Hunter Power Project

Groundwater Impact Assessment

Rev 0

1 April 2021

Snowy Hydro Limited

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Hunter Power Project

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Author:	H Bolton, G Sheppard
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Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 4, 12 Stewart Avenue
Newcastle West, NSW 2302
PO Box 2147
Dangar, NSW 2309
Australia
T +61 2 4979 2600
www.jacobs.com

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Snowy Hydro Limited (Snowy Hydro) ('the Proponent') proposes to develop a gas fired power station near Kurri Kurri, NSW ('the Proposal'). Snowy Hydro is seeking approval from the NSW Minister for Planning and Public Spaces under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) for the Proposal.

The Proposal involves the construction and operation of a power station and electrical switchyard, together with other associated supporting infrastructure. The power station would have a capacity of up to approximately 750 megawatts (MW) which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel as required.

The Proposal would operate as a "peak load" generation facility supplying electricity at short notice when there is a requirement in the National Electricity Market. The major supporting infrastructure that is part of the Proposal would be a 132 kV electrical switchyard located within the Proposal Site. The Proposal would connect into existing 132 kV electricity transmission infrastructure located adjacent to the Proposal Site. A new gas lateral pipeline and gas receiving station will also be required and this would be developed by a third party and be the subject of a separate environmental assessment and planning approval.

Construction activities are anticipated to commence early 2022 and the Proposal is intended to be operational by the end of 2023.

The Proposal Site

The Proposal Site is located in the small suburb of Loxford in the Hunter Valley region of New South Wales, approximately three km north of the town of Kurri Kurri, approximately 30 km west of Newcastle CBD and 125 km north of Sydney. The Proposal Site is located within the Cessnock City Council local government area (LGA). The Proposal Site forms part of the former Kurri Kurri aluminium smelter site which is owned by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro Aluminium). The aluminium smelter ceased operation in late 2012 and was permanently closed in 2014. Demolition and site remediation works are ongoing but would be completed at the Proposal Site prior to construction of the Proposal.

The Proposal Site's current condition is that of a brownfield site, extensively disturbed by past industrial development. The Proposal requires minimal disturbance of undisturbed land.

Existing environment

This report provides a review of the current groundwater conditions and potential groundwater impacts that may arise during the construction and operational phases of the Proposal. Suitable mitigation and management measures are also recommended.

Two groundwater systems are present in the substrata, a shallow aquifer within alluvium and a deeper aquifer within the underlying bedrock / residual clay.

While regionally the dominant groundwater flow direction is anticipated to be generally to the north and north east toward sensitive receptors such as Wentworth Swamp, Black Waterholes Creek and the Hunter River, the plotted water level contours indicate that locally, shallow groundwater flow is controlled by topography. Drainage channels along the western boundary and to the north of the Proposal Site and approximately one km to the east of the Proposal Site represent local controls on groundwater elevation.

Beneath the Proposal Site, groundwater flow is inferred to be predominantly west-north-west toward the unnamed tributary of Black Waterholes Creek along the western and northern boundary of the Proposal Site.

Groundwater elevations beneath the Proposal Site are inferred to range from approximately 12 m AHD at the eastern boundary in the vicinity of borehole MW20 to approximately nine m AHD at the western boundary,

adjacent to the unnamed drainage line. This equates to a depth to water of approximately 1.2 m below ground level (bgl) along the eastern boundary, increasing up to approximately 4.0 m bgl along the western boundary of the Proposal Site.

There are no groundwater dependant ecosystems (GDEs) mapped within the Proposal Site. The nearest GDE is a terrestrial GDE with moderate potential for groundwater interaction (Sydney Sand Flats Dry Sclerophyll Forests) approximately 250 m west and north of the Proposal Site. Approximately two km north-east of the Proposal Site, Wentworth Swamp is mapped as a high potential GDE (Coastal Freshwater lagoon).

In addition to the mapped potential GDEs, a number of sensitive receptors have been identified in the area, including Wentworth Swamp, Black Waterholes Creek and the Hunter River. These areas host either identified GDEs or are areas with a high likelihood of hosting GDEs and/or water dependent riparian vegetation.

The Proposal Site is located within the NSW Water Sharing Plan (WSP) for the *Hunter Unregulated and Alluvial Water Sources 2009*. A search for private water bores showed that there are no registered bores for domestic or agricultural use within 3 km of the Proposal Site. The aquifer resource potential, based on hydraulic conductivity results for the alluvial aquifer, is expected to be low to moderate. The aquifer resource potential for the bedrock aquifer would be expected to be low given the siltstone geology.

Contamination assessments completed as part of remediation of the former Kurri Kurri aluminium smelter site indicate that historical discharges from the aluminium smelter have impacted groundwater quality, mostly around the existing stormwater ponds and waste areas.

Potential impacts

Impacts to groundwater during construction may arise primarily from excavation. Site preparations for lightly loaded power station ancillary components are generally expected to require only shallow excavation in the order of approximately 0.3 m in depth. Excavation for service trenches is anticipated to be up to 1.0 m in depth. The gas turbine and generator foundations would be more substantial involving excavation to approximately 1.8 m depth and bored piles (approximately 0.5 m diameter but subject to detailed design) to bedrock (approximately 18 m depth, again subject to detailed design). Piles may also be expected for some other plant components such as the generator step-up transformer. The proposed stormwater basin to the north of the site would be excavated some 3.0 to 3.5 m below the existing ground level.

Review of groundwater levels indicates that the majority of proposed excavations are unlikely to intercept the groundwater table. It is likely that some of the proposed excavations in the eastern portion of the Proposal Site may intersect the groundwater table, or shallow perched features within the fill material. In the case of intersecting the groundwater table in natural formations, significant inflow or requirement for substantial dewatering is not anticipated to be required due to the limited depth of excavation below the water table and the generally low permeability of the alluvium. Where perched groundwater features are encountered within fill material, some short-term management of inflows may be required. Any resulting groundwater drawdown would be very shallow and localised. No material impacts are anticipated for other groundwater users or environmental values. The level one minimal impact considerations of the NSW Aquifer Interference Policy (Department of Primary Industries, 2012) are met.

During the operational phase, no significant groundwater impacts are anticipated and as such the Proposal meets the level one minimal impact considerations of the NSW Aquifer Interference Policy (DPI, 2012).

Groundwater contamination has the potential to arise from spills and leaks during the operational phase. However, such potential impacts are mitigated and practically eliminated by these areas of the site being sealed and a stormwater capture and treatment system being in place.

Recommendations made to mitigate and manage identified potential groundwater impacts during construction and operation of the Proposal include a range of soil and water related management plans.

1. Introduction

1.1 Proposal summary

Snowy Hydro Limited (Snowy Hydro) ('the proponent') proposes to develop a gas fired power station near Kurri Kurri, NSW ('the Proposal'). Snowy Hydro is seeking approval from the NSW Minister for Planning and Public Spaces under the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) for the Proposal.

The Proposal involves the construction and operation of a power station and electrical switchyard, together with other associated supporting infrastructure. The power station would have a capacity of up to approximately 750 megawatts (MW) which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel as required, if there were a constraint or unavailability in the natural gas system and there was a need to supply electricity to the National Electricity Market (NEM).

The proposed power station would operate as a "peak load" generation facility supplying electricity at short notice when there is a requirement in the National Electricity Market. The major supporting infrastructure that is part of the Proposal would be a 132 kV electrical switchyard located within the Proposal Site. The Proposal would connect into existing 132 kV electricity transmission infrastructure located adjacent to the Proposal Site. A new gas lateral pipeline and gas receiving station will also be required and this would be developed by a third party and be the subject of a separate environmental assessment and planning approval. Other ancillary elements of the Proposal include:

- Water storage tanks and other water management infrastructure
- Fire water storage and firefighting equipment such as hydrants and pumps
- Stormwater basin
- Maintenance laydown areas
- Diesel fuel storage tank(s) and truck unloading facilities
- Site access roads and car parking
- Office/administration, amenities, workshop/storage areas.

Construction are anticipated to commence early 2022 and the Proposal is intended to be fully operational by the end of 2023. Further description of the Proposal is provided in Chapter two of the Environmental Impact Statement.

1.2 The Proposal Site

The Proposal Site (Proposal Site) is located in the small suburb of Loxford in the Hunter Valley region of New South Wales, approximately three km north of the town of Kurri Kurri, approximately 30 km west of Newcastle CBD and 125 km north of Sydney. The Proposal Site is located within the Cessnock City Council local government area (LGA).

The Proposal Site forms part of the former Kurri Kurri aluminium smelter site which is owned by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro Aluminium). The aluminium smelter ceased operation in late 2012 and was permanently closed in 2014. Demolition and site remediation works are ongoing but would be completed at the Proposal Site prior to construction of the Proposal.

The Proposal Site can be seen in more detail in Figure 1.1 and Figure 1.2. The Proposal Site's current condition is that of a brownfield site, extensively disturbed by past industrial development. The Proposal requires minimal disturbance of undisturbed land.

The Proposal Site and surrounds are currently zoned RU2 Rural Landscape under the *Cessnock Local Environmental Plan 2011*. However, the Proposal Site and vicinity is currently the subject of a rezoning application. Under this plan, the Proposal Site would be designated as Heavy Industrial.

The suburban areas of Kurri Kurri are approximately three km south and south-west of the Proposal Site. Further residential areas at Heddon Greta and Cliftleigh are situated approximately 2.5 km to the east. There are some sparse rural residential properties south and south-east of the Proposal Site, the nearest being located on Dawes Avenue, Loxford which is approximately 1.25 km south-east of the Proposal Site (and is owned by Hydro Aluminium). The Kurri Kurri Speedway Club is on Dickson Road, Loxford and is approximately 800 to 850 m south-east of the Proposal Site. Immediately south of the Proposal Site are the remains of the former Kurri Kurri aluminium smelter and the M15 Hunter Expressway. There is some native vegetation adjacent to the Proposal Site in the north, east and west.

1.3 Purpose of this report

This report provides a review of the current groundwater conditions and potential groundwater impacts that may arise during the construction and operational phases of the Proposal. Suitable mitigation and management measures are also recommended.

1.4 Secretary's Environmental Assessment Requirements (SEARs)

An environmental impact statement (EIS) for the Proposal has been prepared under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Groundwater Impact Assessment has been prepared to support the EIS. The purpose of this report is to address the relevant sections of the Secretary's Environmental Assessment Requirements (SEARs) issued on 5 February 2021 (SSI 12590060). The report preparation has also taken cognisance of any applicable agency comments. Table 1.1 outlines the SEARs relevant to this assessment.

Table 1.1: SEARs relevant to this assessment

Secretary's requirement
Water – an assessment of the impacts of the project on groundwater aquifers and groundwater dependent ecosystems having regard to the *NSW Aquifer Interference Policy* and relevant *Water Sharing Plans*

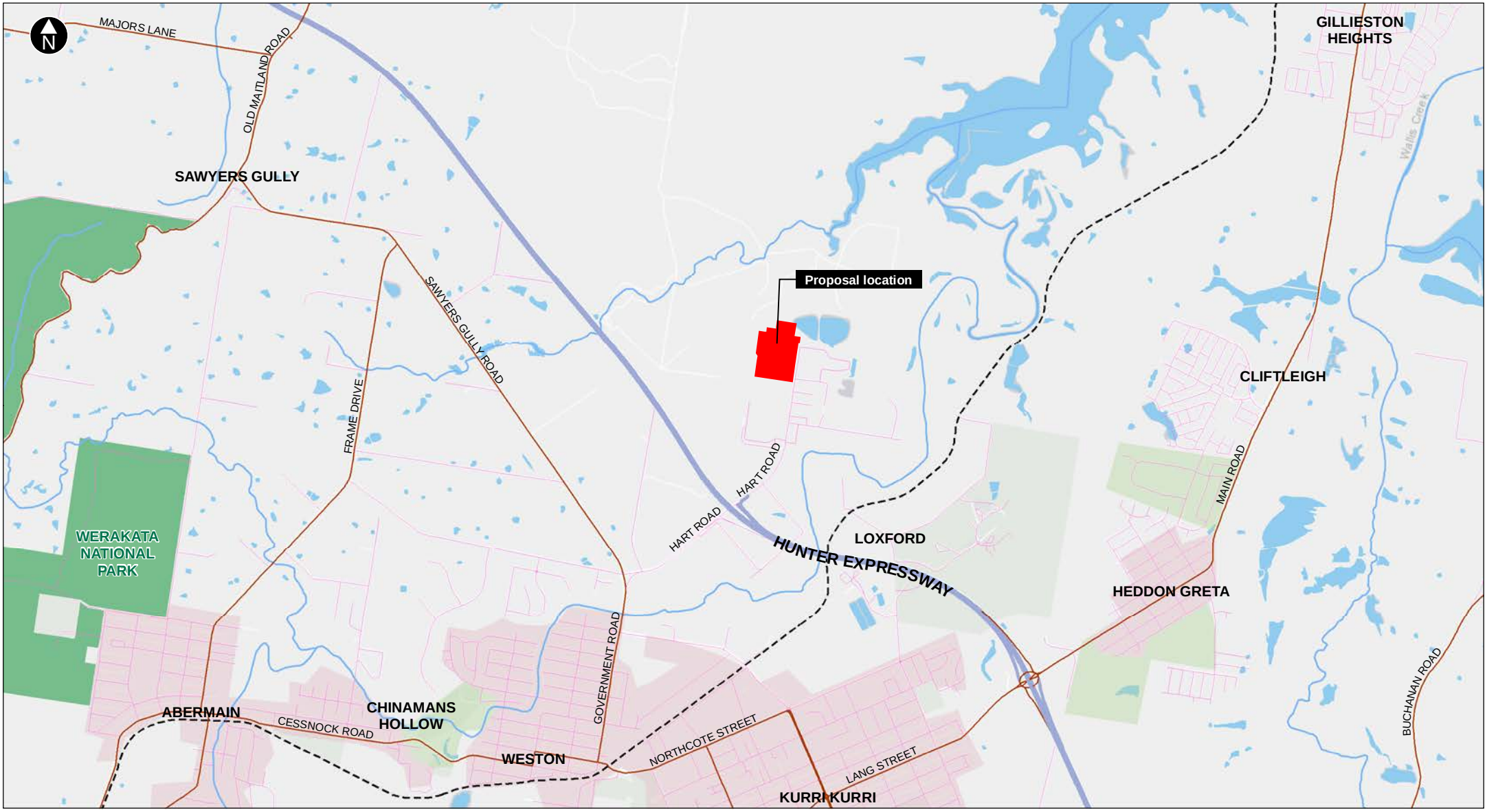

Figure 1-1 Proposal location (regional)

Proposal Site
Detention basin
Existing electrical transmission easement
Motorway
Main roads
Roads
Railway
Waterbodies

1 Proposed Switchyard Area
2 Proposed Plant Area
3 Proposed Buffer Area

0 250 500 m

1:12,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs
Metromap (Aerometrex) 2020
NSW Spatial Services

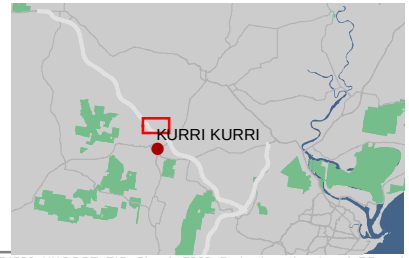

Figure 1-2 Proposal location (local)

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2. Legislation, policy and guidelines

2.1 Legislation and policy

2.1.1 Water Management Act NSW (2000) and Water Act (1912)

Summary

The Water Management Act 2000 (WM Act) and the Water Act 1912 are the two key pieces of legislation for the management of water in NSW and contain provisions for the licensing of water access and use. The Acts are administered by the NSW Department of Planning, Industry and Environment (Water) (DPIE Water). The *Water Act 1912* is being progressively phased out and replaced by the WM Act. Responsibilities for granting and managing water licences and approvals are split between the independent Natural Resources Access Regulator (NRAR) and WaterNSW. Water sharing plans are managed by WaterNSW. NRAR is responsible for water access licences and associated approvals related to state significant developments and state significant infrastructure.

The overall objective of the WM Act is "sustainable and integrated management of the State's water". The Act establishes a system of licensing and approvals whereby access to water is generally regulated by way of water access licences (WALs). The WM Act enables the State's water resources to be managed under water sharing plans, which establish the rules for sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source.

The majority of water access licences are issued under the WM Act, however where there is no water sharing plan, some access rights are still issued in the form of licences or permits under the *Water Act 1912* which are tied to the land.

The general and aquifer interference activities' water management principles as set out in the WM Act are:

- Water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded
- Habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored
- The water quality of all water sources should be protected and, wherever possible, enhanced
- The cumulative impacts of water management
- Licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised
- Geographical and other features of Aboriginal significance should be protected
- Geographical and other features of major cultural, heritage or spiritual significance should be protected
- The social and economic benefits to the community should be maximised
- The principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements
- The carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated
- The impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.

Relevance

Elements of the *Water Management Act 2000* relating to drainage management, aquifer interference activities and general principles that are relevant to this Proposal have been considered in this assessment to inform potential construction and operational phase risks of the Proposal.

Dewatering is not likely to be required during the construction or operation phases.

As the Proposal was declared Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning and Public Spaces in December 2020 under *State Environmental Planning Policy (State and Regional Development) 2011*, water-take related approvals would not be required from the NSW National Resources Access Regulator (NRAR). However, as the Proposal does not intend to extract groundwater and will source potable water from municipal supply, there will not be any groundwater take as a result of the Proposal and no water-take approvals are required.

2.1.2 The NSW Aquifer Interference Policy (2012)

Summary

The NSW Aquifer Interference Policy (DPI, 2012) is the instrument for the assessment and licencing of aquifer interference activities administered by the WM Act.

The NSW Aquifer Interference Policy outlines minimal impact considerations for water table and groundwater pressure drawdown for high priority groundwater dependent ecosystems (as identified in the relevant Water Sharing Plan), high priority culturally significant sites (as identified in the relevant Water Sharing Plan) and existing groundwater supply bores. Water quality impact considerations for groundwater and surface water are also outlined within the NSW Aquifer Interference Policy.

For the purpose of minimal impact consideration criteria, the NSW Aquifer Interference Policy considers the type of water source (alluvial, coastal sands, porous rock, or fractured rock), and the productivity of the groundwater source as either highly productive or less productive. Highly productive groundwater sources are defined by the NSW Aquifer Interference Policy to have total dissolved solids concentrations of less than 1,500 milligrams per litre and yields greater than five litres per second at bores.

The WM Act defines aquifer interference as an activity that involves any of the following:

- The penetration of an aquifer
- The interference with water in an aquifer
- The obstruction of the flow of water in an aquifer
- The taking of water from an aquifer while carrying out mining or any other activity prescribed by the regulations.

Relevance

Elements of the NSW Aquifer Interference Policy including interference of flow of water in an aquifer and extraction or disposal of groundwater have been considered in this assessment to inform potential construction and operational phase risks associated with the Proposal. The Proposal has been assessed against the minimum impact considerations.

2.1.3 The NSW Groundwater Protection Policy (1998)

Summary

The NSW Groundwater Quality Protection Policy (Department of Land & Water Conservation, 1998) adopts the management principles outlined in the *NSW State Groundwater Policy Framework Document* (DLWC, 1997) in relation to groundwater quality protection, including:

- All groundwater systems should be managed so that the most sensitive identified beneficial use (or environmental value) is maintained
- Town water supplies should be afforded special protection against contamination
- Groundwater pollution should be prevented so that future remediation is not required
- For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the resource
- A groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwaters that are incompatible with soil, vegetation or receiving waters
- Groundwater dependent ecosystems will be afforded protection
- Groundwater quality protection should be integrated with the management of groundwater quantity
- The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource
- Where possible and practical, environmentally degraded areas should be rehabilitated, and their ecosystem support functions restored.

Relevance

The policy identifies management tools to achieve groundwater protection, some of which would be relevant to the Proposal, including the use of groundwater management plans and groundwater monitoring. This assessment also reviews potential groundwater dependent ecosystems (GDEs) which are afforded special protection under the NSW Groundwater Protection Policy, of which none were identified at risk from construction or operation of the Proposal.

2.1.4 The NSW Groundwater Dependent Ecosystem Policy (2002)

Summary

The Groundwater Dependent Ecosystems Policy (Department of Land & Water Conservation, 2002) provides a framework for the sustainable management of groundwater, specifically principles for the management of groundwater dependent ecosystems (GDEs).

Relevance

The completed groundwater impact assessment did not identify GDEs at risk from construction or operation of the Proposal.

2.2 Guidelines

The National Water Quality Management Strategy (NWQMS) (ANZECC and ARMCANZ 2000a) provides a nationally consistent approach to water quality management and the information and tools to help water resource managers, planning and management agencies, regulatory agencies and community groups manage and protect their water resources.

The NWQMS comprises a description of policies, principles and guidelines for end users and water sources. The main policy objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development.

The NWQMS process involves development and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other water body, by community and government. These plans focus on the reduction of pollution released into coastal pollution hotspots and other aquatic ecosystems around the country. Local government, community organisations and other agencies implement these plans using the NWQMS to protect agreed environmental values.

The NWQMS consists of some 21 guideline documents which broadly cover ambient and drinking water quality, monitoring, groundwater, rural land uses and water quality, stormwater, sewerage systems and effluent management for specific industries. Two additional publications were released in 2001:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)*
- *Australian Guidelines for Water Quality Monitoring and Reporting (2000).*

These publications outline the current approach for deriving water quality guidelines, objectives and targets. They provide highly detailed and comprehensive information for water quality monitoring and management in Australia and New Zealand.

Water quality mitigation and management strategies consistent with NWQMS are required during construction and operation of the Proposal such that the environmental values of the sensitive receiving waterways are not adversely impacted. These mitigation and management measures should be included in the construction and operational environmental management plans.

3. Methodology

The following tasks have been completed as part of the groundwater impact assessment:

- A desktop study of existing hydrogeological conditions at the Proposal Site including:
  - Description of aquifers, depth to groundwater, groundwater quality and groundwater flow directions
  - Existing groundwater users, groundwater dependent ecosystems and groundwater-surface water interaction.
- Review of relevant previous investigations, including:
  - Ramboll ENVIRON (2016) Environmental Impact Statement, Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation. Prepared for Hydro Aluminium Kurri Kurri Pty Limited.
  - ENVIRON (2012) Phase 2 Environmental Site Assessment, Kurri Kurri Aluminium Smelter. Prepared for Norsk Hydro ASA. Project DE11HDR043. November 2012.
- WaterNSW records indicated that there are up to 17 existing groundwater bores at or near the Proposal Site, including 11 monitoring bores and six bores of unknown purpose.
  - A bore census has been undertaken to confirm the location of the bores and record total depth and depth to standing water level.
  - Water quality samples were obtained from six selected groundwater bores.
- Assess any potential dewatering requirements and associated drawdown impacts due to construction dewatering and any proposed ongoing water take associated with the Proposal.

4. Existing environment

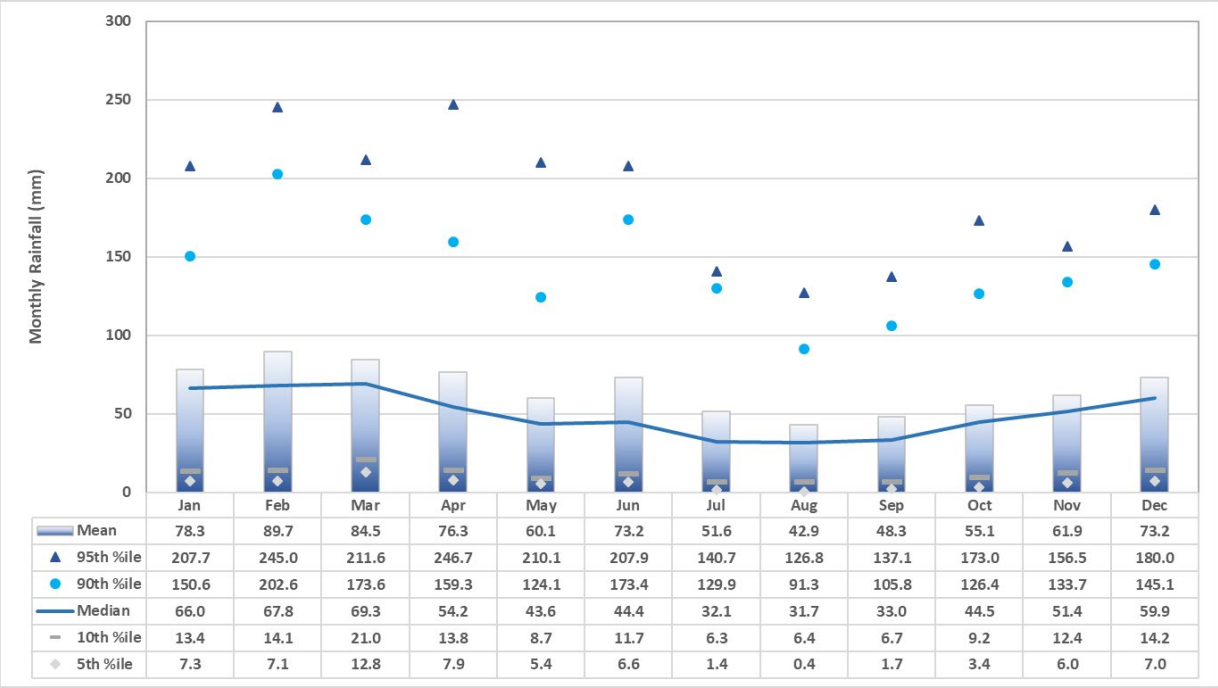
4.1 Climate

Climate at the Proposal Site has a Köppen classification of temperate (no dry season (hot summer)) with a mean maximum summer temperatures of 29.2°C to 30.5°C and mean maximum winter temperatures of 17.6°C to 19.5°C (Cessnock Airport AWS). Long term climate data from the Proposal Site was obtained from the Bureau of Meteorology (BoM) SILO Data Drill, which is derived from the BoMs extensive database of recorded observations taken from its network of weather recording stations.

Representative rainfall data for the Proposal Site is shown in Table 4.1 and presented in Figure 4.1. Monthly rainfall shows a low to moderate degree of seasonal distribution with a drier period of lower rainfall from July through November and a wetter period from December through April. The median monthly rainfall is lowest in August (31.7 mm) and highest in February (67.8 mm).

Table 4.1: Annual rainfall statistics (SILO data drill, 1900-2020)

Statistic	Annual rainfall (mm)
Mean	794
P95	1,154
P90	1,055
P50 (Median)	782
P10	545
P5	498
Standard deviation (mm)	200
Coefficient of variation	0.25



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	78.3	89.7	84.5	76.3	60.1	73.2	51.6	42.9	48.3	55.1	61.9	73.2
95th %ile	207.7	245.0	211.6	246.7	210.1	207.9	140.7	126.8	137.1	173.0	156.5	180.0
90th %ile	150.6	202.6	173.6	159.3	124.1	173.4	129.9	91.3	105.8	126.4	133.7	145.1
Median	66.0	67.8	69.3	54.2	43.6	44.4	32.1	31.7	33.0	44.5	51.4	59.9
10th %ile	13.4	14.1	21.0	13.8	8.7	11.7	6.3	6.4	6.7	9.2	12.4	14.2
5th %ile	7.3	7.1	12.8	7.9	5.4	6.6	1.4	0.4	1.7	3.4	6.0	7.0

Figure 4.1: Monthly rainfall statistics (SILO data drill, 1900-2020)

4.2 Topography and surface water features

The Proposal Site and surrounds are primarily flat at an elevation of approximately 14 m AHD, with natural drainage falling gradually towards the north-east towards Black Waterholes Creek. There are two large, shallow artificial ponds located north-east of the Proposal Site, which were constructed to capture stormwater runoff from the former Kurri Kurri aluminium smelter site and are integrated with the natural drainage regime. In addition to evaporation, water from the ponds was also discharged as irrigation onto an adjacent paddock further to the north east. Land further east and north of the Proposal Site comprises low-lying open rural land, and the waterways of Swamp Creek, Black Waterholes Creek and the Swamp Creek wetlands, which lead to the Wentworth swamps which are part of the extensive Hunter River floodplain (refer Figure 1.1 and Figure 1.2). The Hunter River is approximately nine km north-east of the Proposal Site in Maitland.

4.3 Biodiversity

The Proposal Site has largely been cleared due to the former Kurri Kurri aluminium smelter land use. However, the Proposal Site's northern edges and the immediate surrounds include regrowth native vegetation and likely fauna habitat including aquatic habitat.

Direct impacts to vegetation are limited to a relatively small portion of the Proposal Site at the north-west perimeter of the proposed new 132 kV switchyard.

Biodiversity values are outlined in the Biodiversity Development Assessment Report (BDAR) prepared as part of the Environmental Impact Statement (EIS) for the proposal.

4.4 Geology and soil landscapes

The Proposal Site was raised by localised cut and fill activities during construction of the Kurri Kurri aluminium smelter and has been heavily disturbed due to the construction activities of the aluminium smelter between 1969 and 2014, which included widespread foundations and footings extending to more than 1.5 metres depth. The Proposal Site is currently subject to an extensive, staged demolition and remediation program of works which would be completed to a suitable standard prior to Snowy Hydro taking possession of the Proposal Site.

A geotechnical review and intrusive investigation completed for the Proposal indicated deep alluvial soils across the Proposal Site, with siltstone bedrock encountered at approximately 14 m to 18 m in depth. Laboratory testing undertaken on near surface soils indicates that they are sodic and hence have the potential to be dispersive in nature.

Acid Sulphate Soils (ASS) are considered unlikely to be present at the Proposal Site according to probability mapping (refer Figure 4.2) (DPIE, 2021a). Soils approximately 500 metres north and east of the Proposal Site, surrounding and within Black Waterholes Creek and Swamp Creek, are classified as 'Class 2 - high probability of ASS greater than one metre below ground surface' and 'Class 4 - low probability of ASS greater than three metres below ground surface', respectively. However, laboratory testing results from geotechnical investigations indicated a possible risk of ASS in the alluvial soils at depth. Given the relatively shallow excavation proposed for construction of the Proposal, low pH runoff or dewatering, ASS disturbance is considered unlikely.

Proposal Site
Motorway
Main roads
Roads
Railway
Waterbodies

Acid Sulphate Soils Risk Class
Class 2
Class 3
Class 4

1 Proposed Switchyard Area
2 Proposed Plant Area
3 Proposed Buffer Area

0 250 500 m

1:12,000 at A4
Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs 2020
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 4-2 Acid Sulphate Soils

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Created by : AA | QA by : GS

4.5 Groundwater features

4.5.1 Aquifer characterisation

The underlying hydrogeology at the Proposal Site is understood to comprise of two groundwater systems which are present in the substrata, a shallow aquifer within alluvium and a deeper aquifer within the underlying bedrock / residual clay.

4.5.1.1 Alluvial aquifer

The water table aquifer is hosted in the alluvium and is unconfined. Several bores have intersected a clay layer within the alluvium, which may be laterally extensive and may create a multi-level aquifer body. It has been suggested that the alluvium may comprise an upper and lower aquifer, with the lower aquifer having sub-artesian pressures. However, the uncertainty around the condition of the clay layer is high and it is unlikely to represent a regional aquitard. The nature of the alluvium is variable, and yield is uncertain.

Hydraulic testing has been undertaken on a number of monitoring bores and the formations tested interpreted to have a hydraulic conductivity of between $2x10^{-5}$ m/s and $8x10^{-6}$ m/s (1.7 m/d to 0.7 m/d), which is representative of sand and silty sand expected of a similar aquifer.

4.5.1.2 Bedrock aquifer

The bedrock aquifer is considered a minor aquifer due to the fact it is comprised of siltstone predominantly. More permeable zones are likely to be located where weathered sandstone is found or in the fractures and jointing of the rock units.

4.5.2 Groundwater bore observations

A bore census was undertaken in November 2020 to confirm the location of existing monitoring bores in the vicinity of the Proposal Site. A total number of 31 bores were found in the vicinity of the Proposal Site of which four bores required maintenance as they are either damaged or covered over. Figure 4.3 shows monitoring bores in the vicinity of the Proposal Site. The depth to water in the alluvium ranges from approximately 1.0 m bgl to 8.0 m bgl, with the closest monitoring site (MW20) having a depth to water of approximately 1.2 m bgl. Details of the bore census findings are summarised in Appendix A.

In addition to the groundwater levels observed in existing monitoring bores around the Proposal Site, ground water strike observations from geotechnical drilling completed at the Proposal Site during February 2021 also provides an indication of likely groundwater depths. Five geotechnical boreholes were drilled within the Proposal Site, as shown on Figure 4.3. Indicated depths to water typically ranged from 2.0 to 3.0 m bgl. At one borehole (BH202), however, water was encountered within a cavity at a depth of 0.8 m bgl. It was not confirmed whether this is indicative of the local groundwater table, or an anomaly perched feature within fill material. Given the high rainfall in the months preceding the geotechnical drilling, it is considered most likely that the observed water was ephemerally saturated fill material perched above the local groundwater table.

4.5.3 Groundwater levels and flow

The former Kurri Kurri aluminium smelter site infrastructure has locally influenced the water table at the Proposal Site. Stormwater drains have potentially lowered the water table in certain areas and groundwater mounds have been identified by others near existing stormwater retention ponds outside of the Proposal Site. The existing stormwater retention ponds and groundwater mounds are considered to be a potential source of groundwater recharge, and potentially groundwater contamination.

Groundwater elevation contours are presented on Figure 4.3 based on observed groundwater depths (refer section 4.5.2) and one metre LiDAR digital elevation model data from the NSW Foundation Spatial Data Framework (2012). The resulting contours are indicative only considering the low resolution of the terrain data and highly modified nature of the former Kurri Kurri aluminium smelter site.

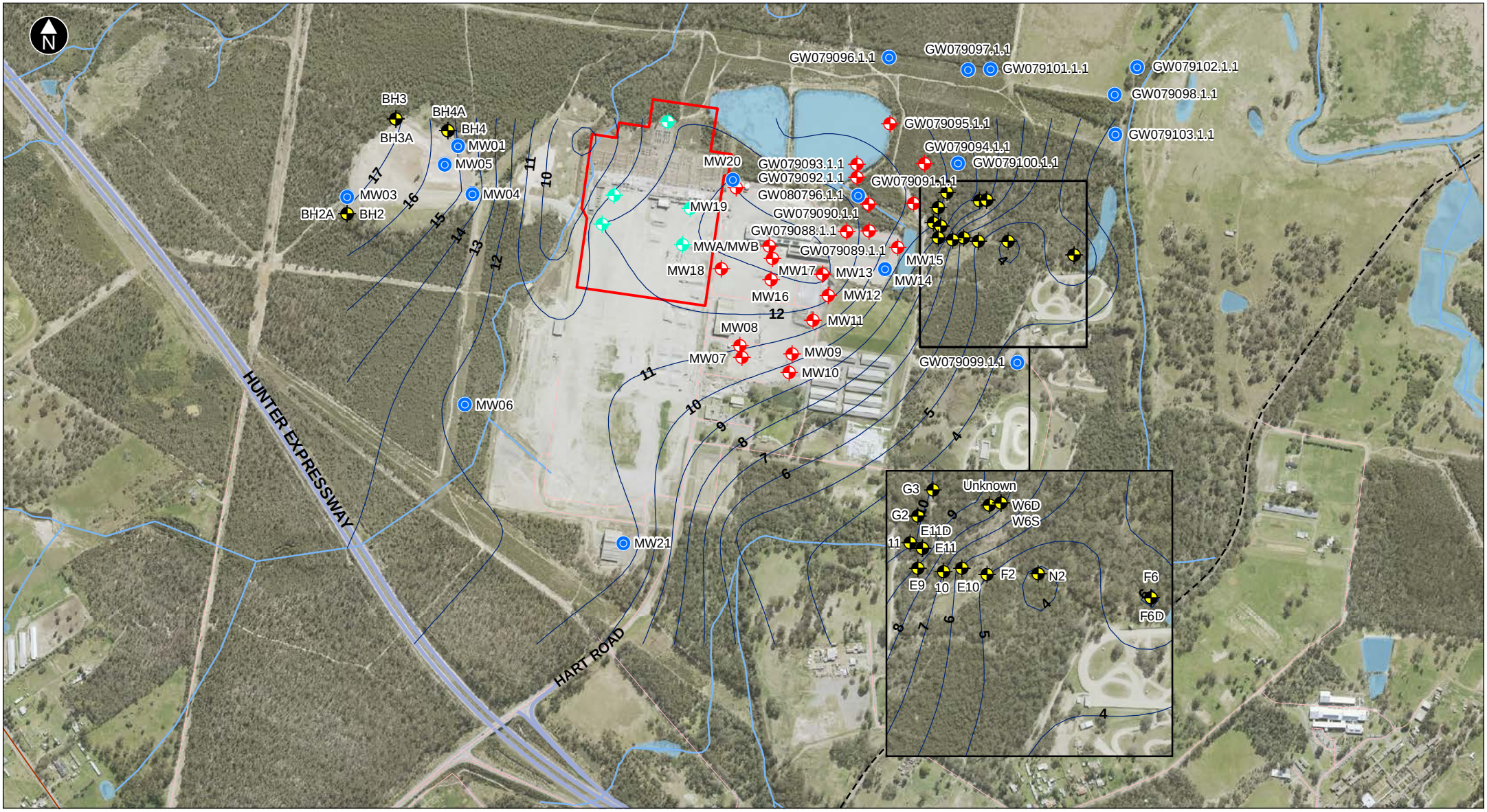
While regionally the dominant groundwater flow direction is anticipated to be generally to the north and north east toward sensitive receptors such as Wentworth Swamp, Black Waterholes Creek and the Hunter River, the plotted water level contours indicate that locally, shallow groundwater flow is controlled by topography. Drainage channels along the western boundary and to the north of the Proposal Site and approximately 1 km to the east of the Proposal Site represent local controls on groundwater elevation.

Beneath the Proposal Site, groundwater flow is inferred to be predominantly west-north-west toward the unnamed tributary of Black Waterholes Creek along the western and northern boundary.

Groundwater elevations beneath the Proposal Site are inferred to range from approximately 12 m AHD at the eastern boundary in the vicinity of borehole MW20 to approximately 9 m AHD at the western boundary, adjacent to the unnamed drainage line. This equates to a depth to water of approximately 1.2 m bgl along the eastern boundary, increasing up to approximately 4.0 m bgl along the western boundary of the Proposal Site.

East of the Proposal Site there is a general easterly groundwater flow direction.

The mine subsidence area (Glen Ayr Colliery) approximately 2.4 km to the east of the Proposal Site is not likely to have any significant influence on site groundwater conditions.



Proposal Site

Motorway

Main roads

Roads

Railway

Waterbodies

Monitoring bores locations to be sampled

Existing monitoing bore locations

Unregistered bores

Geotech boreholes

Groundwater level contours (mAHD)

Hydroline

0 250 500 m

1:12,000 at A4

Coordinate System: GDA2020 MGA Zone 56

Data sources:
Jacobs
Metromap (Aerometrex) 2020
NSW Spatial Services

Figure 4-3 Monitoring bore locations

4.5.4 Groundwater surface water interaction

The alluvial aquifer is considered to be connected to surface water features such as Swamp Creek and Black Waterholes Creek that lead to the Wentworth Swamp wetlands based on the direction of groundwater flow and the groundwater depth. As discussed in Section 4.5.3, the local drainage lines are considered to provide a control on groundwater levels and as such are likely a point of ephemeral groundwater discharge or evapotranspiration.

4.5.5 Groundwater dependent ecosystems and sensitive receiving environments

Figure 4.5 shows a map of potential GDEs from the Bureau of Meteorology Groundwater Dependant Ecosystem Atlas. There are no GDEs mapped within the Proposal Site. The nearest GDE is a terrestrial GDE with moderate potential for groundwater interaction (Sydney Sand Flats Dry Sclerophyll Forests) approximately 250 m west and north of the Proposal Site.

Approximately two km north-east of the Proposal Site, Wentworth Swamp is mapped as a high potential GDE (Coastal Freshwater lagoon).

In addition to the mapped potential GDEs, a number of sensitive receptors have been identified in the area, including Wentworth Swamp, Black Waterholes Creek and the Hunter River. These areas host either identified GDEs or are areas with a high likelihood of hosting GDEs and/or water dependent riparian vegetation. The Hunter River alluvium is also known to host stygofauna, which is considered a GDE (however, it is unlikely that the alluvium at Proposal Site will host significant stygofauna given the predominantly fine grained nature of the sediments).

4.5.6 Groundwater quality

Previous industrial activities at the former Kurri Kurri aluminium smelter site have impacted groundwater quality, primarily via the stormwater ponds and waste storage areas, which are adjacent the Proposal Site. Leachate contamination plumes have been identified at the capped waste stockpile, refuelling area and the stormwater ponds. Stormwater has also been irrigated onto adjacent bushland north of the stormwater ponds but impacts, if any, are downgradient and would not affect the Proposal Site.

Basic groundwater quality (major anions, pH, Electrical Conductivity) was analysed from samples collected at five selected monitoring bore locations (MW06, MW13, MW20, MW21, GW079099) around the Proposal Site in November 2020. A summary of water quality parameters is provided in Table 4.2. Field measurements and laboratory analytical results are provided in Appendix A.

Analysis of the results indicate:

- High variation in water quality. Electrical conductivity results ranged from slightly brackish (MW20 and MW13) (1219 to 1610 µS/cm) to saline (GW079099, MW21 and MW6) (14,100 to 20,700 µS/cm). The samples are all from similar depth and it is inferred that the reduced salinity at MW20 and MW13 may be due to locally enhanced rainfall infiltration or possibly due to seepage from existing site stormwater drains
- Groundwater appears to range from near neutral to acidic with measurements of pH ranging from 4.84 to 7.08.

Table 4.2: Water Quality Summary

Monitoring Bore	Salinity (µS/cm)	pH
MW6	20,700	6.65
MW13	1,610	4.84
MW20	1,219 [1]	6.76
MW21	19,900	7.08
GW079099	14,100	5.65

1. field reading

Relative concentrations of major ions for the samples are plotted on a Piper Diagram on Figure 4.4. For the MW20 sample, alkalinity results are not available so the resulting interpretation is indicative only. Inclusion of alkalinity data would only act to offset the plotted position parallel to the bicarbonate plus carbonate axis in the anion field.

From Figure 4.4, the following is observed:

- In the cation field, all samples are sodium dominant, particularly MW20.
- In the anion field, MW6, MW21 and GW079099 are chloride dominant. MW13 has increasing influence of sulphate and MW20 appears to be strongly sulphate dominant.

The elevated sulphate at MW13 and MW20 may be indicative of historical contamination or of the influence of acid sulphate soils.

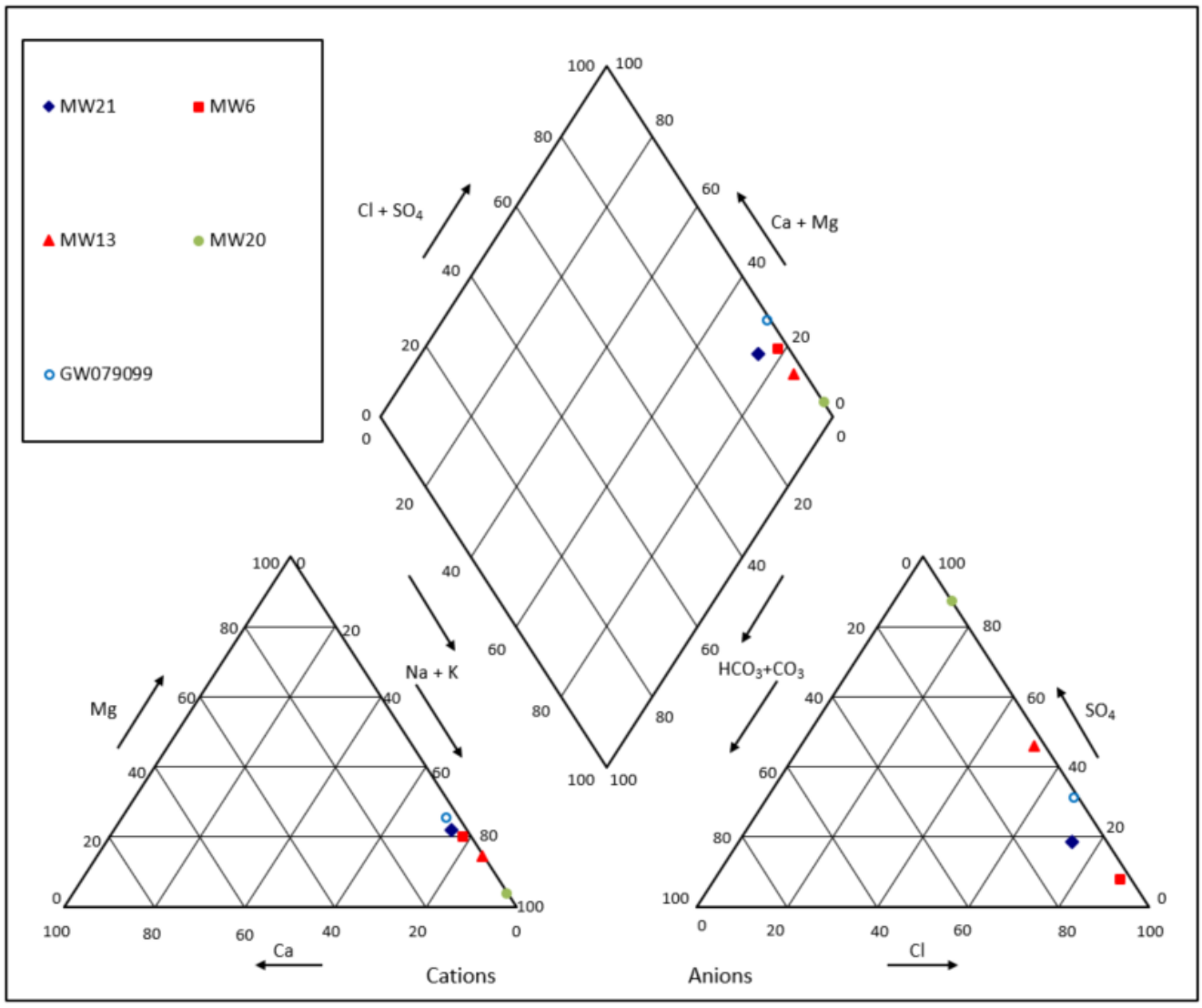


Figure 4.4: Piper Diagram

4.5.7 Water Sharing Plan

The Proposal Site is located within the Wallis Creek Water Source of the Water Sharing Plan (WSP) for the *Hunter Unregulated and Alluvial Water Sources 2009*.

The WSP for the *Hunter Unregulated and Alluvial Water Sources* declares the amount of water available for abstraction on an annual basis. It also defines the sharing objectives and guidelines to ensure water is appropriately shared between the environment and licensees, and between the different categories of licences. Excluding basic landholder rights, all water extraction must be authorised under a water access license.

4.5.8 Local groundwater resource and users

A search for private water bores was completed and showed that there are no registered bores for domestic or agricultural use within three km of the Proposal Site.

The aquifer resource potential, based on the hydraulic conductivity results indicated in Section 4.5.1 for the alluvial aquifer, is expected to be low to moderate. The aquifer resource potential for the bedrock aquifer would be expected to be low given the siltstone geology.

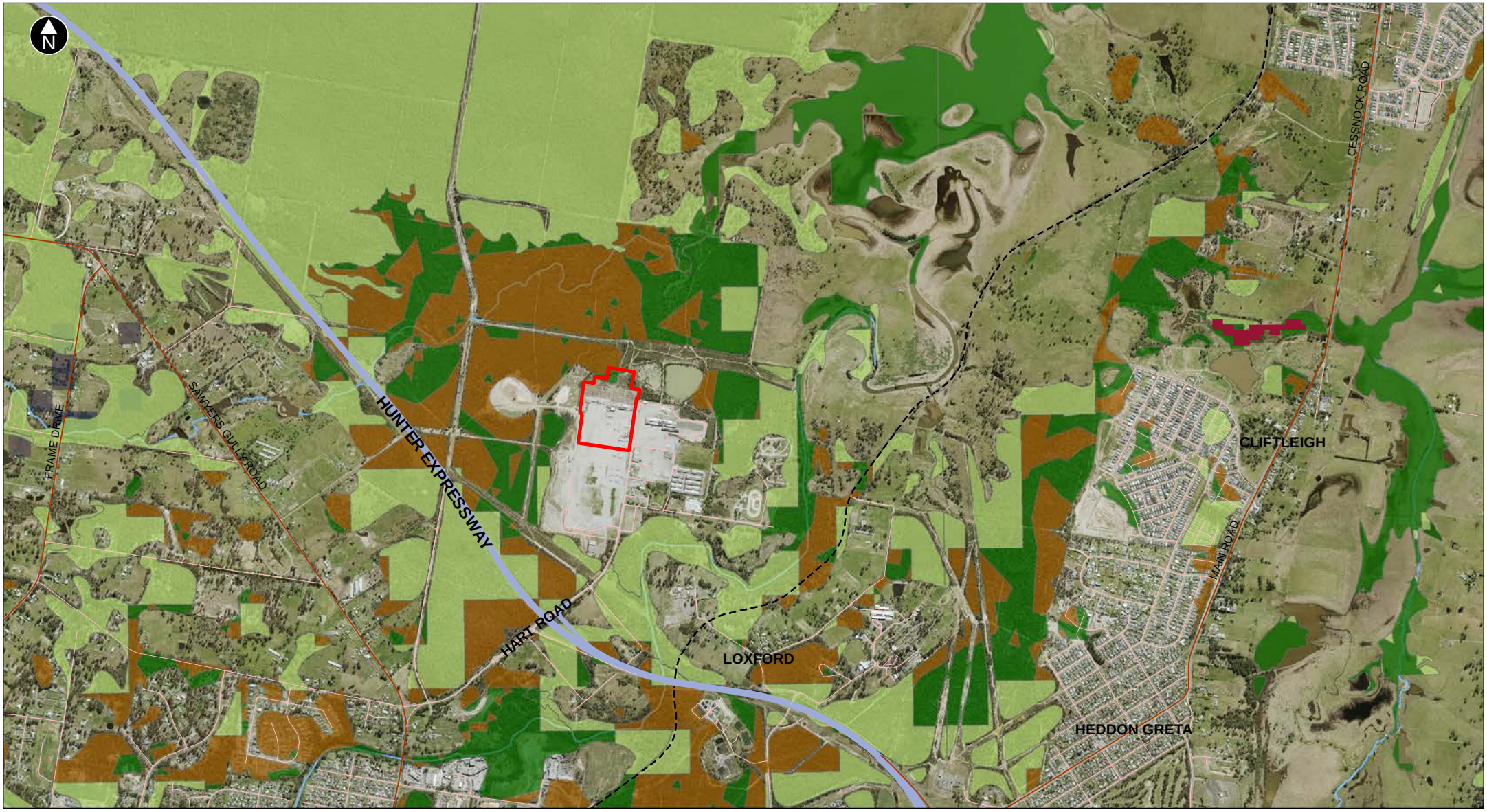


Figure 4-5 Groundwater dependent ecosystems (GDE)

5. Assessment of potential impacts

5.1 Construction impacts

The Proposal is anticipated to be in operation by the end of 2023. Key construction activities for the Proposal include:

- Clearing of limited vegetation at the Proposal Site
- Earthworks to prepare the Proposal Site and construction areas
- Installation of foundations and underground services
- Installation of aboveground civil, mechanical and electrical plant and equipment
- Commissioning and testing.

5.1.1 Potential impacts

The groundwater system underlying the Proposal Site is reliant on rainfall as its primary recharge method. Therefore, altered surface water runoff due to vegetation clearing, installation of site drainage and increase in the impervious surfaces and earthworks may potentially affect the local groundwater level during construction. This impact will also continue throughout the operational period but is predicted to be minimal and not extend much beyond the Proposal Site. The proposed extent of vegetation clearing is not anticipated to be influential in terms of an impact on groundwater.

Impacts on groundwater quality may also arise from spills and leaks of temporary storage and handling of fuels, oils and chemicals. Groundwater also has the potential to become contaminated by spills or leaks of oil and fuel from construction equipment.

Impacts to groundwater during construction may also arise due to excavation. Site preparations for the lightly loaded power station components are generally expected to require only shallow excavation in the order of approximately 0.3 m. Excavation for service trenches is anticipated to be up to approximately 1.0 m. The gas turbine foundations would be more substantial involving excavation to approximately 1.8 m depth and bored piles (approximately 0.5 m diameter, but subject to detailed design) to bedrock (approximately 18 m in depth, but again subject to detailed design). Piles may also be expected for some other plant components such as the generator step-up transformer. The proposed stormwater basin to the north of the site would be excavated some 3.0 to 3.5 m below the existing ground level.

A diagram showing the interpreted groundwater depths beneath an approximate west-east section through the Proposal Site is shown in Figure 5.1.

The diagram indicates that most of the proposed excavations are unlikely to intercept the groundwater table. It is likely that some of the proposed excavations in the eastern portion of the Proposal Site may intersect the groundwater table, or shallow perched features within the fill material. In the case of intersecting the groundwater table in natural formations, significant inflow or requirement for substantial dewatering is unlikely due to the limited depth of excavation below the water table and the generally low permeability of the alluvium. Where perched groundwater features are encountered within fill material during construction, there may be some temporary inflows that require short-term management. Any resulting groundwater drawdown would be very shallow and confined to the Proposal Site.

Excavation for the stormwater basin at the northern boundary of the Proposal Site, and various pits and potential below ground tanks may intercept the local groundwater table and means to minimise water ingress would be adopted during construction. In addition, the stormwater basin may result in some minor localised groundwater recharge during construction. No material impacts are anticipated for other groundwater users or environmental values due to the localised changes in groundwater levels if this occurred.

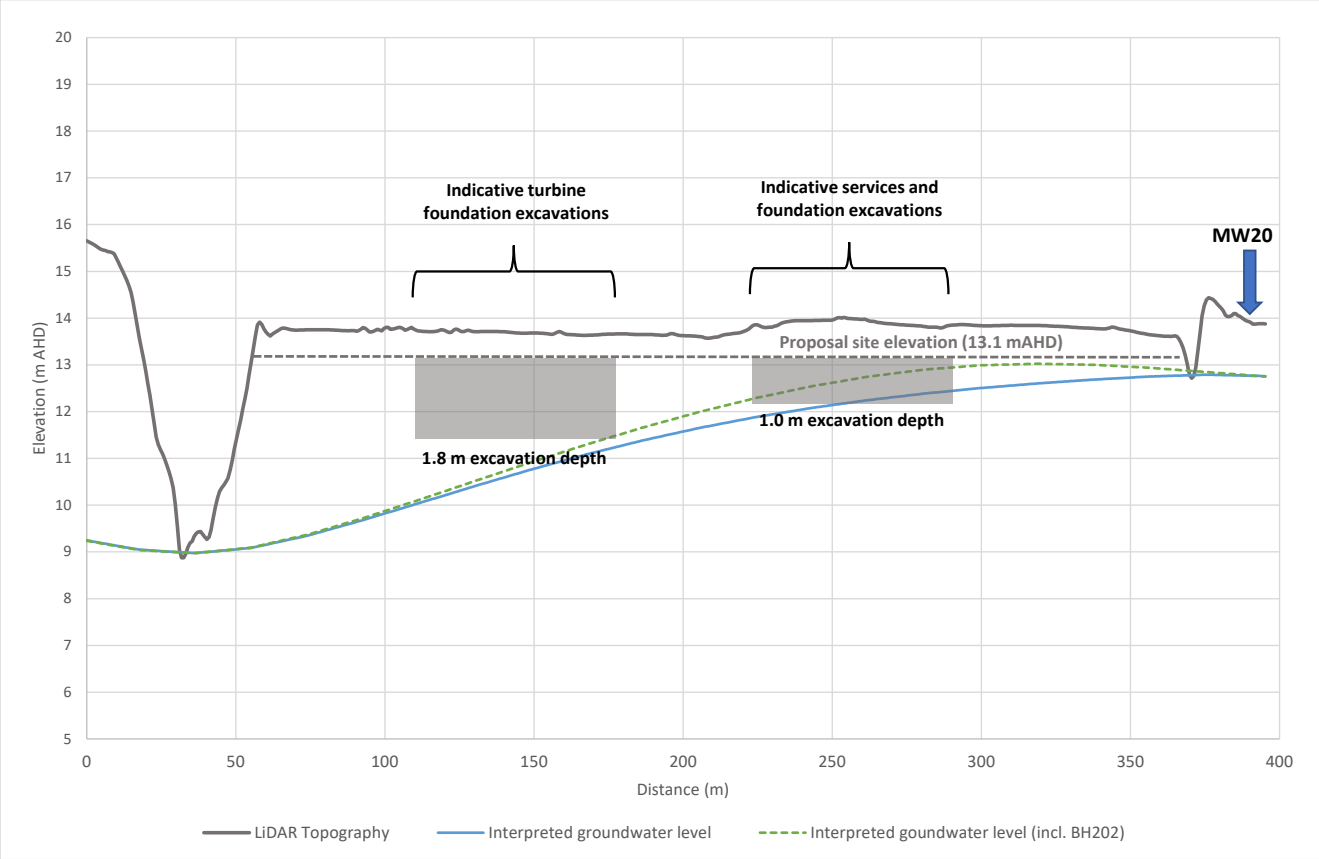


Figure 5.1: Indicative depths of excavations and groundwater (two scenarios)

5.1.2 NSW Aquifer Interreference Policy minimum impact considerations

Given the typically elevated groundwater salinity and low permeability of the sediments at the Proposal Site, the alluvial water source is considered locally as a less productive water source based on the NSW Aquifer Interference Policy classification. During the construction phase, the level one minimal impact considerations of the NSW Aquifer Interference Policy (Department of Primary Industries, 2012) are met as summarised in Table 5.1.

Table 5.1: Assessment against NSW Aquifer Interference Policy minimal impact considerations

Water source	Assessment

Alluvial Water Source
▪ Alluvial
▪ Less productive
	Water table:
	▪ Meets level one consideration with respect to drawdown at High Priority GDEs and water supply works.
	  ▪ No significant drawdown is anticipated to occur at High Priority GDEs or water supply works.
	Water pressure:
	▪ Meets level one consideration with respect to pressure head at water supply works.
	  ▪ No significant drawdown is anticipated to occur at water supply works.
	Water quality:
	▪ Meets level one consideration with respect to water quality.

Water source	Assessment
	▪ No reduction in beneficial use of the alluvial water source is anticipated to occur greater than 40 m from the Proposal Site. ▪ The Proposal construction is not anticipated to result in an increase in the long-term average salinity of the alluvial water source.

5.2 Operational impacts

5.2.1 Potential impacts

Increased areas of impervious surfaces at the Proposal Site could potentially decrease the amount of local groundwater recharge. However, due to the existing clay soil types underlying the Proposal Site, such impacts are expected to be insignificant.

Groundwater contamination may arise from spills and leaks during the operational phase. These may occur via the storage and handling of fuels, oils and chemicals, leaks of oil or fuel from operational equipment or refuelling activities. However, such impacts are practically eliminated by these areas of the site being sealed and a stormwater capture and treatment system being in place. Proposed stormwater treatment includes an oil water separator and a stormwater detention basin to further improve quality of all stormwater discharged from the site. The proposed stormwater basin may result in some minor localised groundwater recharge. However, no material impacts are anticipated for other groundwater users or environmental values due to the localised changes in groundwater levels if this occurred.

5.2.2 NSW Aquifer Interference Policy minimum impact considerations

During the operational phase, no groundwater impacts are anticipated and as such the Proposal meets the level one minimal impact considerations of the NSW Aquifer Interference Policy.

5.3 Cumulative impacts

Given the negligible potential groundwater impacts identified in section 5, there is a low potential for any cumulative impacts to groundwater when considering potential developments on adjacent land.

6. Environmental management measures

6.1 Construction

The following measures are recommended to mitigate and manage identified potential groundwater impacts during construction of the Proposal:

- Development and implementation of a Construction Environment Management Plan (CEMP) that addresses temporary storage and handling of fuels, oils and chemicals, including a Spill Response Plan
- Development and implementation of a Soil and Water Management Plan (SWMP) that addresses potential erosion and sediment control
- Preparation of a Dewatering Procedure to be implemented in the event of excavations encountering ephemeral or temporary groundwater, including: shoring advice to minimise groundwater inflows, water quality requirements before discharge, any recommended treatment, discharge location and method, monitoring requirements and permits and records required
- Excavation activities will implement testing and management procedures for potential acid sulfate soils. The procedures will be set out in an ASS management plan, which will be prepared during detailed design.

6.2 Operation

The following measures are recommended to mitigate and manage identified potential groundwater impacts during operation of the Proposal:

- Preparation and implementation of a Spill Response Plan as part of the Operational Environment Management Plan (OEMP) that addresses storage and handling of fuels, oils and chemicals, including a Spill Response Plan.

7. Conclusion

The following tasks have been completed as part of the groundwater impact assessment:

- A desktop study of existing hydrogeological conditions at the Proposal Site including:
  - Description of aquifers, depth to groundwater, groundwater quality and groundwater flow directions
  - Existing groundwater users, groundwater dependent ecosystems and groundwater-surface water interaction.
- Review of relevant previous investigations
- WaterNSW records indicated that there are up to 17 existing groundwater bores at or near the Proposal Site, including 11 monitoring bores and 6 bores of unknown purpose.
  - A bore census has been undertaken to confirm the location of the bores and record total depth and depth to standing water level.
  - Water quality samples were obtained from six selected groundwater bores.
- Assess any potential dewatering requirements and associated drawdown impacts due to construction dewatering and any proposed ongoing water take associated with the project

Review of groundwater levels indicates that the majority of proposed excavations are unlikely to intercept the groundwater table. It is likely that some of the proposed excavations in the eastern portion of the Proposal Site may intersect the groundwater table, or shallow perched features within the fill material. In the case of intersecting the groundwater table in natural formations, significant inflow or requirement for substantial dewatering is not anticipated to be required due to the limited depth of excavation below the water table and the generally low permeability of the alluvium. Where perched groundwater features are encountered within fill material, some short-term management of inflows may be required. Any resulting groundwater drawdown would be very shallow and localised. No material impacts are anticipated for other groundwater users or environmental values. The level one minimal impact considerations of the NSW Aquifer Interference Policy (Department of Primary Industries, 2012) are met.

During the operational phase, no significant groundwater impacts are anticipated and as such the Proposal meets the level one minimal impact considerations of the NSW Aquifer Interference Policy.

Groundwater contamination may arise from spills and leaks during the operational phase. However, such impacts are practically eliminated by these areas of the site being sealed and a stormwater capture and treatment system being in place. Proposed stormwater treatment includes an oil water separator treating stormwater runoff and a stormwater detention basin to further improve quality of all stormwater discharged from the site.

Recommendations made to mitigate and manage identified potential groundwater impacts during construction and operation of the Proposal including a range of soil and water related management plans.

8. References

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Jacobs (2020a). Kurri Kurri Gas Fired Power Station, Due Diligence Report. Prepared for Snowy Hydro Limited. Project IS338400. November 2020.

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Department of Primary Industries (2012). NSW Aquifer Interference Policy: NSW Government policy for the licensing and assessment of aquifer interference activities. Prepared by NSW DPI – Office of Water.

NSW Government Department of Land & Water Conservation (1997) NSW State Groundwater Policy Framework Document

9. Terms and acronyms

Term / Acronym	Description
AHD	Australian Height Datum
ASS	Potential Acid Sulfate Soils or Acid Sulfate Soils
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
EIS	environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is flood prone land.
GDE	groundwater dependent ecosystem
Hazard	A source of potential harm or situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community.
HDD	Horizontal directional drilling
kL	Kilolitre, one thousand litres
L/s	Litres per second. Unit used to describe water usage or discharge.
m AHD	Metres Australian Height Datum (AHD)
m bgl	Metres below ground level
ML	Megalitre, one million litres
m/s	Metres per second. Unit used to describe the velocity of floodwaters.
m^3/s	Cubic metres per second or "cumecs ". A unit of measurement of creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.
OEH	Office of Environment and Heritage
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
SEPP	State Environmental Planning Policy
TEC	threatened ecological community
WAL	Water Access License
WM Act	The *Water Management Act 2000*

Appendix A. November 2020 Field Monitoring and Bore Census

Site Visit on 26 and 27 November 2020 - Kurri Kurri Gas Fired Power Station								
Monitoring Bores Locations Shown On Map								
Bore	Status	East	North	Stickup (m)	Total Depth (mbgl)	Static Water Level (mbtp)	Static Water Level (mbgl)	Comments
MW01	broken - out of ground - wasp nest	357155.5	6371502					
MW03	operational	356899.6	6371386	0.72	10.51	6.69	5.97	
MW04	operational	357189.3	6371392	0.75	10.68	4.06	3.31	
MW05	destroyed or removed	357125.7	6371460					
MW06	operational	357171.5	6370906	0.76	5.74	2.33	1.57	Sampled
MW07	destroyed or removed	357812.2	6371014					
MW08	destroyed or removed	357807.4	6371041					
MW09	destroyed or removed	357928.6	6371023					
MW10	destroyed or removed	357920.6	6370979					
MW11	destroyed or removed	357975.8	6371100					
MW12	bent, but can measure water level	358011.5	6371157	0.44	12.52	6.76	6.32	
MW13	operational	357998.6	6371207	0.74	6.09	1.37	0.63	Sampled
MW14	destroyed or removed	358142.9	6371218					
MW15	destroyed or removed	358171.8	6371269					
MW16	destroyed or removed	357879.6	6371193					
MW17	destroyed or removed	357882.4	6371244					
MW18	destroyed or removed	357764.8	6371219					
MW19	destroyed or removed	357799.1	6371407					
MW20	operational	357790.6	6371425	0.66	5.43	1.88	1.22	Sampled
MW21	operational	357538.1	6370585	0	11.47	5.11	5.11	Sampled
MWA/MWB	destroyed or removed	357875	6371272					
GW079088	asphalted over - no access	358053.7	6371306					can't remove gatic cover
GW079089	asphalted over - no access	358105.8	6371306					can't remove gatic cover
GW079090	destroyed or removed	358104.9	6371368					
GW079091	destroyed or removed	358208.9	6371369					
GW079092	destroyed or removed	358078	6371429					
GW079093	destroyed or removed	358077.5	6371460					
GW079094	destroyed or removed	358233.7	6371462					
GW079095	destroyed or removed	358154.2	6371553					
GW079096	destroyed or removed	358152	6371707					
GW079097	destroyed or removed	358334.6	6371679					
GW079098	destroyed or removed	358673.7	6371623					
GW079099	operational	358448.4	6371003	0.8	11.75	7.77	6.97	also called G7. Sampled
GW079100	destroyed or removed	358311.7	6371463					
GW079101	destroyed or removed	358386.6	6371680					
GW079102	destroyed or removed	358724.8	6371685					
GW079103	destroyed or removed	358675	6371530					
New Bores (Not registered)								
BH2	operational	?	?	0.79	7.03	6.93	6.14	
BH2A	operational	?	?	0.77	11.9	6.84	6.07	
BH3	operational	357013	6371567	0.76	3.76	Dry		
BH3A	operational	357013	6371567	0.72	12.04	6.44	5.72	
BH4	operational	357133	6371540	0.78	2.1	Dry		
BH4A	operational	357133	6371540	0.78	11.97	7.96	7.18	vibrating wire piezometer
11	operational	358255	6371326	0	3.97	3.75	3.75	
E11	operational	358272	6371319	0.75	3.96	2.91	2.16	
E11D	operational	358272	6371319	0.85	13.48	8.11	7.26	
G2	operational	358266	6371362	0.74	12.62	8.53	7.79	
G3	operational	358286	6371397	0.72	2.51	Dry		
Unknown	operational	358362	6371377	0.74	2.12	2.26	1.52	
W6S	operational	?	?	1.06	2.8	Dry		
W6D	operational	?	?	0.68	8.12	5.97	5.29	
F6	operational	358580	6371252	0.55	6.56	1.62	1.07	
F6D	operational	358580	6371252	0.71	15.87	5.12	4.41	
N2	operational	358428	6371284	0.84	4.76	4.83	3.99	
F2	operational	358359	6371283	0.86	5.97	5.73	4.87	
E10	operational	358325	6371292	0.83	5.47	5.27	4.44	
10	operational	358300	6371287	0.84	3.96	2.06	1.22	
E9	operational	358266	6371292	0.87	3.53	2.69	1.82	
mbtp - meters below top of pipe								
mbgl - meters below ground level								

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (inc), low yielding wells)

PROJECT INFORMATION			
WELL ID:	MW21	**Project Number:** 13354500	**Date:** 26/11/20
		Client: Snowy Hydro	**Sampled By:** QB + JB
		Site Location: Kurri Kurri	**Time:** 8.30am

Weather Conditions (Temperature, Precipitation, Wind): 22°C, clear, sunny, no wind

Well Maintenance Required? YES / NO Detail: pumped dry, sampled bailer

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	11.47

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	5.11	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model

WQM Calibration Certificate

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
8:30am	39			6.78	17138.7	188.6	~~HSeSH~~	23.02					turbid with sediment

SAMPLING RECORD

Time Sampled: 8.30am

Colour: brown

Odour: none

Turbidity: Low Medium (High)

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.

Sample IDs

Primary Duplicate:

Secondary Duplicate:

Trip Blank:

Rinsate:

Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Sample Filtration Method:

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N

Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):

Washes/Rinses:

FEBRUARY 2016
Source: Golder, 2016

6.5m x 2 = 13L x 3 = 39L

GROUNDWATER SAMPLING RECORD FORM
LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID:	MW6	**Project Number:** 15354500	**Date:** 26/11/18
		Client:	**Sampled By:** SH + RB
		Site Location:	**Time:** 9.9m

Weather Conditions (Temperature, Precipitation, Wind): 22°C, clear, sunny, a slight wind

Well Maintenance Required? YES / NO Detail: muddy bottom, 16L purged with bailer sampled with bailer

WELL INFORMATION	
Diameter of standpipe (mm)	50mm
Standpipe stick up (m)	0.76
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	6.5

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	2.33	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model

WQM Calibration Certificate

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
9.25am				7.02	20000.0	189.0	8.34	21.88					grey, highly turbid

SAMPLING RECORD

Time Sampled: 9.25am 9.25am
Colour: grey
Odour: none
Turbidity: Low Medium (High)
Hydrocarbon Sheen ? Yes (No)
DI Water Lab Certificate No.

Sample IDs

Primary Duplicate:
Secondary Duplicate:
Trip Blank:
Rinsate:
Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N
Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):
Washes/Rinses:

Sample Filtration Method:

4 x 2 = 8 x 3 = 24L

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID:	GW079099	**Project Number:** 15334500	**Date:** 27/11/20
		Client:	**Sampled By:** CB + JB
		Site Location:	**Time:** 11.25

Weather Conditions (Temperature, Precipitation, Wind)

Well Maintenance Required? YES / NO Detail

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.8
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	12.55

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	7.77	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model

WQM Calibration Certificate

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
11:25	30			6.80	12050	18.6	3.27	22.85					grey, highly turbid

SAMPLING RECORD

Time Sampled: 11.25

Colour: grey

Odour: none

Turbidity: Low Medium (High)

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.

Sample IDs

Primary Duplicate:

Secondary Duplicate:

Trip Blank:

Rinsate:

Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N

Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):

Washes/Rinses:

Sample Filtration Method:

FEBRUARY 2018
Source: Golder, 2018

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID:	Bore EIID	**Project Number:**	13354500
		Client:	
		Site Location:	
		Date:	27/11/22
		Sampled By:	OS + JB
		Time:	9.40

Weather Conditions (Temperature, Precipitation, Wind): Overcast

Well Maintenance Required? YES / NO Detail:

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.85
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	14.33

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	8.11	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model:

WQM Calibration Certificate:

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
9.40	36L			8.14	5585.1	-24.3	4.06	19.41					

SAMPLING RECORD

Time Sampled: 9.40

Colour: light turbid brown

Odour: per dacayed organic matter

Turbidity: Low (Medium) High

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.:

Sample IDs

Primary Duplicate:

Secondary Duplicate:

Trip Blank:

Rinsate:

Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N

Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):

Washes/Rinses:

Sample Filtration Method:

FEBRUARY 2018

Source: Golder, 2018

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

WELL ID:	Bore E11

PROJECT INFORMATION

Project Number:	1535500	Date:	27/11/20
Client:		Sampled By:	QB+JB
Site Location:		Time:	9.30

Weather Conditions (Temperature, Precipitation, Wind): overcast

Well Maintenance Required? YES / NO Detail: initial organic odour

WELL INFORMATION

Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.75
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	~~4.71~~ 4.71

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION

Pre-Sampling Information		Purging and Sampling Information	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	2.91	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings

CPM	
Refill	
Discharge	
Throttle	

WQM Model:

WQM Calibration Certificate:

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
9.30am	12			7.93	892.9	~~-191.1~~ -191.1	~~1.47~~ 1.47	19.77					

SAMPLING RECORD

Time Sampled: 9.30

Colour: turbid brown

Odour: yes - decayed organic matter

Turbidity: Low (Medium) High

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.:

Sample IDs

Primary Duplicate:	
Secondary Duplicate:	
Trip Blank:	
Rinsate:	
Field Blank:	

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

____ Vials (P/UP)	____ Metals (F/UF;P/UP)
____ 1L Amber	____ Cyanide
____ 1L Plastic	____ Sulphide
____ Phenols/COD/NH3 (F/UF; P/UP)	____ Other
____ Ferrous/Ferric Iron (F/UF; P/UP)	____ Other

Sample Filtration Method:

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N

Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):

Washes/Rinses:

FEBRUARY 2018
Source: Golder, 2018

~~12~~ 12

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID: MW13	**Project Number:** 18357500	**Date:** 26/11/20	
	Client:	**Sampled By:** RH+JG	
	Site Location:	**Time:** 1.15pm	

Weather Conditions (Temperature, Precipitation, Wind): sunny ; clear

Well Maintenance Required? YES / NO Detail:

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.74
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	6.83

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	1.37	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model:

WQM Calibration Certificate:

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
1.45				6.33	1827.6	193.0	8.50	24.69					

SAMPLING RECORD

Time Sampled: 1.45

Colour: rusty brown

Odour: none

Turbidity: Low Medium (High)

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.:

Sample IDs

Primary Duplicate:

Secondary Duplicate:

Trip Blank:

Rinsate:

Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Sample Filtration Method:

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? □ Y □ N

Decon Required? □ Y □ N

Type of Decontamination Fluid(s):

Washes/Rinses:

5 x 2 = 10 x 3 = 30L

GROUNDWATER SAMPLING RECORD FORM

LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID:	MW20	**Project Number:**	**Date:** 26/11/20
		Client:	**Sampled By:** AB + TB
		Site Location:	**Time:** 1.45pm

Weather Conditions (Temperature, Precipitation, Wind)

Well Maintenance Required? YES / NO Detail

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.66
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	6.09

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	1.88.	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model

WQM Calibration Certificate

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
1.45pm				~~7.16~~	~~1219.3~~	~~233.2~~	~~3.94~~	~~24.36~~					
				7.16	1219.3	233.2	3.94	24.36					

SAMPLING RECORD

Time Sampled: 1.45pm

Colour: yellow/brown

Odour: none

Turbidity: Low Medium (High)

Hydrocarbon Sheen ? Yes (No)

DI Water Lab Certificate No.

Sample IDs

Primary Duplicate:	
Secondary Duplicate:	
Trip Blank:	
Rinsate:	
Field Blank:	

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

Vials (P/UP)	Metals (F/UF;P/UP)
1L Amber	Cyanide
1L Plastic	Sulphide
Phenols/COD/NH3 (F/UF; P/UP)	Other
Ferrous/Ferric Iron (F/UF; P/UP)	Other

Sample Filtration Method:

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N

Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):

Washes/Rinses:

FEBRUARY 2018
Source: Golder, 2018

5 x 2 = 10 x 3 = 30L

GROUNDWATER SAMPLING RECORD FORM
LOW FLOW PURGING and SAMPLING (incl. low yielding wells)

PROJECT INFORMATION			
WELL ID:	MW12	**Project Number:** 1535450	**Date:** 26/11/20
		Client:	**Sampled By:** QB + JB
		Site Location:	**Time:** 12.45

Weather Conditions (Temperature, Precipitation, Wind): Sunny, Clear

Well Maintenance Required? YES / NO Detail: Bent casing, ~~[illegible]~~ oversized bailer / couldn't fit

WELL INFORMATION	
Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.44
Surveyed reference point	
Depth to top of filter pack (from log)	
Depth to bottom of filter pack (from log)	
Depth of well (from log)	12.96

mbRP - metres below top of reference point
Hose volume - 0.12 L/m of 1/2 inch diameter hose
Hose volume - 0.07 L/m of 3/8 inch diameter hose
Hose volume - 0.03 L/m of 1/4 inch diameter hose

GAUGING INFORMATION			
Pre-Sampling Information		*Purging and Sampling Information*	
Interface probe used?	YES / NO	Depth of pump intake (mbRP)	
Initial depth to water (mbRP)	6.76	Length of hose (m)	
Depth to product (mbRP)		Volume in hose (L)	
Thickness of product (m)		Depth to water after placement of pump (mbRP)	
Bailed product thickness (m)		Depth to water at end of purging (mbRP)	
Total depth of well (mbRP)		Depth to water after collection of samples (mbRP)	
Thickness of sediment on base of well (m)		Purging and Sampling Method	

Controller settings	
CPM	
Refill	
Discharge	
Throttle	

WQM Model

WQM Calibration Certificate

GROUNDWATER MONITORING WELL PURGING RECORD

Time	Cumulative Volume Purged (L)	Flow Rate (L/min)	Depth to Water (mbRP)	±0.1 pH	±5% Conductivity (µS/cm)	±10 Redox (mV)	±10% Dissolved Oxygen (ppm)	±0.5°C Temperature (°C)	Field Spectrophotometry Fe2+ (mg/L)	Fe Total (mg/L)	Mn (mg/L)	Al3+ (mg/L)	Appearance (Colour, Turbidity, Odour, etc)
12.45													
			NO SAMPLE										

SAMPLING RECORD

Time Sampled: 12.45
Colour: turbid brown
Odour: none
Turbidity: Low Medium (High)
Hydrocarbon Sheen ? Yes (No)
DI Water Lab Certificate No.:

Sample IDs

Primary Duplicate:
Secondary Duplicate:
Trip Blank:
Rinsate:
Field Blank:

Sample Containers/Preservation (F=Filtered; UF=Unfiltered; P=Preserved; UP=Unpreserved)

_____ Vials (P/UP)
_____ 1L Amber
_____ 1L Plastic
_____ Phenols/COD/NH3 (F/UF; P/UP)
_____ Ferrous/Ferric Iron (F/UF; P/UP)
_____ Metals (F/UF;P/UP)
_____ Cyanide
_____ Sulphide
_____ Other
_____ Other

Decontamination of Sampling Equipment

All Equipment Dedicated/Single Use? ☐ Y ☐ N
Decon Required? ☐ Y ☐ N

Type of Decontamination Fluid(s):
Washes/Rinses:

Sample Filtration Method:

FEBRUARY 2018
Source: Golder, 2018

6 x 2 = 12L x 3 = 36L

PHO WN

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

☐BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5800 E: gladstone@alsglobal.com

☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

☐MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

☐NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

☐WOLLONGONG 1/19-21 Ralph Black Dr, North Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: Jacobs	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☑ Standard TAT (List due date):
OFFICE: 177 Pacific Highway, North Sydney, NSW		☐ Non Standard or urgent TAT (List due date):
PROJECT: IS354500		
SITE: Kurri Kurri Groundwater	ALS QUOTE NO.:	
PURCHASE ORDER:	COUNTRY OF ORIGIN: Australia	
PROJECT MANAGER: Karl Ivanusic (Karl.Ivanusic@jacobs.com)	CONTACT PH: (03) 8668 6041	
SAMPLER: Quan Bui / Julia Bayada	SAMPLER MOBILE: 0412 580 712	
COC Emailed to ALS? (YES / (NO) original copy	EDD FORMAT (or default): EDD and CSV	
Email Reports to: Quan.Bui@jacobs.com, Costante.Conte@jacobs.com, Karl.Ivanusic@jacobs.com		
Email Invoice to (will default to PM if no other addresses are listed): Julia.Bayada@jacobs.com, Costante.Conte@jacobs.com, Karl.Ivanusic@jacobs.com		

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes / (No) / N/A

Free ice / frozen ice bricks present upon receipt? (Yes) / No / N/A

Random Sample Temperature on Receipt: -3.7 °C

Other comment:

COC SEQUENCE NUMBER (Circle)

COC: (1) 2 3 4 5 6 7

OF: (1) 2 3 4 5 6 7

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Jacobs	ALS	MM 5pm	HJ
DATE/TIME: 1.20 27/11/20	DATE/TIME: 27/11/20 1:18pm	DATE/TIME: 27/11/20	DATE/TIME: 27.11.20 7:30pm

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).	Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	Physico-chemical parameters – pH, EC and major cation/anions	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	MW21	26/11	W		3	✓	
2	MW6	26/11	W		3	✓	
3	MW13	26/11	W		3	✓	
4	MW20	26/11	W		3	✓	
5	GW079099	27/11	W		3	✓	
				TOTAL			

REGISTERED

LAB OF ORIGIN: NEWCASTLE

Environmental Division
Sydney
Work Order Reference
ES2042139

Telephone : +61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2042139**	Page	: 1 of 3
Client	: **JACOBS GROUP (AUSTRALIA) PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: KARL IVANUSIC	Contact	: Tyler Anderson
Address	: 177 Pacific Highway North Sydney 2060	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61 2 8784 8555
Project	: IS354500	Date Samples Received	: 27-Nov-2020 13:18
Order number	: 1688	Date Analysis Commenced	: 26-Nov-2020
C-O-C number	: ----	Issue Date	: 04-Dec-2020 17:28
Sampler	: QUAN BUI / JULIA BAYADA		
Site	: Kurri Kurri Groundwater		
Quote number	: EN/222		
No. of samples received	: 5		
No. of samples analysed	: 5		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Neil Martin	Team Leader - Chemistry	Chemistry, Newcastle West, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	MW21	MW6	MW13	MW20	GW079099
			Sampling date / time	26-Nov-2020 00:00	26-Nov-2020 00:00	26-Nov-2020 00:00	26-Nov-2020 00:00	27-Nov-2020 00:00
Compound	CAS Number	LOR	Unit	ES2042139-001	ES2042139-002	ES2042139-003	ES2042139-004	ES2042139-005
				Result	Result	Result	Result	Result
EA005: pH								
pH Value	----	0.01	pH Unit	7.08	6.65	4.84	6.76	5.65
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	19900	20700	1610	----	14100
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	934	294	24	----	87
Total Alkalinity as CaCO3	----	1	mg/L	934	294	24	----	87
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1800	797	337	96	2240
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	5270	6420	280	10	3550
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	133	66	<1	1	76
Magnesium	7439-95-4	1	mg/L	527	478	24	7	406
Sodium	7440-23-5	1	mg/L	3360	3460	265	321	2130
Potassium	7440-09-7	1	mg/L	37	7	3	1	32
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	205	204	15.4	----	148
ø Total Cations	----	0.01	meq/L	197	193	13.6	----	131
ø Ionic Balance	----	0.01	%	1.91	2.58	6.27	----	6.39