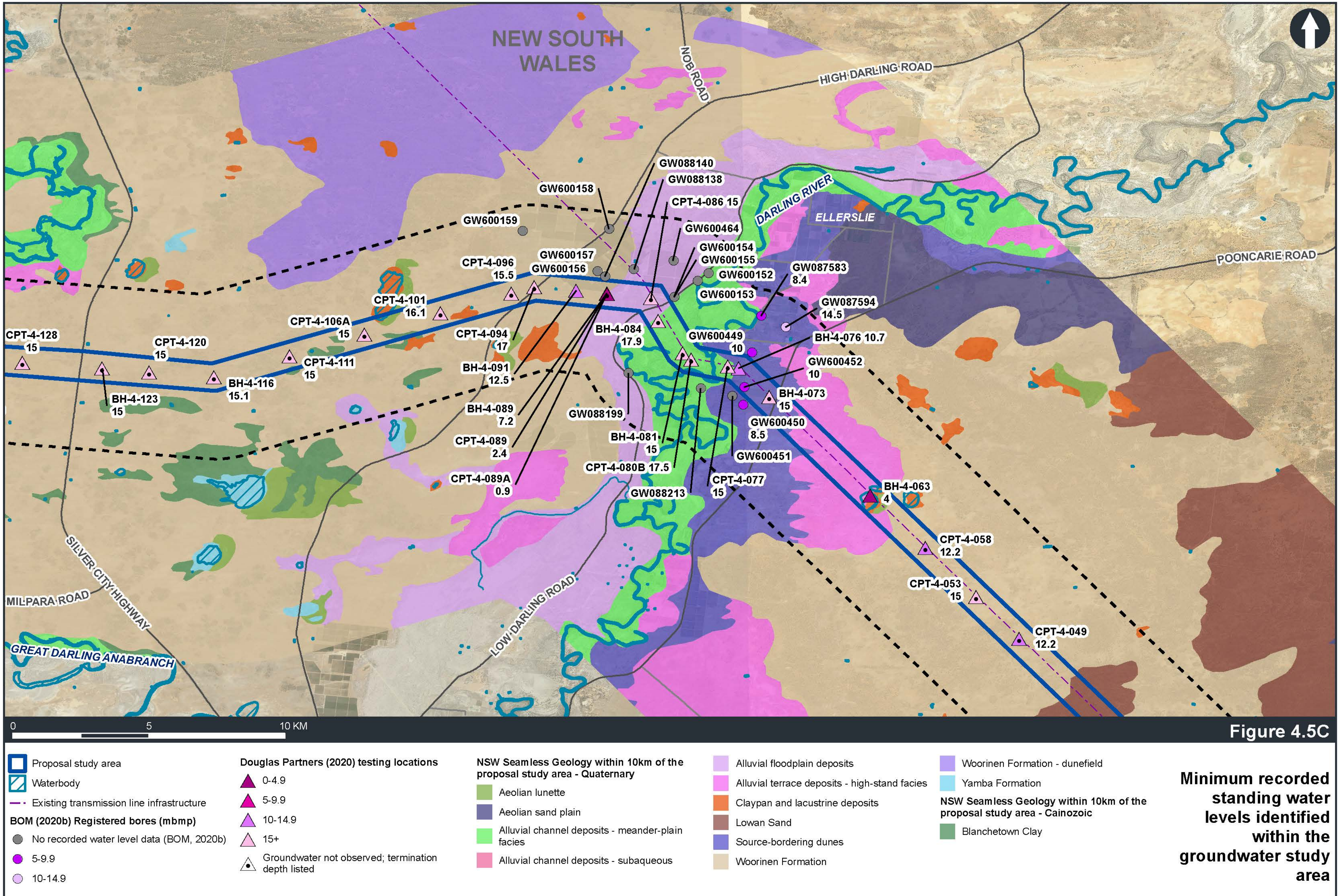

Figure 4.5C

Minimum recorded standing water levels identified within the groundwater study area

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP, BOM, Douglas Partners

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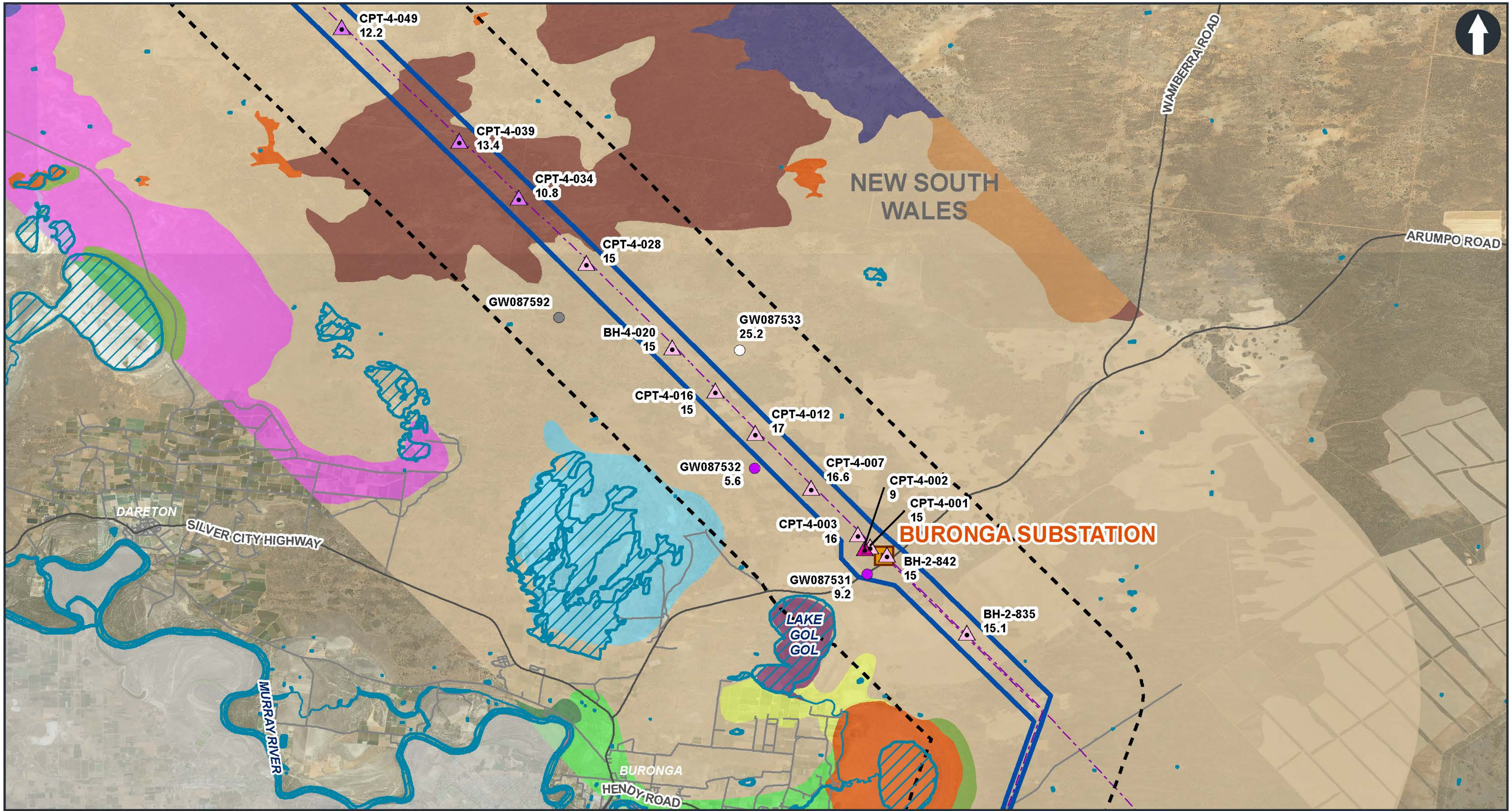

Figure 4.5D

Buronga substation

Proposal study area

Waterbody

Existing transmission line infrastructure

BOM (2020b) Registered bores (mbmp)

No recorded water level data (BOM, 2020b)

5-9.9

15+

Douglas Partners (2020) testing locations

5-9.9

10-14.9

15+

Groundwater not observed; termination depth listed

NSW Seamless Geology within 10km of the proposal study area - Quaternary

Aeolian lunette

Aeolian sand plain

Alluvial channel deposits - meander-plain facies

Alluvial channel deposits - subaqueous

Alluvial floodplain deposits

Alluvial terrace deposits - high-stand facies

Alluvial valley deposits

Claypan and lacustrine deposits

Lake deposits (aqueous)

Lowan Sand

Lowan Sand - longitudinal dunes

Playa lake deposits

Source-bordering dunes

Woorinen Formation

Yamba Formation

NSW Seamless Geology within 10km of the proposal study area - Cainozoic

Blanchetown Clay

Minimum recorded standing water levels identified within the groundwater study area

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP, BOM, Douglas Partners

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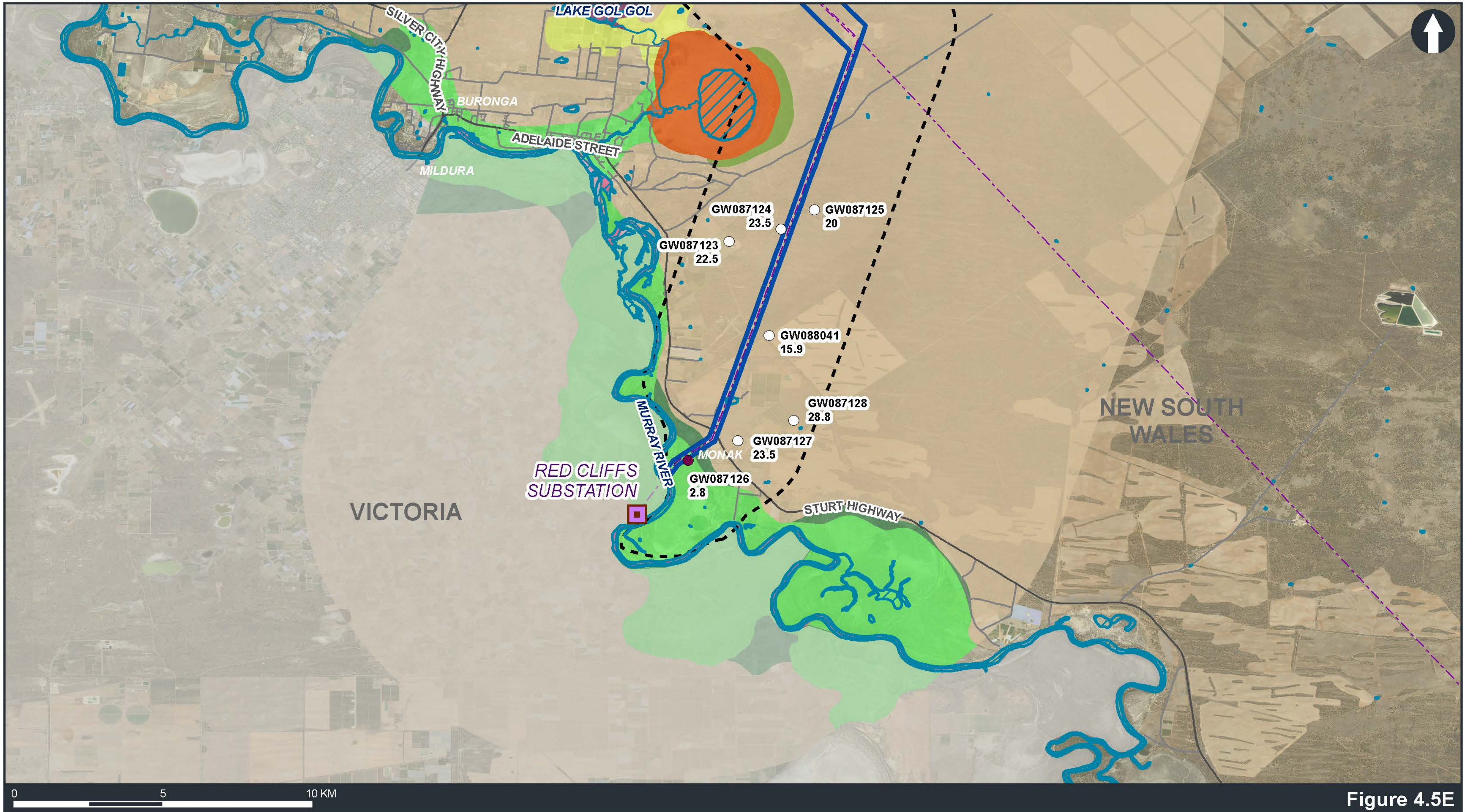

Figure 4.5E

Red Cliffs substation (out of scope)
Proposal study area
Waterbody
Existing transmission line infrastructure

BOM (2020b) Registered bores (mbmp)
- 0-4.9
- 15+

NSW Seamless Geology within 10km of the proposal study area - Quaternary
- Aeolian lunette
- Alluvial backswamp deposits
- Alluvial channel deposits - meander-plain facies
- Alluvial channel deposits - subaqueous
- Alluvial valley deposits
- Claypan and lacustrine deposits
- Lake deposits (aqueous)
- Woorinen Formation

NSW Seamless Geology within 10km of the proposal study area - Cainozoic
- Blanchetown Clay

Minimum recorded standing water levels identified within the groundwater study area

Source: Colquhoun, Hughes & Deyssing et al, 2019; NSWSS, ESRI, Transgrid, WSP, BOM, Douglas Partners

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4.8 SENSITIVE RECEPTORS

4.8.1 GROUNDWATER DEPENDENT ECOSYSTEMS

No high priority GDEs were identified in either of the previous groundwater related water sharing plans that were superseded on 1 July 2020 (refer to Table 2.4). Publicly available location (GIS) data, including information on high priority GDEs, is currently unavailable for the new water sharing plans that were enacted on 1 July 2020. Personal communication with the DPIE indicates that the data is currently under internal review before public release later in the year (personal comms. DPIE, 9 July & 27 August 2020).

Six GDEs with high potential for groundwater interaction within the groundwater study area (Table 4.6 and Figure 4.6) have been identified through a review of the NGIS (BOM, 2020b). Low and moderate potential GDEs have also been identified in the groundwater study area.

Table 4.6 GDEs with high potential for groundwater interaction within the groundwater study area (BOM 2020b)

GDE TYPE	NAME	COVERAGE (HA)
Terrestrial (aquatic)	Darling River	–
Terrestrial (aquatic)	Murray River	–
Subterranean (vegetation)	Eucalyptus Camaldulensis	6571
Subterranean (vegetation)	Eucalyptus Largiflorens	7127
Subterranean (vegetation)	Grassy Riverine Forest	<1
Subterranean (vegetation)	Mallee	7584[1]

(1) Combined total area of Mallee vegetation communities listed as very sparse, sparse, and isolated.

Generally, all identified high potential GDEs within the groundwater study area are in proximity to the Darling River, Great Darling-Anabranch and Murray River, with the larger high potential GDE communities located adjacent to the Darling River and Murray River. The following high potential GDEs were also identified:

- two non-connected populations of Mallee (vegetation) that occur approximately 20 kilometres northeast of Lake Victoria; one at the edge of the proposal study area and the other within transmission line corridor and extending approximately five kilometres to the northwest.
- an additional grouping of Mallee and Eucalyptus Largiflorens occur proximal to the townships of Buronga and Wentworth, approximately one kilometre from the proposal study area.

Groundwater dependent ecosystems, particularly high priority GDEs, and the potential impacts will be reassessed following the release of the GIS data pertaining to GDEs in the Darling Alluvial Groundwater Sources 2020 and NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020 water sharing plans. This will be undertaken during detailed design, or if available sooner, during the submission report.

The Protect Matters Search Tool (DAWE, 2020) identified no RAMSAR wetlands in NSW within 25 kilometres from the proposal study area. However, the Riverland RAMSAR wetland is located within South Australia, approximately three and a half kilometres southwest of the proposal study area. Key actual or potential groundwater threats to the wetlands include elevated and altered groundwater regime and salinity (SA DEH, 2009).

Proposal study area
Groundwater study area
Existing transmission line infrastructure
Major road
Minor road
Watercourses
Waterbody

Terrestrial (aquatic) GDE within the groundwater study area

Moderate potential for groundwater interaction
Low potential for GW interaction

Subterranean (vegetation) GDE within 3km transmission line corridor

High potential GDE
Moderate potential GDE
Low potential GDE

Figure 4.6A

Mapped Groundwater Dependent Ecosystem's (GDE's) relevant to the proposal study area

Source: National Groundwater Information System (NGIS) (BOM, 2020b); NSWSS, ESRI, Transgrid, WSP

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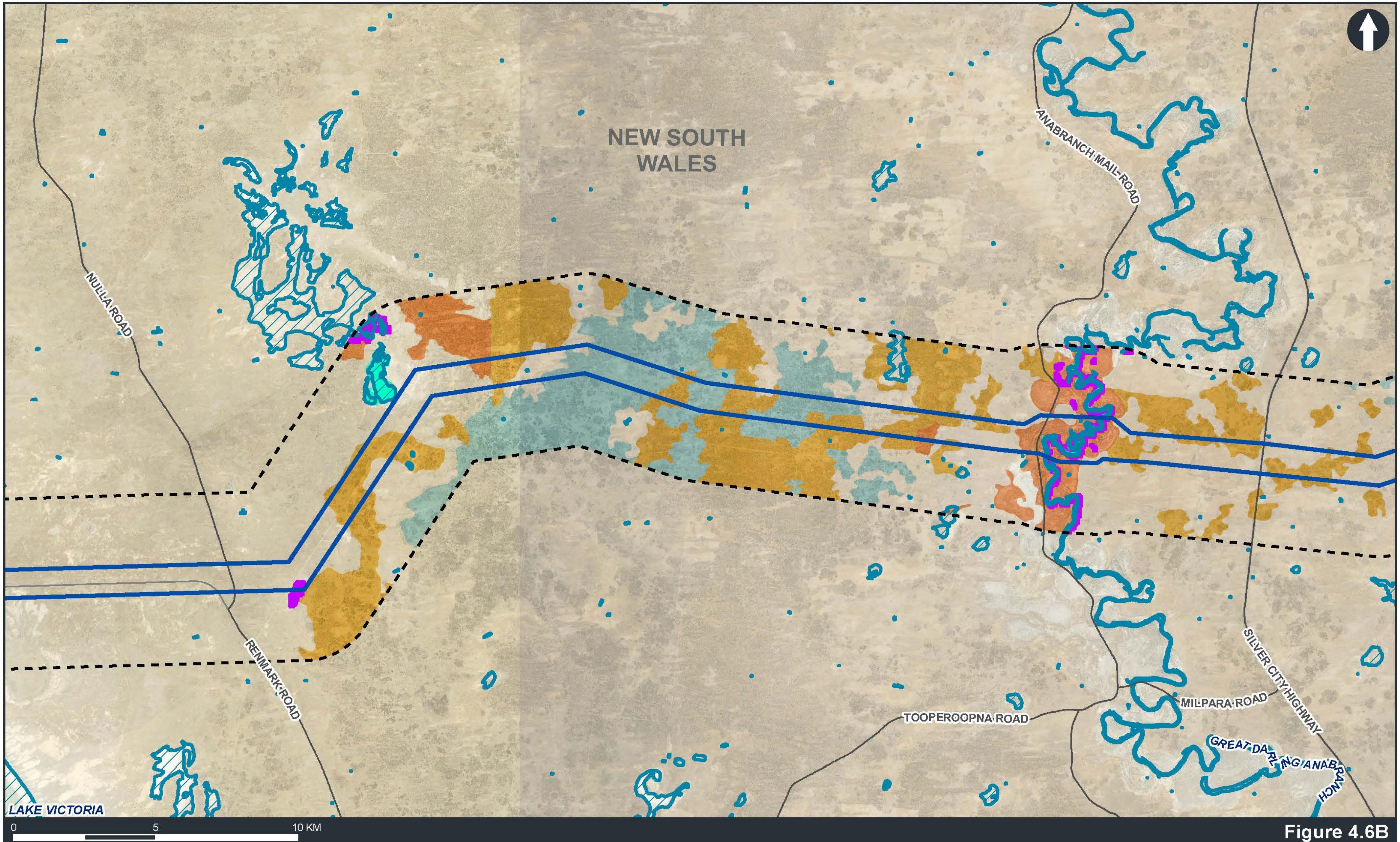

Proposal study area
Groundwater study area
Existing transmission line infrastructure
Major road
Minor road
Watercourses
Waterbody

Terrestrial (aquatic) GDE within the groundwater study area
- Moderate potential for groundwater interaction
- Low potential for GW interaction

Subterranean (vegetation) GDE within 3km transmission line corridor
- High potential GDE
- Moderate potential GDE
- Low potential GDE

Figure 4.6B

Mapped Groundwater Dependent Ecosystem's (GDE's) relevant to the proposal study area

Source: National Groundwater Information System (NGIS) (BOM, 2020b); NSWSS, ESRI, Transgrid, WSP

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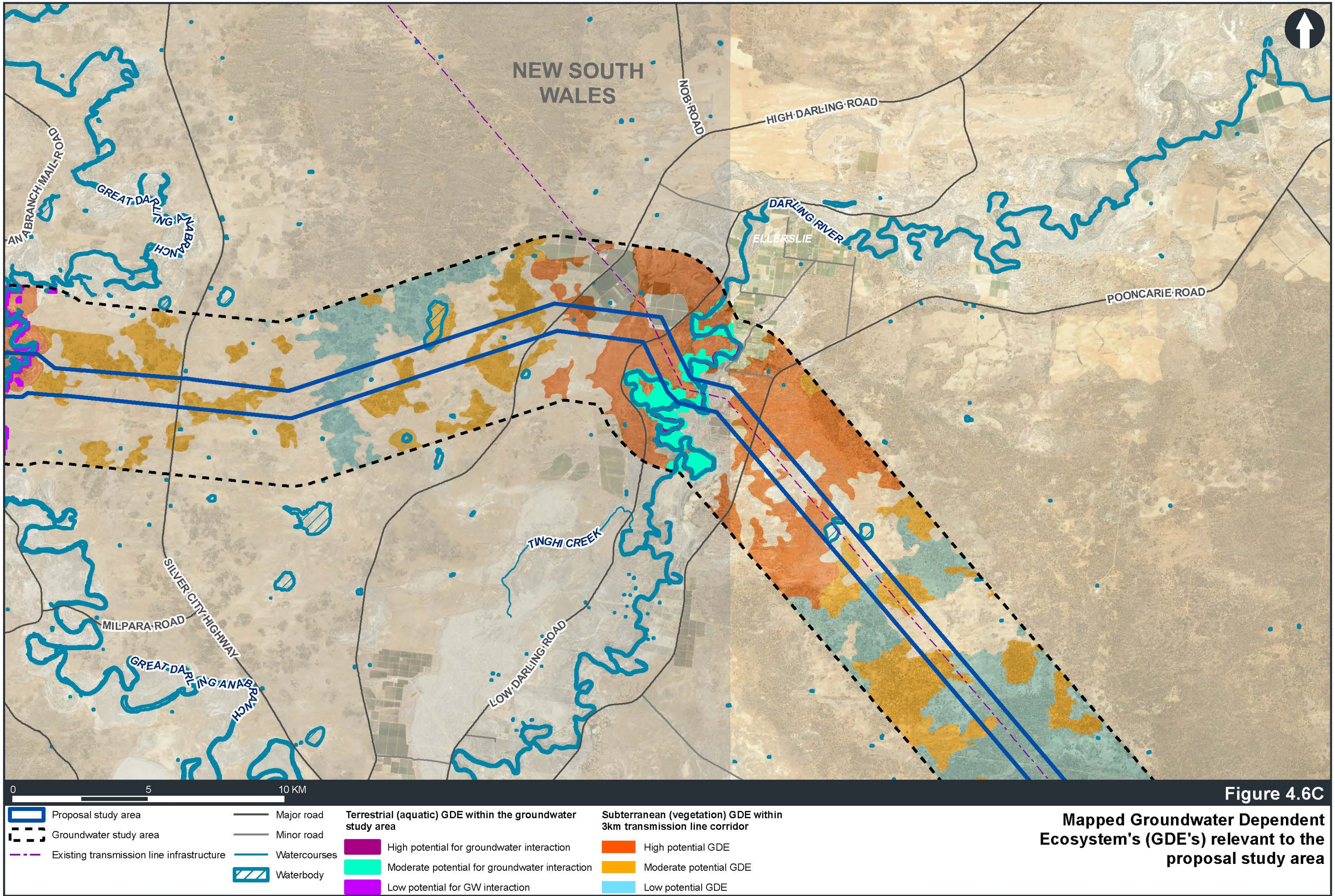

Figure 4.6C

Mapped Groundwater Dependent Ecosystem's (GDE's) relevant to the proposal study area

Source: National Groundwater Information System (NGIS) (BOM, 2020b); NSWSS, ESRI, Transgrid, WSP

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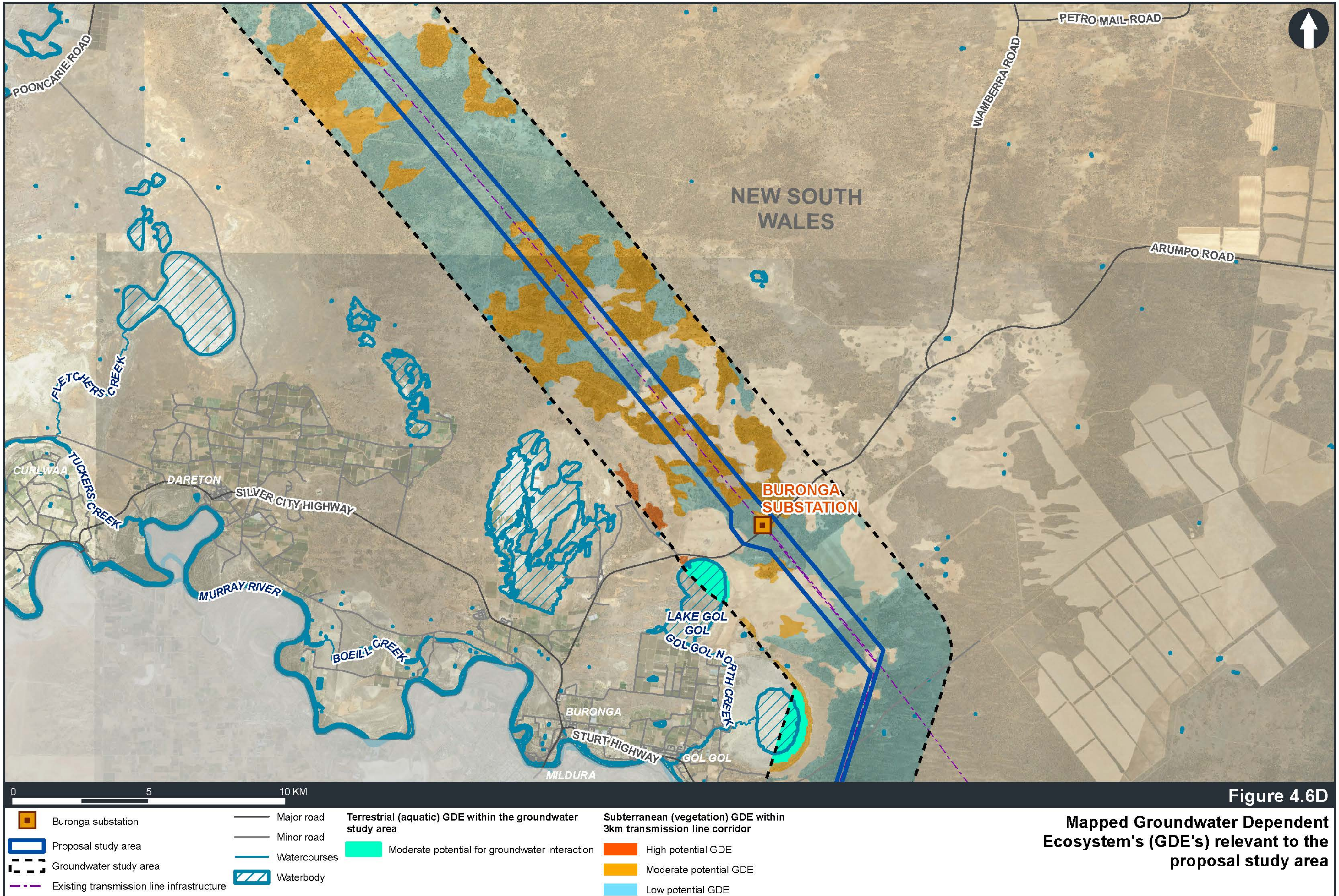

Figure 4.6D

Mapped Groundwater Dependent Ecosystem's (GDE's) relevant to the proposal study area

Source: National Groundwater Information System (NGIS) (BOM, 2020b); NSWSS, ESRI, Transgrid, WSP

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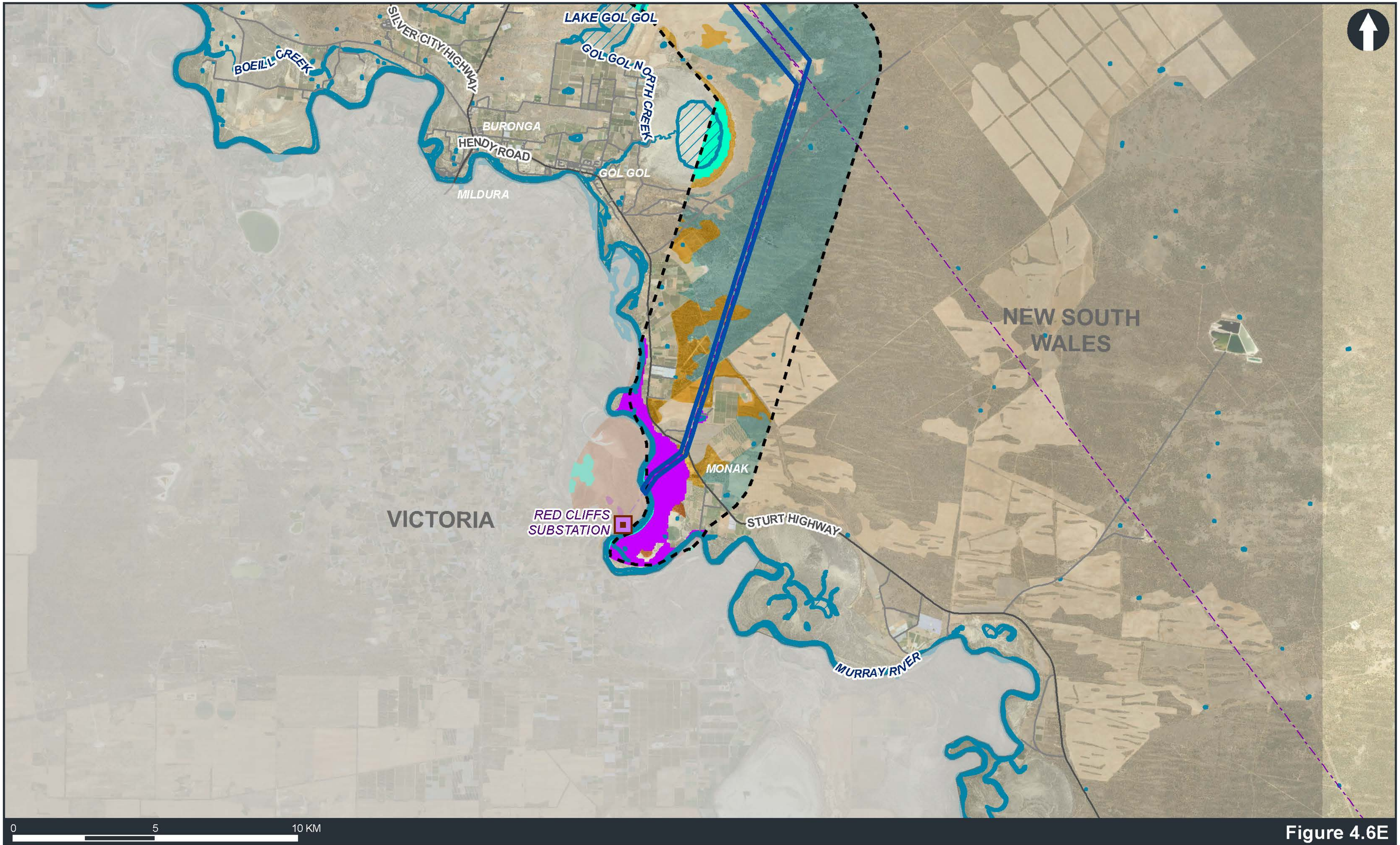

Figure 4.6E

Mapped Groundwater Dependent Ecosystem's (GDE's) relevant to the proposal study area

Red Cliffs substation (out of scope)
Proposal study area
Groundwater study area
Existing transmission line infrastructure
Major road
Minor road
Watercourses
Waterbody

Terrestrial (aquatic) GDE within the groundwater study area
High potential for groundwater interaction
Moderate potential for groundwater interaction
Low potential for GW interaction

Subterranean (vegetation) GDE within 3km transmission line corridor
High potential GDE
Moderate potential GDE
Low potential GDE

Source: National Groundwater Information System (NGIS) (BOM, 2020b); NSWSS, ESRI, Transgrid, WSP

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4.8.2 LAKE VICTORIA

Lake Victoria is a naturally occurring, shallow, freshwater lake that is a culturally and spiritually significant place to the Aboriginal community, particularly the Barkindji and Maraura people (MDBA, 2019a) and located at the edge of the proposal study boundary. Lake Victoria is managed in accordance to an Aboriginal Heritage Impact Permit (AHIP), under the *National Parks and Wildlife Act 1974*. Refer to Technical Report No. 2 – Cultural and Heritage Assessment (NOHC, 2020) for further information regarding cultural and heritage impacts.

Lake Victoria is a key water resource storage of the Murray-Darling Basin. The Lake Victoria Cultural Landscape Plan of Management (CLPoM) indicates that annual groundwater monitoring under condition 51 is required to monitor for changes in water quality, particularly salinity (MDBA, 2019b). Limited groundwater information was able to be sourced, however the Lake Victoria 2018 annual compliance report (MDBA, 2019a) noted the following hydrogeological information in additional to the groundwater level information summarised in section 4.7.6:

- Localised fresh lenses of groundwater were identified near the river inlet and outlet along the southern margin of the lake, where Frenchman's Island group are found, and near Lock 8 along the Murray River. Outside of the freshwater lenses, salinity ranged from 30,000 micro microsiemens per centimetre within the Coonambidgal Formation to 70,000 microsiemens per centimetre within the Loxton-Parilla Sands.
- Towards the east and north east of Lake Victoria, groundwater was hypersaline (greater than 52,000 microsiemens per centimetre) after a few hundred metres from current lake levels during the reporting period.

4.8.3 REGISTERED BORES

The registered groundwater bore search (refer to section 3.1.4) lists eight of the 53 registered bores in the groundwater study area as containing a registered purpose as a potential groundwater user (i.e. registered purpose other than monitoring). From the eight bores, two were registered as household water supply (GW088272 and GW500139), one for irrigation (GW600168) and the remaining five were listed as unknown purpose (GW036851, GW087749, GW087754, GW087756 and GW088454). The bores listed with unknown purpose are documented as part of the Lake Victoria groundwater monitoring network (MDBA, 2019a), and therefore the assessment has not classified these bores as a sensitive user.

Only three bores are located within the proposal study area, GW600452 (monitoring bore), GW087531 (monitoring) and GW088454 (unknown purpose, nested bore). Registered bore GW6004521 is located proximal to the Darling River and GW087531 is located near the Buronga Substation. Only registered bore GW088454 is located within the transmission line corridor, north of Lake Victoria. GW088454 is listed as a nested bore and may exist as a single bore with a multi-screen set up or as two individual bores in proximity.

The list of bores that have a registered purpose as a groundwater user is provided in Table A.2, Appendix A. For hydrogeological information obtained from registered bores, refer to section 4.7.4.

5 ASSESSMENT OF CONSTRUCTION IMPACTS

Construction activities are described in detail in the EIS report Chapter 6. However, the construction activities listed in Table 5.1 are considered the key construction activities at the time of this assessment that pose the greatest potential impact to groundwater. Activities not listed in Table 5.1, are considered to have negligible groundwater impacts.

Table 5.1 Key construction activities assessed for impact to groundwater

CONSTRUCTION ACTIVITY	DOMINANT GROUNDWATER IMPACT
Construction of access tracks for construction machinery and materials to access each transmission line structure site.	Potential impacts to groundwater level and quality (refer to sections 5.1.1, 5.1.3 and 5.2).
Replacement of shallow, unsuitable material with engineered fill.	Potential impacts to groundwater level and quality (refer to sections 5.1.1, 5.1.3 and 5.2).
Earthworks and establishment of construction pads for each transmission line structure (assumed to be approximately 60 x 90 metres).	Potential impacts to groundwater level and quality (refer to sections 5.1.1 and 5.2).
Construction of footings and foundation works for the new transmission line structures including boring, helical screw anchor and/or driven steel pile up to 1.2 metres in diameter, installed generally up to 25 metres below ground level.	Potential impacts to groundwater level and quality (refer to sections 5.1.2 and 5.2).
Laydown and staging areas.	Potential impacts to groundwater level and quality (refer to sections 5.1.1, 5.1.3 and 5.2).
Site offices and accommodation camps.	Potential impacts to groundwater level and quality (refer to sections 5.1.1, 5.1.3 and 5.2).
Construction and upgrade of the Buronga substation.	Potential impacts to groundwater level and quality (refer to sections 5.1.1, 5.1.2, 5.1.3 and 5.2).
Dust suppression activities for construction works.	Potential impacts to groundwater level and quality (refer to sections 5.1.3 and 5.2).
Vegetation removal.	Potential impacts to groundwater level and quality (refer to sections 5.1.3 and 5.2).

Water supply for construction is to be sourced from existing infrastructure and within existing water allocations, licencing and approvals. As such no additional infrastructure or additional take is being proposed during construction for the purpose of water supply.

5.1 IMPACTS TO GROUNDWATER LEVELS

Construction activities, listed above, have the potential to penetrate the local groundwater tables during their execution, and thereby cause local impacts to the groundwater systems. These impacts are discussed under the following construction categories based on the nature of the disturbance.

5.1.1 SHALLOW EARTHWORKS

Shallow earthworks would be carried out by conventional earth moving equipment (such as backhoes, graders or excavators) for clearing of vegetation, development of access tracks and foundation of light structures, such as, construction camps, to a maximum depth of five metres below ground level.

Shallow earthworks for the majority of the proposal would be less than two metres deep. As such, groundwater is unlikely to be intercepted during shallow earthworks for the construction phase of the proposal. Where groundwater may be encountered, design and construction methodology will be adopted in order to avoid groundwater inflows. If groundwater is unexpectedly encountered, it is likely to be perched, non-permanent and localised (that is, not connected regionally). In addition, any excavation for the construction pads of transmission line structures would only be open for a limited duration. This limits the potential impact of the proposal on sensitive receptors (such as high priority or potential GDEs, groundwater bore users and connected surface water and groundwater systems) due to decreasing groundwater levels resulting as part of the construction phase of the proposal.

Proposed shallow excavations near surface water features of the Darling River, Great Darling Anabranch and Murray River are unlikely to intercept groundwater within two metres of the surface, subject to maintaining an appropriate distance from the river systems. The appropriate distance would be confirmed during detail design. Within the proposal study area, groundwater is anticipated to be:

- approximately 2.5 to five metres below ground surface within 500 metres of the Great Darling Anabranch and generally five to 10 metres below the ground surface within its floodplain, up to 1.2 kilometres away from the river
- deeper than five metres below ground surface within the Darling River floodplain
- approximately 2.5 to five metres below ground surface within the Murray River floodplain (within the groundwater study area). Note this is based on limited information at greater than 500 metres from the Murray River and thus shallower groundwater levels may occur at closer distances to the river.

However, this is dependent on various factors at the time of construction, including climatic conditions, stream stage (flow conditions), and nearby land use, such as irrigation. If groundwater is intercepted during shallow construction earthworks, such as near surface water features, potential impacts to groundwater and sensitive receptors would be minimised by limiting the depth and size of the excavation and the time the excavation is open.

Proposed shallow earthworks at the Buronga substation, including the stripping of unsuitable soils and installing shallow electrical equipment conduits, trenches and general site drainage works, are not anticipated to intersect groundwater. Groundwater was not observed during geotechnical investigations up to 15 metres below ground level within the proposed substation upgrade area (Douglas Partners, 2020b). In additional, hydrographs of registered monitoring bore GW087531, located approximately 500 metres to the south east of the Buronga substation towards Lake Gol Gol indicates the groundwater level has fluctuated between 9.2 to 11.6 metres below ground level from 1988 to 2018. This is below the maximum anticipated shallow excavation depth of five meters.

5.1.2 PILING

Where shallow earthworks are not suitable for foundation design of the transmission line structures, either due to shallow groundwater levels or geotechnical constraints, construction methodology would involve bored (using a tremie system), helical screw anchor and/or driven steel piles. Piles are anticipated to be installed typically to depths of 15 to 20 metres below ground level. In areas with soft soil conditions or larger transmission line structure spacing, such as at river crossings, piling depths will generally extend to 25 metres below ground level. None of the methodologies would result in the removal of groundwater during construction, and thus there would not be a reduction in groundwater levels and subsequent potential impact to sensitive receptors.

5.1.3 OTHER CONSTRUCTION ACTIVITIES

Groundwater mounding, or localised increase in groundwater levels, can occur through the following ways:

- When soils are compacted, such as through the addition of sediment or soils over existing land. This may occur during the construction of the proposal where it may be necessary to improve the shallow soils ability to support structures or vehicles, such as at the Buronga substation where the maximum anticipated fill depth is up to six metres. It can also occur by using driven steel pile methodology for deep foundations as the pile is driven into the underlying sediments using force, causing compaction of the aquifer at and surrounding the compaction force (compaction halo) at the base of the pile. The compaction may cause changes in the permeability of the sediments, impacting groundwater flow resulting in groundwater level rise.
- Through increased groundwater recharge and reduced groundwater uptake. This may occur during the construction of the proposal where it may be necessary to remove vegetation.

The impact to groundwater level changes due to compaction and mounding is considered low risk due to the dominance of shallow rooted vegetation, depth to groundwater, relative small compaction footprint, small magnitude (shallow depth of the compaction halo) of the rise and effect of compaction-related changes to subsurface hydraulic conductivity.

Groundwater levels during the construction of the proposal may also be impacted through changing the pervious land surface through construction of impermeable structures such as construction camp buildings, that can reduce infiltration of rainfall or surface water to the underlying aquifer. This potential impact could result in the lowering of groundwater levels and would be greatest at construction staging areas. However, potentially impacted areas are small relative to the local catchment area and temporary. The net impact on regional recharge and groundwater levels is therefore considered to be low.

5.2 IMPACTS TO GROUNDWATER QUALITY

The construction of the proposal has the potential to degrade the water quality of the aquifers underlying and down gradient of the proposal disturbance area in the following ways:

- disturbance and migration of potential existing contamination from previous land uses, such as heavy metals, nutrients and hydrocarbons
- contamination through the use and maintenance of vehicles, machinery and plant equipment, including possible spills from storage of associated chemicals
- contamination from leakage to the water table from concrete slurry and wastewater from mobile concrete batching plants
- increase in salinity through the mobilisation of salts in areas of groundwater level rise (mounding).

The likelihood and magnitude of risks would vary depending on a number of factors, such as the type of construction, the area and location of disturbance, rainfall conditions, existing contamination, and intercepting groundwater in excavations. Noting that:

- groundwater take is not anticipated and the resulting risk is considered low
- the predominantly high saline to hyper saline groundwater, dominance of shallow rooted vegetation within the proposal study and depth to groundwater, the potential increase in salinity resulting from groundwater level rise or mounding would have a negligible to low risk on the beneficial use of the aquifers.

In accordance with controls provided by a construction and environment management plan (CEMP), groundwater mitigation and management measures would be implemented within a soil and water sub-plan at all construction sites and this would limit the potential impact of the proposal. These would be groundwater measures which are commonly applied and well understood, with detail provided in Chapter 9. Further information on identified contaminants of potential concern are documented in the Contaminated Land Management Impact Assessment (WSP, 2020) (refer to Technical report 5).

Without appropriate management, saline groundwater can impact the durability of construction materials through degradation of cementitious foundation substrate, potential leaching into and impacting the surrounding groundwater quality. The impact would be related to the rate of corrosion and surface area of the impacted material. Considering the dimension of piling (1.2 metre diameter), a low risk to localised groundwater quality exists without the implementation of mitigation measures.

5.3 SENSITIVE RECEPTORS

5.3.1 EXISTING USERS (REGISTERED BORES)

Three registered bores (GW088272, GW500139 and GW600168) within the groundwater study area were identified as sensitive receptors. Two of the bores were registered for household water supply (GW088272 and GW500139, located approximately 150 metres and 900 metres from the proposal study area, respectively) and one for irrigation (GW600168, located approximately two kilometres from the proposal study area). Considering their location and distance from the proposal study area and transmission line corridor, the risk of impacts from the construction phase of the proposal is considered low.

The risk of impact to the remaining registered bores located within the groundwater study area, but outside the proposal study area, being able to continue functioning for their registered purpose (monitoring) is considered negligible.

Three registered bores (GW088454-nested, GW087531 and GW600452) exist within the proposal study area, with GW088454 located in the transmission line corridor and may exist as a single bore or as two bores in proximity. Although not deemed a sensitive receptor, given they are registered for use as monitoring, they may accidently be damaged or be required to be removed for construction of the proposal. Damage may accidently occur through direct impact to the bores, such as being hit by plant equipment, or indirectly, such as damaged caused to the bores casing by induced vibrations from plant equipment. These bores should have their condition assessed prior to construction and if they are unable to remain or have been damaged at completion of the construction phase, the bores are to be replaced, and if necessary, relocated, subject to consultation with the registered owner.

5.3.2 GROUNDWATER DEPENDENT ECOSYSTEMS

No high priority GDEs were identified within the recently superseded water sharing plans for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011 and Lower Murray Darling Unregulated and Alluvial Water Sources 2011. Publicly available location (GIS) data, including information on high priority GDEs, is currently unavailable for the new water sharing plans that were enacted on 1 July 2020. Therefore, an assessment of low, medium and high potential GDEs identified in the NGIS database (BOM, 2020b) has been undertaken.

The majority of the identified high potential GDEs are located within the floodplains of the Great Darling Anabranch, Darling River and Murray River and within approximately three kilometres east of the Darling River floodplain. Potential impacts could relate to lowering groundwater levels or, decreasing water quality through the pathways identified in sections 5.1 and 5.2. The impact of potential declining groundwater levels to identified high potential GDEs are considered low for the same reasons outlined in sections 5.1.1 and 5.1.3. The impact to high potential GDEs resulting from declining groundwater quality from the pathways outlined in 5.2 is considered low.

Groundwater dependent ecosystems, particularly high priority GDEs, and the potential impacts will be reassessed following the release of the GIS data pertaining to GDEs in the Darling Alluvial Groundwater Sources 2020 and NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020 water sharing plans. This will be undertaken during detailed design, or if available sooner, during the submission report.

5.3.2.1 RAMSAR WETLAND RIVERLAND

No RAMSAR wetlands were identified in NSW within 25 kilometres of the proposal. However, the Riverland RAMSAR wetland is located within SA, approximately 3.5 kilometres southwest of the proposal study area. Considering the key or potential groundwater threats (altered groundwater regime and salinity) to the wetland, the distance from the proposal study area, the depth to groundwater within the proposal study area between the SA border and Lake Victoria (anticipated to be between 20 metres to 30 metres below ground level, refer to section 4.7.6) and no anticipated groundwater take, it is considered that any groundwater impacts on this wetland would be negligible.

5.3.3 CONNECTED SURFACE WATER AND GROUNDWATER SYSTEMS

Potential groundwater mounding due to construction of the proposal located near fresh surface water features connected to groundwater systems, such as the Darling River and Lake Victoria, may cause saline groundwater intrusion into freshwater lenses within the alluvial sediments. This could be further exasperated by the removal of vegetations that would utilise rainfall, increasing recharge to the groundwater system. This could potentially impact the surrounding water quality within these aquifers and the surface water feature through increased salinity. As stated in section 5.1.3, the impact to groundwater level changes due to compaction and mounding is considered low risk, and thus the risk of saline intrusion is also considered low.

5.4 SUMMARY OF POTENTIAL CONSTRUCTION IMPACTS

During construction, the potential impacts to groundwater are likely to be temporary, localised and negligible to low. A summary of potential construction impacts and their significance is provided in Table 5.2.

Table 5.2 Summary of potential impacts during construction of the proposal

POTENTIAL IMPACT	SUMMARY OF POTENTIAL IMPACTS DURING CONSTRUCTION	SIGNIFICANCE OF POTENTIAL IMPACT
Groundwater levels	Groundwater level drawdown due to groundwater take, including reducing the groundwater available for identified sensitive receptors.	Low
	Groundwater level increase due to aquifer compaction.	Low
	Groundwater level increase due to removal of vegetation.	Low
	Groundwater level decrease due to reduced recharge from the placement of impermeable layers at ground surface.	Low
Groundwater quality	Potential increase in groundwater salinity through groundwater mounding, or groundwater level rise, resulting from compaction of the underlying sediments or removal of vegetation.	Low
	Potential migration of introduced contaminants from construction activities into the groundwater aquifers.	Low
	Potential change in beneficial use category of groundwater resources.	Negligible to low
	Degradation of construction materials impacting groundwater quality.	Low
Existing user (Registered bores)	Bores GW088454 (nested), GW087531 and GW600452 unable to be used for their intended function (monitoring). Restricted for access or damaged by construction works.	Low
GDEs	Groundwater level drawdown due to groundwater take or mounding, reducing the groundwater available for GDEs[1].	Low
	Changes to groundwater quality resulting from saline groundwater intrusion or introduced contaminants from construction activities.	Low
RAMSAR wetland Riverland	Changes to groundwater quality or groundwater levels	Negligible
Connected surface water and groundwater systems	Changes to groundwater quality resulting from saline groundwater intrusion.	Negligible to low

(1) It is anticipated that there will be no change in the potential impacts or low risk rating currently assigned to GDE's following the review.

6 ASSESSMENT OF OPERATIONAL IMPACTS

6.1 IMPACTS TO GROUNDWATER LEVELS

Potential risk to groundwater levels during the operation of the proposal would include groundwater mounding resulting from compaction of the aquifers and removal of vegetation. While some access tracks and the temporary construction camps would be removed and areas rehabilitated, the aquifers may remain impacted.

In the long-term, the consequence of these works may present potential risk by causing groundwater levels to increase on the up-gradient side (relative to groundwater flow direction) and decrease down-gradient of the groundwater mound, causing a 'groundwater shadow', in response to a decrease in permeability of the underlying aquifer. The magnitude of these effects depends on the local hydraulic gradients. The reduction of groundwater levels could reduce groundwater contributions to adjacent groundwater and surface water features within an impact zone of influence. In addition, groundwater level may rise in areas where vegetation has been cleared during the construction phase. However, groundwater level impacts due to mounding and vegetation removal to groundwater levels, flow and resources is considered low for the same reasons outlined in section 5.1. The rehabilitation of the majority of areas impacted during construction will further limit the impact associated with groundwater mounding and vegetation removal.

During the operation of the proposal, groundwater levels may also be impacted through changing the natural pervious land surface into impermeable layers such as concrete pavement, that can reduce infiltration of rainfall and surface water recharge to the underlying aquifer. This potential impact could result in the lowering of groundwater levels and would be greatest at the transmission line structures and the Buronga substation. However, the proposed impervious areas are small relative to the local catchment area and the net impact on regional recharge and groundwater levels is low.

No groundwater take is required during the operation of the proposal.

6.2 IMPACTS TO GROUNDWATER QUALITY

The operation of the proposal has the potential to degrade the water quality of the aquifers underlying and down gradient of the proposal footprint. The operational activities that may impact water quality are related to maintenance activities along the transmission lines and at transmission line structures. However, these potential impacts would be minor and localised, and provided correct operational procedures and safeguards are implemented, the residual likelihood of impacts would be low.

New impervious areas at the Buronga Substation may result in the mobilisation of underlying salts and migration of contaminants to the aquifers through increased runoff volumes and speed. Provided adequate drainage systems are implemented to collect and discharge surface waters appropriately, the potential risk to groundwater quality is low from this component of the proposal. Further information regarding impacts to water quality and mitigation measures due to increased runoff volumes and speed are discussed in Technical paper 6 Hydrology, flooding and water quality (WSP, 2020a).

Without appropriate management, saline groundwater can impact the durability of construction materials through degradation of cementitious foundation substrate, potential leaching into and impacting the surrounding groundwater quality. The impact would be related to the rate of corrosion and surface area of the impacted material and likely eventuate during the operation of the proposal. Considering the dimension of piling (estimated at 1.2 metre in diameter), a low risk to localised groundwater quality exists without the implementation of mitigation measures.

6.3 SENSITIVE RECEPTORS

6.3.1 REGISTERED BORES

Three registered bores (GW088272, GW500139 and GW600168) are within the groundwater study area and were identified as sensitive receptors. These sensitive receptors are outside the proposal study area and with no groundwater take required for the operation of the proposal, the risk of impact to the registered bores groundwater quality and groundwater levels is considered negligible.

Although not deemed sensitive users, three registered bores, two within the proposal study area (GW087531 and GW600452) and GW088454 (nested) located within the transmission line corridor, would be expected to be able to remain in the easement during the operation of the proposal (assuming they were not destroyed or removed during construction). No impact to the bores intended function (monitoring) is anticipated as access would be maintained. If the bore was damaged or access obstructed, make good arrangements would apply.

6.3.2 GROUNDWATER DEPENDENT ECOSYSTEMS

For the same reasons as given in section 5.3.2, GDEs, particularly high priority GDEs, and the potential impacts will be reassessed following the release of the GIS data pertaining to GDEs in the Darling Alluvial Groundwater Sources 2020 and NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020 water sharing plans. This will be undertaken during detailed design, or if available sooner, during the submission report. The potential impacts to identified high potential GDEs noted in the NGIS database (BOM, 2020b) relate to lower groundwater levels or, decreasing water quality through the pathways identified in sections 6.1 and 6.2. However, the risk is considered low due to the reasons outlined within the same sections.

6.3.3 RIVERLAND RAMSAR WETLAND

Considering the potential impacts discussed in sections 6.1 and 6.2 and the assessment in section 5.3.2.1, groundwater impacts on this wetland are considered negligible.

6.3.4 CONNECTED SURFACE WATER AND GROUNDWATER SYSTEMS

Whilst the potential impact to fresh groundwater systems connected to surface water features could continue during the operation of the proposal, the risk is considered negligible to low for the same reasons as provided in section 5.3.3. The risk is further limited by rehabilitation of areas that were impacted during construction of the proposal.

6.4 SUMMARY OF POTENTIAL OPERATIONAL IMPACTS

A summary of potential proposal operational impacts and their significance is provided in Table 6.1.

Table 6.1 Summary of potential impacts during operation of the proposal

POTENTIAL IMPACT	SUMMARY OF POTENTIAL IMPACTS DURING OPERATION	SIGNIFICANCE OF POTENTIAL IMPACT
Groundwater levels	Changes to groundwater levels (increase and/or decrease) resulting from groundwater mounding or vegetation removal during the construction phase.	Low
	Groundwater level decrease due to reduced recharge from the placement of impermeable layers at ground surface.	Low
Groundwater quality	Changes to groundwater quality due to operation of the substation.	Low
	Changes to groundwater quality from maintenance and operational activities of the transmission lines and towers.	Low
Registered bores	Bores GW088454 (nested), GW087531 and GW600452 unable to be used for their intended function (monitoring).	Low
GDEs	Groundwater level drawdown due to groundwater take or mounding, reducing the groundwater available for GDEs.	Low
	Changes to groundwater quality resulting from saline groundwater intrusion.	Low
Riverland RAMSAR wetland	Changes to groundwater quality or groundwater levels.	Negligible
Connected surface water and groundwater systems	Changes to groundwater quality resulting from saline groundwater intrusion.	Negligible to low

7 MINIMAL IMPACT CONSIDERATIONS

Aquifer interference approvals under the *Water Management Act 2000* have yet to commence. However, the aquifer interference policy is used to guide proponents and DPIE in assessing aquifer interference activities.

As stated in section 2.1, the Aquifer Interference Policy includes minimal impact considerations for assessing the impacts of all aquifer interference activities. NSW groundwater sources need to be categorised as being either highly productive or less productive, based on the general character of the water source meeting or not meeting the criteria of 1,500 mg/L total dissolved solids and a bore yield rate of greater than 5 L/s. This categorisation applies to a whole groundwater source as it is defined in a water sharing plan, not to the specific groundwater conditions at a specific location. In the groundwater study area, the categorisation is as follows:

- Highly productive – Darling Alluvial Groundwater Sources. The water sharing plan encompasses the alluvial sediments along the Darling River and corresponds to the unconfined alluvial aquifers associated with surface water features described in section 4.7.1. The water source is considered as highly productive given the water quality is expected to be fresh, with an EC of around 500 microsiemens per centimetre. Although there is limited information on groundwater yield, a conservative approach has been applied to the classification of this groundwater source as a highly productive alluvial groundwater source that is highly connected to surface water sources.
- Less productive – NSW Murray Darling Basin Porous Rock Groundwater Source. Groundwater covered within this water sharing plan includes the remaining unconfined, semiconfined and confined aquifers outlined in section 4.7.1 and section 4.7.2. These groundwater sources are categorised as less productive porous rock and not highly connected to surface water sources. The groundwater sources have also previously been recognised as having low sustainability risk ratings for socio-economic and environmental risk (NSW Office of Water, 2012c).

An assessment of the proposals impacts from the potential changes in groundwater levels and quality on GDEs, beneficial use category, water supply works (i.e. registered bores), highly connected surface water source and culturally significant sites is provided in Table 7.1 and Table 7.2.

Table 7.1 Aquifer Interference Policy minimal impact consideration for a 'less productive porous rock aquifer'

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water table	1. Less than or equal to ten per cent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any: — high priority groundwater dependent ecosystem; or — high priority culturally significant site. Listed in the schedule of the relevant water sharing plan. A maximum of a two metres decline cumulatively at any water supply work.	There is a low risk of the proposal causing groundwater level change. Any potential change would be minimal due to the expected groundwater depth and selection of appropriate construction methodologies. No groundwater take is anticipated for construction or operation of the proposal. The Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources 2011 does not list any high priority culturally significant groundwater sites. A review against currently assessed locations and their impacts to culturally significant groundwater sites against the water sharing plan for the Murray-Darling Basin Porous Rock Groundwater Sources 2020 would need to be undertaken when GIS data becomes publicly available. The Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources 2011 has not identified any high priority GDEs within the groundwater resource. A review against currently assessed locations and their impacts to GDEs identified in the Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources 2020 would need to be undertaken when GIS data becomes publicly available.
	2. If more than ten percent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any: — high priority groundwater dependent ecosystem; or — high priority culturally significant site. Listed in the schedule of the relevant water sharing plan then appropriate studies will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than two metres decline cumulatively at any water supply work then make good provisions would apply.	Refer to Item 1 response that indicates this condition is not triggered.

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water pressure	3. A cumulative pressure head decline of not more than a two metres decline, at any water supply work.	Pressure heads are not anticipated to be lowered (or raised) due to the expected depth of the confined aquifers in the groundwater study area and selection of appropriate construction methodologies. No groundwater take is anticipated for construction or operation of the proposal.
	If the predicted pressure head decline is greater than Requirement 3 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Refer to Item 3 responses that indicates this condition is not triggered.
Water quality	4. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Groundwater within the groundwater source is highly saline and has a limited beneficial use classification. Any potential impact to groundwater is not expected to result in significant change in water quality that results in lowering the beneficial use category beyond 40 metres from the activity.
	If condition 1. is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Refer to Item 4 response that indicates this condition is not triggered.

Table 7.2 Aquifer Interference Policy minimal impact consideration for a 'highly productive alluvial aquifer'

	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water table	1. Less than or equal to ten per cent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any: — high priority groundwater dependent ecosystem; or — high priority culturally significant site — listed in the schedule of the relevant water sharing plan; or A maximum of a two metres decline cumulatively at any water supply work.	There is a low risk of the proposal causing groundwater level change. Any potential change would be minimal due to the expected groundwater depth and selection of appropriate construction methodologies. No groundwater take is anticipated for construction or operation of the proposal. No high priority GDEs or high priority cultural significant site was identified within the proposal study area in the recently superseded Water Sharing Plan for the Lower Murray – Darling Unregulated and Alluvial Water Sources 2011. A review against currently assessed locations and their impacts for cultural significant sites and high priority GDEs would need to be undertaken when GIS data for the Water Sharing Plan for the Darling Alluvial Groundwater Sources 2020 becomes publicly available.
	if more than ten percent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any: — high priority groundwater dependent ecosystem; or — high priority culturally significant site; — listed in the schedule of the relevant water sharing plan then appropriate studies will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than two metres decline cumulatively at any water supply work then make good provisions would apply.	Refer to item 1 responses that indicates this condition is not triggered.

	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water pressure	2. A cumulative pressure head decline of not more than forty percent of the "post-water sharing plan" pressure head above the base of the water source to a maximum of a 2 metres decline, at any water supply work.	N/A – the assessed highly productive aquifer is not a confined system.
	If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Refer to item 1 responses that indicates this condition is not triggered.
Water quality	3. (a) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity; and (b) No increase of more than one per cent per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a "reliable water supply" is not an appropriate mitigation measure to meet considerations 1.(a) and 1.(b) above. (c) No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source- whichever is the lesser distance) of a highly connected surface water source that is defined as a "reliable water supply". (d) Not more than ten per cent cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 metres laterally from the top of high bank and 100 metres vertically beneath a highly connect surface water source that is defined as a "reliable water supply".	There is a low risk that the proposal will lower the beneficial use of the groundwater quality due to the expected depth to the water table and selection of appropriate construction methodologies. The proposal is not anticipated to have a negative impact to highly connected surface water sources (the Darling River or Lake Victoria) with regards to increasing salinity. Increasing groundwater levels or altering groundwater flow direction leading to mobilisation of salts is the primary factor for increasing salinity within the Darling (and Murray) Rivers. The proposal has a low risk of causing changes to groundwater flow direction as no groundwater take is anticipated during construction or operation of the proposal. There is also a low risk of increasing groundwater levels due to relatively small compaction footprint, small magnitude (shallow depth of the compaction halo) of the rise and effect of compaction-related changes to subsurface hydraulic conductivity. Therefore, there is a low risk to changes in salinity from groundwater impacting highly connected surface water features. The proposal is not a mining activity.

	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
	If condition 1.(a) is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works. If condition 1.(b) or 1.(d) are not met then appropriate studies are required to demonstrate to the Minister's satisfaction that the River Condition Index category of the highly connected surface water source will not be reduced at the nearest point to the activity. If condition 1.(c) or 1.(d) are not met, then appropriate studies are required to demonstrate to the Minister's satisfaction that: — there will be negligible river bank or high wall instability risks — during the activity's operation and post-closure, levee banks and landform design should prevent Probable Maximum Flood from entering the activity's site; and — low-permeability barriers between the site and the highly connected surface water source will be appropriately designed, installed and maintained to ensure their long-term effectiveness at minimising interaction between saline groundwater and the highly connected surface water supply.	Refer to item 1 responses that indicates this condition is not triggered.

The assessment of the proposals impacts on aquifers and GDEs in regard to the minimal impact considerations of the NSW Aquifer Interference Policy indicates the proposal complies with Level 1 criteria, which considers the potential impacts as acceptable. Further assessment of the GDEs when information is available, was also noted, as stated above.

7.1 LICENSING REQUIREMENTS

Water trading license requirements are outlined within the relevant water sharing plans (refer to section 2.3.1).

Water supply for construction is to be sourced from existing infrastructure and within existing water allocations, licencing and approvals.

Groundwater take is not expected to occur during the construction or operation of the proposal. Shallow earthworks, for the majority of the proposal, would be less than two metres deep, and as such, groundwater is unlikely to be intercepted. Where groundwater may be encountered, design and construction methodology will be adopted in order to avoid groundwater inflows. Piling for foundation/footing construction of transmission line structures will generally be up to 25 metres below ground level and would be undertaken through either bored pile using boring (tremie pipe), driven steel pile or helical screw anchor. These piling methods do not extract groundwater.

Potential groundwater extraction is anticipated to not result in more than 3 megalitres per water year per groundwater source, and therefore no additional licensing or approvals are required.

8 CUMULATIVE IMPACT

Cumulative impact assessment means the consideration of other nearby development projects along with the proposal. Projects with the potential for cumulative impacts with the proposal were identified through a review of publicly available information and environmental impact assessments from the following databases:

- NSW Major Projects website (NSW Government, searched June 2020)
- Wentworth Shire Council website (Wentworth Shire Council, searched June 2020)
- Australian Government – Department of Environment and Energy, EPBC Public notices list (Australian Government, searched June 2020).

Three proposed developments have been identified and discussed in the following sections.

8.1 COPI MINERAL SANDS MINE

The Copi Mineral Sands development, located around 25 kilometres north of the proposed alignment, involves an open cut mineral sands mine and associated infrastructure to extract and process up to 1.5 million tonnes per annum for up to six years, transporting the heavy mineral concentrate via road for off-site processing; and progressively rehabilitating the site.

This development is in the early stages of planning, but the impacts of the project will largely be isolated from the proposal, but the preliminary environmental assessment (RRL, 2018) identified the following preliminary potential impacts to groundwater:

- drawdown of standing water levels within the Loxton-Parilla Sands, which would adversely impact on surrounding water users or groundwater dependent ecosystems
- changes to groundwater chemistry during storage prior to reinjection could result in reduced groundwater quality.

The Applicant may potentially be unable to obtain the required water access licences, or to obtain approval to reinject extracted groundwater.

Considering the preliminary development information available and the distance between the development and the proposal, the risk of cumulative impacts is considered low.

8.2 BURONGA SOLAR FARM

The Buronga solar farm development includes a 400 megawatt solar farm with energy storage and associated infrastructure located adjacent to the Buronga substation. Currently a preliminary EIS is available for referencing (Renew Estate, 2018).

Groundwater is expected to be at significant depth within both the development and proposals Buronga substation expansion, with geotechnical investigations for the proposal not encountering groundwater within 15 metres of the ground surface. The developments preliminary EIS notes a monitoring bore within the development boundary had recorded a standing water level of 30.81 metres in 2005.

Considering the depth to groundwater, no cumulative impacts are anticipated between the proposal and the development.

8.3 BURONGA – GOL GOL RESIDENTIAL EXPANSION

Wentworth Shire Council are planning new subdivisions to provide approximately 500 new large residential housing allotments in the Buronga – Gol Gol growth area, approximately 10 kilometres to the west of the proposal study area. Limited impacts to groundwater are anticipated and the cumulative impacts are considered low.

9 MITIGATION MEASURES

The proposal is anticipated to have a limited impact to groundwater, which will be further reduced with the implementation of mitigation measures outlined within the CEMP and the soil and water sub-plan.

The mitigation measures would be implemented and monitored for their effectiveness during construction. Typical provisions within the CEMP would include:

- procedures for the documentation and reporting of results related to groundwater or potential groundwater impacts
- requirements for training, inspections, corrective actions, notifications and classification of environmental incidents, record keeping and performance objectives for handover on completion of construction.

Measures and procedures to address potential impacts to groundwater would be specified in a soil and water management sub-plan. The sub-plan will set out measures to mitigate and manage groundwater impacts.

Mitigation measures to be applied for construction and operation of the proposal are presented in Table 9.1.

Table 9.1 Mitigation measures to be applied for the detailed design, construction and operation of the proposal

ID	IDENTIFIED MITIGATION MEASURE	TIMING	APPLICABLE LOCATION(S)
GW-1	A review of additional geotechnical and hydrogeology data, and any publicly available mapping of high priority GDEs as documented in the latest relevant water sharing plan, will be carried out to confirm the groundwater conditions, and: — to determine if any additional mitigation measures are required to limit and manage groundwater inflows, or impacts to groundwater dependant ecosystems (GDEs) — to confirm no or minimal impact to groundwater sources as per the minimal impact criteria listed within the Aquifer Interference Policy.	Detailed design and pre-construction.	All locations
GW-2	To limit the potential for groundwater inflows, the construction methodology for transmission line structure foundations will ensure excavations will not occur within 40 metres of the Darling River, Great Darling Anabranch or Murray River. Where groundwater may be encountered design and construction methodology will be adopted in order to avoid groundwater inflows. Depth of groundwater at transmission line structure locations will be confirmed prior to commencement of construction.	Detailed design and pre-construction.	All locations

<table>
<tr><th>ID</th><th>IDENTIFIED MITIGATION MEASURE</th><th>TIMING</th><th>APPLICABLE LOCATION(S)</th></tr>
<tr><td>GW-3</td><td>Earthworks and construction activities that result in compaction of soils will be limited where possible in areas within 40 metres of the Darling River, Murray River and Great Darling Anabranch to prevent potential impacts to groundwater.</td><td>Pre-construction and construction</td><td>Transmission line locations adjacent to the Darling River, Murray River and Great Darling Anabranch.</td></tr>
<tr><td>GW-4</td><td>Direct impacts to registered bores GW088454 (nested), GW087531 and GW600452 will be avoided, where possible. If the bores are:
— not required to be removed during construction, then they will be clearly demarcated with a 5x5 metre construction exclusion zone
— to be removed during construction or unavoidably damaged, then make good provisions would apply in consultation with the registered bore owner.</td><td>Pre-construction and construction</td><td>Registered bores GW088454 (nested), GW087531 and GW600452.</td></tr>
<tr><td>GW-5</td><td>A bore condition assessment is to be conducted prior and post construction on GW088454 (nested), GW087531 and GW600452 where required, to identify any adverse impact to the bores integrity that may have resulted during construction.
If impacts are identified, repair or replacement of the bore will be undertaken in discussion with the registered owner.</td><td>Pre-construction and construction</td><td>Registered bores GW088454 (nested), GW087531 and GW600452.</td></tr>
</table>

It is anticipated that implementation of appropriate groundwater construction management measures, as discussed above, will mitigate and minimise the impact to the underlying aquifers. As such, construction and operation of the proposal would not cause significant changes to the groundwater environment or impacts to sensitive receptors.

10 CONCLUSION

The impacts of the proposal to the groundwater environment are likely to be localised and minor. Impacts to the groundwater associated with construction are predominately associated with the following:

- potential groundwater quality degradation resulting from chemicals used during construction
- over compaction of sediments causing groundwater mounding and mobilisation of salt
- potential groundwater level decline from shallow excavations near surface water features or areas of low topography.

Groundwater take is not anticipated during the construction or operation of the proposal. Water supply for construction is to be sourced from existing infrastructure and within existing water allocations, licencing and approvals. Additional groundwater, outside of existing licencing and infrastructure has, at the time of this report, not been considered for water supply.

The primary potential impact to groundwater during the operation phase of the proposal would be related to accidental chemical spills impacting groundwater quality and the compaction of the aquifers. These impacts, if eventuated, would be expected to be localised and minor, due to the quantity of chemicals used during standard maintenance works and the area.

Mitigation and management measures have been identified to inform the design, construction and operation of the proposal. With the implementation of appropriate groundwater impact mitigation and management measures as discussed within this report, the risk for residual impacts to groundwater would be low.

The assessment of the potential impacts on aquifers and GDEs (in regard to the minimal impact considerations of the NSW Aquifer Interference Policy) was undertaken, with the predicted impacts less than the Level 1 minimal impact considerations and thus these impacts would be considered as acceptable. A reassessment of GDEs and potential impacts to GDEs will be undertaken once GIS information is available from the latest water sharing plans, during detailed design, or if available sooner, during the submission report.

11 LIMITATIONS

This Report is provided by WSP Australia Pty Limited (WSP) for TransGrid (Client) in response to specific instructions from the Client and in accordance with WSP's proposal dated September 2019 and agreement with the Client dated 31 October 2020 (Agreement).

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APPENDIX A

REGISTERED GROUNDWATER BORE SEARCH RESULTS AND INFORMATION

Table A.1 The status, purpose and construction depth of registered groundwater bores within the proposal study area (BOM, 2020b; WaterNSW, 2020a & 2020b)

BORE ID[1,2]	STATUS[3]	REGISTERED PURPOSE	CONSTRUCTION DEPTH (m)[4]	LOCATION	
				Easting	Northing
713000011[1]	Unknown	Monitoring	35	509551	6251849
GW036851	Unknown[3]	Monitoring	502	537403	6246718
GW036851	Unknown[3]	Unknown	Unknown	537403	6246718
GW036851	Unknown[3]	Unknown	Unknown	537403	6246718
GW036851	Unknown[3]	Unknown	Unknown	537403	6246718
GW036851	Unknown[3]	Unknown	Unknown	537403	6246718
GW036851[1,2]	Not listed[3]	Monitoring	83	435276	6186896
GW087123	Unknown	Monitoring	32	616730	6213917
GW087124	Unknown	Monitoring	31	618185	6214315
GW087125	Unknown	Monitoring	24	619119	6214952
GW087126	Unknown	Monitoring	7	615509	6206575
GW087127	Unknown	Monitoring	30	616887	6207232
GW087128	Unknown	Monitoring	41	618461	6207888
GW087531	Unknown	Monitoring	14	615719	6225149
GW087532	Unknown	Monitoring	13	612706	6228606
GW087533	Unknown	Monitoring	27	612364	6232451
GW087583	Unknown	Monitoring	17	593923	6255012
GW087592	Abandoned	Monitoring	36	607478	6233578
GW087594	Unknown	Monitoring	22	594673	6254588
GW087749	Unknown	Monitoring	27	537371	6246728
GW087754[1]	Unknown[3]	Unknown	No data	534263	6246770
GW087754[1,2]	Not listed[3]	Monitoring	21	534221	6245728
GW087756	Unknown[3]	Unknown	No data	525821	6246228
GW087756	Unknown[3]	Unknown	No data	525821	6246228
GW087756	Unknown[3]	Monitoring	20	525821	6246228
GW087756[2]	Not listed[3]	Monitoring	20	525821	6246228
GW088041	Unknown	Monitoring	30	617810	6210745
GW088090	Unknown	Monitoring	21	565726	6252959
GW088091	Unknown	Monitoring	5[2]	565726	6252959
GW088092	Unknown	Monitoring	4[2]	563720	6251882

BORE ID[1,2]	STATUS[3]	REGISTERED PURPOSE	CONSTRUCTION DEPTH (m)[4]	LOCATION	
				Easting	Northing
GW088094	Unknown	Monitoring	14	565761	6253049
GW088095	Unknown	Monitoring	35	565795	6253090
GW088096	Unknown	Monitoring	29	569135	6252316
GW088138[1]	Unknown	Monitoring	10	590051	6256761
GW088140[1]	Unknown	Monitoring	15	589164	6256503
GW088199[1]	In use	Monitoring	16	589854	6252940
GW088213[1]	Unknown	Monitoring	15	592051	6252369
GW088272[1]	Unknown	Household supply	6	567055	6255043
GW088454[1]	Unknown[3]	Unknown	No data	526118	6248526
GW088454[1]	Unknown[3]	Monitoring	76	526114	6248524
GW088454[1]	Unknown[3]	Unknown	No data	526114	6248524
GW500139[1]	Unknown	Household supply	12	560876	6256039
GW600152	Functioning	Monitoring	21	592325	6256584
GW600153	Functioning	Monitoring	11	591990	6256304
GW600154	Functioning	Monitoring	21	591267	6255726
GW600155	Functioning	Monitoring	10	591267	6255726
GW600156	Functioning	Monitoring	29	588935	6256696
GW600157	Functioning	Monitoring	14	588935	6256696
GW600158	Functioning	Monitoring	22	589305	6258234
GW600159	Functioning	Monitoring	17	586660	6258197
GW600168[1]	In use	Irrigation supply	38	594156	6255796
GW600449	Functioning	Monitoring	19	593623	6253661
GW600450	Functioning	Monitoring	17	593334	6251746
GW600451	Functioning	Monitoring	7	593012	6252076
GW600452	Functioning	Monitoring	21	593385	6252398
GW600464	Functioning	Monitoring	15	591252	6257061

Non-unique bore IDs listed in **bold**; *italicised* font indicates bore is part of the Lake Victoria CLPoM (MDBA, 2019b).

(1) Bore data unable to be located within WaterNSW (2020) or discrepancy between NGIS data noted.

(2) Registered bore data from WaterNSW (2020).

(3) Likely active (refer to Lake Victoria Annual Report 2018 (MDBA, 2019a)).

(4) Rounded to nearest metre.

Table A.2 Groundwater information from registered bores using inferred and available information

BORE ID	CONSTRUCTION DEPTH (m)[1]	SCREENED AQUIFER (mBGL)[2]	SCREENED INTERVAL (m)	GROUNDWATER INFORMATION[3]		
				SWL (mBMP)	SALINITY (EC)	YIELD (L/s)
713000011	35	Bore unable to be located in WaterNSW realtime viewer				
GW036851-1	Nested installation, maximum depth 502.	Loxton Parilla Sands	30-42	20.0-22.5	54,900 µs/cm	2
GW036851-2		NR	69-81	20.5-21.5	32,600 µs/cm	0.45
GW036851-3		Murray Group	200-212	10.5-15.0	35,200 µs/cm	0.50
GW036851-4		Renmark Group	323-335	11.0-15.0	71,200 µs/cm	1.50
GW036851-5		Renmark Group	484-496	11.0-11.5	104,500 µs/cm	4.0
GW087123	32	Loxton Parilla Sand	29-35	22.7-26.0	NR	NR
GW087124	31	Loxton Parilla Sand	25-27	23.7-24.4	9,600 µs/cm	NR
GW087125	24	Loxton Parilla Sand	23-24	19.8-20.5	31,000 µs/cm	NR
GW087126	7	Coonambidgal Formation	5-7	2.8-4.6	57,700 µs/cm	NR
GW087127	30	Loxton Parilla Sand	27-29	23.6-24.7	61,600 µs/cm	NR
GW087128	41	Loxton Parilla Sand	30-32	28.8-30.0	56,800 µs/cm	NR
GW087531	14	NR	10-11	9.2-11.7	55,300 µs/cm	NR
GW087532	13	Possibly perched	11-12	5.6-10.0	83,700 µs/cm	NR
GW087533	27	Loxton Parilla Sand	25-26	25.2-25.5	96,400 µs/cm	NR
GW087583	17	Coonambidgal Formation	8-9	8.4-9.9	1,370 µs/cm	NR
GW087592	36	Hole abandoned – failed to reach water				
GW087594	22	Coonambidgal Formation	15-16	14.5-15.8	3,000 µs/cm	NR
GW087749	27	Loxton Parilla Sand	27	18.6-19.9	57,800 µs/cm	NR
GW087754-1	Bore reinstalled as GW087754-2	Loxton Parilla Sand	20-21	11.7-12.7	NR	NR
GW087754-2	27	Loxton Parilla Sand	25-26	12.3-12.9	72,100 µs/cm	NR
GW087756-1	Bore reinstalled as GW087756-2	NR	19-20	16.2-17.6	NR	NR
GW087756-2	29	NR	20-21	14.9-17.5	77,100 µs/cm	NR

BORE ID	CONSTRUCTION DEPTH (m)[1]	SCREENED AQUIFER (mBGL)[2]	SCREENED INTERVAL (m)	GROUNDWATER INFORMATION[3]		
				SWL (mBMP)	SALINITY (EC)	YIELD (L/s)
GW088041	30	Loxton Parilla Sand	23-26	15.9-16.4	NR	NR
GW088090	21	Coonambidgal Formation	NR	4.3-6.4	NR	NR
GW088091	5	Coonambidgal Formation	0.0-0.0	2.8-7.2	NR	NR
GW088092	4	Coonambidgal Formation	0.0-0.0	5.4-6.1	NR	NR
GW088094	14	Coonambidgal Formation	13-14	2.5-6.4	NR	NR
GW088095	35	NR	34-35	4.0-4.6	NR	NR
GW088096	29	NR	0.0-0.0	11.7-12.4	NR	NR
GW088138	10	Coonambidgal Formation	8.0-9.0	6.6-6.9	NR	NR
GW088140	15	Coonambidgal Formation or Loxton Parilla Sands	13.0-14.0	9.1-9.3	NR	NR
GW088199	16	Coonambidgal Formation	11.5-12.5	6.9-7.4	NR	NR
GW088213	15	Coonambidgal Formation	10.7-11.7	6.6-7.6	NR	NR
GW088272	6	Coonambidgal Formation	NR	NR	930 µs/cm	NR
GW088454	76	Loxton Parilla Sands	36.0-42.0	30.7-31.3	NR	NR
GW500139	12	NR	NR	NR	2,500 µs/cm	NR
GW600152	21	Bore unable to be located in WaterNSW realtime viewer				
GW600153	11	Coonambidgal Formation	8-11	NR	NR	NR
GW600154	21	NR	15-21	NR	NR	NR
GW600155	10	Coonambidgal Formation	7-10	NR	NR	NR
GW600156	29	NR	24-29	NR	NR	NR
GW600157	14	NR	8.5-14	NR	NR	NR
GW600158	22	NR	15-22	NR	NR	NR
GW600159	17	NR	8-14	NR	NR	NR

BORE ID	CONSTRUCTION DEPTH (m)[1]	SCREENED AQUIFER (mBGL)[2]	SCREENED INTERVAL (m)	GROUNDWATER INFORMATION[3]		
				SWL (mBMP)	SALINITY (EC)	YIELD (L/s)
GW600449	19	NR	12-19	10.0	NR	NR
GW600450	17	NR	10-17	8.5	NR	NR
GW600451	7	NR	3-7	NR	NR	NR
GW600452	21	NR	16-21	10	NR	NR
GW600464	15	NR	8-15	NR	NR	NR

Nested bores listed in **bold**; *italicised* font indicates bore is part of the Lake Victoria CLPoM (MDBA, 2019b), grey font is no recorded data or insufficient information for inference.

(1) Recorded construction depth noted to have discrepancies with other recorded depth information (such as screened interval or standing water level).

(2) Where no data recorded, aquifer has been inferred.

(3) Available groundwater information from BOM (2020b) and WaterNSW (2020a & 2020b). SWL = standing water level; MBMP = metres below measuring point, L/S = litres per second; NR = no record; µs/cm = microsiemens per centimetre. All information is approximate.

Table A.3 Registered groundwater bores listed as potential sensitive users within the proposal study area

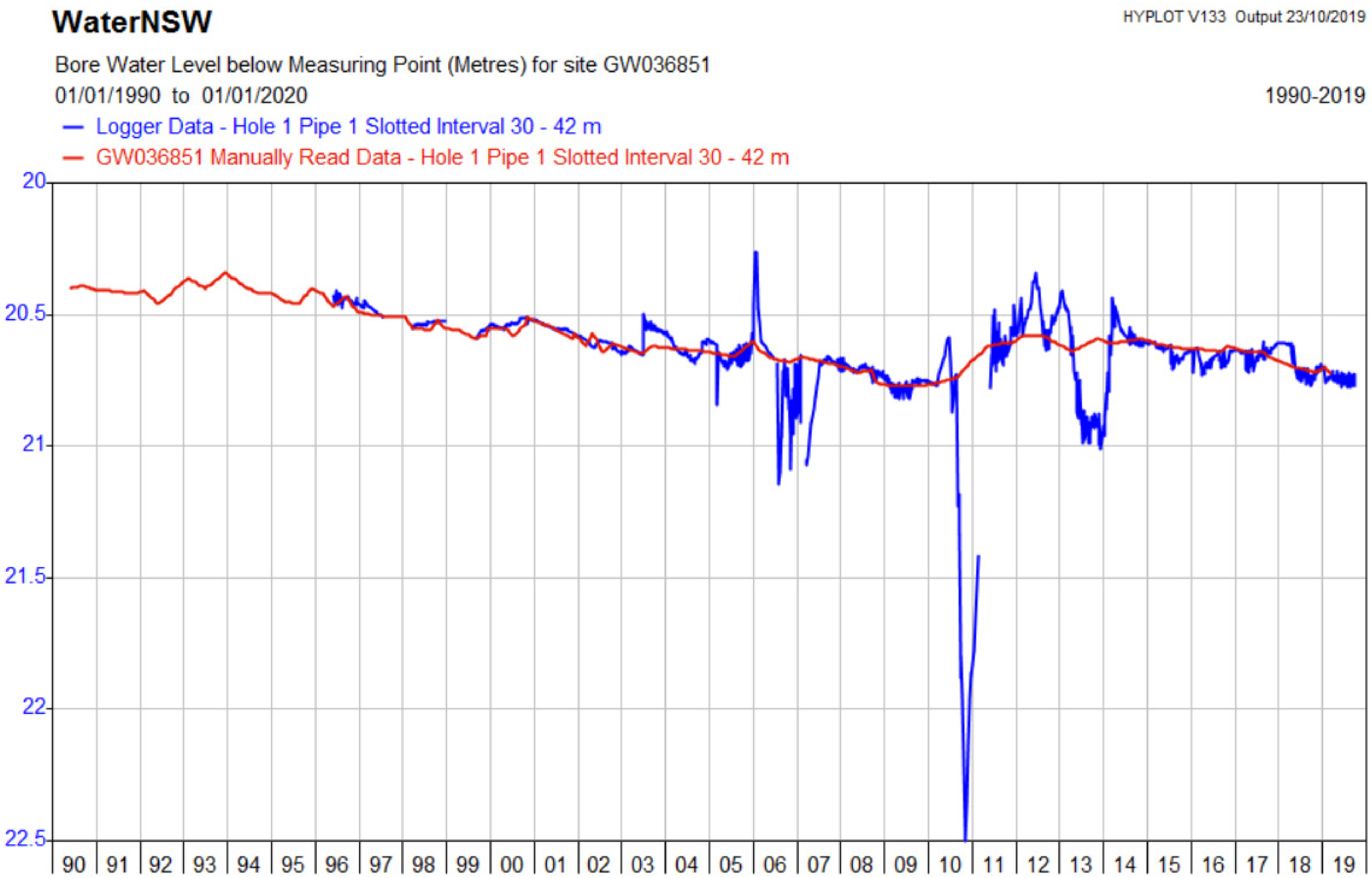
BORE ID	PURPOSE	CONSTRUCTED DEPTH (m)	STANDING WATER LEVEL (mBGL)	SCREENED HYDROGEOLOGICAL FORMATION[1]	ADDITIONAL ACCOMPANYING DATA
GW088272	Household supply	6.37	NR	Coonambidgal Formation (Quaternary alluvial)	One salinity record of 605 TDS (~930 µs/cm)
GW500139	Household supply	12	NR	NR	One salinity record of 1,628 TDS (~2,500 µS/cm)
GW600168	Irrigation supply	38	NR	Coonambidgal Formation (Quaternary alluvial) or Loxton-Parilla Sands	NR

Available groundwater information from BOM (2020b) and WaterNSW (2020a). M = metres; NR = No record.

(1) Inferred based on construction depth and anticipated hydrogeological formations.

APPENDIX B

WATERNSW PUBLISHED HYDROGRAPHS



WaterNSW
HYPLOT V133 Output 23/10/2019
Bore Water Level below Measuring Point (Metres) for site GW036851
01/01/1990 to 01/01/2020
1990-2019
Logger Data - Hole 1 Pipe 1 Slotted Interval 30 - 42 m
GW036851 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 30 - 42 m
20
20.5
21
21.5
22
22.5
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
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09
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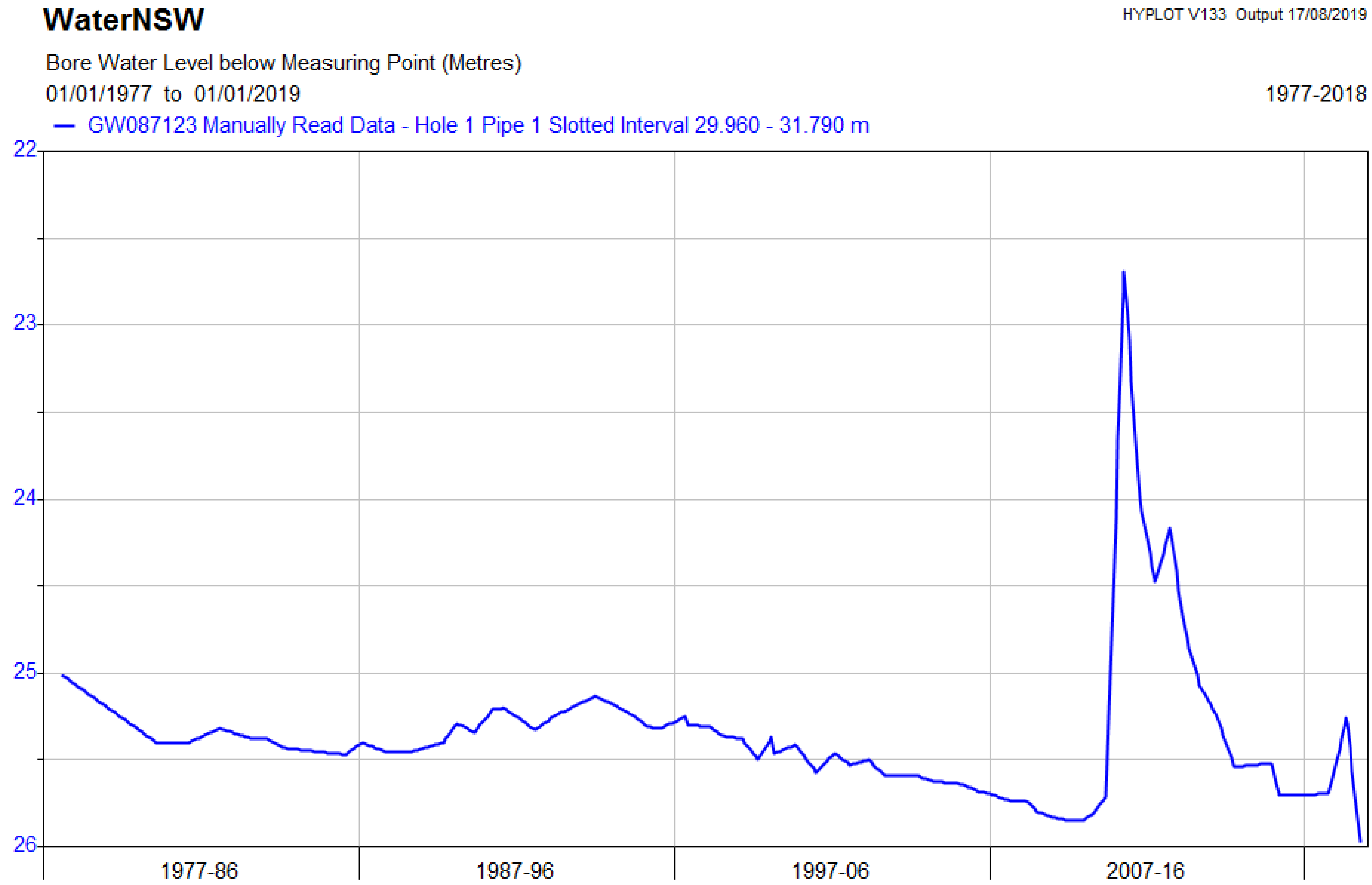
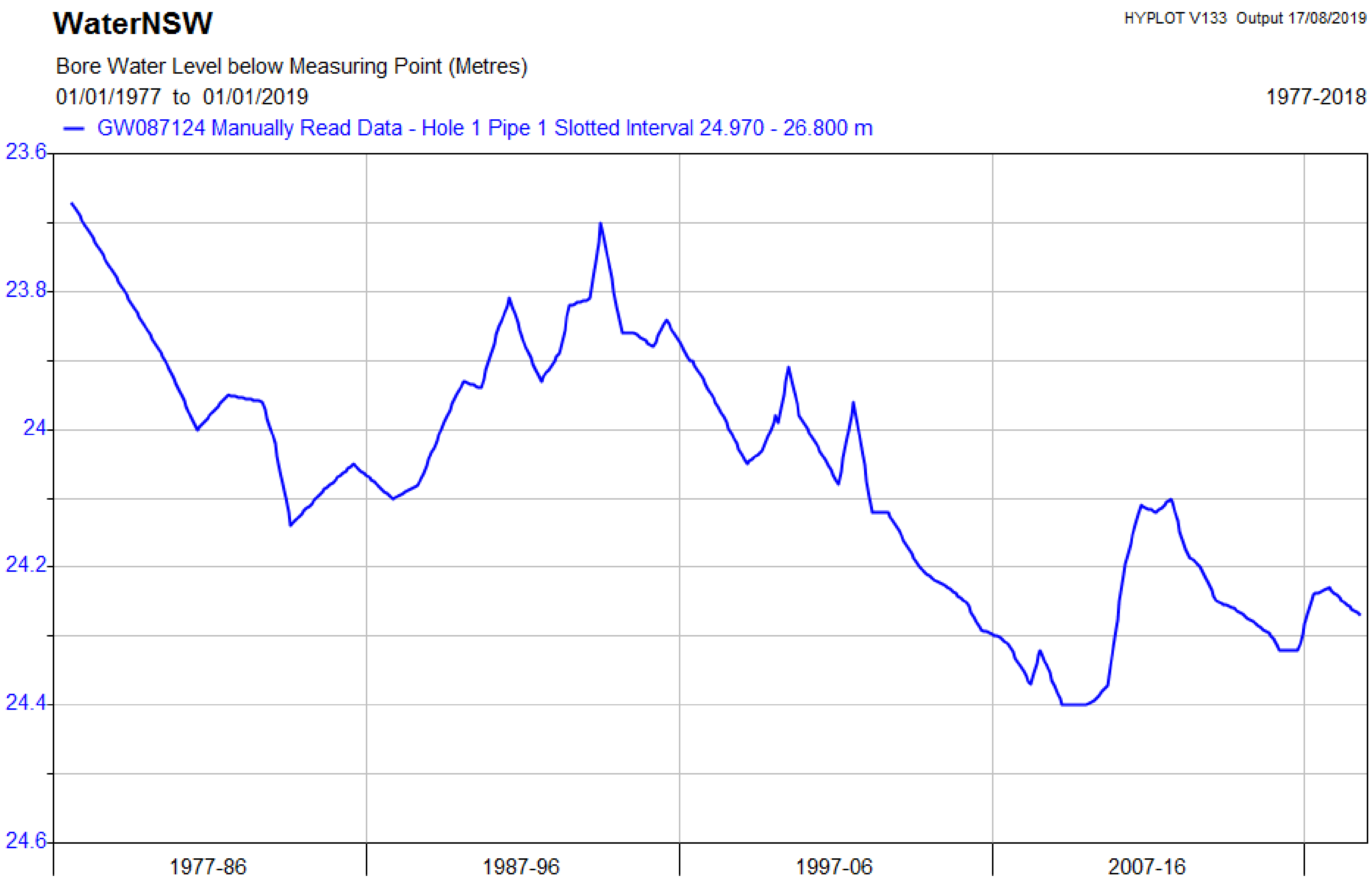
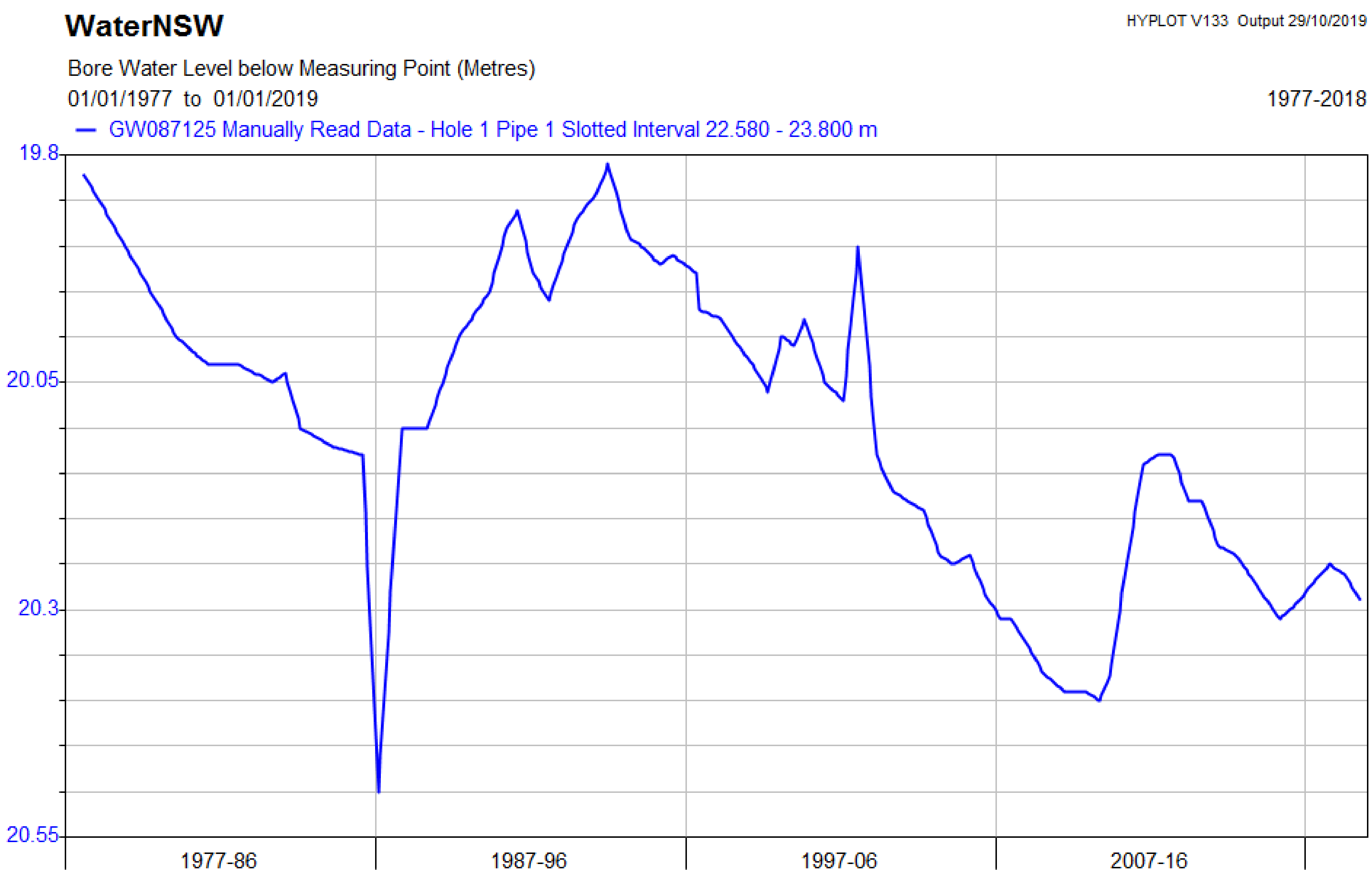
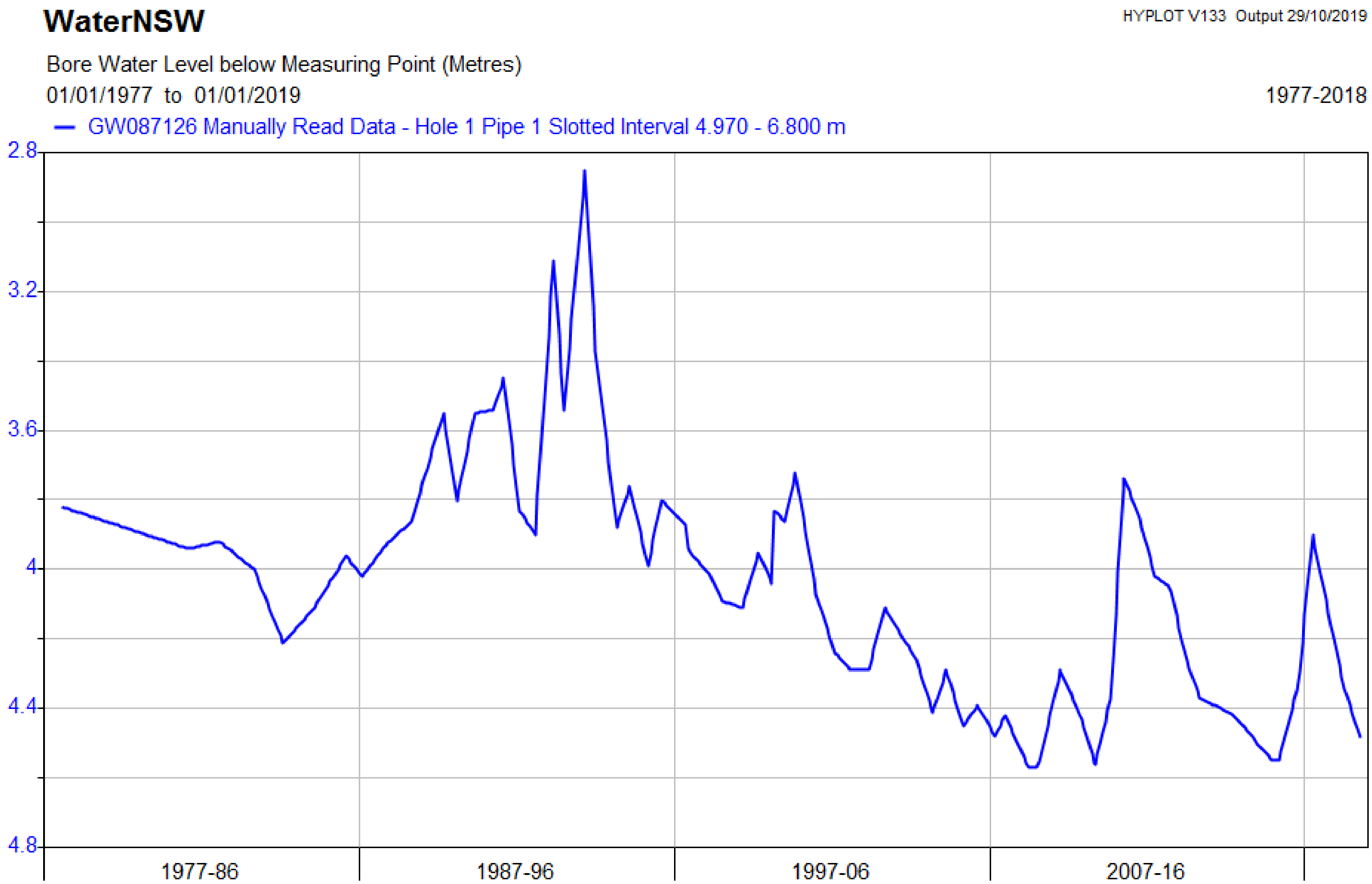
12
13
14
15
16
17
18
19

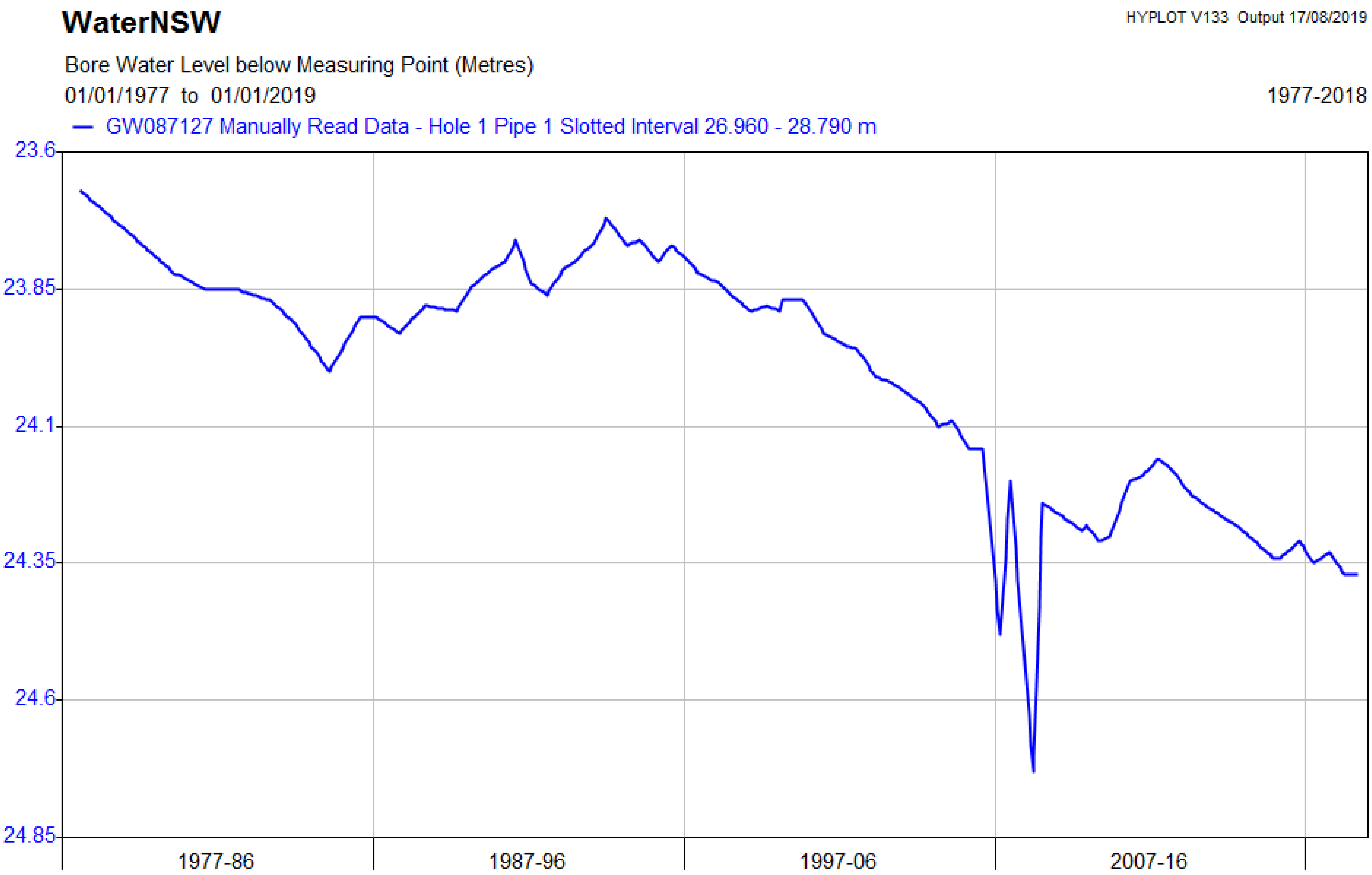


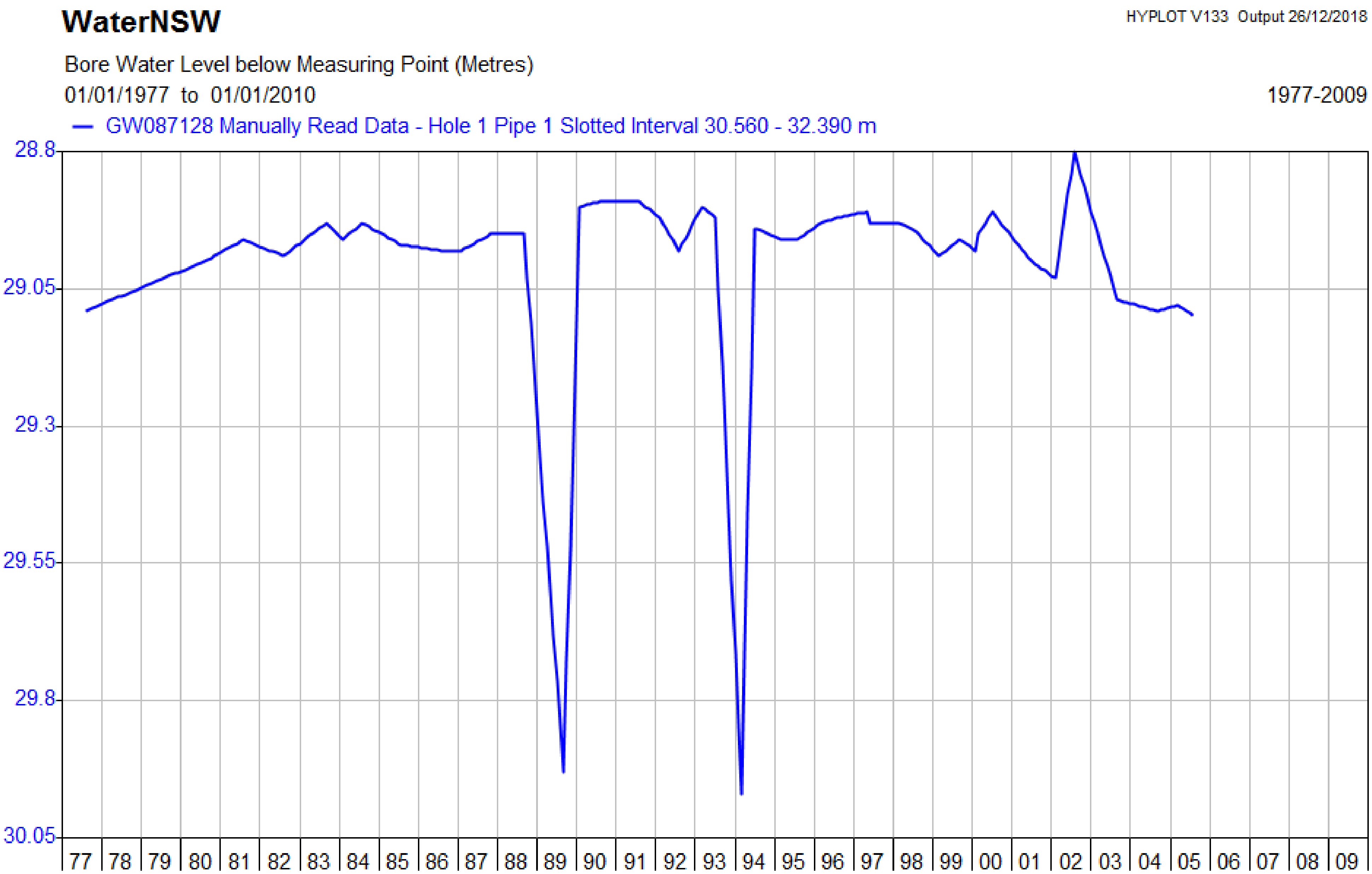
WaterNSW
HYPLOT V133 Output 17/08/2019
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2019
1977-2018
GW087123 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 29.960 - 31.790 m
22
23
24
25
26
1977-86
1987-96
1997-06
2007-16

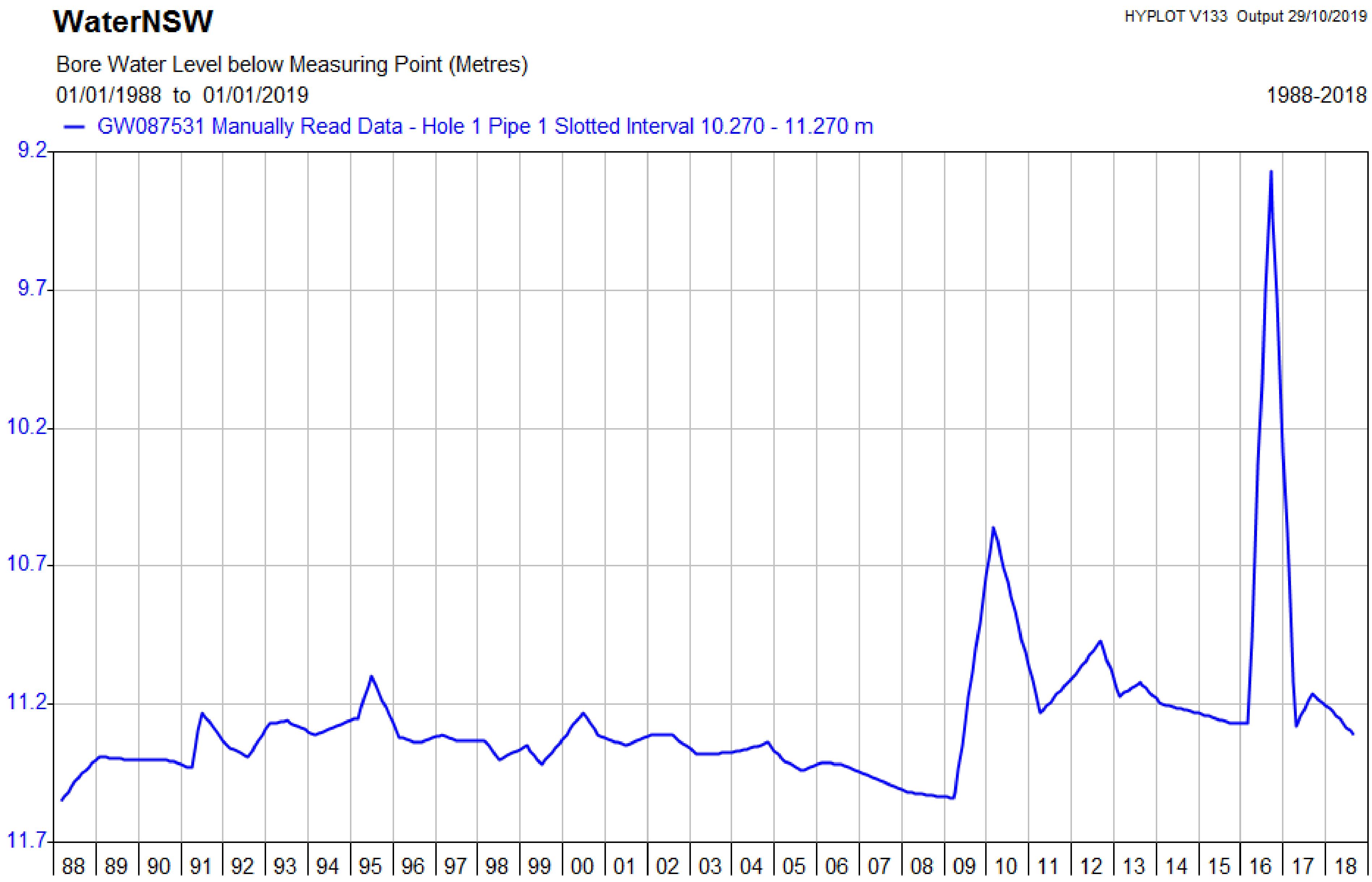

WaterNSW
HYPLOT V133 Output 17/08/2019
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2019
1977-2018
GW087124 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 24.970 - 26.800 m
23.6
23.8
24
24.2
24.4
24.6
1977-86
1987-96
1997-06
2007-16


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2019
1977-2018
GW087125 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 22.580 - 23.800 m
19.8
20.05
20.3
20.55
1977-86
1987-96
1997-06
2007-16


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2019
1977-2018
GW087126 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 4.970 - 6.800 m
2.8
3.2
3.6
4
4.4
4.8
1977-86
1987-96
1997-06
2007-16


WaterNSW
HYPLOT V133 Output 17/08/2019
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2019
1977-2018
GW087127 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 26.960 - 28.790 m
23.6
23.85
24.1
24.35
24.6
24.85
1977-86
1987-96
1997-06
2007-16


WaterNSW
HYPLOT V133 Output 26/12/2018
Bore Water Level below Measuring Point (Metres)
01/01/1977 to 01/01/2010
1977-2009
GW087128 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 30.560 - 32.390 m
28.8
29.05
29.3
29.55
29.8
30.05
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1988 to 01/01/2019
1988-2018
GW087531 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 10.270 - 11.270 m
9.2
9.7
10.2
10.7
11.2
11.7
88
89
90
91
92
93
94
95
96
97
98
99
00
01
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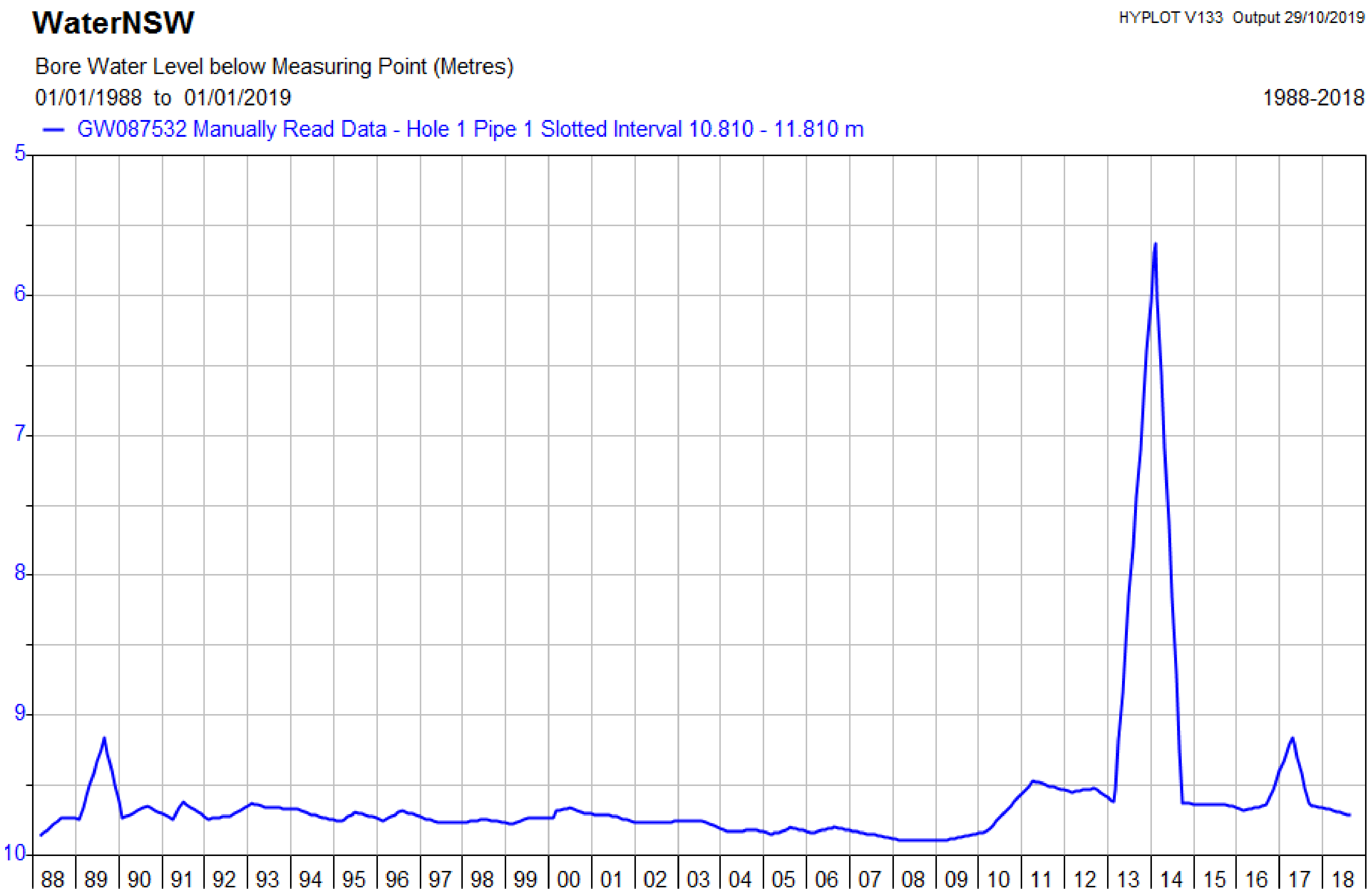
16
17
18


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1988 to 01/01/2019
1988-2018
GW087532 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 10.810 - 11.810 m
5
6
7
8
9
10
88
89
90
91
92
93
94
95
96
97
98
99
00
01
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03
04
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06
07
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09
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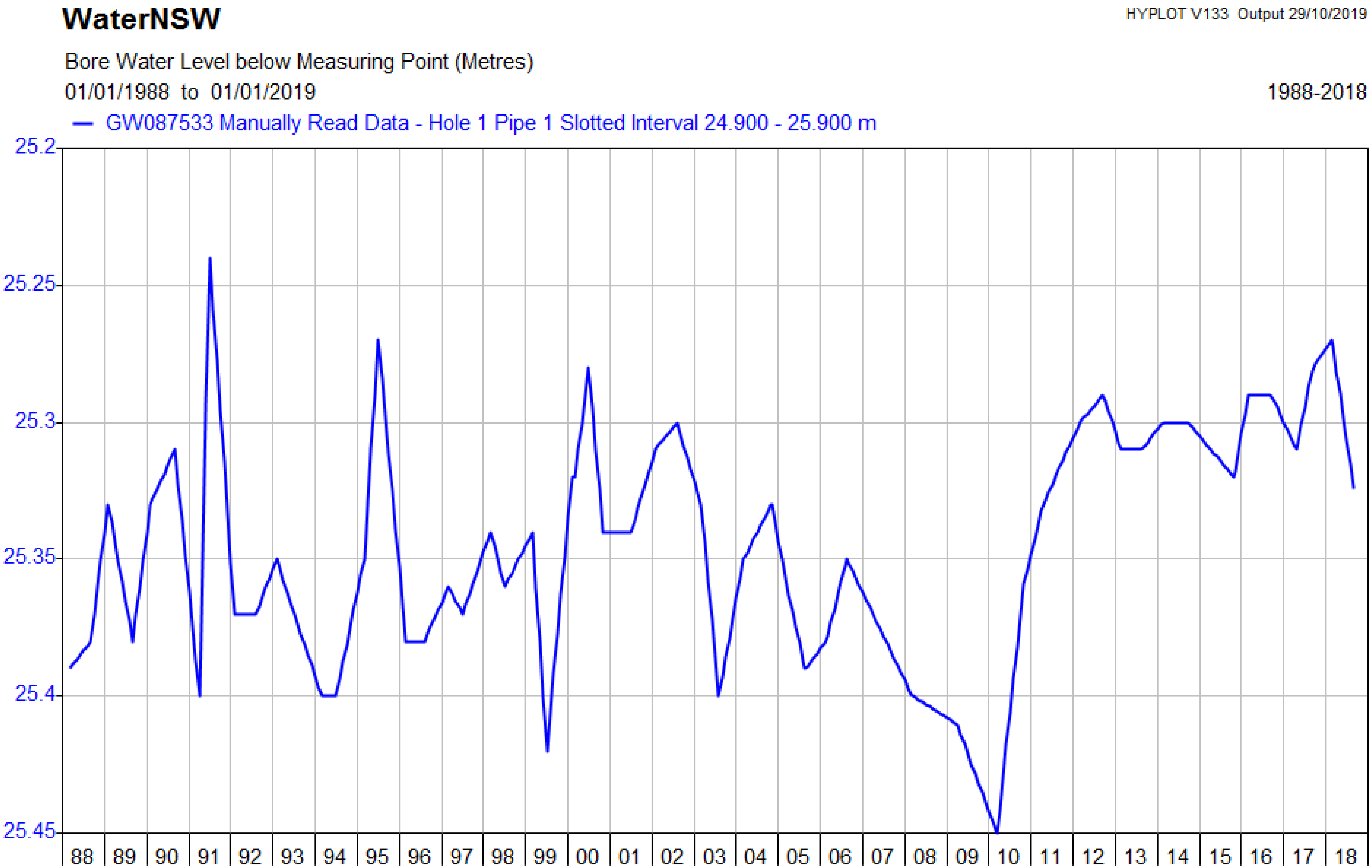
14
15
16
17
18


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1988 to 01/01/2019
1988-2018
GW087533 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 24.900 - 25.900 m
25.2
25.25
25.3
25.35
25.4
25.45
88
89
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1990 to 01/01/2019
1990-2018
GW087583 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 8.220 - 9.220 m
8
8.4
8.8
9.2
9.6
10
90
91
92
93
94
95
96
97
98
99
00
01
02
03
04
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06
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08
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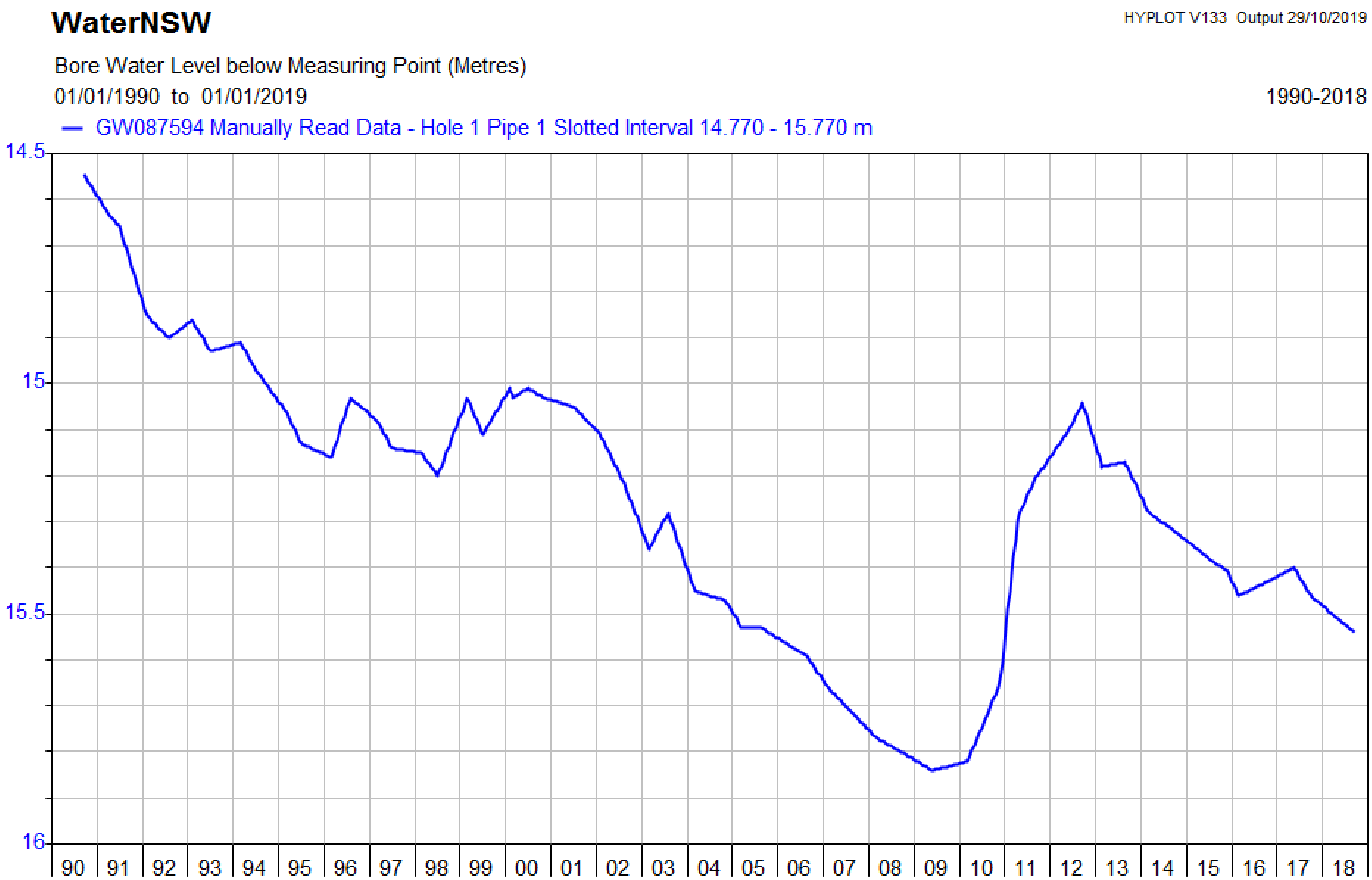
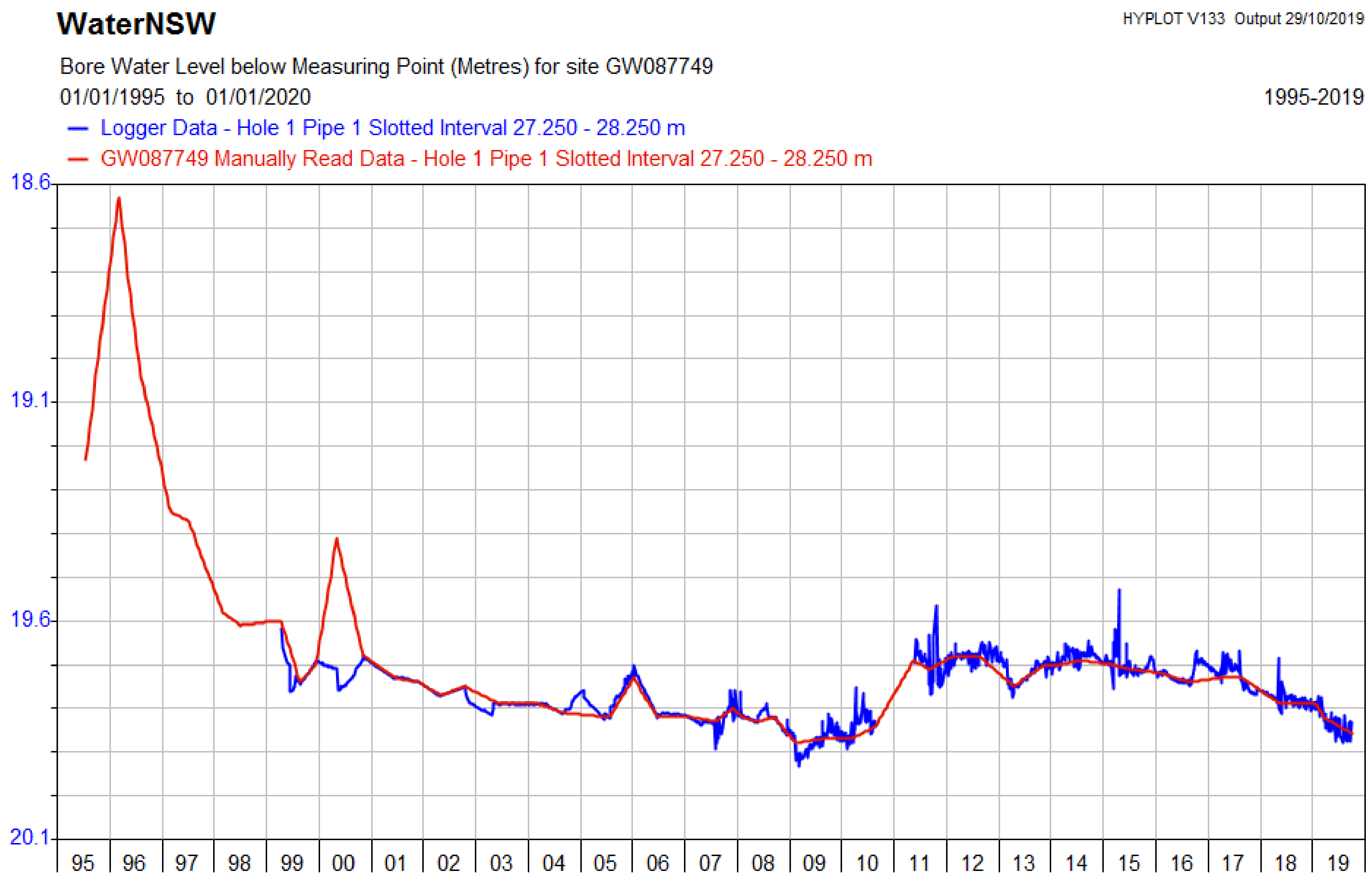
14
15
16
17
18



WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1990 to 01/01/2019
1990-2018
GW087594 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 14.770 - 15.770 m
14.5
15
15.5
16
90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18



WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres) for site GW087749
01/01/1995 to 01/01/2020
1995-2019
Logger Data - Hole 1 Pipe 1 Slotted Interval 27.250 - 28.250 m
GW087749 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 27.250 - 28.250 m
18.6
19.1
19.6
20.1
95
96
97
98
99
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
19

WaterNSW

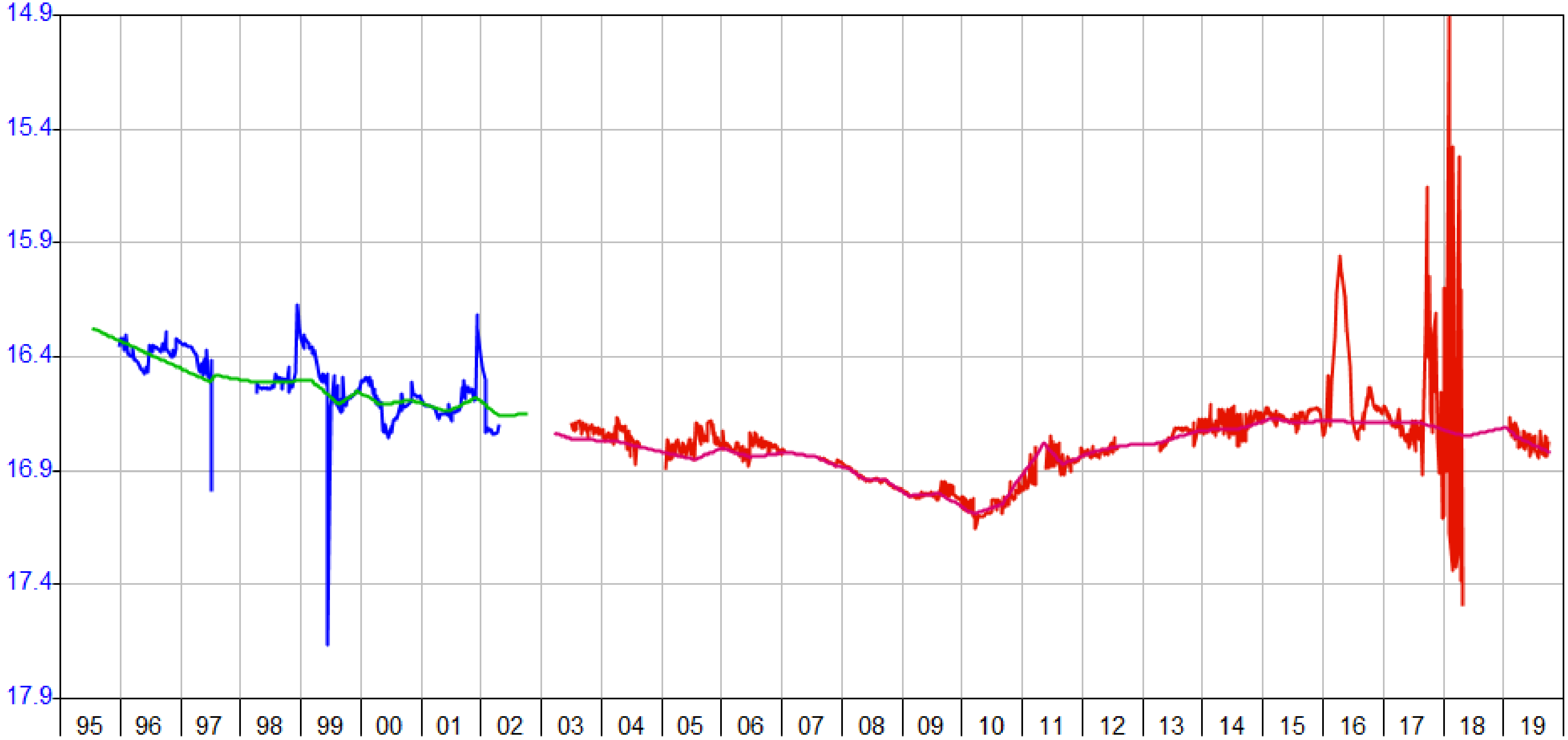
HYPLOT V133 Output 29/10/2019

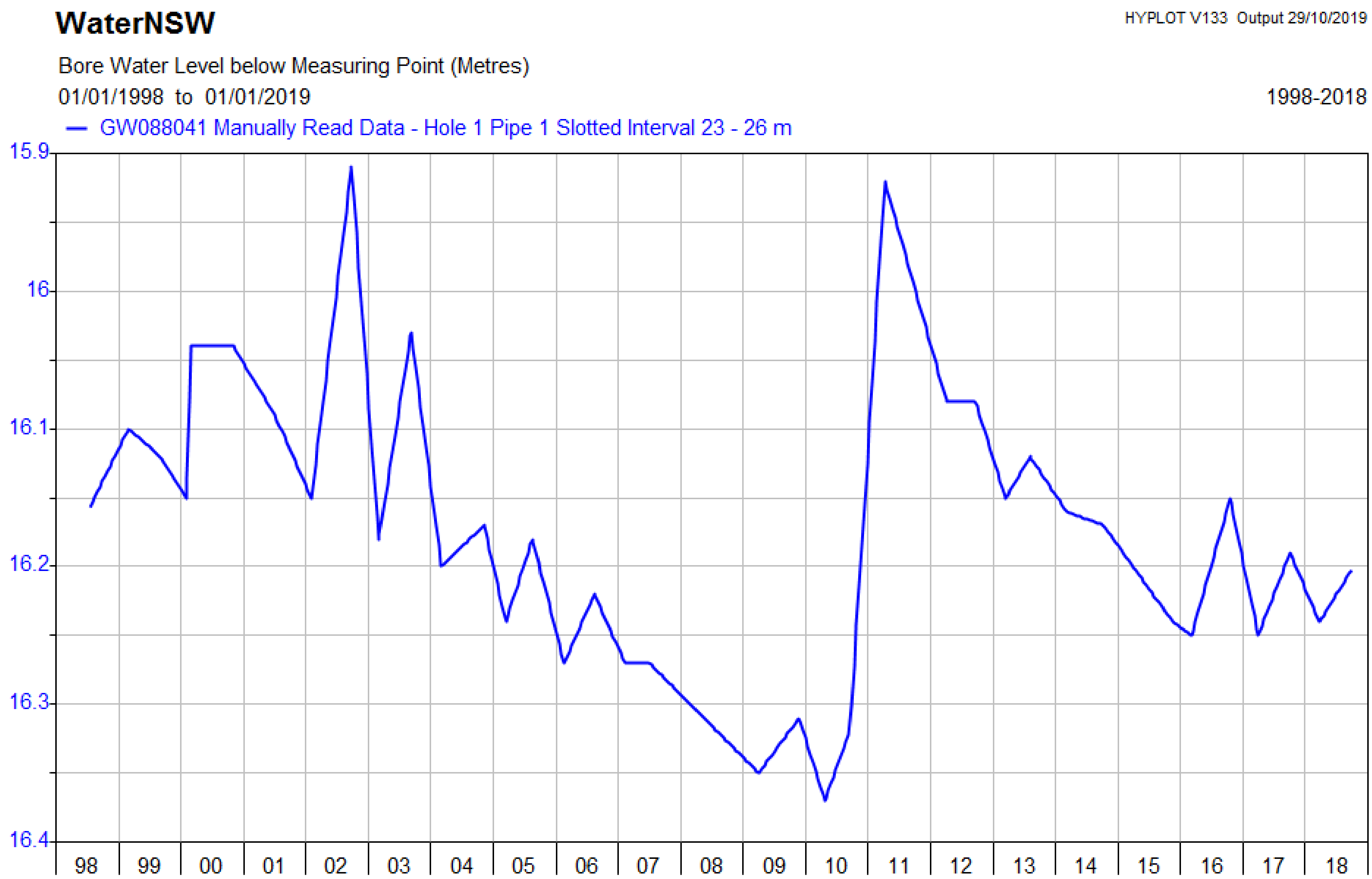
Bore Water Level below Measuring Point (Metres) for site GW087756

01/01/1995 to 01/01/2020

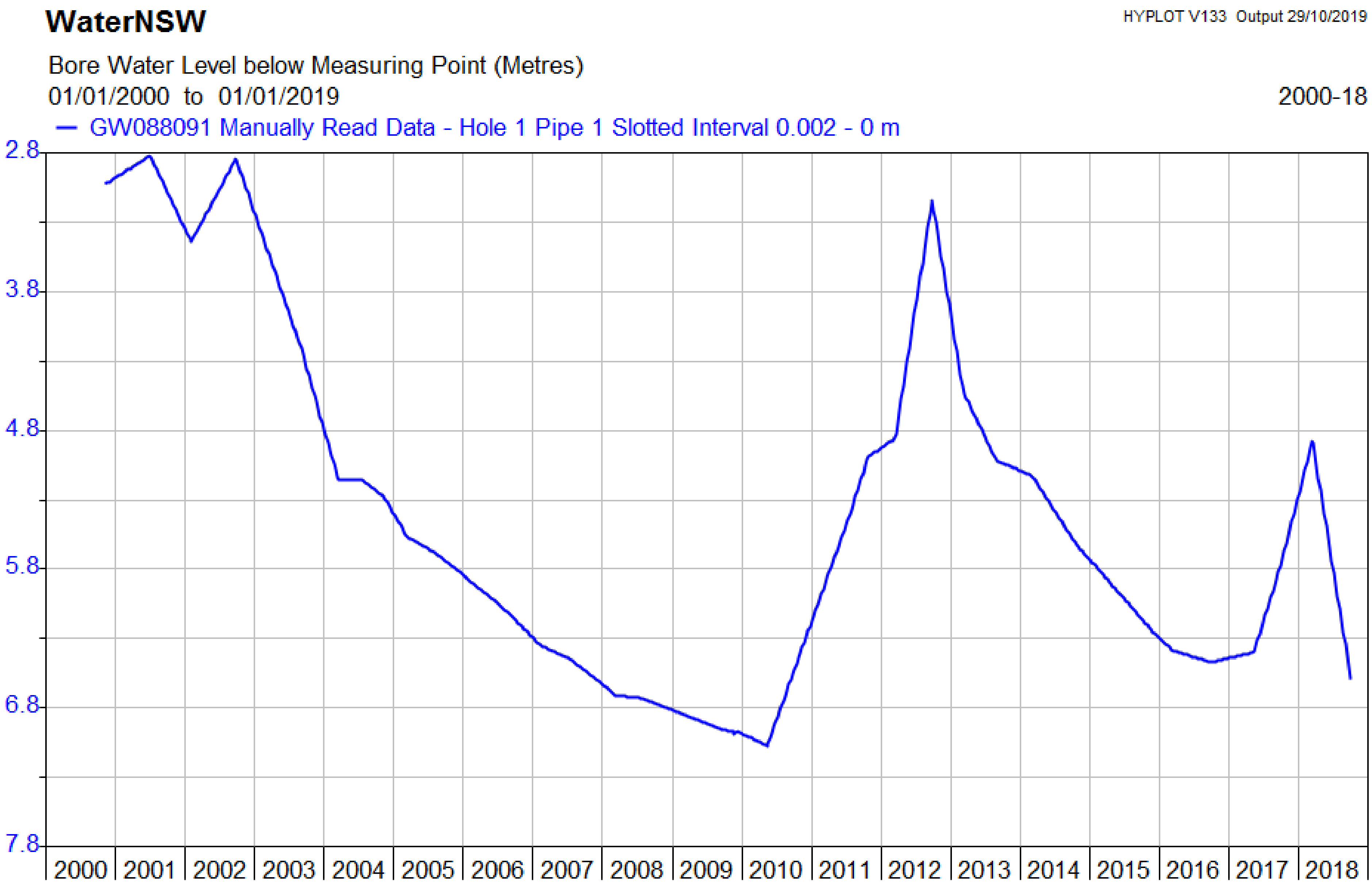
1995-2019

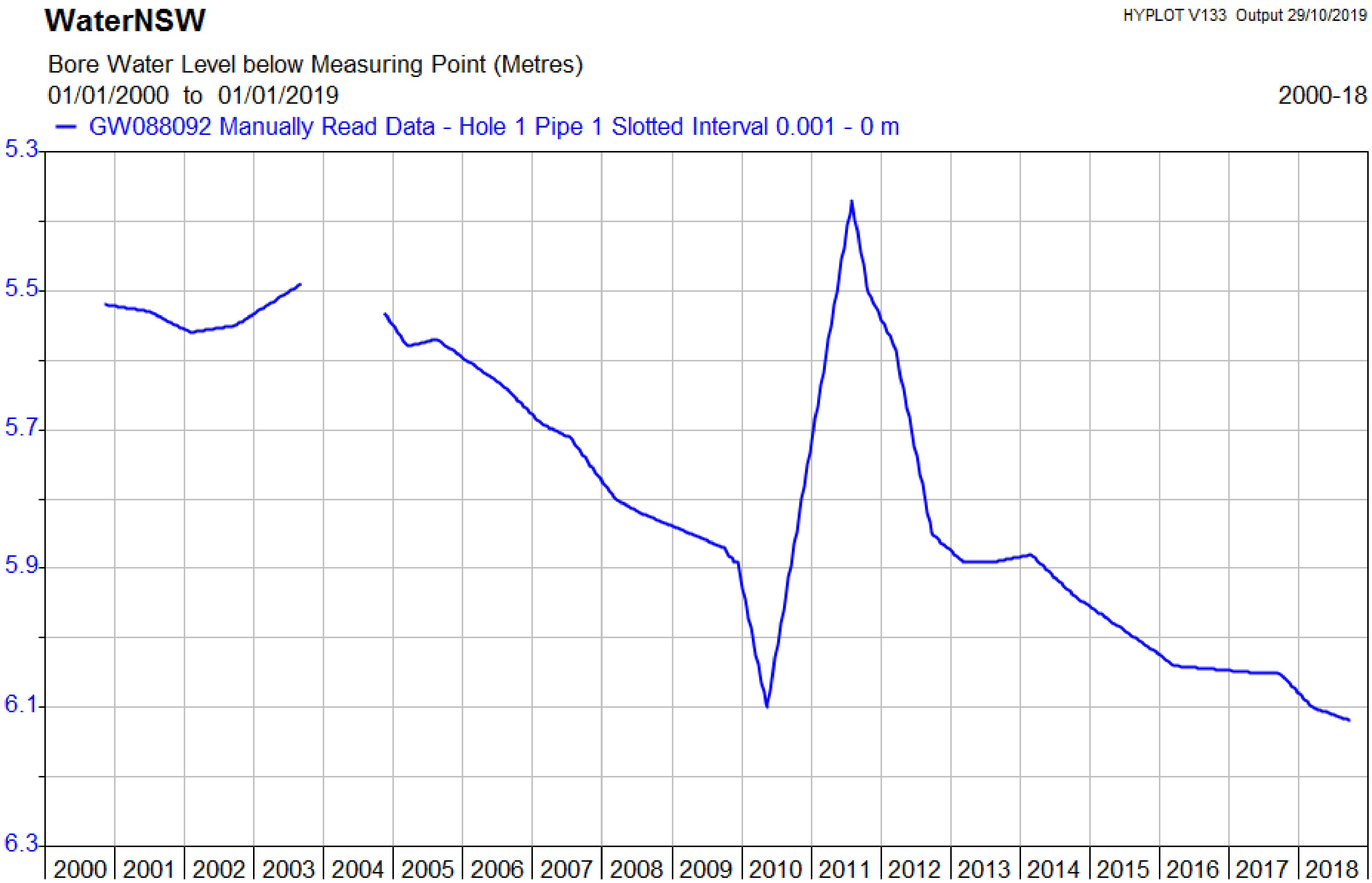
- Logger Data - Hole 1 Pipe 1 Slotted Interval 19.500 - 20 m
- Logger Data - Hole 2 Pipe 2 Slotted Interval 20 - 21 m
- GW087756 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 19.500 - 20 m
- GW087756 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 20 - 21 m

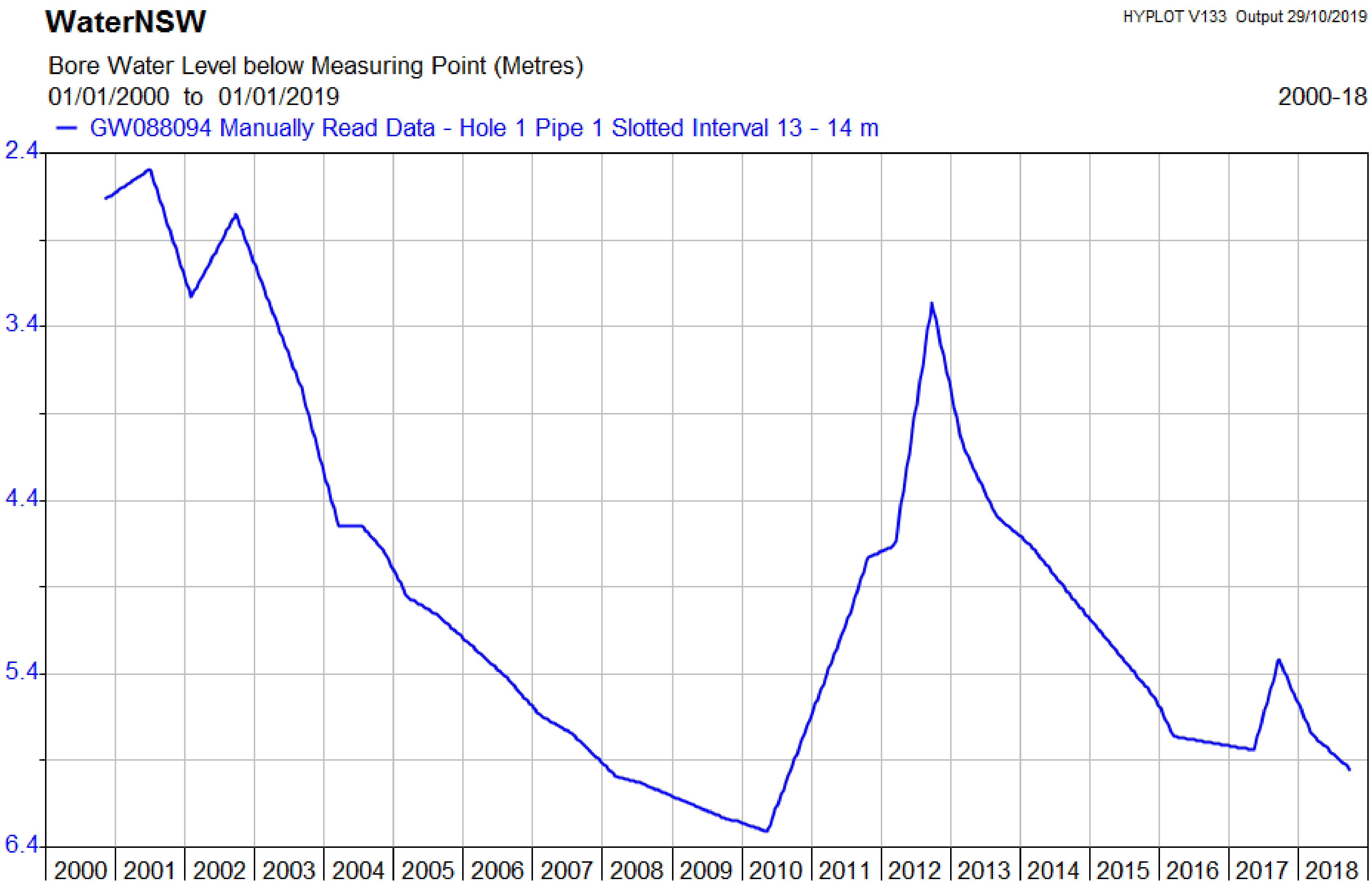


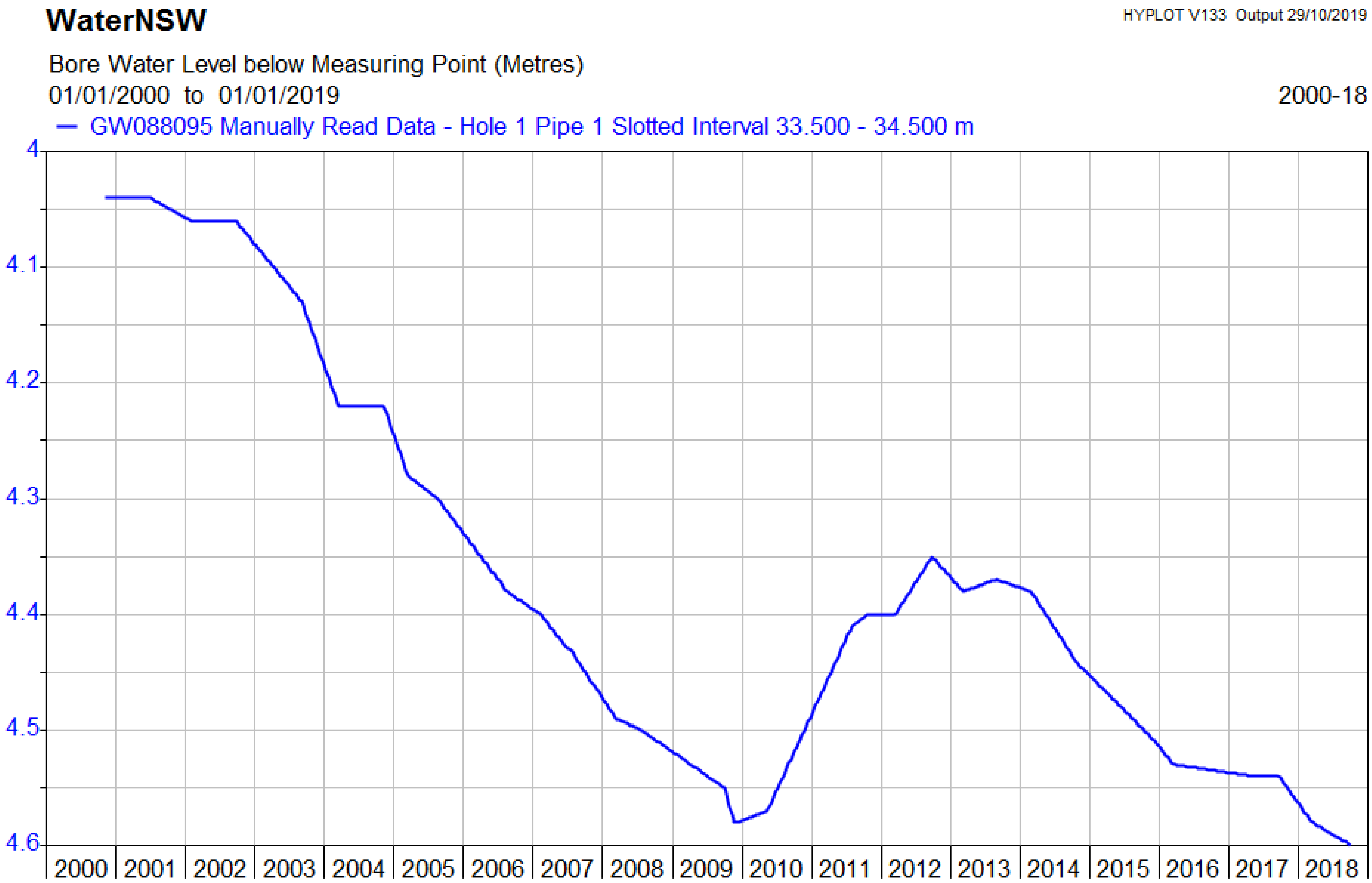


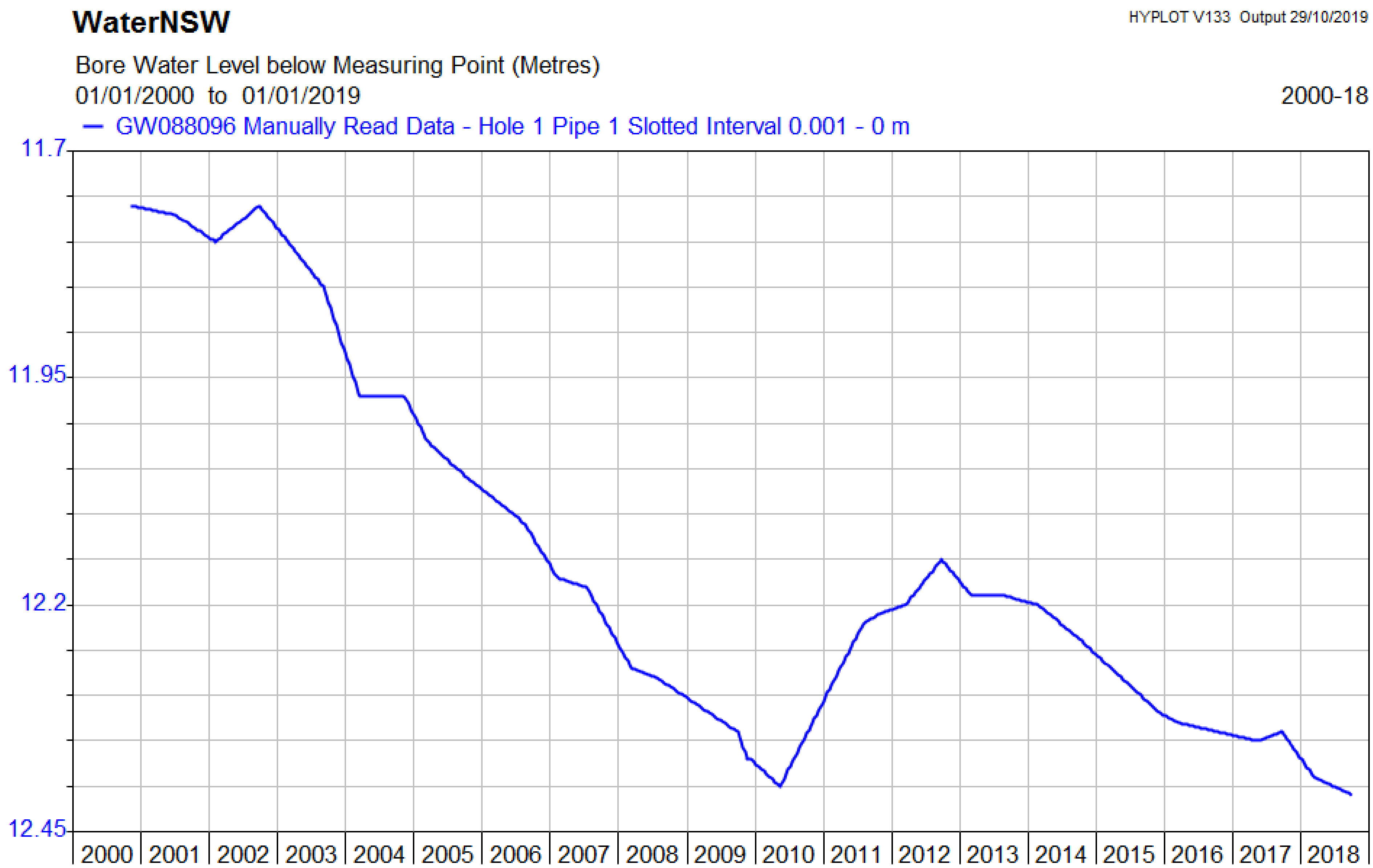
WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/1998 to 01/01/2019
1998-2018
GW088041 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 23 - 26 m
15.9
16
16.1
16.2
16.3
16.4
98
99
00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18

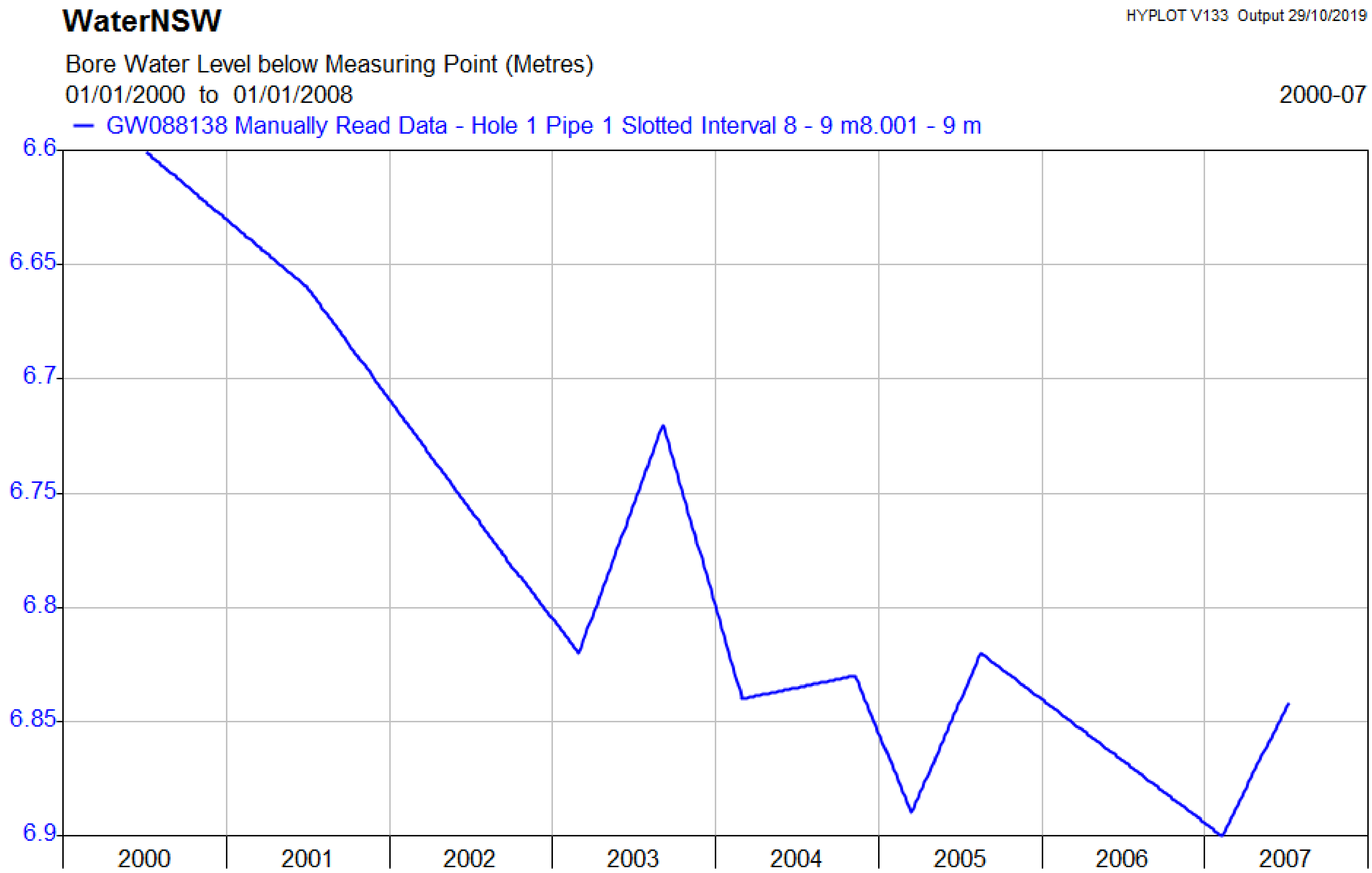

WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088091 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0.002 - 0 m
2.8
3.8
4.8
5.8
6.8
7.8
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088092 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0.001 - 0 m
5.3
5.5
5.7
5.9
6.1
6.3
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

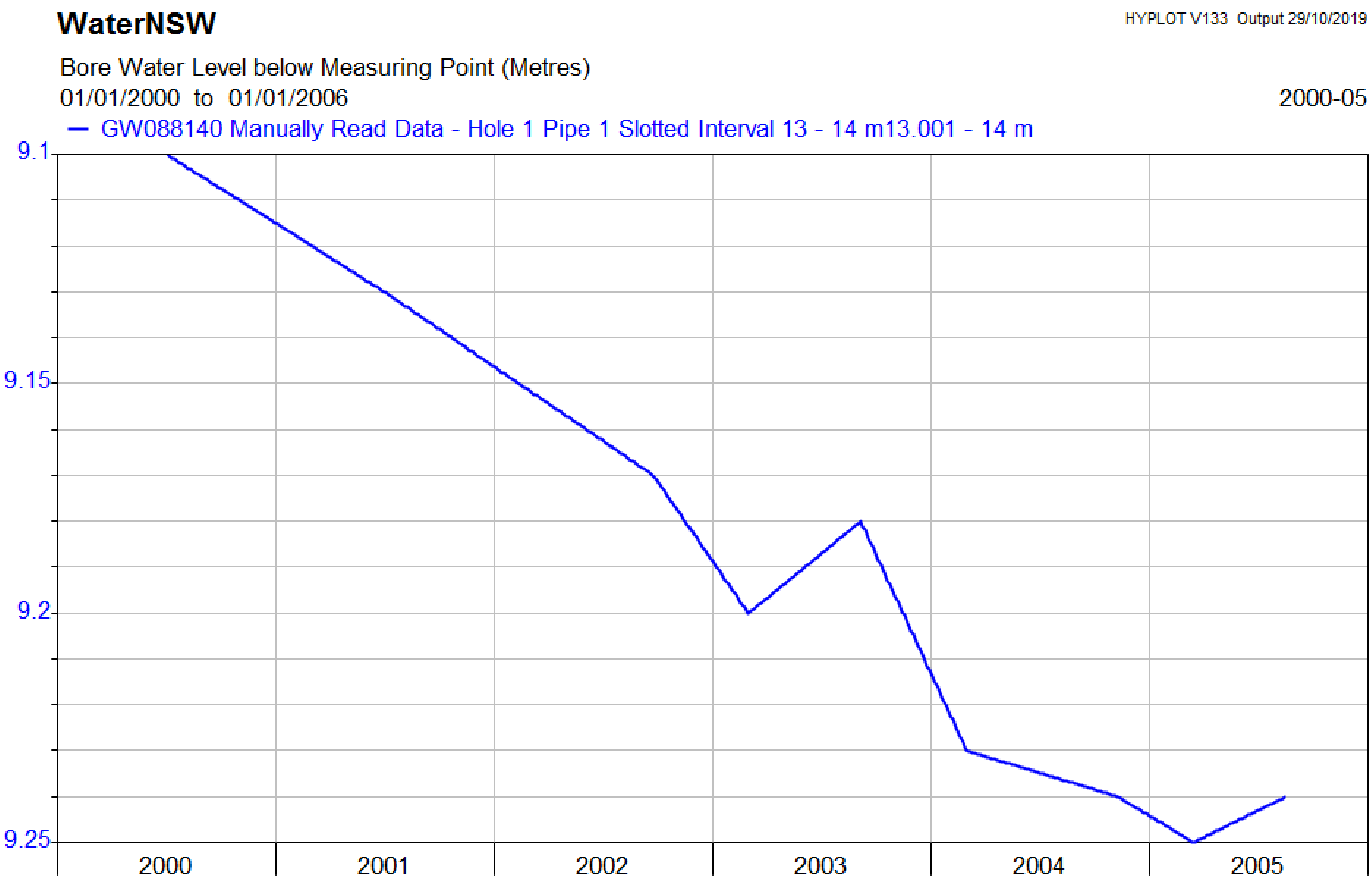

WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088094 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 13 - 14 m
2.4
3.4
4.4
5.4
6.4
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088095 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 33.500 - 34.500 m
4
4.1
4.2
4.3
4.4
4.5
4.6
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

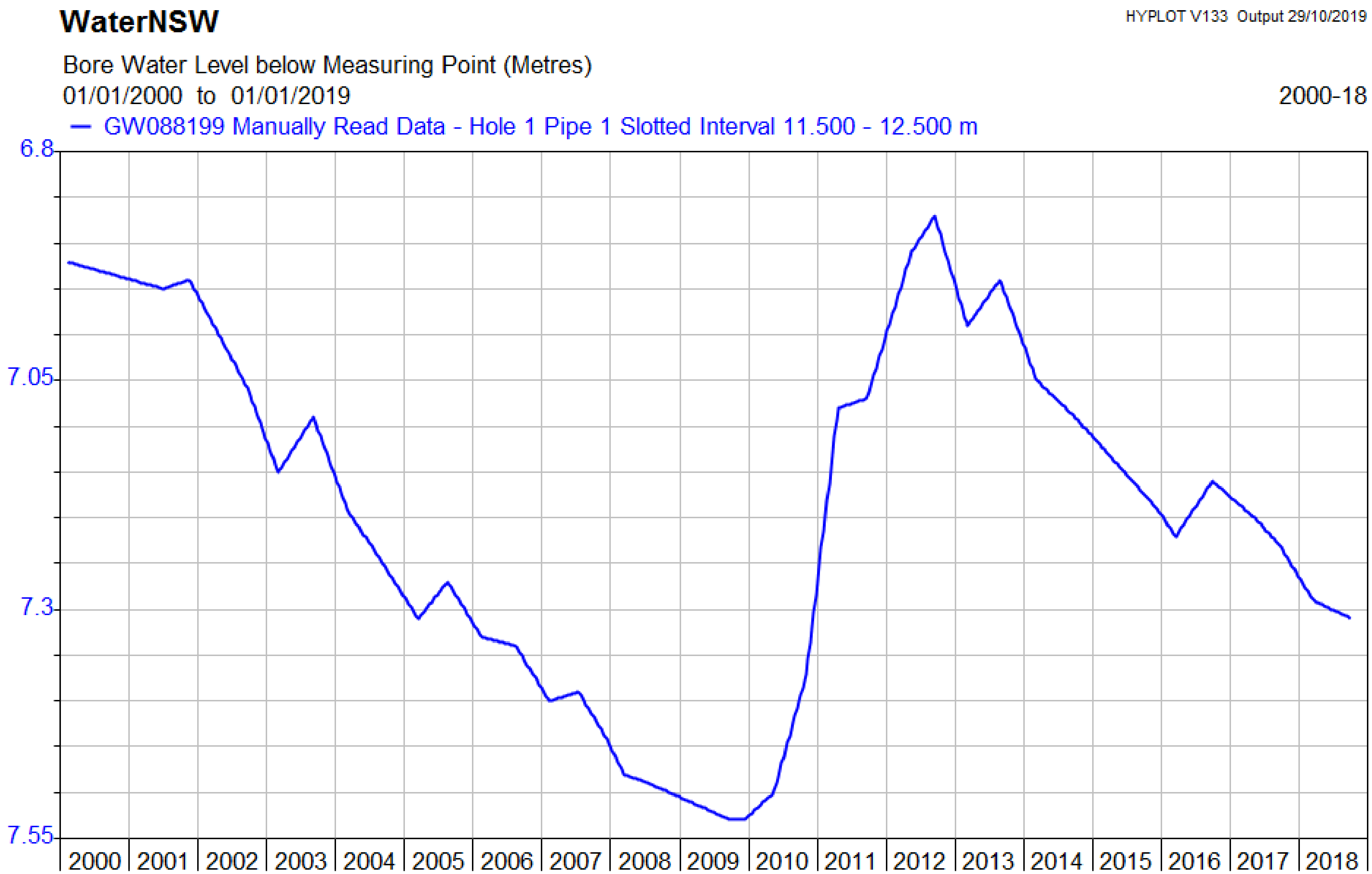

WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088096 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0.001 - 0 m
11.7
11.95
12.2
12.45
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018



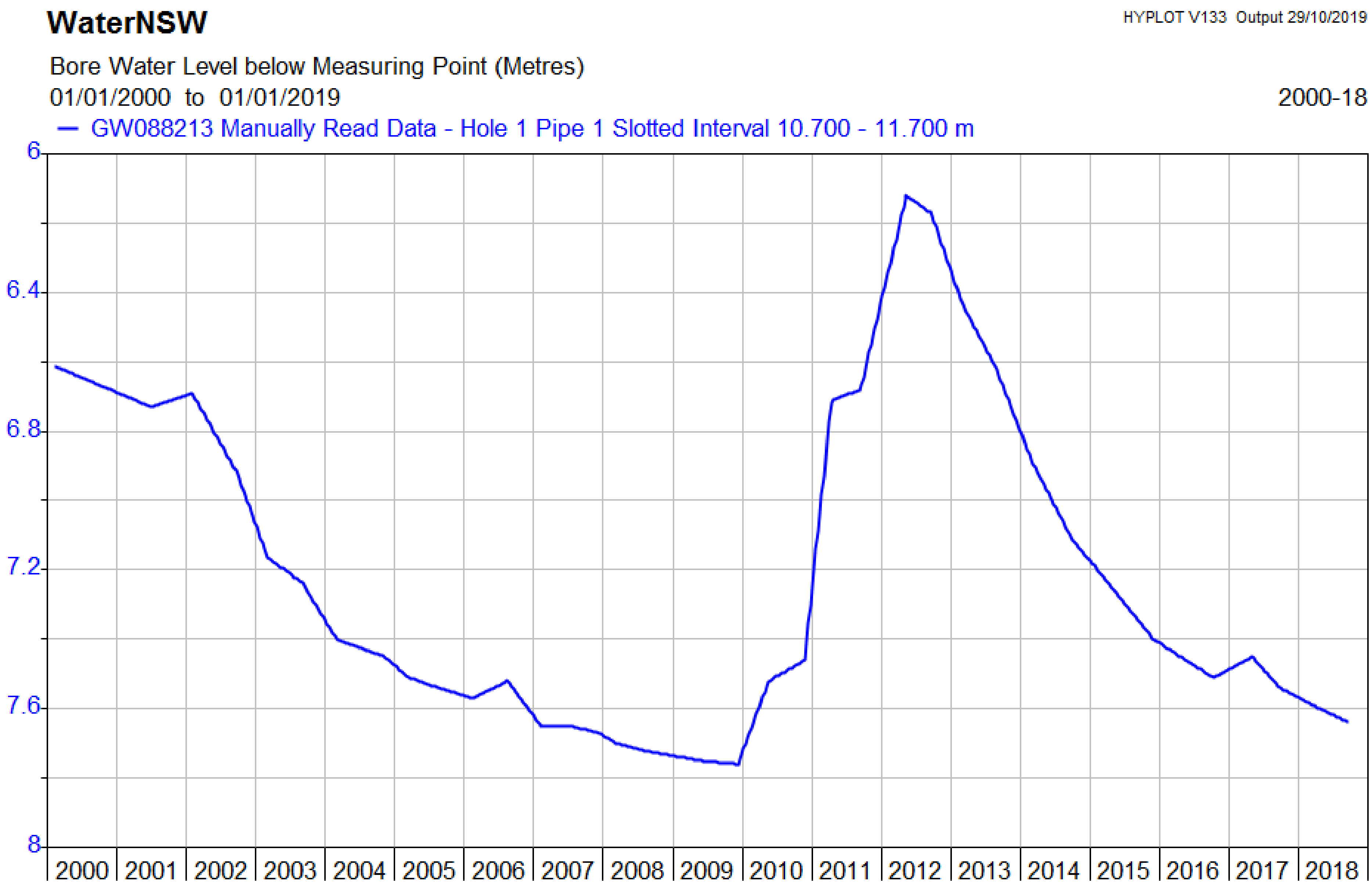
WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2008
2000-07
GW088138 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 8 - 9 m8.001 - 9 m
6.6
6.65
6.7
6.75
6.8
6.85
6.9
2000
2001
2002
2003
2004
2005
2006
2007

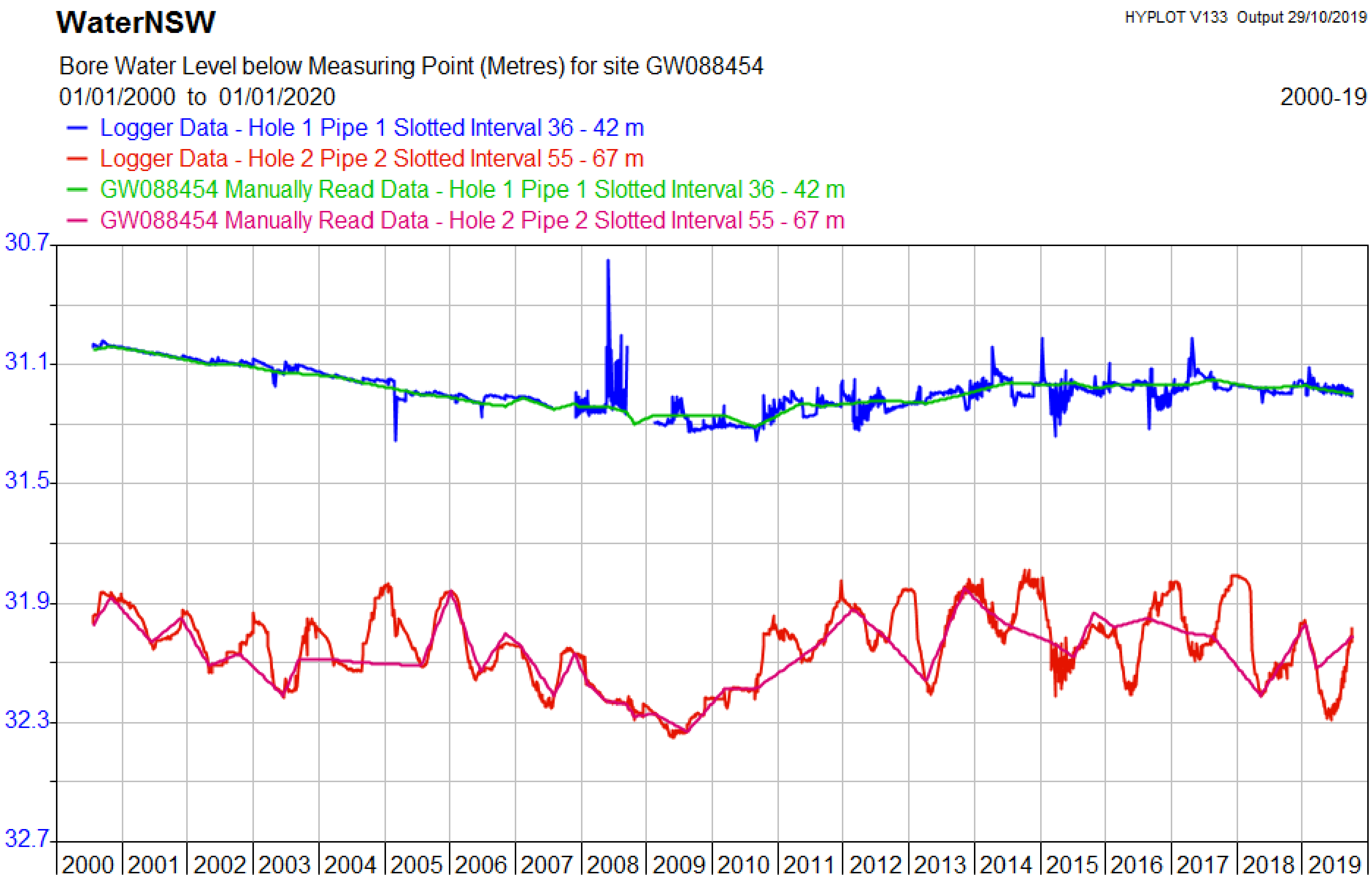


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2006
2000-05
GW088140 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 13 - 14 m13.001 - 14 m
9.1
9.15
9.2
9.25
2000
2001
2002
2003
2004
2005



WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088199 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 11.500 - 12.500 m
6.8
7.05
7.3
7.55
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres)
01/01/2000 to 01/01/2019
2000-18
GW088213 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 10.700 - 11.700 m
6
6.4
6.8
7.2
7.6
8
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


WaterNSW
HYPLOT V133 Output 29/10/2019
Bore Water Level below Measuring Point (Metres) for site GW088454
01/01/2000 to 01/01/2020
2000-19
Logger Data - Hole 1 Pipe 1 Slotted Interval 36 - 42 m
Logger Data - Hole 2 Pipe 2 Slotted Interval 55 - 67 m
GW088454 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 36 - 42 m
GW088454 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 55 - 67 m
30.7
31.1
31.5
31.9
32.3
32.7
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

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