APPENDIX O - STYGOFAUNA ASSESSMENT

Isaac Downs Extension
Stygofauna Impact Assessment

Prepared for
Stanmore Resources Ltd
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Document Control Summary

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Executive summary

Freshwater Ecology Consulting was engaged by Stanmore ID Extension Pty Ltd (ID Extension), a wholly owned subsidiary of Stanmore Resources Limited (Stanmore), to undertake a stygofauna pilot study and assess the potential impacts to stygofauna within the study area of the proposed Isaac Downs Extension Project (the Project).

Bores were selected for sampling across the range of aquifers present and potentially impacted by the Project. Ten bores were sampled for stygofauna with nine of the ten bores meeting the suggested specification of being more than twelve months old. The tenth bore was selected due to the lack of other bores present which intersected the Vermont seam at a deeper location, and to provide sampling results from that depth.

In situ water quality collected at the time of sampling indicated that pH and conductivity were within the optimal range for supporting stygofauna communities for three bores but were sub-optimal for the remaining bores.

Stygofauna were recorded in three bores, two of which were in the alluvial aquifer. The detection of stygofauna in one bore in the Vermont seam is considered out of character with the historical sampling across the region due to the depth and strata. Due to the young age of the bore at the time of sampling (i.e. two months since construction) it is likely that the stygofauna were not being recorded from the aquifer that the bore was slotted in and rather entered the bore from the alluvial aquifer during construction. This is supported by the water quality recorded from this bore not being optimal for a diverse stygofauna assemblage and reflective of the extremes from which they have been recorded. In addition, the stygofauna assemblages recorded were similar to those (but with a lower abundance) to adjacent bores that intersected the alluvial aquifer. Therefore, the alluvial aquifer in the vicinity of the Isaac River is considered to be the primary location for stygofauna assemblages within and surrounding the Project area.

Five higher taxonomic groups were identified, with nine taxa groups when considered at the lowest level of identification. None of the stygofauna found are listed as threatened. This included three taxa that were considered to be true stygobionts (obligate stygofauna), two as likely stygobionts with the remaining taxa considered likely to be stygoxenes (facultative stygofauna not reliant on groundwater).

These results show a relatively diverse stygofauna assemblage within the alluvial aquifer adjacent to the Isaac River. This is due partially to the level of identification being lower than historical sampling across the region and in line with the Guideline for the environmental assessment of Subterranean aquatic fauna (DSITI 2015). At a taxonomic level comparable with historical reporting across the region these results are consistent with those that have previously been recorded. The same taxonomic groups are the most commonly recorded across Queensland.

Potential impacts identified from the Project were;

- Changes in groundwater quality through accidental leaks or spills of hydrocarbons and other chemicals from infrastructure areas or mining equipment, and seepage from spoil dumps or the void lake to groundwater.
- Changes in groundwater levels due to drawdown associated with mining activities.

With the implementation of the proposed mitigation and management measures for the Project, the risk to the aquifers and stygofauna communities from leaks and spills is very low.

There are no incremental (i.e. Project only) drawdown impacts exceeding 1 m predicted for the alluvium (i.e. alluvial aquifer) as a result of the Project. Cumulative drawdown in the alluvium ranges from 1 to 10m, with this almost entirely due to the influence of other projects. The groundwater monitoring and management plan will be implemented and will identify if there are changes to groundwater levels that are not within the expectations of the groundwater modelling.

Acronym	Definition
ACARP	Australian Coal Association Research Program
AEP	Annual Exceedance Probability
AR	Analytical Reagent
CHPP	Coal Handling and Preparation Plant
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
DES	Department of Environment and Science
DETSI	Department of Environment, Tourism, Science and Innovation
DOC	Dissolved Organic Carbon
DSITI	Department of Science, Information Technology and Innovation
EA	Environmental Authority
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EoH	End of Hole (bore hole)
EPBC	Environment Protection and Biodiversity Conservation Act 1999
EPC Act	Environmental Protection Act 1994
GDE	Groundwater Dependent Ecosystem
GMMP	Groundwater Monitoring and Management Plan
IDE	Isaac Downs Extension Project (the Project)
IDM	Isaac Downs Mine
IESC	Independent Expert Scientific Committee
IPC	Isaac Plains Complex
IPM	Isaac Plains Mine
mBGL	metres Below Ground Level
mBTOC	metres Below Top Of Casing
MLES	Matters of Local Environmental Significance
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
MLA	Mining Lease Application
PRCP	Progressive Rehabilitation and Closure Plan
ROM	Run Of Mine
Stygobiont	Obligate, groundwater-adapted organisms.
Stygofauna	Organisms that are found in groundwater and includes stygobionts and stygoxenes.
Stygoxene	Organisms not specifically groundwater-adapted but are able to survive the harsh conditions in aquifers.
SWL	Standing Water Level
TEC	Threatened Ecological Community
ToR	Terms of Reference
WA EPA	Environmental Protection Authority, Western Australia

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1. Introduction and Scope

1.1. Background

Stanmore ID Extension Pty Ltd, a wholly owned subsidiary of Stanmore Resources Ltd (Stanmore), proposes to develop the Isaac Downs Extension (IDE) Project (the Project). The Project will extend the life of mining operations at Isaac Plains Complex (IPC) (comprising Isaac Downs Mine (IDM) and Isaac Plains Mine (IPM)) through the development of an open cut coal mine pit and associated infrastructure, primarily mining metallurgical (steel making) coal. Approximately 46 million tonnes of run of mine coal will be mined over 15 years, with approximately 2 – 4.5 million tonnes per annum.

The Project requires approvals from the:

- State under the Environmental Protection Act 1994 (EP Act), for a new environmental authority (EA) and progressive rehabilitation and closure plan (PRCP) schedule.
- Commonwealth through referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPC Act).

The proponent has applied for four mining leases (MLs) for the Project (ML application [MLA] 700081, MLA 700082, MLA 700083 and MLA 700084), together forming the Project area. The proponent is preparing a voluntary environmental impact statement (EIS) under the EP Act which will support the EA, PRCP schedule and Referral for the Project.

Freshwater Ecology Pty Ltd (Freshwater Ecology) was commissioned by Stanmore to undertake a stygofauna assessment for the Project to inform an Environmental Impact Statement (EIS). This report forms part of the EIS submission for the Project.

Specifically, the scope for this assessment included:

- Undertake desktop assessments, using information from Stanmore studies at nearby mines and relevant publicly available databases and imagery, to identify potential stygofauna values of the Study Area (encompassing the Project area and surrounds).
- Undertake stygofauna field surveys in accordance with State and Commonwealth relevant standards, guidelines and procedures.
- Determine if the survey area provides habitat for State or Commonwealth listed stygofauna species, ecosystems or threatened ecological communities (TECs) that may be impacted.
- Describe the regulatory framework that inform the stygofauna impact assessment, including relevant State and Commonwealth legislation.
- Assess all direct and indirect impacts on stygofauna, inclusive of inputs from other Project studies such as assessments of groundwater dependent ecosystem (GDEs), groundwater, hydrology / flooding change, water management and surface water.
- Provide a high level assessment of cumulative impacts associated with other mining activities (as identified through the groundwater impact assessment).
- Develop monitoring and management measures for stygofauna.
- Assess the risk that the Project poses to stygofauna.

1.2. Project overview

The Project is located in the Bowen Basin of central Queensland approximately 15 km southeast of Moranbah and 150 km southwest of Mackay.

The proponent intends to commence construction activities in late 2027 / early 2028, subject to obtaining all required approvals, with construction commencing in 2028 and run of mine (ROM) coal extraction in 2029.

The open cut mining methods for the Project will be similar to those at IDM, including:

- clearing of vegetation, stripping and stockpiling of topsoil
- drilling and blasting of pre-strip overburden
- removing the pre-strip overburden using mining equipment at IDM being a dragline and / or truck and shovel fleets and / or dozers
- drilling and blasting of overburden
- drilling and blasting of pit floor for geotechnical stability to allow for in-pit dumping
- overburden removal using the existing dragline at IDM and / or truck and shovel fleets
- coal mining using excavators
- formation of out of pit and in-pit overburden dumps as mining progresses
- progressive rehabilitation of overburden dump areas.

ROM coal will be transported from the Project's ROM coal pad to the coal handling and preparation plant (CHPP) at IPM for washing, utilising existing haul roads at IPC and new haul roads, including a bridge across the Isaac River, constructed in the Project area. The dragline will be walked from IDM to the Project via a temporary crossing of the Isaac River.

The primary access to the Project for workers and deliveries will be via IDM's existing access road and new internal roads connecting with the Project, utilising the bridge to be constructed across the Isaac River. There is potential for a secondary access route to the Project between the Project and Stanmore's Eagle Downs project, utilising new and existing roads to connect with the Peak Downs Mine Road.

During operations, levees will be constructed to protect the open cut pit area from flooding of the Isaac River, Cherwell Creek and Conrock Gully up to a 0.1% annual exceedance probability (AEP) (1:1,000 year) flood event. Conrock Gully will be diverted around the active mining areas into the Isaac River, with the diversion remaining post mining. Any residual void remaining post mine life will not be located within the 0.1% AEP flood event.

A mine affected water dam will store water from the pit, ROM pad, go line and crib area, with the ability to transfer mine affected water to and from IDM and IPM within IPC's integrated water management system, thereby enabling the balancing of water supply and demand. Sediment water drains and dams will be constructed to capture runoff from overburden dumps. Clean water drains and dams will be constructed to separate clean water from mine affected water and sediment water.

Topsoil stockpile areas will be used for storage of topsoil that has been stripped from mining and infrastructure areas, for future use in rehabilitation.

Power for the dragline will be supplied via connections to IDM's existing power supply.

The proposed Project layout, MLA areas (2,707 ha) and proposed disturbance area (2,080 ha) is shown in **Figure 1** The proposed disturbance allows for working and construction areas within and around proposed Project activities and infrastructure. The disturbance area has been refined to minimise and / or avoid sensitive ecological features (e.g. habitat for listed threatened species and riparian areas). The disturbance area may be subject to further refinement for environmental or operational reasons.

The Project area is largely located on Winchester Downs station (Lot 8 SP277834) but also has overlaps with a State Reserve (Lot 9 GV33) which has grazing rights for the owners of Winchester Downs, a local road used to access Winchester Downs, the Isaac River and Cherwell Creek.

The Project operational workforce will be similar to, but lower than that for current operations at IPC, with around 300 - 400 workers, compared to around 400 - 450 workers. Approximately 100 – 150 workers will be engaged at the Project for infrastructure construction. Through the Project, Stanmore will continue to support local and regional suppliers and contractors, providing additional economic benefits and employment in the region.

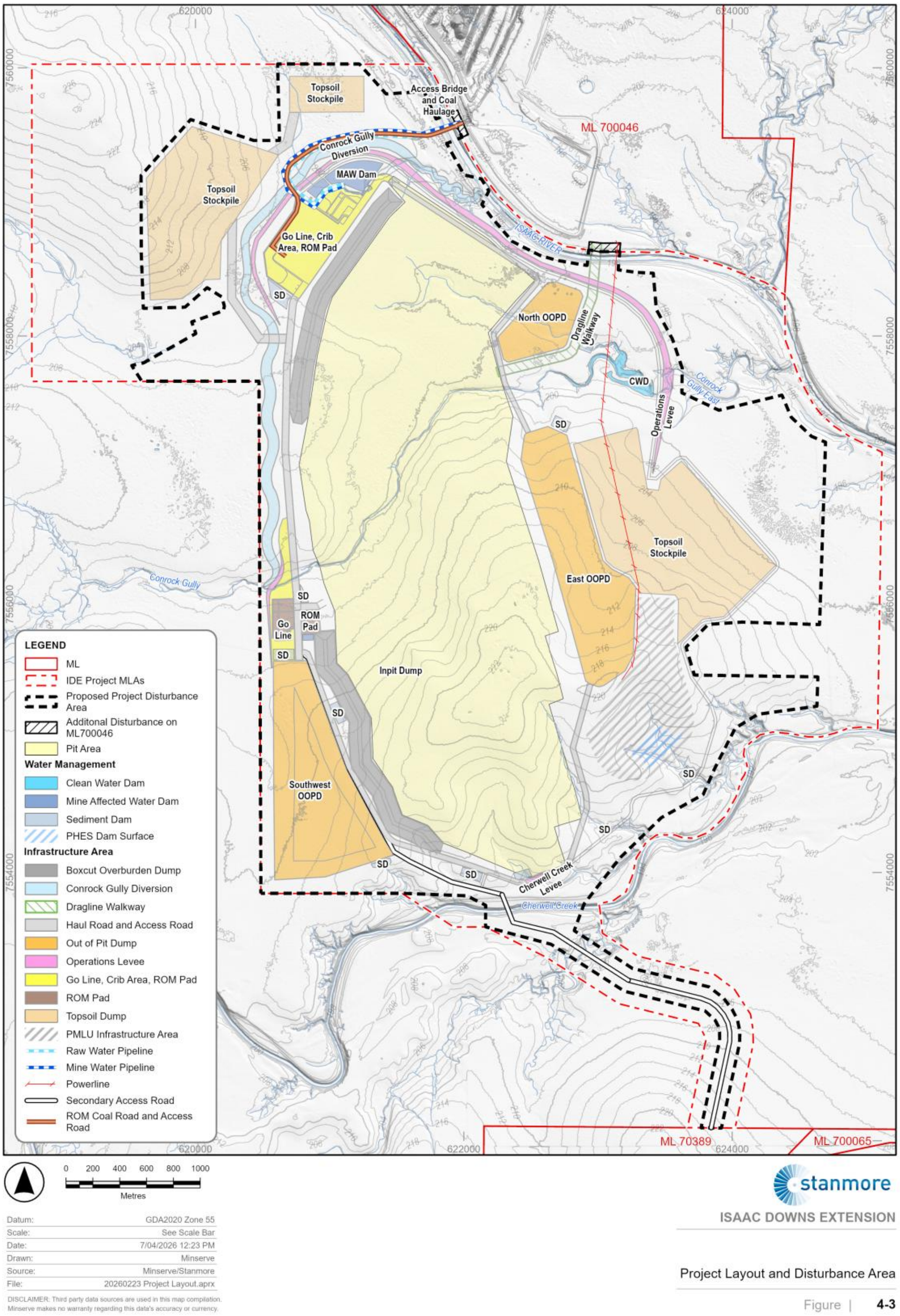

Figure 1: Proposed Project layout

1.3. Terms of Reference

This stygofauna assessment forms part of the EIS for the Project. This assessment has been prepared to satisfy the requirements of the Terms of reference (ToR) for the Project's EIS issued by the Department of Environment, Tourism, Science and Innovation (DETSI) on 11 December 2025.

This impact assessment addresses the ToR relevant to stygofauna. **Table 1** lists the elements of the ToR relevant to this assessment and the sections of this report where those ToR requirements are addressed.

Table 1: Terms of Reference for EIS relevant to aquatic ecology

Project specific matters	Requirement	Report Section
Flora and fauna		
9.67	Conduct the impact assessment in accordance with relevant guidelines, including the latest version of the department's EIS information guidelines that cover terrestrial ecology (ESR/2020/5309) (DETSI 2024), aquatic ecology (ESR/2020/5295) (DETSI 2024 now 2026), groundwater dependent ecosystems (ESR/2020/5301) (DETSI 2024), water (ESR/2020/5312) (DETSI 2024), matters of national environmental significance (ESR/2020/5304) (DETSI 2024), and biosecurity (ESR/2020/5297) (DETSI 2024).	Sections 4, 5 and 6
Biodiversity - Existing environment		
9.70	Describe all significant species and ecological communities, prescribed environmental matters listed as MNES and MSES, and all listed flora and fauna species, and regional ecosystems, on the project site and in its vicinity.	Section 2.4. No MNES or MSES stygofauna present
9.73	Describe the connectivity of habitats and the integrity of ecosystems.	Section 3.1
Biodiversity – Impact Assessment		
9.75	Assess, describe, quantify and illustrate all potential direct and indirect significant impacts on terrestrial/ aquatic and/or marine ecological values. Assess the impacts on all potentially affected areas, whether on or off the project site. Include all stages of the project from initial development through to rehabilitation.	Section 6
9.76	Address in the assessment:	
	(a) all significant species and ecological communities (MNES, MSES, MLES, listed threatened flora and fauna species and regional ecosystems)	Section 2.4. No MNES or MSES stygofauna present
	(b) the conservation status of each identified ecological value under the Nature Conservation Act 1992, Vegetation Management Act 1999 and the EP Act	Section 2.4. No MNES or MSES stygofauna present
	(c) the integrity of ecological processes, including habitats of listed threatened, near threatened or special least-concern species	Section 2.4. No MNES or MSES stygofauna present
	(d) interactions between terrestrial and aquatic ecosystems (including groundwater dependent ecosystems and stygofauna)	No surface aquatic GDEs detected (Freshwater Ecology 2026), terrestrial

		GDEs see (Watermark Ecohydrology 2026).
	(e) connectivity of habitats and ecosystems	Section 3.2
	(f) the integrity of landscapes and places, including wilderness and similar natural places	Not applicable
	(g) biological diversity	Section 5.4
	(h) chronic, low-level exposure to contaminants or the bio-accumulation of contaminants	Section 6.1.1
	(i) direct and indirect impacts on terrestrial, aquatic or marine species and ecosystems whether acting individually or in combination. Relevant matters include vegetation clearing, hydrological changes, discharges of contaminants to water, air or land, noise, and the influence of climate change	Section 6
Biodiversity – Mitigation measures		
9.80	Propose effective and proven measures to avoid, minimise, mitigate and/or offset direct or indirect impacts on environmental values. In particular, address measures to protect or preserve any listed threatened, near-threatened or special least concern species or other MSES. Demonstrate that clearing and the adverse impacts of clearing have been reasonably avoided, or reasonably minimised consistent with Performance Outcome 1 of State Code 16 (Queensland Government 2025a).	Section 6
9.81	Describe the practicality, effectiveness and risks for each avoidance and mitigation measure. Include the timeframes in which the results would be delivered.	Section 6
9.82	Justify how applying all proposed avoidance and management measures would result in acceptable outcomes for terrestrial, aquatic and/or marine ecology. Describe how achieving the measures successfully will be monitored, measured and audited. Include provisions to regularly evaluate all the mitigation measures so that improvements may be made as new technologies and best practices evolve.	Section 6
Appendix 3 Terms of reference for matters of national environmental significance (MNES) under the Environment Protection and Biodiversity Conservation Act 1999 requirements		
Impacts on water resources		
A3.71	Provide information to identify and assess risks and impacts to all groundwater resources (and dependent flora and fauna) in the project area.	Section 6
A3.72	Provide information and data to characterise long-term impacts to groundwater levels and quality depending on the final landform design, which has not been determined – e.g., open voids acting as a groundwater sink and permitting evaporative concentration of contaminants	Section 6.2, detailed modelling presented in the Groundwater Impact Assessment (SLR 2026a)
A3.77	Provide information including using a robust numerical groundwater model to evaluate how changes in groundwater level and flux may impact on the GDEs.	Section 6.2, detailed modelling presented in the Groundwater Impact Assessment (SLR 2026a)
A3.80	Provide information on stygofauna, including sampling methodology and analyses, following the guidelines in Department of Science, Information Technology and Innovation Guideline for the	

	Environmental Assessment of Subterranean Aquatic Fauna – Sampling methods and survey considerations (2015), including, but not limited to:	
	a) survey timing (i.e. over how many years the pilot survey was completed, and if seasonal changes were adequately accounted for)	Section 4.3
	b) survey methods and techniques for sampling stygofauna	Section 4.3
	c) bore mapping (i.e. which bores were sampled for stygofauna in the project area, and how many bores were sampled).	Section 3.3
A3.81	Sample bores in relevant aquifers to confirm the presence of stygofauna and to confirm their dependency on groundwater in the project area.	Section 4.3
A3.82	Provide an evidence-based assessment that the potential impacts (due to dewatering and groundwater quality degradation) and expected depletion of aquifers will not affect other water users, aquifers, and associated environmental values.	Section 6.1, 6.2
Avoidance, mitigation and management measures		
A3.92	The EMPs must include details of specific and measurable environmental outcomes, performance criteria, monitoring, reporting, triggers and corrective actions, responsibility, and timing for each measure, including an assessment of the expected or predicted effectiveness of the proposed measures for relevant protected matters, including, but not limited to:	
	f) water quality and levels baseline data and details of trigger levels for groundwater and surface water contaminants	Groundwater Impact Assessment (SLR 2026a) and Groundwater Monitoring and Management Plan (SLR 2026b)
	g) information about other groundwater users and potential cumulative impacts of groundwater drawdown to these users as a result of the project	Groundwater Impact Assessment (SLR 2026a)
Offsets		
All points	There were no stygofauna of MNES or MSES, therefore no significant impacts on either of these matters and no offsets are required.	Not applicable

2. Overview of stygofauna

In Australia, Groundwater Dependent Ecosystems (GDEs) are defined as ‘ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services’ (Richardson *et al*. 2011). Not all GDEs draw on groundwater directly and not all GDEs are solely reliant on groundwater.

Six types of GDEs have been identified in Australia:

- Terrestrial vegetation that relies on the availability of shallow groundwater.
- Wetlands such as paperbark swamp forests and mound springs.
- River baseflow systems where groundwater discharge provides a significant baseflow component to the river.
- Aquifer and cave ecosystems where life exists independent of sunlight (this GDE contains stygofauna and is the focus of the current survey).
- Terrestrial fauna species, both native and introduced, that rely on groundwater as a source of drinking water.
- Estuarine and near-shore marine systems, such as coastal mangroves, salt marshes and sea-grass beds, which rely on the submarine discharge of groundwater.

Until recently (mid 1990’s), aquifers were considered to be devoid of life, however, research in Australia and overseas has highlighted the fact that groundwater systems provide habitat for a diverse range of aquatic fauna called stygofauna (Hose *et al.* 2015, Glanville *et al.* 2016). The term stygofauna encompasses a variety of different types of organisms that are found in groundwater, and includes animals that are obligate, groundwater-adapted organisms (stygobionts), and those that are not specifically groundwater-adapted but are able to survive the harsh conditions in aquifers (stygoxenes) (Hose *et al.* 2015).

Stygofauna are aquatic subterranean animals that are found throughout Australian aquifers. Groundwater ecology surveys and studies over the past 40 years in Australia have identified a diverse range of organisms inhabiting groundwater systems, however, whilst the groundwater ecosystem is diverse and unique, this ecosystem is probably the least studied globally. Tomlinson & Boulton (2008) noted that stygofauna are valued as a biodiversity resource, as indicators of groundwater ecosystem health and potential providers of ecosystem services including, nutrient cycling and storage (e.g. carbon, nitrogen, phosphorus), organic matter cycling and redistribution, water treatment (e.g. filtering water to remove toxins), water regulation (e.g. increasing the size of interstitial pore spaces to maintain hydraulic flow pathways and infiltration rates), and mineral weathering and formation.

Stygofauna are morphologically and physiologically different from even closely related surface-dwelling species having independently evolved common morphological traits such as lacking eyes, having hardened body parts, lacking body pigments and having worm-like body shapes and enhanced sensory appendages as an adaption to the groundwater environment (Humphreys 2006).

Stygofauna are adapted to groundwater environments and conditions of constant temperature, no sunlight, low nutrient and oxygen content, stable water quality and sediments that provide a limited and narrow pore space (Hose *et al.* 2015). Stygofauna have low metabolic rates and low reproductive rates relative to surface species which enables them to survive in the low energy, low oxygen groundwater environment. Groundwater ecosystems typically have few stygobiont species at any one locality and consequently low diversity. However, the isolation of aquifers and limited dispersal abilities of groundwater organisms has created a fauna dominated by short-range endemic species (Harvey 2002). The major pressures on groundwater systems in Queensland, as elsewhere, are from anthropogenic activities (i.e. agriculture, industry and domestic water supply) that modify aspects of the groundwater environment and impact on groundwater quantity (water levels and pressures), groundwater quality (salinity, chemistry, contamination) and groundwater interactions between surface and sub-surface systems. The pressures on groundwater ecosystems are also cumulative (Danielopol *et al.* 2003).

2.1. Ecological requirements of stygofauna

Thirty years ago it was believed that stygofauna only existed within a very narrow physico-chemical parameter range. More recent surveys and studies have shown that this is not the case and that stygofauna may be found across a more diverse physico-chemical range of groundwater systems than was previously commonly assumed. Only recently has the true biological diversity of aquifers begun to emerge, both in Australia and globally.

In 2016, Glanville *et al.*, reviewed a state-wide database which included 755 stygofauna samples from 582 sites in Queensland and the current knowledge on stygofauna biodiversity and biogeography. This study correlated stygofauna recordings against environmental data and reported the following important outcomes:

- Groundwater with a wide range of physico-chemical properties have been recorded as supporting groundwater ecosystems in Queensland.
- Stygofauna have been recorded living in groundwater ranging in depth from 0.1 to 63.2 metres below ground level; electrical conductivity (EC) ranging from 11.5 to 54,800 µS/cm; groundwater temperatures ranging from 17.0 to 30.7^{o}C, and groundwater pH ranging from 3.5 to 10.3.
- Stygofauna taxon richness shows a general negative trend with increasing depth to groundwater or electrical conductivity (a default measurement for salinity).
- Taxon richness is highest in neutral to slightly alkaline pH groundwater systems and in water temperatures between 18 and 27^{o}C.
- Taxon richness was shown to decrease sharply with increasing groundwater acidity and alkalinity.

It was acknowledged that the stygofauna preferences identified from the Queensland database may partially reflect the limited sampling effort that has occurred across physico-chemically diverse groundwater systems and that the data was predominantly from sites sampled only once.

Hose *et al.* (2015) also noted a number of key factors determining the presence/absence of stygofauna in aquifers:

- Stygofauna are predominantly found in aquifers with large (1mm or greater) pore spaces which are more common in alluvial, karstic and some fractured rock aquifers. The pore spaces within an aquifer matrix are a critical determinant of whether an aquifer can support organisms as stygofauna move within an aquifer by either crawling or swimming. The size of the interstitial spaces also influences the hydraulic conductivity and flow of water which ultimately controls the delivery of carbon and oxygen throughout the ecosystem. Hahn & Fuchs (2009) identified that stygofauna were rare or absent in areas with hydraulic conductivity (Kf) less than 10-4cm/s.
- Stygofauna diversity and abundance typically decreases with depth below ground. Stygofauna are rarely found more than 100 m below ground level and are most abundant less than 20 m below ground (Hancock & Boulton 2008).
- Stygofauna are found across a range of water quality conditions (from fresh to saline) but are most common in fresh and brackish water (i.e. where EC is less than 5,000 µS/cm). 4T (2012) in their review of stygofauna data from Australia reported that stygofauna have been found in hypersaline groundwater (86,900 µS/cm), but are most common at salinities less than 10,000 µS/cm.
- Stygofauna are rarely found in hypoxic groundwater where dissolved oxygen concentrations are less than 0.3 mg/L. 4T (2012) reported that stygofauna have been recorded in groundwater with dissolved oxygen concentrations ranging from 0.2 to 15.3 mg/L.
- Stygofauna are more abundant in areas of surface water-groundwater exchange when compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge with poor hydraulic conductivity. Schmidt *et al.* (2007) noted that hydrological exchange between aquifer and surface water can be more important than other hydrogeological conditions in shaping stygofauna assemblages.

Stygofauna were recorded inhabiting a wide range of lithologies, including unconsolidated sedimentary material (e.g. alluvium, sand); consolidated sedimentary rocks (e.g. sandstone) and fractured rocks (e.g. basalt, granite, volcanics). Whilst sampling data are scarce or absent for many lithologies, the results from Glanville *et al.* (2016) suggest that groundwater systems cannot be eliminated as potential habitat for stygofauna based solely on geology or lithology. Stygofauna were also shown to exist across a diverse physico-chemical range of groundwater systems, and as a result, general assumptions of habitat suitability should not be used to guide sampling activities.

Stygofauna are adapted to a low nutrient (particularly carbon) and oxygen environment. For aquifers to sustain stygofauna there must be a continuous vertical flow of dissolved organic carbon (DOC) from the surface to the aquifer. It is this carbon plus dissolved nutrients that are the basis of the simple food web that sustains bacteria and fungi (biofilms) which stygofauna can feed on (Humphreys 2006). It is largely for this reason that stygofauna diversity and abundance decrease with depth and distance along groundwater flow paths as nutrient supplies decline.

2.2. Stygofauna diversity

Hose *et al.* (2015) reports that in 2000 there were over 7,800 known stygofauna species globally, however, research efforts in Australia and Europe have shown that this number is an underestimation. Guzik *et al.* (2010) reported some 770 stygofauna taxa were known from Western Australia alone, however, this value was estimated to be only 20% of the true number of stygobiont taxa. True richness for the region may be in excess of 4,000 stygobitic species. Based on these values, and that the diversity of stygofauna in the eastern states is largely unexplored, it is likely Australia is globally significant in terms of stygofauna diversity (Hose *et al.* 2015).

Many of Queensland's stygofauna communities are unstudied or understudied, hampering both global and local comparisons. Queensland is known to host at least 24 described families and 23 described genera of stygofauna across 9 of the 17 major stygofauna taxonomic groups. Undescribed families have also been recorded across a further three major stygofauna taxonomic groups (Glanville *et al.* 2016). The composition of stygofauna in Queensland is broadly consistent with the world average with the notable exception of high richness of oligochaetes and syncarids and low numbers of molluscs. Despite indications that a significant diversity of stygofauna is likely to exist across Queensland groundwater systems, stygofauna biodiversity largely remains undocumented due to limited sampling effort, limited taxonomic resolution and the tendency for stygofauna to exhibit morphological similarities (Glanville *et al.* 2016).

2.3. Potential impacts on groundwater and stygofauna

There are three major changes in groundwater conditions that can impact groundwater ecosystems. These stressors are:

- Spatial and temporal changes in water level (i.e. groundwater drawdown);
- Altered groundwater quality; and
- Altered aquifer properties (including aquifer porosity, hydraulic conductivity and depressurisation).

Such changes in the physical and chemical properties of an aquifer, either individually or cumulatively, are likely to affect the occurrence and/or the distribution of stygofauna in an aquifer. Cumulative impacts from multiple stressors need to be considered in combination when assessing impacts on the groundwater environment.

2.4. Status under Commonwealth and State legislation

Stygofauna have no conservation listings at the Queensland level. At the Commonwealth level there are numerous stygofauna species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) but all are confined to the Pilbara region in Western Australia. Stygofauna communities associated with Great Artesian Springs are also listed as Endangered under the EPBC Act; however, the Project area is outside the Great Artesian Basin. Therefore, MNES and MSES species of stygofauna do not occur in or surrounding the Project Area.

As the controlling provisions for the Project's Referral under the EPBC Act includes a 'water resource', in relation to coal seam gas development and large coal mining development', the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) will seek advice from the Independent Expert Scientific Committee (IESC) on impacts to water resources. As such, this report will contribute to the information reviewed by the IESC.

3. Project Location and Site Selection

3.1. Project area

The Project area is located in the upper Isaac River catchment in the Fitzroy River Basin of central Queensland, approximately 15 km southeast of Moranbah and 150 km southwest of Mackay. The Project area is located on mining lease application (MLA) 700084, MLA 700081, MLA 700082 and MLA 700083 (**Figure 1**). Surveys were also undertaken adjacent to the Project MLAs in a wider Study Area

3.2. Hydrogeology

The hydrogeological regime of the Project area comprises the following key hydrogeological units:

- Cenozoic sediments:
    - Quaternary alluvium (i.e. alluvium) – forms the unconfined alluvial aquifer (sporadically water-bearing strata of permeable unconsolidated sand or gravel with interlayered clays and silts) localised to major ephemeral drainage lines (Isaac River and Cherwell Creek) in the Project area and in the Study Area.
    - Perched groundwater systems are likely to occur within the alluvium. These are discrete groundwater units sitting above the alluvial aquifer / water table and are separated by an unsaturated zone. Downward percolation of groundwater in these perched systems is restricted by a material of localised low permeability such as a clay lens.
    - Quaternary to Tertiary non-alluvial sediments and weathered units (collectively termed 'regolith') – unconfined unit with variable but limited saturation and generally present at the surface within the Project area.
- Triassic Rewan Group – considered a regional scale aquitard, however, some saturated, more hydraulically conductive horizons exist within, particularly within the upper weathered zone. The Rewan Group subcrops on the eastern side of the Project area.
- Permian coal measures with:
    - low permeability interburden and overburden units with aquitard properties.
    - coal seams that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

Where present, the alluvial aquifer is disconnected from the riverbed elevation. Spatially, the alluvial aquifer is locally variably saturated and drilling results close to the Project have indicated it is dry and/or comprised only of clay in several locations, with groundwater hosted only in the deeper coarser grained intersections of alluvium that are likely representative of incised paleochannels.

Shallow perched groundwater systems occur locally within recent channel sands and bank deposits, typically within 1–2 m of the ground surface. These perched systems are transient, seasonally recharged during flow and flood events, and are hydraulically disconnected from the deeper alluvial aquifer. Perched groundwater is facultatively accessed by riparian vegetation, predominantly River Red Gum, fringing the Isaac River and lower reaches of Cherwell Creek. Away from the immediate proximity of the river channel, the alluvial aquifer occurs at depth generally between 10 and 12 metres below ground level (mBGL) and not accessible by terrestrial vegetation. Groundwater levels within the alluvial aquifer and the Leichhardt and Vermont coal seams are all below the stream bed elevations of the Isaac River and Cherwell Creek, indicating there is no potential for groundwater discharge into these surface water features.

Regionally, groundwater flow within the alluvial aquifer is a subdued reflection of topography, with groundwater flowing in a southeasterly direction consistent with the alignment of the Isaac River and northeasterly along Cherwell Creek. Groundwater levels within the alluvium are also highest close to the main surface water features, indicating losing conditions from the surface water features to the underlying alluvium aquifer during flow periods. Over 50% of flow events are shorter than 10 days, highlighting that most flow events are relatively brief. Recharge to the unconsolidated sediments is primarily from stream flow losses or flooding (i.e. losing streams), with direct infiltration of rainfall also occurring rapidly where there are no substantial clay barriers in the shallow sub surface.

Hydraulic connection between the Cenozoic unconsolidated sediments (including alluvium) and the underlying formations is limited to areas where relatively high hydraulic conductivity units (e.g. coal seams) subcrop beneath the unconsolidated sediments, although the weathering horizon at the interface of the Permian and overlying Cenozoic units may reduce this connectivity. General downwards recharge to deeper units is limited by the low hydraulic conductivity (confining) coal measure interburden sequences. Water quality in the Cenozoic sediments (including alluvium) ranges from brackish to highly saline and is indicated to be unsuitable for aquatic ecosystem protection however is considered suitable for stock watering and irrigation.

The Triassic aged Rewan Group, present across the eastern extent of the Project area is considered a regional scale aquitard, though still contains some saturated horizons. Due to its typically fined grained nature, the Rewan Group generally exhibits a low vertical hydraulic conductivity, resulting in limited hydraulic connection between the unit and the underlying/overlying units, however local permeability testing indicates hydraulic conductivity values may be higher in the upper weathered zone of the unit.

In the Permian aged coal measures strata, groundwater is encountered mainly in the coal seams, and only occasionally in the sandstone/siltstone units. As with the rest of the Bowen Basin, the coal seams are the main groundwater bearing units within the Permian sequences, with low hydraulic conductivity interburden generally confining the individual seams. Hydraulic conductivity of the coal decreases with depth due to increasing overburden pressure reducing the aperture of fractures. Vertical movement of groundwater (including recharge) is limited by the confining interburden layers, meaning that groundwater flow is primarily horizontal through the seams with recharge only occurring at subcrop where the overlying strata permits. Regionally, groundwater within the Permian coal measures flows in a south-easterly direction with local flow towards the active mining areas proximal to the Project.

The Permian coal measures at and surrounding the Project have undergone extensive deformation, including folding and faulting. The main northwest-southeast trending fault is the Isaac Thrust Fault. Faults significantly compartmentalise the Permian groundwater system, particularly the major northwest-southeast trending faults. Hydraulic testing of faults at sites near to the Project area indicate that faulting zones tested are not pathways for preferential flow but rather act as hydraulic barriers. Testing of the Isaac Thrust Fault immediately east of the Project has supported the previous findings that the fault zone is 'healed' by mineralisation and the fault does not provide a higher permeability pathway for groundwater flow in the Permian coal measures, with hydraulic conductivity values several orders of magnitude lower than the coal seams.

Recharge to the Permian coal measures occurs where the unit subcrops. Due to the low hydraulic conductivity of the interburden material, groundwater largely flows horizontally, along the bedding plane of the coal seams. Groundwater discharge occurs predominantly via evaporation from pit faces in mining operations. Water quality in the Permian units ranges from brackish to highly saline and is indicated to be generally unsuitable to be used for stock watering, irrigation, and aquatic ecosystem protection.

3.3. Site selection

Bores within and surrounding the Project area were selected for sampling of stygofauna. Bores were selected that intersect the water table, are vertical, have a diameter larger than 50 mm, allow sampling from the variety of aquifers available and, where possible, were over twelve months since construction. A total of 12 groundwater bores were selected across a Study Area, which encompasses the Project area and surrounds, by Freshwater Ecology Consulting for pilot survey sampling, two of which were found to be dry. The locations of the groundwater bores sampled within the proposed Study Area are shown in **Figure 2**. The location and history of each bore are presented in **Table 2** and bore hole characteristics presented in **Table 3**. All bores were used primarily for groundwater monitoring purposes. Bore construction dates for two bores was unknown (but at least 15 years old), 2020 for two bores, 2022 for seven bores and 2025 for the remaining bore. The bore that was constructed two months prior to sampling was sampled due to further suitable bores not being accessible or dry. The bores ranged from 13.5 to 180 metres deep.

Bore inspection and sampling was conducted for this Project by Freshwater Ecology from 20th to 22nd of July 2025.

Table 2: Location of groundwater bores sampled for stygofauna (N/A – data not available)

Bore Code	Easting (GDA94)	Northing (GDA94)	Strata description	Bore Purpose	Date Drilled	Date Sampled
593	622610	7555055	Rangal Coal Measures - Vermont coal seam	Mine Monitoring	Unknown, but in existence for at least 15 years	22/07/2025
594	622610	7555054	Rangal Coal Measures - Leichhardt coal seam	Mine Monitoring	Unknown, but in existence for at least 15 years	22/07/2025
MBID23	621795	7559591	Alluvium (alluvial aquifer)	Mine Monitoring	28/06/2020	20/07/2025
MBID28	622918	7558534	Alluvium (alluvial aquifer)	Mine Monitoring	29/06/2020	22/07/2025
MBIS03	624321	7557561	Rangal Coal Measures - Vermont coal seam	Mine Monitoring	16/05/2025	20/07/2025
MBIS06	622200	7553757	Regolith	Mine Monitoring	18/11/2022	20/07/2025
MBIS08	623708	7554323	Rangal Coal Measures - Leichhardt coal seam	Mine Monitoring	19/11/2022	21/07/2025
MBIS09	623708	7554321	Rangal Coal Measures - Vermont coal seam	Mine Monitoring	18/11/2022	21/07/2025
MBIS10	624998	7555106	Regolith	Mine Monitoring	26/11/2022	22/07/2025
MBIS16	623872	7552348	Rangal Coal Measures - Vermont coal seam	Mine Monitoring	15/11/2022	21/07/2025
MBIS17	625803	7553336	Regolith	Mine Monitoring	16/11/2022	20/07/2025
MBIS18	625821	7553337	Rangal Coal Measures - Leichhardt coal seam	Mine Monitoring	16/11/2022	21/07/2025

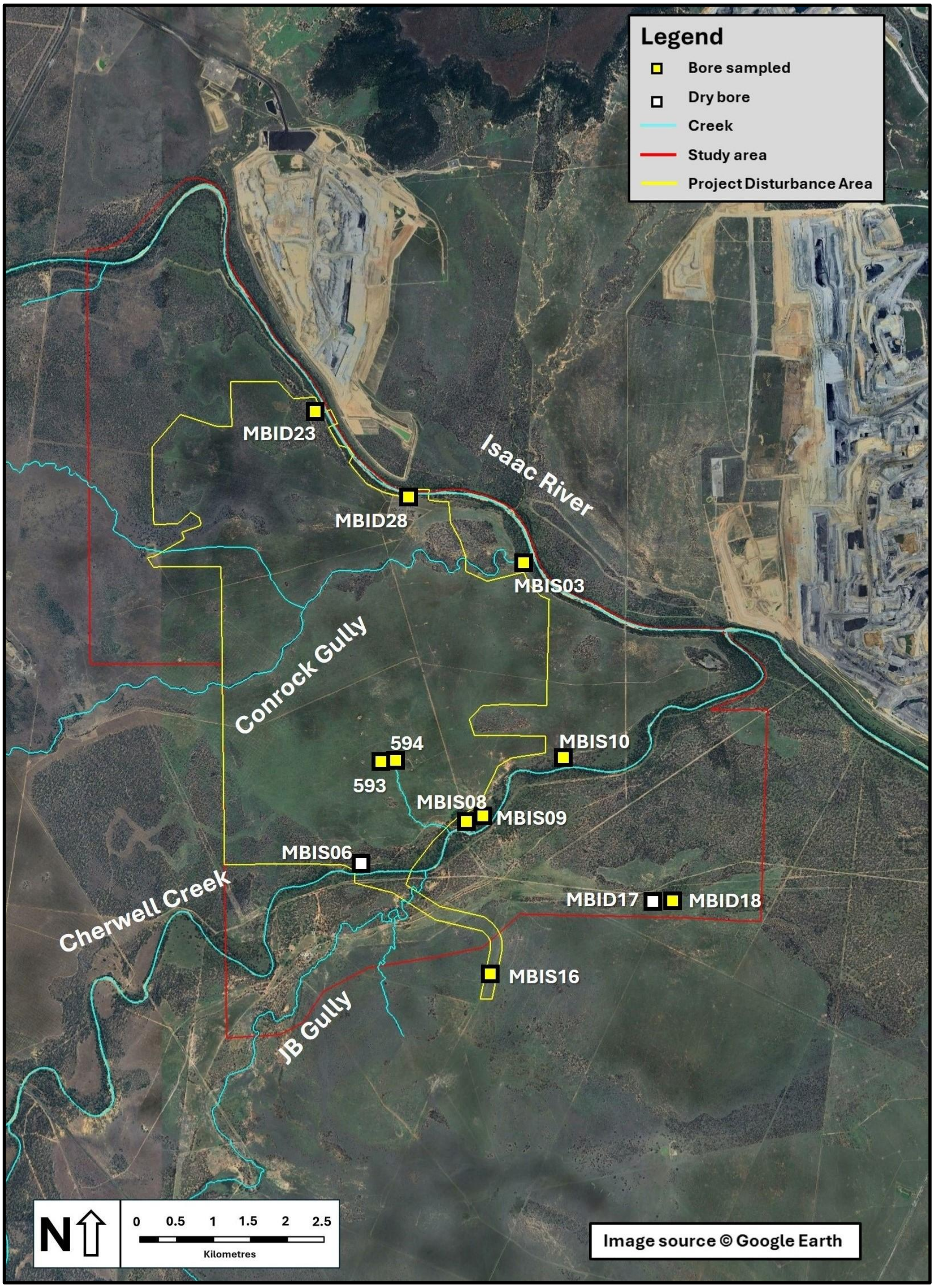

Figure 2: Location of bores sampled for stygofauna

Table 3: Bore Hole Characteristics (mBGL - metres below ground level; mBTOC - metres below top of casing; EoH – end of hole; SWL – standing water level) (N/A – data not available)

Bore Code	SWL (mBTOC)	Bore Diameter (mm)	Top Screen (mBGL)*	Base Screen (mBGL)*
593	27.27	50	N/A	95
594	26.97	50	N/A	46.88
MBID23	9.70	50	7.5	13.5
MBID28	9.86	50	12	15
MBIS03	9.53	50	171	181
MBIS06	-	50	7	10
MBIS08	11.80	50	42	48
MBIS09	14.20	50	80	92
MBIS10	13.03	50	80	92
MBIS16	29.52	50	59	67
MBIS17	-	50	17	20
MBIS18	20.55	50	146	149

***values obtained for bore hole logs**

4. Methods

4.1. Desktop assessment

A review was undertaken to search for available data and reports on stygofauna within and adjacent to the Project area. This included:

- Bore records in vicinity of the Project (provided by SLR Consulting Australia Pty Ltd). Including both hydrogeological and water quality data.
- Syntheses of existing knowledge (Hose *et al.* 2015, Glanville *et al.* 2016).
- Searches for projects in adjacent areas known to have undertaken environmental assessments. There were three available stygofauna reports identified in proximity to the Study Area; Olive Downs (DPM Environmental 2018), Isaac Downs (FRC 2020) and Winchester South (ESP 2022a, 2022b).
- The Queensland subterranean aquatic fauna database (Queensland Government 2026). The Queensland subterranean aquatic fauna database provides data from 602 bores sampled between 2003 and 2015.

It was determined that the most appropriate approach to sampling was to undertake a pilot survey to address the knowledge gaps in the desktop review. A pilot survey typically consists of sampling a minimum of ten bores with bore locations satisfying specific criteria for conducting stygofauna surveys.

4.2. Sampling team

Field sampling was conducted by Dr Tim Howell and Michael Howell from Freshwater Ecology. Both staff are professional aquatic ecologists and experienced in stygofauna sample collection and analysis. Dr Tim Howell has in excess of 15 years' experience working on groundwater ecology projects throughout Australia.

4.3. Stygofauna sampling

The groundwater bores were sampled for stygofauna in accordance with the methods defined in Queensland Environment Protection (Water) Policy 2009 – Monitoring and Sampling Manual for Biological Assessment (DES 2018) and following established sampling techniques defined elsewhere in Australia and overseas (DSITI 2015, Hancock & Boulton 2008, Dumas & Fontanini 2001, WA EPA Guidance Statements 54 and 54a 2003 & 2007). The field sampling program adopted by Freshwater Ecology met all requirements required for conducting a stygofauna pilot survey.

Netting was undertaken in all bores using phreatobiological nets (net design and construction conformed with WA EPA Guideline [2003 & 2007] specifications). For bores with a greater than 50 mm internal diameter a 50 mm diameter was used and for the remaining bores a 40 mm diameter net was used. Nets were made of 50 µm nybolt mesh material and weighted at the bottom with a brass fixture and an attached plastic collecting jar. The net was lowered to the bottom of the bore, bounced three to five times to dislodge any resting animals, and slowly retrieved. At the top of each haul (the aim was always to collect between 4 and 6 hauls with all hauls reaching the bottom of the bore), the collecting jar was rinsed into a 50 µm mesh brass sieve and the net lowered again.

Once all net hauls were completed the entire sieve contents were then transferred to a labelled sample jar and preserved in methylated spirits (> 95% ethanol). DNA testing of aquatic specimens was not required for this Project at the time of sampling. A small amount of Rose Bengal, which stains animal tissue pink, was added to each sample to aid in sample processing.

All field equipment was of high quality and fit for purpose, well maintained and operated in accordance with scientific protocols specified above.

4.4. Laboratory processing of field samples

Field samples were logged into a Laboratory Information Management System to record and track sample processing details. Stygofauna sample containers were drained of methylated spirits and stain and washed gently into channelled Sedgwick-Rafter counting trays to create a thin layer of sediment spread across the bottom of the tray. Samples were then sorted under a stereomicroscope with 10x objective lenses and a zoom capability of between 6.3x and 60x. All aquatic animals present were removed (stygofauna and non-stygofauna) and identified to Order/Family level (or lower taxonomic rank if visually possible) in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna – Sampling* methods and survey considerations (2015) and placed in labelled, polyethylene containers filled with 100% Analytical Reagent (AR) Grade ethanol for long-term storage.

Sample sorting was undertaken by Susan Jones from Stream Macroinvertebrate Identifications. The sorted samples were sent to Bennelongia Environmental Consultants for identification to the lowest level possible.

4.5. Groundwater quality sampling

Groundwater sampling preceded biological sampling to ensure the groundwater contained within the bore was undisturbed. The field meter was calibrated in the laboratory prior to its use in the field, with calibrations regularly cross-checked in the field. All water quality monitoring equipment was of high quality and fit for purpose, well maintained and operated in accordance with the manufacturer's specifications.

Groundwater quality was measured for temperature (°C), pH (units), electrical conductivity (µS/cm), dissolved oxygen (mg/L) and turbidity (NTU) using a multi-parameter water quality meter to provide a general estimate of standing groundwater quality.

Water samples were collected from each bore using a bailer lowered by hand to approximately 2 m to 3 m below the standing water level (SWL) prior to stygofauna sampling. Care was taken to slowly and gently pour water from the bailer into a container prior to inserting the water quality probes so as to reduce any artificial aeration that might occur during this process. As this could not be totally eliminated, dissolved oxygen results should be treated with caution.

5. Existing Environment

5.1. Desktop assessment

The diversity and biogeography of stygofauna in Queensland was synthesized based on records from the *Queensland Subterranean Aquatic Fauna Database* (755 samples and 582 sites) by Glanville *et al.* (2016). A total of 24 described families and 23 described genera have been recorded from Queensland across numerous bioregional areas. The most widely distributed taxon were syncarids (a type of crustacean with two families - *Bathynellidae* and *Parabathynellidae* - recorded), followed by *Cyclopidae* (copepods) and *Naididae* (clitellate oligochaete worms). The synthesis was largely restricted to order. Subsequently, the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DSITI 2105) was released which specifies minimum taxonomic resolution (i.e. genus, family, order) based on major stygofauna taxonomic groups.

A second synthesis was undertaken across Australia on behalf of the Australian Coal Association Research Program (ACARP) by Hose *et al.* 2015, which summarised the key findings from 12 studies from the Bowen Basin. These studies identified stygofauna assemblages in alluvial aquifers that contain common stygobionts such as copepods, amphipods and syncarids, and to a lesser extent also from basalt aquifers and coal seams. In the Bowen Basin stygofauna were recorded where standing water level was between 1.4 and 45 m below ground level and from groundwaters with the following with electrical conductivity ranging from 342 – 9,975 µS/cm, pH from 6.39 – 10.27 and dissolved oxygen from 0.93 – 6.54 mg/L.

A review of the *Queensland Subterranean Aquatic Fauna Database* identified 48 bores that had been sampled within a 50 kilometre radius of the Study Area. Several stygobionts, and likely stybionts, were recorded from thirteen of the bores, with all but one bore intersecting the alluvium (that bore intersected basalt). The high level that samples were identified to prevents clarification on which organisms were true stygobionts, however, the samples included *Clitella* oligochates (worms), *Bathynellidae* and Copepods (of the orders *Cyclopoida* and *Harpacticoida*).

Several, more recent, stygofauna assessment have been conducted for environmental impact assessments (EIAs) in the vicinity of the Project since the above mentioned studies. An assessment of two bores sampled for the Olive Downs South Project recorded no stygofauna, however it was noted that suitable conditions existed in the bores to support stygofauna (DPM Envirosciences 2018). Of ten bores sampled for the Isaac Downs EIS, two stygoxenes were recorded but no stygobites (frc environmental 2019). Initial stygofauna sampling for the Winchester South Project EIS detected no stygofauna (ESP 2022a) however two taxon (*Bathynellidae* and *Candonidae* – an ostracod) were recorded during supplementary surveys (ESP 2022a).

5.2. *In situ* water quality

Water quality can be an important determinant in the presence and abundance of stygofauna, most notably for electrical conductivity (EC) and pH. The median EC of water from which stygofauna have been sampled in Queensland, is 1,348 µS/cm with a range of (11.5 – 54,800 µS/cm) (Glanville *et al.* 2016). Abundance of stygofauna typically decreases with increasing EC above 5,000 µS/cm (Hancock & Boulton 2008, *Glanville et al.* 2016). EC recorded from bores in the Study Area ranged from 1,570 – 23,140 µS/cm (**Table 4**) and was therefore consistent within the preferred range for stygofauna at only some bores (i.e. bores MBID23, MBID28 and MBIS10). Stygofauna have been recorded from groundwater with pH range of 3.5 to 10.3, but diversity is highest between 6.5 and 7.5 (Hancock & Boulton 2008). The pH of groundwater from the Study Area ranged from 6.9 – 8.9 and thus aligned with the range known to support stygofauna communities but was within the preferable range at only four sites (**Table 4**).

Table 4: ***In situ*** **groundwater quality**

Bore Code	**pH** (units)	**Dissolved Oxygen** (% satn)	**Conductivity** (µS/cm)	**Turbidity** (NTU)	**Temperature** (ºC)	**Sample Volume** (L)
593	8.2	23.1	14,370	12.1	24.1	2
594	7.3	21.0	23,140	48.5	24.6	2
MBID23	7.6	22.1	1,570	181	25.4	2
MBID28	6.9	19.2	1,570	3.8	24.0	2
MBIS03	8.9	20.3	10,410	14.3	25.4	2
MBIS06	-	-	-	-	-	-
MBIS08	7.7	41.4	10,750	17.9	24.6	2
MBIS09	8.0	22.1	10,540	13.6	24.0	2
MBIS10	7.3	26.0	2,890	14.4	25.7	2
MBIS16	7.5	17.8	14,440	14.7	25.6	2
MBIS17	-	-	-	-	-	-
MBIS18	7.8	16.3	9,910	6.0	25.5	2

5.3. Sampling effort

The quality of stygofauna samples collected across the 12 groundwater bores in July 2025 is summarised in **Table 5** below. The sampling method aimed to collect between four and six replicate hauls off the bottom of each bore in order to be classified as a good sample. Overall, high quality stygofauna samples were collected from the 10 bores which held water, indicating both a significant and successful sampling effort.

Table 5: Summary of stygofauna sampling effort and sample quality

Bore Code	No. hauls	Sample Quality
593	6 hauls	Good, all hauls off the bottom.
594	6 hauls	Good, all hauls off the bottom.
MBID23	6 hauls	Good, all hauls off the bottom.
MBID28	6 hauls	Good, all hauls off the bottom.
MBIS03	6 hauls	Good, all hauls off the bottom.
MBIS06	-	dry
MBIS08	6 hauls	Good, all hauls off the bottom.
MBIS09	6 hauls	Good, all hauls off the bottom.
MBIS10	6 hauls	Good, all hauls off the bottom.
MBIS16	6 hauls	Good, all hauls off the bottom.
MBIS17	-	dry
MBIS18	4 hauls	Good, with all hauls off the bottom. Only four hauls due to depth and viscosity increasing with each haul.

5.4. Stygofauna

Results from the analysis of the groundwater samples for the presence of stygofauna are presented in **Table 6**. Stygofauna were recorded from three bores; MBID23, MBID28 and MBIS03, all of which are located immediately adjacent to the Isaac River. MBID23 and MBID28 are screened in the alluvial aquifer of the alluvium. The recording of stygofauna in bore MBIS03 is considered out of character with the historical sampling across the region due to the depth and strata. Further, the water quality recorded from this bore was not optimal for a diverse stygofauna assemblage and reflective of the extremes from which they have been recorded. In consideration of this bore having been installed only two months prior to sampling (and only sampled in the absence of other suitable bores which were more established) it is likely that the stygofauna were not being recorded from the aquifer that the bore was slotted in and rather entered the bore from the alluvial aquifer during construction. This is supported by the similar taxa composition but lower abundance than bore MBID23. A second round of sampling at MBIS03 was undertaken in April 2026 to investigate further. These results are currently being processed and were unavailable for this report. Therefore, the alluvial aquifer in the vicinity of the Isaac River is considered to be the primary location for stygofauna assemblages within and surrounding the Project area.

Single specimens of individuals from the Phylum Nematoda were recorded from a further three sites. These were considered highly unlikely to be stygofauna due to the extremely low abundances and the fact that these bores also contained large amounts of terrestrial insects parts and some individuals. Nematodes are abundant in a range of habitats including the surface areas and in soil, and are extremely difficult to identify from morphological characteristics alone. The nematodes recorded in the three bores containing stygofauna were considered to likely be stygofauna as the samples were clean (i.e. less terrestrial insect parts and surface organic matter) and were relatively abundant.

All other fauna recorded were considered to be comprised of animals which had accidentally fallen into the bores. Most of these were distinct terrestrial fauna (isoptera – termites, coleoptera – beetles, hemipterans – true bugs, arachnids – spiders) and the lower level identification confirmed this.

Table 6: Analysis of groundwater samples for the presence of stygofauna

Bore Code	Stygofauna	Non-Stygofauna Taxa	General comments
593	-	4 Histiostomatidae sp. 1 Phthiraptera sp. 1 Oribatida sp. 1 Thysanoptera sp. 1 Nemetoda	Large amounts of terrestrial insect parts
594	-	1 Oribatida sp. 1 Thysanoptera sp.	Many isoptera body parts
MBID23	50 Nematoda 18 Platyhelminthes 39 Oligochaeta 57 Copepoda 65 Syncarida	1 Hemiptera sp. 1 Oribatida sp. 1 Mesostigmata sp.	Clean sample
MBID28	1 Nematoda 18 Oligochaeta	1 Formicidae sp. 2 Hemiptera sp. 2 Oribatida sp.	Clean sample
MBIS03	1 Nematoda 16 Oligochaeta 2 Copepoda 12 Syncarida	-	Clean sample
MBIS06	-	-	dry
MBIS08	-	1 Acarina	-
MBIS09	-	2 Acarina 1 Coleoptera larvae 1 Hemiptera sp. 1 Lepidoptera sp. 2 Thysanoptera sp.	Clean sample
MBIS10	-	1 Acarina	Clean sample
MBIS16	-	4 Acarina sp. 1 Astigmata sp. 1 Collembolla 1 Lepidoptera sp. 1 Mesostigmata sp. 2 Oribatida sp. 1 Nematoda sp.	Crambidae/ Coleoptera heads
MBIS17	-	-	dry
MBIS18	-	1 Thysanoptera sp. 1 Nematoda	Diptera larva parts

The identification of stygofauna recorded in the three bores found to contain them is presented in **Table 7**. A total of 489 stygofauna specimens were recorded across the three bores across five higher taxonomic groups, with nine taxa groups when considered at the lowest level of identification. Of these taxonomic groups only three taxa were considered to be true stygobionts (obligate stygofauna), two as possibly stygobiont with the remaining taxa considered likely to be stygoxenes (facultative stygofauna not reliant on groundwater). The determination of the likely classifications was supported by the Queensland subterranean fauna database for the same taxonomic classifications from within 50 kilometres of the Study Area.

Table 7: Stygofauna and possible stygofauna identified to lowest level practical. Obligate stygofauna denoted in light grey

Bore	Higher Taxonomic Order	Lowest level of identification	No. specimens	Likely classification
MBID23	**Nematoda**	Nematoda	50	Stygoxene
	Platyhelminthes	Microturbellaria sp.	18	Stygoxene
	Annelida - Oligochaeta	Enchytraeidae	31	Stygobiont / Stygoxene
		Naididae	8	Stygobiont / Stygoxene
	Arthropoda - Copepoda (Cyclopoida – Harpacticoida)	*Australocamptus*	4	Stygoxene
		Dussartstenocaris	250	**Stygobiont**
		Stygonitocrella	2	Stygoxene
	Arthropoda - Syncarida	Bathynellidae	65	**Stygobiont**
MBID28	**Nematoda**	Nematoda	15	Stygoxene
	Annelida - Oligochaeta	Enchytraeidae	1	Stygobiont / Stygoxene
MBIS03	**Nematoda**	Nematoda	15	Stygoxene
	Annelida - Oligochaeta	Enchytraeidae	1	Stygobiont / Stygoxene
		Naididae	15	Stygobiont / Stygoxene
	Arthropoda - Copepoda (Cyclopoida – Harpacticoida)	*Parastenocaris*	2	Stygobiont
	Arthropoda - Syncarida	Bathynellidae	12	**Stygobiont**

These results show a relatively diverse stygofauna assemblage within the alluvial aquifer adjacent to the Isaac River. This is due partially to the level of identification being lower than historical sampling across the region and in line with the *Guideline for the environmental assessment of Subterranean aquatic fauna* (DSITI 2015). At a taxonomic level comparable with historical reporting across the region these results are consistent with those that have previously been recorded (Hose *et al.* 2015, Glanville *et al.* 2016), see **Section 5.1**. The same taxonomic groups are the most commonly recorded across Queensland (Glanville *et al.* 2016).

In comparison with other recent surveys these are more diverse and abundant, however, stygobionts have been recorded in Isaac River alluvium in proximity to the Project Area in recent years (ESP

2022b) and other studies have noted that they are likely to be present in this aquifer despite their absence or low abundances (ESP 2022a, DPM Envirosciences 2018). This also highlights the variability in detection rates of stygofauna both spatially and temporally within a given aquifer (Garry Bennison and Peter Hancock 2026 pers comm.).

6. Potential Impacts and Mitigation

6.1. Potential changes in groundwater quality

Potential impacts to groundwater quality could occur through:

- Accidental leaks or spills of hydrocarbons and other chemicals from infrastructure areas or mining equipment.
- Seepage from spoil dumps or the void lake to groundwater.

6.1.1. Leaks or Spills

Any leaks or spills would be highly localised (e.g. at the Project's go-line area), and controls will be implemented to prevent or remediate any spills or leaks. Whilst hydrocarbons and chemicals can impact aquatic fauna at relatively low concentrations, it is unlikely that localised spills or leaks in active mining areas would interact with aquifers in which stygofauna may be present.

Leaks and spills would be managed through the following procedures:

- Facilities at the go line for the storage of fuels and minor maintenance requirements will be constructed and bunded in accordance with the relevant Australian Standard specifications, including but not limited to the provisions of AS 3780:2008 – The storage and handling of corrosive substances, AS 1940:2004 – The storage and handling of flammable and combustible liquids (AS 1940), AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers.
- Fuel storage areas will be inspected regularly, with repair and maintenance work completed as required. Bunds filled with stormwater will be drained or pumped out by a licensed contractor as soon as practicable to maintain the bund volume.
- A waste oil system will collect all waste oils for transfer offsite or recycling onsite, so that waste oils are not released to the environment. Lubricants will be stored in a bunded concrete area with a sump to collect any spills.
- All runoff from areas with potential contaminants will pass through water management controls such as an oily water separator or sediment trap before entering the mine affected water management system.
- Incident reporting and the management of spills will be undertaken in accordance with the site operational incident reporting forms and procedures. A spill response protocol will be developed and implemented. Spills management procedures will be designed to contain and remediate any spills of fuels or chemicals to prevent impacts on surface waters.
- Specific waste bins and bunding will be used to isolate waste liquids, chemicals and hazardous wastes.
- Spill kits will be available close to areas where chemicals are being used or kept.
- Hazardous liquid wastes awaiting disposal, such as hydrocarbons and oils, will be stored appropriately in accordance with AS1940:2004 'The storage and handling of flammable and combustible liquids'.

- All areas containing potential contaminants or hazardous wastes will be protected from flooding by levees with flood protection for a 0.1% AEP (1:1,000 year) flood event. Hence, they will have a negligible risk of releasing contaminants during flood events.

With the implementation of the proposed mitigation and management measures for the Project, the risk to the aquifers and stygofauna communities from leaks and spills is very low.

6.1.2. Seepage - Spoil

Spoil emplacement at the Project will occur both within the mined void (in-pit backfill) and at designated out-of-pit spoil dump landforms, including the south-west and east out-of-pit dumps. Terrenus (2026) assessed the geochemical properties and environmental risk associated with spoil across both emplacement settings.

Terrenus (2026) demonstrated that spoil materials proposed for both in-pit and out-of-pit emplacement are overwhelmingly non-acid forming, with low total sulphur concentrations and a strong excess of acid neutralising capacity. Leach testing showed that seepage from spoil is expected to be neutral to alkaline, with low salinity and very low dissolved metal concentrations, typically at or near laboratory detection limits.

For out-of-pit spoil dumps, Terrenus (2026) concluded that the low contaminant source strength of spoil, combined with landform design and internal attenuation within the spoil mass, results in a low risk of groundwater quality impacts. No sustained acid generation or metalliferous drainage is expected from these landforms post-closure.

For in-pit spoil emplacement, interaction between groundwater and backfilled spoil is similarly characterised by neutral to alkaline seepage chemistry. Terrenus (2026) identified that minor quantities of waste coal potentially incorporated within in-pit backfill will be diluted and encapsulated by large volumes of non-acid forming spoil, ensuring groundwater quality is not adversely affected.
Based on the geochemical characteristics and assessed seepage behaviour of both in-pit and out-of-pit spoil, Terrenus (2026) concluded that spoil emplacements present a low risk to groundwater quality during operations and post-closure.

As a result, the risk to the aquifers and stygofauna communities from changes to groundwater quality from seepage from spoil is low. The implementation of the groundwater monitoring and management plan (GMMP) (SLR 2026b) will identify if there are changes to groundwater quality that exceed trigger levels for investigation.

6.1.3. Seepage - Void

SLR (2026a) provides results from final predicted groundwater inflows to the residual void from the groundwater model. The results indicate that over time all flow is inwards towards the void and there is no outwards flux from the void. This means that means the residual void functions as a long-term groundwater sink, limiting the potential for off-site groundwater quality impacts. The water quality in the void would therefore not pose a risk to the surrounding groundwater regime as the final void would remain as a groundwater sink in perpetuity.

As a result, the risk to the aquifers and stygofauna communities from changes to groundwater quality from the residual void lake spoil is very low.

6.2. Changes in groundwater levels

Stygofauna within and surrounding the Project area have been identified in the alluvial aquifer in the alluvium adjacent the Isaac River. SLR (2026a) models the groundwater drawdown in the alluvium as a result of the Project only (i.e. incremental drawdown) and cumulatively with all other existing and proposed resource projects included in the groundwater model. The results are presented in **Figure 3** and **Figure 4** for incremental and cumulative drawdown, respectively. There are no incremental (i.e. Project only) drawdown impacts exceeding 1 m predicted for the alluvium as a result of the Project. Cumulative drawdown in the alluvium ranges from 1 to 10m, with this almost entirely due to the influence of other projects.

The Project therefore has a negligible contribution to drawdown in the alluvium and therefore a negligible contribution to any potential impacts on stygofauna in the alluvium.

As a result of the findings of a low risk of impacts to stygofauna from drawdown from the Project, no stygofauna specific management measures are proposed. However, the GMMP (SLR 2026b) will be implemented and will identify if there are changes to groundwater levels that are not within the expectations of the groundwater modelling.

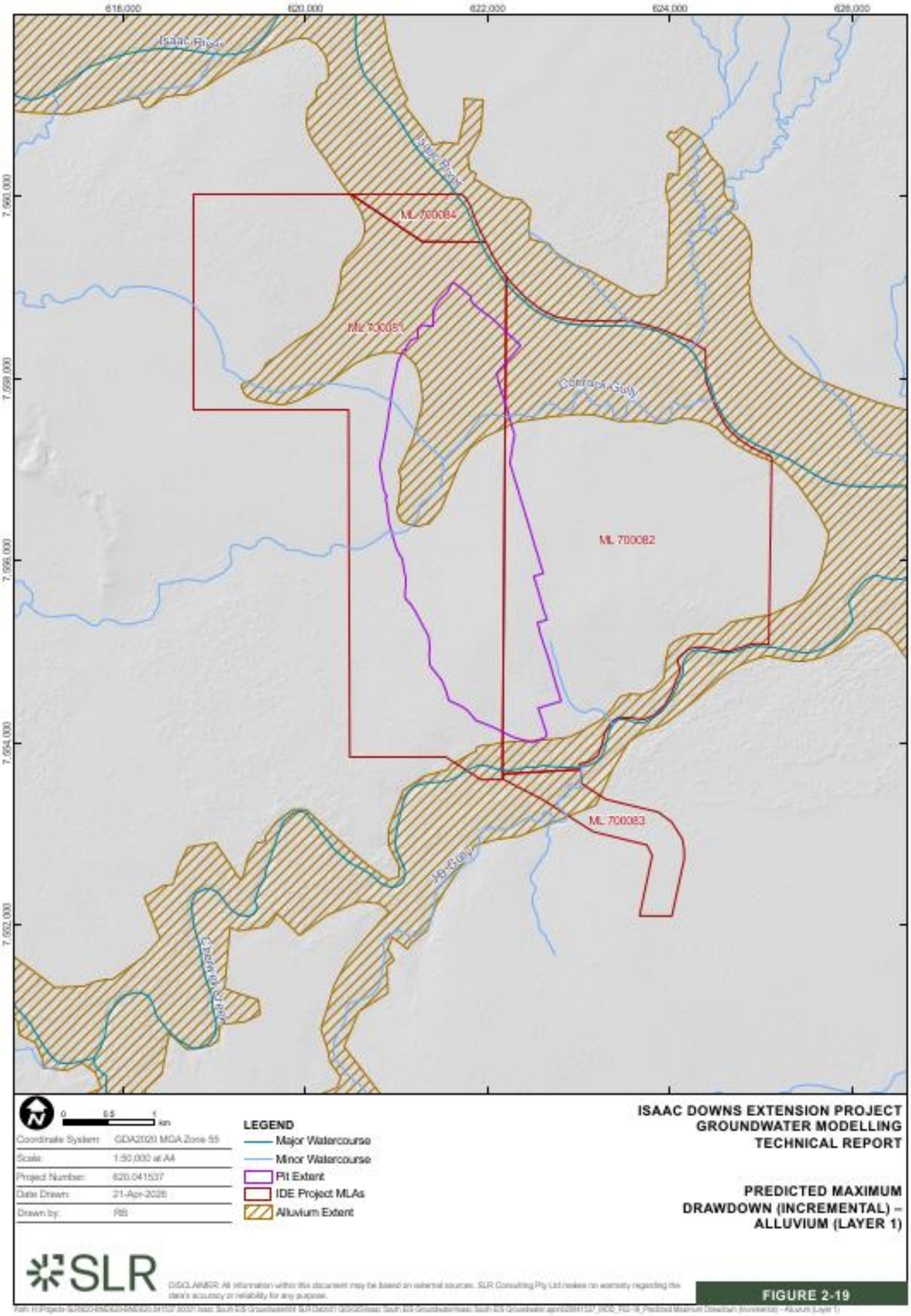

Figure 3: Predicted maximum drawdown on alluvial aquifers from the IDE Project

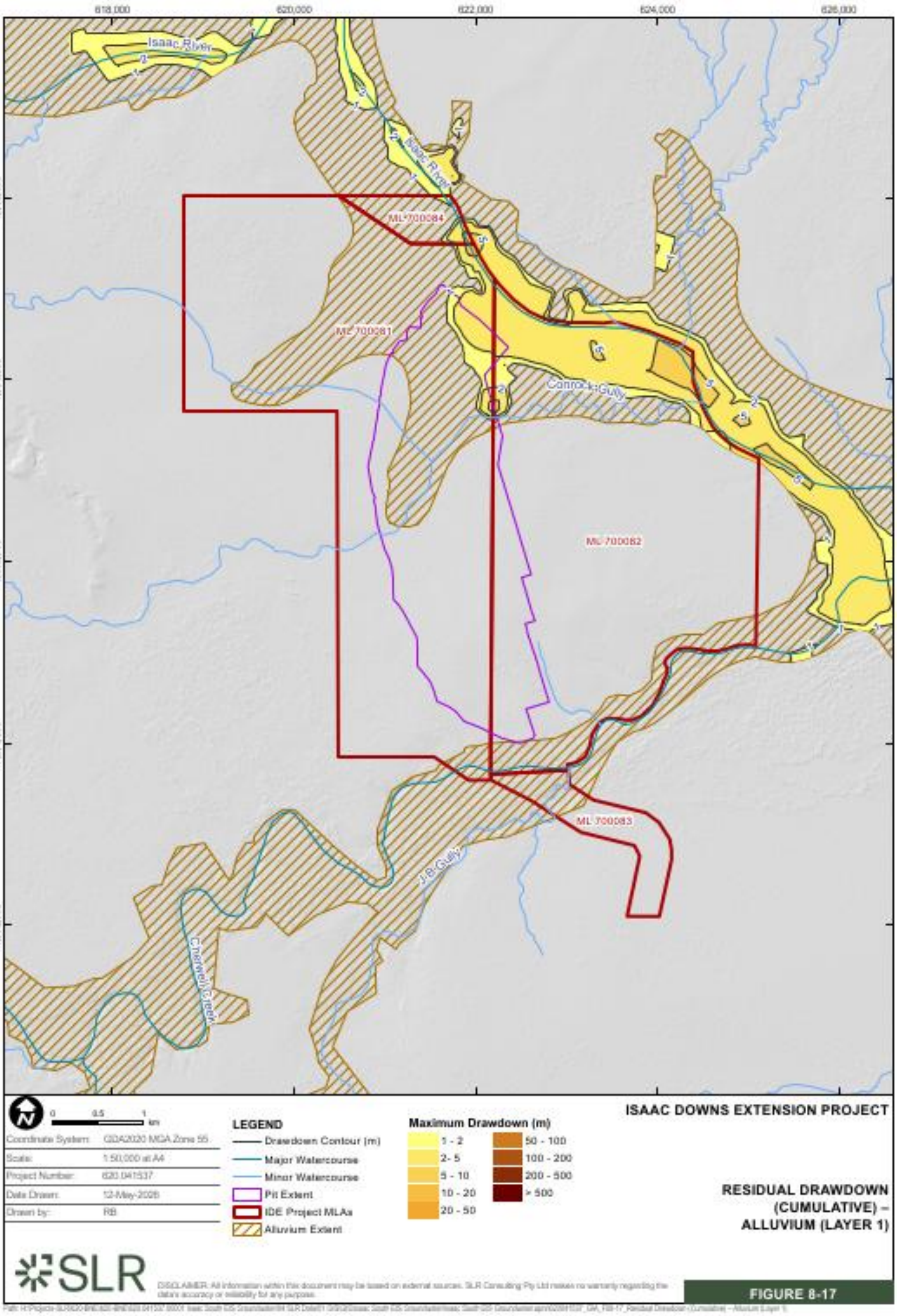

Figure 4: **Predicted maximum cumulative drawdown on alluvial aquifers**

7. Cumulative Impacts

Potential cumulative impacts across multiple coal projects on stygofauna relate to combined influences on groundwater drawdown, notably the alluvial aquifer (alluvium). Potential cumulative drawdown impacts on the alluvium are shown in **Figure 4**. Whilst the Project is making a negligible contribution to cumulative impacts, the potential cumulative impacts on stygofauna identified in the vicinity of the Project have been considered.

At the taxonomic level available for other studies across the region, the stygofauna assemblages identified in the current assessment are not unique. Localised cumulative impacts to the alluvium represent a relatively small portion of the available habitat. Therefore, the Project is considered unlikely to impact the long term survival and persistence of these communities.

8. Conclusions

Stygofauna were recorded from three of the bores sampled, one of which appeared to be an erroneous result, and likely due to alluvial aquifer intrusion during the construction only two months prior to sampling. Therefore, the alluvial aquifer in the vicinity of the Isaac River is considered to be the primary location for stygofauna assemblages within and surrounding the Project area. None of the stygofauna found are MNES or MSES species or communities.

The potential impacts on stygofauna identified from the Project were:

- Potential changes in groundwater quality through accidental leaks or spills of hydrocarbons and other chemicals from infrastructure areas or mining equipment, and seepage from spoil dumps or the void lake to groundwater.
- Changes in groundwater levels due to drawdown associated with mining activities.

With the implementation of the proposed mitigation and management measures for the Project, the risk to the aquifers and stygofauna communities from leaks and spills is very low.

There are no incremental (i.e. Project only) drawdown impacts exceeding 1 m predicted for the alluvium as a result of the Project. Cumulative drawdown in the alluvium ranges from 1 to 10m, with this almost entirely due to the influence of other projects. The groundwater monitoring and management plan will be implemented and will identify if there are changes to groundwater levels that are not within the expectations of the groundwater modelling.

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