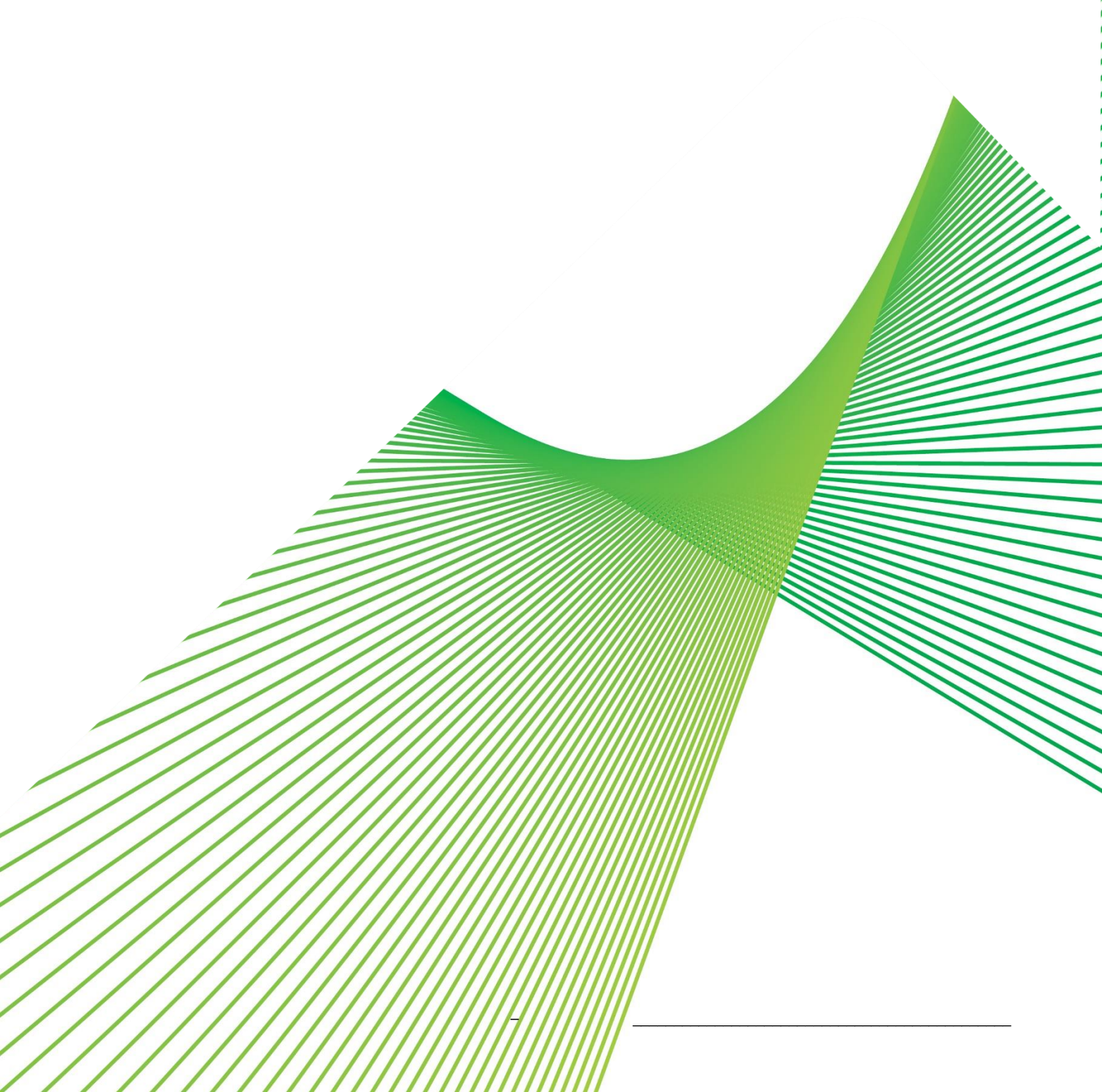


Environmental Impact Statement

EnergyConnect (NSW – Eastern Section)

Technical paper 15 – Groundwater impact assessment



Transgrid

EnergyConnect (NSW – Eastern Section)

Technical Paper 15 –
Groundwater Impact Assessment

DECEMBER 2021



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Glossary

TERM / ACRONYM	DESCRIPTION
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 plasticity.
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 <i>confined aquifer</i> , 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.
Construction impact area	Refers to the area that would be directly impacted by construction of the proposal comprising the following: — construction of all proposal infrastructure elements (including the proposed transmission line alignment, transmission line easement, substation site works (at both the proposed Dinawan 330kV and upgraded and expanded Wagga Wagga substations), optical repeater infrastructure, and other ancillary works) — locations for construction elements such as construction compounds and accommodation camps, access tracks (excluding public roads proposed to be used for access routes), site access points, water supply points, laydown and staging areas, concrete batching plants, brake/winch sites and site offices.

TERM / ACRONYM	DESCRIPTION
	The area is identified based on realistic project component locations and areas however it is indicative at this stage. The area would be confirmed during finalisation of the design and construction methodology and would be developed as part of the consideration of avoidance and impact minimisation. This area includes the operational impact area (including areas required for maintenance) (refer definition below).
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.
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 generally comprises a four kilometre wide corridor (i.e. around 2 kilometres either side of the transmission line easement). 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.
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.
Hydrostratigraphic unit	Geological material with similar hydrogeological properties that have been grouped together for assessment purposes.
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.
Operational impact area	Refers to the area that would be directly impacted by permanent components of the proposal, including all proposed infrastructure elements such as the proposed transmission line easement, transmission line and transmission towers, any new or upgraded substation infrastructure and permanent access tracks.

TERM / ACRONYM	DESCRIPTION
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 easement	An area surrounding and including the transmission lines, which is a legal right allowing for construction of the transmission line, along with ongoing access and maintenance of the lines and will be acquired from landholders either by agreement or pursuant to compulsory acquisition process. The easement width would be 80 metres wide.
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. <i>yield</i> of a borehole.

Abbreviations

AHD	Australian Height Datum
BOM	Bureau of Meteorology
CEMP	Construction and Environment Management Plan
EIS	Environmental impact statement
GDE	Ground dependent ecosystem
GIS	Graphical information systems
GWIA	Groundwater impact assessment
HSU	Hydrostratigraphic Unit
LTAAEL	Long-term average annual extraction limit
mBGL	metres Below Ground Level
mBTC	metres Below Top of Casing
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MNES	Matters of national environment and significance
NGIS	National groundwater information system
NSW	New South Wales
QLD	Queensland
SA	South Australia
SEARs	Secretary's Environmental Assessment Requirements
VIC	Victoria

Executive summary

EnergyConnect (NSW – Eastern Section)

Transgrid (electricity transmission operator in New South Wales (NSW)) and ElectraNet (electricity distributor in South Australia (SA)) are currently investigating the proposed construction and operation of a new electrical interconnector and network support options between NSW and SA, with an added connection to north-west Victoria.

The proposal, focussing on the eastern section of EnergyConnect in NSW, would include the construction and operation of new high voltage transmission lines between the existing Buronga substation and existing Wagga Wagga substation, a new 330kV substation (referred to as the proposed Dinawan 330kV substation), upgrade and expansion of the existing Wagga Wagga substation as well as other ancillary infrastructure.

Groundwater environment overview

The proposal overlies the following three defined hydrostratigraphic units (HSUs):

- Murrumbidgee Alluvium, which corresponds to the Lower Murrumbidgee Alluvium groundwater source identified within the Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources 2020. The HSU is separated into a shallow and deep aquifer, with the shallow aquifer including all water bearing zones up to 40 metres below ground level (mBGL).
- Porous rock, which corresponds to the Western Porous Rock groundwater source identified within the Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020. The HSU is separated into a shallow and deep aquifer, with the shallow aquifer including all water bearing zones up to 50 metres mBGL.
- Lachlan fractured rock, which corresponds to the Lachlan Fold Belt Murray-Darling Basin groundwater source identified within the Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020. The HSU is separated into a shallow and deep aquifer, with the shallow aquifer including all water bearing zones up to 30 mBGL.

The Murrumbidgee Alluvium and Porous rock HSUs are hydraulically connected with groundwater flow through occurring from the Murrumbidgee Alluvium into the Porous rock HSU. The Lachlan fractured rock HSU is not hydraulically connected to either the Murrumbidgee Alluvium or Porous rock HSUs. There is also limited hydraulic connectivity anticipated between the groundwater environment (HSUs) and surface water features.

Groundwater impacts

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 receptors 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 third party geotechnical field investigations.

Construction

The construction of the proposal is considered to have a low risk of impacting the groundwater environment. Changes to groundwater levels, quality and risk from contamination are low as the regional groundwater table is anticipated to be below bulk excavation depths for all construction activities. Therefore, the key construction activity risks associated with the proposal are from contamination during construction activities and localised controlled blasting that may be undertaken in areas of shallow hard rock to allow for appropriate embedment depth of transmission tower footings. Construction activities have the potential to impact the underlying groundwater quality, whilst blasting has the potential to fracture the surrounding rock potentially impacting groundwater levels and quality.

Contamination from construction activities would be appropriately managed as part of the Construction Environment Management Plan (CEMP). Blasting, if required, is anticipated to only impact less than five percent of the transmission line easement and is expected to result in a minimal blast halo, less than around 10 metres. Currently no registered bores and only one high potential groundwater dependent ecosystem (GDE) (Sandy Creek) are located within around 50 metres of a potential blast location. Through appropriate mitigation measures the potential impact is considered low.

Groundwater supply for construction is to be sourced from existing infrastructure and licensing allocations and approvals. Therefore, the potential impact to the groundwater environment relating to groundwater supply is considered low.

Eleven registered bores were identified within construction impact area and therefore contain an increased risk of being accidentally damaged during construction activities.

Operation

The proposal does not require groundwater take during its operation and therefore the key potential operational impacts to the groundwater environment are through impacts to water quality from maintenance operations or permanent impacts to groundwater levels and quality from blasting (if required) during the construction phase. However, the potential risk and impacts would be less than during the construction phase and are considered low.

Minimal impact considerations

The proposal complies with Level 1 acceptance criteria of the *Minimal impact considerations* outlined in the Aquifer Interference Policy and is therefore considered to have minimal impact on the groundwater environment.

Mitigation measures

Impacts from the proposal during the construction phase would be managed through a Construction Environmental Management Plan (CEMP) which would include a Groundwater Management sub-plan. The Groundwater Management sub-plan would detail appropriate measures in the event that groundwater is encountered during construction.

Direct impacts to registered bores within the construction impact area would be avoided where possible. Make good provisions in consultation with the registered owner would occur where registered bores are inadvertently damaged.

The exact locations requiring blasting would be defined during pre-construction following additional geotechnical investigations. To preventatively mitigate against the potential impacts from blasting, a 50 metre buffer around high potential GDEs and registered bores has been applied. If blasting is to be undertaken within the buffer, mitigation measures such as further assessment of potential blasting halo and impact radius to ensure minimal impact to GDEs and registered bores or alternative construction methodologies, such as jack-hammering or engineering solutions are to be given preference over blasting.

Where blasting is required an additional desktop assessment involving the latest spatial information for GDEs and registered bores would be undertaken. The assessment would include identification of any high potential GDEs or registered bores within 50 metres of the blast location. Where a high potential GDE or registered bore is identified further assessment considering the encountered geology, likely blast impact radius and the resulting risk to the high potential GDE or registered bore would be undertaken, and mitigation measures adopted for inclusion in the CEMP.

Conclusion

The groundwater impact assessment has assessed the impacts of the proposal on groundwater aquifers and groundwater dependent ecosystems having regard to the NSW Aquifer Interference Policy and relevant water sharing plans. The proposal complies with Level 1 acceptance criteria of the *Minimal impact considerations* outlined in the Aquifer Interference Policy.

Through the proposed mitigation and management measures the proposal is anticipated to have a low impact on the groundwater environment.

1 Introduction

1.1 Proposal context and overview

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 aims to reduce the cost of providing secure and reliable electricity transmission between NSW and SA in the near term, 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 (NSW Department of Planning and Environment (DPE), 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.

EnergyConnect comprises of several sections (shown on Figure 1-1) that would be subject to separate environmental planning approvals under the relevant jurisdictions. It includes:

- NSW sections including:
 - Western Section, which would extend from:
 - the SA/NSW border (near Chowilla in SA) to Transgrid's existing Buronga substation
 - Buronga substation to the NSW/Victoria border at Monak (near Red Cliffs in Victoria)
 - Eastern Section, which would extend from the Buronga substation to the existing Wagga Wagga substation
- a Victorian Section, which would extend from the NSW/Victoria border to Red Cliffs substation
- a SA Section, which would extend from Robertstown to the SA/NSW border.

Transgrid is currently seeking planning approval for the NSW – Eastern Section (the proposal), which is the subject of this EIS.

Transgrid has previously sought and received separate environmental planning approvals for the NSW – Western Section of EnergyConnect and Victorian Section. ElectraNet is responsible for obtaining environmental planning approval for the section of EnergyConnect located in SA.

1.1.1 *Proposal objectives*

The primary objective for EnergyConnect (which the proposal comprises an extensive component of) is to reduce the cost of electricity by providing secure electricity transmission between NSW and SA in the near term and facilitate the longer-term transition of the energy sector across the NEM to low emission energy generation sources. More specifically, EnergyConnect (including the proposal) aims to:

- lower power prices
- improve energy security
- increase economic activity
- support the transition to a lower carbon emission energy system
- support a greater mix of renewable energy in the NEM.



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 30 September 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.

1.3 Proposal overview

1.3.1 Key features of the proposal

The key components of the proposal include:

- about 375 kilometres of new 330 kilovolt (kV) double circuit transmission line and associated infrastructure between the Buronga substation and the proposed Dinawan 330kV substation
- connection of the proposed transmission lines to the existing Buronga 330kV substation
- construction of a new 330kV substation around 30 kilometres south of Coleambally, referred to as the proposed Dinawan 330kV substation
- connection of the proposed transmission lines to the proposed Dinawan substation
- about 162 kilometres of new 500 kilovolt (kV) double circuit transmission line and associated infrastructure between the proposed Dinawan substation and the existing Wagga Wagga substation at Wagga Wagga, NSW
- upgrade and expansion of the Wagga Wagga substation to accommodate the new transmission line connections including the installation of new line bays, relocation and upgrade of existing bays and associated electrical and civil works (road, kerb, gutter, drainage works and earthworks)

- provision of three optical repeater structures and associated connections to existing local electrical supplies
- new and/or upgrade of access tracks as required
- 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 in Figure 1-2. Further detail on the key infrastructure components of the proposal and construction activities are provided in Chapter 5 and Chapter 6 of the main environmental impact statement, respectively.

1.3.2 Construction

1.3.2.1 Key construction works

Key construction works for the proposal would typically include (but not be limited to):

- site establishment works, which may include (but not be limited to):
 - establishment of construction compound and accommodation sites, access tracks and service relocations
 - vegetation clearance.
 - transportation of equipment such as steelwork, high voltage plant, switchgear, between dock and site as part of the construction works
- ancillary works to facilitate the construction of the proposal (e.g. intermediate laydown and staging areas, concrete batching plants, brake/winch sites, site offices and accommodation camps)
- construction of the proposed transmission lines, which would include (but not be limited to):
 - access tracks to accommodate safe access of construction machinery and materials to each transmission line tower site
 - earthworks (including establishment of construction pads) and the construction of footings and foundations for each transmission line tower
 - erection of the new transmission line towers using crane(s) and or helicopter(s)
 - stringing of the conductors and overhead earth wires and optical ground wire
 - installation of earthing conductors
 - testing and commissioning of the transmission lines
- construction of the proposed Dinawan 330kV substation, which would include (but not be limited to):
 - civil construction works including earthworks
 - slab construction at the new substation site
 - electrical fit out with new substation equipment
 - testing and commissioning of the new substation equipment
- upgrade and expansion of the existing Wagga Wagga substation to enable the proposed connection and operation of the new transmission lines which would include (but not be limited to):
 - civil construction works including earthworks and slab construction at the expanded substation site
 - electrical fit out with new substation equipment
 - testing and commissioning of the new substation equipment
- connection of the proposed transmission lines to the existing Buronga substation
- demobilisation and remediation of areas disturbed by construction activities.

A detailed description of construction works for the proposal is further described in Chapter 6 of the Environmental Impact Statement (EIS).

1.3.2.2 Construction program

Construction of the proposal would commence in late-2022 (enabling works phase), subject to NSW Government and Commonwealth planning approvals.

The construction of the transmission lines and substation facilities would take around 18 months. The upgraded and expanded Wagga Wagga substation and new Dinawan 330kV substation are expected to be operational by late-2024. Site decommissioning and remediation would extend around six months beyond the commissioning (operational) phase, with estimated completion in mid-2025.

The final program would be confirmed as part of finalisation of the proposal infrastructure following approval of the proposal.

1.3.2.3 Indicative duration transmission line construction activities

Construction at each transmission line tower would be intermittent and construction activities would not occur for the full duration at any one location. Figure 1-3 presents an indicative duration of construction activities associated with the transmission line towers. These durations could vary and breaks between activities may be shorter which may lead to longer inactive periods in subsequent stages of construction at an individual transmission line tower. Durations of any particular construction activity, and respite periods, may vary for a number of reasons including (but not limited to), multiple work fronts, resource and engineering constraints, works sequencing and location.

These activities would also have multiple work fronts, therefore (for example) foundation works or tower erection would be occurring in several locations along the easement at the same time.

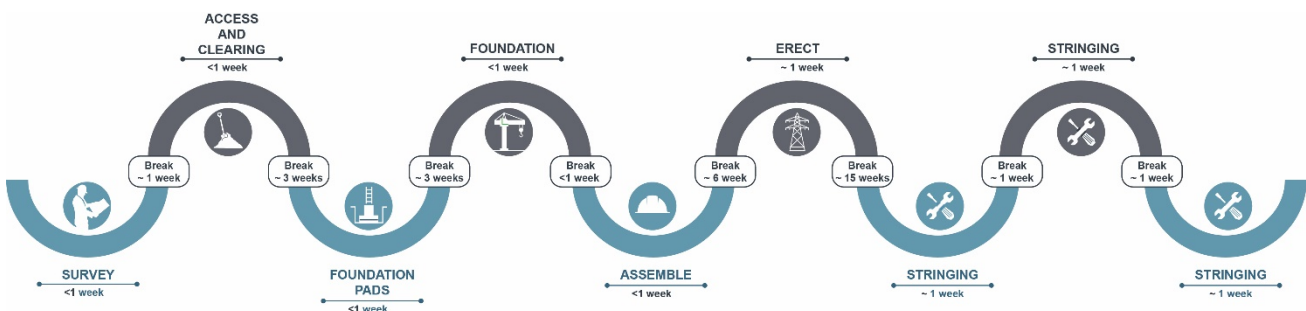


Figure 1-3 Indicative duration of construction activities at each transmission line tower site

1.4 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 purpose of this technical paper is to identify and assess the potential impacts of the proposal in relation to groundwater impacts. It responds directly to the Secretary's Environmental Assessment Requirements (SEARs) (refer to Section 1.4.1).

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 is detailed in Chapter 3 of this technical paper.

1.4.1 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	Details on water requirements, supply arrangements and wastewater disposal arrangements for construction and operation	Section 2.2.2.1 of this technical paper (licencing) Technical paper 8 – Hydrology, flooding and water quality Technical paper 14 – Phase 1 contamination assessment
	An assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the <i>NSW Aquifer Interference Policy and relevant Water Sharing Plans</i>	Chapter 5, 6 and 7

1.5 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 Groundwater impact assessment.
- *Chapter 4 – Existing environment:* Describes the existing hydrogeological environment.
- *Chapter 5 – Assessment of construction impacts:* Identifies and discusses regional and proposal risks and their potential impact to the assessed groundwater sources.
- *Chapter 6 – Assessment of operational impacts:* Describes the potential operational impacts associated with the proposal.
- *Chapter 7: Minimal impact considerations:* An assessment of the proposals impacts on aquifers and GDEs in regard to the minimal impact considerations of the NSW Aquifer Interference Policy.
- *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 – Limitations:* Identifies the general limitations considered in the preparation of this report.
- *Chapter 12 – References:* Identifies the key reports and documents used to generate this report.

There are two appendices to this report:

- *Appendix A* – Registered groundwater bore search results and information.
- *Appendix B* – Available hydrographs from registered bores (WaterNSW).

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 DPIE, water resource plans and supporting documents published by DPIE, groundwater levels, quality and registered bore data published by WaterNSW and collated by the Bureau of Meteorology. The latest spatial data for the location of Groundwater Dependent Ecosystems (GDEs) and water sharing plans, used in this assessment at the time of reporting was obtained from the NSW Government SEED database. Where this data is out of date, this assessment has, within reason, attempted to assess the spatial location of high priority GDEs from available low-quality images within the water sharing plan legislation.

Existing investigations include the latest geotechnical and preliminary site investigation reports by Douglas Partners (DP) (2020a & 2020b) and SMEC (2020a, 2020b & 2020c), which were used to obtain information on the existing environment within the groundwater study area, predominantly the geology, with groundwater observations also recorded when encountered. The impact assessment is limited to a qualitative assessment based on 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 collected by third parties and information sourced during the desktop review. The impact assessment conclusions may differ from those reported in this report 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 design of the proposal is finalised and validation is undertaken during construction.

2 Legislative and policy context

The following sections outline key Commonwealth and State legislations, policy and guidelines relevant to water resource management for the groundwater study area.

2.1 Commonwealth legislation and policy

2.1.1 *Environmental Protection and Biodiversity Act 1999*

The objective of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to protect and manage prescribed Matters of National Environmental Significance (MNES). Under the EPBC Act, proposed ‘actions’ that are likely to have a significant impact on MNES, on Commonwealth land, or caused by a Federal Government agency, must be referred to the Federal Minister for the Environment for assessment.

A referral under the EPBC was submitted on 25 August 2020. The Australian Department of Agriculture, Water and the Environment determined the proposal to be a controlled action on 30 September 2020 and will be assessed using the bilateral assessment process. The SEARs that were issued on 2 October 2020 included the relevant Commonwealth requirements under the bilateral assessment process.

There are no controlled actions relevant to this groundwater assessment.

2.1.2 *Water Act 2007*

The *Water Act 2007* allows the Commonwealth in conjunction with the Basin States (South Australia (SA), Victoria (VIC), NSW, Queensland (QLD) and the Australian Capital Territory (ACT)) to manage Australia’s largest water resource, the Murray-Darling Basin (MDB), in the national interest. Notably it gives functions to the Bureau of Meteorology (BOM) in reporting of water information and transferred the powers and functions of the Murray-Darling Basin Commission to the Murray-Darling Basin Authority (MDBA) through the Murray-Darling Basin Agreement. The purpose of the Agreement is to:

‘promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water and other natural resources of the Murray-Darling Basin, including by implementing arrangements agreed between the Contracting Governments to give effect to the Basin Plan, the Water Act and state water entitlements’.

The MDB Plan 2012, hereafter referred to as the Basin Plan, uses water resource plans (WRPs) as a tool to effectively meet the objectives of the agreement. An outline of the Basin Plan, and the WRPs which apply to water resources relevant to the proposal are discussed in the following sections.

2.1.2.1 Murray-Darling Basin Plan 2012

The Basin Plan aims to provide a coordinated approach to water use and management across the MDBs 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 surface water and groundwater use and water quality.

Water resource plans

WRPs are an integral tool for implementing the objectives of 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. The MDBA works 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 (refer to Section 2.2.2.2), to ensure they comply with the Basin Plan, including sustainable diversion limit 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). The individual WRP extents match the corresponding water sharing plan boundaries (refer to Section 2.2.2.2). The WRPs are behind schedule for accreditation with assessment and negotiation between NSW and the MDBA on-going (MDBA, 2021). Whilst the WRPs have not reached the accreditation stage, the latest water sharing plans are enforced, but will align with finalised WRPs once the WRPs are accredited.

The MDB within NSW is covered by 20 WRPs (nine surface water and 11 groundwater). The groundwater study area includes sustainable diversion limit resource units which indicates how much water, on average, is allowed to be used in a given year, governed by the following relevant groundwater WRPs:

- NSW Murray-Darling Basin Porous Rock: includes sustainable diversion limit resource units for Gunnedah-Oxley Basin, Sydney Basin, Western Porous Rock and Oaklands Basin. The proposal is situated within the Western Porous Rock.
- Murrumbidgee Alluvium: includes three sustainable diversion limit resource units; Lake George Alluvium, Mid Murrumbidgee Alluvium and Lower Murrumbidgee Shallow Alluvium. The proposal is situated within the Lower Murrumbidgee Alluvium.
- NSW Murray-Darling Basin Fractured Rock: includes groundwater stored within the fractures, joints, bedding planes, faults and cavities within the geological rock mass of the NSW MDB as well as alluvial sediments that overlie these fractured rock systems that have not been explicitly captured elsewhere. It comprises nine sustainable diversion limit resource units, of which only one (Lachlan Fold Belt) is directly relevant to the proposal.

2.2 State legislation and policy

2.2.1 *Environmental Planning and Assessment Act 1979*

The EP&A Act and Environmental Planning and Assessment Regulation 2000 (EP&A Regulation) establish a framework for the assessment and approval of developments in NSW. They also provide for the making of environmental planning instruments, including state environmental planning policies (SEPPs) and local environmental plans (LEPs), which determine the permissibility and approval pathway for development proposals and form a part of the environmental assessment process.

The proposal has been declared as critical State Significant Infrastructure (CSSI) in accordance with Section 5.13 of the EP&A Act. Under Section 5.14 of the EP&A Act, the approval of the Minister for Planning and Public Spaces is required for SSI (including CSSI), and an EIS has been prepared under Division 5.2 of the EP&A Act.

2.2.2 *Water Act 1912 and Water Management Act 2000*

Water resources are administered under the *Water Act 1912* (Water Act) and the *Water Management Act 2000* (WM Act) by DPIE. The objective of the WM Act is the sustainable and integrated management of the state's water sources for the benefit of present and future generations. The WM Act governs the issue of water access licences (WALs) and approvals for those water sources (rivers, lakes, estuaries and groundwater) in NSW where water sharing plans have commenced. Water sharing plans establish rules for sharing water between water users and the environment, and areas rules for water trading.

The Water Act is being progressively phased out and replaced with the WM Act. The Water Act continues to apply in those remaining water sources where a water sharing plan has not been enacted. Groundwater resources within the groundwater study area are governed under the WM Act and subject to both water sharing plans, discussed below, and the WRPs discussed in Section 2.1.2.

2.2.2.1 Licensing

Part 2 of the WM Act establishes access licences for the take of water within a particular water management area. Access licence exemptions are described within of Part 1 of Schedule 4, of the *Water Management (General) Regulation 2018*.

Part 3 of the WM Act establishes three types of approvals that a proponent may be required to obtain. These are:

- water use approvals
- water management work approvals (water supply work approvals, drainage work approvals and flood work approvals)
- activity approvals (controlled activity approvals and aquifer interference approvals).

However, under Section 5.23(1) of the EP&A Act, approved state significant infrastructure does not require a water use approval under section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the WM Act if groundwater extraction activities are assessed and approved as part of State Significant Infrastructure projects.

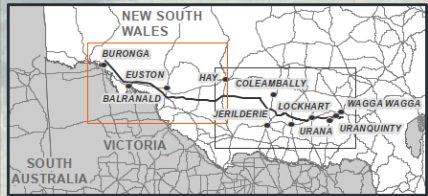
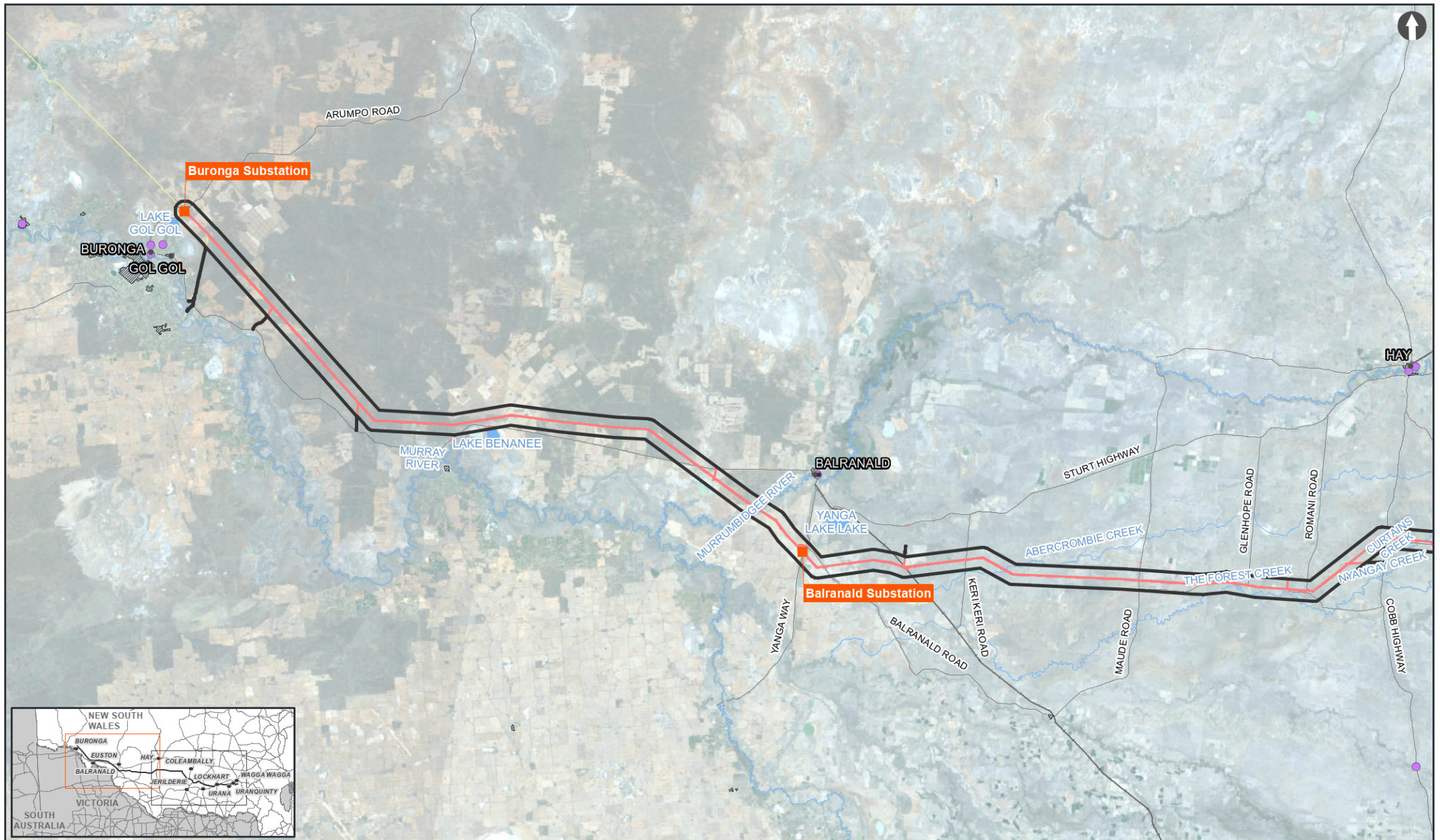
Therefore, if the proposals groundwater extraction is assessed and approved as part of the State Significant Infrastructure proposal, only a WAL would be required. A WAL relevant to the applicable water sharing plan is required for dewatering and any other taking of water from any water source. The WAL will list the entitled water volume and requires a nominated water supply work.

Table 2-1 lists the 26 proposed water supply points, anticipated usage volume and purpose for the proposal. The water fill points include water sourced from surface water features and groundwater aquifers. Required water volumes will be sourced through private arrangements with existing WAL holders and use existing groundwater infrastructure. As existing infrastructure will supply groundwater for construction within existing WAL entitlements, no water supply work approvals are required. Location of the water fill points are shown in Figure 2-1.

Table 2-1 Proposal water fill points and anticipated usage volumes and purpose.

LOCATION	PROPOSAL STATION ID	OWNER	ANTICIPATED USE	ESTIMATED USAGE (kL PER DAY)
Modica Crescent, Wentworth	—	Wentworth Council	All proposed uses	100
Beverley Street, Wentworth	603	Wentworth Council	All water activities except concrete batching	60
River Drive, Buronga	602	Wentworth Council	Dust suppression, earthworks, washdown	60
Alcheringa Rd	601	Western Murray Irrigation	Dust suppression, earthworks, washdown	100
Church Street, Balranald	501	Balranald Shire Council	All proposed uses	200
Wanganella	407	Edward River Council	All proposed uses	100
Cadell S	402	Hay Shire Council	All proposed uses	60
Pine St	401	Hay Shire Council	All proposed uses	60
111 Jerilderie St, Jerilderie	302	Murrumbidgee Council	All proposed uses	100
3 Bencubbin Av, Coleambally	301	Murrumbidgee Council	All proposed uses	80

LOCATION	PROPOSAL STATION ID	OWNER	ANTICIPATED USE	ESTIMATED USAGE (kL PER DAY)
Coleambally to Camp 3	300	Murrumbidgee Council	All proposed uses	200
Bulgary	206	Riverina Water	All proposed uses	200
Boree Creek	205	Riverina Water	All proposed uses	60
Urana	204	Riverina Water	All proposed uses	100
French Park	203	Riverina Water	All proposed uses	200
Tootool	202	Riverina Water	All proposed uses	200
Lockhart	201	Riverina Water	All proposed uses	250
The Rock O/Head	114	Riverina Water	All proposed uses	200
The Rock	108	Riverina Water	All proposed uses	200
Forest Hill	107	Riverina Water	All water activities except concrete batching	100
Lake Albert	105	Riverina Water	All water activities except concrete batching	200
Glenfield	104	Riverina Water	All water activities except concrete batching	200
Ashfords Road	103	Riverina Water	Office/Welfare, dust suppression, earthworks, washdown	200
Koorinal Sewage Treatment Plant	102	Wagga Wagga City Council	Dust suppression, earthworks, washdown	100
Narrung Sewage Treatment Works	100	Wagga Wagga City Council	Dust suppression, earthworks, washdown	100
Gregadoo Waste Management	23	Wagga Wagga City Council	Dust suppression, earthworks, washdown	300

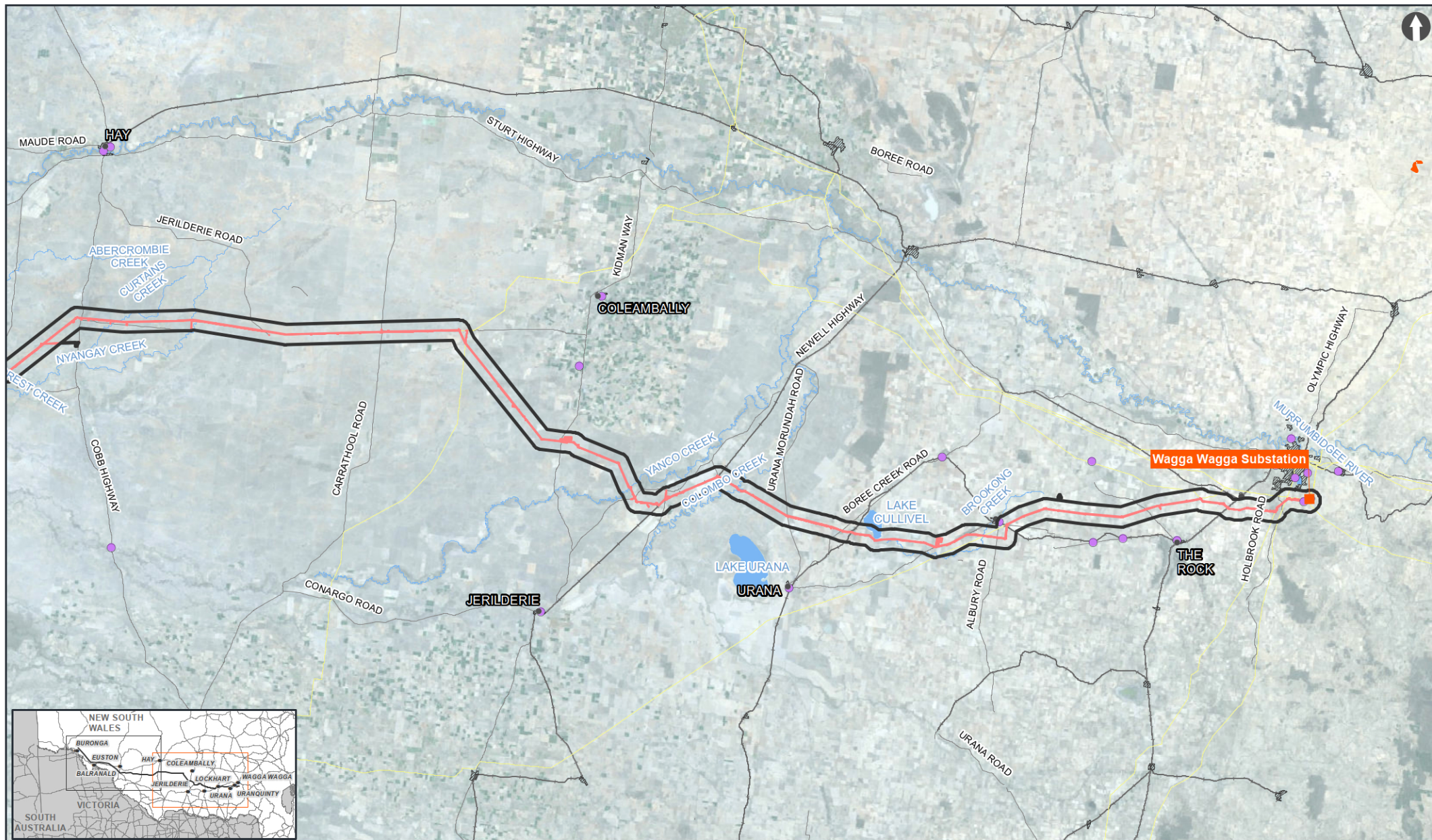


Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation
- Water Fill Point

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater - Figure 2-1
Water Fill Points



Groundwater - Figure 2-1
Water Fill Points

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation
- Water Fill Point

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

2.2.2.2 Water sharing plans

Water sharing plans within the proposal cover the same areas as the WRPs and incorporate a number of water sources which typically equate directly to the sustainable diversion limits resource areas defined within the WRPs. Available water limits set out in water sharing plans are being negotiated with the MDBA to meet agreed limits within the WRPs. Whilst the WRPs have not reached the accreditation stage, the latest water sharing plans are enforced, but will align with finalised WRPs once the WRPs are accredited. Water sharing plans describe the annual surface water 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), which define the limit of water that can be taken for all purposes (including domestic and stock, urban, industrial, agriculture use and held environmental water) from each water source (DPIE, 2019a). Provisions are made for environmental water allocation, basic landholder rights, domestic and stock rights and native title rights.

The proposal is overlying several water sharing plans which may overlap each other depending on the depth of the respective groundwater resource, and include:

- Murrumbidgee Alluvial Groundwater Sources 2020
- NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020
- NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020.

Table 2-2 lists the groundwater sources within the water sharing plans that are present within the proposal with the spatial extent of each outcropping water sharing plan in relation to the groundwater study area displayed in Figure 2-2.

Table 2-2 Groundwater sources underlying the groundwater study area

WATER SHARING PLAN	RELEVANT GROUNDWATER SOURCE	MANAGEMENT ZONE
Murrumbidgee Alluvial Groundwater Sources 2020	Lower Murrumbidgee Alluvium	N/A
NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020	Western Porous Rock	N/A
NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020	Lachlan Fold Belt MDB	Other

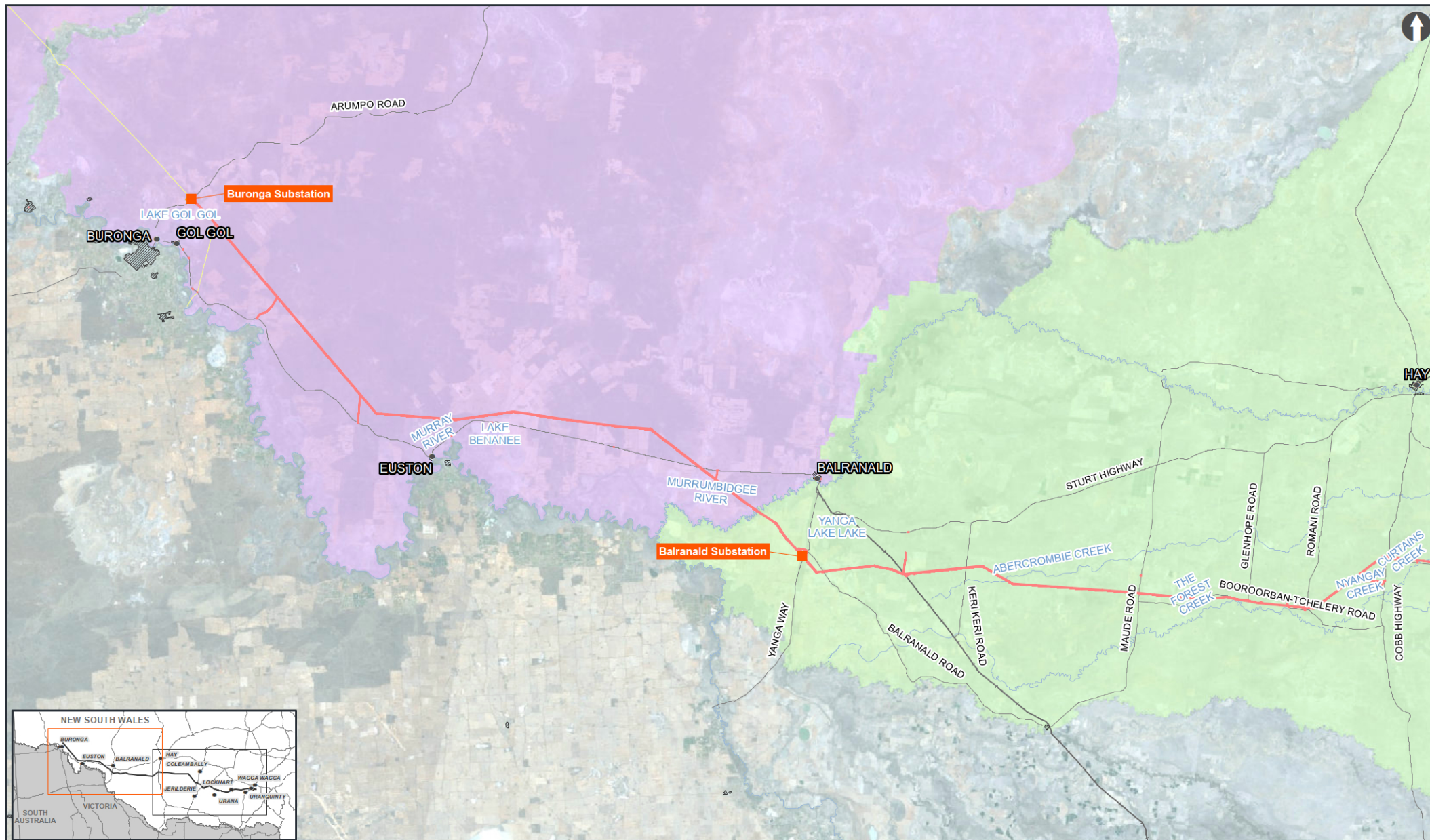
2.2.2.3 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) clarifies the requirements for obtaining water licences and the assessment processes for aquifer interference activities under the WM Act and other relevant legislative frameworks. The AIP also defines considerations in assessing whether more than minimal impacts might occur to a key water-dependent asset.

An aquifer interference activity involves any of the following:

- penetration of an aquifer
- interference with water in an aquifer
- obstruction of the flow of water in an aquifer
- taking of water (referred to as water take) from an aquifer whilst mining or any other activity prescribed by the regulations
- disposal of water taken from an aquifer while mining or any other activity prescribed by the regulations.

The WM Act includes the concept of ensuring ‘no more than minimal harm’ for both the granting of water access licences and the granting of approvals. Approvals under the AIP will be granted provided adequate arrangements are in place to ensure that no more than minimal harm will be imposed on any water source or its dependent ecosystems.



Project Components

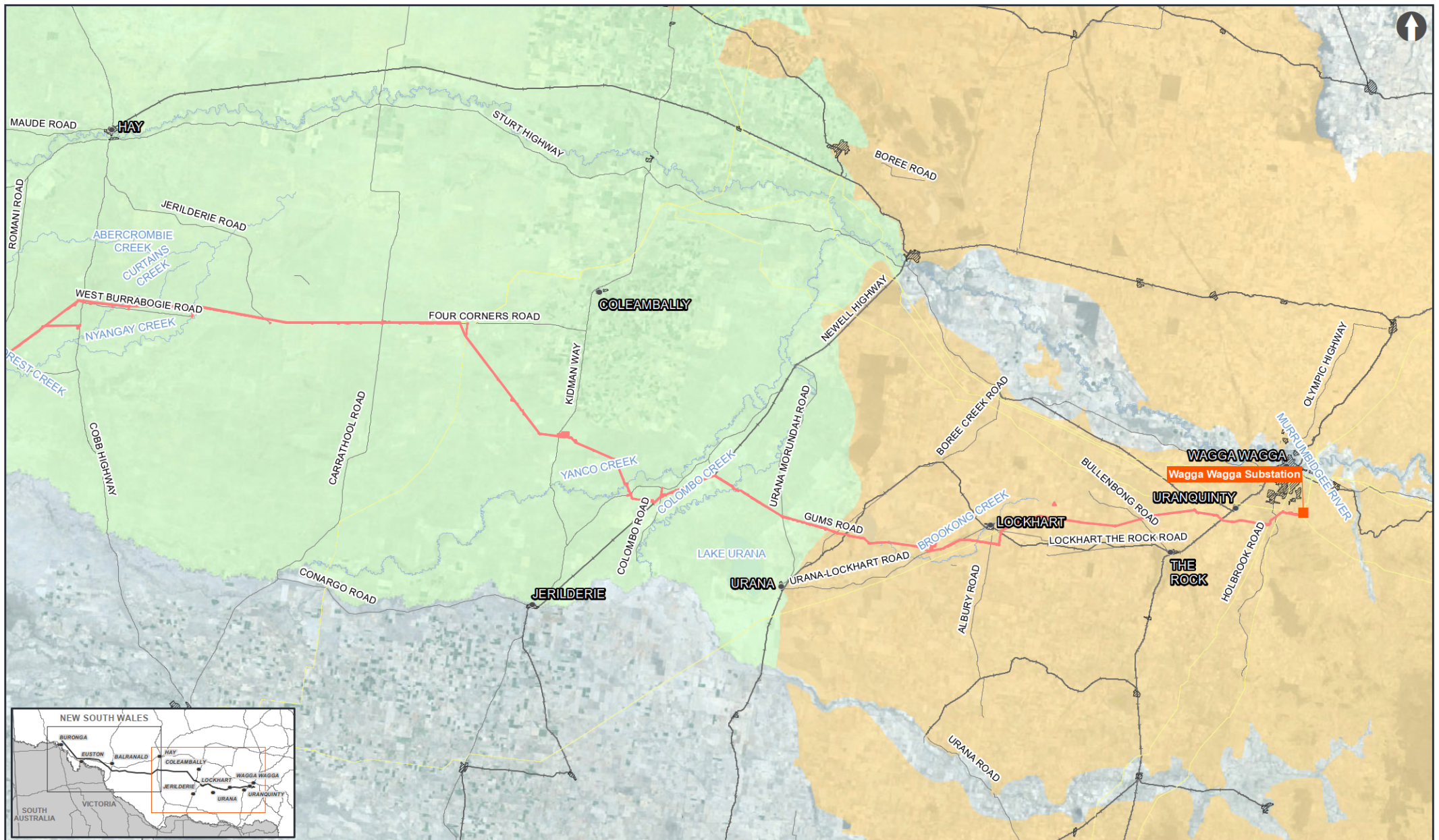
- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Built Up Areas

Outcropping Groundwater Sources (Water Sharing Plan)

- Lachlan Fold Belt MDB (NSW Murray Darling Basin Fractured Rock Groundwater Sources)
- Lower Murrumbidgee Alluvium (Lower Murrumbidgee Shallow Groundwater Sources)
- Western Murray Porous Rock (NSW Murray Darling Basin Porous Rock Groundwater Sources)

Groundwater - Figure 2-2

Outcropping Groundwater Sources and Corresponding Water Sharing Plans



0 25 50 KM

Project Components - Construction Impact Area - Main Construction Compounds and Accommodation Sites	- Existing Transmission Line Infrastructure - Existing Substation - Existing Railway - Built Up Areas	Outcropping Groundwater Sources (Water Sharing Plan) - Lachlan Fold Belt MDB (NSW Murray Darling Basin Fractured Rock Groundwater Sources) - Lower Murrumbidgee Alluvium (Lower Murrumbidgee Shallow Groundwater Sources) - Western Murray Porous Rock (NSW Murray Darling Basin Porous Rock Groundwater Sources)	Groundwater - Figure 2-2 Outcropping Groundwater Sources and Corresponding Water Sharing Plans Sheet 2 of 2
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For aquifer impact assessments, the AIP divides groundwater sources into ‘highly productive’ and ‘less productive’ based on water quality and yield. Highly productive groundwater sources have total dissolved solids less than 1,500 milligram per litre (mg/L) and can sustain yields greater than 5 litres per second (L/s). On this basis, within the groundwater study area, all groundwater sources are considered less productive. This groundwater impact assessment evaluates the proposal against the AIP minimal impact criteria which considers impacts to the water table, water pressure and water quality (Chapter 7).

2.2.3 *Water Management (General) Regulation 2018*

The *Water Management (General) Regulation 2018* specifies procedural, technical and licence requirements and exemptions under the WM Act. It also defines the function and powers of water supply authorities. Under this regulation a WAL or a water use approval is exempt if groundwater extraction (such as for excavation to construct or maintain a building, road or infrastructure) is less than three mega litres in any one water calendar year (commencing on 1 July each year). Requirements for this exemption are set out in Clause 21(6) of the *Water Management (General) Regulation 2018* and include:

- record the water take within 24 hours in the approved form and manner
- keep the water take records for a period of five years
- provide the water take records to the Minister (or WaterNSW) by no later than 28 July for the year ending 1 July during which the water was taken.

2.2.4 *NSW Government Groundwater Framework Documents*

The NSW Government Groundwater Policy Framework Document (Department of Land and Water Conservation (DLWC), 1997) aims to manage the State’s groundwater resources to sustain their environmental, social and economic uses. The policy has three component policies:

- *NSW Groundwater Quality Protection Policy* (DLWC, 1998)
- *NSW Groundwater Dependent Ecosystems Policy* (DLWC, 2002)
- *NSW Groundwater Quantity Management Policy* (DLWC, undated).

These framework policy documents have been incorporated, where relevant, into generation of the governing policies and legislations discussed above.

3 Methodology

To understand the hydrogeological environment within the groundwater study area, a desktop review of available data was undertaken, including from national and state databases, reports, and existing third party 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 conceptual hydrogeological model 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 Groundwater study area

To adequately characterise the hydrogeological conditions for the proposal, a regional scale understanding is required. Therefore, a larger area than the construction impact footprint, 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.

The groundwater study area would comprise a four kilometre wide corridor (i.e. around two kilometres either side of the identified transmission line easement for the proposal) which has generally been applied for assessment of impacts to potential sensitive receptors, comprising groundwater dependent ecosystems (GDEs), registered groundwater bores, culturally significant groundwater related sites and waterways with groundwater connectivity.

The groundwater study area would cover a number of Local Government Areas (LGAs) across regional western NSW across comprising the following: Wentworth Shire; Balranald Shire; Murray River; Edward River; Hay Shire; Murrumbidgee; Federation; Lockhart Shire; and Wagga Wagga.

3.2 Existing environment

3.2.1 *Climate and rainfall*

Rainfall data was sourced from the Bureau of Meteorology (BOM, 2021a). Three weather stations were selected based on available data and location to provide a representative indication of rainfall across the groundwater study area. The weather stations at Irymple (station number: 076015), Urana (station number: 074110) and Wagga Wagga (Gurwood Street, station number: 074127), were selected. They are located within the western, approximate central and eastern portion of the groundwater study area, respectively.

3.2.2 *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 (2021).

Mapped geological data within the groundwater study area was obtained from the Seamless Geology Project (Colquhoun, Hughes & Deyssing et al., 2019). Additional information was compiled from existing geotechnical and preliminary site investigations within the groundwater study area (SMEC, 2020a; 2020b & 2020c), readily available governmental studies and published scientific journal papers.

The potential area of shallow hard rock was assessed by a third party that relied predominately on a desktop assessment of the mapped outcropping geology and topographic profiling.

3.2.3 *Hydrogeology*

An assessment on the hydrogeological conditions and development of a conceptual hydrogeological model incorporated results from existing geotechnical and preliminary site investigations within the groundwater study area (DP, 2020a & 2020b; SMEC, 2020a; 2020b & 2020c), 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, 2021b).

3.2.4 *Registered bore search*

A registered bore search was conducted by downloading data provided from the NGIS database (BOM, 2021b). The database was filtered to only include registered bores within the defined groundwater study area. Where NGIS data was missing, information relevant to this assessment, such as registered function, an additional search through the WaterNSW real-time data website (2021) was completed.

3.2.5 *Groundwater Dependent Ecosystems*

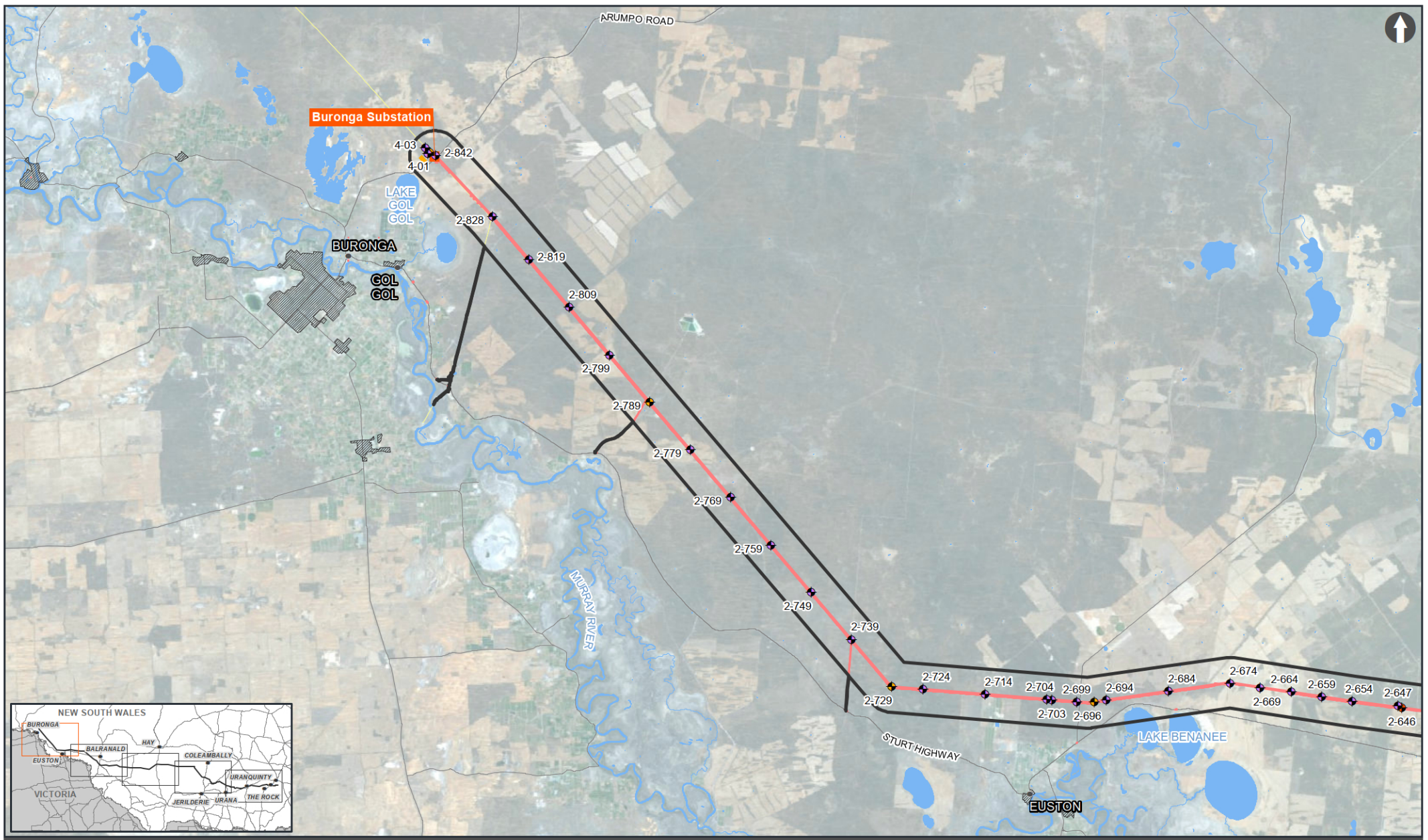
The GDE search was conducted by reviewing the relevant water sharing plan documents and their additional appendices that list and graphically display identified high priority GDEs. A second search involving GDE data downloaded from the NGIS database (BOM, 2021b) was graphically presented and data confined to the groundwater study area using GIS software. A search through the Department of Agriculture, Water and the Environment (2021) Protected Matters Search Tool was conducted to identify any Ramsar wetlands within 10 kilometres of the construction impact footprint.

As the protection of GDEs in water sharing plans needs to be balanced with the demands of licenced water users, protection is legislatively restricted to high priority GDEs (DPIE, 2021). Publicly available location data in GIS format, including information on high priority GDEs detailed in the 2020 water sharing plans, is currently not available through the NSW SEED portal for the new water sharing plans that were enacted on 1 July 2020. Therefore, an assessment using the approximate location determined from the high priority GDE location figures in the corresponding 2020 water sharing plans was undertaken. The assessment concluded that the high priority GDEs generally match the location of high potential GDEs recorded in the NGIS database (BOM, 2021b).

Therefore, the assessment of impacts to high priority GDEs within this report is included in the assessment of high potential GDEs and uses the assumption that their location matches the spatial extent of mapped high potential GDEs from NGIS (2021b). This approach is considered adequate based on the available data and that the available data is considered unlikely to change prior to construction, to address the requirement of the SEARs (refer to Section 1.4.1).

3.3 Geotechnical site investigations

A review of geotechnical investigations undertaken in 2020 by DP (2020a and 2020b) and SMEC (2020a, 2020b & 2020c) was undertaken to inform the conceptual hydrogeological model. The location of the field investigations, including borehole drilling, test pits and cone penetration tests (CPTs) are shown in Figure 3-1. Whilst subsurface investigation depths varied, termination depths were generally around 15 metres below ground level (mBGL). No hydrogeological assessment or groundwater monitoring was undertaken as part of the field works, with observations on groundwater only recorded at the time of site investigations.



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

Geotechnical Test Locations (NOHC)

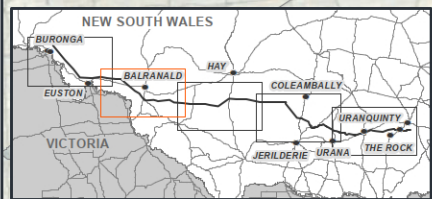
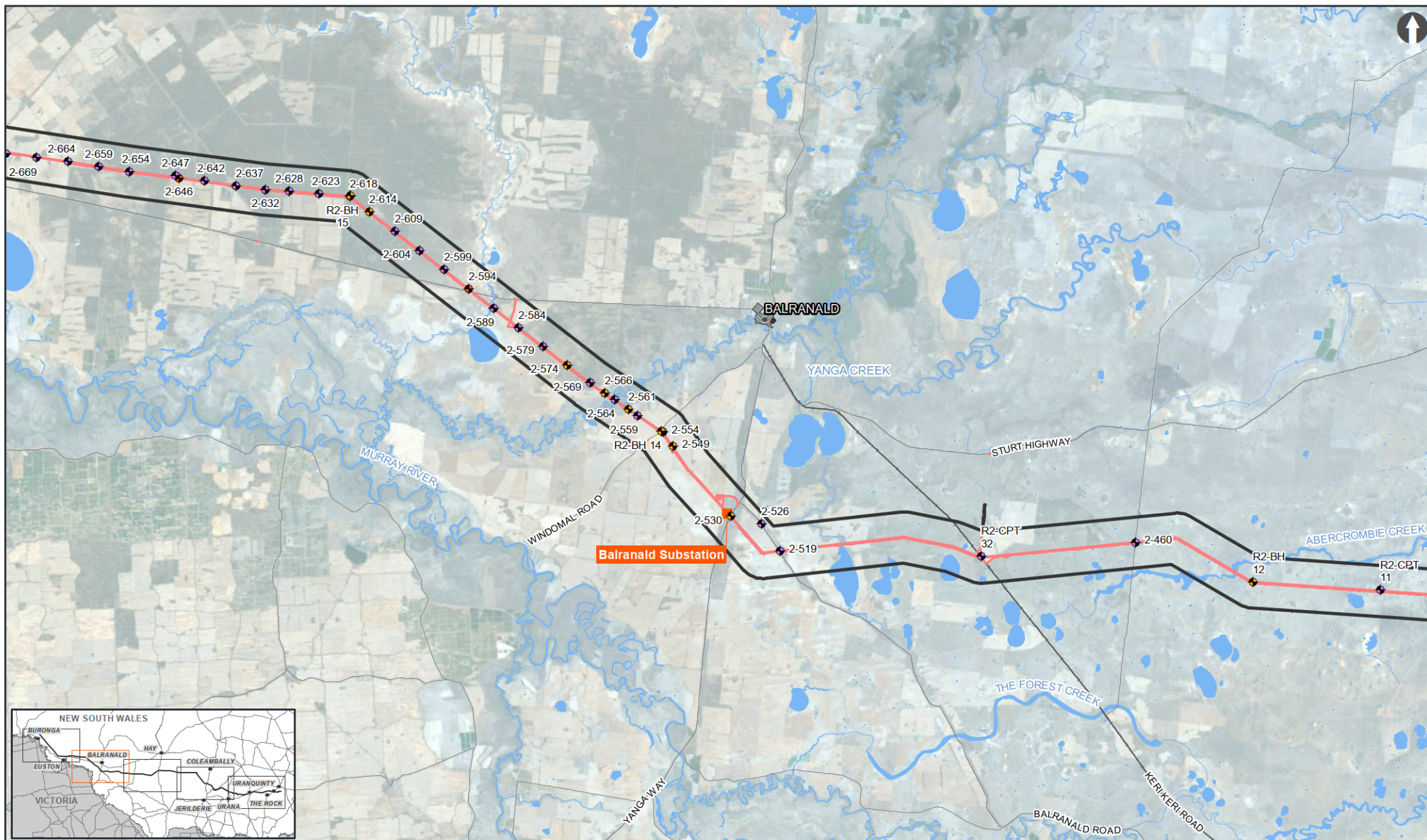
- BH (4)
- BH/CPT (1)
- CPT (26)

Legend

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater - Figure 3-1
Geotechnical Site Investigations

Sheet 1 of 5



0 10 20 KM

Project Components

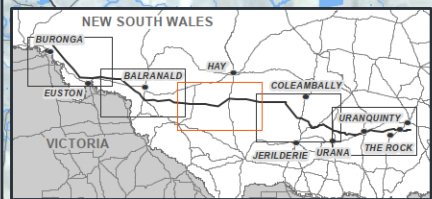
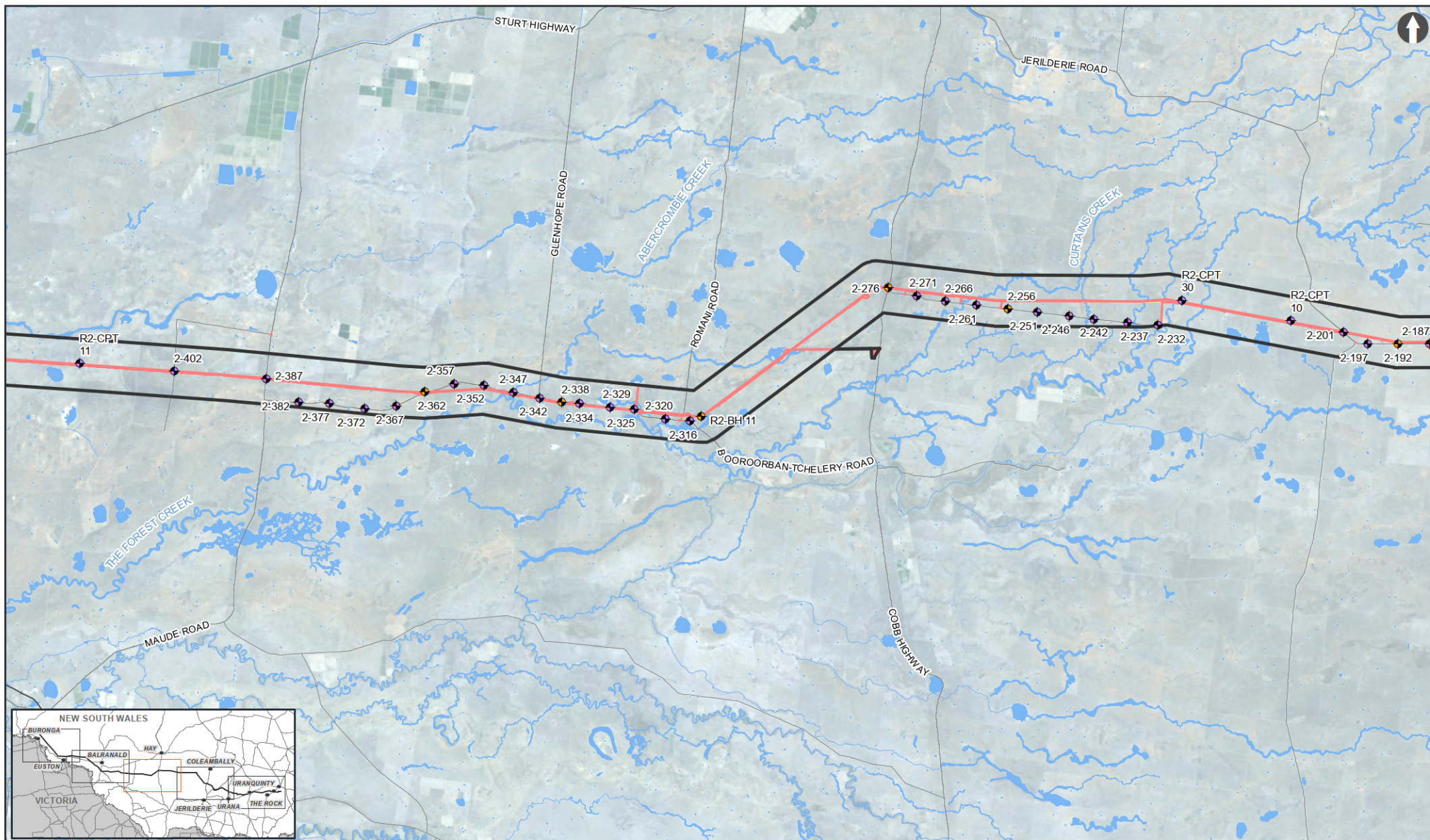
- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Geotechnical Test Locations (NOHC)

- ◆ BH (9)
- ◆ BH/CPT (2)
- ◆ CPT (27)

Groundwater - Figure 3-1
Geotechnical Site Investigations



0 10 20 KM

Project Components

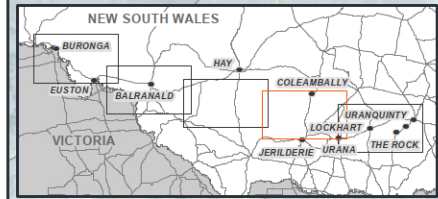
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- Built Up Areas

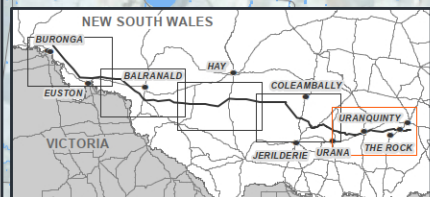
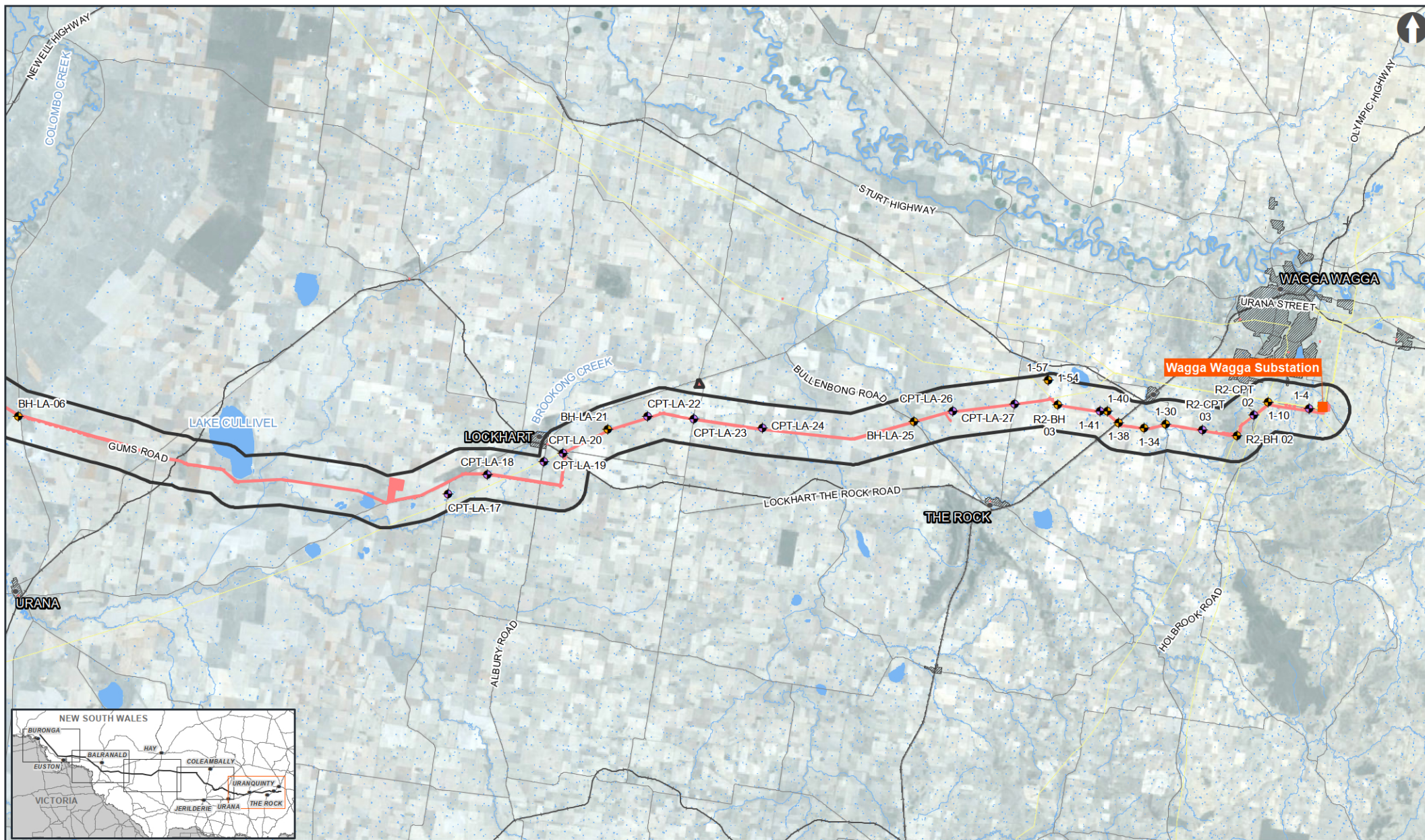
Geotechnical Test Locations (NOHC)

- ◆ BH (6)
- ◆ CPT (29)

Groundwater - Figure 3-1
Geotechnical Site Investigations



-  BH (27)
-  CPT (25)
-  PC (1)
-  TP (11)



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Geotechnical Test Locations (NOHC)

- ◆ BH (11)
- ◆ CPT (14)

Groundwater - Figure 3-1
Geotechnical Site Investigations

3.4 Impact assessment

3.4.1 Methodology

A qualitative assessment of the potential groundwater impacts from the proposal was conducted and considered the findings of the desktop review and geotechnical site investigations. Two primary potential groundwater impact mechanisms were determined to occur through, and primarily relate to, construction activities, they are:

- construction activities that have the potential to intersect the permanent regional water table and result in dewatering. These activities include bulk excavation earthworks for placement of transmission tower foundations or earthwork material sites
- construction activities that have the potential to significantly alter groundwater flow paths, impact groundwater levels. The only construction activity identified with this potential is blasting. Blasting may be undertaken in areas where shallow hard rock is encountered for the placement of transmission tower foundations.

The following items were considered for assessing the impact rating of the proposal:

- the existing hydrogeological environment (groundwater levels and quality, registered bores and GDEs) and the conceptual hydrogeological model
- the potential impacts and their risk to the hydrogeological environment from construction and operational activities, including:
 - the risk of intersecting the groundwater table
 - the potential risk of dewatering
 - potential changes to the availability and water quality for GDEs and registered water supply bores
- the effectiveness of identified mitigation measures
- any residual impacts post-mitigation.

The construction impact assessment (refer to Chapter 5) aims to identify potential impacts to groundwater based on the current understanding of the likely construction approach and construction methods.

The operational impact assessment (refer to Chapter 6) identifies potential impacts to groundwater from the operation of the proposal.

3.4.2 Impact risk ratings

For the purpose of this assessment, four potential impact significance rating categories were assessed with respect to potential impacts relating to the proposal. The considered impact ratings are:

- negligible, which indicates the impact is considered to cause no perceptible change to the local or regional hydrogeological environment
- low, which indicates a low potential for limited (in extent and/or time) impact to the hydrogeological environment may exist. However, the potential impact would cause no permanent perceptible change to the regional hydrogeological environment including GDEs and registered users
- moderate, which indicates a potential for permanent, but limited impact to the local hydrogeological environment may exist. However, the potential impact would cause no perceivable change to the regional hydrogeological environment
- high, which indicates a potential for permanent impact to the hydrogeological environment at both the local and regional scale. The potential impact could cause significant changes to groundwater availability or quality.

Outcomes of the impact assessment were used to develop mitigation measures to inform future stages of the design, construction and operation of the proposal.

3.4.3 *Minimal impact consideration*

An assessment of the proposal's 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 sources and culturally significant sites, against the *Minimal impact considerations* criteria outlined in the AIP (DPI, 2012), was undertaken in Chapter 7.

4 Existing environment

4.1 Catchment and waterbodies

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. There are a number of sub-catchments within the Murray-Darling Basin (MDB) (Murray-Darling Basin Authority, 2020) of which the proposal is located in the Murrumbidgee, Mid-Murray and Lower Darling catchments.

The majority of the groundwater study area is located in the Murrumbidgee catchment. The Murrumbidgee catchment is about 84,000 square kilometres (NSW DPI, 2020), around eight per cent of the MDB. The major river is the Murrumbidgee River which covers a length of 1,485 kilometres beginning in the Australian Alps in Kosciuszko National Park flowing west to its confluence with the Murray River near Balranald. Most of the inflow of the catchment occurs in the Great Dividing Range.

About 100 kilometres of the groundwater study area between Kidman Way and County Boundary Road is located in the Mid-Murray catchment. This catchment is about three percent of the MDB and spans the border with Victoria comprising an area of 14,675 square kilometres. It includes the Murray and Edward rivers and supports extensive areas of irrigated agriculture (pasture and crops). The groundwater study area is located in the upper reaches of this catchment.

The western 120 kilometres, from around Waldaira Creek to Buronga is located in the Lower Darling catchment. The Lower Darling catchment is about three per cent of the MDB. The major river systems are the Darling River and the Great Darling Anabranch, located around 32 and 40 kilometres west of the proposal, respectively.

A local intermediate catchment exists around the eastern portion of the groundwater study area that drains into Lake Albert at around 190 metres Australian Height Datum (mAHD). Lake Alberts catchment is surrounded by the Gregadoo Hills to the south and local relief.

Lakes and waterbodies located along the length of the proposal include Dry Lake, Lake Bennee, Lake Caringay, Waldaira Lake, Condoulpe Lake, Dusty Lake, Five Tree Dam, Lake Urana, Lake Cullivel and Lake Albert.

Lake Urana is a large shallow intermittent salt lake in a depression at the end of the drainage basin of Billabong, Coonong and Urangeline creeks. It fills every ten to 20 years and retains water for several years (NSW National Parks and Wildlife Service, 2020). Lake Albert is a 125 hectare artificial lake in the suburb of Lake Albert in Wagga Wagga. The lake is used for recreational purposes including water sports, boating and fishing (Wagga Wagga City Council, 2020).

4.2 Topography

The topography of the groundwater study area varies from the western end to the eastern end. At a macro level, the catchments slope from east to west with the eastern end of the groundwater study area at about 200 metres above sea level and the western end of the groundwater study area at about 40 metres above sea level at Mildura. Localised topographic highs of up to around 380 mAHD occur around 10 kilometres west of the Wagga Wagga substation and are associated with the Gregadoo Hills (granitic mountain ridge).

4.3 Climate and rainfall

The region has a semi-arid climate with hot summers and cool winters. The average temperature range is around 16 to 33°C in summer and around 4 to 15°C in winter. The average annual rainfall across the groundwater study area is variable, however generally average rainfall values are higher at the eastern end of the groundwater study area and lower at the western end.

The closest weather station to Buronga at the western end of the groundwater study is Irymple (station number: 076015), which 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 Urana Post Office weather station (station number: 074110) near the eastern half of the groundwater study area records an annual average rainfall of 442.2 millimetres (1871–2020). The average monthly rainfall is slightly higher in May and June.

Near the eastern end of the groundwater study area, the average annual rainfall at Wagga Wagga Gurwood Street station (station number: 074127) is 528.1 millimetres from 2001–2020 and 568 millimetres from 1941–2020 at Wagga Wagga AMO station (station number: 072150).

4.4 Land use

Most of the groundwater study area is used for grazing native vegetation and is classified as such in mapping completed by the former NSW Office of Environment and Heritage, *NSW Land Use* 2013 (OEH, 2013). Grazing of goats, cattle and sheep (for wool and meat) is common. Much smaller proportions are classified as cropping or grazing modified pastures by OEH (2013).

4.5 Soil types

The soils along the groundwater study area are mapped as primarily vertosols according to Australian Soil Classification (CSIRO, 2016) found along the main watercourses sand and alluvial plains in proximity to the Murrumbidgee, Darling, and Darling – Anabranch Rivers. Published soil mapping along the alignment indicates that the regional geology and soils are expected to be predominantly transported Quaternary-aged sediments deposited in alluvial flood plains, and dune. The predominant soil types are typically sand and clay or a mixture of the two.

4.6 Geology

The groundwater study area occurs within the MDB and its associated sediments. This section provides a general summary of the NSW MDB stratigraphy and identification of published mapped outcropping sediments within the groundwater study area.

4.6.1 Murray-Darling Basin stratigraphy

The underlying regional geology of the MDB can be separated into three distinct groups based on age (Brown, 1985) that extend up to 600 metres in thickness (Evans & Kellet, 1989). The geological groups are shown in Figure 4-1 and summarised below (in decreasing age):

- The Renmark Group is at the base of the MDB, comprising of 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 around 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 MDB and is 12 to 30 million years old. The Murray Group includes 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 MDB.
 - 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 underlie a sequence of aeolian dunes that dominate the western MDB geology, known as the Woorinen Formation.
 - Recent alluvial deposits restricted to proximity to the major rivers within the region comprise the Coonambidgal Formation as well as scattered gypsum (calcrete) of the Yamba Formation and clay lunettes.

Within the Lower Murrumbidgee and along the proposal alignment, the basin sediments are estimated to reach a maximum thickness of 400 metres near Balranald (DPIE, 2019b).

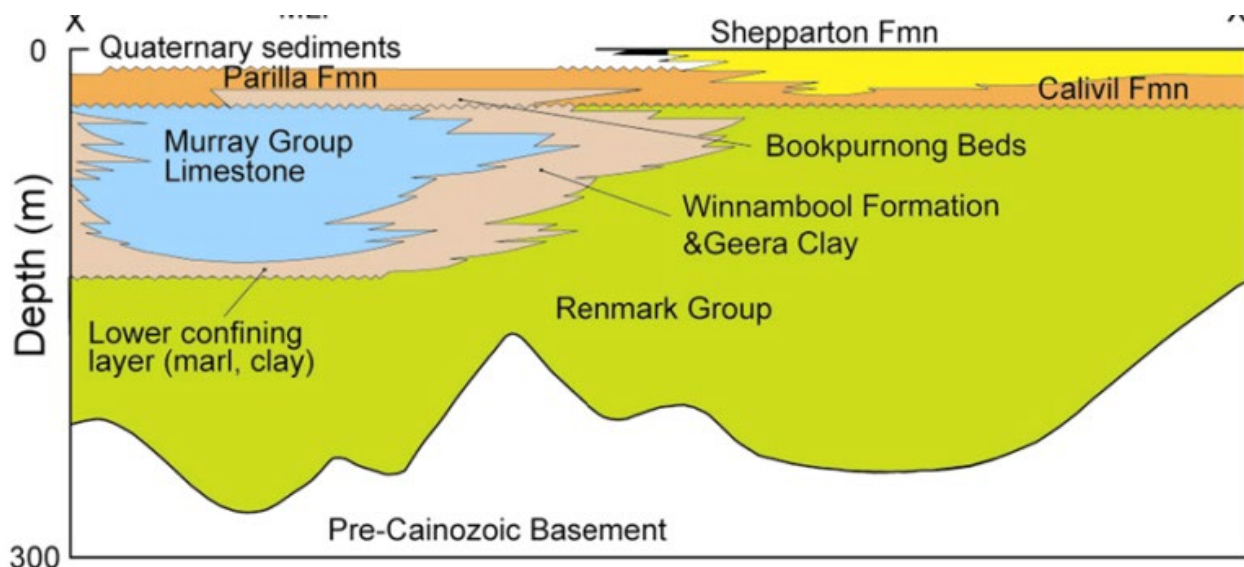


Figure 4-1 Simplified geological cross-section (east to west) of the MDB (Evans & Kellet, 1989, adapted by Cartwright et al, 2012)

4.6.2 Mapped geology

Published geological mapping data from the Seamless Geology Project (Colquhoun, Hughes & Deyssing et al, 2019) identified multiple distinct geological regions across the groundwater study area. The regions broadly correspond to:

- An eastern region that defines the Lake Albert catchment around the Wagga Wagga substation and extends around 10 kilometres west. This region corresponds to an area of varying elevation that ranges from around 200 to 380 mAHD, where the geology is dominated by outcropping and potentially shallow hard rock with associated residual and colluvial soils of the Lachlan Fold Belt. Alluvium sediments are present and occur at lower elevations (below around 250 mAHD) and increase in extent to the north, towards Lake Albert. Locally outcropping granite and aeolian sand plains exist east of the Wagga Wagga substation.

- A region west of the outcropping rock that defines the Lake Albert catchment and extends around 90 kilometres west to Lake Urana. This region is dominated by colluvial, residual and aeolian sediments, with localised alluvium and playa lake deposits. Fluvial sediments of the Shepparton Formation exist proximal to Lake Urana and localised shallow hard rock, such as duricrust or ironstone may be present due to regolith processes. Where the Shepparton Formation is absent, the outcropping geology is part of the Lachlan Fold Belt.
- A large region that starts around Lake Urana and extends west for 250 kilometres. This region is dominated by the clay rich sediments of the fluvial Shepparton Formation. Localised aeolian lunettes, dunes, claypans and lacustrine deposits, alluvial and aeolian sand plains occur.
- A large region, around 175 kilometres, that extends from Buronga at the western end of the proposal to the region dominated by the Shepparton Formation sediments. This area is mainly covered by aeolian sand dune fields of the Woorinen Formation. Localised alluvial and fluvial sediments of the Shepparton Formation and playa lake and lacustrine deposits occur.

The majority of the groundwater study area is covered by the sediments of the Shepparton Formation. Shallow hard rock determined through the methodology outlined in Section 3.2.2 is anticipated to occur within less than five percent of the construction impact area and is associated with the Lachlan Fold Belt geology (outcropping hard rock geology such as granites, residual soils with identified ferricrete or colluvium sediments).

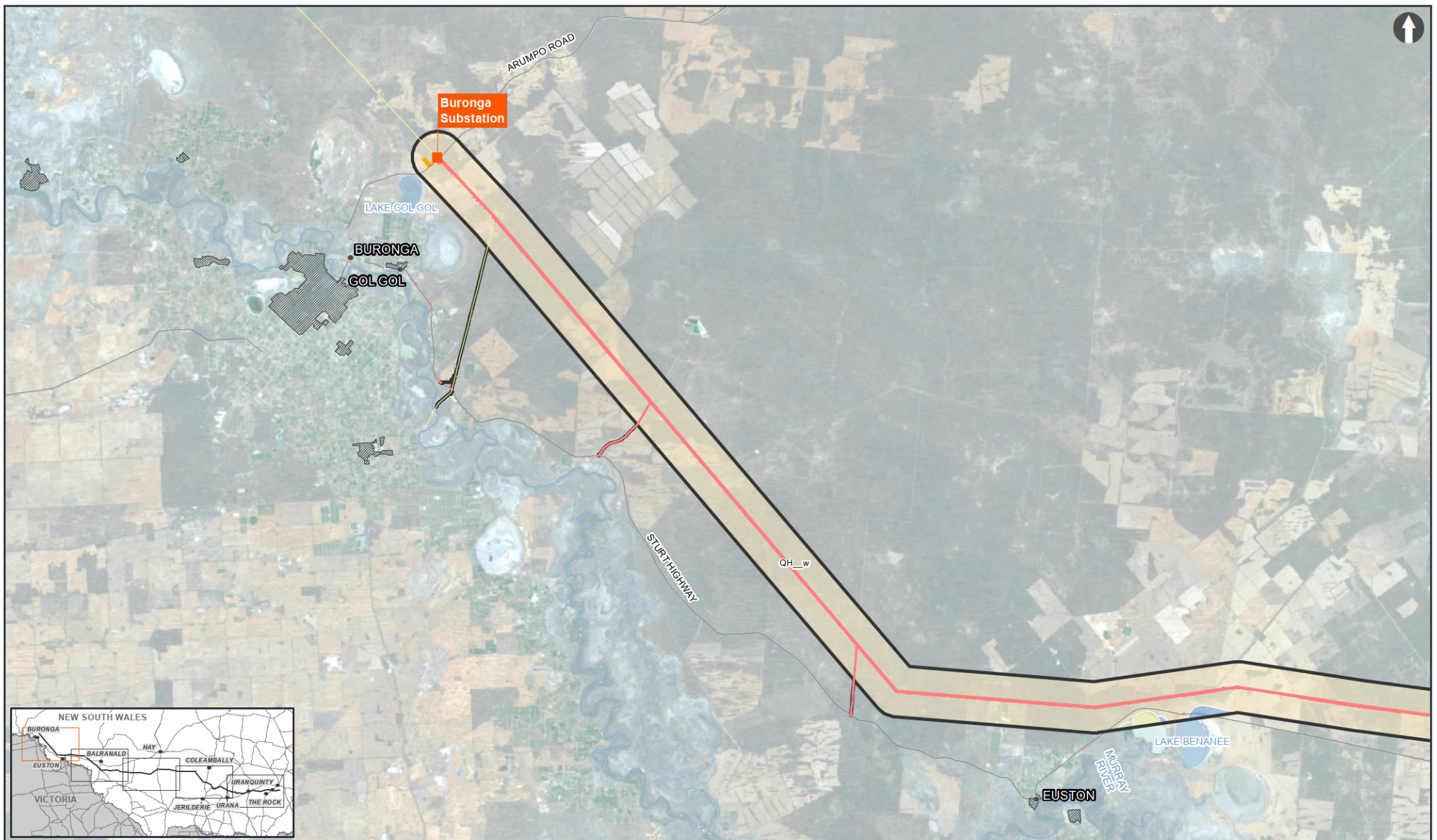
Geological units within the groundwater study area, their origin and corresponding dominant soil type are listed in Table 4-1, with mapped geology shown in Figure 4-2.

Table 4-1 Main regional geological units within the groundwater study area

NSW SEAMLESS GEOLOGY CODE	GEOLOGICAL UNIT¹	GEOLOGICAL MATERIAL TYPE
Q_a	Alluvium	Channel and flood plain alluvium; gravel, sand, silt, clay.
Q_acm	Alluvium	Alluvium channel deposits – meander-plain facies.
Q_af	Alluvial floodplain	Silt, very fine- to medium-grained lithic to quartz-rich sand, clay.
Q_ath	Alluvial terrace deposits	Silt, clay, polymictic gravel, (fluvially-deposited) fine- to medium-grained quartz-lithic sand.
Q_c	Colluvium	Poorly sorted, weakly cemented to unconsolidated colluvial lenses of polymictic conglomerate with medium- to very coarse-grained sand matrix.
Q_cr	Colluvium and/or residual	Colluvium and/or residual deposits, talus, scree, sheet wash; boulder, gravel, sand, may include minor alluvial or sand plain deposits.
Q_ddl	Aeolian lunette	Red-brown to light brown, silty bi-modal quartz sand, sporadically clayey; locally capped by off-white to beige mobile quartz sand. Regolith carbonate accumulations at depth.
Q_dds	Dunes	Red-brown to light-brown, poorly sorted to bi-modal, very fine- to medium-grained feldspathic quartz sand.
Q_ds	Aeolian sand plain	Flat to low undulating or hummocky fossil sand plain, red-brown to brown and humic, clayey, silty to fine-grained sand, silty clay at depth; abundant regolith & pedogenic carbonate, extensively modified by pedogenesis.

NSW SEAMLESS GEOLOGY CODE	GEOLOGICAL UNIT ¹	GEOLOGICAL MATERIAL TYPE
Q_l	Claypan and lacustrine deposits	Friable to plastic, finely laminated grey clay, silty clay, humic clay.
Q_ld	Drainage depression deposits	Clay-rich silt and very fine- to medium-grained unconsolidated lithic-quartz sand.
Q_lp	Playa lake deposits	Friable to plastic, finely laminated grey clay, silty clay, humic clay.
Q_r	Quaternary residual deposits	Soil material which results from the weathering and decomposition of the underlying parent rock that has not been transported from its place of origin. Dominant material type will be dependent on the underlying parent material.
Cza	Alluvium	Channel and flood plain alluvium; gravel, sand, silt, clay; may be incised by present day drainage.
CZ_rff	Residual	Ferricrete, indurated red-brown to near black regolithic material or duricrust and/or ironstone.
Czwua	Blanchetown Clay	Laminated greenish-grey and red-brown clay and silty clay, locally calcareous and gypsiferous; minor interbedded quartz sand, ostracod sand; contains calcareous, gypsiferous and siliceous nodules.
Czswus	Shepparton Formation	Unconsolidated to poorly consolidated mottled variegated clay, silty clay with fences of polymictic, coarse to fine grained sand and gravel; includes, intercalated red-brown paleosols. Forms extensive flat alluvial floodplains.
Oada	Abercrombie Formation	Brown and buff to grey, thinly to thickly bedded, fine- to coarse-grained mica-quartz sandstone, interbedded with laminated siltstone and mudstone.
O_sw	Wagga Group	Quartzose, siltstone, sandstone, quartz-mica, schist, phyllite, chert, locally metamorphosed, minor quartzite, graphitic schist, hornfels.
QH_s	Lowan Sand	Unconsolidated, locally mobile, red-brown-pale orange quartz sand dunes; medium to fine quartz grains admixed with humic debris and fragmented calcareous and gypsiferous filamental rhizoliths; weakly modified by pedogenesis.
QH_w	Woorinen Formation	Fossil dunefields of openly spaced, east- west linear dunes; red-brown to light brown humic, clayey to silty, fine- to medium-grained sand with red clay cutans, silty clay at depth; abundant regolithic and pedogenic carbonate; modified by pedogenesis.
Skym	Mount Flankey Granite	Felsic, fractionated granite.
Stgw	Wantabadgery Granite	Medium-grained, grey, massive to foliated (at the margins), equigranular to porphyritic granite.
Suwc	Collingullie Granite	Felsic, unfractionated granite.

(1) Not in stratigraphic order.



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

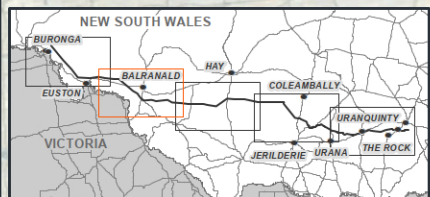
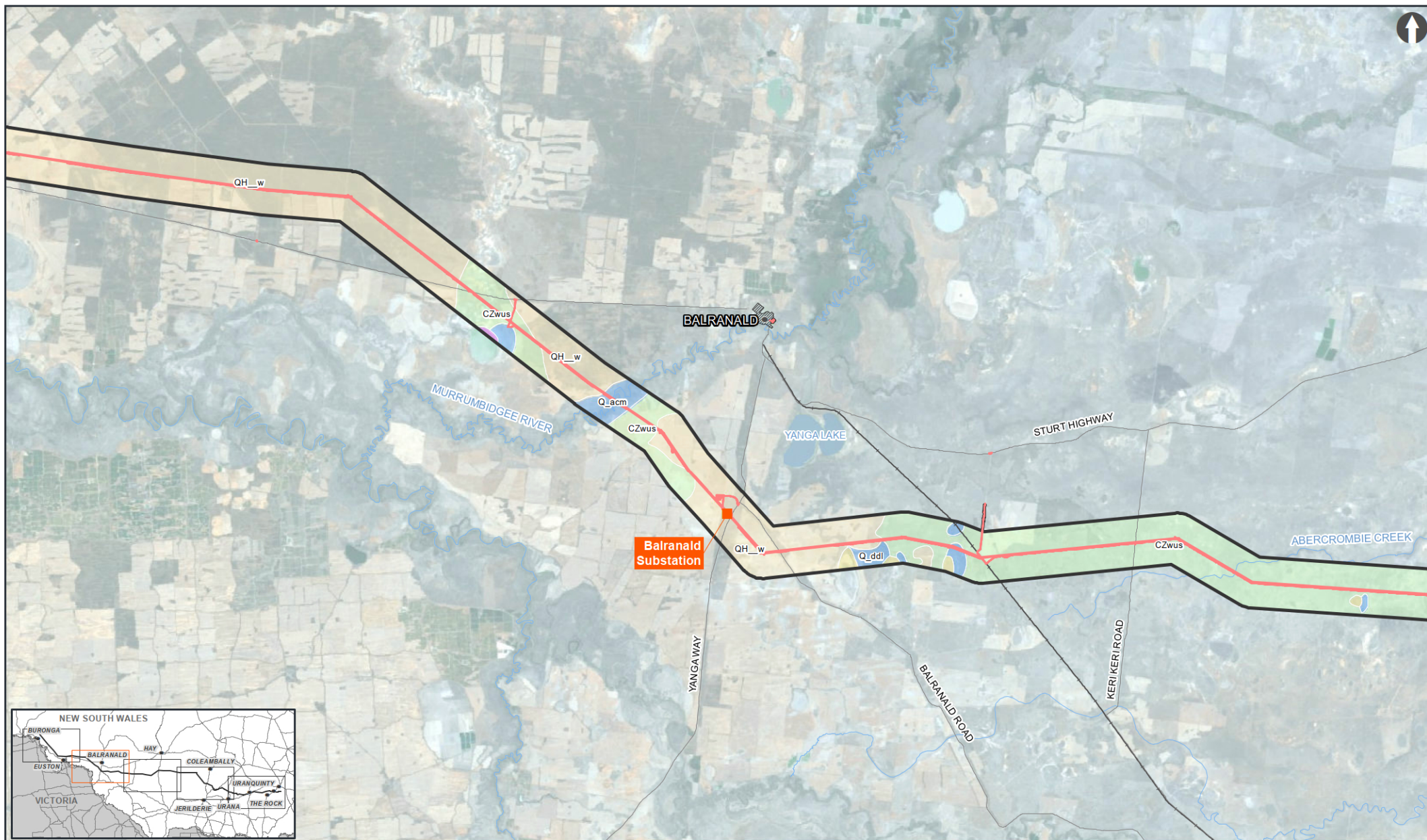
Cenozoic Sedimentary Province

- CZwus: Shepparton Formation
- QH_w: Woorinen Formation
- Q_ddl: Aeolian lunette
- Q_l: Claypan and lacustrine deposits

Groundwater - Figure 4-2

Regional Geology

Sheet 1 of 5



0 10 20 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

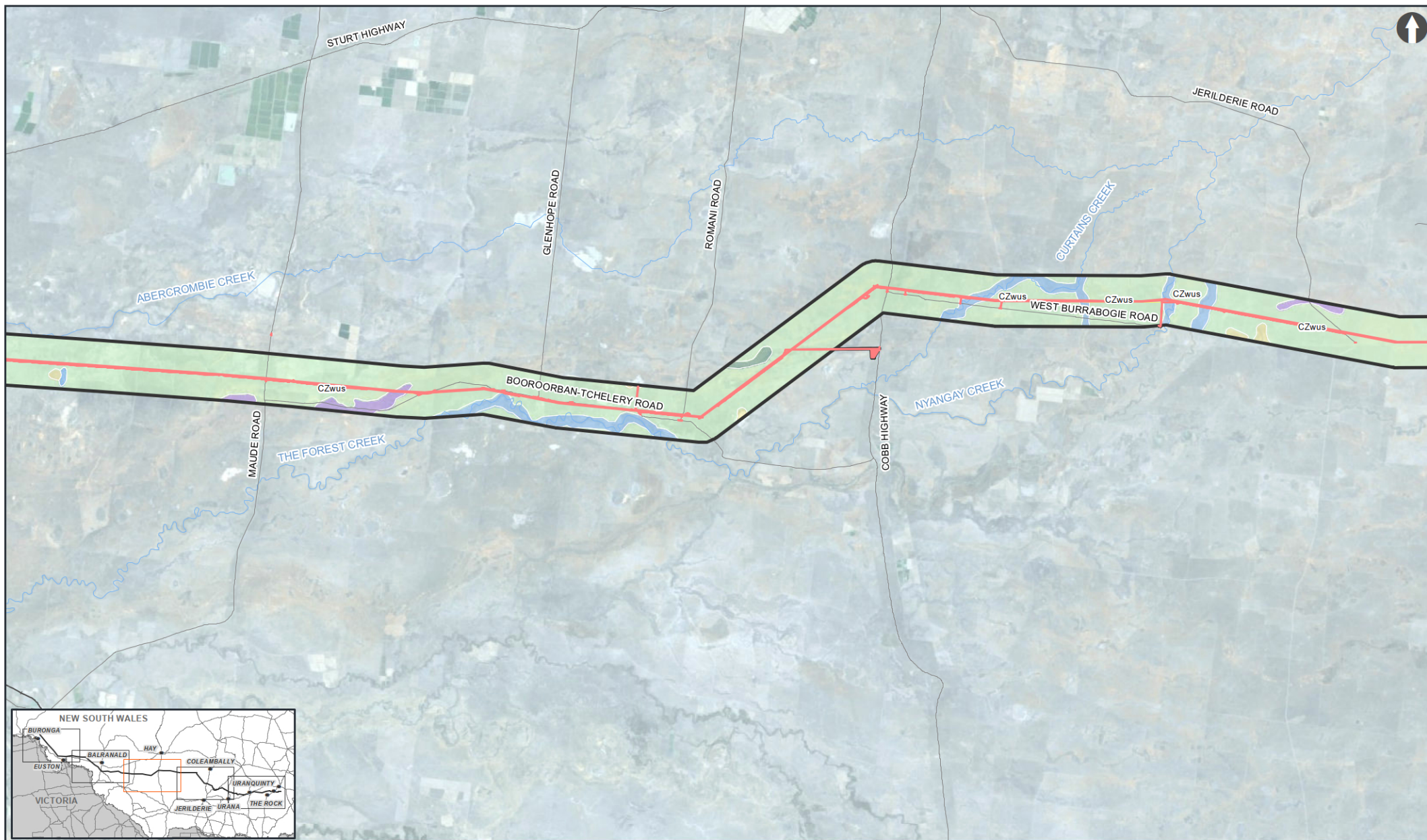
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Cenozoic Sedimentary Province

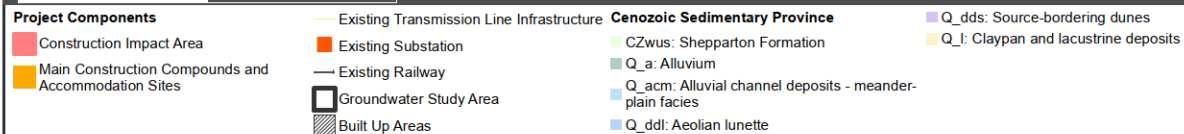
- CZwus: Shepparton Formation
- QH_w: Woorinen Formation
- Q_acm: Alluvial channel deposits - meander-plain facies
- Q_ddl: Aeolian lunette

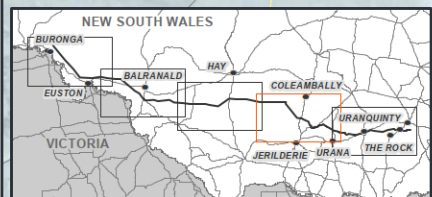
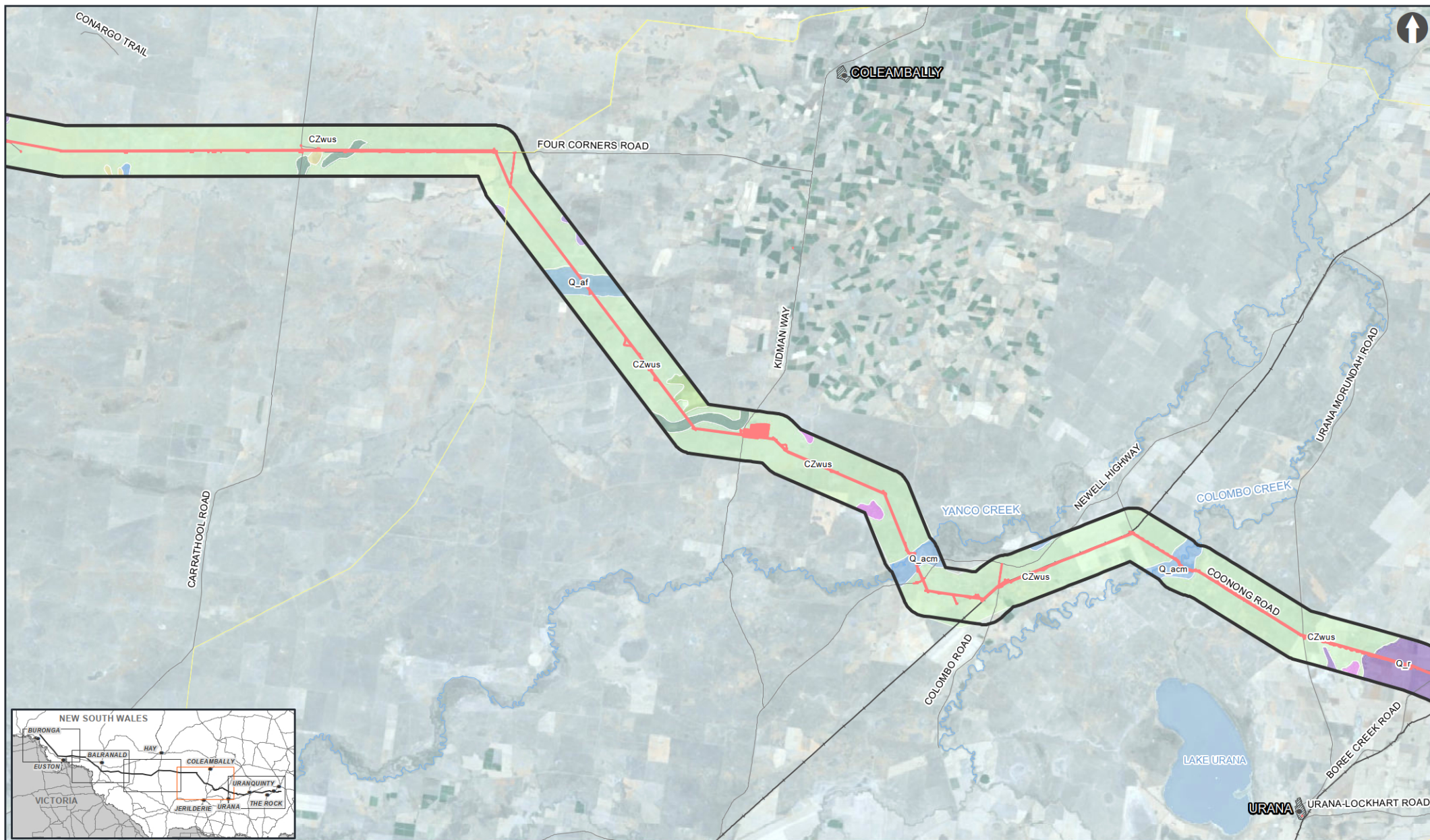
- Q_l: Claypan and lacustrine deposits
- Q_lp: Playa lake deposits

Groundwater - Figure 4-2
Regional Geology



Groundwater - Figure 4-2
Regional Geology





Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

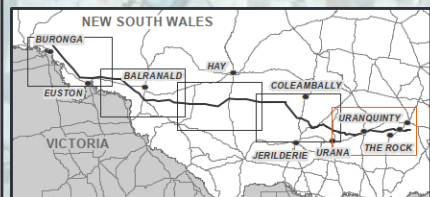
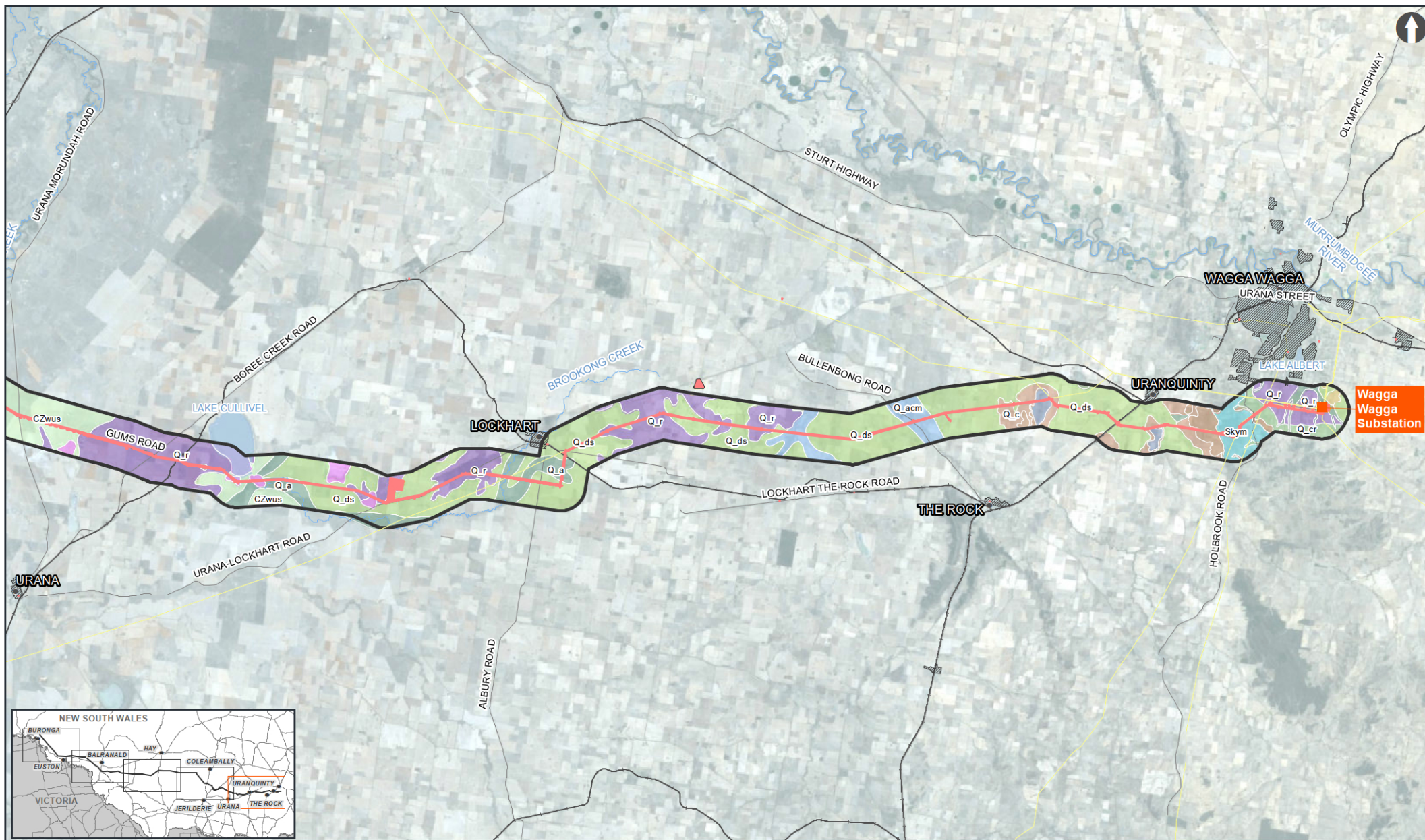
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Cenozoic Sedimentary Province

- CZwus: Shepparton Formation
- Q_a: Alluvium
- Q_acm: Alluvial channel deposits - meander-plain facies
- Q_af: Alluvial floodplain deposits

- Q_ddl: Aeolian lunette
- Q_dds: Source-bordering dunes
- Q_ds: Aeolian sand plain
- Q_l: Claypan and lacustrine deposits
- Q_lp: Playa lake deposits
- Q_r: Residual deposits

Groundwater - Figure 4-2
Regional Geology



0 10 20 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Lachlan Orogen

- Oada: Abercrombie Formation
- Skym: Mount Flakney Granite
- Stgw: Wantabadgery Granite
- Suwc: Collingullie Granite
- CZ_rff: Residual deposits- ferricrete
- CZwus: Shepparton Formation
- Q_a: Alluvium
- Q_acm: Alluvial channel deposits - meander plain facies

Cenozoic Sedimentary Province

- Q_c: Colluvium
- Q_cr: Colluvial and residual deposits
- Q_ds: Aeolian sand plain
- Q_ld: Drainage depression deposits
- Q_lp: Playa lake deposits
- Q_r: Residual deposits

Groundwater - Figure 4-2
Regional Geology

4.7 Hydrogeology

4.7.1 Hydrostratigraphy

This section describes the hydrostratigraphic units (HSUs) which underlie the groundwater study area and have been adopted for this assessment. HSUs are defined as geological material of similar hydrogeological properties. HSUs are generally based on stratigraphic units, although units of similar groundwater storage and transmissive properties are often classified together as a single HSU.

For the groundwater study area, HSUs are delineated as per groundwater sources listed within the water sharing plans (Section 2.2.2.2) as this provides a consistent classification approach for the groundwater impact assessment. Details on the HSUs, taken from the groundwater resource descriptions (DPIE, 2019a, 2019b & 2019c), within the groundwater study area are provided in Table 4-2 and their relationship to the MDB sediments identified. Note, the Lachlan Fold Belt MDB groundwater source is henceforth referred to as ‘Lachlan fractured rock’ and the NSW Murray-Darling Basin Porous Rock Groundwater Sources as ‘Porous rock’. The encountered depth listed corresponds to the HSU and not exact groundwater levels, which are discussed in Section 4.7.2. For the purpose of this assessment the depth distinction between the shallow and deep aquifers of the corresponding HSUs have been simplified to:

- Murrumbidgee Alluvium
 - Shallow: includes all water bearing zones up to 40 mBGL
 - Deep: includes all water bearing zones deeper than 40 mBGL
- Porous rock
 - Shallow: includes all water bearing zones up to 50 mBGL
 - Deep: includes all water bearing zones deeper than 50 mBGL
- Lachlan fractured rock
 - Shallow: includes all water bearing zones up to 30 mBGL
 - Deep: includes all water bearing zones deeper than 30 mBGL.

Table 4-2 Hydrostratigraphic units within the groundwater study area and their thickness, depths and characteristics (DPIE, 2019a; 2019b & 2019c)

HSU	AQUIFER	ESTIMATED THICKNESS (m)	ENCOUNTERED DEPTH (mBGL)	CORRESPONDING MDB GEOLOGY	CHARACTERISTICS
Murrumbidgee Alluvium	Shallow	40–60	0 (surface)	Shepparton Formation	- Typically unconfined consisting of clay and silt sediments interbedded with water bearing sand layers. - Recharge occurs through leakage from the Murrumbidgee River and its various tributaries and anabranches, infiltration from rainfall and irrigation activity. - Groundwater flow is generally east to west.
	Deep	40–400	40+	Calivil Formation and Renmark Group	- Typically confined to semi-confined where sediments of the Calivil Formation consist of fluvial paleo-drainage paths of water bearing sand and gravel layers up to 12 metres thick and the Renmark Group is dominated by water bearing sand layers. - Recharge to the system is primarily through connectivity between groundwater sources and leakage from the overlying shallow aquifer. - Groundwater flow is generally east to west. - Bore yields vary but have been reported to be as high as 350 litres per second (L/s).
Porous rock	Shallow	10–90	Variable, dependent on aeolian cover	Pliocene sands (Loxton Parilla and Calivil Formation)	- Semi-confined aquifer where groundwater flow is governed by both primary porosity (movement of water around rock grains) and secondary porosity (water movement through fractures). - Groundwater flow is strongly influenced by the degree of weathering of the rock mass. - Recharge to the system is primarily through infiltration from rainfall, runoff, surface water within outcropping areas and groundwater flow from connected groundwater sources. - Bore yields are highly variable, ranging between 0.5–100 L/s, but commonly greater than 10 L/s. - Groundwater flow is generally east to west.

HSU	AQUIFER	ESTIMATED THICKNESS (m)	ENCOUNTERED DEPTH (mBGL)	CORRESPONDING MDB GEOLOGY	CHARACTERISTICS
	Deep	10–330	40+	Renmark Group	— Confined water bearing sands of the Renmark Group. — Recharge to the system is primarily through connectivity between groundwater sources and leakage from the overlying shallow aquifer. — Bore yields typically range between 0.5–50 L/s, but can occasionally be greater than 50 L/s. — Groundwater flow is generally east to west but influenced by the underlying Lachlan fractured rock topography.
Lachlan fractured rock	Shallow	0–30	Can significantly vary	Pre-Cainozoic Basement and associated overlying sediments	— Unconfined to confined aquifer depending on location and overlying geology. — Groundwater is stored and moves through fractures, joints, bedding plains, faults and cavities within the rock mass or weathered zone (for the shallow aquifer). — Groundwater flow is generally controlled by topography but will be influenced by localised fracture systems and regional geological structures. — Hydraulic connectivity between surface water features, other overlying aquifers and between the shallow and deep fractured rock aquifers is limited to the degree of fracturing extending between the aquifers or the bed of the surface water features. — The fractured rock aquifers are considered to generally contain low hydraulic connection with overlying aquifers and surface water features throughout the groundwater study area.
	Deep	100+	Can significantly vary	Pre-Cainozoic Basement	

4.7.2 Groundwater levels

Groundwater level information was collated from relevant regional studies, available local information (such as registered bores) and site-specific data are provided in the following subsections. For the conceptual understanding of expected groundwater levels refer to Section 4.7.6.

4.7.2.1 Published regional groundwater levels

Murrumbidgee Alluvium

The regional groundwater level contour map generated from 2015–2016 government data (DPIE, 2019a) is shown in Figure 4-3. Refer to Figure 2-2 for the location of the proposal relative to the groundwater resource. Based on the contour map, groundwater levels are anticipated to be around 115–120 mAHD along the eastern boundary of the HSU and decreasing to 55 mAHD at Balranald. This is indicatively 5–10 mBGL at the eastern HSU boundary and 10 mBGL at Balranald.

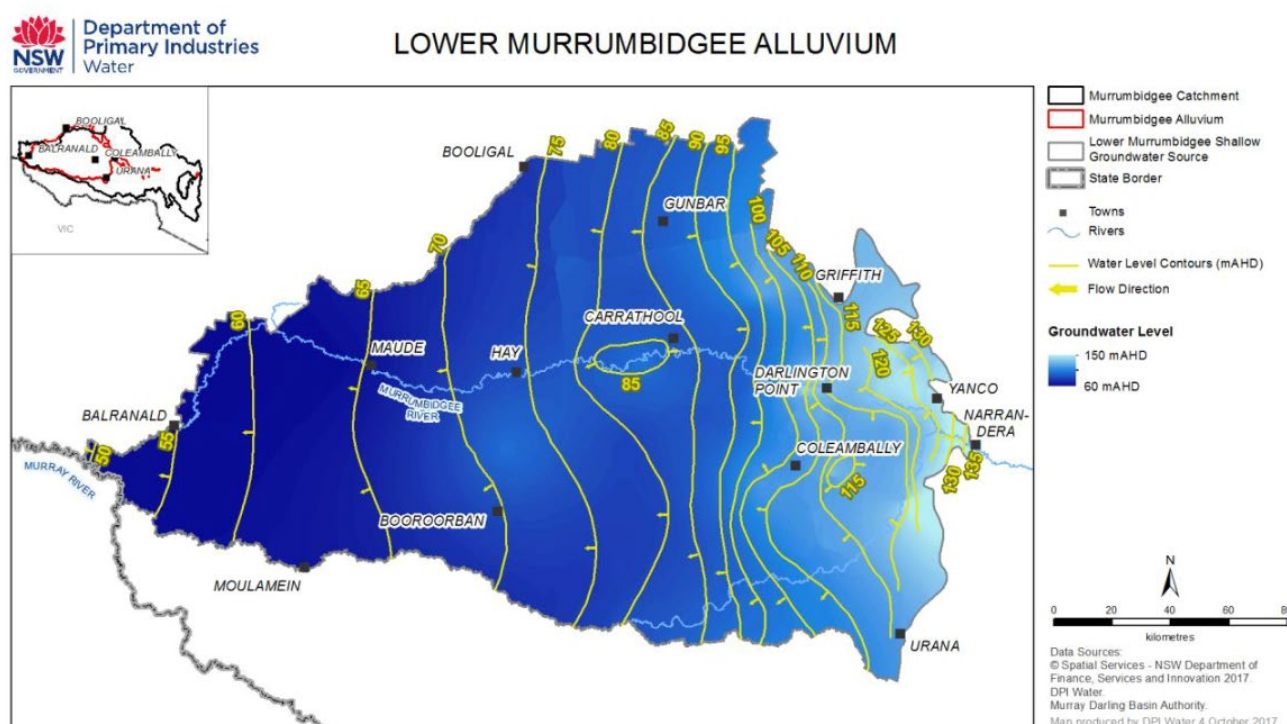


Figure 4-3 Murrumbidgee Alluvium HSU groundwater contour map 2015/2016 (DPIE, 2019a)

Porous rock

There are no available regional groundwater contour maps or proximal groundwater level information published within the DPIE (2019b) water resource description report for the corresponding Porous rock HSU.

Lachlan fractured rock

There are no available regional groundwater contour maps or proximal groundwater level information published within the DPIE (2019c) water resource description report for the corresponding Lachlan fractured rock HSU.

4.7.2.2 Groundwater levels from registered bores

Table 4-3 summarises the available groundwater level records from reviewed registered bore data within the groundwater study area. The complete list of reviewed registered bore data is provided in Appendix A, with available hydrographs from registered monitoring bores presented in Appendix B. The location and additional registered bore details, such as the registered purposes and functions of identified registered bores is shown and discussed in Figure 4-5 and Section 4.7.5.1, respectively.

Table 4-3 Registered groundwater bores and their groundwater level statistics (WaterNSW, 2021).

INFERRED HSU	AQUIFER	GROUNDWATER LEVEL (mBTC) ¹				
		Count ²	Minimum SWL ³	Maximum SWL	Average SWL	Median SWL
Murrumbidgee Alluvium	Shallow	28	9.0	24.0	17.4	17.8
	Deep	11	15.8	27.0	22.0	22.7
Porous rock	Shallow	15	7.1	21.9	17.0	17.0
	Deep	6	9.0	30.8	16.7	15.1
Lachlan fractured rock	Shallow	5	2.0	7.6	4.0	3.0
	Deep	17	27.4	61.0	41.0	39.9

(1) mBTC = metres below top of casing (as recorded in WaterNSW (2021))

(2) Number of unique groundwater level measurements used to determine statistics

(3) SWL = Standing water level

4.7.2.3 Gregadoo monitoring bores

Wagga Wagga City Council operates the Gregadoo Waste Management Centre at Ashfords Road, Wagga Wagga NSW. As part of its Environmental Protection Agency licencing requirements, Wagga Wagga City Council monitors groundwater levels and quality. The location of the monitored groundwater bores and Gregadoo Waste Management Centre is shown in Figure 4-4 and is located at the eastern extent of the proposal and groundwater study area.

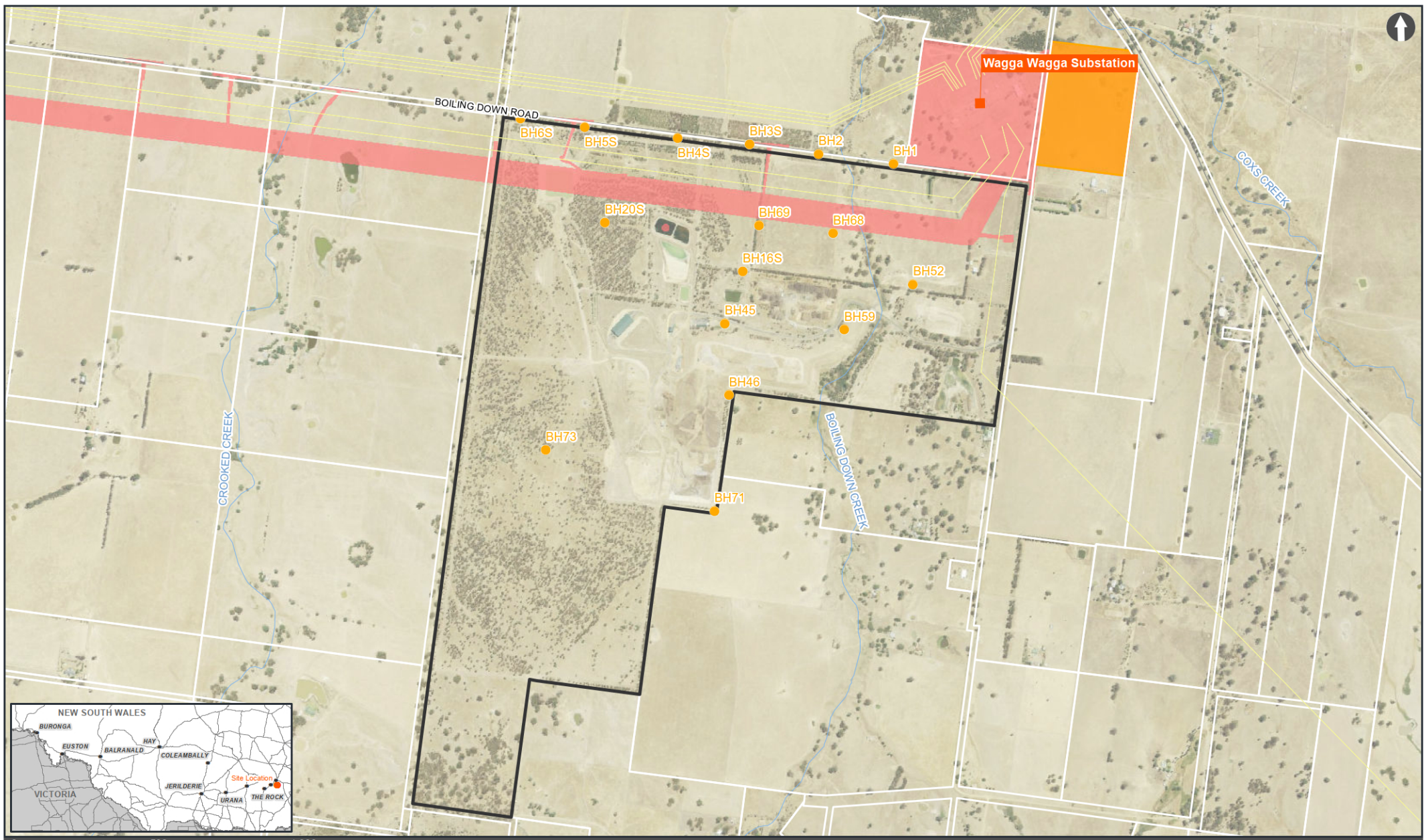
A summary of groundwater levels monitored from 2012 to 2020 by McMahon Earth Science (2020) is provided in Table 4-4. The monitored groundwater levels correspond to groundwater levels measured in colluvium and alluvium deposits of the Lachlan fractured rock HSU shallow aquifer (this report). Typically, throughout the monitoring period the bores were dry, however elevated (shallow) groundwater levels were observed once during the monitoring period locally in BH4S, BH5S, BH6D, BH16D and BH46.

Table 4-4 Gregadoo monitoring bore groundwater level summary (McMahon Earth Science, 2020)

MONITORING BORE ID	DRILLED DEPTH	GROUNDWATER LEVEL (m)	
		Minimum	Maximum
BH1	22.70	Dry	Dry (>22.70)
BH2	16.10	Dry	Dry (>16.10)
BH3S	5.45	Dry	Dry (>5.45)
BH3D	12.65	Dry	Dry (>12.65)
BH4S	5.10	0.98	Dry (>5.10)
BH4D	12.40	11.98	Dry (>12.40)

MONITORING BORE ID	DRILLED DEPTH	GROUNDWATER LEVEL (m)	
		Minimum	Maximum
BH5S	5.80	1.37	Dry (>5.80)
BH5D	12.30	Dry	Dry (>12.30)
BH6S	4.80	Dry	Dry (>4.80)
BH6D	11.70	0.70	Dry (>11.70)
BH16S	5.40	5.46	Dry (>5.40)
BH16D	11.90	1.55	Dry (>11.90)
BH20S	4.80	1.45	Dry (>4.80)
BH20D	12.70	Dry	Dry (>12.70)
BH45	8.80	5.30	6.31
BH46	5.80	0.33	Dry (>5.80)
BH52	7.80	3.15	Dry (>7.80)
BH59	22.00	22.00	Dry (>22.00)
BH68	12.00	5.64	Dry (>12.00)
BH69	11.70	Dry	Dry (>11.70)
BH71	11.70	Dry	Dry (>11.70)
BH73	22.00	16.32	Dry (>22.00)
MB01	24.00	Dry (>24.00) ¹	
MB02	14.60	Dry (>14.60) ¹	
MB03	14.60	Dry (>14.60) ¹	
MB04	29.50	Dry (>29.50) ¹	
MB05	29.47	Dry (>29.47) ¹	
MB06	29.60	24.3 (>29.60) ¹	
MB07	23.55	Dry (>23.55) ¹	
MB08	26.45	16.18 (>26.45) ¹	
MB09	11.60	Dry (>11.60) ¹	
MB10	11.55	Dry (>11.55) ¹	

(1) Monitoring bore installed in 2020.



Groundwater - Figure 4-4

Project Components		Existing Transmission Line Infrastructure	Groundwater Monitoring Bore (Wagga Wagga City Council)
Construction Impact Area	Existing Substation	Existing Railway	
Main Construction Compounds and Accommodation Sites	Gregadoo Waste Management Site		

Gregadoo Waste Management Monitoring Bores

4.7.2.4 Site specific groundwater levels

Table 4-5 lists the groundwater observations by DP (2020a and 2020b) and SMEC (2020a, 2020b & 2020c) with a summary provided in Table 4-6. It is inferred due to the maximum depth of investigations that groundwater observations relate to shallow aquifers or perched groundwater. Investigation locations are shown in Figure 3-1 (Section 3.3).

Table 4-5 Locations of observed groundwater inflow during field investigations (DP, 2020a & 2020b; SMEC, 2020a, 2020b & 2020c)

GEOTECHNICAL LOCATION ID	INFERRED HSU	OBSERVED GROUNDWATER LEVEL (mBGL) ¹
BH1-10	Lachlan fractured rock	7.8
BH12-338	Murrumbidgee Alluvium	12.5
BH1-255	Murrumbidgee Alluvium	8.2
BH-2-549	Murrumbidgee Alluvium	10
BH-2-561	Murrumbidgee Alluvium	7
BH-2-574	Porous rock	8.5
BH-2-614	Porous rock	12.5
BH-2-646	Porous rock	5.5
BH-2-729	Porous rock	10.3
BH-LA-02	Murrumbidgee Alluvium	6.9
BH-LA-06	Murrumbidgee Alluvium	10.2
BH-LA-25	Porous rock	11
CPT-22	Porous rock	7.9
CPT2-232	Murrumbidgee Alluvium	18.1
CPT2-387	Murrumbidgee Alluvium	7.6
CPT2-519	Murrumbidgee Alluvium	7.5
CPT-2-564A	Porous rock	7.3
CPT-2-594	Porous rock	7.6
CPT-31	Murrumbidgee Alluvium	10.2
CPT-37	Porous rock	4.5
CPT-382	Murrumbidgee Alluvium	7.7
R2-BH 01	Lachlan fractured rock	12
R2-BH 08	Murrumbidgee Alluvium	8
R2-BH 09b	Murrumbidgee Alluvium	14
R2-BH 14	Murrumbidgee Alluvium	8.3
R2-BH 24	Lachlan fractured rock	7.8

(1) mBGL = metres below ground level.

(2) N/A = not applicable. mAHD could not be determined as no surveyed elevation details provided.

Table 4-6 Minimum and maximum groundwater level observations from site investigations per HSU (excludes site locations where groundwater was not encountered).

INFERRED HSU	AQUIFER	GROUNDWATER LEVEL (mBGL) ¹		
		Count ²	Minimum SWL	Maximum SWL
Murrumbidgee Alluvium	Shallow	14	4.5	18.1
Porous rock	Shallow	9	4.5	12.5
Lachlan fractured rock	Shallow	3	7.8	12.0

(1) mBGL = metres below ground level

(2) Only includes locations where groundwater was observed.

4.7.3 Groundwater quality

Groundwater quality, considering relevant regional studies and available local information (such as registered bores) is provided in the following subsections. No groundwater quality samples were collected during geotechnical site investigations.

4.7.3.1 Regional groundwater quality

The typical regional quality of the groundwater based on the groundwater resource descriptions published by DPIE (2019a, 2019b & 2019c) is provided in Table 4-7.

Table 4-7 Indicative regional groundwater quality (DPIE, 2019a, 2019b & 2019c)

HSU	AQUIFER	GROUNDWATER QUALITY AND SALINITY (EC)
Murrumbidgee Alluvium	Shallow	Groundwater quality can significantly vary both laterally and vertically within the shallow aquifer from fresh (585 $\mu\text{S/cm}$) to saline (32,800 $\mu\text{S/cm}$). Average salinity recorded is 8,314 $\mu\text{S/cm}$.
	Deep	Groundwater quality ranges from 364 to 8,930 $\mu\text{S/cm}$ (fresh to brackish) with a mean of 1,300 $\mu\text{S/cm}$.
Porous rock	Shallow	Groundwater quality ranges from fresh through to saline (greater than 50,000 $\mu\text{S/cm}$).
	Deep	
Lachlan fractured rock	Shallow	Groundwater quality significantly varies from fresh to saline based on rock type, fracture density, aquifer depth and climate.
	Deep	

4.7.3.2 Groundwater quality from registered bores

Key statistics of available and relevant groundwater quality records obtained from the registered bore search (BOM, 2021) are listed in Table 4-8. The full table of compiled results are provided in Appendix A. No qualitative groundwater quality records were available for the Porous rock (deep) HSU in the groundwater study area.

Table 4-8 Registered bores with quantitative groundwater quality records

INFERRED HSU (AQUIFER)	NUMBER OF REGISTERED BORES ¹	GROUNDWATER QUALITY – SALINITY (EC $\mu\text{S}/\text{cm}$) ²			
		Minimum	Maximum	Average ³	Classification ⁴
Murrumbidgee Alluvium (shallow)	3	1,500–4,475	4,475–10,450	5,971	Marginal to moderately saline
Murrumbidgee Alluvium (deep)	11	0–750	4,475–10,450	2,346	Fresh to moderately saline
Porous rock (shallow)	10	8,365	75,360	41,358	Slightly saline to hyper saline
Lachlan fractured rock (shallow)	1	0–750			Fresh
Lachlan fractured rock (deep)	1	750–1,500			Fresh to marginal

- (1) Excludes proposed or planned bores, bores with no quantitative groundwater quality record within the groundwater study area.
- (2) Values recorded as total dissolved solids (TDS) or parts per million (ppm) were converted to microSiemens per centimetre ($\mu\text{S}/\text{cm}$) using a factor of 0.67.
- (3) Where an EC range was provided, the average was used for calculations.
- (4) Based on the classification ranges provided in Hounslow (1995).

4.7.3.3 Gregadoo Monitoring bores

Limited groundwater quality was available from McMahon Earth Science (2020), with three water quality analysis results recorded. The available results are summarised in Table 4-9.

Table 4-9 Gregadoo monitoring bore groundwater quality (salinity) summary (McMahon Earth Science, 2020)

MONITORING BORE ID ¹	INFERRED HSU (AQUIFER)	GROUNDWATER QUALITY – SALINITY		
		Total dissolved solids (mg/L)	Electrical conductivity ($\mu\text{S}/\text{cm}$) ¹	Classification ²
MB06	Lachlan fractured rock (shallow)	6,310	9,418	Slightly saline
MB08	Lachlan fractured rock (shallow)	5,340	7,970	Slightly saline
GW036997 ³	Lachlan fractured rock (deep)	6,230	9,299	Slightly saline

- (1) Values recorded as total dissolved solids (TDS) or parts per million (ppm) were converted to microSiemens per centimetre ($\mu\text{S}/\text{cm}$) using a factor of 0.67.
- (2) Based on the classification ranges provided in Hounslow (1995).
- (3) Monitoring bore is not part of the Gregadoo Waste Management Centre monitoring network.

4.7.4 Connectivity

4.7.4.1 Groundwater – Surface water

There is limited groundwater connectivity to surface water features within the groundwater study area. The connectivity is predominately limited to recharge via leakage from overlying surface water features (refer to Section 4.7.1). Surface water features (streams, rivers, creeks and lakes) are generally ephemeral, with the main exceptions being the Murrumbidgee River and Colombo Creek, and receive the majority of available water from upstream, particularly within the Murrumbidgee Alluvium and Porous rock HSUs.

On the eastern portion of the outcropping rock, that forms part of the Lake Albert catchment area, groundwater within the shallow Lachlan fractured rock HSU aquifer is anticipated to have limited hydraulic connectivity to Lake Albert. It is estimated that Lake Albert is primarily recharged from surface water flows of Crooked Creek and Stringybark Creek and represents a losing system under normal climatic conditions (Wagga Wagga City Council, 2010). Limited inflows from groundwater may occur when the lake level is low.

Groundwater connectivity to surface water features within the identified HSUs of the groundwater study area are summarised below:

- Murrumbidgee Alluvium: The groundwater table is generally below surface water features including the Murrumbidgee River, Yanco Creek and Colombo Creek resulting in a ‘losing system’ for streams, rivers, creeks and lakes (DPIE, 2019a).
- Porous rock: The groundwater table is generally below surface water features resulting in a ‘losing system’ for streams, rivers, creeks and lakes (DPIE, 2019b).
- Lachlan fractured rock: Connection between groundwater and surface water systems would be limited to the degree of fracturing that propagates from the groundwater source connecting the surface water feature. The degree of connection within the groundwater study area is expected to be low (DPIE, 2019c)

Based on the above, none of the assessed groundwater sources are classified as highly connected to surface water sources.

4.7.4.2 Hydrostratigraphic units

The relative connectivity between groundwater sources within the groundwater study area is described in Table 4-10.

Table 4-10 Interconnectivity of groundwater sources located within the groundwater study area.

HSU (AQUIFER)	CONNECTED HSU	DEGREE OF CONNECTION
Murrumbidgee Alluvium (shallow)	Lachlan fractured rock	Negligible
	Murrumbidgee Alluvium (deep)	Hydraulically connected. The shallow aquifer generally provides recharge through vertical leakage to the underlying deeper groundwater sources. Connectivity may diminish westwards.
	Porous rock (shallow)	Hydraulically connected by horizontal flow between corresponding groundwater sources along their contiguous boundaries.
Porous rock (shallow)	Murrumbidgee Alluvium (shallow)	Hydraulically connected by horizontal flow between corresponding groundwater sources along their contiguous boundaries.
	Porous rock (deep)	Hydraulically connected. The shallow aquifer generally provides recharge through vertical leakage to the underlying deeper groundwater sources.
	Lachlan fractured rock	Negligible
Lachlan fractured rock (shallow)	Porous rock	Negligible
	Murrumbidgee Alluvium (both)	Negligible
	Lachlan fractured rock (deep)	Limited and based on degree of connected fractures, joints and defects.

4.7.5 Sensitive receptors

A sensitive receptor for the purpose of this assessment is any identified receptor that utilises groundwater. Registered bores with a registered use as water supply are therefore considered as a sensitive receptor as they rely on the use of the groundwater resource to supply their water requirements across household, stock and domestic, irrigation and commercial uses. GDEs are also classified as sensitive receptors as they need access to groundwater to meet some or all their water requirements to maintain their communities, processes and ecosystem services.

Registered bores and GDEs identified within the groundwater study area are further discussed in the following sub-sections. The potential impacts to these sensitive receptors are addressed in Chapter 5 and Chapter 6.

4.7.5.1 Registered bores

A search of the NGIS (BOM, 2021) and WaterNSW groundwater databases identified a total of 243 registered groundwater bores across the groundwater study area.

Of the 243 bores located within the groundwater study area, the beneficial use of the majority was listed as monitoring or observation (138) followed by water supply (including irrigation, stock and domestic and household water supply) (76), unknown (19), drainage (six) and exploration or mine (four). Of these bores located within the groundwater study area:

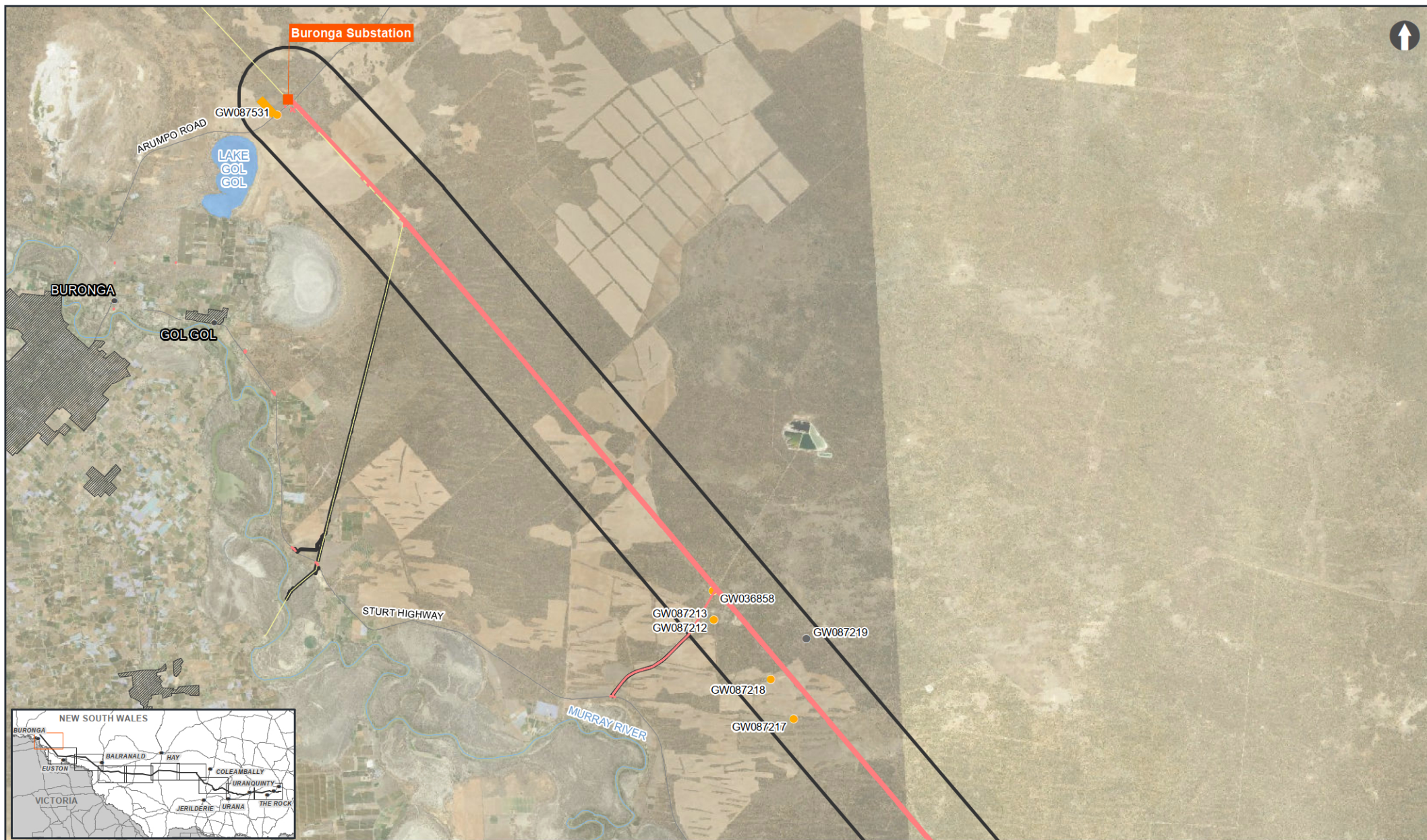
- 141 are in an unknown condition
- 92 are functioning or in use
- six are either non-functional, abandoned or removed
- four are proposed.

From the 243 registered bores, 11 registered bores are located within the construction impact area. The 11 registered bores within the construction impact area are listed in Table 4-11.

Table 4-11 Registered bores within the construction impact area

BORE ID	HSU	STATUS	PURPOSE	BORE DEPTH (mBTC)
GW415977	Lachlan fractured rock	Functioning	Monitoring	25.0
GW415978	Lachlan fractured rock	Functioning	Monitoring	10.6
GW415979	Lachlan fractured rock	Functioning	Monitoring	19.0
GW415980	Lachlan fractured rock	Functioning	Monitoring	7.0
GW415982	Lachlan fractured rock	Functioning	Monitoring	22.0
GW049852	Murrumbidgee Alluvium	Proposed	Exploration	152.4
GW084098	Murrumbidgee Alluvium	Functioning	Monitoring	7.0
GW012872	Murrumbidgee Alluvium	Functioning	Monitoring	29.9
GW403762	Murrumbidgee Alluvium	Unknown	Household supply	76.0
GW032607	Murrumbidgee Alluvium	In use	Stock and domestic	51.8
GW087095	Porous rock	Unknown	Monitoring	23.0

The location of registered bores within the groundwater study area and their purpose is shown in Figure 4-5.



Project Components

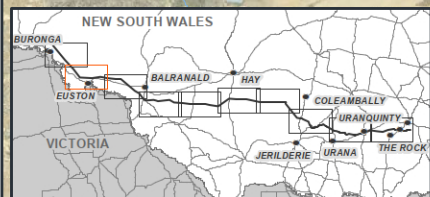
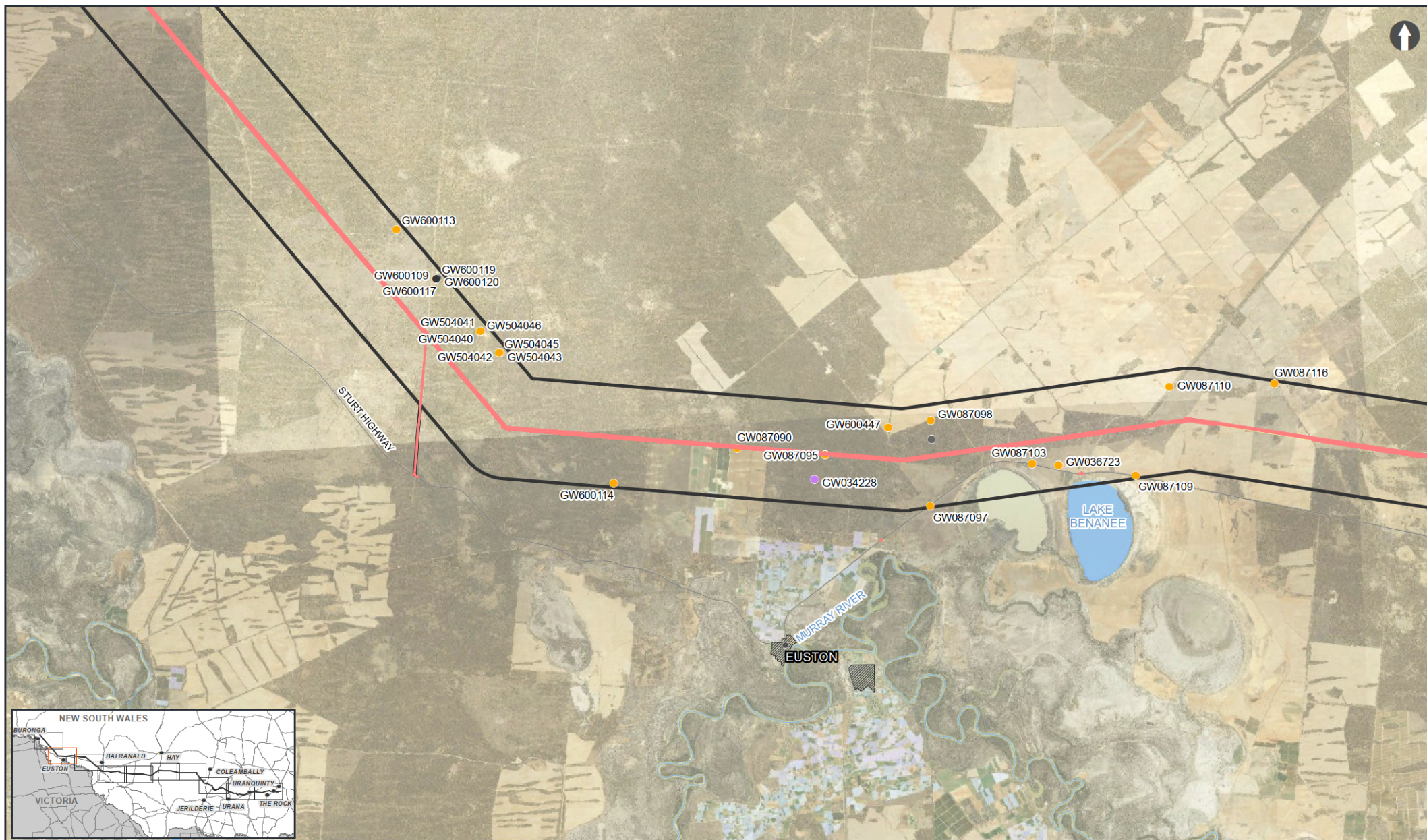
- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
 - Existing Substation
 - Existing Railway
 - Groundwater Study Area
 - Built Up Areas
- Groundwater Monitoring Bore Function**
- Monitoring (8)
 - Unknown (1)

Groundwater - Figure 4-5

Registered Bores Within the Groundwater Study Area

Sheet 1 of 10



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Drainage - Groundwater (3)
- Household (1)

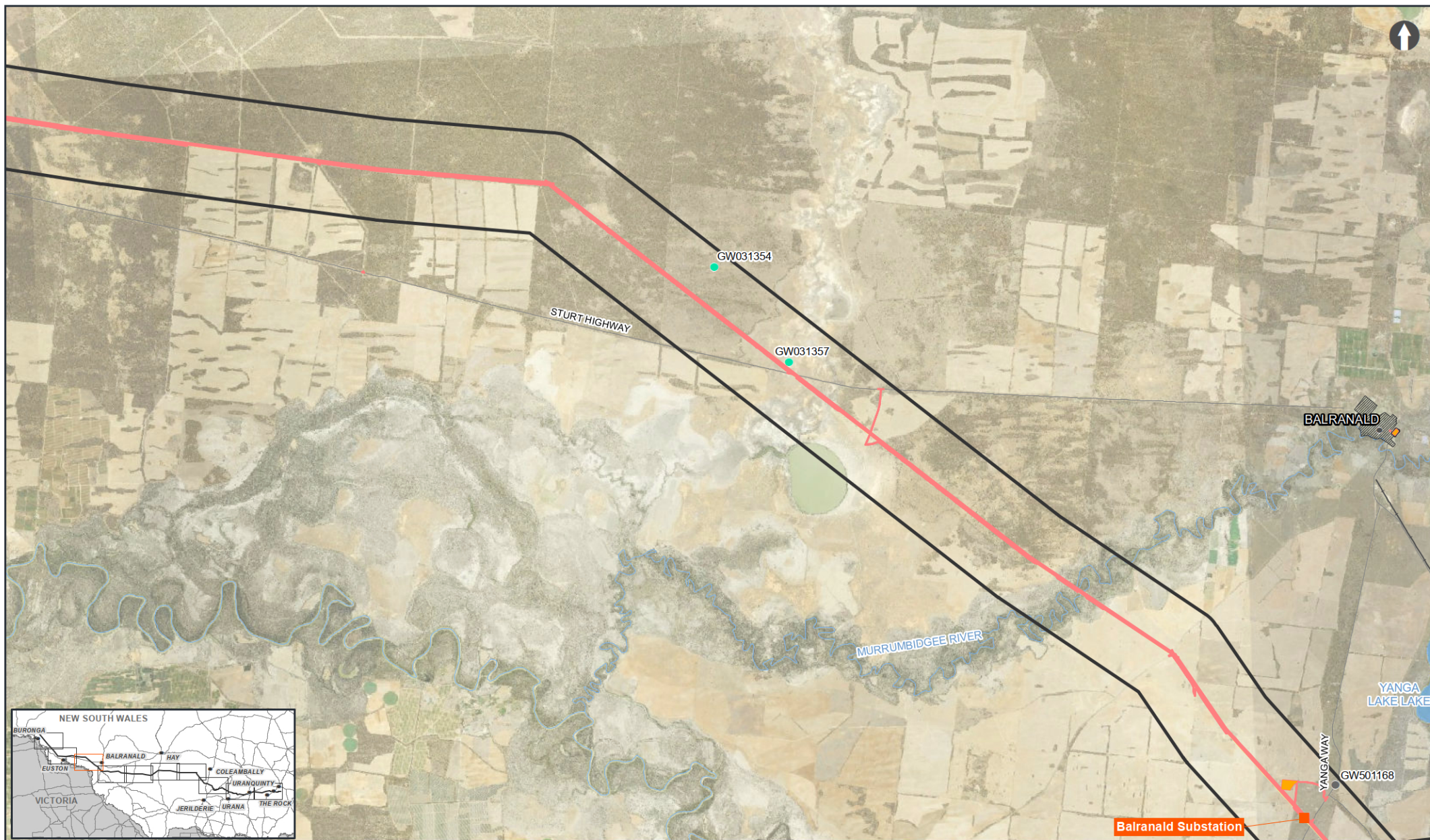
Groundwater Monitoring Bore Function

- Mining / Mining Activities (1)
- Monitoring (19)
- Unknown (6)

Groundwater - Figure 4-5

Registered Bores Within the Groundwater Study Area

Sheet 2 of 10



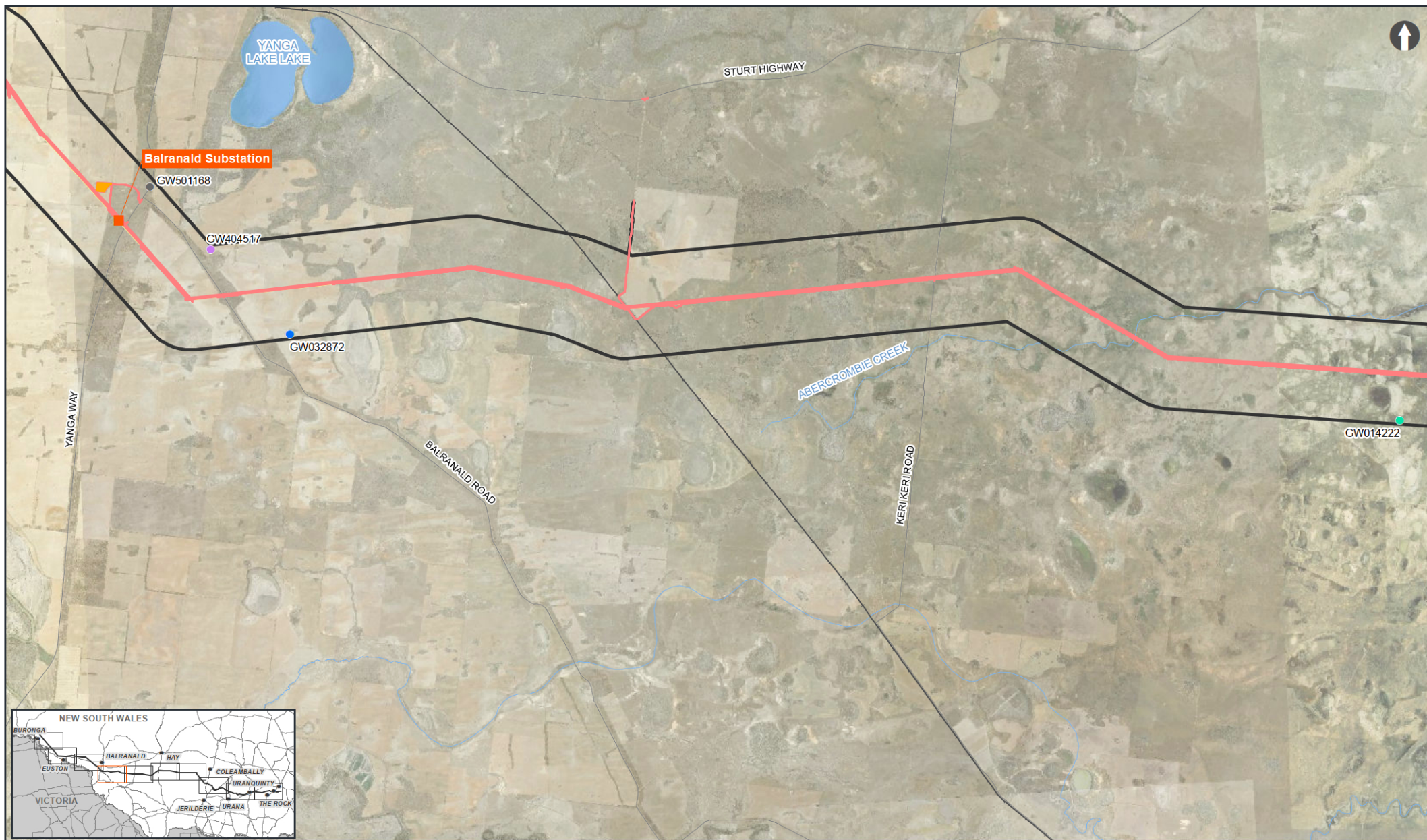
Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
 - Existing Substation
 - Existing Railway
 - Groundwater Study Area
 - Built Up Areas
- Groundwater Monitoring Bore Function**
- Unknown (1)
 - Water Supply for Livestock (2)

Groundwater - Figure 4-5

Registered Bores Within the Groundwater Study Area



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Household (1)
- Water Supply for Livestock (1)
- Unknown (1)
- Water Supply (1)

Groundwater - Figure 4-5
Registered Bores Within the Groundwater Study Area



Groundwater - Figure 4-5

Registered Bores Within the Groundwater Study Area

Project Components

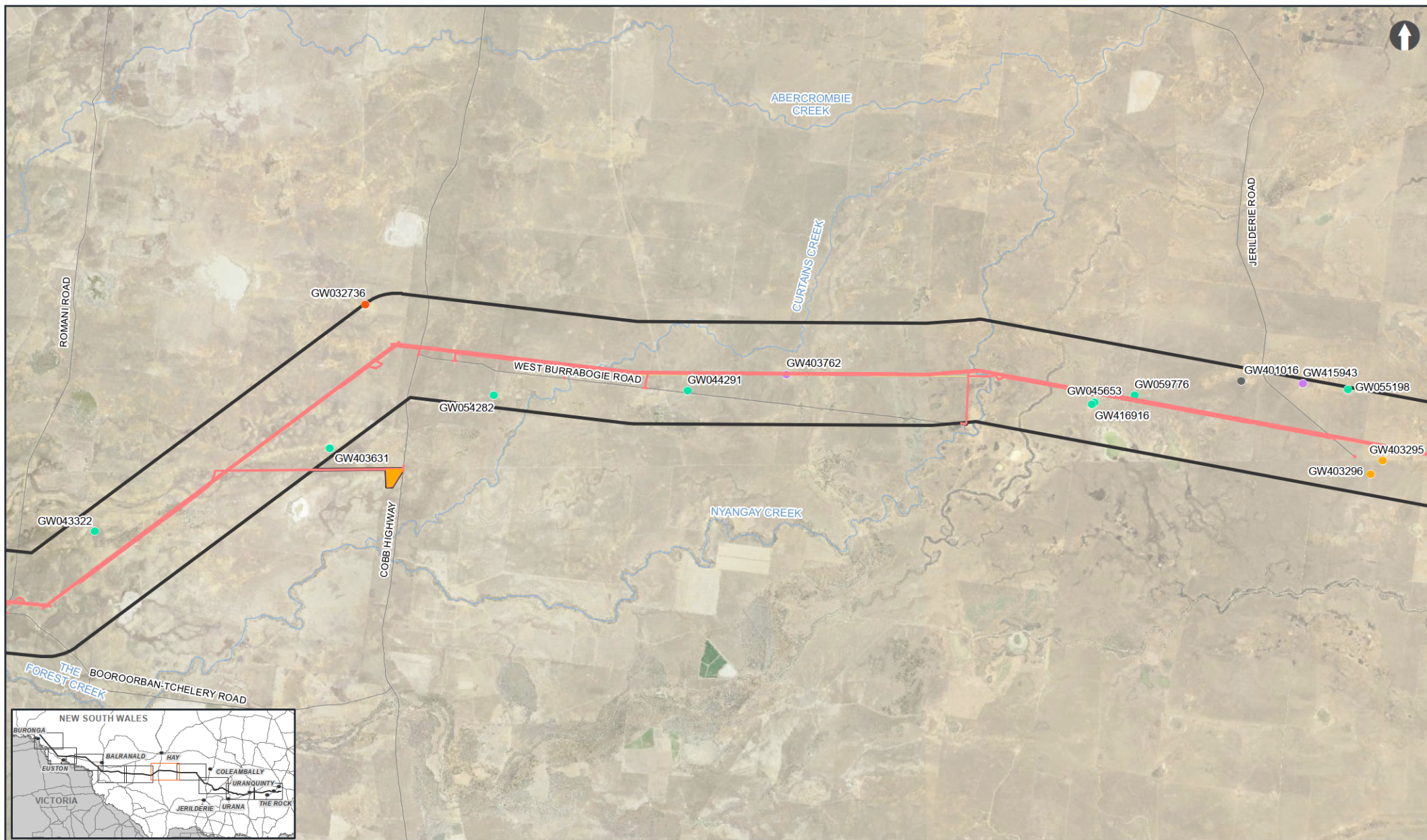
- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Household (2)
- Monitoring (3)

- Water Supply for Livestock (8)
- Unknown (3)



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

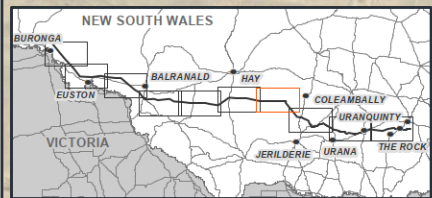
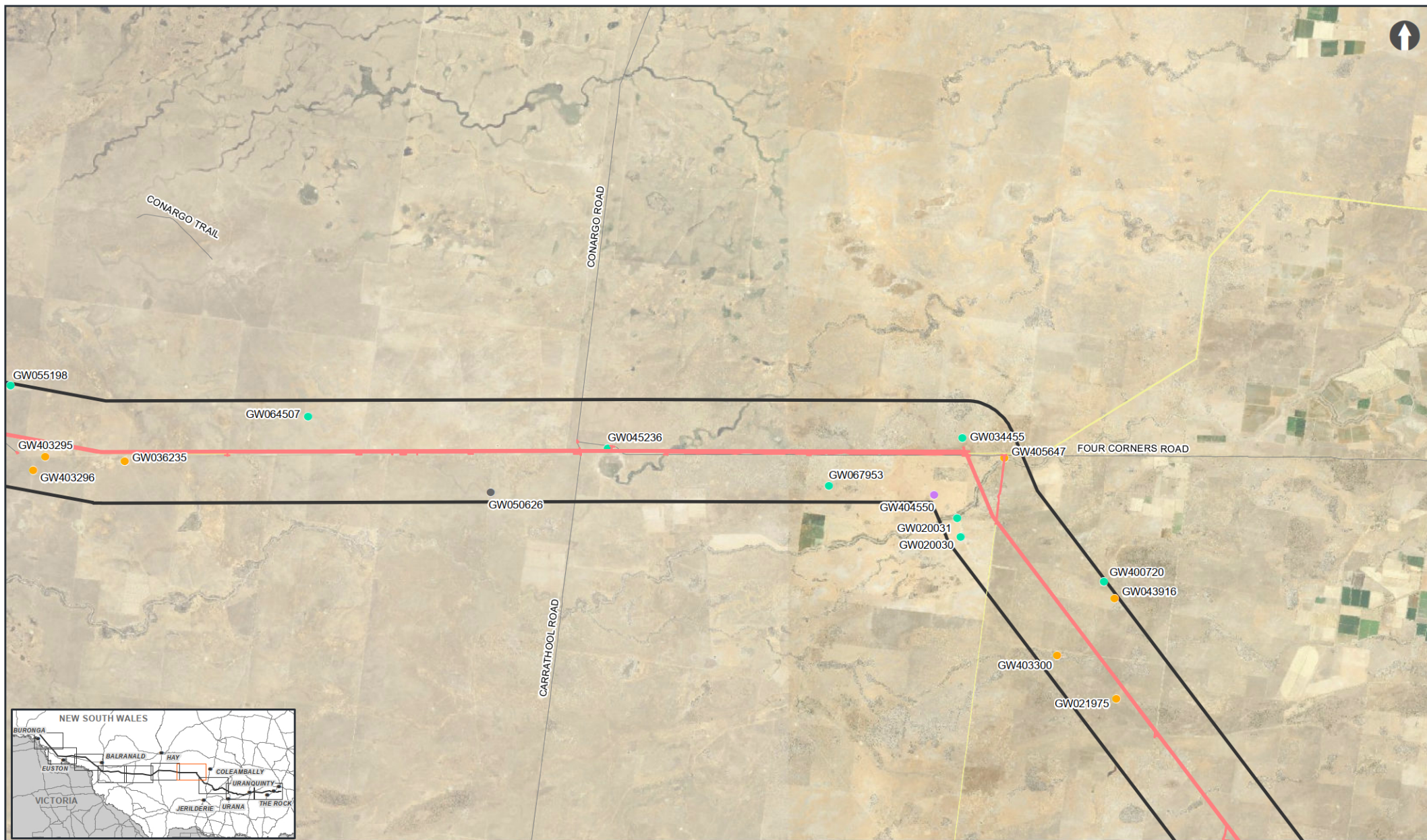
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Household (2)
- Irrigated Agriculture (1)

- Monitoring (2)
- Water Supply for Livestock (8)
- Unknown (1)

Groundwater - Figure 4-5
Registered Bores Within the Groundwater Study Area



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

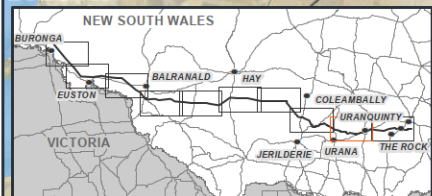
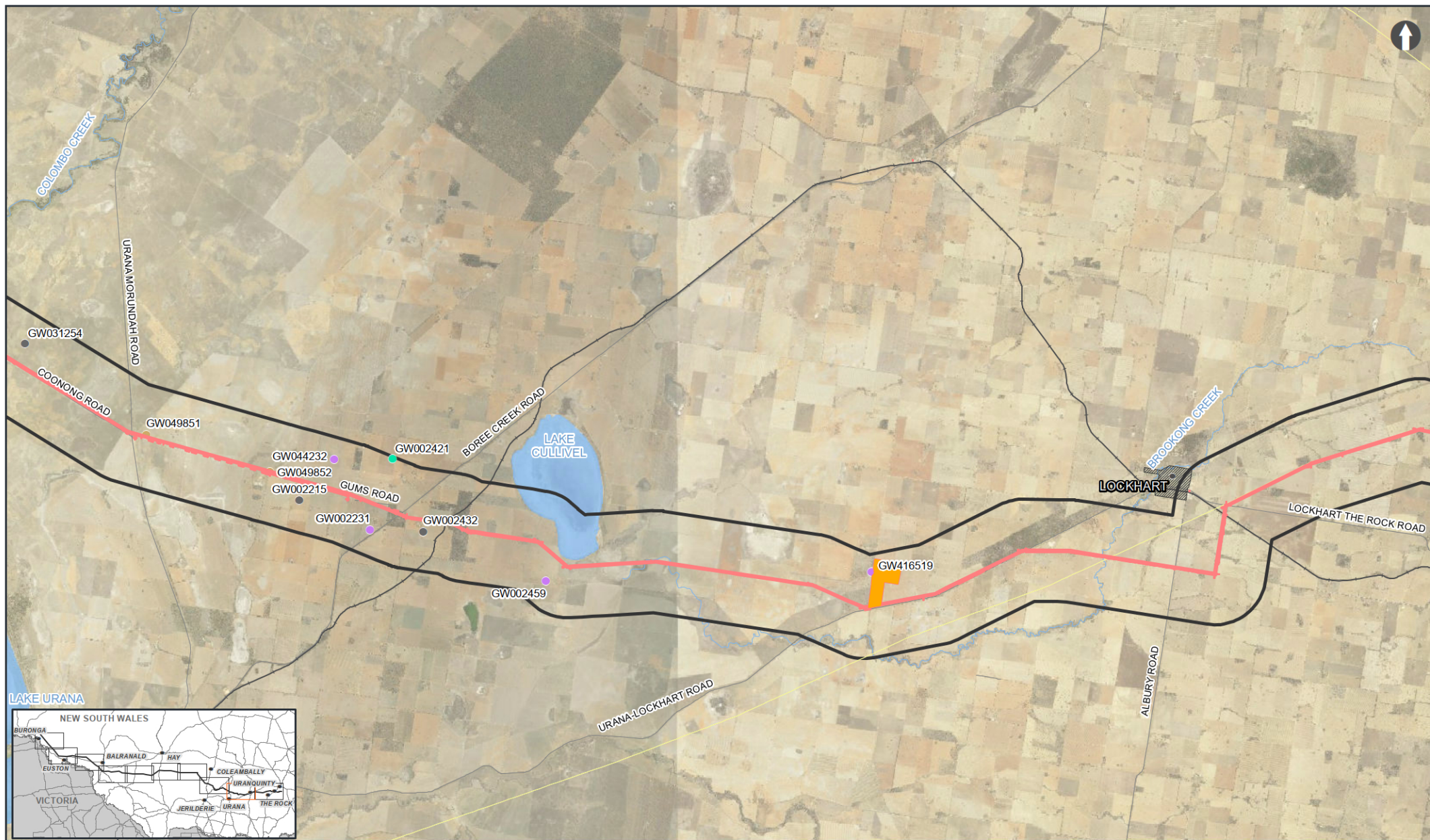
- Household (1)
- Monitoring (8)

Groundwater Monitoring Bore Function

- Water Supply for Livestock (8)
- Unknown (2)

Groundwater - Figure 4-5

Registered Bores Within the Groundwater Study Area



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites

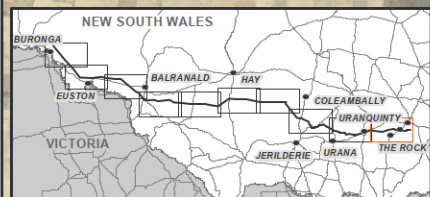
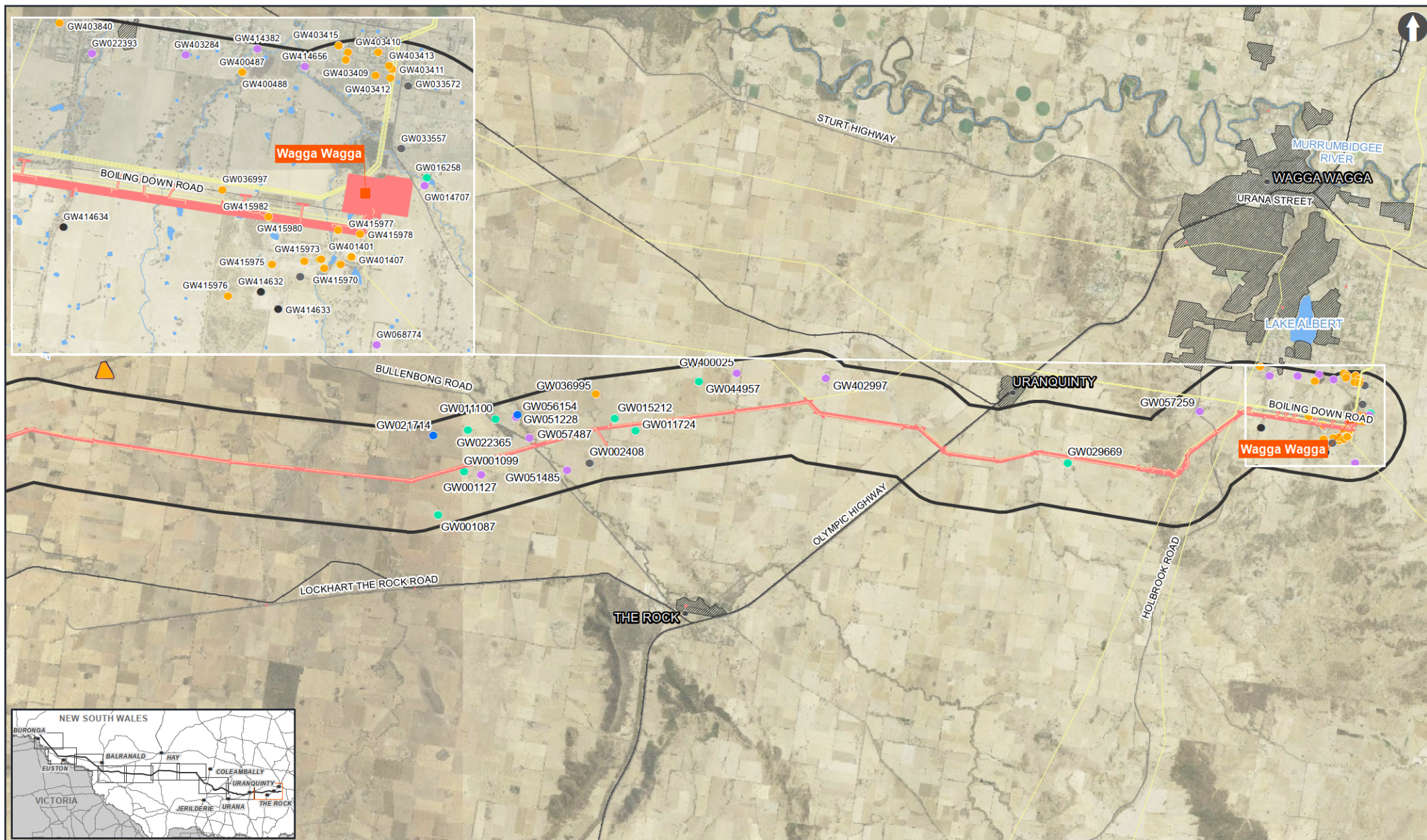
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Exploration / Mining Activities (2)
- Household (4)

- Monitoring (2)
- Water Supply for Livestock (1)
- Unknown (3)

Groundwater - Figure 4-5
Registered Bores Within the Groundwater Study Area



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Access Tracks
- Existing Transmission Line Infrastructure
- Existing Substation
- Existing Railway
- Groundwater Study Area
- Built Up Areas

Groundwater Monitoring Bore Function

- Drainage - Groundwater (3)
- Household (13)
- Monitoring (54)

Water Supply for Livestock (9)

- Water Supply for Livestock (9)
- Unknown (4)
- Water Supply (2)

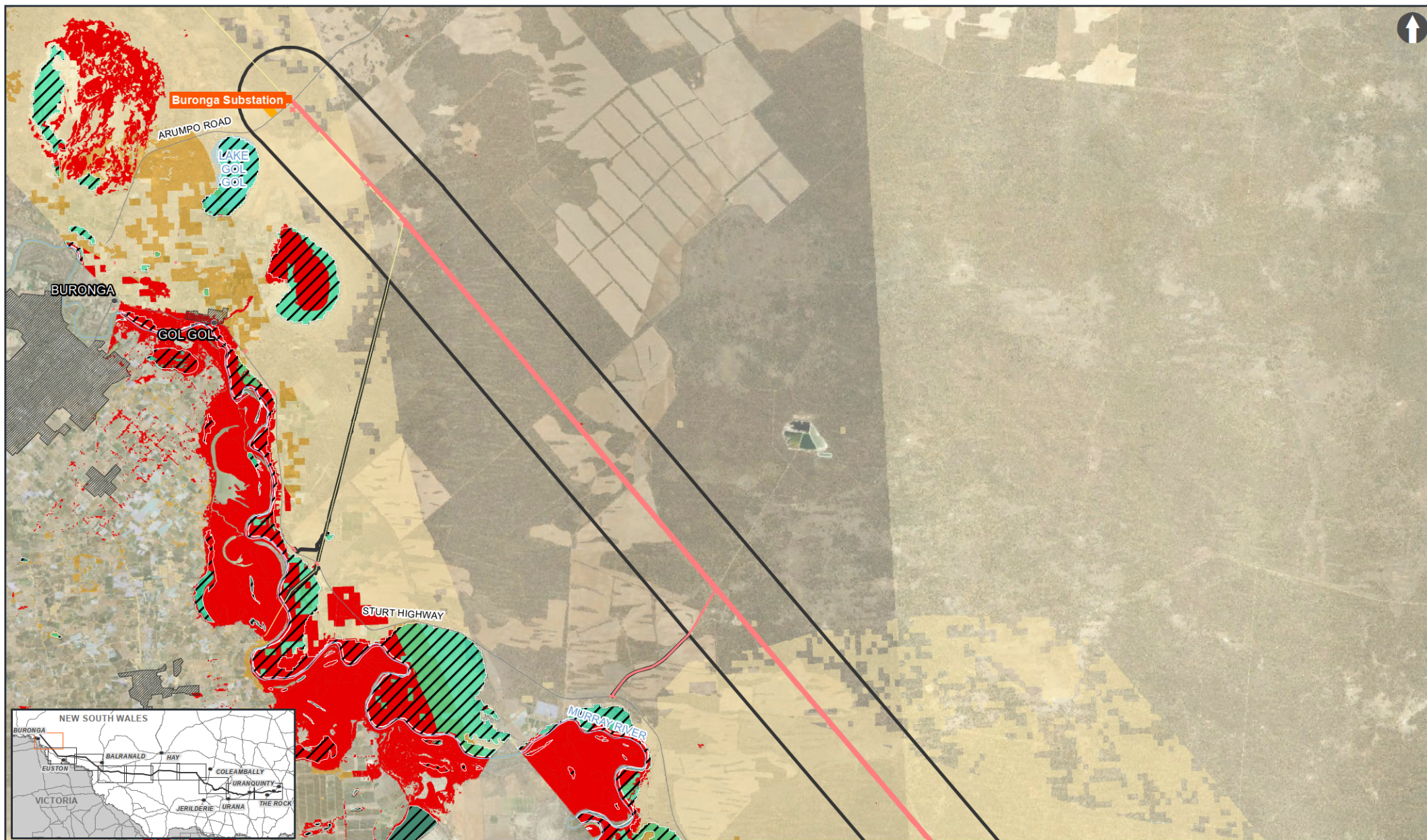
Groundwater - Figure 4-5
Registered Bores Within the Groundwater Study Area

4.7.5.2 Groundwater dependent ecosystems

High potential GDEs are listed in Table 4-12, with their location, including low and moderate potential GDEs shown in Figure 4-6. As discussed in Section 3.2.5, high priority GDEs have been included in the assessment of high potential GDEs as they share the same spatial extent as high potential GDEs.

Table 4-12 GDEs with high potential for groundwater interaction within the groundwater study area (BOM, 2021b)

GDE TYPE	NAME	HSU
Aquatic	Coloboralli Creek	Lachlan fractured rock
Aquatic	Stringybark Creek	Lachlan fractured rock
Aquatic	Boiling Down Creek	Lachlan fractured rock
Aquatic	Crooked Creek	Lachlan fractured rock
Aquatic	Sandy Creek	Lachlan fractured rock
Aquatic	Lake Cullival	Lachlan fractured rock
Aquatic	Wetlands	Lachlan fractured rock and Murrumbidgee Alluvium
Terrestrial	River Red Gum	Lachlan fractured rock
Terrestrial	Red River Gum and Warrego Grass	Murrumbidgee Alluvium
Terrestrial	Red River Gum and Wallaby Grass	Murrumbidgee Alluvium
Terrestrial	Red River Gum and Lignum	Murrumbidgee Alluvium
Terrestrial	Red River Gum and Black Box	Murrumbidgee Alluvium
Terrestrial	Lignum shrubland	Murrumbidgee Alluvium
Terrestrial	Black box	Murrumbidgee Alluvium
Terrestrial	Canegrass Swamp	Porous rock
Terrestrial	Dillon bush (Nitre bush)	Porous rock
Terrestrial	Nitre Goosefoot shrubland	Porous rock



Project Components

- Construction Impact Area
- Main Construction Compound and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

Groundwater Study Area

- Existing Substation
- Groundwater Study Area
- Built Up Areas

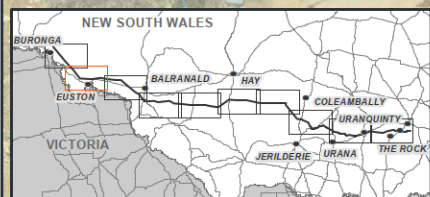
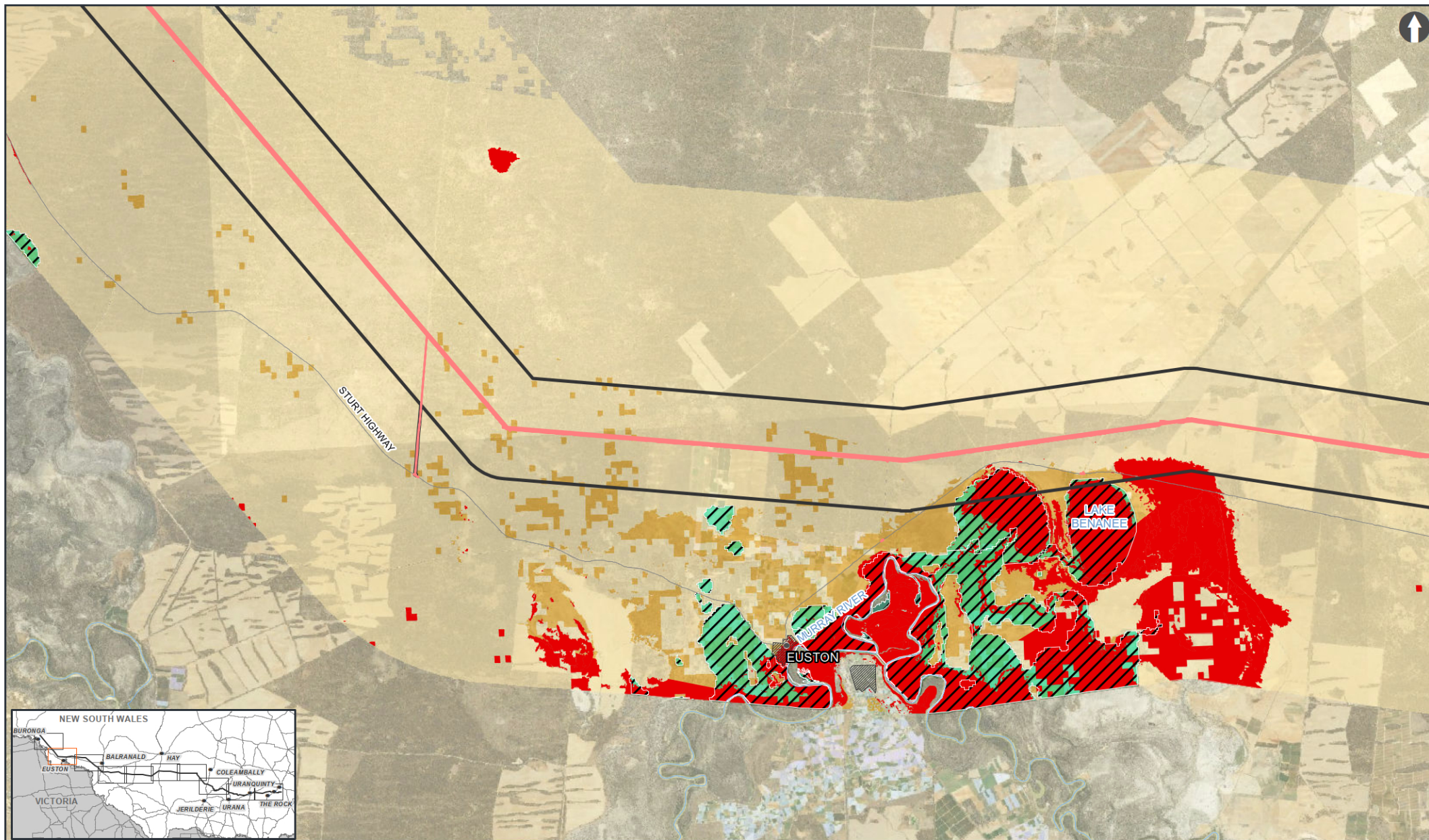
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE
- Unclassified potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

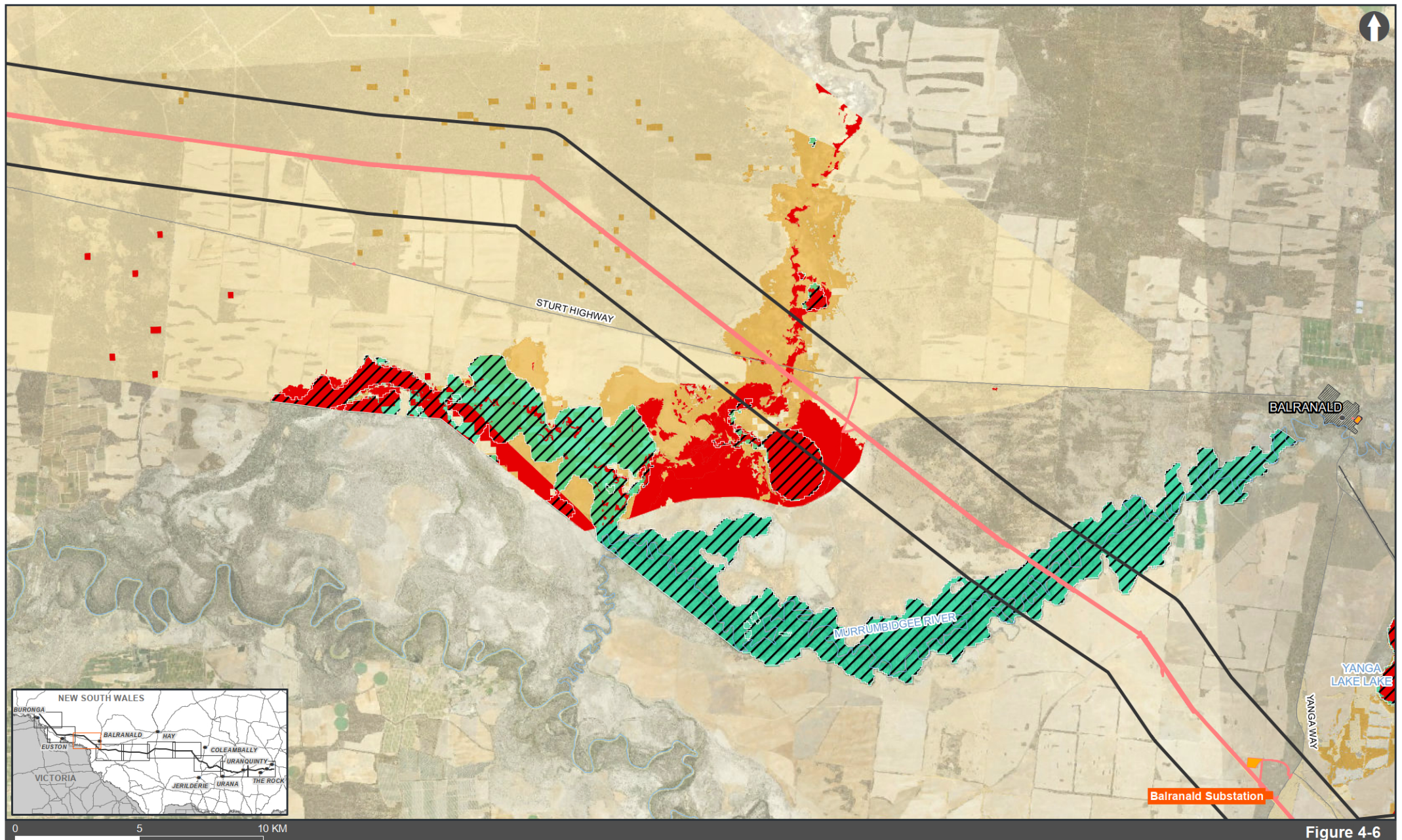
Terrestrial GDE

- Existing Substation
- Groundwater Study Area
- Built Up Areas
- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE
- Unclassified potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

- Existing Substation
- Groundwater Study Area
- Built Up Areas

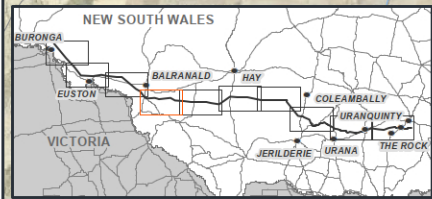
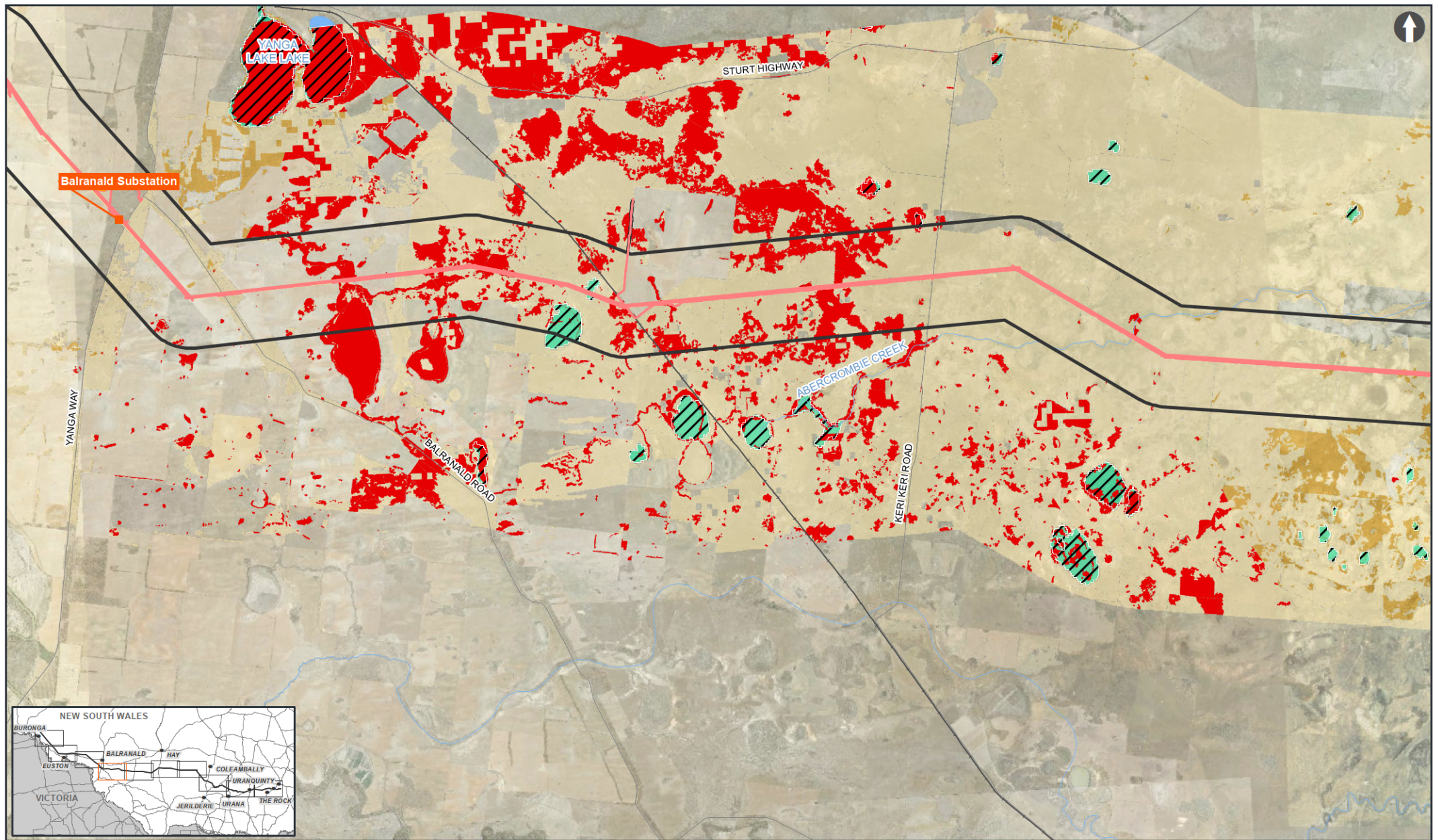
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- Moderate potential GDE
- Low potential GDE
- Unclassified potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

Existing Substation

Groundwater Study Area

Built Up Areas

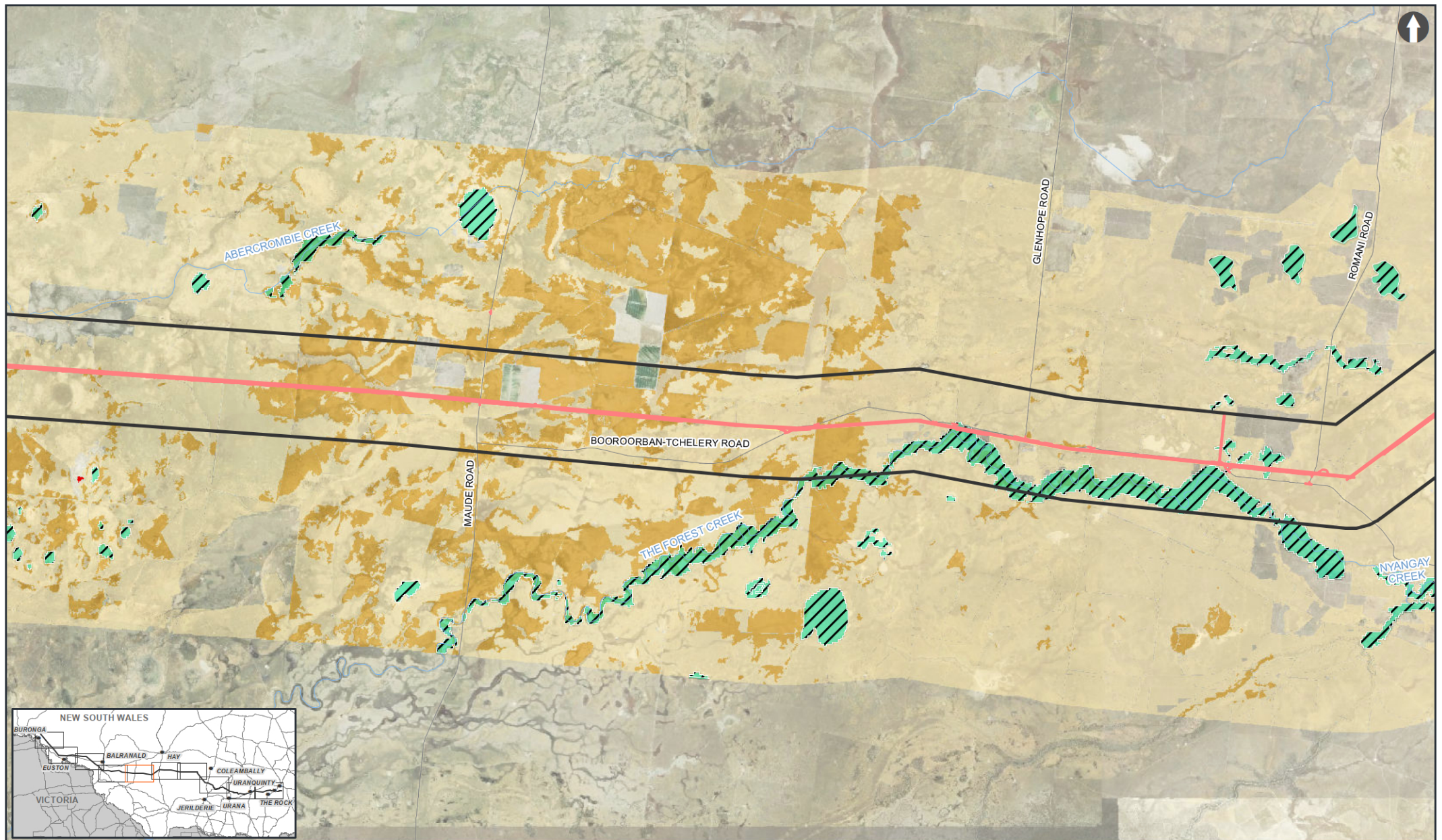
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- Moderate potential GDE
- Low potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



0 5 10 KM

Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

- Existing Substation
- Groundwater Study Area
- Built Up Areas

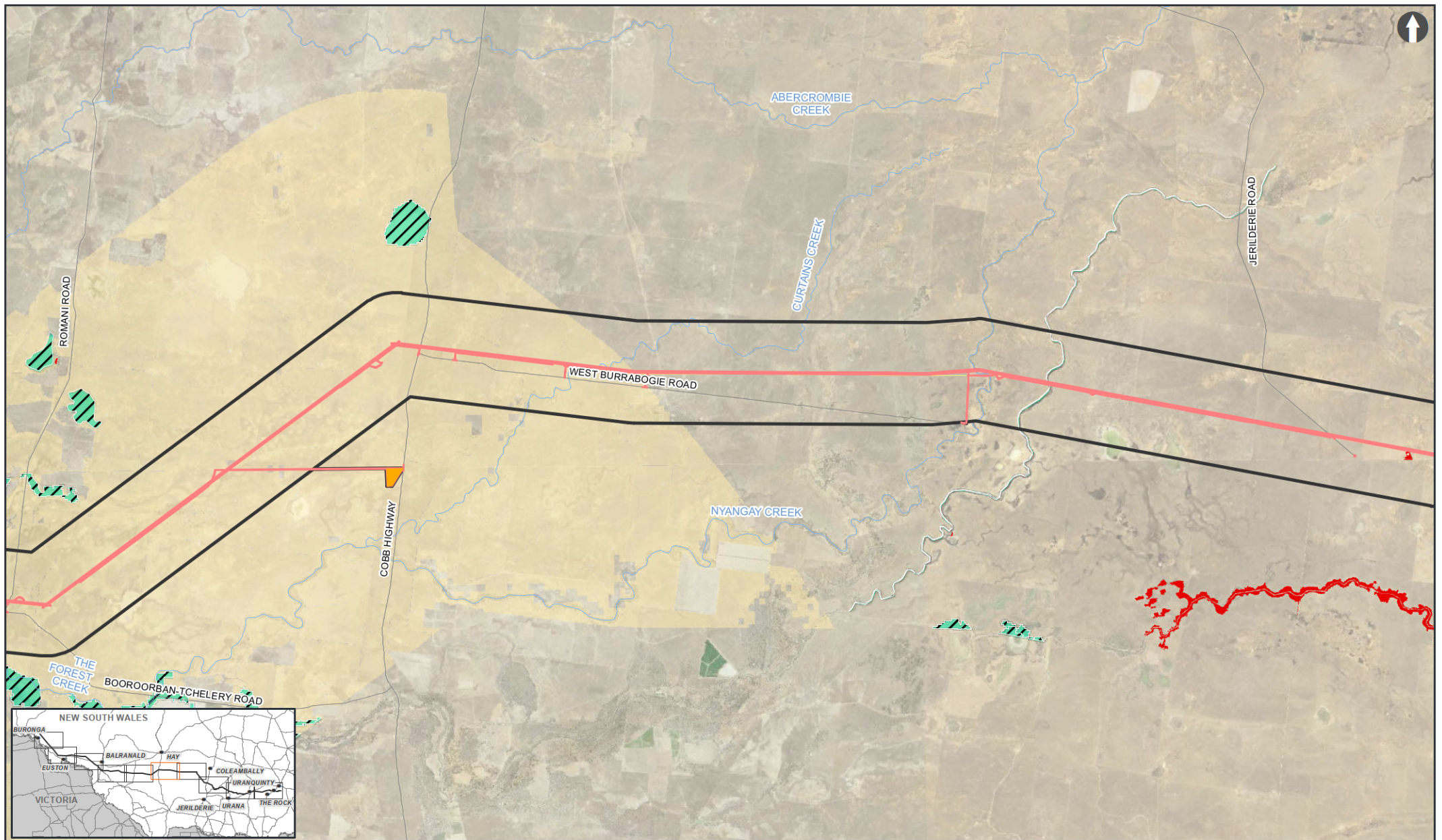
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- Moderate potential GDE
- Low potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

- Existing Substation

- Groundwater Study Area
- Built Up Areas

Terrestrial GDE

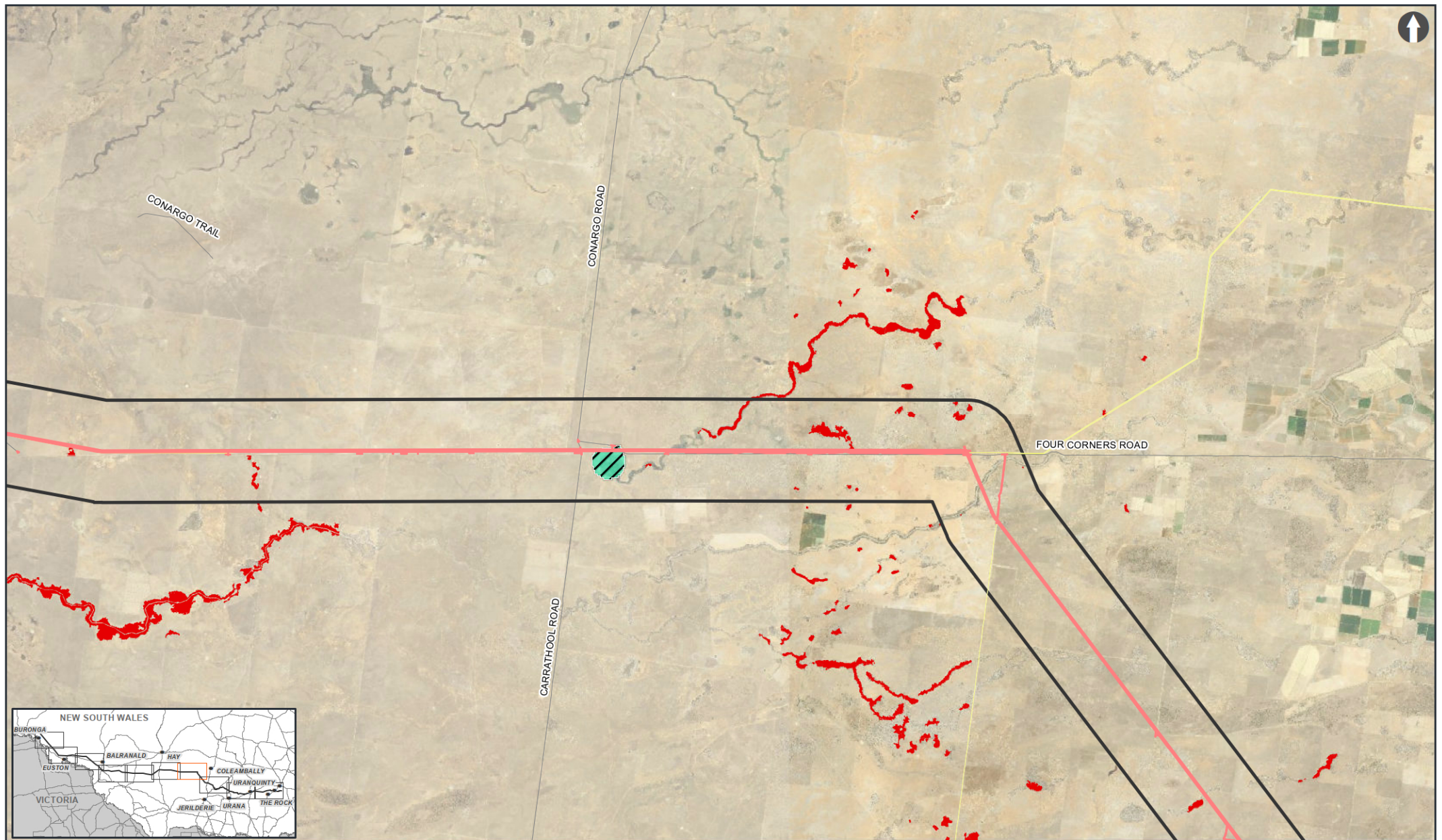
- High potential GDE
- Low potential GDE

Aquatic GDE

- Low potential GDE

Figure 4-6

Groundwater Dependent
Ecosystems



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

Groundwater Study Area

- Groundwater Study Area
- Built Up Areas

Terrestrial GDE

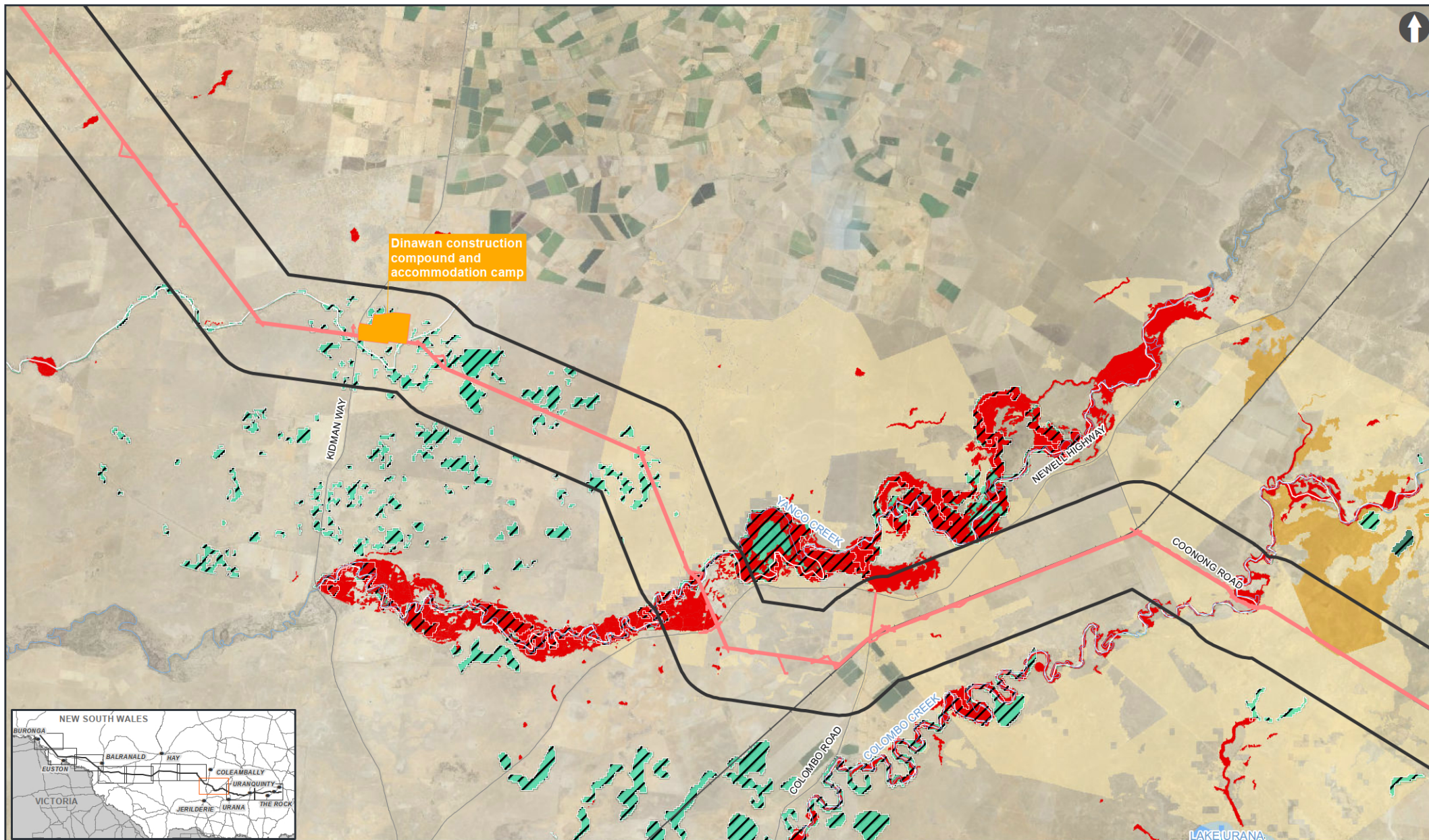
- High potential GDE

Aquatic GDE

- Low potential GDE

Figure 4-6

Groundwater Dependent
Ecosystems



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

- Existing Substation
- Groundwater Study Area
- Built Up Areas

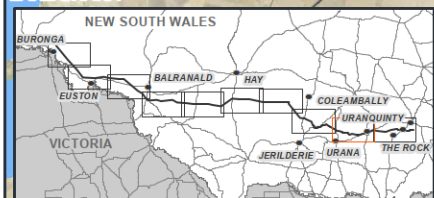
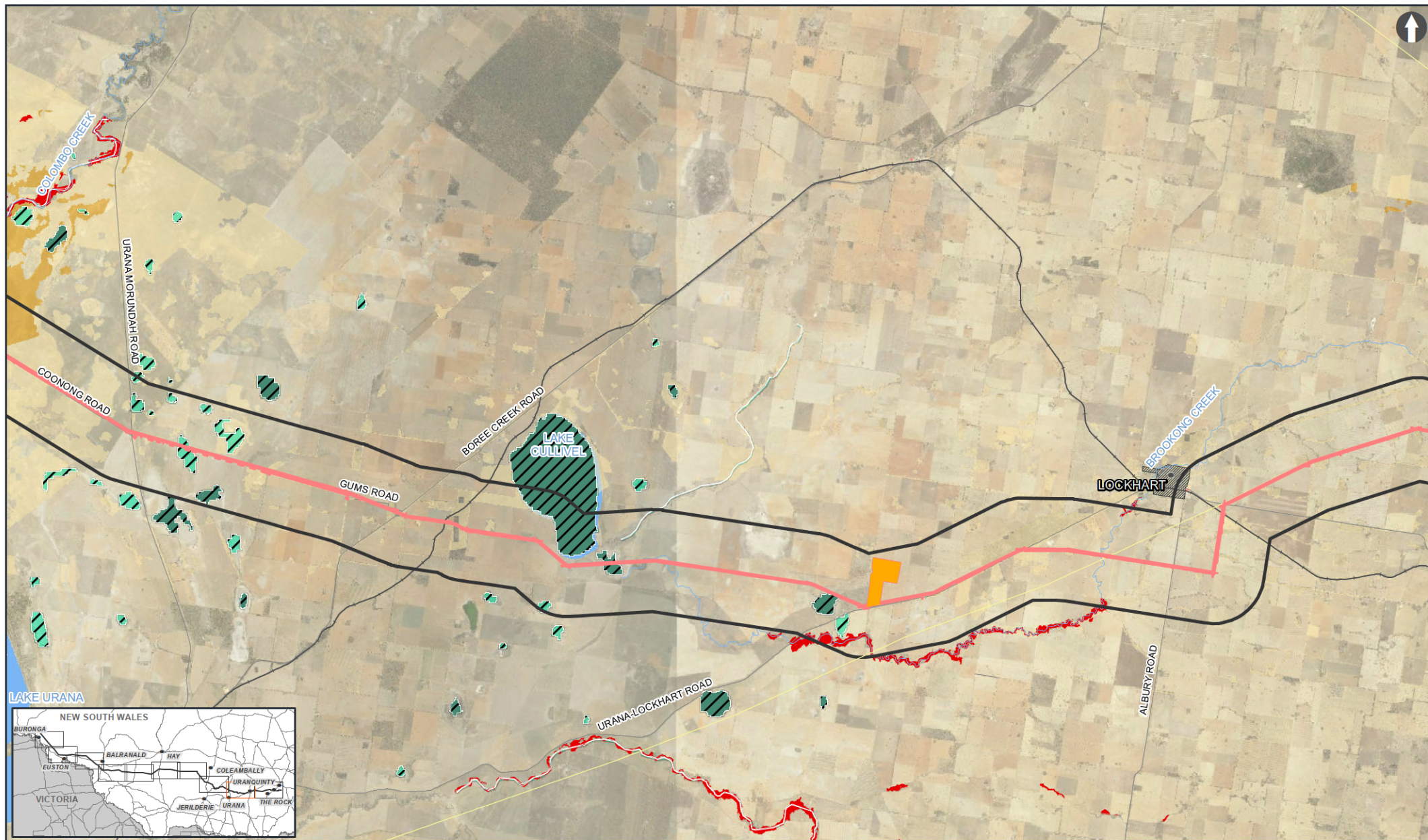
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Figure 4-6
Groundwater Dependent Ecosystems



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Railway

- Existing Substation
- Groundwater Study Area
- Built Up Areas

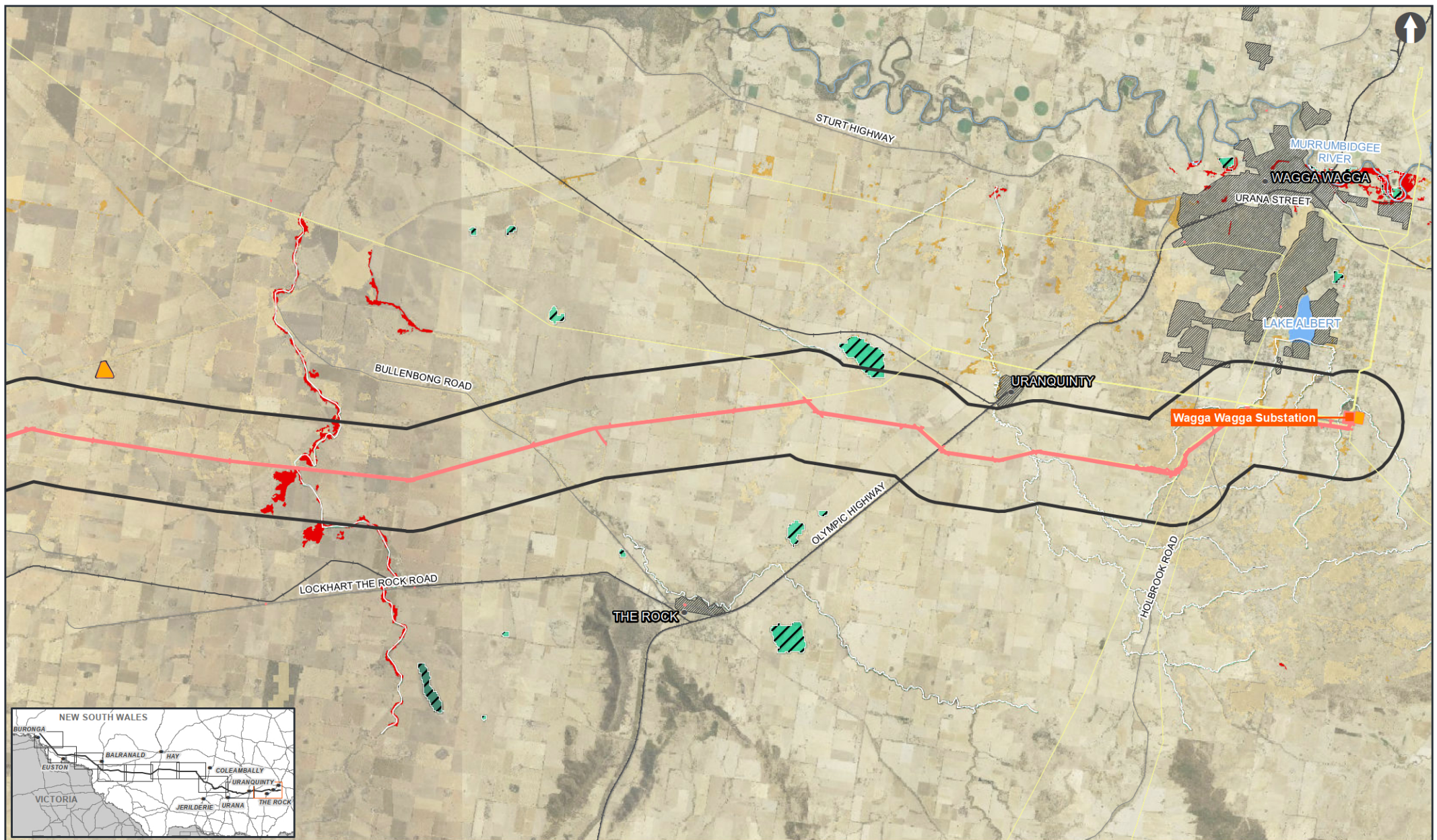
Terrestrial GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Aquatic GDE

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Figure 4-6
Groundwater Dependent
Ecosystems



0 5 10 KM

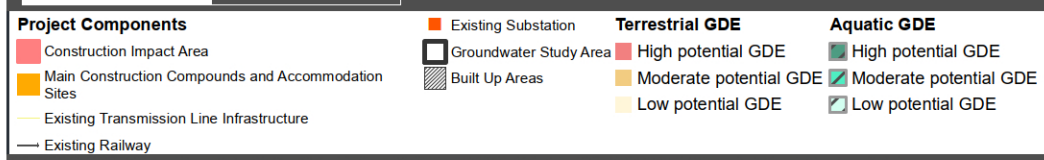


Figure 4-6
Groundwater Dependent
Ecosystems

4.7.6 Conceptual hydrogeological model

A conceptual hydrogeological model has been generated for the groundwater study area based on the available data. The regional groundwater system is conceptualised in the sections below. Perched systems can be locally present, however these are not discussed in detail.

4.7.6.1 Murrumbidgee Alluvium

Shallow aquifer

Recharge is anticipated to primarily occur from leakage from losing surface water features, such as rivers, creeks or lakes when at flowing, flooding or filled conditions, groundwater flow through from the east and infiltration from rainfall. Therefore, groundwater flow is anticipated to generally follow surface water flows, typically east to west.

Groundwater levels are anticipated to be greater than 10 mBGL based on available data from DPIE (2019a), registered bores (WaterNSW, 2021) and geotechnical site investigations (SMEC, 2020a; 2020b & 2020c). However, areas proximal to surface water features may contain shallower groundwater levels as these areas act as recharge points from losing surface water systems. The groundwater table underlying and proximal to these features when they are flowing or filled, may mound (become shallower) and contain fresher water quality. Within the groundwater study area, the horizontal extent of mounding is expected to be limited due to the typical channel size of the creeks and rivers. The impact of mounding from lakes, such as Lake Urana and Lake Cullivel, would be dependent on the volume of water held within the lake at any given time.

Given that groundwater levels are generally below surface water features, groundwater to surface water connectivity is anticipated to be limited.

Groundwater quality is anticipated to be variable with higher salinity groundwater expected to increase in occurrence as groundwater flows west across the HSU. Available regional data (DPIE, 2019a) indicates groundwater quality may range from fresh (585 $\mu\text{S}/\text{cm}$) to saline (32,800 $\mu\text{S}/\text{cm}$) with average water quality around 8,314 $\mu\text{S}/\text{cm}$. Limited data from registered bores (WaterNSW, 2021) has recorded groundwater quality within the groundwater study area to be marginal to slightly saline, between 4,475–10,450 $\mu\text{S}/\text{cm}$.

Groundwater yields are expected to be typically less than 1 L/s but can be up to 5 L/s (WaterNSW, 2021) within the groundwater study area.

Deep aquifer

Recharge to the deep aquifer is anticipated to primarily be from groundwater flow through from the east and from leakage from the overlying shallow aquifer. Groundwater flow is expected to be from east to west.

Groundwater levels are anticipated to be greater than 15 mBGL based on limited data from registered bores (WaterNSW, 2021). The deeper aquifer is semi-confined to confined and may exhibit a potentiometric groundwater level that is similar to the overlying shallow aquifer groundwater table. In areas where the confining layer is absent, groundwater may exchange between these two aquifers.

Due to the depth of the aquifer, it is not anticipated to be in hydraulic connection with any surface water features.

Groundwater quality is expected to be fresher than the shallow aquifer based on regional data (DPIE, 2019a) and registered bore data within the groundwater study area (WaterNSW, 2021). Groundwater quality data from 11 registered bores indicated the groundwater quality to be fresh to slightly saline, up to 10,450 $\mu\text{S}/\text{cm}$ with an average of 2,346 $\mu\text{S}/\text{cm}$.

Groundwater yields identified within the groundwater study area were generally similar to the shallow aquifer. However, locally yields were recorded to be up to 25 L/s (WaterNSW, 2021). Regional information from DPIE (2019b) indicates yields may be significantly higher than identified within the groundwater study area, with yields up to 350 L/s recorded within the wider HSU.

4.7.6.2 Porous rock

Shallow aquifer

Recharge is anticipated to primarily occur from leakage from losing surface water features, such as rivers, creeks or lakes when at flowing, flooding or filled conditions, groundwater flow through from the east and limited infiltration from rainfall. Therefore, groundwater flow is anticipated to flow east to west around Balranald and southwest around Buronga.

The depth to groundwater from surface will be dependent on the degree of aeolian cover of the Woorinen Formation. In topographic lows, such as in claypans and proximal to ephemeral lakes, groundwater is anticipated to occur between five to 10 mBGL. In areas of elevated topography or thick aeolian cover, groundwater is anticipated to be greater than 15 mBGL.

Given that groundwater levels are generally below surface water features, groundwater to surface water connectivity is anticipated to be limited.

Groundwater quality is anticipated to be variable, but typically saline, with higher salinity groundwater expected to increase in occurrence in the western portion of the HSU. Limited groundwater quality data from DPIE (2019b) and registered bores (WaterNSW, 2021) has identified localised groundwater salinity as high as 75,360 $\mu\text{S}/\text{cm}$, which is considered hyper saline and greater than seawater (around 60,000 $\mu\text{S}/\text{cm}$) (DPIE, 2019b).

Limited information on groundwater yields was available within the groundwater study area. However, from regional data (DPIE, 2019b) yields greater than 10 L/s are common but can vary from 0.5 to 100 L/s.

Deep aquifer

Recharge to the deep aquifer is anticipated to primarily be from groundwater flow through from the east and north east and from leakage from the overlying shallow aquifer. Groundwater flow is expected to generally follow the overlying shallow aquifer.

Groundwater levels are anticipated to be greater than 9 mBGL based on limited data from registered bores (WaterNSW, 2021). The deep aquifer is semi-confined to confined and registered bore data indicates the potentiometric groundwater level is similar to the overlying shallow aquifer groundwater table. In areas where the confining layer is absent, groundwater may exchange between these two aquifers.

Due to the depth of the aquifer, it is not anticipated to have hydraulic connectivity to any surface water features.

No information on groundwater quality was available and only one registered bore contained yield information, which was recorded as 0.38 L/s.

4.7.6.3 Lachlan fractured rock

Shallow aquifer

The Lachlan fractured rock HSU underlies the entire groundwater study area, but only outcrops in the eastern portion proximal to Wagga Wagga. Where the HSU underlies the Murrumbidgee Alluvium or Porous rock HSUs, it is at significant depth and contains limited connectivity with the overlying aquifers and will not be impacted by the proposal.

Where the HSU outcrops, recharge to the shallow aquifer would primarily be from direct infiltration from rainfall. The shallow aquifer is anticipated to exist within the upper weathered zone of the underlying fractured rock or at the interface between soil and rock. Within the HSU, the depth to rock varies with shallow bedrock located along topographic highs associated with the granitic ridge southwest of Lake Albert. At the base of these highs, bedrock is expected to be deeper due to the deposition of colluvial and alluvial soils and increased residual soil profiles due to weathering. These deeper profiles exist proximal to the Gregadoo Waste Management Centre and east of Lake Cullival.

Shallow groundwater is anticipated to be perched in locations of topographic highs or undulating terrain, particularly within and proximal to areas where rock outcrops. The presence and permanency of groundwater will depend on the climatic conditions, including rainfall and evapotranspiration. The regional permanent shallow groundwater table is anticipated to generally be greater than 5 metres below ground level based on identified water bearing zones from registered bore data (WaterNSW, 2021), groundwater observations from McMahon Earth Sciences (2020) at the Gregadoo Waste Management Centre and geotechnical investigations (SMEC, 2020a & 2020c). However, the groundwater may be shallower under wetter climatic conditions or be semi-confined, showing a potentiometric effect (increased groundwater levels) once intersected. Groundwater flow is expected to follow topography and contain limited connectivity to surface water features.

Groundwater quality, whilst regionally variable is anticipated to be fresh to slightly saline based on limited recorded water quality data and the primary conceptual recharge mechanism from rainfall infiltration.

Groundwater yields are expected to be variable, but generally low and would be dependent on the underlying geological material and structures, including the degree of weathering.

Deep aquifer

Flow within the deep aquifer is anticipated to be structurally controlled by the presence of fractures and joint openings and their degree of connectivity. Recharge would be predominantly from groundwater flow through or leakage from the shallow aquifer where connectivity between the aquifers is increased due to fractures or joints. From the available groundwater observations, groundwater levels are expected to be greater than 25 mBGL, indicating potential vertical leakage from the overlying shallow aquifer. Groundwater flow is expected to follow the topography and any structural orientations imparted on the geological material. Due to the depth of the aquifer, it is not anticipated to be hydraulic connected to any surface water features.

Groundwater quality is anticipated to be regionally variable, but based on limited data, it is anticipated to be fresh to slightly saline within the groundwater study area.

5 Assessment of construction impacts

Construction and operation of the proposal, if undertaken without adequate management controls in place, has the potential to impact on the identified groundwater resources and environmental values through changes to groundwater availability and groundwater quality. This chapter identifies the associated risks, impact pathways through construction or operational activities, and qualitative and quantitative impact assessment of the risks.

5.1 Overview of potential groundwater construction impacts

The following proposal features have been assessed for their potential construction impacts on the hydrogeological environment, including sensitive GDE and registered bore receptors:

- transmission tower infrastructure, including transmission towers and substations and their required excavations for footings (such as pad footings or piling) which may be undertaken through conventional earthwork plant or blasting
- temporary accommodation camps, construction compounds and access tracks, which may include bulk excavations, foundation improvement and filling
- temporary earthwork material sites excavated through traditional plant equipment
- groundwater supply from nominated fill points (Section 2.2.2.1).

The key issues identified for the proposal are the risk associated to groundwater levels (availability) and quality resulting from:

- potential dewatering during bulk excavations
- blasting for the installation of transmission tower footings in shallow hard rock
- potential contamination from all construction activities.

Table 5-1 identifies the potential risks to the hydrogeological environment resulting from the construction.

Table 5-1 Potential risks to the groundwater environment during construction of the proposal

RISK	DESCRIPTION OF IMPACT AND CAUSE	POTENTIAL CONSTRUCTION ACTIVITY RESULTING IN IMPACT TYPE
Groundwater level decline due to dewatering	Dewatering resulting in groundwater level decline, potential impact to groundwater resources and sensitive receptors.	Construction activities associated with transmission tower infrastructure, accommodation, laydown areas and access tracks and earthwork material sites that require bulk earthworks. Blasting, where undertaken, for transmission tower footings in areas of shallow hard rock. Groundwater take for construction water supply.

RISK	DESCRIPTION OF IMPACT AND CAUSE	POTENTIAL CONSTRUCTION ACTIVITY RESULTING IN IMPACT TYPE
Changed recharge or groundwater flow paths	Changes to groundwater recharge or flow paths through altering surface infiltration, impacting confining layers between shallow and deep aquifer systems or barriers to groundwater flows. Changed recharge patterns or groundwater flow paths can impact sensitive receptors.	General construction activities that result in changes to surface infiltration, such as the creation of construction camps, access paths and removal of vegetation. Construction activities associated with transmission tower infrastructure, accommodation, laydown areas and access tracks and earthwork material sites that require bulk earthworks. Blasting, where undertaken, for transmission tower footings in areas of shallow hard rock.
Changes to groundwater quality (salinity and contamination)	Changes to groundwater flow paths, including introduction of groundwater flow barriers or groundwater discharges which may change groundwater quality. Changes to groundwater levels and quality resulting from salinity and contamination can impact sensitive receptors such as registered bores and GDEs.	Construction activities associated with transmission tower infrastructure, accommodation, laydown areas and access tracks and earthwork material sites that require bulk earthworks. Blasting, where undertaken, for transmission tower footings in areas of shallow hard rock. Saline water supply used during construction activities that may infiltrate to the underlying groundwater table.

5.2 Transmission tower infrastructure

The key construction activity risk associated with the transmission towers is through bulk excavations required for foundations that may intercept the regional groundwater table or localised controlled blasting that may be undertaken in areas of shallow hard rock to allow for appropriate embedment depth of footings.

Foundations for transmission towers may require bulk excavations up to around three metres where pad footings are adopted (depending on existing topography).

Where deeper foundations and footings are required, bulk excavations may be battered (stepped down) to required design depths. However, this would result in large excavation footprints and would become more difficult to manage in the presence of groundwater. Therefore, foundations that require deeper excavations and where groundwater is anticipated to be above the final design depth would be undertaken through piling by bored, driven or helical screw methodologies. Pile diameters are expected to be either 1.2 metres or 2.4 metres and extend down to a maximum of 25 metres from the surface. The final pile depth would be dependent on ground conditions but would likely intersect the regional groundwater table.

In areas of shallow hard rock, which is anticipated to exist within less than five percent of the transmission line easement, controlled blasting may be undertaken to allow for the appropriate embedment of transmission tower footings.

5.2.1 *Impacts to groundwater levels*

Considering the conceptual hydrogeological model, the permanent regional shallow groundwater table is not expected to be intersected within any of the HSUs through bulk excavation earthworks and therefore contain a low risk to altering groundwater levels.

Perched water may be encountered within three metres of the surface, particularly in areas of shallow hard rock within the Lachlan fractured rock HSU. However, it is likely to be localised, therefore the risk and potential impact to the hydrogeological environment would be low. GDEs within the Lachlan fractured rock HSU in the groundwater study area are predominately aquatic creeks and unlikely to be reliant on perched systems.

Where piling is undertaken using bored pile/cast in-situ methodology and intersects the groundwater table, concrete would be poured wet into the pile footings. This would result in minimal water being removed from the top of the concrete, as required. The use of driven or screw pile methodology would also not result in dewatering. Overall, the risk of impact to altering groundwater levels is low due to minimal, if any, groundwater being removed during the piling transmission line tower foundation process.

Where blasting is undertaken, it has the potential to fracture the surrounding rock, which may result in localised groundwater level decline. This could potentially impact neighbouring GDEs or registered water supply bores, if present, such as Sandy Creek, Stringybark Creek or Coloboralli Creek, which are located proximal to mapped outcropping rock. Sandy Creek is currently the only high potential GDE within 50 metres of potential blasting areas. No registered bores are located within 50 metres of potential blasting areas. A decrease in groundwater levels would likely adversely impact GDEs by reducing their available dependent water source.

The degree of impact from blasting would be dependent on the charge required, depth to groundwater and the presence of existing defects within the rock. Where an appropriate charge is selected, the groundwater level is below the blasting depth and the underlying geology is competent, the resulting blasting halo (the fracturing of rock directly related to the blast) would be limited. It is not anticipated that the blasting halo from an appropriate charge for the embedment of tower footings would extend more than 10 metres.

Mitigation measures related to the impacts of blasting and potential blasting locations are discussed in Chapter 9. The exact locations requiring blasting would be defined during pre-construction following additional geotechnical investigations, but indicative potential locations are provided in Figure 9-1.

5.2.2 *Impacts to groundwater recharge or flow paths*

Groundwater is not anticipated to be intersected for bulk excavations. However, it may be intersected during piling, but the limited piling diameter is unlikely to alter groundwater flow paths. Similarly, the infrastructure surface footprint is minimal compared to the groundwater HSUs extent and the risk and potential impact from reduced recharge from surface infiltration is low. In addition, the risk and potential impact is further diminished in the Murrumbidgee Alluvium and Porous rock HSUs where groundwater flow through and losing surface water features are considered the primary recharge mechanisms. Therefore, the risk to groundwater recharge or flow paths is low.

Where blasting is undertaken it has the potential to fracture the surrounding rock, potentially altering localised groundwater flow paths and available recharge to the aquifer. As blasting would only be undertaken in areas of shallow hard rock, recharge from rainfall may increase through the resulting fracturing leading to increased infiltration. If surface water features are present, the blasting and resulting fracturing may increase connectivity between the surface water and groundwater systems. Based on the conceptual hydrogeological model, this would result in increased losses from the surface water feature (if present within the blasting halo).

Due to the thickness of the shallow aquifer HSUs, blasting is not anticipated to increase the connectivity between the shallow and deep aquifers.

For the reasons discussed and those outlined in Section 5.2.1, the impact resulting from blasting is anticipated to be low subject to mitigation measures identified in Chapter 9.

5.2.3 *Impacts to groundwater quality*

Groundwater is not anticipated to be intersected for bulk excavations. Where piling is required for deeper foundations that intersect the groundwater table, groundwater quality may potentially be impacted through degradation of the infrastructure foundation or footing material if inappropriately selected to withstand the salinity and aggressivity of the groundwater (and soil) environment. However, with appropriate mitigation measures (refer to Chapter 9) and minimal piling diameters the residual risk and impact to groundwater quality would be low.

Where blasting is required in areas of shallow hard rock, it has the potential to fracture the surrounding rock, potentially altering groundwater flow paths. This could lead to mobilising existing groundwater contamination plumes and saline groundwater or increased seepage to the groundwater aquifer from overlying contaminated sediments. This may adversely impact GDEs and registered users through changing their dependent groundwater source quality.

The potential impact to groundwater quality would be related to the extent and degree of the contaminated groundwater plume, saline groundwater or overlying contaminated sediments. However, as the blast halo is anticipated to be limited, it is unlikely that controlled blasting would result in changes to groundwater quality as the existing groundwater would be comparable within the blasting halo.

Impacts from overlying contaminated sediments would be limited as the bulk of overlying sediments would be removed prior to blasting.

The potential risk and impact to groundwater quality, both salinity and contamination, is considered low.

5.3 Construction compounds, accommodation camps and access tracks

Minimal earthworks are required for accommodation camps, laydowns and access paths. Earthworks would generally be limited to stripping of topsoil, improving soil foundations for heavy plant or light infrastructure, such as temporary accommodation camps and installation of turkey's nests for grey water collection. A turkey's nest is a small basin type structure that would collect treated effluent (greywater) from the wastewater treatment facilities. The turkey's nest would be lined with high density polyethylene or geosynthetic clay liner. Earthworks involving bulk excavations greater than one metre are not anticipated.

5.3.1 *Impacts to groundwater levels*

Given the shallow depths of anticipated earthworks required, the groundwater table is not expected to be intersected. Turkey's nests would be appropriately lined by low hydraulic conductivity material such as polyethylene or geosynthetic clay liner that would act as a barrier, limiting leakage to the underling groundwater. Therefore, the risk to impacting groundwater levels is negligible.

5.3.2 *Impacts to groundwater recharge or flow paths*

Groundwater is not anticipated to be intersected during earthworks for accommodation camps, laydown areas and access paths. Therefore, no impacts to groundwater flow paths are expected.

Recharge from infiltration may be impacted through changes in the permeability of the underlying soils through compaction, installation of turkey's nests or the presence of new hard stand areas for the construction activities. However, the required surface footprint is minimal compared to the groundwater HSUs extent and the risk and potential impact to recharge or groundwater flow paths is low.

5.3.3 *Impacts to groundwater quality*

Groundwater is not anticipated to be intersected during required earthworks for the accommodation camps, laydown areas and access paths. Turkey's nests would be appropriately lined creating a barrier that limits leakage to the underlying groundwater. This limits the potential interaction between construction activities that may introduce contaminants to the underlying HSU. Therefore, the risk and potential impact to groundwater quality is low.

5.4 Substations

Shallow earthworks for substation foundations and service installations (such as wiring and drainage) would be required to upgrade the Wagga Wagga substation and build a new substation at Dinawan. The limited earthworks are anticipated to require excavation of up to two metres.

5.4.1 *Impacts to groundwater levels*

Given the shallow depths of anticipated earthworks required, the groundwater table is not expected to be intersected. Therefore, the risk to impacting groundwater levels is negligible.

5.4.2 *Impacts to groundwater recharge or flow paths*

Groundwater is not anticipated to be intersected during earthworks for the substation upgrade at Wagga Wagga or the proposed Dinawan 330kV substation and the required surface footprint for the construction or upgrade of the substations are minimal compared to the groundwater HSUs extent. Therefore, the risk and potential impact to recharge or groundwater flow paths is low.

5.4.3 *Impacts to groundwater quality*

Groundwater is not anticipated to be intersected during required earthworks for the substations. This limits the potential interaction between construction activities that may introduce contaminants to the underlying HSU. Therefore, the risk and potential impact to groundwater quality is low.

5.5 Earthwork material site

An earthwork material site is proposed at the Dinawan 330kV substation to provide site won material for the construction of the proposal. The Dinawan 330kV substation is located within the Murrumbidgee Alluvium HSU. Excavation depths for the earthwork material site would require up to two to three metres of material to be removed.

5.5.1 *Impacts to groundwater levels*

Given the shallow depths of anticipated earthworks required, the groundwater table is not expected to be intersected. Therefore, the risk to impacting groundwater levels is negligible.

5.5.2 *Impacts to groundwater recharge or flow paths*

The proposed earthwork material site is located within the construction impact area of the assessed substation (Section 5.4), and for the same reasons outlined, the impact is considered to be low.

5.5.3 *Impacts to groundwater quality*

The proposed earthwork material site is located within the construction impact area of the assessed substation (Section 5.4), and for the same reasons outlined, the impact is considered to be low.

5.6 Water supply

5.6.1 Impacts to groundwater levels

Groundwater supply for construction is to be sourced within existing infrastructure and licencing. Therefore, the risk and potential impact to groundwater levels is low

5.6.2 Impacts to groundwater recharge or flow paths

Groundwater supply for construction is to be sourced within existing infrastructure and licencing and therefore no risk or potential impact is considered regarding recharge or groundwater flow paths.

5.6.3 Impacts to groundwater quality

Groundwater supply for construction is to be sourced within existing infrastructure and licencing and is generally of potable through to slightly saline quality. The amount of water required that may potentially infiltrate to the groundwater table is minimal compared to the regional groundwater aquifer. Therefore, the risk and potential impact to groundwater quality resulting from water supply is low.

5.7 Impacts to registered bores

Eleven registered bores were identified within construction impact area (refer to Table 4-11, Section 4.7.5.1) and therefore contain an increased risk of being accidentally damaged during construction activities. Appropriate mitigation and management measures discussed in Chapter 9 can reduce the risk and potential impact to these registered bores.

5.8 Summary of potential construction impacts

During construction, the potential impacts to groundwater are likely to be low as earthworks for the construction items are not anticipated to intersect the water table. Blasting in areas of shallow hard rock, if undertaken for the required embedment depth of the transmission tower footings may result in increased risk of impact to groundwater levels, recharge and flow paths and quality. However, the area subject to potential blasting is anticipated to be less than five percent of the length of the transmission line easement and only one high potential GDE (Sandy Creek) was identified within 50 metres of a potential blast location. Due to the minimal area for potential blasting, anticipated limited extent of the blasting halo and use of appropriate mitigation measures (refer to Chapter 9), the potential impact is considered 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

CONSTRUCTION ITEM	POTENTIAL IMPACT	SIGNIFICANCE OF POTENTIAL IMPACT
Transmission tower infrastructure	Groundwater levels	Low
	Groundwater recharge and flow paths	Low
	Groundwater quality (salinity and contamination)	Low
Accommodation camps, laydown areas and access paths	Groundwater levels	Low
	Groundwater quality (salinity and contamination)	Low
	Groundwater recharge and flow paths	Low

CONSTRUCTION ITEM	POTENTIAL IMPACT	SIGNIFICANCE OF POTENTIAL IMPACT
Substations	Groundwater levels	Low
	Groundwater quality (salinity and contamination)	Low
	Groundwater recharge and flow paths	Low
Earthwork material sites	Groundwater levels	Low
	Groundwater quality (salinity and contamination)	Low
	Groundwater recharge and flow paths	Low
Water supply	Groundwater levels	Low
	Groundwater quality (salinity and contamination)	Low
	Groundwater recharge and flow paths	Low
All construction activities	Registered bores	Low

6 Assessment of operational impacts

Operational risk and potential impacts, including to GDEs and registered bores, are expected to be lower than during construction due to the following:

- the operation of the proposal does not require groundwater take
- reduced potential impact pathways, such as no longer requiring construction material stockpiles and laydown areas, no on-going earthworks, and rehabilitation of temporary accommodation, laydown areas, earthwork material sites and non-essential access pathways.

This limits the key operational risks to those outlined in Table 6-1 which are summarised as risk to:

- impacts to groundwater flow paths from footings that intersect the groundwater table or increased fracturing and connectivity due to blasting (where undertaken during the construction of the proposal)
- degradation of groundwater quality due to inappropriate foundation or footing materials
- groundwater contamination from maintenance activities
- reduced recharge from permanent hard stand areas.

Table 6-1 Potential risks to the groundwater environment during operation of the proposal

RISK	DESCRIPTION OF IMPACT AND CAUSE	POTENTIAL OPERATION ACTIVITY RESULTING IN IMPACT TYPE
Changed recharge or groundwater flow paths	Changes to groundwater recharge or flow paths through altering surface infiltration, impacting confining layers between shallow and deep aquifer systems or barriers to groundwater flows. Changed recharge patterns or groundwater flow paths can impact sensitive receptors.	Permanent infrastructure that results in changes to surface infiltration, such as new substations. Permanent associated subsurface foundations and footings for infrastructure, such as transmission tower foundations or their construction methodology that may permanently impact groundwater flow paths, such as blasting (where undertaken).
Changes to groundwater quality (salinity and contamination)	Changes to groundwater flow paths, including introduction of groundwater flow barriers or groundwater discharges which may change groundwater quality. Changes to groundwater levels and quality resulting from salinity and contamination can impact sensitive receptors such as registered bores and GDEs. Degradation of water quality through the migration of potentially existing contamination plumes within the groundwater environment. Degradation of water quality from corrosive groundwater impacting foundations.	Permanent associated subsurface foundations and footings for infrastructure, which may degrade and impact groundwater quality. Storage, spillage and leaks of hazardous substances used during operation. Permanent subsurface foundations and footings for infrastructure that alter groundwater flow paths, distributing existing contaminants. Leaching of contaminants from contaminated fill.

6.1 Impacts to groundwater recharge and flow paths

Groundwater dewatering is not required for the operation of the proposal. However, piling may intersect the groundwater table and act as a barrier to groundwater flow. The risk of the piling causing impact to the groundwater environment is low as the piling diameter (1.2 metres or 2.4 metres) is negligible compared to the extent of the groundwater HSUs.

Similarly, the permanent operational infrastructure surface footprint is minimal compared to the groundwater HSUs extent and the risk and potential impact from reduced recharge from surface infiltration is low.

If blasting was undertaken during the construction of the proposal, the impact would enhance fracturing and jointing within the rock, increasing connectivity that could potentially alter local groundwater flow paths, improve connectivity to surface water features and infiltration. The degree of impact from blasting would be dependent on the charge required, depth to groundwater and the presence of existing defects within the rock. However, it is not anticipated that the blasting halo from an appropriate charge for the embedment of tower footings would extend more than 10 metres. Whilst the impact from blasting would still be present during the operation of the proposal, for the reasons outlined in (Section 5.4), the impact would be limited and subject to mitigation measures outlined in Chapter 9.

6.2 Impacts to groundwater quality

Groundwater quality may be impacted due to degradation of footing materials under aggressive groundwater (and soil) conditions. This could impact GDEs and registered users that are reliant on the underlying groundwater. However, the potential impact is considered low due to the minimal pile footing diameter and localised impact radius that would unlikely lead to degradation in groundwater quality of the groundwater resource.

Existing groundwater contamination, if present, is not anticipated to be mobilised due to the operation of the proposal as dewatering is not required for its operation and any potential impact from blasting is expected to result in a limited halo and radius of influence.

The operational impact for groundwater quality (contamination) related to the proposal would be potential hydrocarbon (fuels, diesel, oils) contamination of soil, surface water and groundwater arising from incidents involving vehicle accidents, leaks and spills in the transmission line easement or at the proposed substation sites. Spill volumes from such incidents would be expected to be minor; however, the potential for hydrocarbon fuel to migrate off-site cannot be discounted. Spill containment facilities (such as bunded containers, designated fill points, and spill kits) would be used on maintenance work sites and at the proposed Dinawan and Wagga Wagga substations. Furthermore, the operator will implement and develop incident response procedures to manage the risk from these occurrences.

7 Minimal impact considerations

Interference approvals under the WM Act 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 2.2.2.3 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, all groundwater sources (HSUs) are categorised as less productive.

An assessment of the proposal's 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 to Table 7-3.

The assessment complies with Level 1 acceptance criteria indicating that the proposal is anticipated to have minimal impact to the underlying groundwater environment.

Table 7-1 Aquifer Interference Policy *Minimal impact considerations* for ‘less productive alluvial water sources’ – Murrumbidgee Alluvium (Lower Murrumbidgee Alluvium groundwater source)

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water table	— Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: — high priority groundwater dependent ecosystem; or — high priority culturally significant site listing in the schedule of the relevant water sharing plan; or — A maximum of a two metre decline cumulatively at any water supply work unless make good provisions should apply.	No groundwater take is anticipated for the construction or operation of the proposal.
	— If more than 10% cumulative variation in the water table, allowing for typical climatic “post water sharing plan” variations, 40 m 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 should apply.	Refer to above responses that indicates this condition is not triggered.
Water pressure	— A cumulative pressure head decline of not more than 40% of the “post-water sharing plan” pressure head above the base of the water source to a maximum of 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.
	— 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 above response that indicates this condition is not triggered.

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water quality	— Condition 1 (a). Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity; and — Condition 1 (b). No increase of more than 1% per activity in long-term average salinity in a highlight 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 above. — Condition 1 (c)./No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the three dimensional extent of the alluvial material – whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”.	The proposal is not anticipated to result in: — a change in groundwater quality which would lower the beneficial use category — increase of more than 1% per activity in long-term average salinity in connected surface water sources. The proposal is not a mining activity.
	— 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) is 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) is 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 designs should prevent the Probable Maximum Flood from entering the activity’s site — 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 above responses that indicates this condition is not triggered.

Table 7-2 Aquifer Interference Policy *Minimal impact considerations* for a ‘less productive porous rock aquifer’ – Western porous rock groundwater source

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water table	— Less than or equal to ten per cent cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m 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 metre decline cumulatively at any water supply work.	No groundwater take is anticipated for the construction or operation of the proposal.
	— If more than ten percent cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m 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 above responses that indicates this condition is not triggered.
Water pressure	— A cumulative pressure head decline of not more than a two metre 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.
	— If the predicted pressure head decline is greater than two metres decline cumulatively at any water supply work, 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 above responses that indicates this condition is not triggered.

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water quality	Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	The proposal is not anticipated to result in: - a change in groundwater quality which would lower the beneficial use category - increase of more than 1% per activity in long-term average salinity in connected surface water sources. The proposal is not a mining activity.
	If the above condition 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 above responses that indicates this condition is not triggered.

Table 7-3 Aquifer Interference Policy *Minimal impact considerations* for a ‘less productive fractured rock aquifer’ – Lachlan fractured rock

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water table	— Less than or equal to ten per cent cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m 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 two metre decline cumulatively at any water supply work.	There is generally low risk of the proposal causing equal to or greater than ten per cent cumulative variation in the water table from any high priority (= high potential) GDE or culturally significant site or over two metre decline cumulatively at any water supply work as no groundwater take is anticipated for the construction or operation of the proposal. Subject to the appropriate mitigation measures identified in Chapter 9, blasting, if undertaken in areas of shallow hard rock, is not expected to result in equal to or greater than ten per cent cumulative variation in the water table from any high priority (= high potential) GDE or culturally significant site or over two metre decline cumulatively at any water supply work.
	— If more than ten percent cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m 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 above responses that indicate this condition is not triggered.

FEATURE	MINIMAL IMPACT CONSIDERATIONS	RESPONSE
Water pressure	— A cumulative pressure head decline of not more than a two metre decline, at any water supply work.	There is generally low risk of the proposal causing a cumulative pressure head decline of two metres at any supply work as groundwater take is not anticipated for the construction or operation of the proposal. Subject to the appropriate mitigation measures identified in Chapter 9, blasting, if undertaken in areas of shallow hard rock, is not expected to result in a cumulative pressure head decline of two metres at any supply work.
	— If the predicted pressure head decline is greater than listed 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 above responses that indicate this condition is not triggered.
Water quality	— Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	The project is generally not anticipated to result in a change in groundwater quality which would lower the beneficial use category. Subject to the appropriate mitigation measures identified in Chapter 9, blasting, if undertaken in areas of shallow hard rock, is not expected to result in a change in groundwater quality which would lower the beneficial use category.
	— If the above condition 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 above responses that indicate this condition is not triggered.

7.1 Licensing requirements

Water license requirements are outlined within the relevant water sharing plans (refer to Section 2.2.2.2). No groundwater licencing approvals or requirements are expected to be triggered by the proposal. This is due to groundwater take from dewatering being limited to minimal groundwater removed during the piling process for transmission line tower foundations. No dewatering is required during operation of the proposal.

Groundwater dewatering volumes for the piling process at transmission line tower locations will be recorded and if during construction more than three megalitres is expected during a water calendar year (July to June) in each groundwater source collectively for the proposal, appropriate WALs with sufficient water volume will be obtained.

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

8 Cumulative impacts

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 October 2021)
- Relevant council websites (searched October 2021)
- Australian Government – Department of Environment and Energy, EPBC Public notices list (Australian Government, searched October 2021).

A number of proposed developments have been identified and these include:

- EnergyConnect (NSW – Western Section)
- Buronga Solar Farm
- Buronga Landfill Expansion
- Buronga – Gol Gol residential expansion
- Inland Rail – Albury to Illabo
- Uranquinty Solar Farm
- Gregadoo Solar Farm.

8.1 EnergyConnect (NSW – Western Section)

The NSW – Western Section of EnergyConnect would comprise around 135 kilometres of new 330kV double circuit transmission line and associated infrastructure between the SA/NSW border and the existing Buronga substation, upgrade of the Buronga substation and upgrade of the existing 22 kilometre 220kV single circuit transmission line between the Buronga substation and the NSW/Victoria border at Monak. Transgrid has previously sought and received separate environmental planning approvals for EnergyConnect (NSW – Western Section).

The EnergyConnect (NSW – Western Section) was approved in September 2021. Construction of the proposal is scheduled to commence in early-2022 (enabling phase). The construction of the transmission lines would take around 18 months while the Buronga substation upgrade and expansion would be delivered in two components and be operational by late-2023.

The EnergyConnect (NSW – Western Section) is located down-gradient from the EnergyConnect (NSW – Eastern Section) therefore any cumulative impact would be dependent on the degree of impact to the groundwater environment within the Eastern Section (this report). As the risk and potential impact is considered low and groundwater take is not anticipated for construction or operation of either proposal due to the depth of expected groundwater, the risk of cumulative impacts to groundwater levels or quality of the groundwater environment is considered low.

Construction of the Western Section is scheduled to start before the Eastern Section however there is potential for minimal overlap within their proposed construction schedules. Depending on the degree of overlap and the construction activity locations during the overlapping schedules, there could be increased local demand for construction water. However, the risk would be low as water take would be adequately licenced and could be managed by appropriate construction scheduling given the extensive alignment and multiple water supply fill locations.

8.2 Buronga Solar Farm

The Buronga Solar Farm development includes a 400 MW solar farm with energy storage and associated infrastructure located adjacent to the proposal Buronga substation. The EIS for the project is currently being prepared. The project would also involve the construction of a 220kV or 330kV transmission line for connection to the existing Buronga substation. The construction schedule for the proposal is identified as being about approximately 18 to 24 months from site establishment to completion (noting commencement subject to approval from DPIE).

The EnergyConnect (NSW – Western Section EIS) (Transgrid, 2020) notes that groundwater is expected to be at significant depth (greater than 15 mBGL) within the Buronga Solar Farm. Considering the depth to groundwater, the cumulative impact to the groundwater environment is considered low.

8.3 Buronga landfill expansion

The proposal includes the expansion to the existing Buronga landfill to allow for an increase in the total quantity of waste that can be accommodated from 30,000 tonnes to 100,000 tonnes of general waste per annum. The proposal would consist of the construction of multiple additional landfill cells over the next 30 years comprising a volume of around 4.8 million cubic metres over an area of around 395,000 square metres (including the current active landfill cell).

The Buronga Landfill proposed expansion preliminary scoping report (Wentworth Shire Council, 2020) anticipates groundwater to be deeper than six metres from the surface. Landfill cells will comply with environmental guidelines and industry best practices for cell construction to minimise the risk of leachate contamination and impacting groundwater quality. In addition, groundwater monitoring is required under the existing EPA licence to identify any potential contamination.

As the Buronga Landfill proposed expansion would have appropriate mitigation measures to minimise its impact to the groundwater environment and no groundwater take is anticipated for the EnergyConnect (NSW – Eastern Section), the cumulative risk to the groundwater environment is low.

8.4 Buronga – Gol Gol residential expansion

Wentworth Shire Council is proposing new subdivisions to provide around 500 new large residential housing allotments in the Buronga – Gol Gol growth area, around 10 kilometres to the west of the proposal.

It is not expected that there would be cumulative impacts to flood risk and geomorphology because the development will need to comply with the Wentworth Shire Council Development Control Plan 2011 which outlines conditions for erosion and sediment control and flood liable land.

No timeframe on proposed development of the urban release areas has been identified at this time, however should the proposed residential expansion commence at the same time as the construction of the proposal, this may result in a cumulative demand for water during the construction phase. Long term water supplies may be impacted if water demand management strategies are not developed.

8.5 Inland Rail – Albury to Illabo

ARTC is proposing to upgrade the Albury to Illabo section, along the 185 kilometres of existing operational narrow-gauge railway from the Victorian/New South Wales border to Illabo in regional NSW. The Proposal would provide clearance of the existing ‘Main South’ corridor to operate 1,800 metres long, 6.5 metres high, double stacked trains and includes the provision of dual track in areas for train passing. The project is made up of discrete sections of proposed upgrade, including upgrades within the existing rail corridor at Uranquinty, The Rock and within the centre of Wagga Wagga.

Subject to planning approval, construction is planned to commence in mid-2023 and complete by late 2024. Operations to commence in 2025.

As the Albury to Illabo project would include appropriate mitigation measures to minimise its impact to the groundwater environment and no groundwater take is anticipated for the EnergyConnect (NSW – Eastern Section), the cumulative risk to the groundwater environment is low.

8.6 Uranquinty Solar Farm

Origin Energy is proposing to develop a commercial scale solar photovoltaic site and associated battery storage at Uranquinty. The proposal would have a capacity of up to 200 megawatts (MW) of renewable energy production for the local electricity supply. The site is located north-west of Uranquinty village along Uranquinty Cross Road, around 15 kilometres south-west of Wagga Wagga. Given current timing for the proposed solar farm, there is the potential for the proposal and the solar farm construction periods to overlap.

Groundwater was not identified as a key environmental consideration in the Uranquinty Solar Farm scoping report (Origin Energy, 2021). Therefore, the cumulative impact to the groundwater environment is anticipated to be low. If construction periods overlap, there could be increased demand for groundwater resources. However, it is expected that all groundwater take for construction water supply purposes would be adequately licenced and therefore the cumulative impact to groundwater resources would be low.

8.7 Gregadoo Solar Farm

The Gregadoo Solar Farm will be located about 13 km south-east of Wagga Wagga. The project is proposed to comprise construction, operation and decommissioning of a maximum 47 MW solar farm and associated infrastructure. Construction is expected to commence mid-2021.

The Gregadoo Solar Farm State Significant Development Assessment (DPIE, 2018) has assessed that the project would not have any impact on groundwater sources or GDEs, therefore the cumulative impact to the groundwater environment is considered low.

8.8 Summary

The identified proposals that may cause cumulative impacts are not anticipated to intersect the groundwater table or were identified as not having impact on the groundwater environment. Therefore, the expected cumulative impact to groundwater levels and quality of the groundwater environment is low.

Depending on the construction schedules and if groundwater is used for construction water supply purposes, there could be increased demand for groundwater resources. However, it is expected that all groundwater take for construction purposes would be adequately licensed, resulting in low cumulative impact to groundwater resources.

9 Mitigation measures

9.1 Construction Environment Management Plan

The proposal is anticipated to generally have a limited impact to groundwater, which would be further reduced with the implementation of mitigation measures outlined within the CEMP. Groundwater controls would be part of the CEMP and be included within the soil and water management 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.

A SWMP would also be prepared for the proposal and contain details appropriate measures in the event that groundwater is encountered during construction. The sub-plan would include but is not limited to:

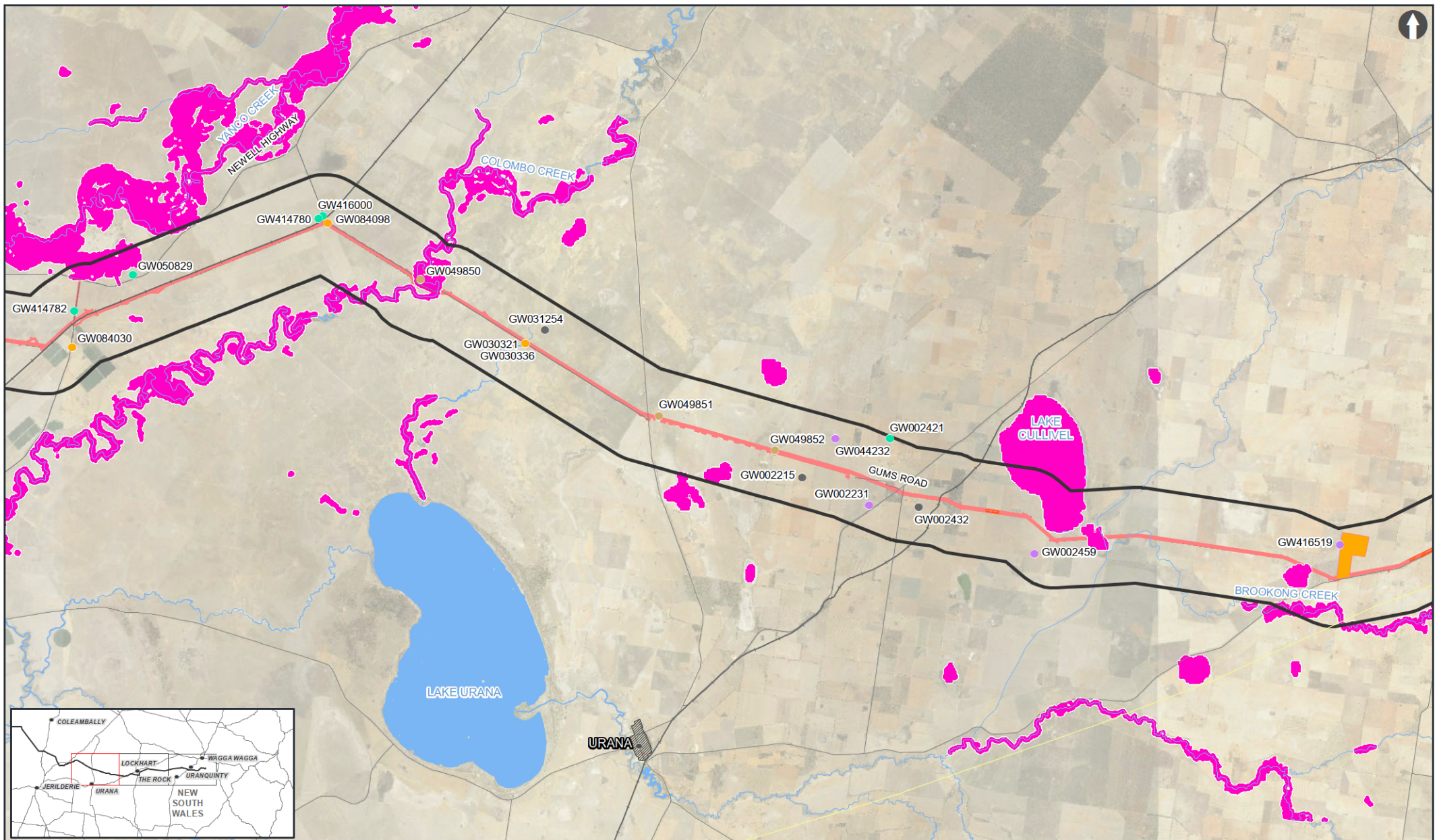
- management of dewatering processes, expected groundwater take and licencing requirements
 - assessment of groundwater take impacts against the minimal impact criteria listed within the Aquifer Interference Policy and relevant water sharing plans
 - procedures for the appropriate handling, storage, transport and disposal of groundwater.
-

9.2 Blasting mitigation measures

Blasting was identified as a key risk during construction that could potentially impact groundwater levels, recharge, flow paths and quality. Blasting may be required during construction of transmission towers in areas of shallow hard rock. However, the associated blasting halo is expected to be minor and not extend more than 10 metres and is anticipated to result in low impact to the groundwater environment (refer to Section 5.2). There are no registered bores and only one high potential GDE (Sandy Creek) currently within 50 metres of a potential blast location.

The exact locations requiring blasting would be defined during pre-construction following additional geotechnical investigations, but indicative potential locations are provided in Figure 9-1. To preventatively mitigate against the potential impacts from blasting, a 50 metre buffer around high potential GDEs and registered bores has been applied (refer Figure 9-1).

If blasting is to be undertaken within the buffer, further assessment of the potential blasting halo and impact radius to ensure minimal impact to GDEs and registered bores would be undertaken or alternative construction methodologies, such as jack-hammering or engineering solutions are to be given preference over blasting. The further assessment would consider the encountered geology, likely blast impact radius and the resulting risk to the GDE or registered bore and mitigation measures to mitigate any identified impacts should be identified and implemented. Where there are no high potential GDEs or registered bores within 50 metres of blasting then further assessment is not required.



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation

Groundwater Study Area

- Groundwater Study Area
- Built Up Areas
- Potential Blasting Locations
- Blasting Mitigation Areas
- Waterbody

Groundwater Monitoring Bore Function

- Monitoring (4)
- Exploration / Mining Activities (3)
- Household (4)
- Unknown (3)
- Water Supply for Livestock (5)

Groundwater - Figure 9-1

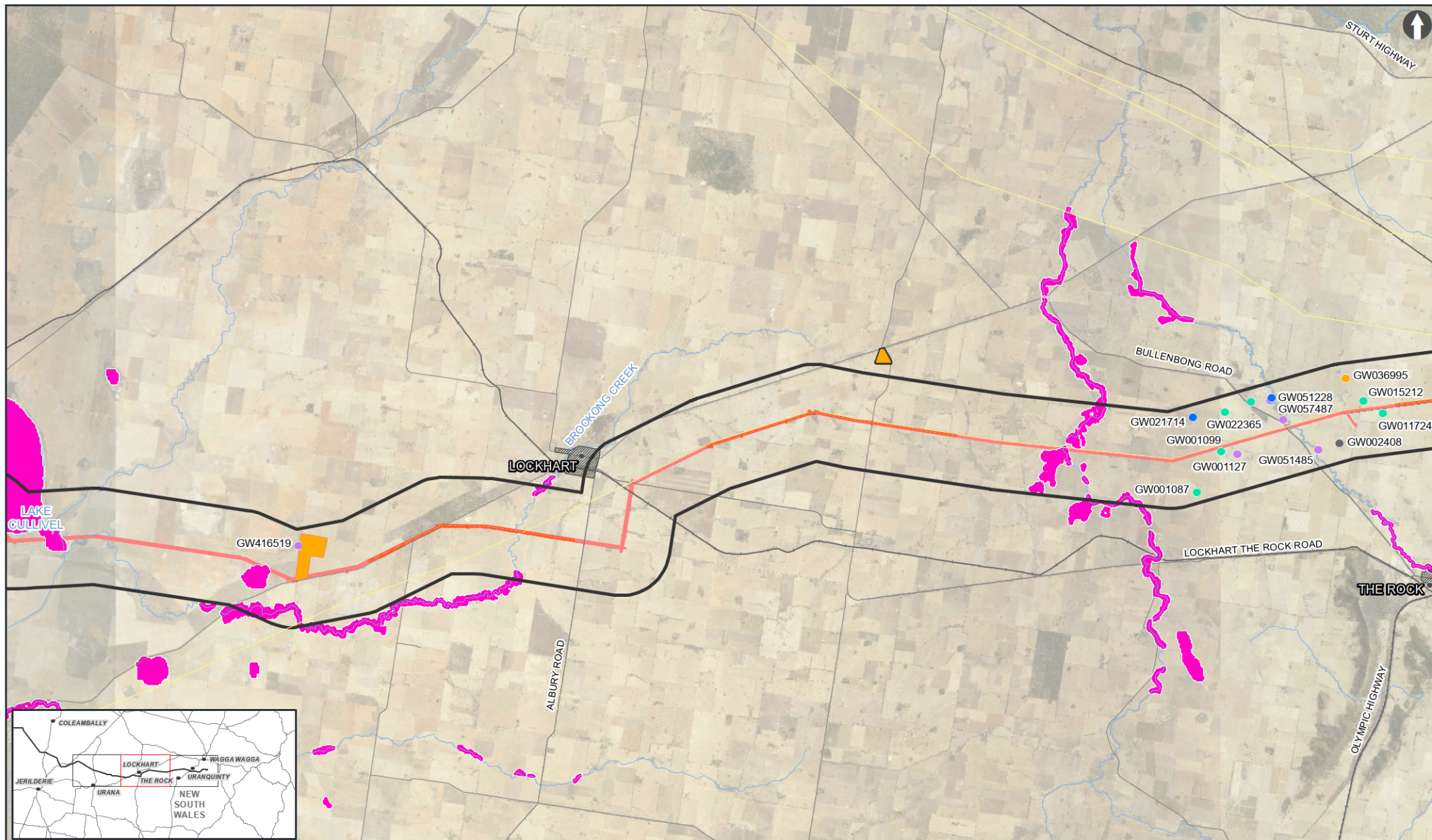
Blasting Mitigation Areas

0 5 10 KM

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Sheet 1 of 3

Source: NSWSS, ESRI, Transgrid, WSP



Groundwater - Figure 9-1

Blasting Mitigation Areas

Project Components

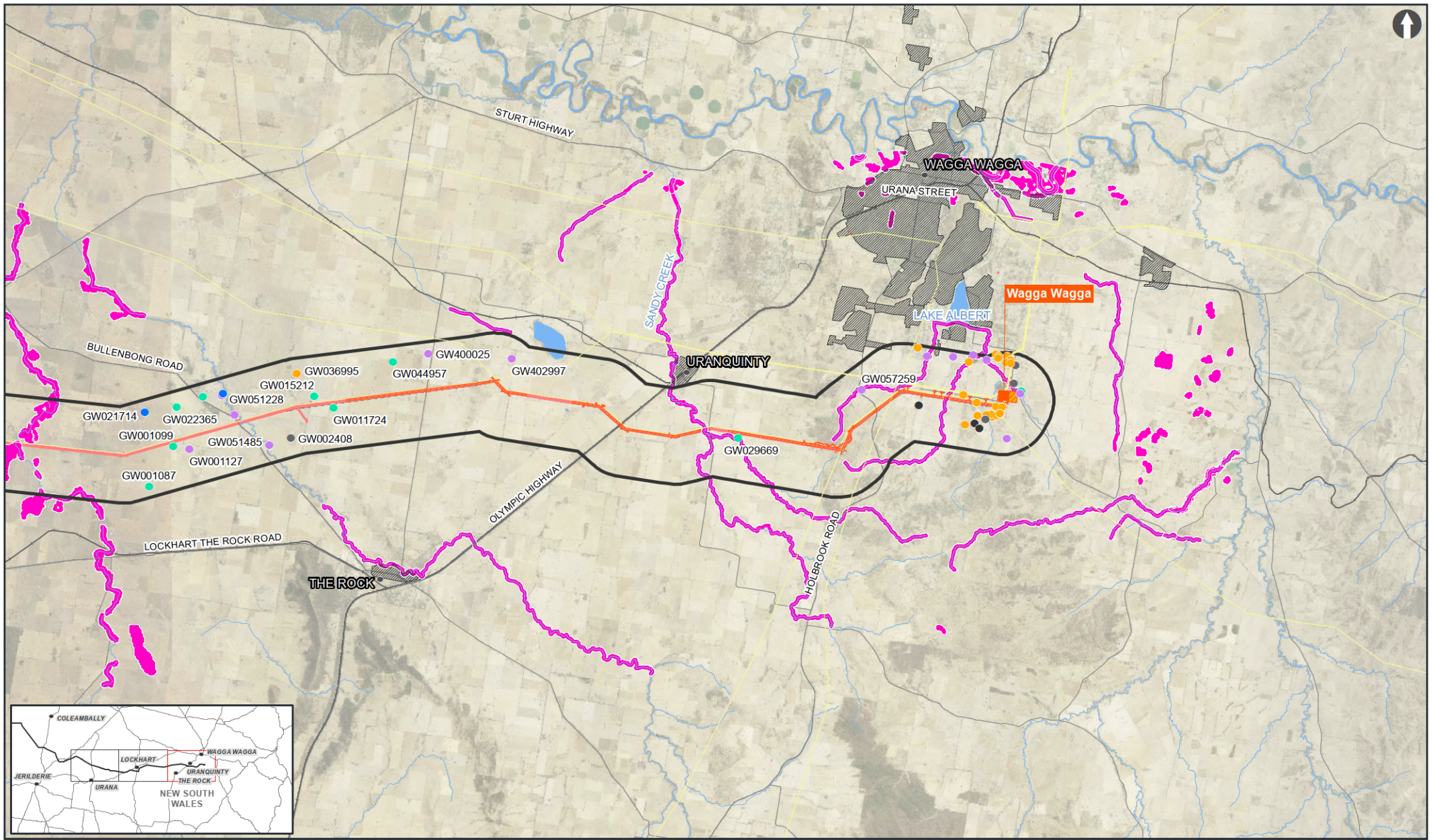
- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation

- Groundwater Study Area
- Built Up Areas
- Potential Blasting Locations
- Blasting Mitigation Areas
- Waterbody

Groundwater Monitoring Bore Function

- Household (5)
- Monitoring (1)

- Water Supply for Livestock (6)
- Unknown (1)
- Water Supply (2)



Project Components

- Construction Impact Area
- Main Construction Compounds and Accommodation Sites
- Existing Transmission Line Infrastructure
- Existing Substation

Groundwater Study Area

- Groundwater Study Area
- Built Up Areas
- Potential Blasting Locations
- Blasting Mitigation Areas
- Waterbody

Groundwater Monitoring Bore Function

- Drainage - Groundwater (3)
- Household (13)
- Monitoring (54)
- Water Supply for Livestock (9)
- Unknown (4)
- Water Supply (2)

Groundwater - Figure 9-1

Blasting Mitigation Areas

0 5 10 KM

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Sheet 3 of 3

Source: NSW55, ESRI, Transgrid, WSP

9.3 Proposed mitigation measures

Mitigation measures to be applied to the proposal are presented in Table 9-1.

Table 9-1 Mitigation measures – groundwater

ID	IDENTIFIED MITIGATION MEASURE	TIMING	APPLICABLE LOCATION(S)
GW-1	Construction materials would be selected to withstand high saline soil and groundwater environment (where applicable).	Pre-construction	Porous rock and Murrumbidgee Alluvium HSU or as determined from site specific hydrogeological investigations
GW-2	Direct impacts to registered bores GW415977, GW415978, GW415979, GW415980, GW415982, GW049852, GW084098, GW012872, GW403762, GW032607 and GW087095 would be avoided, where possible. If the bores are: - not required to be removed during construction, then they would be clearly demarcated with a 5x5 metre construction exclusion zone - are to be removed during construction or unavoidably damaged, then make good provisions would apply in consultation with the registered bore owner.	Pre-construction and construction	Registered bores GW415977, GW415978, GW415979, GW415980, GW415982, GW049852, GW084098, GW012872, GW403762, GW032607 and GW087095
GW-3	Prior to carrying out any blasting, a desktop assessment would be carried out to identify any high potential GDEs and registered bores in the vicinity that might be affected. Potential impacts to the GDEs and bores would be assessed using the latest available location data. The assessment would identify any necessary measures to mitigate any potential significant impacts. The measures would be implemented during the blasting. Where the assessment identifies potentially significant impacts to high potential GDEs and bores due to blasting that cannot be mitigated, alternative lesser impact construction methodologies or engineering solutions would be investigated and implemented.	Construction (prior to blasting)	Finalised blasting locations if within 50 metres of high potential GDEs
GW-4	If groundwater is encountered during piling or excavations, groundwater level and any dewatering volumes would be recorded.	Construction	All locations
GW-5	Construction materials, spoil and waste would be suitably stored to minimise the potential for groundwater impacts.	Construction	All locations

As the risk to the groundwater environment is lower during the operation of the proposal than during the construction, any required operational mitigation measures would be finalised at the conclusion of the construction period and be based on discussions with relevant agencies. 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 proposal overlies the following three defined hydrostratigraphic units (HSUs):

- Murrumbidgee Alluvium, which corresponds to the Lower Murrumbidgee Alluvium groundwater source identified within the Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources 2020.
- Porous rock, which corresponds to the Western Porous Rock groundwater source identified within the Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2020.
- Lachlan fractured rock, which corresponds to the Lachlan Fold Belt Murray-Darling Basin groundwater source identified within the Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources 2020.

This report has assessed the impacts of the proposal on the above HSUs, including identified groundwater dependent ecosystems having regard to the NSW Aquifer Interference Policy and relevant water sharing plans and through the proposed mitigation and management measures is anticipated to have a low impact on the groundwater environment.

Two primary potential groundwater impact mechanisms were determined to occur through, and primarily relate to, contamination during construction activities and impacts related to blasting, where undertaken, for transmission line tower foundations.

The majority of impacts from the proposal during the construction phase would be managed through a Construction Environmental Management Plan (CEMP) which would include a soil and water sub-plan (SWMP). Groundwater mitigation measures would be incorporated in the SWMP which would detail appropriate measures in the event that groundwater is encountered during construction.

Where blasting is deemed the most appropriate solution an additional desktop assessment involving the latest spatial information for GDEs and registered bores will be undertaken for blasting locations within 50 metres of high potential GDEs or registered bores prior to blasting during construction of the proposal. The assessment would include identification of any high potential GDEs or registered bores within 50 metres of the blast location. Where a high potential GDE or registered bore is identified within 50 metres of the blast location further assessment considering the encountered geology, likely blast impact radius and the resulting risk to the high potential GDE or registered bore would be undertaken and mitigation measures adopted for inclusion in the CEMP. Where there are no GDEs or registered bores within 50 metres then further assessment is not required.

The proposal complies with Level 1 acceptance criteria of the *Minimal impact considerations* outlined in the Aquifer Interference Policy, indicating that the potential impact of the proposal to the groundwater environment is acceptable.

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).

11.1 Permitted purpose

This Report is provided by WSP for the purpose described in the Agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (Permitted Purpose).

11.2 Qualifications and assumptions

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Except as otherwise stated in the Report and to the extent that statements, opinions, facts, conclusion and/or recommendations in the Report (Conclusions) are based in whole or in part on information provided by the Client and other parties identified in the report (Information), those Conclusions are based on assumptions by WSP of the reliability, adequacy, accuracy and completeness of the Information and have not been verified. WSP accepts no responsibility for the Information.

WSP has prepared the Report without regard to any special interest of any person other than the Client when undertaking the services described in the Agreement or in preparing the Report.

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Appendix A

Registered bore search groundwater level
and yield records



A1 Registered bore search groundwater level and yield records

Table A-1 Summary of viewed registered bores with groundwater level records

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	WATER BEARING ZONES (mBTC) ³	GROUNDWATER LEVEL (mBTC) ³	RECORDED YIELD (l/sec)
GW415978	Lachlan fractured rock shallow	10.6	8.5-10.0	NR	NR
GW415979	Lachlan fractured rock shallow	19.0	5.0-7.0	NR	NR
GW415980	Lachlan fractured rock shallow	7.0	4.0-7.0	NR	NR
GW415982	Lachlan fractured rock shallow	22.0	8.0-10.0 17.0-22.0	NR	NR
GW036997	Lachlan fractured rock deep	53.0	42.0-48.0	30.0	NR
GW057259	Lachlan fractured rock shallow	8.5	4.8-8.2	4.6	0.13
GW402997	Lachlan fractured rock deep	46.0	NR	31.0	NR
GW400025	Lachlan fractured rock shallow	6.4	3.3-9.4	3.0	7.65
GW011724	Lachlan fractured rock deep	76.2	57.9	NR	NR
GW015212	Lachlan fractured rock deep	96.6	57.9-62.5 70.7-96.6	- 51.8	- 0.13
GW036995	Lachlan fractured rock deep	78.5	60.0-74.0	30.0	0.15
GW051485	Lachlan fractured rock shallow	25.3	16.1-21.3	7.6	1.26
GW057487	Lachlan fractured rock shallow	36.0	32.0-33.0	2.0	0.5
GW056154	Lachlan fractured rock shallow	31.4	12.8-13.0 19.2-31.4	NR	NR
GW051228	Lachlan fractured rock shallow	25.4	6.3 11.9-25.4	- 2.7	0.25 3.80
GW011100	Lachlan fractured rock deep	78.6	77.4-78.6	45.1	0.25
GW001127	Lachlan fractured rock deep	66.1	66.1	46.3	0.28
GW022365	Lachlan fractured rock deep	63.1	13.7-14.0 61.9-62.8	- 38.4	- 0.70
GW001099	Lachlan fractured rock deep	65.2	64.0-64.0	45.7	0.28
GW021714	Lachlan fractured rock deep	76.2	24.4-27.4 69.5-74.7	- 36.6	- 0.13
GW001087	Lachlan fractured rock deep	69.5	51.8 64.3 65.5	45.7 45.7 39.9	- - 0.30
GW416519	Lachlan fractured rock deep	115.0	30.0-32.0 60.0-115.0	NR	0.50 4.00
GW002459	Lachlan fractured rock deep	123.4	45.1	27.4	0.03

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	WATER BEARING ZONES (mBTC) ³	GROUNDWATER LEVEL (mBTC) ³	RECORDED YIELD (l/sec)
GW002432	Lachlan fractured rock deep	135.3	77.4	61.0	0.09
GW002231	Lachlan fractured rock deep	70.1	61.9-67.1	54.9	0.63
GW002421	Lachlan fractured rock deep	66.5	47.5 62.8	- 36.6	- 0.51
GW002215	Lachlan fractured rock deep	55.5	38.7 50.3	- 30.5	NR
GW031254	Murrumbidgee Alluvium shallow	31.7	12.2-13.1 27.7-29.5	- 15.2	- 1.26
GW031254	Murrumbidgee Alluvium shallow	24.6	15.2-18.2	11.3	0.04
GW416000	Murrumbidgee Alluvium shallow	39.5	37.0-38.5	NR	3.00
GW050829	Murrumbidgee Alluvium shallow	17.0	15.0-17.0	9.0	1.01
GW056910	Murrumbidgee Alluvium deep	59.7	59.7	15.8	0.60
GW403753	Murrumbidgee Alluvium shallow	42.0	37.5-40.0	17.0	5.00
GW401863	Murrumbidgee Alluvium shallow	29.9	27.0-29.0	15.8	3.00
GW009123	Murrumbidgee Alluvium shallow	27.7	26.5-27.7	20.7	0.61
GW404502	Murrumbidgee Alluvium deep	78.0	70.5-73.5	16.4	2.00
GW019474	Murrumbidgee Alluvium shallow	41.8	36.0 39.6-41.7	- 21.0	- 1.01
GW416527	Murrumbidgee Alluvium shallow	96.0	25.0-27.0 30.0-32.0 66.0-68.0	15.0 - -	NR
GW008851	Murrumbidgee Alluvium shallow	24.1	24.1	20.7	0.51
GW005707	Murrumbidgee Alluvium shallow	43.3	21.3-24.3 43.3	- 22.6	NR
GW035045	Murrumbidgee Alluvium shallow	25.0	24.9	19.8	0.63
GW416059	Murrumbidgee Alluvium deep	59.0	56.8-58.3	27.0	3.00
GW017804	Murrumbidgee Alluvium deep	66.5	66.4	21.3	0.51
GW021975	Murrumbidgee Alluvium shallow	40.6	30.2-31.4 40.5	- 22.9	- 0.63
GW403300	Murrumbidgee Alluvium shallow	41.5	NR	24.0	NR
GW043916	Murrumbidgee Alluvium shallow	49.4	49.3	21.9	0.61
GW400720	Murrumbidgee Alluvium deep	118.2	111.4-117.6	22.7	0.75
GW020030	Murrumbidgee Alluvium deep	67.1	67.1	23.2	0.57
GW404550	Murrumbidgee Alluvium deep	96.0	NR	26.7	1.00
GW034455	Murrumbidgee Alluvium shallow	47.0	26.2-34.1 46.9	22.6 22.6	0.13 0.63
GW067953	Murrumbidgee Alluvium deep	67.1	67.1	20.4	0.63

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	WATER BEARING ZONES (mBTC) ³	GROUNDWATER LEVEL (mBTC) ³	RECORDED YIELD (l/sec)
GW045236	Murrumbidgee Alluvium shallow	44.5	18.6-20.7 44.5	16.2 16.2	- 0.63
GW036235	Murrumbidgee Alluvium deep	289.6	9.1-10.6 68.6-70.1 73.2-74.7 120.4-125.0	NR	NR
GW403295	Murrumbidgee Alluvium shallow	15.5	NR	14.1	NR
GW403296	Murrumbidgee Alluvium shallow	34.0	NR	18.5	NR
GW055198	Murrumbidgee Alluvium shallow	39.4	39.3	21.3	1.82
GW059776	Murrumbidgee Alluvium shallow	45.0	19.0-19.5 45.0	19.0 19.0	NR
GW416916	Murrumbidgee Alluvium deep	145.0	140.0-144.0	25.0	25.00
GW403762	Murrumbidgee Alluvium deep	76.0	71.0-76.0	25.0	NR
GW044291	Murrumbidgee Alluvium shallow and deep	78.3	27.7-28.6 34.3-24.8 46.0-46.9 71.6-76.5 78.3	18.9 18.9 18.9 18.9 18.9	0.19 0.63 0.63 - 0.63
GW403631	Murrumbidgee Alluvium deep	147.0	141.7-146.3	18.6	1.26
GW043322	Murrumbidgee Alluvium shallow	40.2	20.7 23.1 32.9 40.2	- - - 14.3	- - - 0.63
GW414333	Murrumbidgee Alluvium shallow	38.0	30.0-36.0	14.0	2.00
GW019877	Murrumbidgee Alluvium shallow and deep	52.4	16.2 52.4-53.3	16.2 13.6	- 0.61
GW022564	Murrumbidgee Alluvium shallow	49.7	20.7-22.5 32.3-33.5 42.7-43.3 49.7	- - - 12.2	- - - 0.63
GW014222	Murrumbidgee Alluvium shallow	44.2	44.2	11.6	0.38
GW404517	Murrumbidgee Alluvium shallow	15.0	NR	9.0	NR
GW031354	Porous rock deep	341.4	204.2 274.3 338.3	NR	NR
GW087109	Porous rock shallow	18.3	NR	14.8	NR
GW087110	Porous rock shallow	18.0	NR	15.6	NR
GW036723	Porous rock deep	412.0	48.0-84.0 99.0-121.0 326.0-333.0	12.0 13.0 9.0	NR
GW087103	Porous rock shallow	12.5	11.7-12.3	7.1	NR
GW087098	Porous rock shallow	NR	22.5-26.5	21.3	NR

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	WATER BEARING ZONES (mBTC) ³	GROUNDWATER LEVEL (mBTC) ³	RECORDED YIELD (l/sec)
GW087095	Porous rock shallow	23.0	21.9-25.0	20.7	NR
GW087090	Porous rock shallow	18.0	17.1-17.7	16.3	NR
GW600114	Porous rock shallow	38.0	NR	18.8	NR
GW504043	Porous rock deep	57.0	50.0-56.0	18.2	NR
GW504040	Porous rock deep	61.0	58.0-61.0	17.2	NR
GW600109	Porous rock deep	66.0	NR	30.8	NR
GW600117	Porous rock shallow	66.0	NR	16.7	NR
GW600120	Porous rock shallow	48.0	NR	15.8	NR
GW600113	Porous rock shallow	39.0	NR	17.0	NR
GW087217	Porous rock shallow	31.0	NR	20.4	NR
GW087218	Porous rock shallow	NR	30.6-31.5	18.0	NR
GW087219	Porous rock shallow	NR	26.8-27.8	21.9	NR
GW087212	Porous rock shallow	27.0	25.8-26.8	19.5	NR
GW036858	Porous rock shallow and deep	75.0	39.1-42.0 57.0-63.0	26.9 26.8	0.19 0.38
GW087531	Porous rock shallow	14.0	10.3-11.3	11.2	NR

- (1) Excludes bores with no groundwater level record.
- (2) Inferred based on drilled depth and water bearing zones listed in the registered bore information. The distinction between shallow and deep HSUs is described in Section 4.7.1.
- (3) mBTC = metres below top of casing.

A2 Registered bore search water quality records

Table A-2 Summary of viewed registered bores with quantitative groundwater quality records

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	GROUNDWATER QUALITY (µS/cm) ³
GW014707	Lachlan fractured rock (deep)	76.2	750–1,500
GW022564	Murrumbidgee Alluvium (deep)	49.7	4,475–10,450
GW030336	Murrumbidgee Alluvium (shallow)	24.6	1,500–4,475
GW043916	Murrumbidgee Alluvium (deep)	49.4	0–750
GW044232	Murrumbidgee Alluvium (deep)	42.7	4,475–10,450
GW054282	Murrumbidgee Alluvium (shallow)	35.0	4,475–10,450
GW056910	Murrumbidgee Alluvium (deep)	59.7	0–750
GW057259	Lachlan fractured rock (shallow)	8.5	0–750
GW064507	Murrumbidgee Alluvium (deep)	44.5	1,500–4,475
GW067953	Murrumbidgee Alluvium (deep)	67.1	670
GW087090	Porous rock (shallow)	18.0	11,800–14,908
GW087097	Porous rock (shallow)	13.0	8,500–9,800
GW087098	Porous rock (shallow)	23.3	49,900
GW087103	Porous rock (shallow)	12.5	7,010–9,720
GW087109	Porous rock (shallow)	18.3	17,900–22,110
GW087110	Porous rock (shallow)	18.0	44,400–65,514
GW087116	Porous rock (shallow)	23.3	52,200–75,360
GW087212	Porous rock (shallow)	27.0	61,800–69,540
GW087213	Porous rock (shallow)	30.5	62,700–68,900
GW087217	Porous rock (shallow)	31.0	60,390–64,800
GW400720	Murrumbidgee Alluvium (deep)	118.2	640
GW404502	Murrumbidgee Alluvium (deep)	78.0	1,500
GW414333	Murrumbidgee Alluvium (shallow)	38.0	7,463
GW416059	Murrumbidgee Alluvium (deep)	59.0	1,045

BORE ID ¹	INFERRED HSU ²	DRILLED DEPTH (m)	GROUNDWATER QUALITY (µS/cm) ³
GW416527	Murrumbidgee Alluvium (shallow) ⁴	96.0	1,146
GW416577	Murrumbidgee Alluvium (deep)	53.0	2,537
GW416916	Murrumbidgee Alluvium (deep)	145.0	750

- (1) Excludes proposed or planned bores and bores with no quantitative groundwater quality record.
- (2) Inferred based on drilled depth and water bearing zones listed in the registered bore information. The distinction between shallow and deep HSUs is described in Section 4.7.1.
- (3) Quality refers to salinity. Values recorded as total dissolved solids (TDS) or parts per million (ppm) were converted to microSeimens per centimetre (µS/cm) using a factor of 0.67.
- (4) Available water quality record is listed as correlating to a water bearing zone at 25.0-27.0 m, within the shallow aquifer.

Appendix B

Available WaterNSW hydrographs



WaterNSW

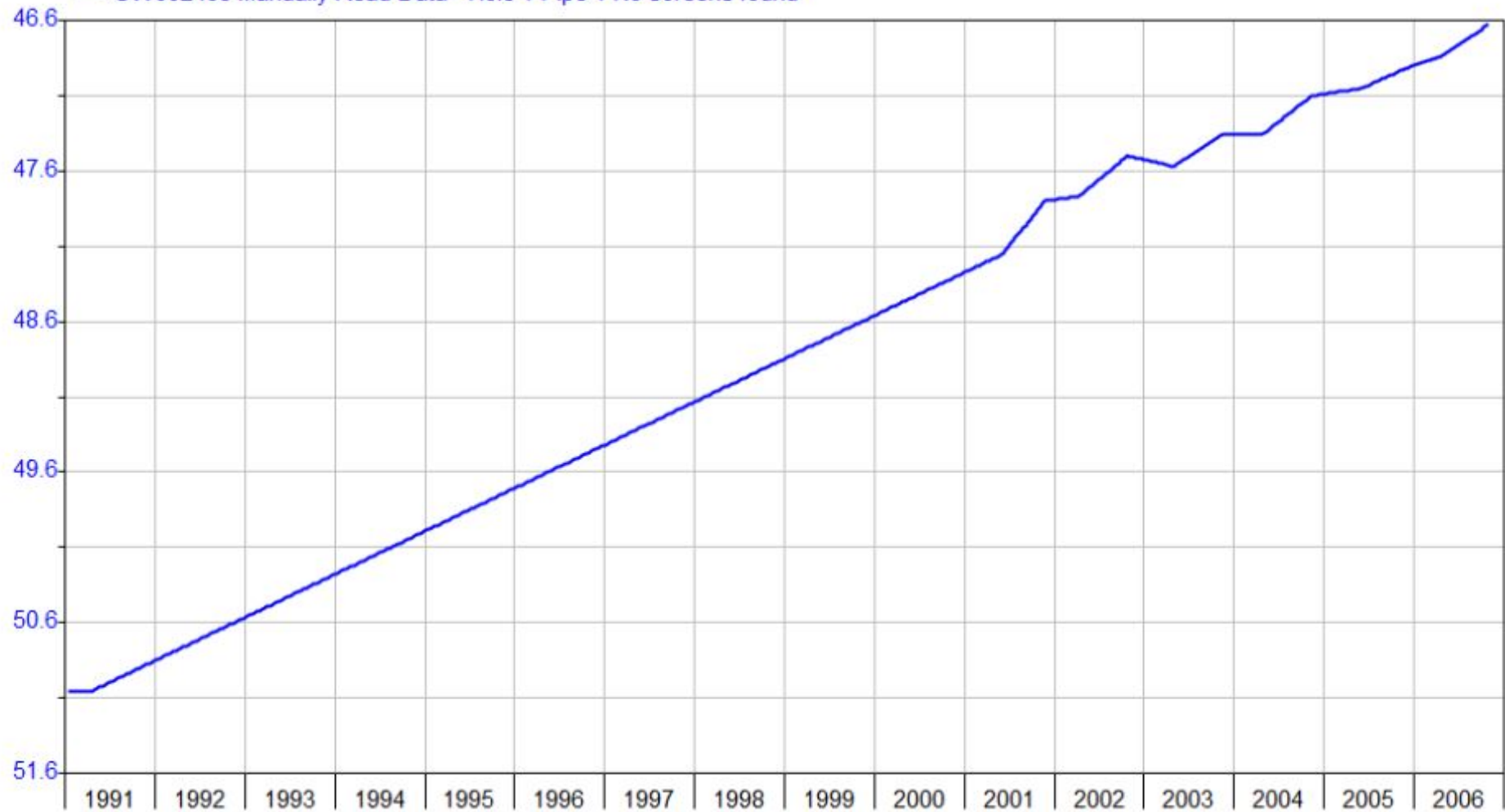
HYPLOT V134 Output 20/10/2020

Bore Water Level below Measuring Point (Metres)

01/01/1991 to 01/01/2007

1991-2006

— GW002408 Manually Read Data - Hole 1 Pipe 1 No screens found



WaterNSW

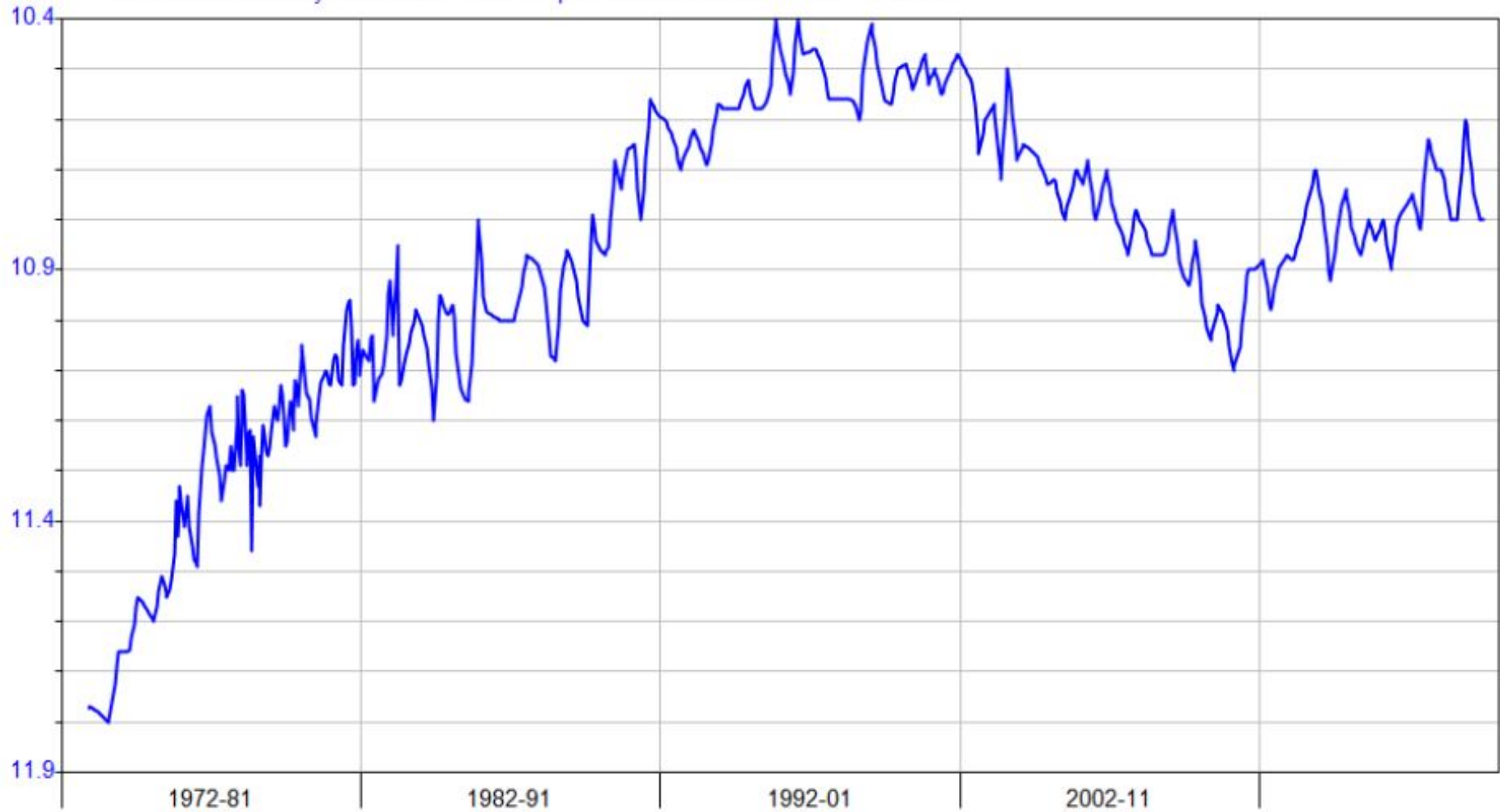
HYPLOT V133 Output 21/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1972 to 01/01/2020

1972-2019

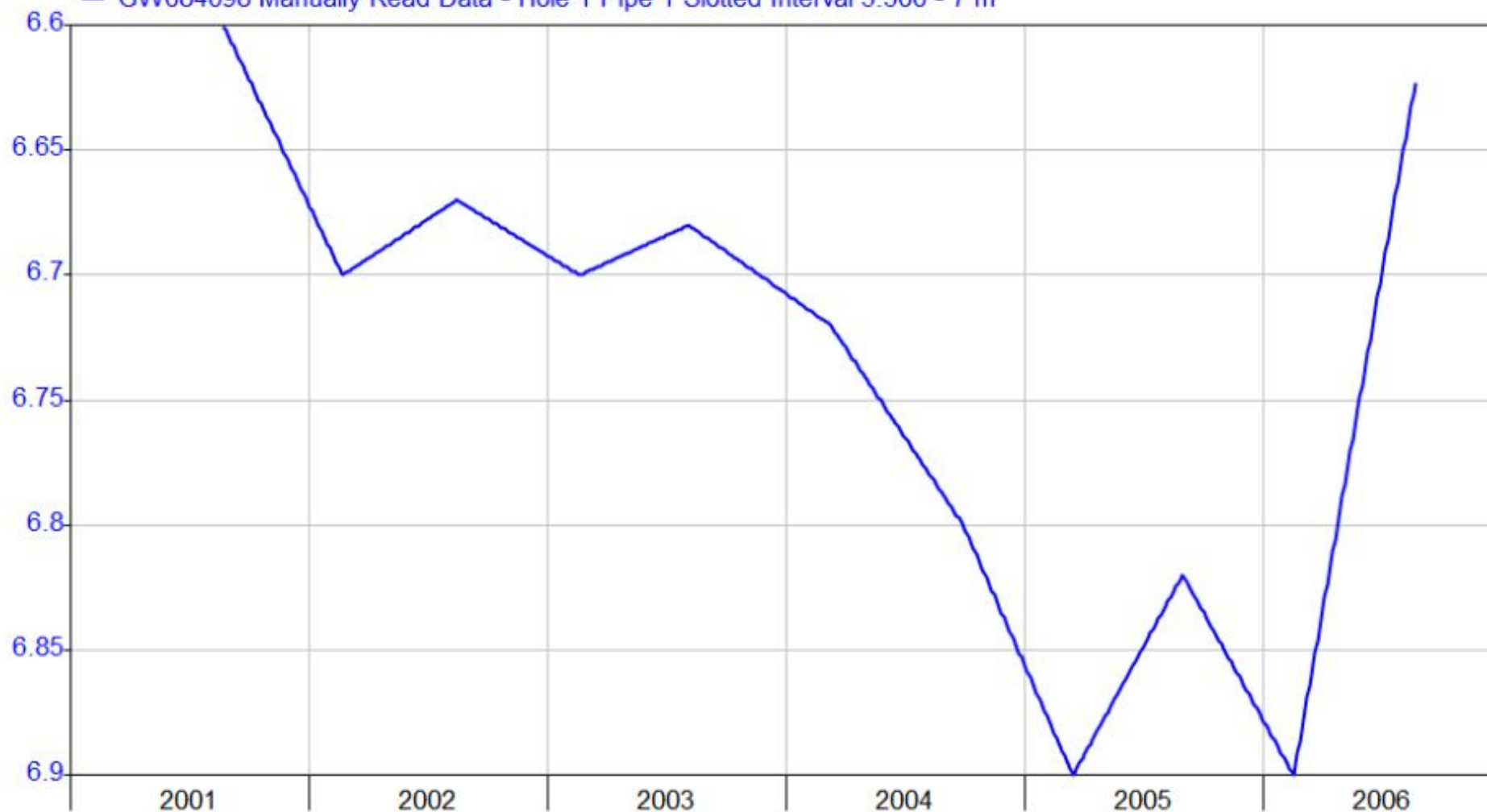
— GW030336 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 15.200 - 18.200 m



Bore Water Level below Measuring Point (Metres)
01/01/2001 to 01/01/2007

2001-06

— GW084098 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 5.500 - 7 m



WaterNSW

HYPLOT V133 Output 23/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1987 to 01/01/2020

1987-2019

- GW036720 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 100 - 112 m
- GW036720 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 250 - 262 m
- GW036720 Manually Read Data - Hole 3 Pipe 3 Slotted Interval 355 - 361 m



WaterNSW

HYPLOT V133 Output 23/10/2019

Bore Water Level below Measuring Point (Metres)

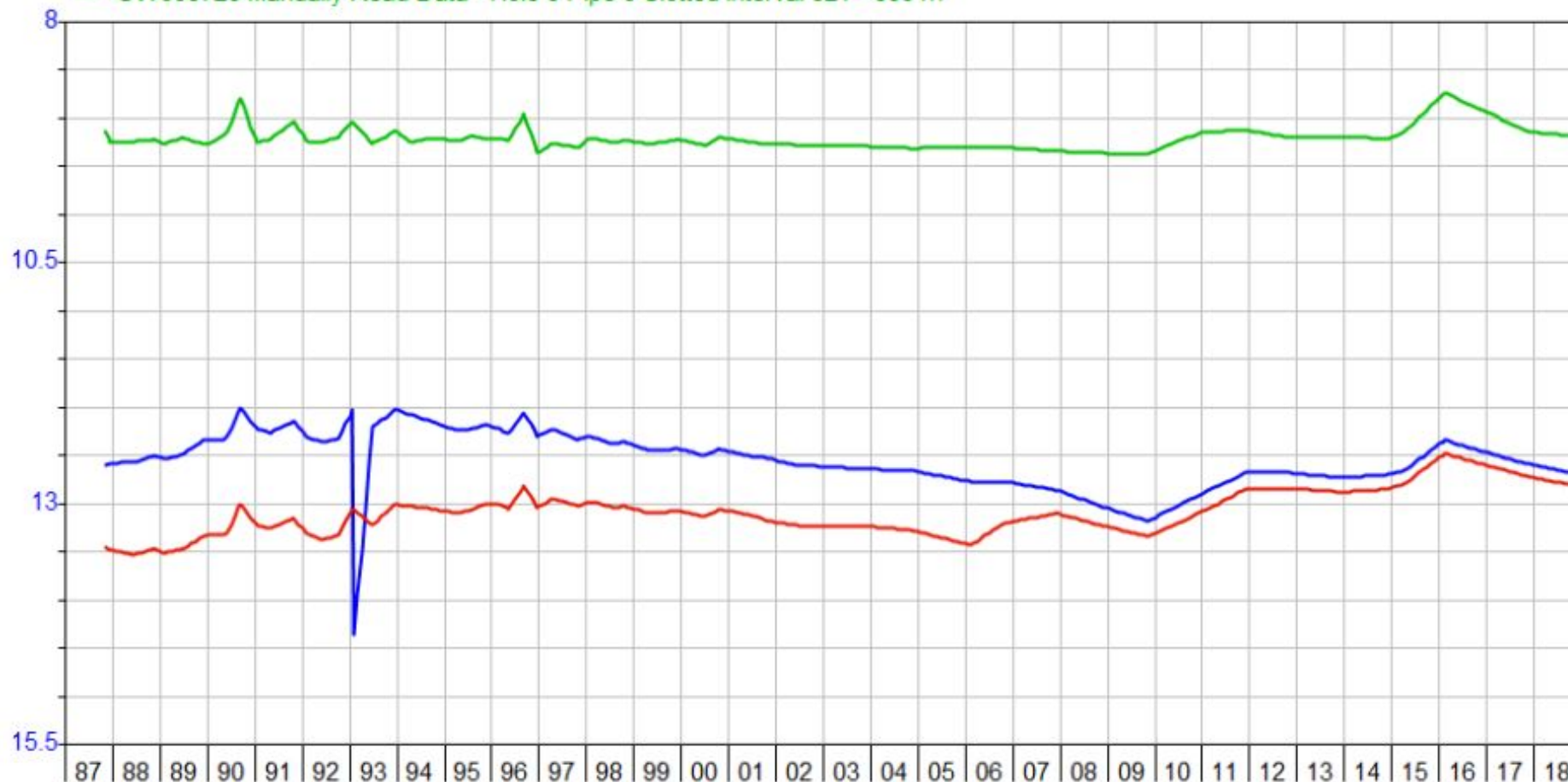
01/01/1987 to 01/01/2019

1987-2018

— GW036723 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 56 - 74 m

— GW036723 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 103 - 115 m

— GW036723 Manually Read Data - Hole 3 Pipe 3 Slotted Interval 321 - 333 m



WaterNSW

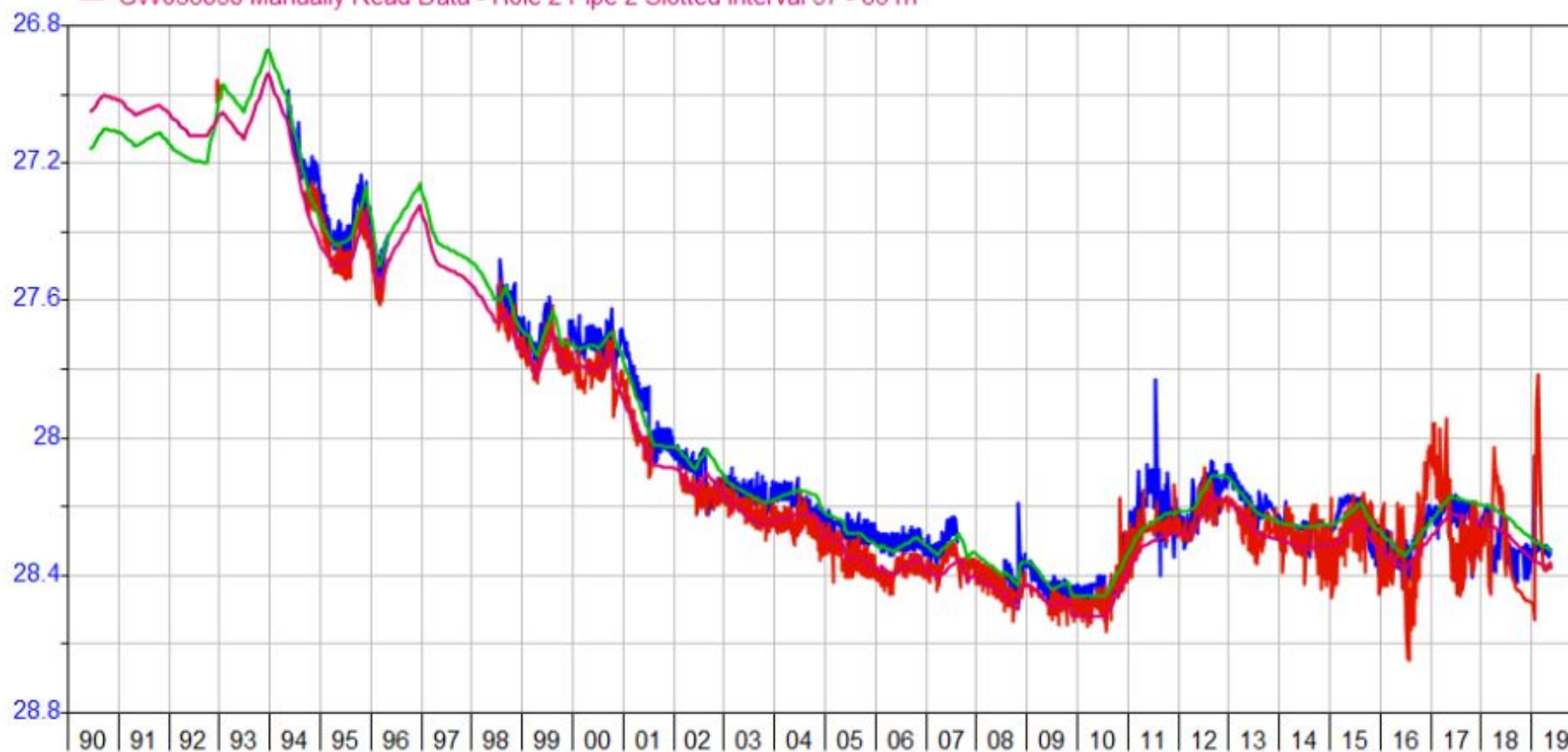
HYPLOT V133 Output 16/08/2019

Bore Water Level below Measuring Point (Metres) for site GW036858

01/01/1990 to 01/01/2020

1990-2019

- Logger Data - Hole 1 Pipe 1 Slotted Interval 39 - 42 m
- Logger Data - Hole 2 Pipe 2 Slotted Interval 57 - 63 m
- GW036858 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 39 - 42 m
- GW036858 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 57 - 63 m



WaterNSW

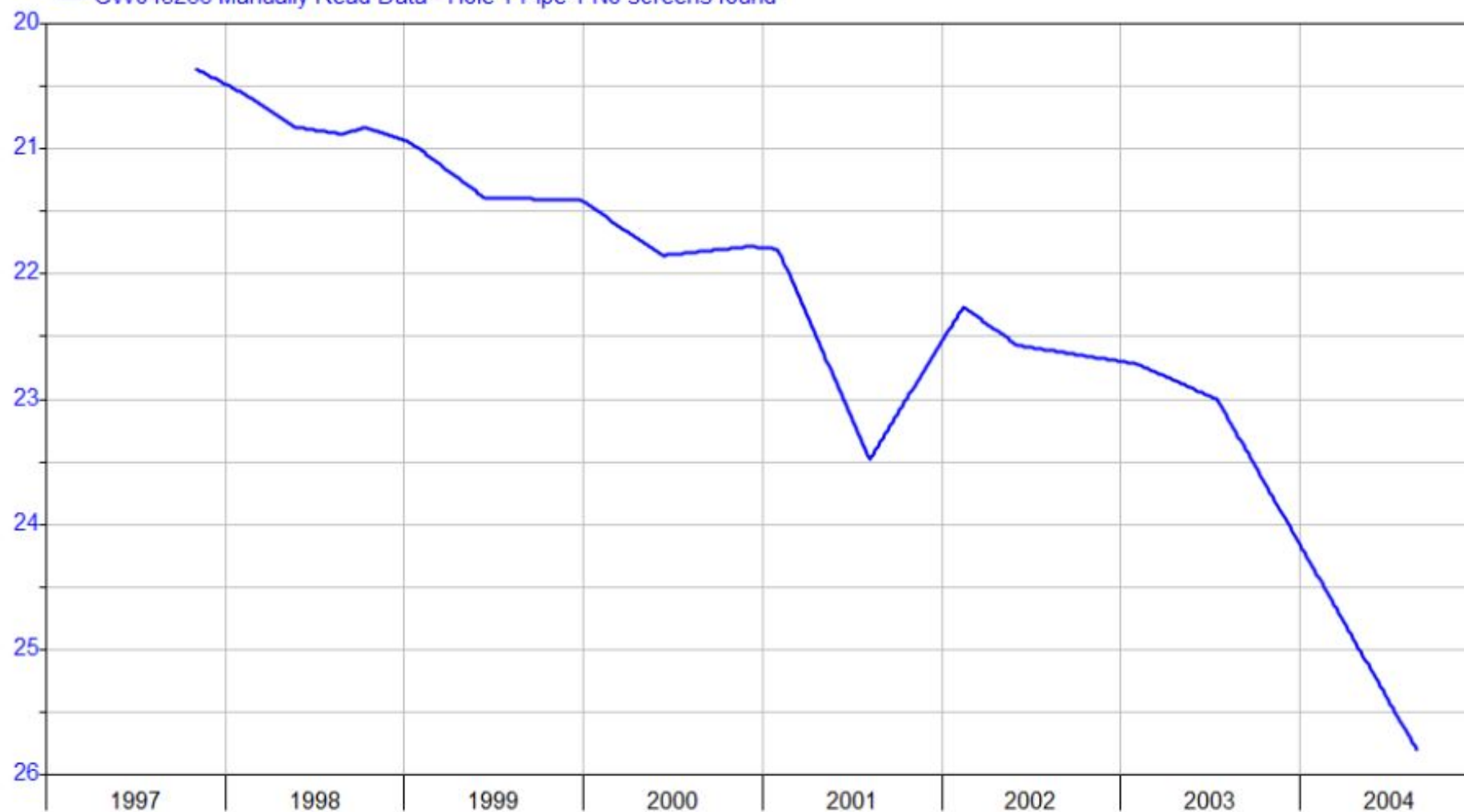
HYPLOT V134 Output 22/12/2020

Bore Water Level below Measuring Point (Metres)

01/01/1997 to 01/01/2005

1997-2004

— GW045236 Manually Read Data - Hole 1 Pipe 1 No screens found



WaterNSW

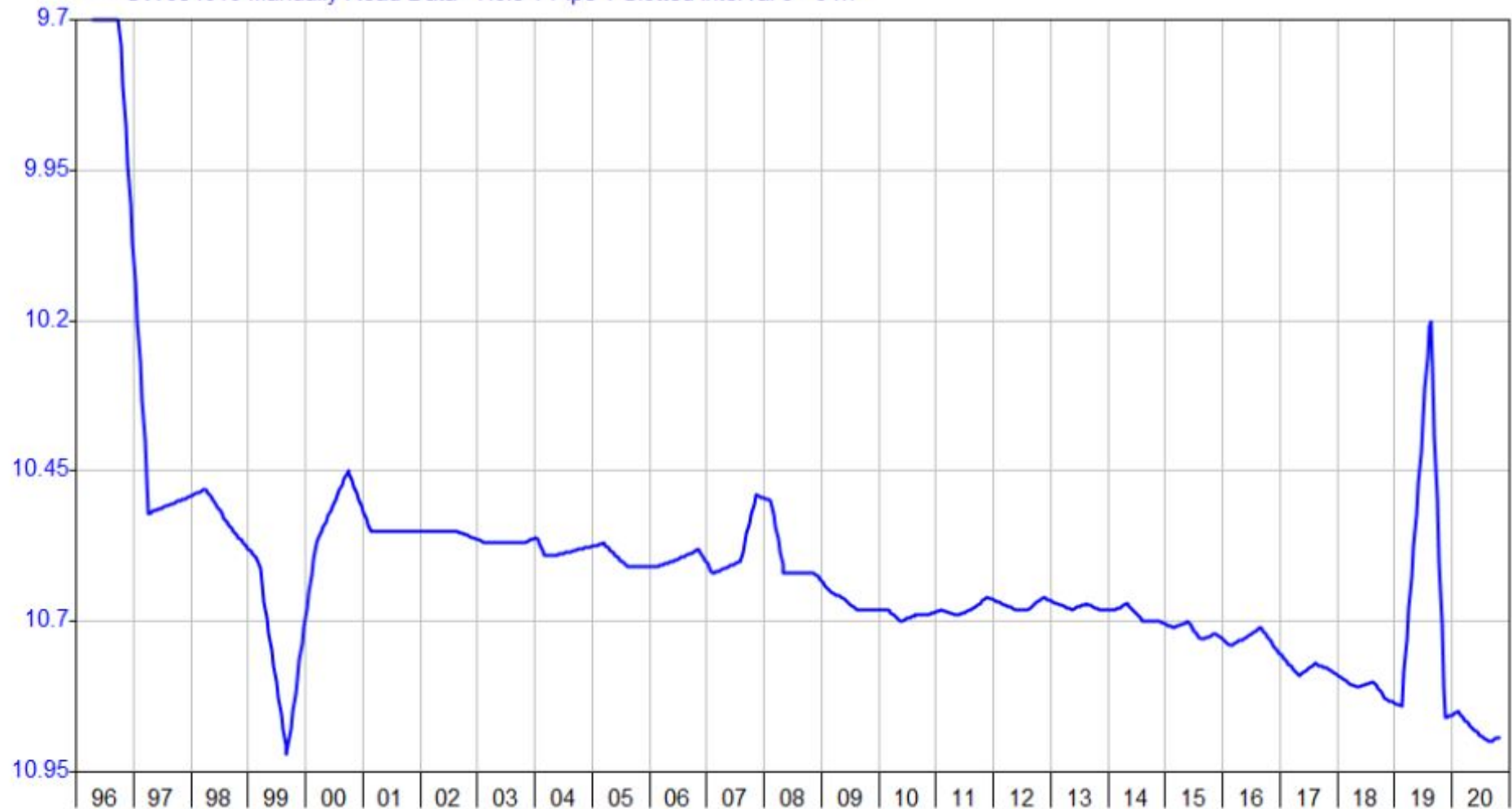
HYPLOT V134 Output 22/12/2020

Bore Water Level below Measuring Point (Metres)

01/01/1996 to 01/01/2021

1996-2020

— GW084019 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0 - 0 m



WaterNSW

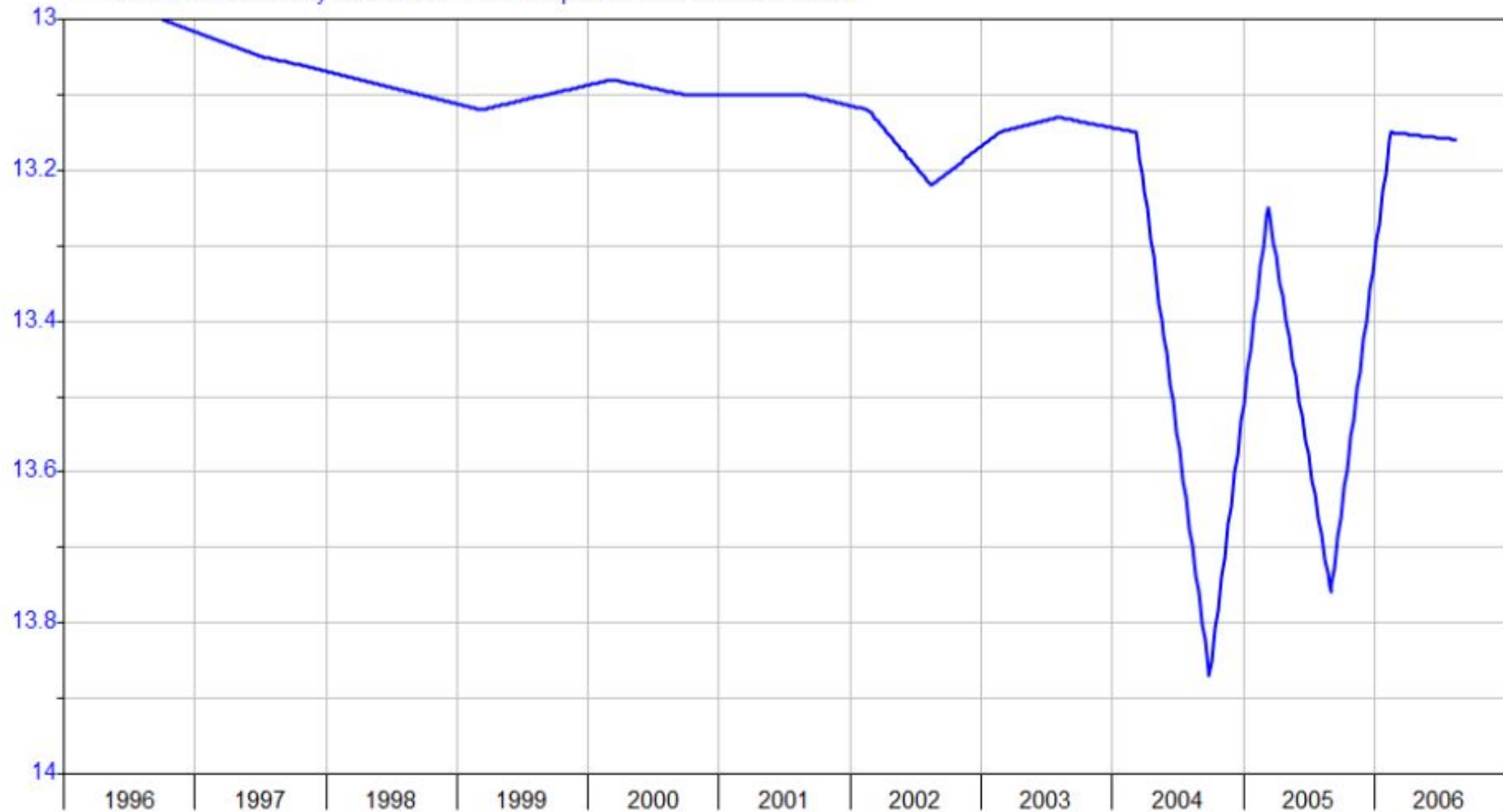
HYPLOT V134 Output 22/12/2020

Bore Water Level below Measuring Point (Metres)

01/01/1996 to 01/01/2007

1996-2006

— GW084030 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0 - 0 m



WaterNSW

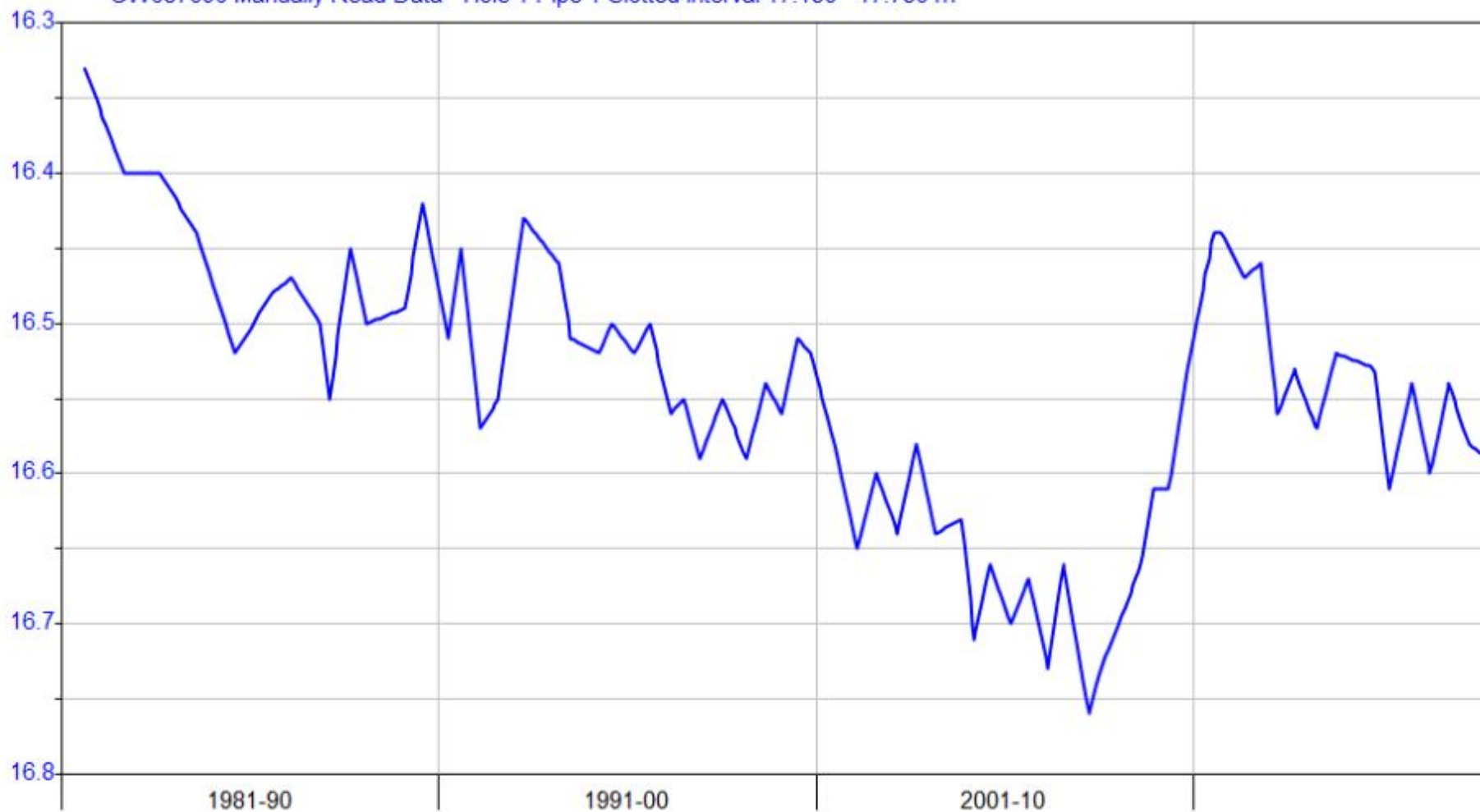
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2019

1981-2018

— GW087090 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 17.180 - 17.780 m



WaterNSW

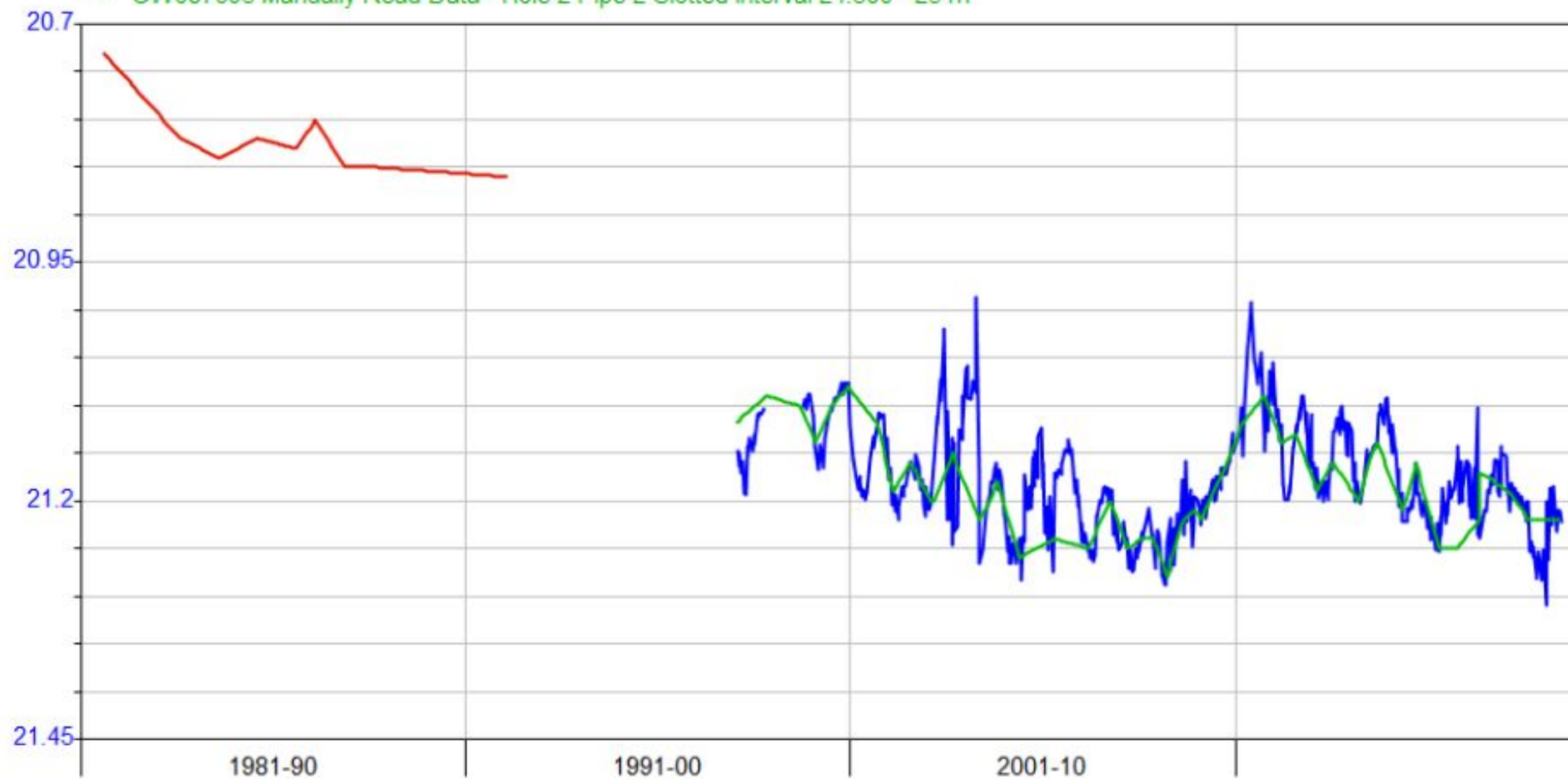
HYPLOT V133 Output 17/08/2019

Bore Water Level below Measuring Point (Metres) for site GW087095

01/01/1981 to 01/01/2020

1981-2019

- Logger Data - Hole 2 Pipe 2 Slotted Interval 24.500 - 25 m
- GW087095 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 21.910 - 22.510 m
- GW087095 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 24.500 - 25 m



WaterNSW

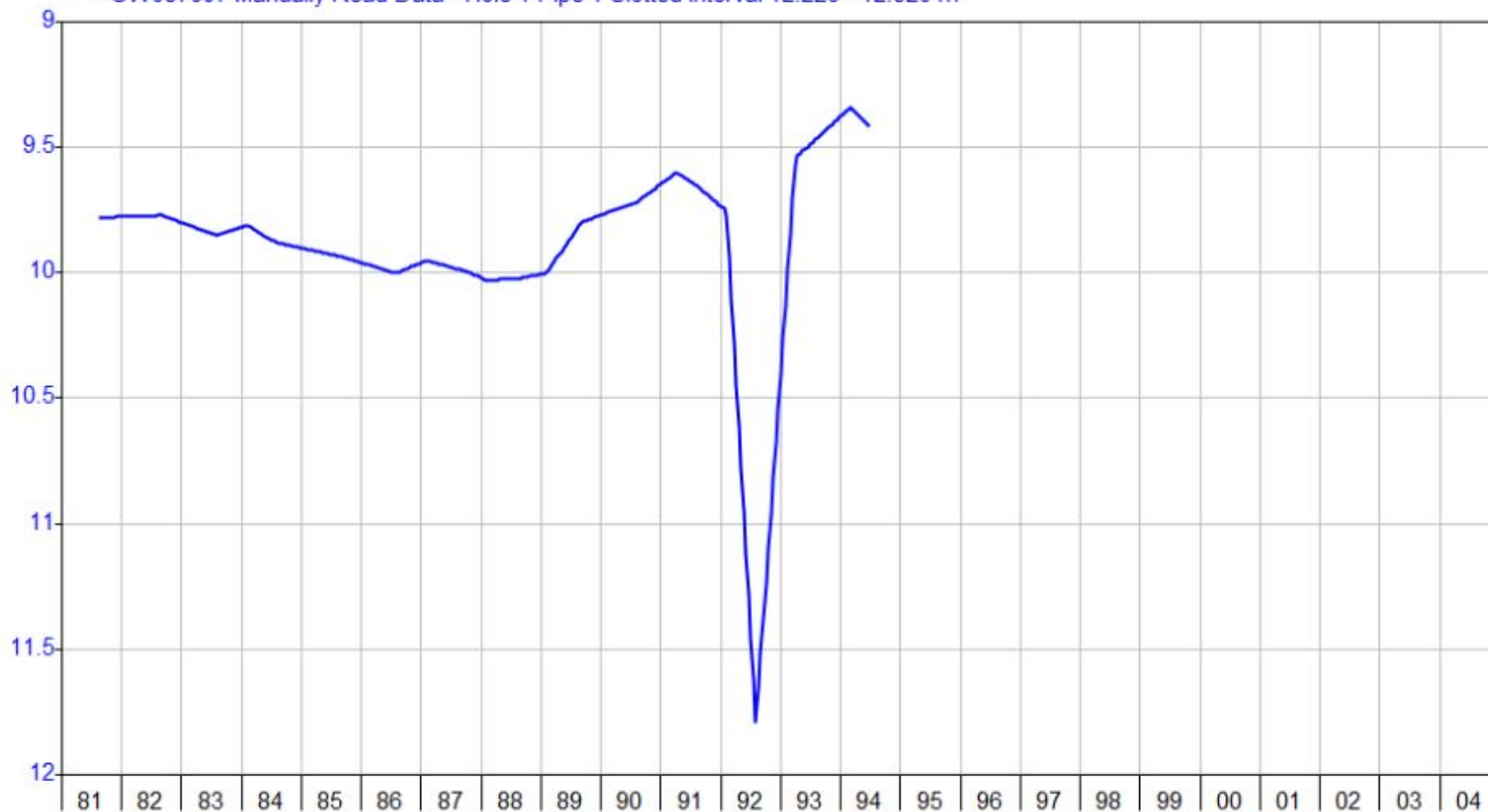
HYPLOT V133 Output 26/12/2018

Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2005

1981-2004

— GW087097 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 12.220 - 12.820 m



WaterNSW

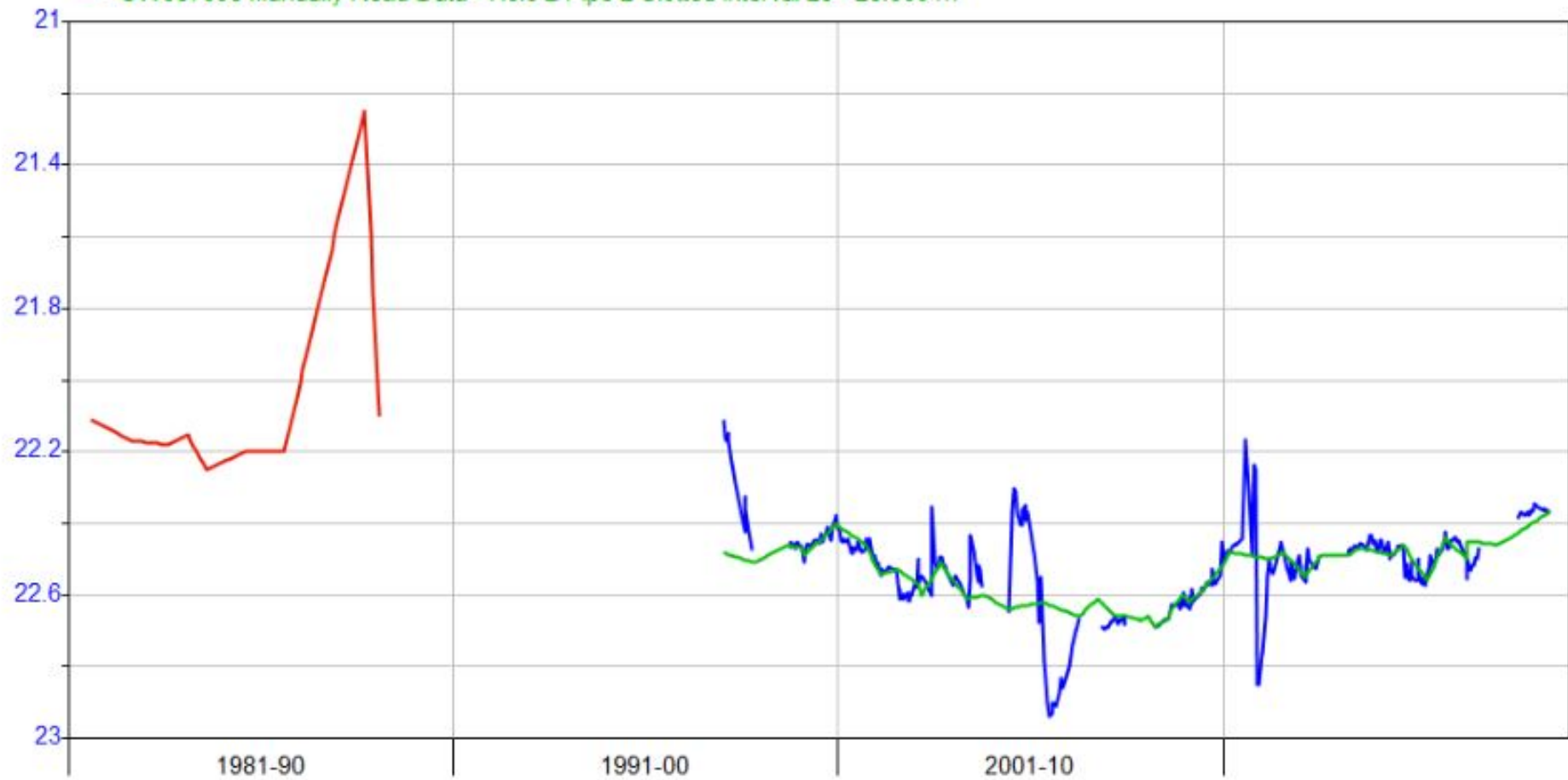
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres) for site GW087098

01/01/1981 to 01/01/2020

1981-2019

- Logger Data - Hole 2 Pipe 2 Slotted Interval 26 - 26.500 m
- GW087098 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 22.540 - 23.140 m
- GW087098 Manually Read Data - Hole 2 Pipe 2 Slotted Interval 26 - 26.500 m



WaterNSW

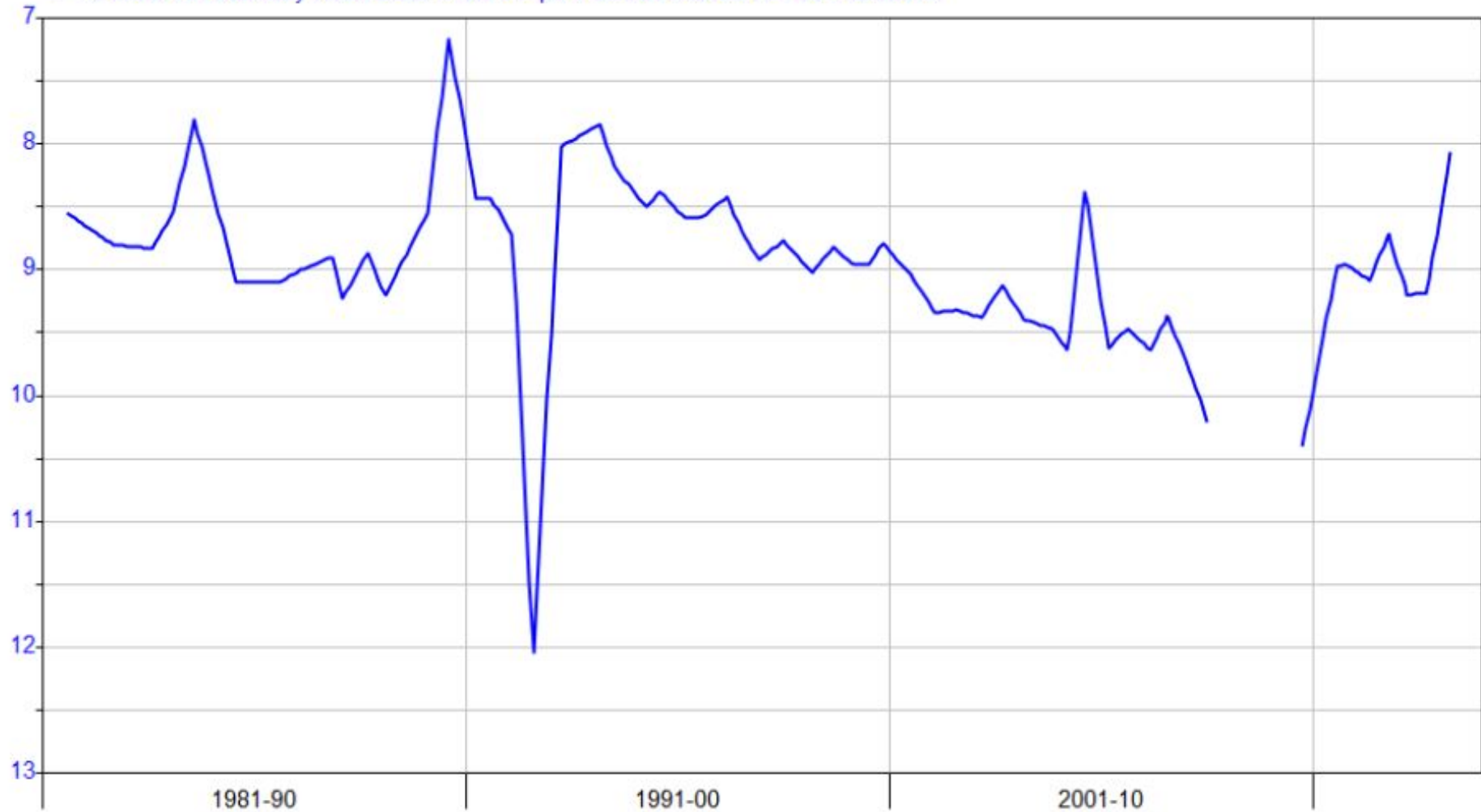
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2015

1981-2014

— GW087103 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 11.720 - 12.320 m



WaterNSW

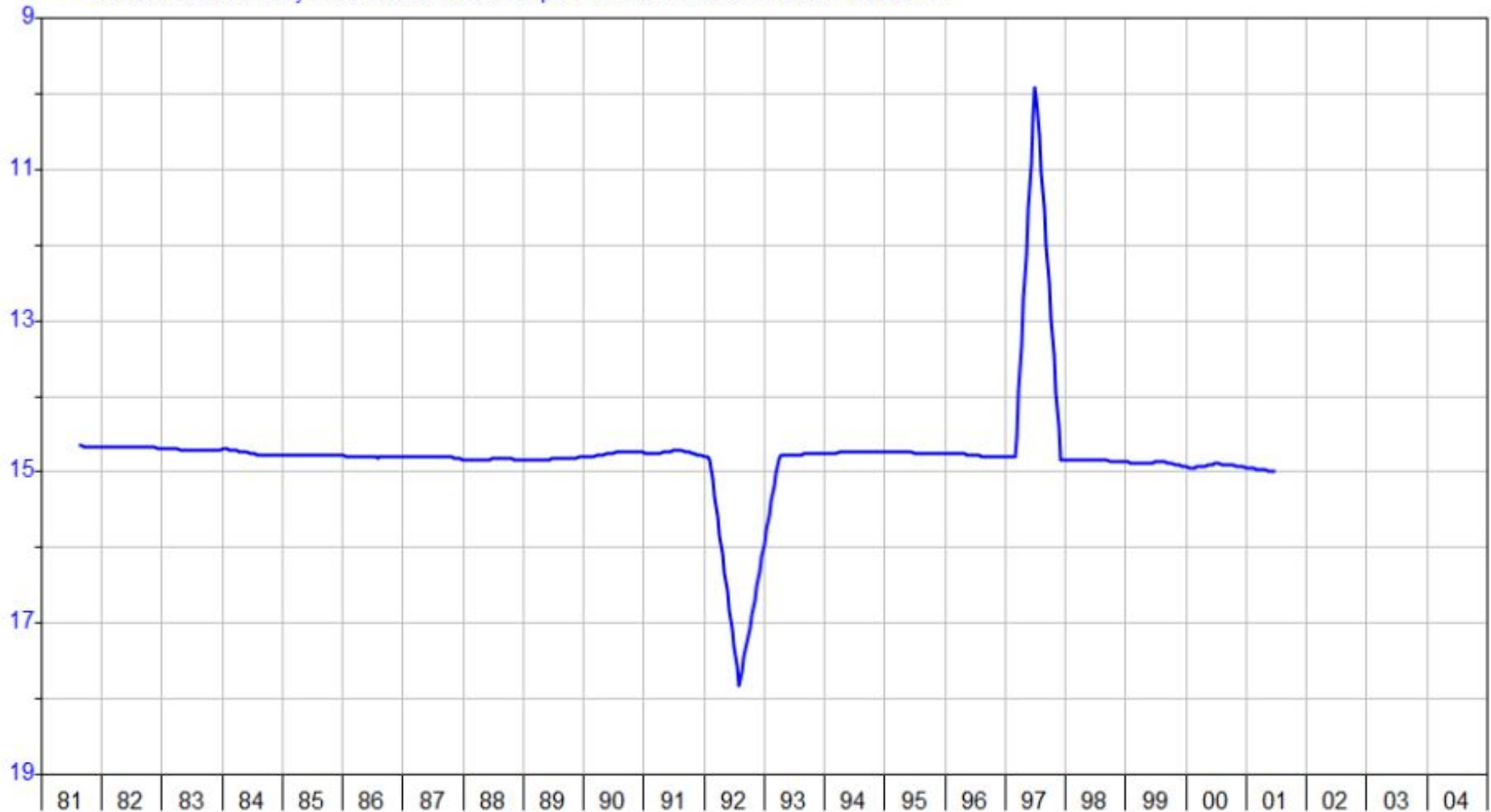
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2005

1981-2004

— GW087109 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 17.580 - 18.180 m



WaterNSW

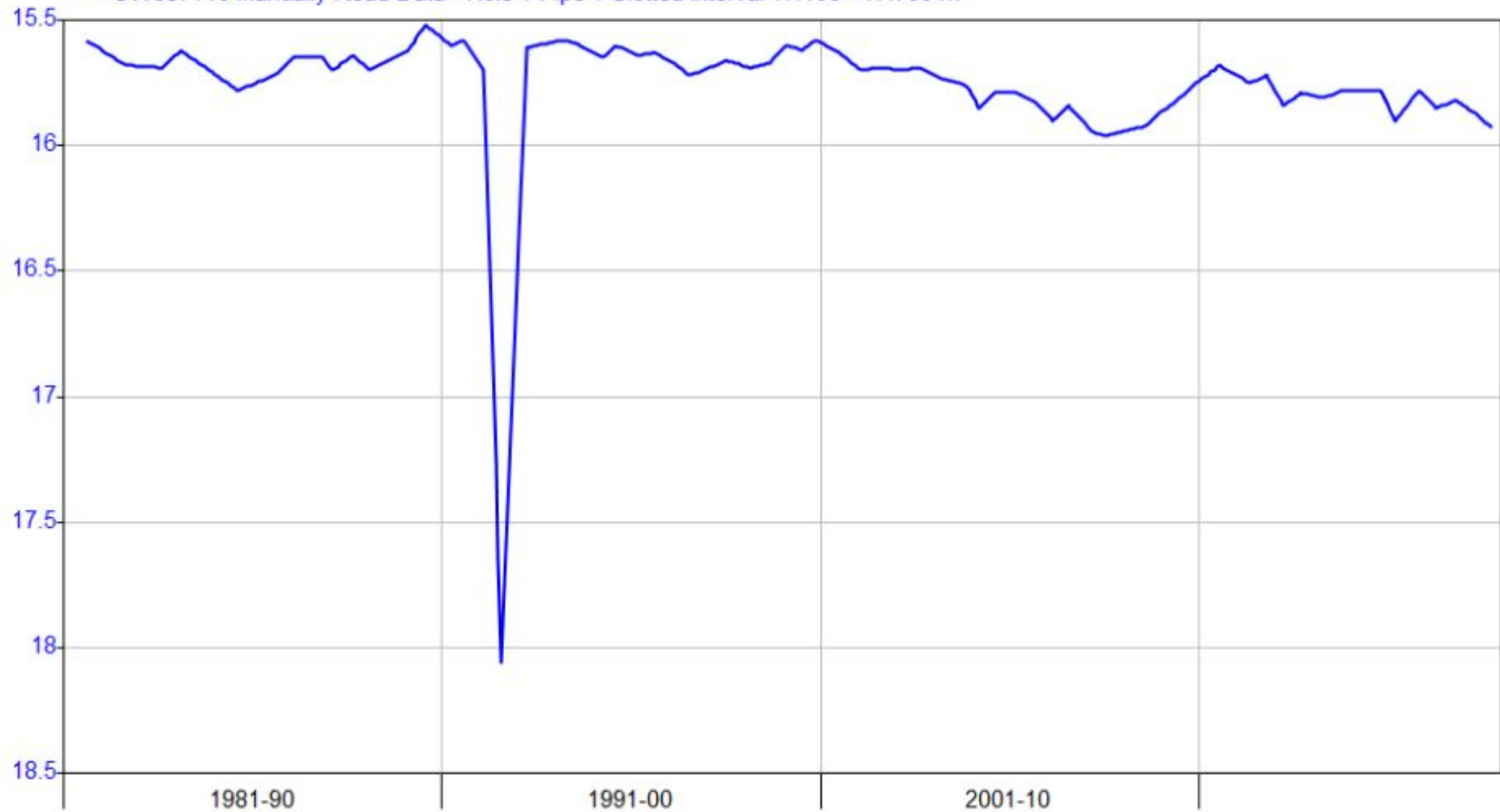
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2019

1981-2018

— GW087110 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 17.190 - 17.790 m

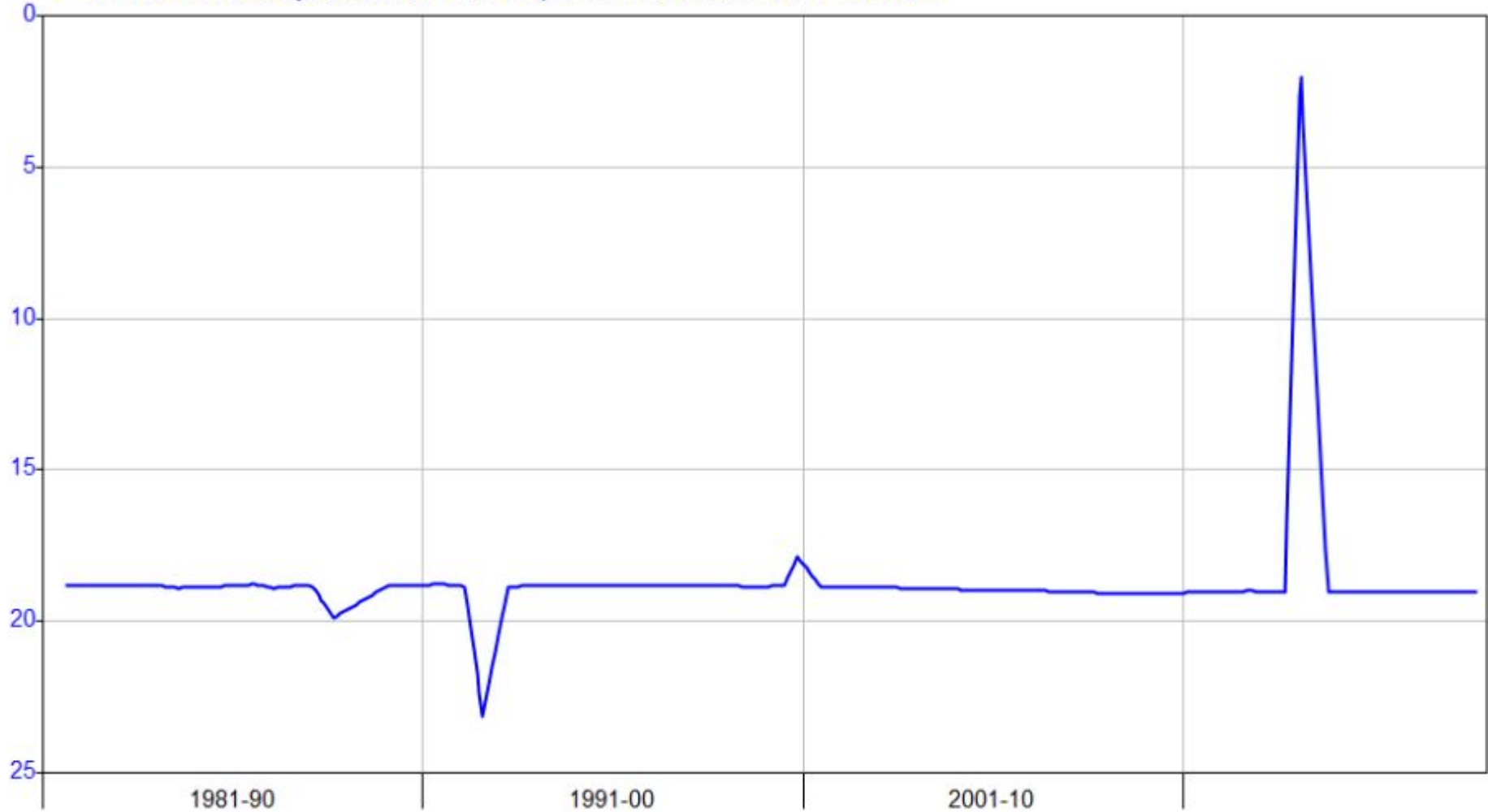


Bore Water Level below Measuring Point (Metres)

01/01/1981 to 01/01/2019

1981-2018

— GW087116 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 22.510 - 23.110 m



WaterNSW

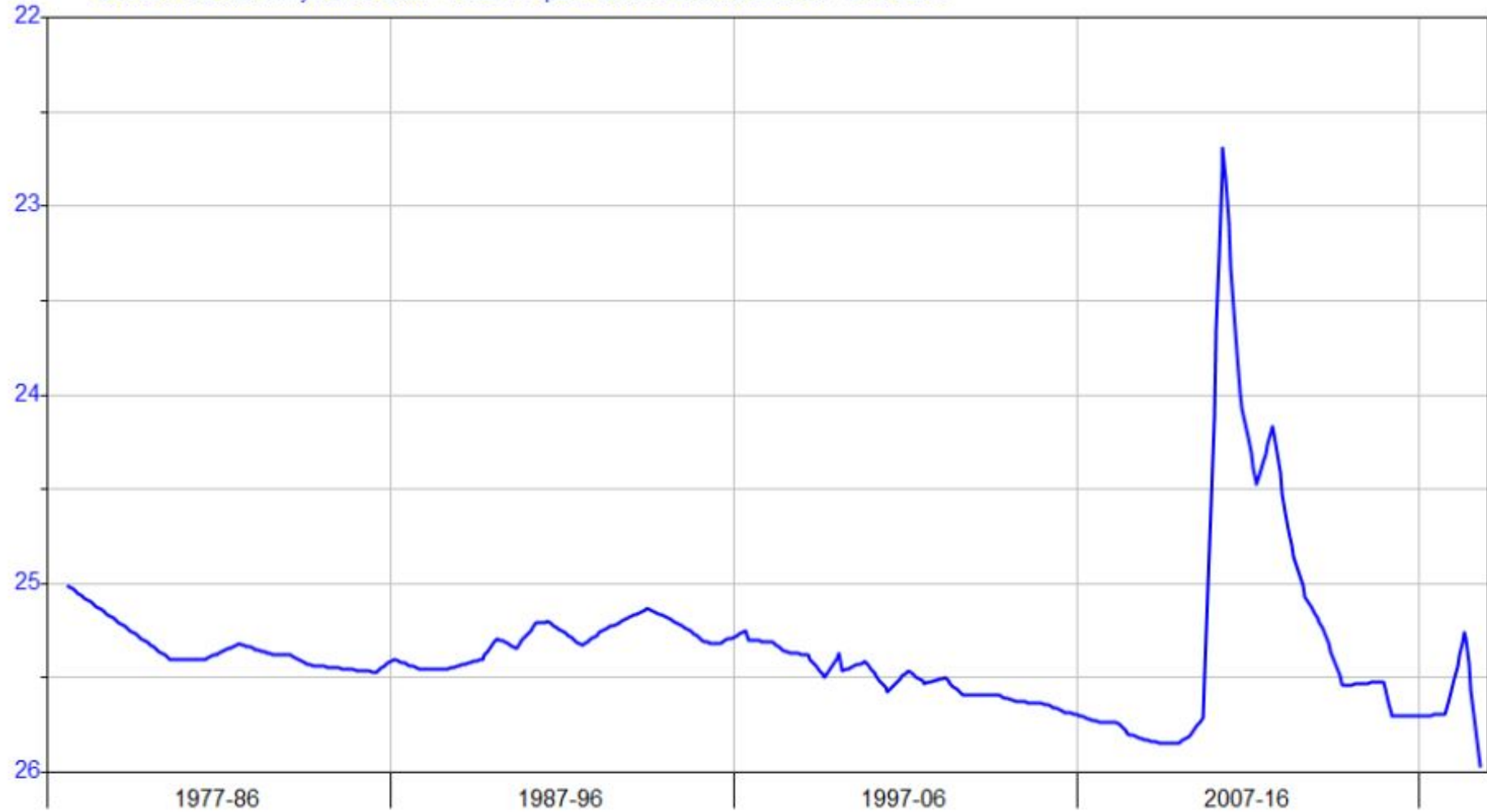
HYPLOT V133 Output 17/08/2019

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



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



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



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



WaterNSW

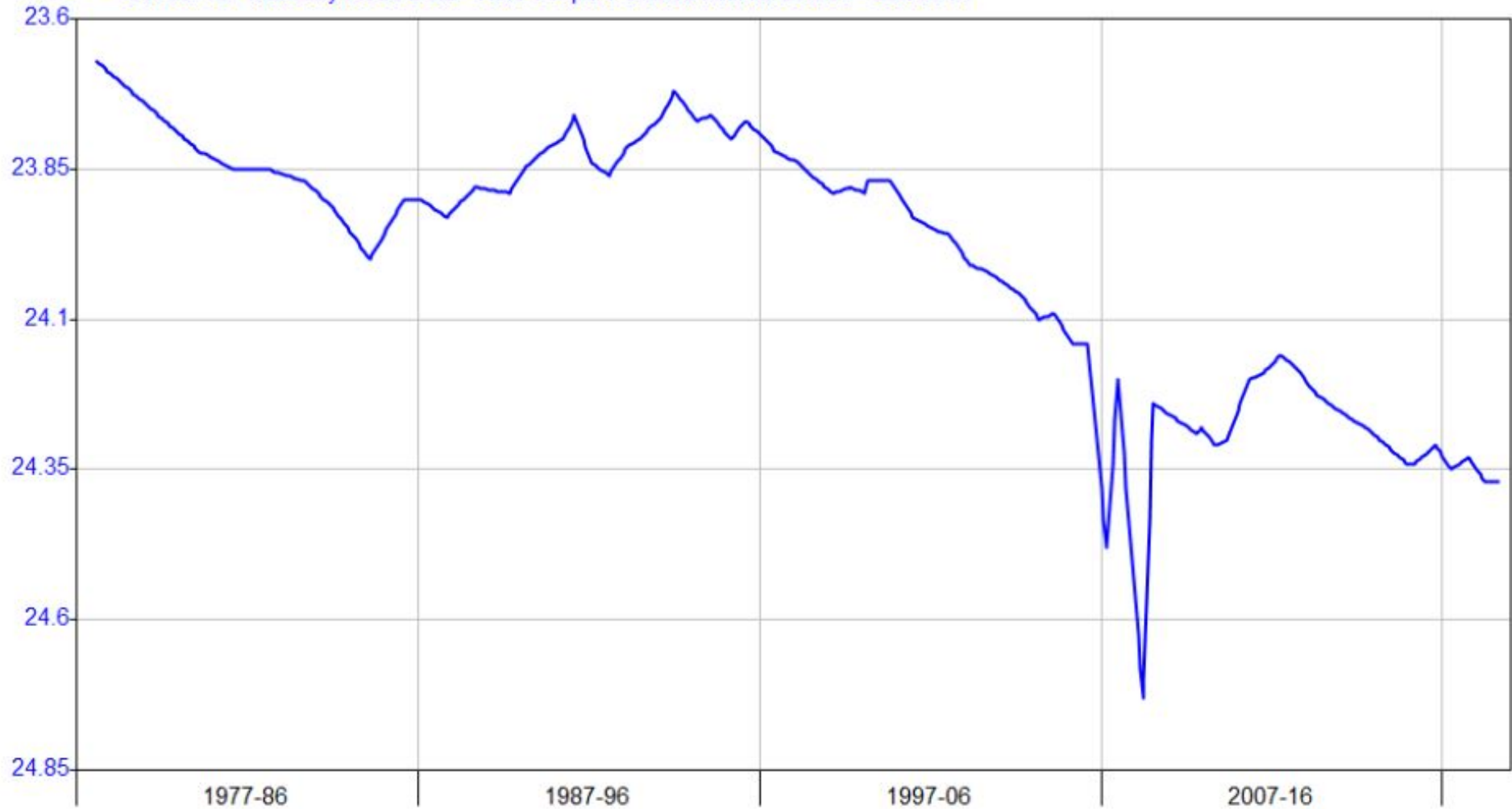
HYPLOT V133 Output 17/08/2019

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



WaterNSW

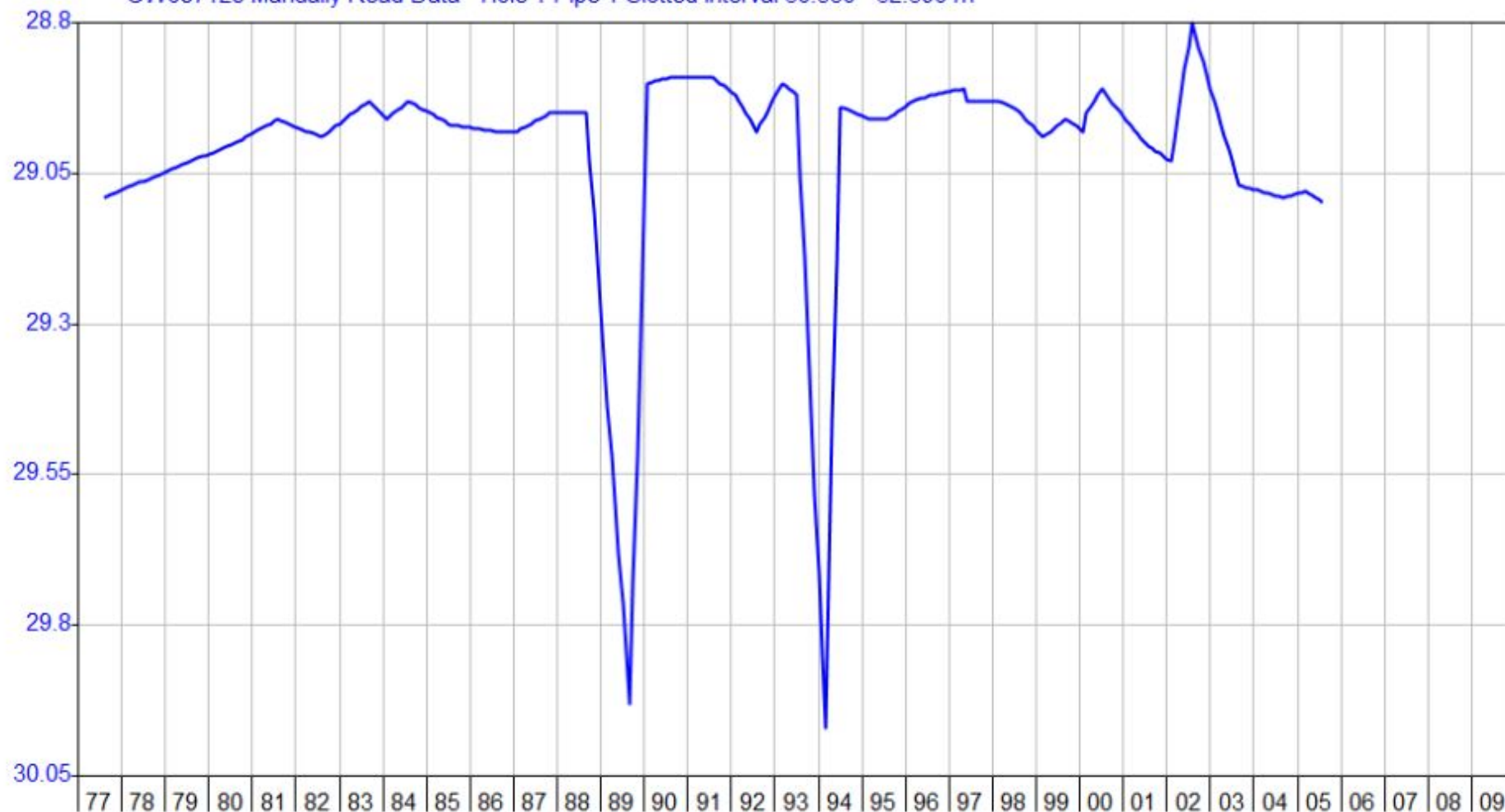
HYPLOT V133 Output 26/12/2018

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



WaterNSW

HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1984 to 01/01/2019

1984-2018

— GW087212 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 25.820 - 26.820 m



WaterNSW

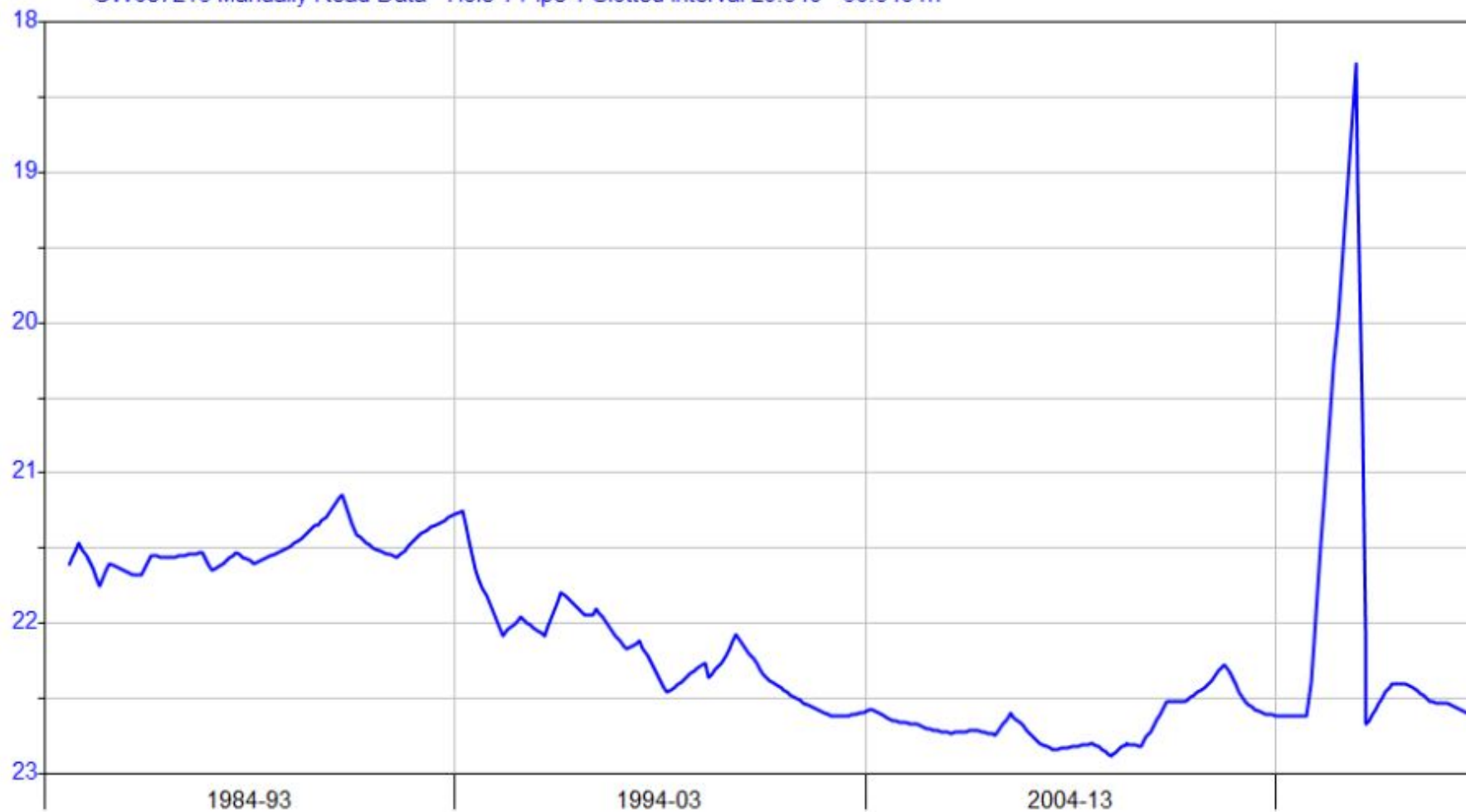
HYPLOT V133 Output 17/08/2019

Bore Water Level below Measuring Point (Metres)

01/01/1984 to 01/01/2019

1984-2018

— GW087213 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 29.340 - 30.340 m



WaterNSW

HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1984 to 01/01/2019

1984-2018

— GW087217 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 28.700 - 29.700 m



WaterNSW

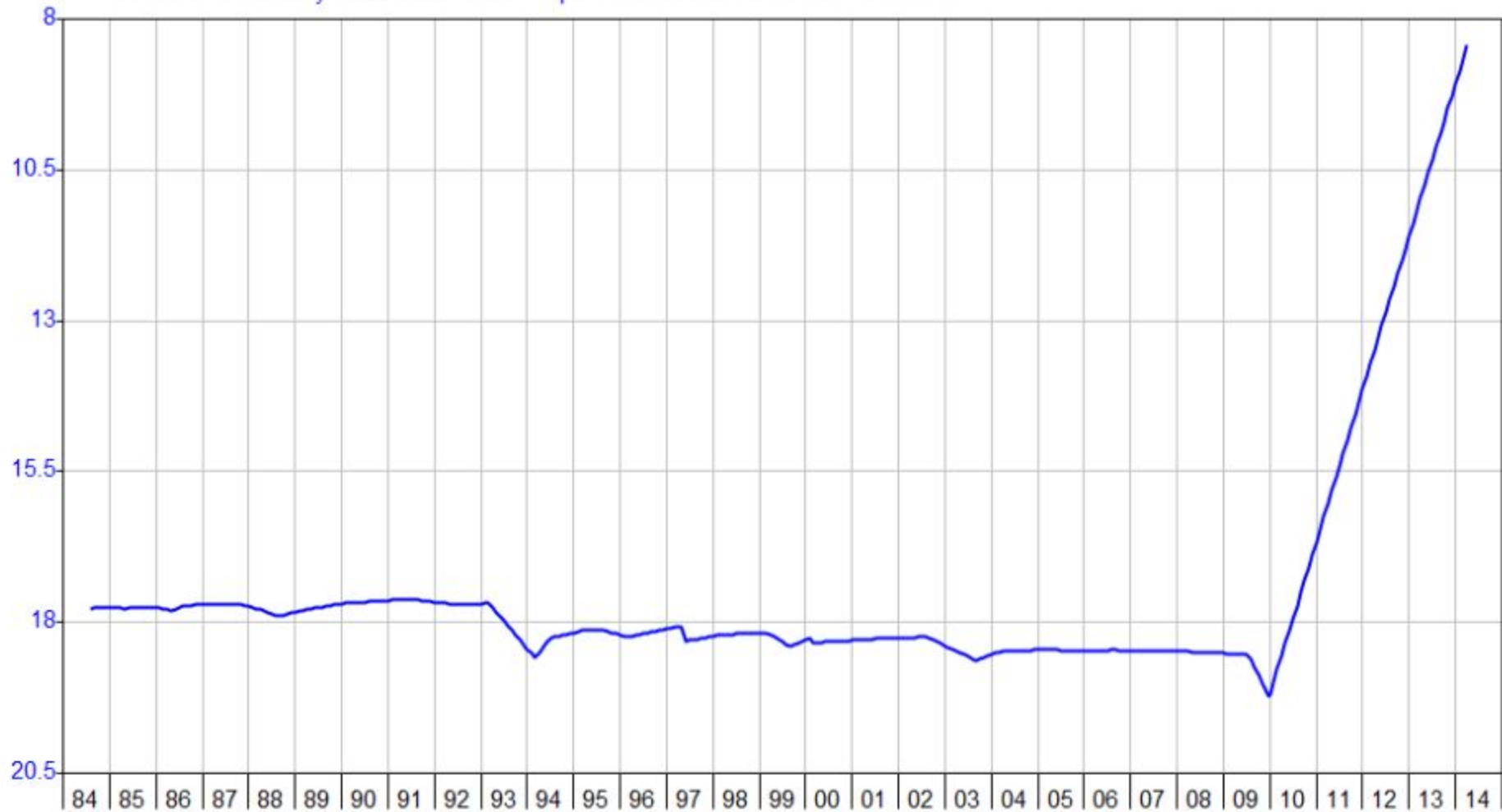
HYPLOT V133 Output 26/12/2018

Bore Water Level below Measuring Point (Metres)

01/01/1984 to 01/01/2015

1984-2014

— GW087218 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 30.590 - 31.500 m



WaterNSW

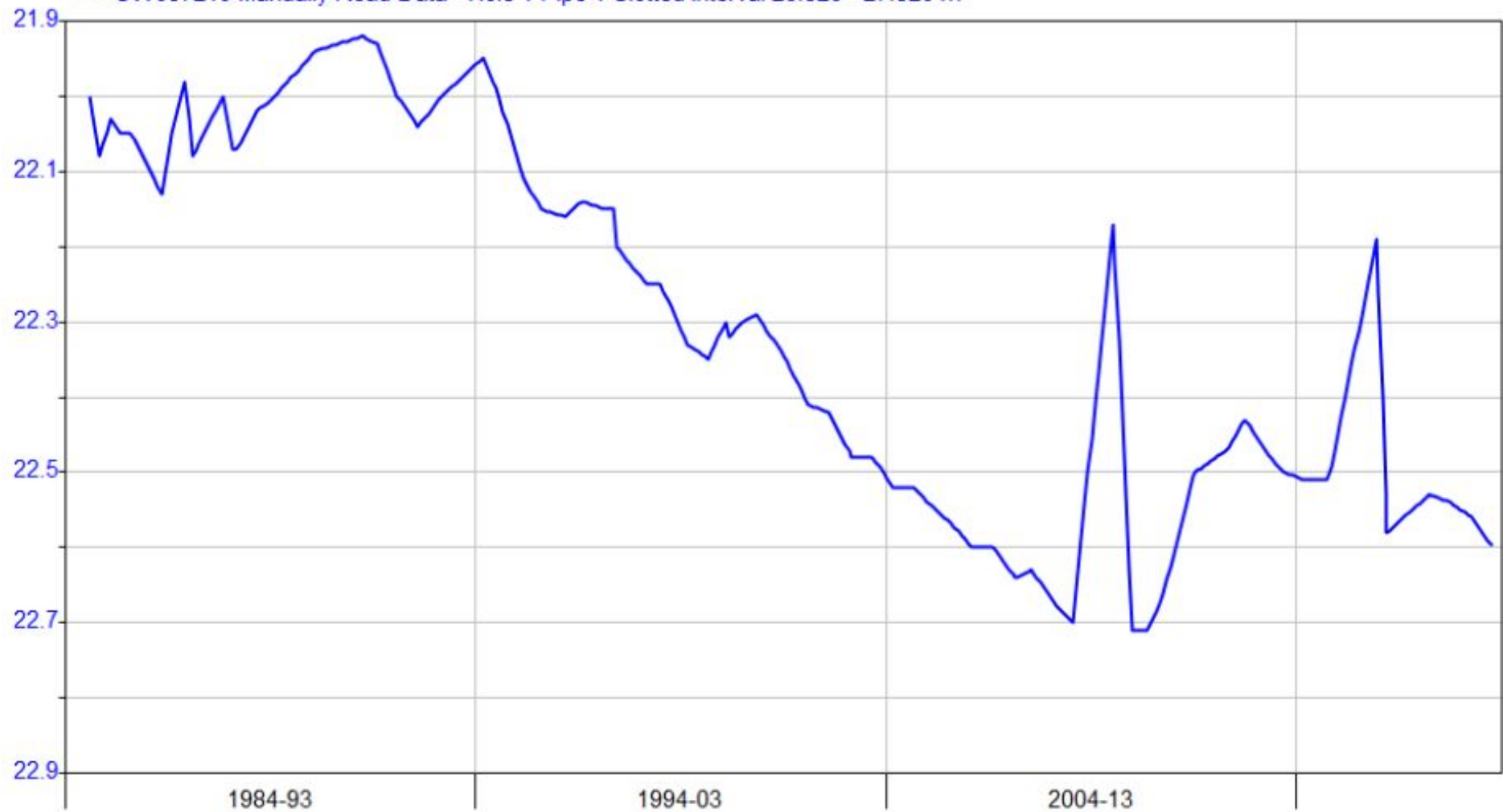
HYPLOT V133 Output 17/08/2019

Bore Water Level below Measuring Point (Metres)

01/01/1984 to 01/01/2019

1984-2018

— GW087219 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 26.820 - 27.820 m



WaterNSW

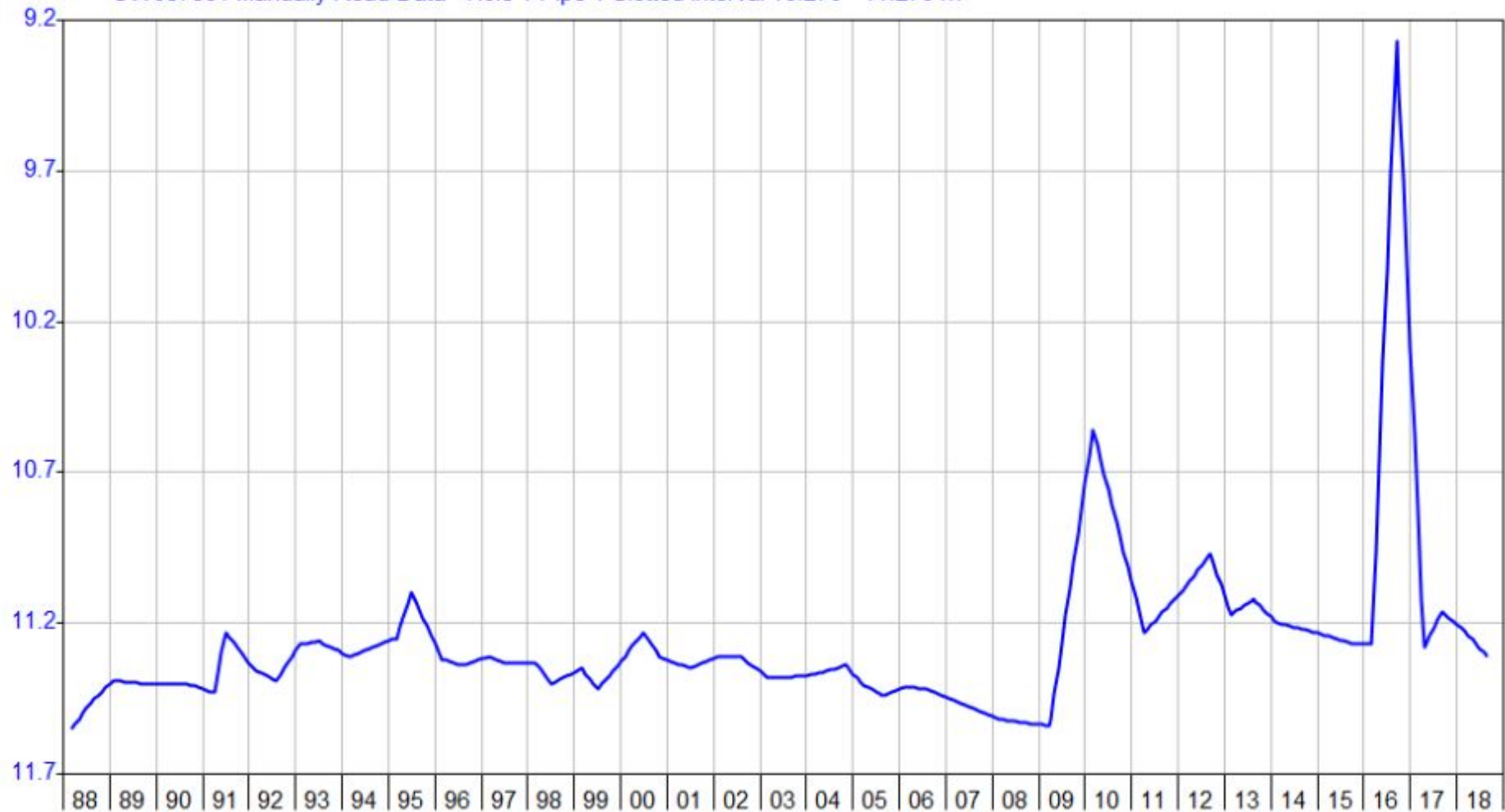
HYPLOT V133 Output 29/10/2019

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

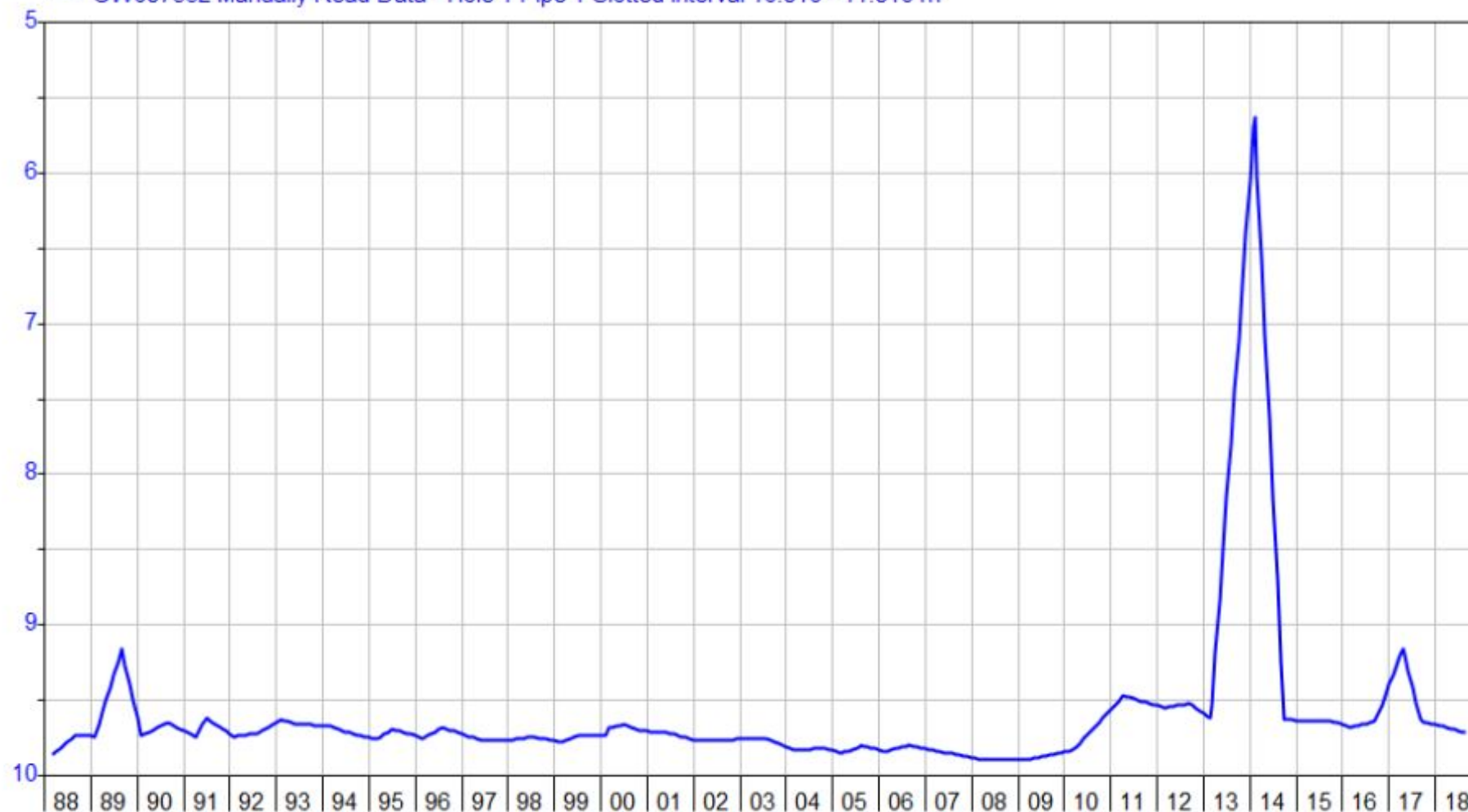


Bore Water Level below Measuring Point (Metres)

01/01/1988 to 01/01/2019

1988-2018

— GW087532 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 10.810 - 11.810 m



WaterNSW

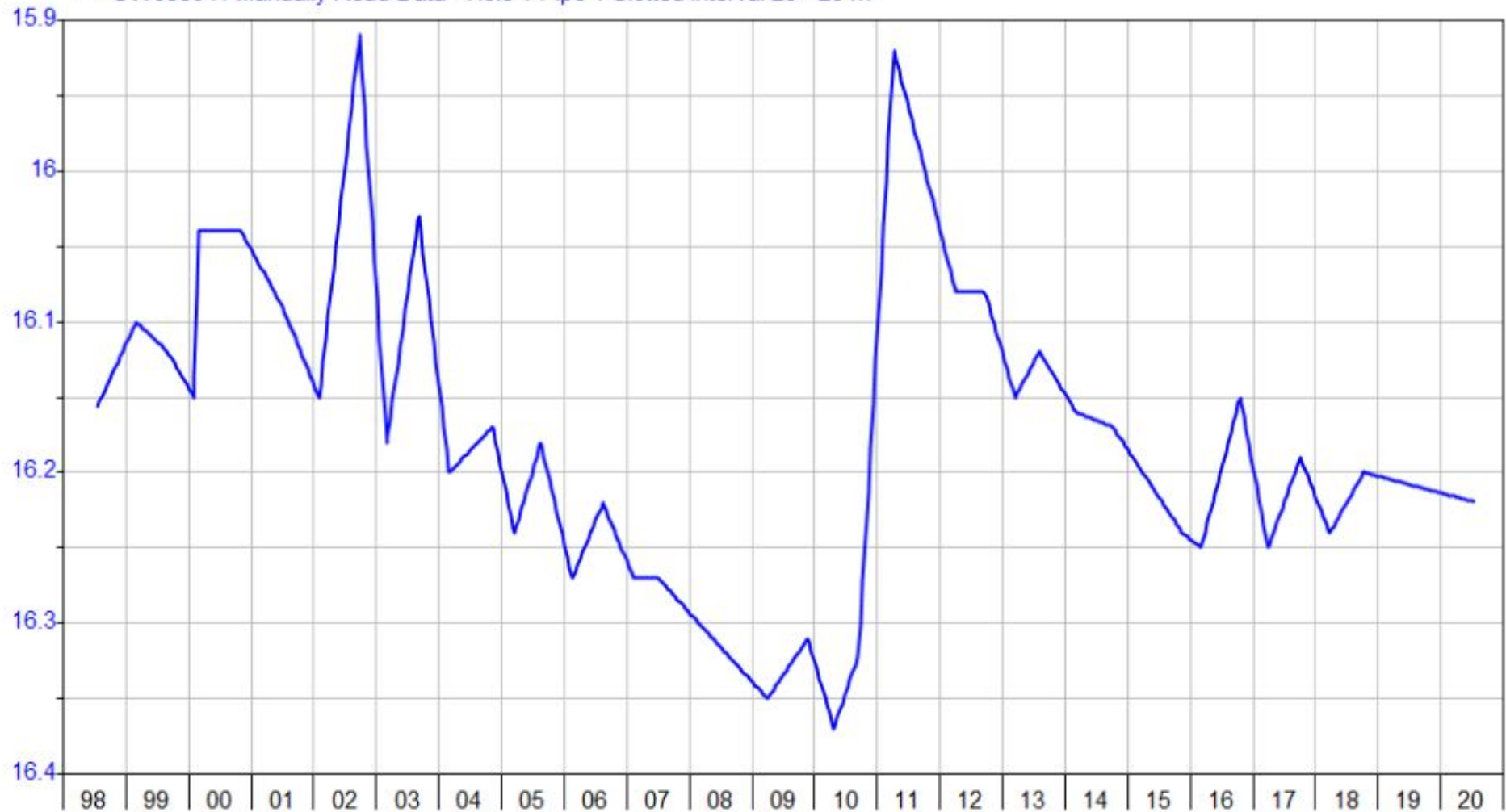
HYPLOT V134 Output 22/12/2020

Bore Water Level below Measuring Point (Metres)

01/01/1998 to 01/01/2021

1998-2020

— GW088041 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 23 - 26 m

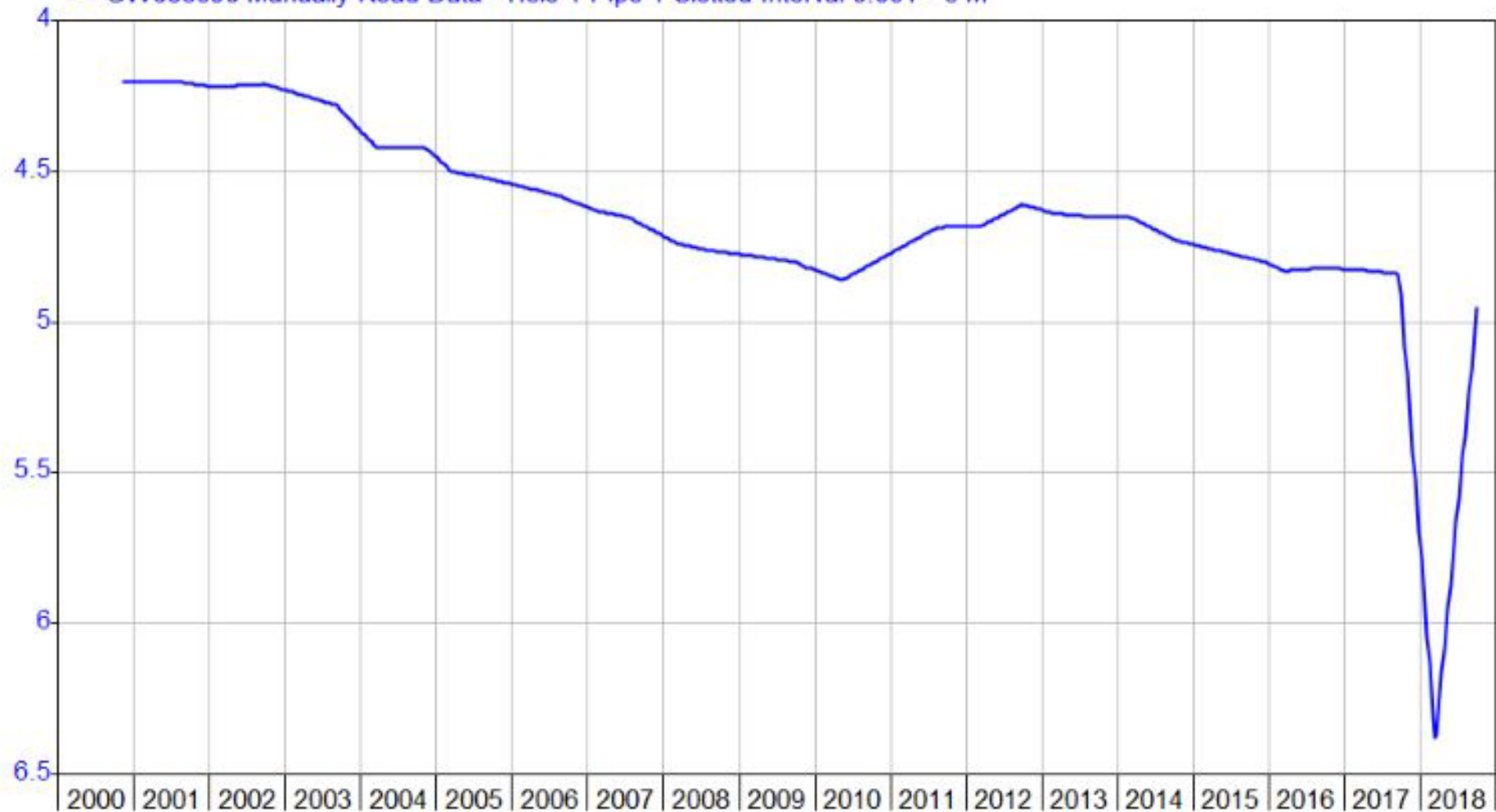


Bore Water Level below Measuring Point (Metres)

01/01/2000 to 01/01/2019

2000-18

— GW088090 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 0.001 - 0 m



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

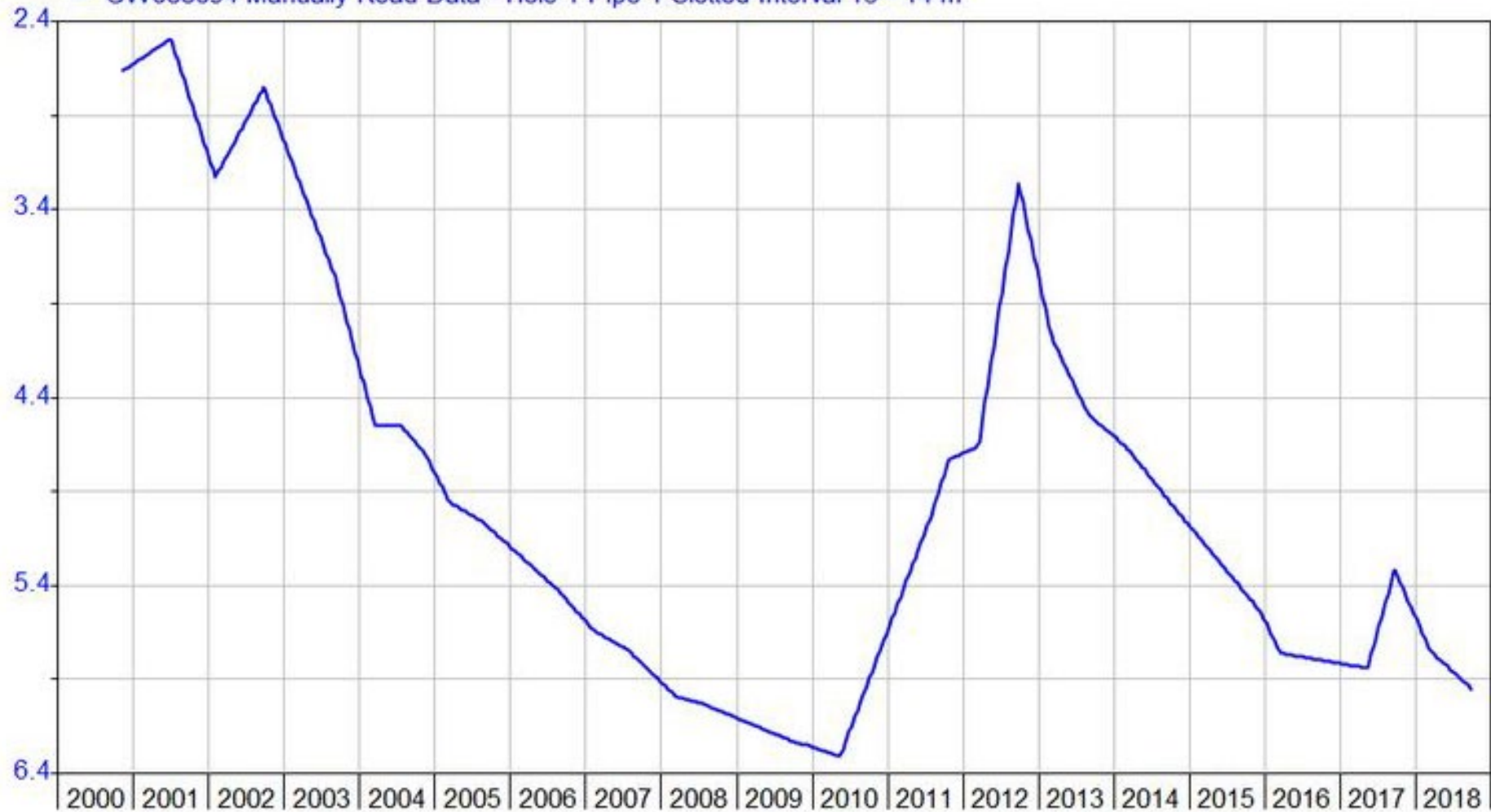


Bore Water Level below Measuring Point (Metres)

01/01/2000 to 01/01/2019

2000-18

— GW088094 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 13 - 14 m



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



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



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



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



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



WaterNSW

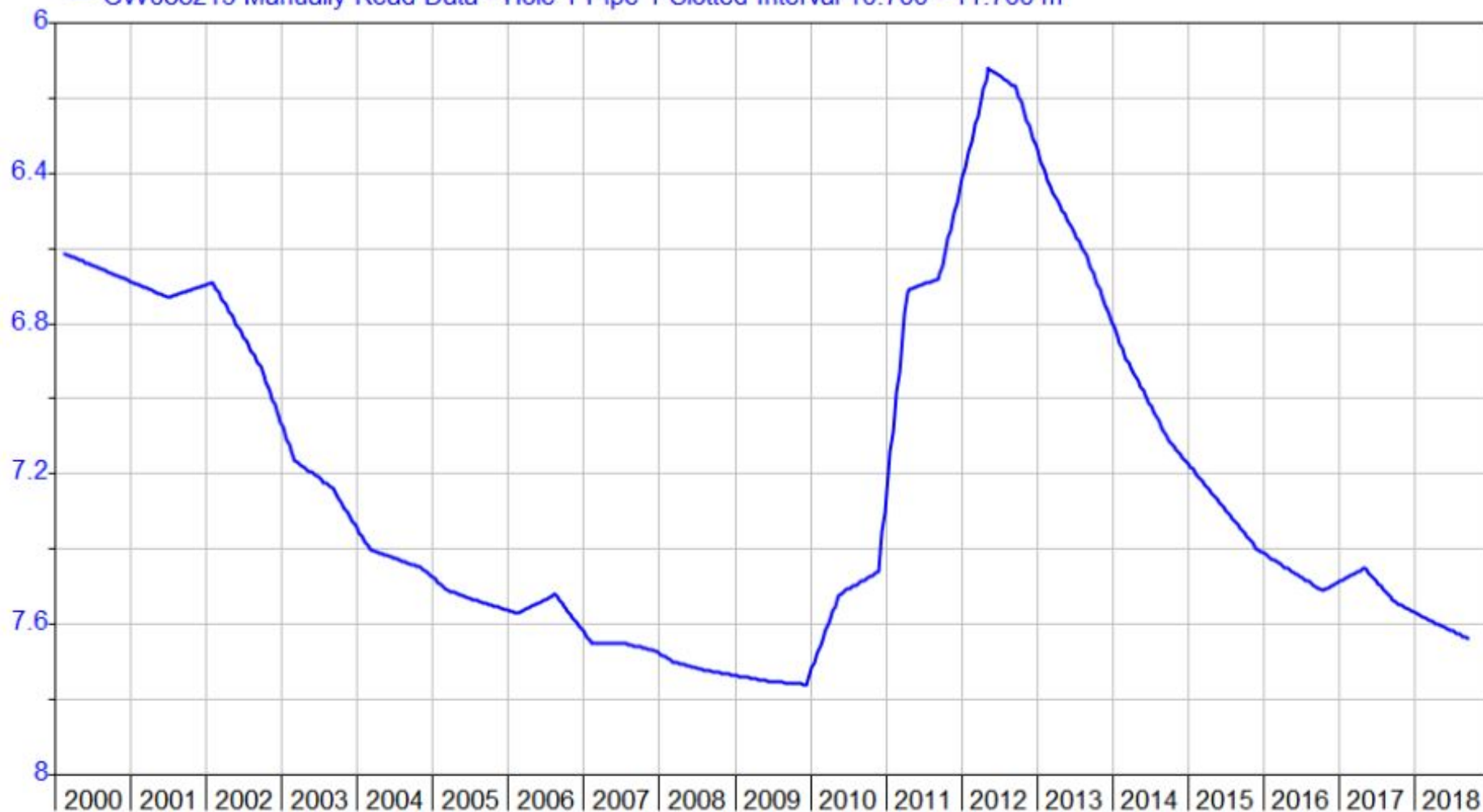
HYPLOT V133 Output 29/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/2000 to 01/01/2019

2000-18

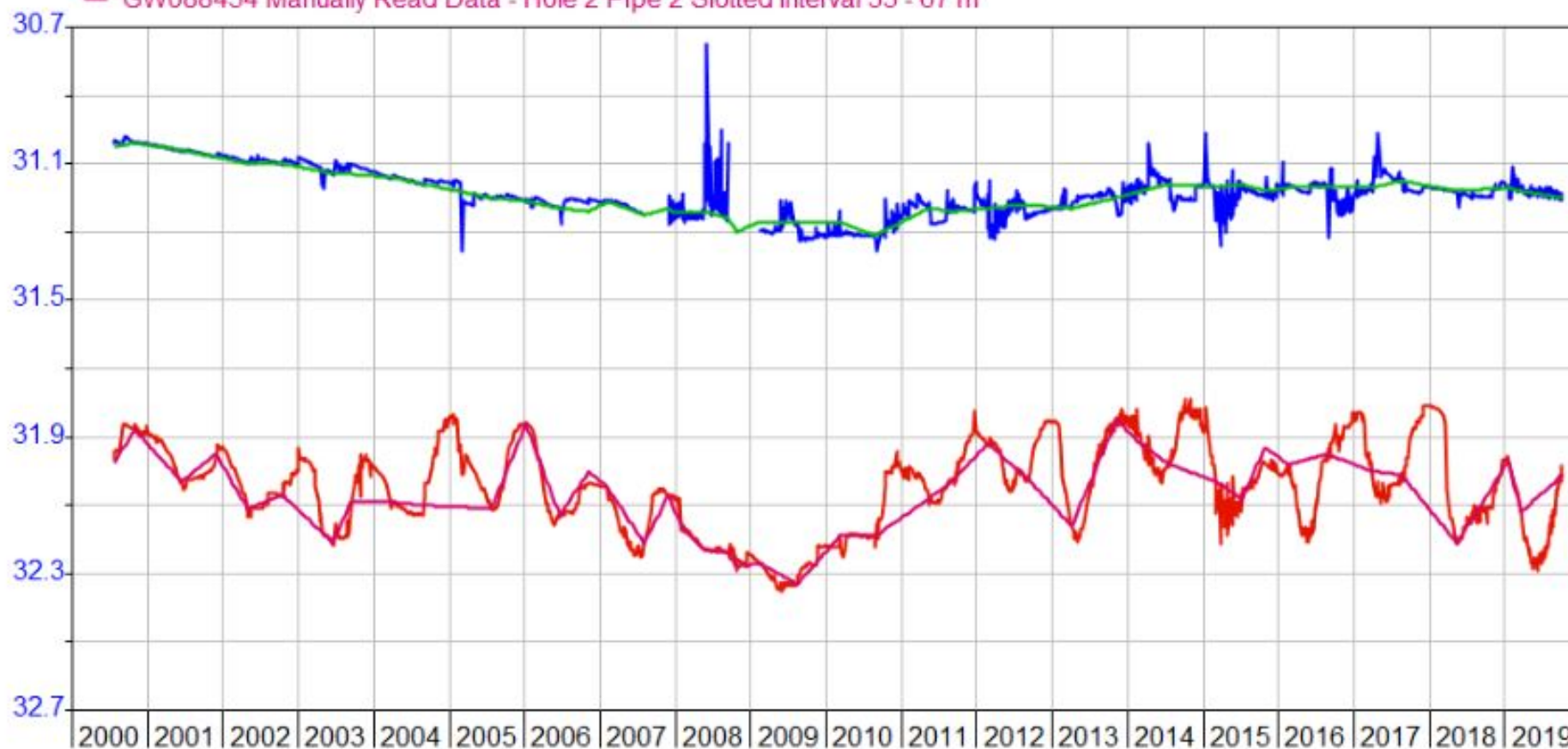
— GW088213 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 10.700 - 11.700 m



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



WaterNSW

HYPLOT V133 Output 21/10/2019

Bore Water Level below Measuring Point (Metres)

01/01/1972 to 01/01/2020

1972-2019

— GW030321 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 96 - 99 m



WaterNSW

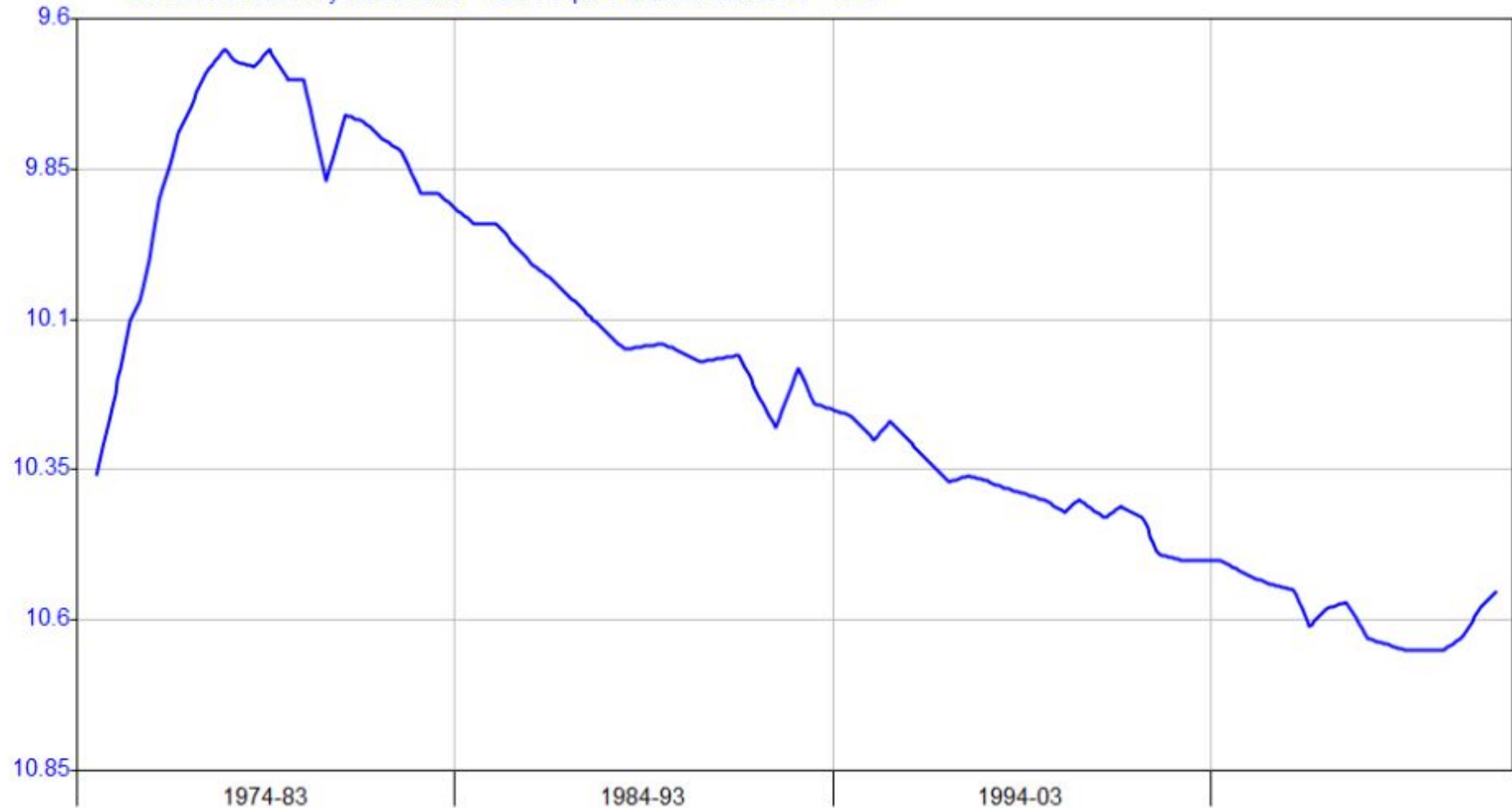
HYPLOT V133 Output 16/01/2019

Bore Water Level below Measuring Point (Metres)

01/01/1974 to 01/01/2012

1974-2011

— GW501168 Manually Read Data - Hole 1 Pipe 1 Slotted Interval 11 - 12 m



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