HORSE PIT EXTENSION EPBC ACT REFERRAL

APPENDIX E

Aquatic Ecology Assessment 2021

Caval Ridge Mine

Horse Pit Extension Project Aquatic Ecology Assessment

Prepared for: SLR Consulting Australia Pty Ltd on behalf of BM Alliance Coal Operations Pty Ltd

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August 2021

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Document Control

Report Title: Caval Ridge Mine: Horse Pit Extension Project Aquatic Ecology Assessment

Project Reference: 1941

Client: SLR Consulting Australia Pty Ltd on behalf of BM Alliance Coal Operations Pty Ltd

Client Contact: Peter Smith, SLR Consulting Australia Pty Ltd

Report Status	Version Number	Date Submitted	Authored By	Reviewed By	Issued By	Comment
Draft	1941.002V1	30/05/2020	R. King K. Keating J. Keep S. Goodwin	L. West L. Thorburn	L. West	Working draft for client comment
Draft	1941.002V2	07/05/2021	S. Goodwin	K. Keating L. West	L. West	Addressed SLR comments
Draft	1941.002V3	07/07/2021	K. Keating	K. Keating	L. West	Addressed BHP comments
Final	1941.002V4	03/08/2021	L. West	L. West	L. West	Final report
Final	1941.002V5	10/08/2021	K. Keating	K. Keating	K. Keating	Addressed BHP comments; final report

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Executive Summary

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) for SLR Consulting Australia (SLR) on behalf of BM Alliance Coal Operations Pty Ltd (BMA) and describes the existing aquatic environment for the Caval Ridge Mine (CVM) Horse Pit Extension Project (the Project). It also assesses the risk of potential impacts associated with the Project on aquatic ecological values and stygofauna communities, and outlines proposed measures to minimise, manage or prevent potential adverse impacts. CVM is an open-cut coal mine that has been in operation since 2014 and is located approximately five kilometres (km) south-west of Moranbah in the Bowen basin region of central Queensland. The Project involves an extension to Horse Pit to enable the current five year mine plan.

The purpose of this aquatic ecology assessment is to summarise aquatic habitats, flora and fauna as well as stygofauna communities known or likely to occur in the vicinity of the Project, and assess potential impacts and measures to minimise, manage and / or prevent potential adverse impacts on the aquatic ecological values of the waterways, wetlands and stygofauna communities. A desktop review and seasonal aquatic ecology and stygofauna field surveys were completed.

Aquatic habitat in waterways and wetlands in the vicinity of the Project was typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality evident at all sites. During the early-wet season survey in December 2019, sites located on waterways (i.e. creeks and tributaries) were generally dry. However, some isolated dry season refuges were recorded at mapped lacustrine wetlands and unmapped farm dams. During the late-wet season survey in April 2020, most sites in both higher stream order waterways and wetlands contained isolated pools, which would only connect and flow during and following periods of heavy rainfall.

Water quality in waterways and wetlands in the vicinity of the Project was highly variable, which is typical of ephemeral systems in the region. Overall, water quality measured in situ was characterised by neutral to slightly alkaline pH, moderate to high electrical conductivity, variable saturation of dissolved oxygen, and high turbidity. Laboratory-analysed results indicated moderate to high concentrations of nutrients and some metals (particularly aluminium and copper). Concentrations of these parameters were outside of the relevant water quality objectives (WQOs) at several sites during the field surveys.

Sediment quality was moderate to good in the vicinity of the Project. Concentrations of most parameters were below the relevant default guideline values (DGVs) during the surveys, except for chromium and nickel, which exceeded the DGVs or the guideline-value high (GV-high) at some sites in the vicinity of the Project at times.

Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the vicinity of the Project were typical of ephemeral systems in central Queensland. All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water is not likely to persist for the majority of the year (except at wetland and farm dam sites). Macroinvertebrate communities were in low to moderate condition relative to those expected in the broader region, and results indicated that a range of factors influenced communities at most sites (including mining, industrial and / or agricultural pollution, high concentrations of nutrients, and harsh environmental conditions).

Most sites that contained water provided habitat for fish from a range of life-history stages during the late-wet season, including adults, intermediates, and juveniles. Two exotic species of fish were also recorded in the April 2020 survey: Mozambique tilapia (*Oreochromis mossambicus*) and platy (*Xiphophorus maculatus*). Tilapia is listed as a restricted biosecurity matter and a noxious fish under the *Biosecurity Act 2014*; platy is a pest species but is not restricted or prohibited under Queensland legislation.

Turtles were not particularly abundant or widespread in the vicinity of the Project and were only caught in the mapped lacustrine wetland. The species captured (Krefft's river turtle) is considered widespread and common throughout waterways in Queensland. No potential habitat for platypus (*Ornithorhynchus anatinus*) was identified.

Results of all aquatic indicators surveyed as part of this assessment were consistent with results from previous aquatic ecology surveys at CVM and in the broader region. No differences were observed in aquatic ecological indicators between sites on mapped potential surface-expression Groundwater Dependent Ecosystems (GDE) and sites on other waterways and wetlands in the region.

Overall, aquatic ecosystem values of waterways and wetlands in the vicinity of the Project were low to moderate, and were considered to be similar to and representative of ephemeral systems in the broader region. Sites on waterways with higher stream orders (i.e. Cherwell Creek and Grosvenor Creek) typically had higher ecological value than sites on waterways with low stream orders (i.e. Horse Creek, Caval Creek and unnamed tributaries). Mapped lacustrine wetlands were assessed as having moderate aquatic ecological value (particularly due to their provision of dry season refuge for aquatic flora and fauna) and palustrine wetlands were assessed as having low aquatic ecological value (as they were dry during the field surveys).

No true stygofauna specimens were recorded from bores sampled during the field survey. This is consistent with the findings of the desktop assessment, which concluded that the aquifer formations within the Project site are unlikely to support diverse stygofauna communities. Stygofauna communities are highly likely to occur further downstream of the Project, in the alluvium associated with the Isaac River and the lower reaches of its major tributaries.

Of the aquatic listed threatened species known to occur in the broader catchment, none were considered likely to occur in the vicinity of the Project. One High Ecological Significance (HES) palustrine wetland, including the associated Wetland Protection Area (WPA), is mapped approximately 20 km downstream of the Project. This wetland is a Matter of State Environmental Significance (MSES). However, it was dry during the field survey and was assessed as having low habitat value for aquatic flora and fauna, as it was in similar condition to other mapped palustrine wetlands in the vicinity area and would rarely be inundated (and therefore would rarely provide aquatic habitat).

Waterways in the vicinity of the Project are mapped as waterways providing for fish passage in the *Queensland Waterways for Waterway Barrier Works* spatial layer, with a low, moderate, high and major risk of adverse impacts to fish passage as a result of waterway barrier works. Water resources within the Project footprint included waterways (all of which were stream order one and highly ephemeral) and a farm dam (which was modified by the presence of a dam wall). Water resources downstream of the Project footprint included waterways (all of which were ephemeral in vicinity of the Project), lacustrine wetlands and farm dams (all of which were modified by the presence of dams), palustrine wetlands (all of which were dry during the field surveys), mapped potential aquatic (i.e. surface expression) GDEs, and subterranean GDEs. These water resources are a Matters of National Environmental Significance (MNES) if the action has, will have, or is likely to have a significant impact.

No other aquatic MNES or MSES were identified within the vicinity of the Project.

A number of potential impacts on aquatic ecological values may be associated with the Project, including:

- loss or modification of aquatic habitat, flora and fauna within the pit extension area and zone for dragline crossing
- temporary loss of minor waterway to be relocated
- changes to aquatic habitat (e.g. loss of habitat features) adjacent to and downstream of the Project
- altering fish passage via loss of sections of waterways and at water crossings, specifically the extension of the haul road requiring a bridge over Horse Creek and (where the location B option is selected for the blasting compound) a medium vehicle access road to the relocated blasting compound requiring a crossing over the existing Horse Creek diversion (although there is another route option also being considered)
- changes to flow and flood regimes or waterways and wetlands downstream of the Project as a result of loss of catchment
- changes to water and sediment quality associated with vegetation and excavation works, dust and particulate matter, surface water run-off, controlled and overflow releases, seepage and saline or acid drainage
- leaks and spills of contaminants
- production of litter and waste, and
- proliferation of aquatic pests.

Changes to groundwater quantity, quality, and interactions are not expected in the unconsolidated sediments of the Isaac River alluvium, in the lower reaches of the Isaac River and at the confluences of larger tributaries (i.e. where stygofauna communities are likely to occur). Therefore, no impacts to stygofauna communities are expected as a result of the Project.

Implementation of the following management measures would mitigate or minimise adverse impacts on aquatic ecology associated with the Project:

- limiting areas disturbed at any one time; progressive and timely reinstatement of the disturbed landform
- avoiding waterway crossings, where possible, or to consider fish passage and flow in crossing designs
- ensuring earthworks and stockpiles are planned (and minimise where possible), including stormwater directed away from waterways
- designing and constructing infrastructure in accordance with the principles in existing strategies and management plans, including the existing Erosion and Sediment Control Plan (ESCP), as well as best practice procedures
- adhering to conditions of the existing Environmental Authority (EA), undertaking the receiving environment monitoring program (REMP) annually, utilising water management systems and complying with management plans developed for the management of water, waste, hydrocarbons and contaminants and pests.

Overall, where these mitigation measures are implemented, potential direct and indirect impacts were considered acceptable, with a low risk of residual impacts to aquatic ecosystem values. Furthermore, no significant impacts to water resources are expected as a result of the Project.

1 Introduction

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) for SLR Consulting Australia (SLR) on behalf of BM Alliance Coal Operations Pty Ltd (BMA) and describes the existing aquatic environment for the Caval Ridge Mine (CVM) Horse Pit Extension Project (the Project). It also assesses the potential impacts associated with the Project on aquatic ecological values and stygofauna communities, and outlines proposed measures to minimise, manage or prevent potential adverse impacts.

1.1 Project Background

CVM is an existing open-cut coal mine located approximately five km south-west of Moranbah in the Bowen basin region of central Queensland (**Figure 1.1**). It is owned and operated by BMA, on behalf of the Central Queensland Coal Associates Joint Venture (CQCA JV) and has been in operation since 2014. Operations at CVM are carried out under the conditions of EA EPML00562013 and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Approval (2008/4417).

The CVM includes two pits: Horse Pit (north of Peak Downs Highway) and Heyford Pit (north of Harrow Creek), both located within Mining Lease (ML) 1775. Existing infrastructure is located primarily within ML 70403 and ML 70462. The CVM Environmental Impact Statement (EIS) (2010) and approval was based on a 30-year mine plan across defined extents for Horse Pit and Heyford Pit. Due to changes in mine sequencing, improvement in mining efficiency and further resource definition, an extension to the approved mining footprint of Horse Pit is required to continue mining. The Project involves an extension of the footprint of the existing Horse Pit at the CVM.

The key mining elements of the Project include:

- extension of the existing Horse Pit beyond the approved extent (exclusive of Moranbah Airport and Moranbah Access Road)
- maximum CVM Run-of-Mine (ROM) coal production up to 15 million tonnes per annum (Mtpa) CVM Life of Mine (LOM) to Financial Year (FY) 2056
- development of an Out of Pit Dump (OOPD) in the north-west of ML 70403 (commencing in FY2028)
- continuation of progressive rehabilitation of disturbed areas with the aim of progressing to a final landform design, including a final void of approximately 680 hectares (ha) in the far east of ML 1775 at the conclusion of mining
- continuation of current open cut mining techniques employed at CVM
- continuation of progressive disposal of mining waste and Coal Handling and Processing Plant (CHPP) rejects to In Pit Spoil Dumps (IPDs) and to the proposed OOPD (commencing in FY2028), and
- continued use of the existing accommodation and workforce strategy.

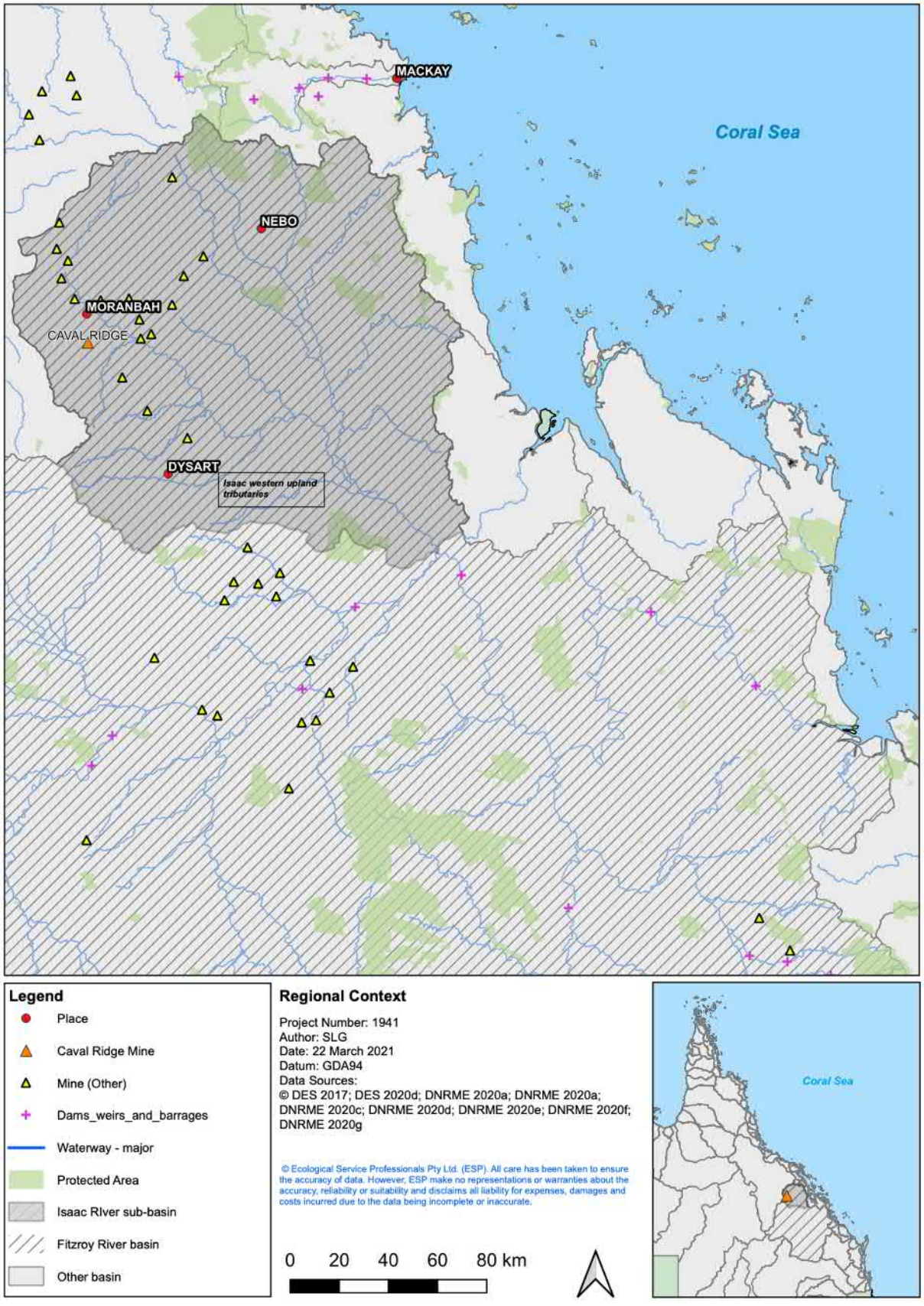

Figure 1.1 Regional Context

The key mine infrastructure elements of the Project include:

- relocation of enabling infrastructure, including: an EME Build Pad, blasting compound, go-lines, substations, back-access roads and powerlines as required by the progress of mining
- extension of the haul road to access the proposed OOPD in the north-west of ML 70403 including the construction of a bridge over Horse Creek
- construction of two flood levees: the northern levee bounds a portion of Horse Pit and the western levee is located at the south-west extent of the proposed OOPD
- relocation of mine water dams and pipelines as required by the progress of mining
- extension of sediment dam capacities and construction of new sediment dams, clean water diversion drains and mine affected water (MAW) drains to manage runoff associated with the proposed OOPD
- relocation of the Peak Downs Highway dragline crossing
- continued use of the CHPP complex (no upgrades to the CHPP are required as a result of the Project)
- continued disposal of dewatered tailings and rejects within spoil, and
- continued use of the conveyor from Peak Downs Mine, Caval Ridge rail spur, train load-out facility, product coal stockpiles, ROM stockpiles, IPDs, water management system and supporting infrastructure (i.e. roads, powerlines, laydown, workshops and offices).

1.2 Scope of the Assessment

The purpose of this aquatic ecology report is to:

- summarise aquatic flora and fauna known or likely to occur in the vicinity of the Project, as informed by the desktop review and results from comprehensive seasonal surveys
- detail the aquatic ecological condition of waterways and potential surface expression GDEs in the vicinity of the Project
- assess the potential likelihood of occurrence of any aquatic MNES and MSES in the vicinity of the Project
- summarise stygofauna communities known from or likely to occur in the groundwater aquifers of the region, as informed by the desktop review and results from two stygofauna pilot studies
- assess the risk and magnitude of potential impacts of the Project on the aquatic ecological values of the waterways and on stygofauna communities, and
- outline proposed measures to minimise, manage and / or prevent potential adverse impacts.

1.3 Description of the Study Area

1.3.1 Waterways and Wetlands in the Vicinity of the Project

A waterway is defined under the *Fisheries Act 1994* (Fisheries Act) as freshwater and tidal waters, both permanent and ephemeral, including a drainage feature, river, creek, stream, watercourse or inlet of the sea. There are several waterways in the vicinity of the Project (**Figure 1.2**). These include:

- an unnamed waterway and its associated tributaries, the headwaters of which are located within the south eastern part of the Project footprint. These waterways flow in a south easterly direction, joining Cherwell Creek approximately 3.5 km downstream of the Project.
- Horse Creek, the tributaries of which originate to the west of CVM and flow in a north easterly direction around the western boundary of CVM and join Grosvenor Creek approximately 2.5 km downstream of the Project. Horse Creek has been historically diverted around active mining areas, however an undiverted reach and several of its tributaries flow through the Project footprint.
- Grosvenor Creek, which originates to the north west of CVM and flows in an easterly direction joining the Isaac River approximately 7 km downstream. It is not within the Project footprint but is downstream of it.
- the Isaac River, which is located to the east of the Project and Cherwell Creek, which flows to the south of the Project. Neither are within the Project footprint but are located downstream of it; the Isaac River is approximately 9.5 km downstream of the Project at its confluence with Grosvenor Creek; and Cherwell Creek is approximately 3.8 km downstream of the Project at its confluence with the unnamed waterway.

In addition to waterways, one mapped lacustrine wetland considered to be modified by the presence of a farm dam is located downstream of the Project. Several farm dams that are unmapped but may provide aquatic habitat are located upstream, within and downstream of the Project. Mapped palustrine wetlands are also mapped in the region, none of which are within the Project footprint. One wetland of High Ecological Significance (HES), regulated under the *Environmental Protection Act 1994* (EP Act), is located on a mapped palustrine wetland approximately 20 km east (downstream) of the Project footprint. The HES wetland incorporates the mapped wetland and Wetland Protection Area (WPA) (**Figure 1.2**).

1.3.2 Watercourses in the Vicinity of the Project

A watercourse is defined under the *Water Act 2000* (Water Act) as a river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events, and does not include drainage features (that lack a natural or artificial channel). The Isaac River as well as Horse Creek (within and downstream of the Project footprint) and Grosvenor Creek are 'watercourses' as defined by the Water Act (**Figure 1.3**). The upstream reaches of Horse Creek are unmapped under the Water Act and the tributaries of Horse Creek that flow within the Project footprint are stream order one and two waterways that are also unmapped under the Water Act.

1.3.3 Isaac River Sub-Basin

These waterways and wetlands are all within the Isaac River sub-basin, which is part of the wider Fitzroy River basin (**Figure 1.1**). The Isaac River sub-basin covers an area of approximately 22,364 square kilometres (km^2). The Isaac River originates north of Moranbah in the Great Dividing Range and flows in a south-easterly direction, flowing adjacent to the Project and eventually discharging into the Mackenzie River, approximately 150 km downstream of the Project. Ultimately, the Mackenzie River joins the Dawson River to form the Fitzroy River, which flows initially north and then east towards the east coast of Queensland and discharges into the Coral Sea southeast of Rockhampton approximately 315 km downstream of the Project (**Figure 1.1**). The waters of the Isaac River sub-basin are included in Schedule 1 of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (WWB)). Under this document, they are classified as being within the Isaac western upland tributaries sub-catchments (DEHP 2011b; **Figure 1.1**). Several of the waterways and wetlands in the vicinity of the Project (upstream and downstream of the Project footprint) are mapped as moderate and high potential surface-expression groundwater dependent ecosystems (GDEs) (refer to **Section 4.7**).

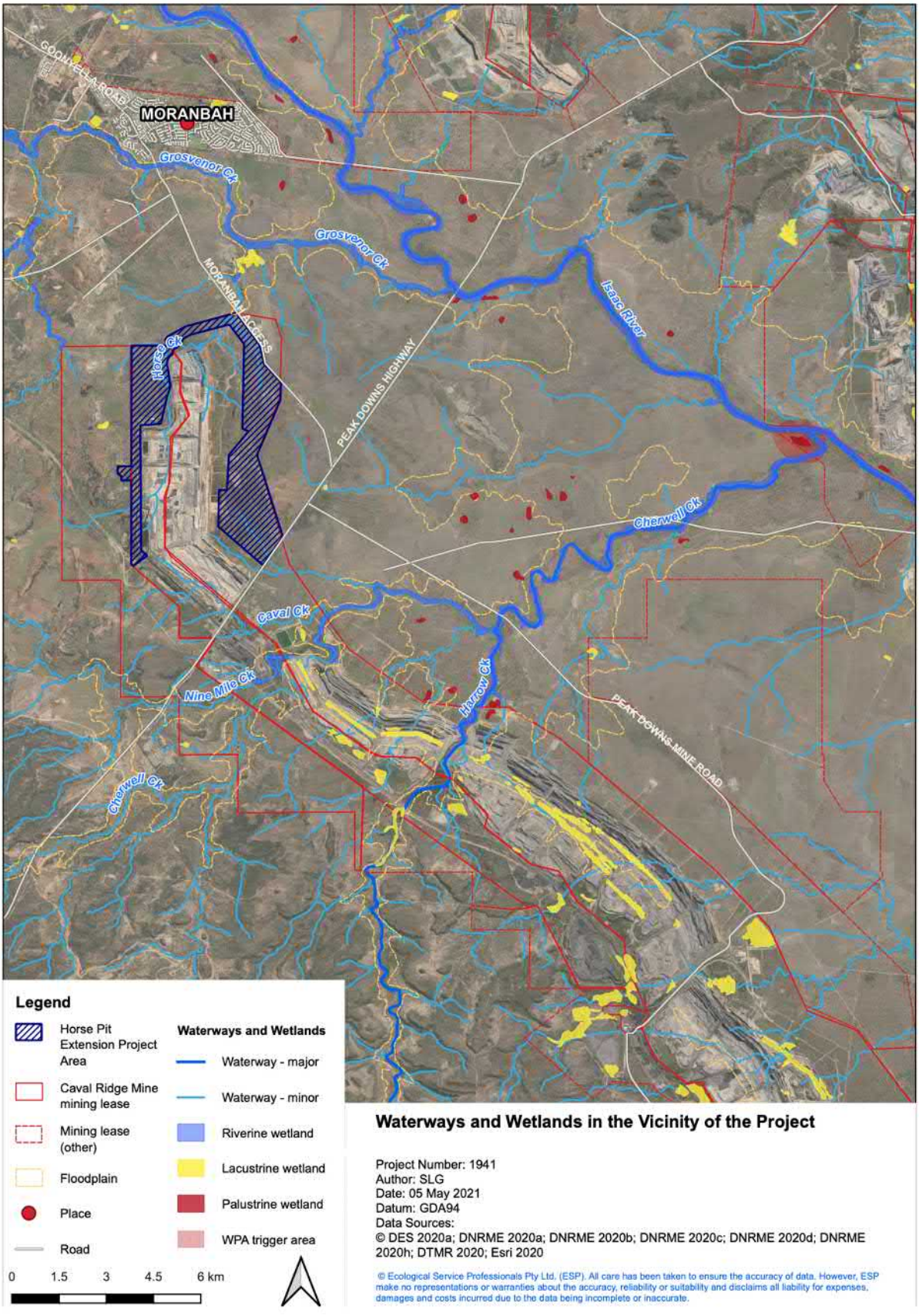

Figure 1.2 Waterways and wetlands in the vicinity of the Project

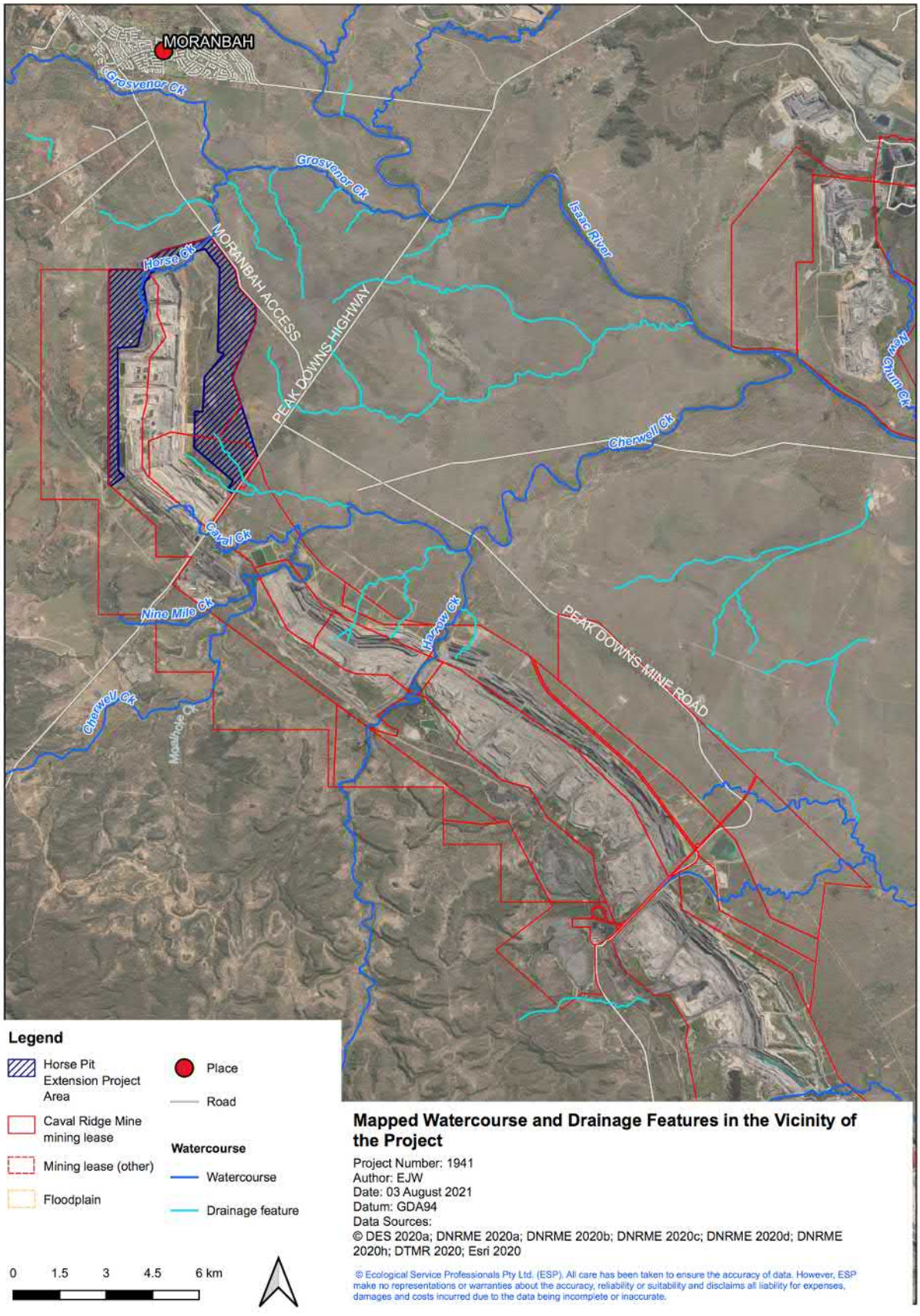

Figure 1.3 Mapped watercourses and drainage features in the vicinity of the Project

2 Relevant Legislation, Policies and Guidelines

The relevant legislation, policies and guidelines relating to aquatic habitat, water quality and aquatic flora and fauna in the vicinity of the Project are outlined in **Table 2.1**. In summary, the key items relating to aquatic ecology are:

- the potential presence of listed aquatic species, specifically:
    - Fitzroy River turtle (*Rheodytes leukops*)
    - white-throated snapping turtle (*Elseya albagula*)
    - silver perch (*Bidyanus bidyanus*), and
    - platypus (*Ornithorhynchus anatinus*).
- the presence of water resources (waterways, wetlands and potential surface expression GDEs) and mapped HES wetlands
- mapped waterways under the *Queensland Waterways for Waterway Barrier Works* spatial layer within and adjacent to the Project footprint (noting that approvals for waterway barrier works are not required within the ML)
- the presence of listed pest species of aquatic plants and animals
- environmental values (EVs) of waterways and Water Quality Objectives (WQOs) for the protection of the relevant EVs, and
- the presence of mapped watercourses and drainage features under the Water Act on the *Watercourse Identification Map* (WIM).

Murray cod (*Maccullochella peelii*) and Australian lungfish (*Neoceratodus forsteri*) are known from the wider Fitzroy River basin; however, there are no records of these species from within the Isaac River sub-basin and they are highly unlikely to occur in the vicinity of the Project due to lack of suitable habitat. Therefore, these species are not considered further.

Regional ecosystems, a MSES protected under the Queensland *Vegetation Management Act 1999*, including those associated with waterways and wetlands, are assessed in the **Significant Impact Assessment Report – Terrestrial Ecology** (E2M 2021) and not considered in this report.

Table 2.1 Summary of relevant legislation, policies and guidelines relating to aquatic ecology that are relevant to the Project

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the EPBC Act *Environmental Offsets Policy* (EO Policy)	Provides for the protection and management of nine matters of national environmental significance (MNES).	Relevant MNES include: • the potential for listed threatened aquatic species to occur, and • water resources (including GDEs) in relation to coal seam gas development and large coal mining development.	The potential for aquatic MNES to occur in the vicinity of the Project is discussed in **Section 4.9**, with no significant impacts expected, as discussed in **Section 6.14**. GDEs are assessed in **Section 4.7.** The requirement for environmental offsets (relating to aquatic ecology) are not considered in this report as significant impacts to MNES are not expected and therefore offsets are unlikely to be required.
Queensland			
Environmental Protection Act 1994 (EP Act) and the subordinate *Environmental Protection Regulation 2019* (EP Regulation)	Provides the basis for effective and efficient management of the natural environment within the context of ecologically sustainable development.	Regulates resource activities, including mining, and provides an approval system (EAs) for environmentally relevant activities (ERAs).	The character, resilience and values of waterways and wetlands, including MSES, fish passage and HES wetlands, are described in **Sections 4** and **5**, with no significant impacts expected following mitigation as described in **Section 6.**

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
EP Act and the subordinate *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (WWB))	Seeks to protect the quality of natural waters in Queensland while supporting ecologically sustainable development.	Environmental Values (EVs) and Water Quality Objectives (WQOs) have been defined for the Isaac River sub-basin under Schedule 1 of the EPP (WWB). A HES wetland (designated as a wetland protection area (WPA) in Great Barrier Reef catchments) is mapped downstream of the Project footprint near the confluence of Cherwell Creek and the Isaac River. There are no high ecological value (HEV) waterways or wetlands within the Project footprint or the broader study area.	The aquatic ecological values of wetlands and waterways protected under the EPP (WWB) are described in **Sections 4.2**, **4.7** and **4.10**. The results of water quality and sediment quality sampling are provided in **Sections 4.2.3** and **4.3.2**. The aquatic ecological values of habitats comprising the HES wetland are described in **Sections 4.1.2.3** and **4.10.3**. No significant impacts to aquatic ecological values are expected following mitigation as described in **Section 6.**
Environmental Offsets Act 2014 (Offsets Act) and the subordinate *Environmental Offsets Regulation 2014* (Offsets Regulation)	Seeks to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets.	An environmental offset may be required as a condition of approval where, following consideration of avoidance and mitigation measures, a prescribed activity is likely to result in a significant residual impact on a prescribed environmental matter(s).	The requirement for environmental offsets (relating to aquatic ecology) are not considered in this report as significant residual impacts to MSES are not expected and therefore offsets are unlikely to be required.
Fisheries Act 1994 (Fisheries Act) and the subordinate	Seeks to achieve economically viable, socially acceptable and ecologically sustainable development of Queensland's	Waterway barrier works approval may be required if new waterway crossings are constructed or existing crossings are modified	The fish habitat value of the waterways in the vicinity of the Project are summarised in **Sections 4.6.1**, **4.8.2** and **4.10**.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Fisheries Regulation 2008	fisheries resources. Measures are designed to protect fisheries resources, include regulation of waterway barrier works, declaration of fish habitat areas and protection of marine plants.	outside of the Mining Lease but as part of the Project. Waterway barrier works approval under the Fisheries Act is not required within the Mining Lease, however waterways within and adjacent to the Project footprint are mapped on the *Queensland Waterways for Waterway Barrier Works* spatial layer and so consideration should be given to the impact to fish passage from the Project.	Significant impacts to fish passage are not expected following mitigation as described in **Section 6.4.**
Nature Conservation Act 1992 (NC Act) and subordinate *Nature Conservation (Wildlife) Regulation 2006* (NCWR)	Provides for the protection of endangered, vulnerable and near threatened species of flora and fauna as listed under the NCWR.	Listed threatened aquatic species are present in the Isaac River sub-basin.	The potential for listed threatened aquatic species to be present within the study area is discussed in **Sections 4.8.3** and **4.9.1**. Significant impacts to are not expected as described in **Section 6.15.**
Biosecurity Act 2014	Provides a framework for the improved management of weeds and pest animals.	Potential aquatic pest plants (also recognised nationally as Weeds of National Significance (WoNS)) and pest animals that could have an adverse economic, environmental or social impact are present in the Isaac River sub-basin.	The potential for aquatic pest species in the vicinity of the Project is discussed in **Sections 4.4** and **4.6**. Weeds and pests will be managed as outlined in **Section 6.12** and significant impacts are not expected.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Planning Act 2016 (Planning Act)	Establishes a system for land use planning, development assessment and related matters that facilitates the achievement of ecological sustainability.	The Planning Act does not apply to development authorised under the *Mineral Resources Act 1989*, unless the development is on a Queensland heritage place or involves work under the *Building Act 1975*.	Not relevant for the Project, as the Planning Act is only relevant where there are works outside of the mining lease.
Water Act 2000	Provides for the sustainable management of water resources, including sustaining the health of ecosystems, water quality, water-dependent ecological processes and biological diversity associated with watercourses, lakes, springs, aquifers and other natural water systems (including, where practicable, reversing degradation that has occurred). Empowers the State to plan for the sustainable management of water through water plans and water use plans (i.e. Water Plans (formerly Water Management Plans) and Water Management Protocols (formerly Resource Operations Plans)).	A riverine protection permit (RPP) is required to excavate, or place fill in a watercourse, lake or spring, and may be required if the RPP exemption requirements cannot be complied with. A Water Licence may be required to interfere with watercourses. Waterways in the Project footprint are mapped on the *Watercourse Identification Map* (WIM), including: • a section of Horse Creek which is mapped as a watercourse • unnamed tributaries of Cherwell Creek which are mapped as drainage features • unnamed tributaries of Horse Creek which are unmapped.	The aquatic ecological values of mapped watercourses are shown on **Figure 6.1**, and described in **Section 4**, and specifically **Section 4.10**. The Project does not involve excavation or placing fill in a watercourse, lake or spring or interfering with watercourses outside of the mining lease. If activities proposed on-lease trigger an RPP and do not comply with the RPP exemption requirements then an RPP or water license will be required.

3 Methods

3.1 Aquatic Ecology Assessment

3.1.1 Desktop Literature Review

A comprehensive desktop assessment was completed to describe the aquatic habitat, flora and fauna of the region. The following sources were reviewed:

- EPBC Act Protected Matters Search Tool and the Queensland Wildlife Online database to determine the aquatic species (including listed threatened species) that are known or are likely to occur in the waterways within 50 km of the Project
- database searches of the species occurring in the area, including the Atlas of Living Australia and the Queensland Government's Wetland Info species lists for the Isaac River sub-basin and Fitzroy River basin
- publicly available water quality data from the Queensland Government's Water Monitoring Information Portal
- existing mapping of the aquatic ecological values in the vicinity of the Project, including the Queensland Government's Queensland Wetland Program mapping, Waterways for Waterway Barrier Works spatial layer and the Watercourse Identification Map
- aquatic ecology baseline assessments for CVM completed in 2008 (BAAM 2009); the CVM Receiving Environment Monitoring Program (REMP) reports for 2016 – 2017 (Gauge Industrial and Environmental 2018) and 2018 – 2019 (Gauge Industrial and Environmental 2020); and the CVM Aquatic Ecosystem Health Program (AEHP) reports for 2018 (CQU 2018) and 2019 (CQU 2019), and
- publicly available reports from aquatic ecology assessments completed in the region.

3.1.2 Field Surveys

3.1.2.1 Survey Timing

In order to adequately describe the range of aquatic ecological values present in the vicinity of the Project, as well as identify any important dry season refuges, field surveys were completed in both the early wet season and the late wet season. An additional aquatic habitat survey was completed in the early wet season. Climate data for the region (BOM 2020a) and data for rainfall recorded from the CVM on-site gauging station at Buffel Park, and flow recorded in Cherwell Creek from the CVM gauging stations located upstream and downstream of CVM were used to describe the environmental conditions leading up to and during each survey.

The 2019 early wet season aquatic ecology survey was completed from 9 to 12 December 2019 (hereafter referred to as the December 2019 survey). The weather was dry and sunny with temperatures ranging from 25 to 40 °C (BOM 2020a). Rainfall leading up to the survey was low (less than 10 millimetres (mm) recorded at the CVM on-site gauging station in the month prior to the survey) (**Figure 3.1**). The region experienced prolonged dry conditions for

some time prior to the survey. The wettest months of the year for the region are typically between October and March (i.e. the wet season); in the 2018/2019 wet season significant rainfall (more than 100 mm) was recorded only in March 2019, while less than 100 mm was recorded in all other months. Flow in the region is typically reflective of rainfall. In the month leading up to the December 2019 survey, no flow was recorded upstream of the Project but minor flows were recorded downstream (**Figure 3.2**; **Figure 3.3**).

The 2020 late wet season aquatic ecology survey was completed from 31 March to 4 April 2020 (hereafter referred to as the April 2020 survey). The weather was dry and sunny with temperatures ranging from 17 to 35°C (BOM 2020a). There was moderate rainfall recorded in the period leading up to the survey. The last few months of 2019 were very dry, with less than 10 mm of rainfall recorded each month (**Figure 3.1**). However, over 120 mm was recorded in January, 90 mm was recorded in February and 50 mm was recorded at the beginning of March (**Figure 3.1**). No rainfall was recorded in the three weeks prior to the survey. The 2020 wet season rainfall was considered a relatively dry wet-season for the region (less than 300 mm was recorded; whereas long-term data for Government gauging stations in the region indicated between 350 and 550 mm of rainfall is usually recorded in the wet-season (BOM 2020b)). However, the survey took place within an appropriate period of time after significant rainfall events to capture post-wet season conditions. In addition, flows were recorded in January, February and March in Cherwell Creek at both upstream and downstream gauging stations (**Figure 3.2**; **Figure 3.3**).

The 2020 early wet season aquatic ecology survey was completed from 23 to 27 November 2020 (hereafter referred to as the November 2020 survey). The weather was dry and sunny with temperatures ranging from 17 to 40°C (BOM 2020a). There was low rainfall recorded in the period leading up to the survey; a total of 4.8 mm recorded in November 2020, with 1.2 mm of rainfall recorded in the week prior to the survey (**Figure 3.1**). The region had experienced lower than average rainfall during the 2019 / 2020 wet season with only January 2020 recording more than 100 mm.

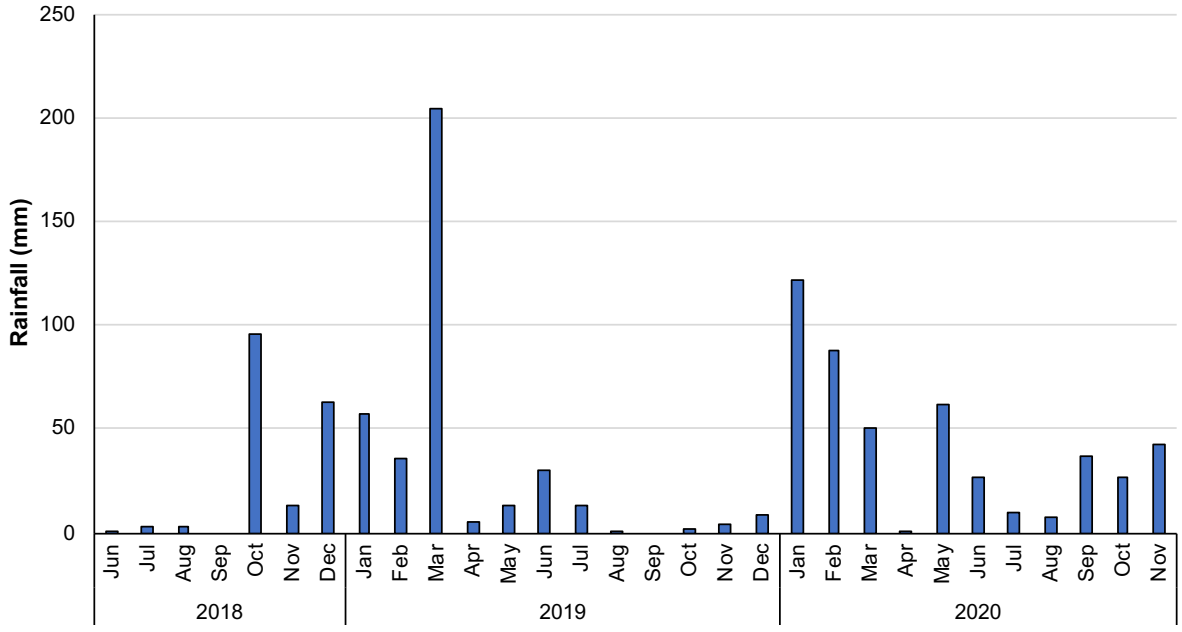

Figure 3.1 Monthly total rainfall recorded at by CVM at Buffel Park leading up to the December 2019, April 2020 and November 2020 surveys

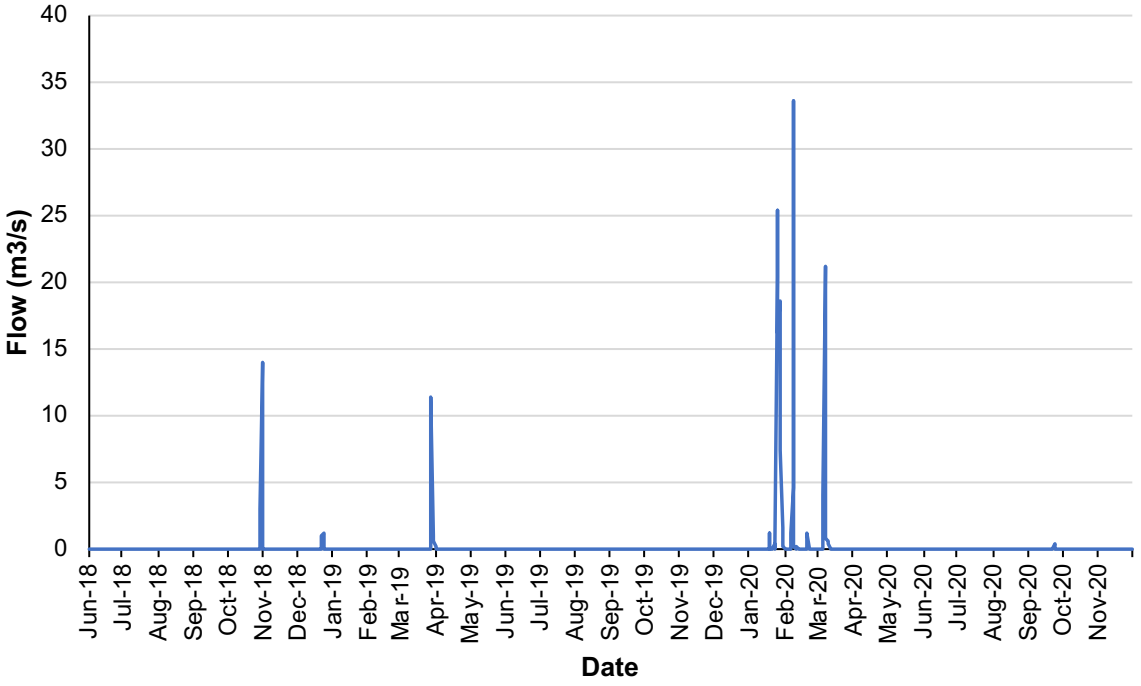

Figure 3.2 Maximum daily stream flow in Cherwell Creek recorded at the upstream gauging station leading up to the December 2019, April 2020 and November 2020 surveys

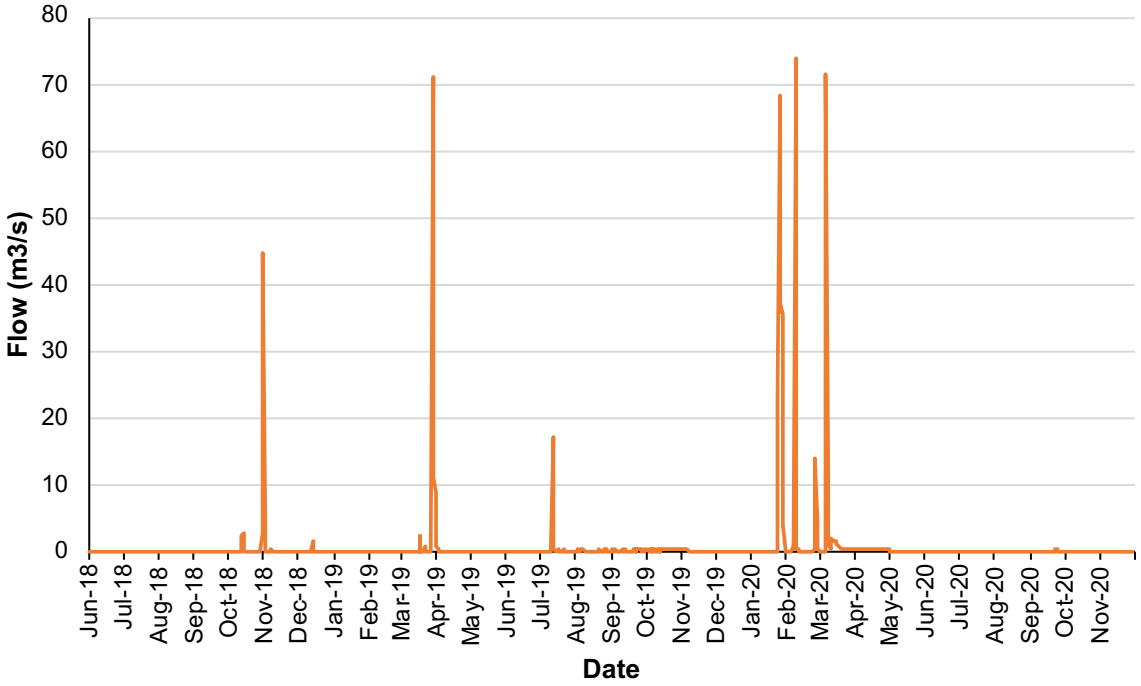

Figure 3.3 Maximum daily stream flow in Cherwell Creek recorded at the downstream gauging station leading up to the December 2019, April 2020 and November 2020 surveys

3.1.2.2 Site Locations

In total twenty-four sites were surveyed, located upstream, within and downstream of the Project (**Table 3.1**; **Figure 3.4**). Not all sites were sampled during all surveys. In December 2019, 14 sites were surveyed and in April 2020, 15 sites were surveyed, including two new sites to align with changes in the Project footprint which occurred between surveys (**Table 3.1**). In November 2020, eight new sites were surveyed to assess aquatic habitat at additional surface water sites.

At comprehensive aquatic ecology assessment sites (i.e. sites marked “C” in **Table 3.1**), a wide range of indicators were assessed in December 2019 and April 2020, which included: aquatic habitat, in-situ and analytical water quality (if water was present), sediment quality, aquatic plants, macroinvertebrates (if water was present), fish (if water was present) and turtles (if water was present and appropriate habitat was identified) and aquatic ecological value. A sub-set of indicators were surveyed at habitat assessment sites (which were all dry) in December 2019 and April 2020, including: aquatic habitat, aquatic plants and aquatic ecological value. In November 2020, only aquatic habitat was surveyed at the additional surface sites.

Aquatic ecological indicators surveyed at each site during the field surveys is presented in **Table 3.1**. The methodologies for each aquatic ecological indicator were in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a) unless modified to suit the objectives of the assessment and are described in the sections below.

Table 3.1 Site details, assessment completed and ecological indicators sampled for at each site surveyed in December 2019, April 2020 and November 2020

					Dec 2019								Apr 2020								Nov 2020
Site	Description	Latitude	Longitude	Assessment Type	Habitat	Water Quality	Sediment Quality	Fish	Turtles	Macroinvertebrates	Aquatic Plants	Habitat	Water Quality	Sediment Quality	Fish	Turtles	Platypus (visual)	Macroinvertebrates	Aquatic Plants	Habitat
Upstream																				
U1	Unnamed waterway, 1 km upstream of CVM	-22.1139	148.0288	*H*	Y^	NS	–	–	–	–	Y	Y^	NS	Y	–	–	–	–	Y	–
U1D	Farm dam on unnamed waterway, 0.5 km upstream of CVM	-22.1129	148.0333	*C*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	–
U2	Caval Creek, 0.5 km upstream of CVM	-22.1379	148.0403	*C*	Y^	NS	Y	–	–	–	Y	Y^	NS	Y	–	–	–	–	Y	–
U3	Unnamed waterway, 0.25 km upstream of CVM	-22.1789	148.0865	*H*	–	–	–	–	–	–	–	Y^	NS	–	–	–	–	–	Y	–
Ca1	Caval Creek, downstream of diversion	-22.1439	148.0821	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	Y	NS	NS	Y	Y	–
Ch1	Cherwell Creek, 1.5 km upstream of CVM	-22.1771	148.0667	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	Y	Y	Y	Y	Y	–
Ch2	Cherwell Creek, downstream of CVM and upstream of the Project site	-22.1451	148.0919	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	Y	NS	NS	Y	Y	–
GC01	Grosvenor Creek approximately 5 km upstream of the confluence with Horse Creek	-22.0138	148.0431	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y
GC02	Grosvenor Creek approximately 700 m upstream of the confluence with Horse Creek	-22.0342	148.0671	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y^
IR01	Isaac River 2 km upstream of confluence with Grosvenor Creek	-22.0343	148.1157	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y^
HC01	Harrow Creek downstream of CVM but upstream of the Project site	-22.1599	148.1409	*H**																Y^
LW2	Lacustrine wetland on unnamed tributary downstream of CVM but adjacent to Project site	-22.1530	148.1699	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y
Within Project Footprint																				
HT1D	Farm dam on tributary of Horse Creek within Project site	-22.0609	148.0679	*C*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	–

Site	Description	Latitude	Longitude	Assessment Type	Dec 2019								Apr 2020							Nov 2020
					Habitat	Water Quality	Sediment Quality	Fish	Turtles	Macroinvertebrates	Aquatic Plants	Habitat	Water Quality	Sediment Quality	Fish	Turtles	Platypus (visual)	Macroinvertebrates	Aquatic Plants	Habitat
Downstream																				
H1	Horse Creek within Horse Pit	-22.0654	148.0570	*C*	Y^	NS	Y	–	–	–	Y	Y^	NS	Y	–	–	–	–	Y	–
ChT1	Tributary of Cherwell Creek downstream of Project site	-22.1296	148.0828	*H*	–	–	–	–	–	–	–	Y^	NS	–	–	–	–	–	Y	–
LW1	Lacustrine wetland on Horse Creek downstream of Project site	-22.0379	148.0722	*C*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NS	Y	Y	–
G1	Grosvenor Creek downstream of Project site	-22.0384	148.1013	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	Y	Y	Y	Y	Y	–
Ch3	Cherwell Creek downstream of CVM	-22.1356	148.1108	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	NS	NS	NS	Y	Y	–
Ch4	Cherwell Creek downstream of its confluence with Harrow Creek	-22.1310	148.1551	*C*	Y^	NS	Y	–	–	–	Y	Y	Y	Y	Y	NS	NS	Y	Y	–
PW1	WPA / HES wetland downstream of the Project site and downstream of confluence of Harrow Creek	-22.0932	148.2282	*C*	Y^	NS	Y	–	–	–	Y	–	–	–	–	–	–	–	–	–
PW2	Palustrine wetland downstream of the Project site and the confluence of Harrow Creek	-22.1306	148.1478	*H*	Y^	NS	–	–	–	–	Y	Y^	NS	–	–	–	–	–	Y	–
GC03	Grosvenor Creek 1.8 km downstream of confluence with Horse Creek	-22.0358	148.0889	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y^
GC04	Grosvenor Creek 4 km downstream of confluence with Horse Creek	-22.0427	148.1064	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y^
IR02	Isaac River downstream of confluence with Grosvenor Creek and Peaks Down Highway	-22.0499	148.1306	*H**	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Y^

Assessment type: C = comprehensive assessment sites surveyed in December 2019 and April 2020, including aquatic habitat, sediment quality, aquatic plants, and where water was present in-situ and analytical water quality, macroinvertebrates, fish and turtles; H = habitat assessment (dry) sites surveyed in December 2019 and April 2020, including aquatic habitat and aquatic plants; H* = additional sites in November 2020, included habitat (including in-situ water quality) only

^ Site dry at the time of the survey

– Not surveyed

Y Indicator sampled

NS Indicator not sampled as appropriate habitat features or sufficient water not available

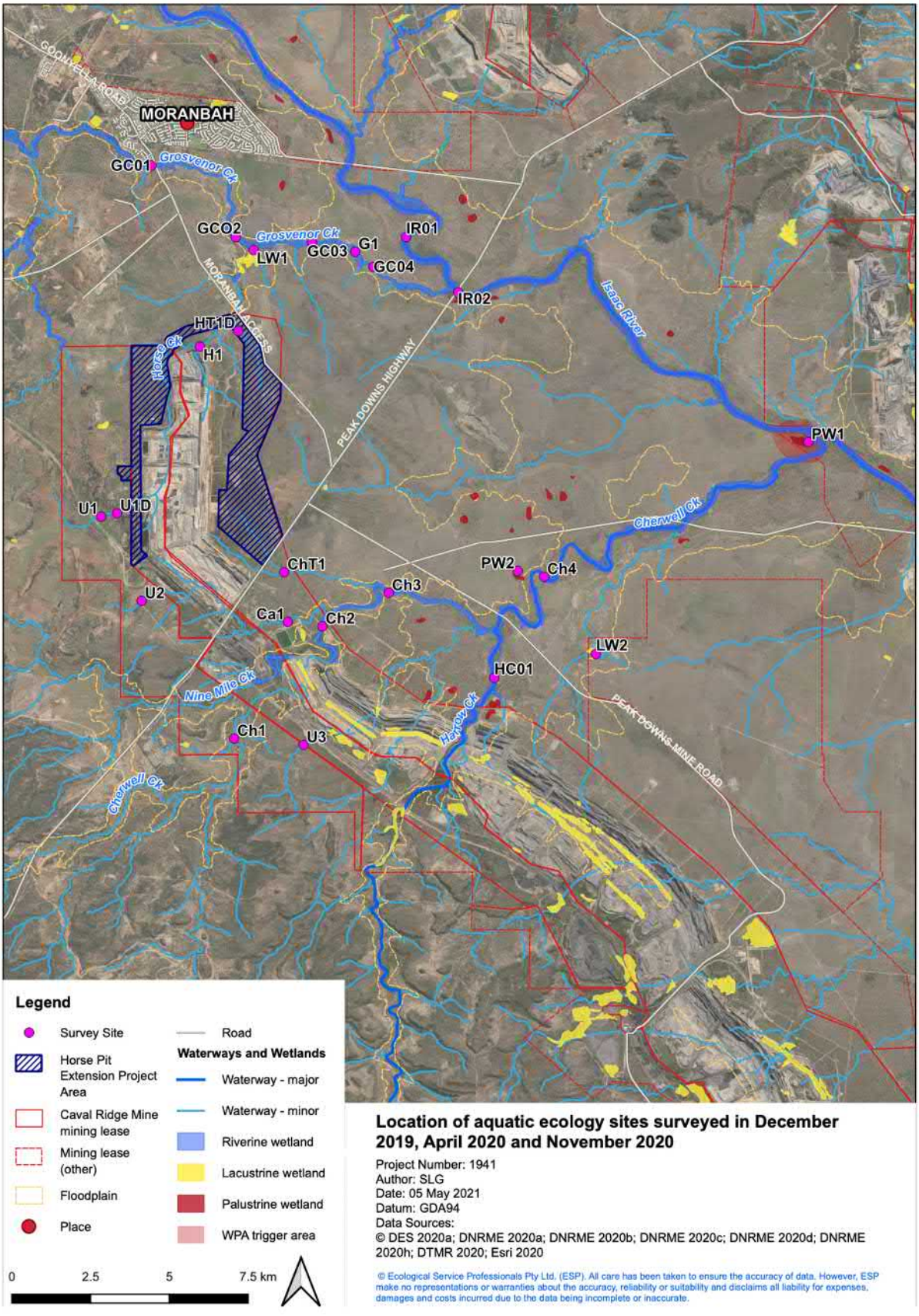

Figure 3.4 Location of aquatic ecology sites surveyed in December 2019, April 2020 and November 2020

3.1.2.3 Aquatic Habitat

Aquatic habitat assessments were completed to describe the aquatic habitat condition, connectivity and ecosystem value of each site. Assessments were based on the Australian River Assessment System (AUSRIVAS) habitat assessment protocol, modified where required to suit the purpose of this assessment. Observations included:

- features of the water body, including bank height, estimate of flow, estimated width and depth of any standing water present
- details of the riparian zone (e.g. width, canopy height, species present) and adjacent land use
- aquatic habitat types present and their relative per cent cover within the reach
- details of the sediment types present (e.g. relative composition of grain sizes, presence of anoxic sediments)
- details regarding any evidence of disturbances or impacts (if present) on aquatic ecosystems, and
- overall habitat condition and value.

Physicochemical water quality was measured as outlined in **Section 3.1.2.4** to assist interpretation of habitat assessments. Habitat assessments were completed using an electronic template to avoid transcription errors. Georeferenced photographs of the reach and key habitat features were also taken at each site. The aquatic habitat at each site was summarised and used to assist interpretation of the biological survey results.

In April 2020, at each site holding water (excluding wetland and dam sites), overall habitat condition was assessed based on the river bioassessment score protocol described in the *Queensland AUSRIVAS Sampling and Processing Manual* (DNRM 2001). Each site was given a numeric score for a number of criteria. The sum of the numerical score from each criterion produced an overall habitat condition score that allocated each site to one of four categories:

- >110 were considered to be in excellent condition
- between 75 and 110 were considered to be in good condition
- between 39 and 74 were considered to be in moderate condition, and
- ≤38 were considered to be in poor condition.

3.1.2.4 Water Quality

The surface water quality assessment was not designed as a comprehensive baseline survey of water quality for the Project. Instead, surface water quality data was collected to provide an indication of the condition of water quality at the time of the surveys in order to inform the interpretation of biological survey results.

At each site that held sufficient water (**Table 3.1**), physicochemical water quality (temperature, conductivity, pH, dissolved oxygen and turbidity) was measured using a YSI ProDSS multi-parameter water quality sonde at a depth of approximately 20 cm below the water surface (at each site that held sufficient water). The water quality meter was calibrated prior to field sampling.

At each comprehensive aquatic ecology site that held sufficient water (**Table 3.1**), grab samples were also collected from approximately 30 cm below the water surface and analysed for:

- total dissolved solids (TDS) and total suspended solids (TSS)
- nutrients (total nitrogen, nitrate, nitrite, oxides of nitrogen (NOx), ammonia, organic nitrogen measured as Total Kjeldahl Nitrogen (TKN), reactive and total phosphorous)
- total hardness
- major ions (calcium, fluoride, magnesium, potassium, sodium and sulphate)
- total and dissolved metals and metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc)
- total petroleum hydrocarbons (TPHs), and
- benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN).

Quality assurance / quality control (QA/QC) measures for water quality sampling and analyses were in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a) and the most current versions of other appropriate Australian Standards. This included the use of powder-free nitrile gloves, which were worn during sample container handling, to reduce the risk of sample contamination during collection. All samples were held under the appropriate conditions (e.g. in eskies in the field and during transport) and delivered to ALS Environmental (a NATA accredited laboratory).

A duplicate field sample (i.e. sample split into two) and field method blank were collected from one site during each survey, to determine the variability in results associated with field sampling. A relative per cent difference (RPD) of < 20 per cent between field replicates was considered acceptable (where the values were more than five to ten times the laboratory limit of reporting) (DES 2018a). Laboratory analyses also included quality control measures, including analysis of blanks, spikes and duplicates. A Certificate of Analysis for water quality samples is provided in **Attachment B**.

Results were reviewed, and all parameters below or equal to the laboratory limit of reporting (LOR) at all sites were noted and not considered further. Results for remaining parameters were compared to available water quality objectives (WQOs) adopted from the following hierarchy of sources (**Table 3.2**):

- WQOs for upper Isaac River catchment freshwaters (used for comparison to waterway sites) and lakes/reservoirs (for lacustrine wetland and farm dam sites) scheduled in the EPP (WWB) for the Isaac River sub-basin (DEHP 2013a)
- default guideline values (DGVs) for slightly to moderately disturbed ecosystems for 95 per cent level of protection (unless otherwise recommended) published in the Australian water quality guidelines (ANZG 2018) for toxicants as specified in the EPP (WWB) for the Isaac River sub-basin (DEHP 2013a), and
- trigger levels (TLs) for aquatic ecosystem protection specified in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2018b).

WQOs differed from those outlined in the REMP design document for some parameters given the REMP has been designed for all BMA and BHP Mitsui Coal (BMC) coal mines in the region (BHP 2018), and many of the guidelines are based on adjacent catchment water quality objectives. The REMP guideline values are shown in **Table 3.2** and were used for interpretation of results, where relevant (i.e. where WQOs differed).

Table 3.2 Relevant Water Quality Objectives (WQOs) used for the aquatic ecology assessment (bold) and the REMP WQOs

Parameter	Units	Freshwater [a]	Lakes and Reservoirs [b]	REMP
Physical				
Temperature	°C	**–**	**–**	
pH	pH	**6.5 – 8.5**	**6.5 – 8.0**	6.5 – 8.5 [m]
Electrical conductivity	µS/cm	**720** [c]	**250** [c]	720 [c,n]
Dissolved oxygen	%Sat	**85 –110**	**90 –110**	85 –110 [m]
Turbidity	NTU	**50**	**1 – 20**	50 [m]
Total dissolved solids (TDS)	mg/L	–	–	–
Total suspended solids (TSS)	mg/L	**55**	–	30 [m]
Major Ions				
Total Hardness as $CaCO_3$	mg/L	–	–	–
Sulfate as SO_4	mg/L	**25**	–	5 [m]
Calcium	mg/L	–	–	–
Magnesium	mg/L	–	–	–
Sodium	mg/L	–	–	–
Potassium	mg/L	–	–	–
Fluoride	mg/L	**2**		1000 [o]
Nutrients				
Ammonia	µg/L	**20**	**10**	900 [p]
Nitrite	µg/L	–	–	–
Nitrate	µg/L	–	–	1100 [j]
Oxides of nitrogen	µg/L	**60**	**10**	–
Organic nitrogen	µg/L	**420**	**330**	–
Total nitrogen	µg/L	**500**	**350**	–
Total phosphorous	µg/L	**50**	**10**	–
Filterable reactive phosphorous (FRP)	µg/L	**20**	**5**	–
Metals and Metalloids [d]				
Aluminium	µg/L	**55**		55 [p]
Arsenic	µg/L	**13** [k]		13 [k]
Boron	µg/L	**370**		370 [p]
Cadmium	µg/L	**$0.2x(H/30)^{0.89}$** [e]		0.2 [p]
Chromium	µg/L	**1.0** [l]		1.0 [l]
Cobalt	µg/L	**90** [f]		90 [j]
Copper	µg/L	**1.4**		2 [j]
Iron	µg/L	**300** [g]		300 [j]
Lead	µg/L	**$3.4x(H/30)^{1.27}$** [e]		4 [j]
Manganese	µg/L	**1900**		1900 [p]

Parameter	Units	Freshwater [a]	Lakes and Reservoirs [b]	REMP
Mercury	µg/L	**0.06** [h]		0.2 [j]
Molybdenum	µg/L	**34** [i]		34 [j]
Nickel	µg/L	**11x(H/30)$^{0.85}$** [e]		11 [p]
Selenium	µg/L	**10** [j]		10 [j]
Silver	µg/L	**0.05**		1 [j]
Uranium	µg/L	**1** [j]		1 [j]
Vanadium	µg/L	**10** [j]		10 [j]
Zinc	µg/L	**8.0x(H/30)$^{0.85}$** [e]		8 [p]
Hydrocarbons				
C6 - C9 Fraction	µg/L	**20**		20 [p]
C10 - C14 Fraction	µg/L	–		–
C15 - C28 Fraction	µg/L	–		–
C29 - C36 Fraction	µg/L	–		–
C10 - C36 Fraction (sum)	µg/L	**100**		100 [p]
BTEXN				
Benzene	µg/L	**950**		–
Toluene	µg/L	–		–
Ethylbenzene	µg/L	–		–
Meta- & Para-Xylene	µg/L	–		–
Ortho-Xylene	µg/L	**350**		–
Total Xylenes	µg/L	–		–
Naphthalene	µg/L	**16**		–

[a] WQO for Upper Isaac River catchment moderately disturbed waters (DEHP 2013a), which defaults to the Australian water quality guidelines for toxicants (ANZG 2018), used for comparison to waterway sites, unless otherwise indicated

[b] WQO for Upper Isaac River catchment moderately disturbed freshwater lakes/reservoirs used for comparison to lacustrine wetland and farm dam sites (DEHP 2013a), which defaults to the Australian water quality guidelines for toxicants (ANZG 2018), unless otherwise specified

[c] WQO for base flow conditions (DEHP 2013a)

[d] Specified WQOs to be applied to dissolved metals and metalloids only (ANZG 2018)

[e] WQO modified based on water hardness-dependent algorithm, where H = water hardness (ANZG 2018)

[f] Moderate reliability WQO (ANZG 2018)

[g] Interim WQO based on Canadian guideline value, as per recommendations in ANZG (2018) and adopted in the Model Water Conditions for Coal Mines in the Fitzroy Basin (DES 2018b)

[h] WQOs for 99% of species protection for slightly to moderately disturbed waters as per recommendations (ANZG 2018)

[i] Low reliability WQO, as per recommendations in ANZG (2018) and adopted in the Model Water Conditions for Coal Mines in the Fitzroy Basin (DES 2018b)

[j] TL for aquatic ecosystem protection outlined in the Model Water Conditions for Coal Mines in the Fitzroy Basin (DES 2018b)

[k] WQOs for arsenic V adopted as a conservative approach (ANZG 2018) because analyses did not speciate arsenic

[l] WQOs for chromium VI adopted as a conservative approach (ANZG 2018) because analyses did not speciate chromium

[m] WQO for the Comet River sub-basin waters scheduled in the EPP (WWB) for the Comet River sub-basin (DEHP 2011a)

[n] WQO for the freshwaters scheduled in the Queensland Water Quality Guidelines (DEHP 2013b)

[o] Lower trigger value for irrigation (cotton) (ANZECC & ARMCANZ 2000)

[p] Freshwater guideline values scheduled in the Australian water quality guidelines (ANZECC & ARMCANZ 2000)

3.1.2.5 Sediment Quality

At each comprehensive aquatic ecology site (**Table 3.1**), sediment quality in the stream channel was assessed. A single composite sample was collected from a low-flow stream bank using a stainless steel trowel, in accordance with methods outlined in the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a) and the guide to *Sediment Quality Assessment* (Simpson & Batley 2016). The composite sample comprised five to 10 sediment grabs collected one to 10 metres (m) apart along the length of each site. Samples were collected into suitable glass jars and were not mixed in the field, as this was completed by the laboratory during sample preparation for analysis.

Samples were held under the appropriate conditions (e.g. in eskies in the field and during transport) and delivered to ALS Environmental (a NATA-accredited laboratory) for analysis of:

- particle size distribution
- total organic carbon
- total metals and metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt, copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium and zinc)
- TPHs, and
- BTEXN.

Strict QA/QC protocols were adhered to throughout each stage of sampling, in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a). Powder-free nitrile gloves were worn during sample container handling, to reduce the risk of sample contamination during collection.

During the sediment surveys, one field replicate sample was collected from one site and analysed for the parameters listed above to determine any small scale (i.e. within site) variation. A relative per cent difference (RPD) of < 50 per cent between field replicates was deemed acceptable (DES 2018a). The laboratory also completed quality control measures including analysis of blanks, spikes and duplicates. A Certificate of Analysis report for sediment quality samples is provided in **Attachment B**.

The sediment quality results were reviewed, and all parameters that were below or equal to the laboratory LOR at all sites were noted and not considered further. Results for remaining parameters were compared to the DGVs and guideline value-high (GV-High) (where available) outlined in the ANZG (2018) and Simpson et al (2013) (**Table 3.3**), which were consistent with the sediment quality guidelines outlined in the REMP design document (BHP 2018).

Table 3.3 Default guideline values (DGV) and guideline values-high (GV-High) for sediment quality (ANZG 2018)

Parameter	Unit	DGV	GV-High [a]
Particle Size Distribution	%	–	–
Total Organic Carbon	%	–	–
Metals and Metalloids			
Aluminium	mg/kg	–	–
Arsenic	mg/kg	20	70
Boron	mg/kg	–	–
Cadmium	mg/kg	1.5	10
Chromium	mg/kg	80	370
Cobalt	mg/kg	–	–
Copper	mg/kg	65	270
Iron	mg/kg	–	–
Lead	mg/kg	50	220
Manganese	mg/kg	–	–
Mercury	mg/kg	0.15	1
Molybdenum	mg/kg	–	–
Nickel	mg/kg	21	52
Selenium	mg/kg	–	–
Silver	mg/kg	1	4
Uranium	mg/kg	–	–
Vanadium	mg/kg	–	–
Zinc	mg/kg	200	410
Total Petroleum Hydrocarbons			
C6 - C9 Fraction	mg/kg	–	–
C10 - C14 Fraction	mg/kg	–	–
C15 - C28 Fraction	mg/kg	–	–
C29 - C36 Fraction	mg/kg	–	–
C10 - C36 Fraction (sum)	mg/kg	280	550

– no guideline value exists for this parameter

[a] GV-High to be used as an indicator of potential high-level toxicity problems, not as a guideline value to ensure protection of ecosystems

3.1.2.6 Aquatic Plants

At each comprehensive aquatic ecology site (excluding wetland and dam sites) surveyed in December 2019 and April 2020 (**Table 3.1**), aquatic plant communities were semi-quantitatively assessed using ten replicated quadrats along a 100 m belt transect via visual assessment. The following were recorded in each quadrat:

- the location (i.e. on bank or in stream) of macrophytes,
- macrophyte growth form (i.e. submerged, emergent, floating), and
- per cent cover of each species (both native and exotic).

At wetland and dam sites, aquatic plants were assessed via visual estimates of species diversity and total per cent coverage within the area of the wetland or dam.

For each comprehensive aquatic ecology site, the total taxonomic richness and per cent cover were calculated to inform the interpretation of biological survey results and to assess the overall aquatic ecological value of the site.

For habitat sites surveyed in December 2019 and April 2020, aquatic plant diversity and abundance was not semi-quantitatively assessed but used to assess the overall aquatic ecological value of the site.

3.1.2.7 Aquatic Macroinvertebrates

At each comprehensive aquatic ecology site that held sufficient water (**Table 3.1**), macroinvertebrate communities (including macrocrustaceans) were surveyed to provide an assessment of ecosystem health. One AUSRIVAS sample was collected from a 10 m section of each available habitat type (e.g. bed / pool and edge) using the standard kick-sweep method.

All samples were collected using a standard triangular AUSRIVAS dip net. Samples were transferred into labelled sample jars, preserved in ethanol solution and transported to ESP's laboratory for processing. The macroinvertebrates in each sample were sorted, counted and identified to the lowest practical taxonomic level (in most instances family) to comply with standard AUSRIVAS methodology. Any macrocrustaceans (e.g. yabbies and freshwater crabs) caught during fish surveys (see below) were also recorded.

Appropriate QA/QC checks were completed in accordance with the recommendations in the Queensland AUSRIVAS Sampling and Processing Manual (DNRM 2001) and the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a). A second ecologist checked approximately 80 per cent of picked samples, and at least 5 per cent of samples were re-identified and counted by a second ecologist. An error rate of < 10 per cent was considered acceptable, as per the Laboratory Identification QA/QC guidelines (DNRM 2001, DES 2018a).

Standard macroinvertebrate indices were calculated for each site, including (Chessman 2003):

- taxonomic richness: count of the number of different macroinvertebrate taxa present at each site. Taxonomic richness does not take into account the relative abundance of each taxon, so rare and common taxa are considered equally

- PET richness: the number of macroinvertebrate taxa at a site that belong to the orders Plecoptera, Ephemeroptera and Trichoptera (i.e. PET taxa). These taxa are considered to be particularly sensitive to changes in their environment, and are therefore good indicators of habitat degradation and water quality. Low PET scores generally indicate poor habitat condition, and high PET scores generally indicate good habitat condition. However, PET taxa are often naturally rare in ephemeral Queensland rivers and creeks (preferring clear, fast-flowing streams), therefore low PET richness is not necessarily indicative of anthropogenic impacts, and
- Stream Invertebrate Grade Number – Average Level (SIGNAL) 2 scores based on the sensitivity of each macroinvertebrate taxa to pollution or habitat degradation. Different macroinvertebrate taxa have been allocated a sensitivity grade number based on their sensitivity to various pollutants, and this number is weighted for abundance (so that the relative abundance of tolerant or sensitive taxa can be considered, and not just the presence / absence of taxa). A low SIGNAL score indicates that taxa are tolerant to a range of environmental conditions and a high score indicates that taxa are more sensitive to such conditions.

Due to very high abundances of microcrustaceans (e.g. copepods, ostracods and Cladocera) in some samples, these taxa were removed from the analysis (van Looij 2009).

Results were compared against the relevant biological objectives outlined in the EPP (WWB) for the Isaac River sub-basin for upper Isaac River catchment freshwaters (DEHP 2013a) (**Table 3.4**), which were consistent with the REMP Macroinvertebrate Water Quality Objectives (BHP 2018). These values are derived for streams (i.e. flowing waters) and as such comparisons of results from wetlands and dams with the biological objectives should be interpreted with caution (as they are stagnant habitats).

Table 3.4 Biological guidelines values for upper Isaac River catchment freshwaters (DEHP 2013a) [a]

Index	Composite [b]	Edge
Taxonomic richness	12 – 21	23 – 33
PET richness	2 – 5	2 – 5
SIGNAL score	3.33 – 3.85	3.31 – 4.20

[a] Macroinvertebrate biological guidelines are based on the Queensland Water Quality Guidelines (QWQGs; DEHP 2013b) Central Coast regional water quality guidelines based on the 20th and 80th percentiles of test site data

[b] Mixture of all bed habitats within the site (e.g. sandy pool, rocky pool, riffle, run, cascade)

SIGNAL 2 scores were interpreted in conjunction with the number of families found in the sample. This was achieved using a SIGNAL 2 / family bi-plot (Chessman 2003). The SIGNAL 2 / family bi-plot is divided into quadrants, with each quadrant indicative of environmental conditions that may influence a community (**Figure 3.5**). Quadrant boundaries for the SIGNAL 2 / Family Bi-plot used for this assessment were based on the upper (80th percentile) biological guideline values for taxonomic richness and SIGNAL scores.

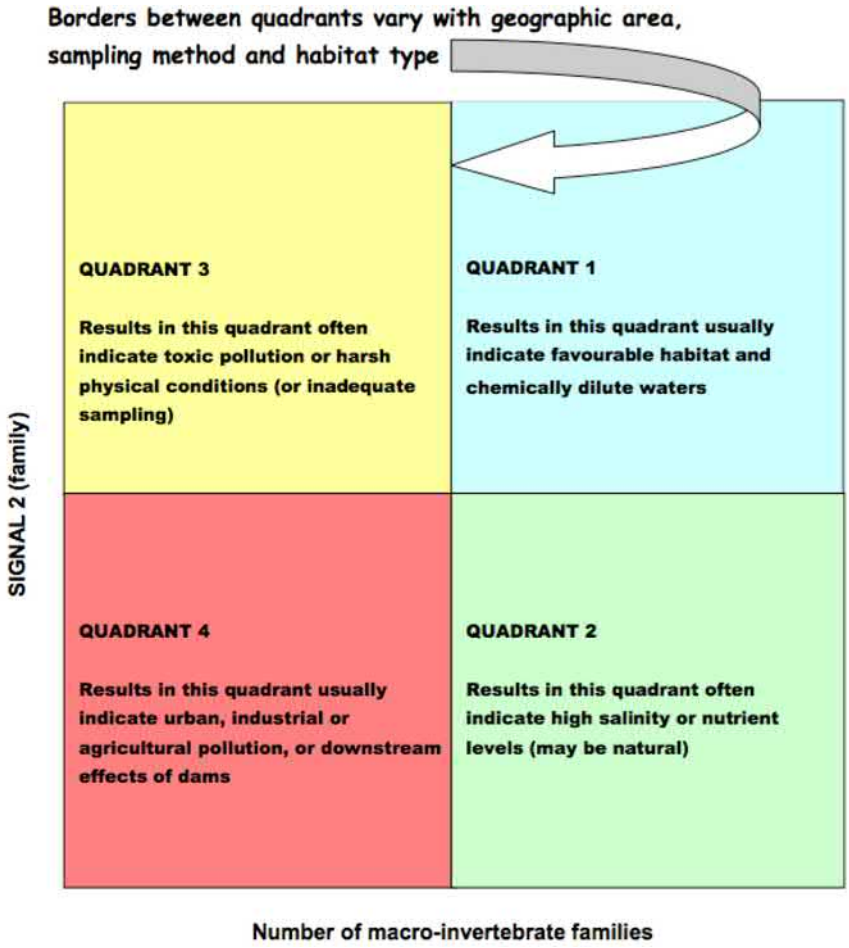

Figure 3.5 Quadrant diagram for SIGNAL2 / Family Bi-plot (Chessman 2003)

3.1.2.8 Fish

At each comprehensive aquatic ecology site that held sufficient water (**Table 3.1**), fish communities were surveyed using a combination of methods depending on the habitat characteristics of the site, including fyke nets, seine nets and baited traps. Survey methods and effort used at each site during each survey are summarised in **Table 3.5**.

All sampling was completed in accordance with the methodology outlined in the latest version of the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a), where appropriate, and relevant permits issued to ESP, including General Fisheries Permit 193593, Animal Ethics Approval CA 2017/06/1072 and Scientific Purposes Permit WA0017831.

All native fish were identified, counted, and returned to the environment. The total length (cm) of fish of a subsample of 20 individuals per species caught at each site was measured. Pest fish were identified, counted and euthanised in accordance with permit conditions.

The abundance of fish species caught at each site was calculated and tabulated. Life history stages of native fish were determined using length measurements (based on information in Pusey et al 2014), graphed and discussed.

Table 3.5 Fish and turtle effort at each survey site in December and April surveys

Location	Site	Method	Number	Date / Time In	Date / Time Out	Total Effort (hours)
December 2019						
Upstream	U1D	Fyke	3	15:30, 11/12/2019	9:00, 12/12/2019	52.5
		Traps	4	15:30, 11/12/2019	9:00, 12/12/2019	70
Within	HT1D	Fyke	3	17:00, 10/12/2019	9:00, 11/12/2019	48
		Traps	5	17:00, 10/12/2019	9:50, 11/12/2019	84
Downstream	LW1	Fyke	3	16:00, 9/12/2019	8:00, 10/12/2019	48
		Traps	5	16:00, 9/12/2019	8:00, 10/12/2019	80
April 2020						
Upstream	U1D	Fyke	2	14:30,02/04/2020	9:00, 3/4/2020	37
		Traps	5	14:30,02/04/2020	9:00, 3/4/2020	92.5
	Ca1	Traps	2	14:30, 3/4/2020	8:00, 4/4/2020	35
	Ch1	Fyke	2	16:45, 2/4/2020	10:30, 3/4/2020	35.5
		Traps	5	16:45, 2/4/2020	10:30, 3/4/2020	177.5
	Ch2	Traps	3	16:30, 3/4/2020	8:15, 4/4/2020	47.25
Within	HT1D	Fyke	2	16:45, 1/4/2020	8:45, 2/4/2020	32
		Traps	5	16:45, 1/4/2020	8:45, 2/4/2020	80
Downstream	LW1	Fyke	2	15:15,31/3/20	10:45, 31/3/2020	39
		Traps	5	15:15,31/3/20	10:45, 31/3/2020	195
	G1	Fyke	2	14:30, 31/3/2020	9:45, 1/4/2020	38.5
		Traps	5	14:30, 31/3/2020	9:45, 1/4/2020	192.5
	Ch4	Seine	2	13:30, 1/4/2020	13:45, 1/4/2020	0.25

3.1.2.9 Turtles

Turtles were surveyed at comprehensive aquatic ecology sites that contained any suitable potential turtle habitat (**Table 3.5**). Turtles were surveyed in conjunction with fish surveys (i.e. fyke nets set for fish surveys were set to trap turtles also). Survey effort used at each site during each survey is summarised in **Table 3.5**.

All sampling was completed in accordance with the *Australian Survey Guidelines for Australia's Threatened Reptiles* (Commonwealth of Australia 2011), *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (Eyre et. al 2018) as well as relevant permits issued to ESP, including Animal Ethics Approval CA 2017/06/1072 and Scientific Purposes Permit WA0017831. Once caught, turtles were identified and returned back to the environment.

Suitable turtle habitat and nesting habitat were noted if present, particularly features preferred by the listed species known to occur in the region (i.e. Fitzroy River turtle (*Rheodytes leukops*) and white-throated snapping turtle (*Elseya albagula*)), such as:

- General habitat features, including:
    - clear, flowing and well oxygenated water with riffle zones and deep pools

- sandy gravel substrate
- a diversity of instream features for shelter and to refuge amongst (e.g. submerged aquatic vegetation, submerged rock crevices, undercut banks and/or submerged logs and fallen trees), and

- Nesting habitat features, including sandy or loam banks (Limpus et al 2011).

While there was habitat available for turtles in some areas, there was no suitable habitat for listed threatened turtle species identified in the study area. As such, no further targeted surveys for these species (such as snorkelling, evening spotlighting or seine netting) were completed.

3.1.3 Aquatic Ecosystem Values

The overall aquatic ecosystem values of the waterways and wetlands were identified based on the criteria outlined in **Table 3.6**. The criteria were developed in accordance with the *Guidelines for Identifying High Ecological Values Aquatic Ecosystems* (Aquatic Ecosystems Task Group 2012), which identifies five core criteria that can be used to determine aquatic ecosystems of high value:

- Diversity: The aquatic ecosystem exhibits exceptional diversity of species (native / migratory), habitats, and / or geomorphological features / processes; includes diversity of ecosystem types (rivers, wetlands, subterranean systems, etc,), biotic diversity (within and between species) and / or abiotic (e.g. geomorphic) features and processes;
- Distinctiveness: The aquatic ecosystem is rare / threatened or unusual; and / or supports rare / threatened / endemic species / communities / genetically unique populations; and / or exhibits rare or unusual geomorphological features / processes and / or environmental conditions (and is likely to support unusual assemblages of species adapted to these conditions, and / or are important in demonstrating key features of the evolution of Australia's landscape, riverscape or biota);
- Vital Habitat: An aquatic ecosystem provides vital habitat for flora and fauna species if it supports unusually large numbers of a particular native or migratory species; and / or maintenance of populations of specific species at critical life cycle stages; and / or key significant refugia for aquatic species that are dependent on the habitat particularly at times of stress; and
- Naturalness: The ecological character of the aquatic ecosystem is not adversely affected by modern human activity.
- Representativeness: The aquatic ecosystem is an outstanding example of an aquatic ecosystem class to which it has been assigned, within a drainage division.

While these guidelines were developed to identify high ecological value aquatic ecosystems at a national level (drainage division scale) they can be used at a range of scales and were therefore adapted where appropriate (e.g. incorporating results of sampling parameters and river bio-assessment scores) to suit the purposes of this assessment as per advice in the guidelines.

Table 3.6 Criteria used to assess aquatic ecosystem value

Criteria [a]	Low	Moderate	High
Diversity	Low biodiversity of aquatic flora and fauna Low habitat diversity Low to moderate habitat bio-assessment scores	Moderate to good biodiversity of aquatic flora and fauna Moderate habitat diversity Good habitat bio-assessment scores	High biodiversity of aquatic flora and fauna High habitat diversity Very good bio-assessment scores
Distinctiveness	Species, communities and processes common Available habitat types common No habitat for protected species No listed protected aquatic areas, habitats or species High tolerance to change or highly adaptive communities	Species, communities and processes moderately common Available habitat types relatively common No core habitat for protected species Listed protected aquatic areas, habitats or species, but unlikely to provide significant habitat (e.g. breeding area) Moderate tolerance to change or moderately adaptive communities	Species, communities and processes rare Available habitat types rare Core habitat for protected species Listed protected aquatic areas, habitats or species Sensitive or poorly adaptive communities
Vital Habitat	Poor refuge or breeding area Supports low numbers of native species Little fisheries value Poor connectivity and fish passage	Limited refuge or breeding area Supports moderate numbers of native species Moderate fisheries value Limited connectivity and fish passage	Important refuge or breeding area Supports high numbers of native species High fisheries value High connectivity and important corridor for fish passage
Naturalness	Highly disturbed Poor riparian condition Poor habitat condition	Moderately disturbed Moderate to good riparian condition Moderate to good habitat condition	Undisturbed, pristine Excellent riparian condition Excellent habitat condition
Representativeness	Highly disturbed Poor example of ecosystem type	Moderately disturbed Average example of ecosystem type	Undisturbed Outstanding example of ecosystem type

[a] Source: Aquatic Ecosystems Task Group 2012

3.2 Stygofauna Assessment

A desktop review and pilot surveys for stygofauna (i.e. subterranean aquatic fauna) in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2019b) was conducted to:

- assess the suitability of local habitat for stygofauna based on the hydrogeology in the vicinity of the Project, and
- assess the likely presence and composition of stygofauna in the vicinity of the Project.

3.2.1 Desktop Review

The desktop review summarised existing general information available on stygofauna and habitat preference in Australia and Queensland, including:

- the Queensland Subterranean Aquatic Fauna Database curated by the Queensland Herbarium
- previous groundwater assessments completed in the vicinity of CVM, including the CVM EIS (URS 2009)
- bore records, and
- scientific publications, including the CSIRO report to the Australian Coal Association Research Program (ACAP) on the extent of knowledge of Stygofauna in Australian Groundwater Systems (Hose et al 2015).

3.2.2 Field Surveys

Two pilot studies were undertaken, the first in April 2020 and the second in November 2020. Methods were in accordance with the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2019b).

3.2.2.1 Bore Locations and Survey Timing

A total of 23 bores were sampled as part of the stygofauna assessment; 13 bores were sampled in April 2020 and 10 bores were sampled in November 2020. Bores were distributed throughout the Project footprint and comparable nearby bores outside of the Project footprint. Each bore was established for at least six months prior to stygofauna sampling and contained groundwater. The locations of the bores sampled are described in **Table 3.7** and displayed on **Figure 3.6**.

Table 3.7 Bore sampling sites surveyed in April and November 2020

Bore ID	Date Surveyed	Latitude	Longitude
Outside the Project Footprint			
MB19CVM03T	April 2020	-22.1396	148.0687
MB19CVM05T	April 2020	-22.1387	148.0771
MB19CVMO6P	April 2020	-22.1387	148.0771
MB19CVMP07T	April 2020	-22.1287	148.0819
MB19CVM08P	April 2020	-22.1287	148.0819
MB19CVMP09A	April 2020	-22.1436	148.0915
MB19CVM10P	April 2020	-22.1519	148.0987
PZ07D	April 2020	-22.1435	148.0917
PZ09	April 2020	-22.1604	148.1099
162145	November 2020	-22.1416	148.1170
162807	November 2020	-22.0372	148.0816
162144	November 2020	-22.0319	148.1162
162044	November 2020	-22.0574	148.1203
162142	November 2020	-22.0411	148.0831
162816	November 2020	-22.1300	148.1535
162045	November 2020	-22.0643	148.1207
182164	November 2020	-22.0375	148.0640
162043	November 2020	-22.0576	148.1009
162048	November 2020	-22.0843	148.1014
Within Project Footprint			
PZ01	April 2020	-22.0584	148.0656
PZ04	April 2020	-22.1016	148.0746
PZ12D	April 2020	-22.0853	148.0743
PZ12S	April 2020	-22.0848	148.0743

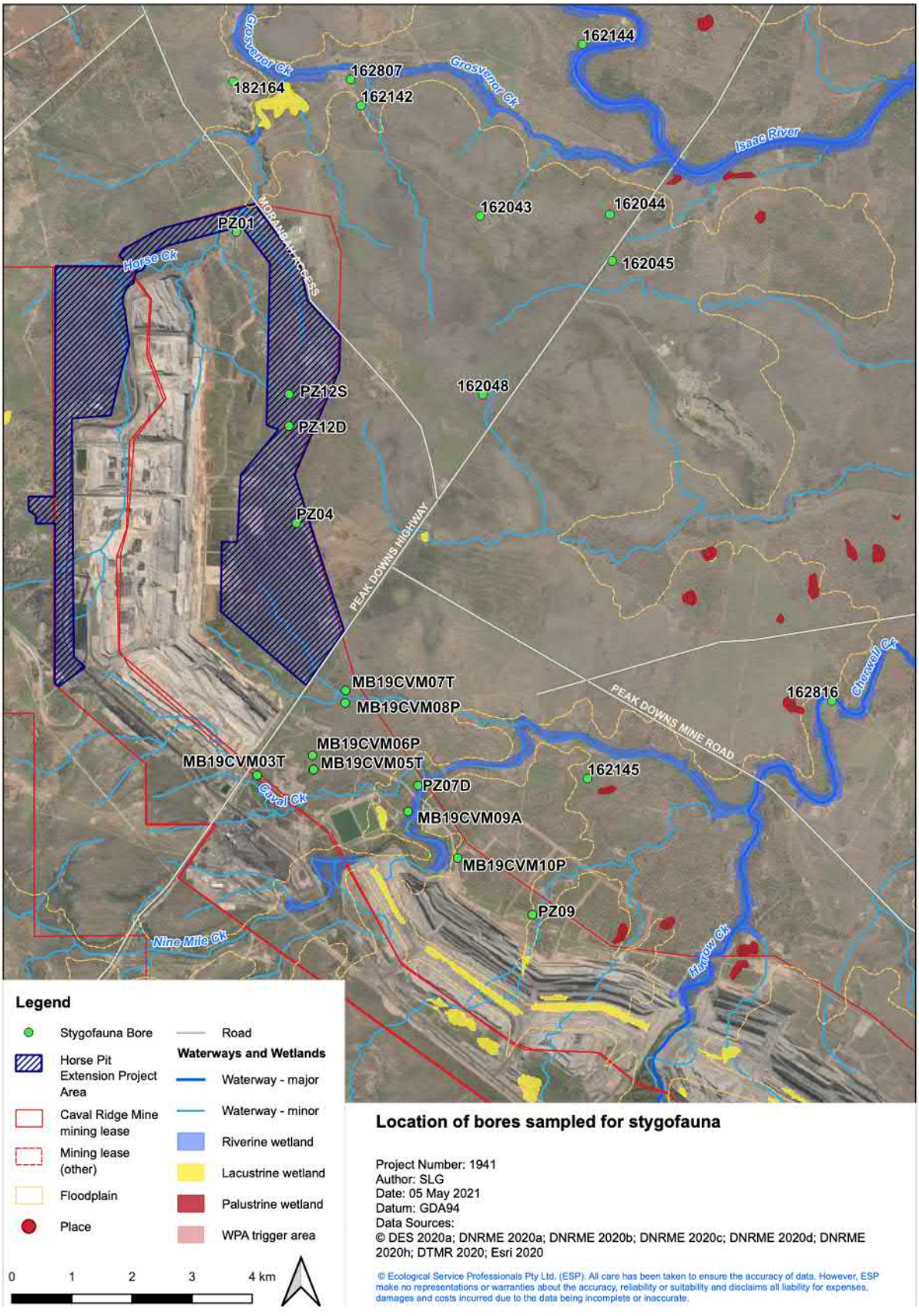

Figure 3.6 Location of bores sampled for the stygofauna assessment

3.2.2.2 Water Quality

Water quality (conductivity and pH) was measured in situ at each bore using a hand-held YSI ProDSS multi-parameter water quality sonde. A bailer was used to collect a water sample from approximately 1-2 m below the water level of the bore. The sample was retrieved slowly and poured into the measuring cup of the water quality probe. The water sample was collected before the stygofauna samples were collected.

The water quality meter was calibrated prior to field sampling.

3.2.2.3 Stygofauna Sampling

The full water column within each bore was sampled by hauling a weighted phraetobiological net. Three hauls were completed with a coarse mesh net (150 µm) and three hauls were completed with a fine mesh net (50 µm). Nets were lowered to the bottom of the bore, bounced five times to dislodge resting animals and then carefully retrieved. After each haul, the net and collection vial were emptied onto a 50 µm sieve and rinsed with deionised water. The three fine mesh hauls and three coarse net hauls were combined into one sample per bore and preserved in 100 per cent ethanol.

Nets were washed thoroughly between survey bores.

Photographs were taken of the bore and surrounding environment. The diameter of the bore, casing type, whether the bore was screened and whether a pump was installed, the height of the collar and the depth of the bore and depth to water level were also recorded.

The equipment used to sample stygofauna complied with standards outlined in the *Guideline for the Environmental Assessment of Subterranean Aquatic Fauna* (DES 2019b).

3.2.2.4 Sample Processing

The composite stygofauna samples were sorted in the laboratory under a stereomicroscope. Each sample container was drained of ethanol and washed into a shallow elongated counting tray to create a thin layer of sediment spread across the bottom of the tray. Any aquatic animals were transferred into 2 millilitre (mL) vials with 100 per cent ethanol and identified to the lowest practical taxonomic level. All field work and processing were undertaken by suitably qualified ecologists.

4 Description of the Existing Environment

4.1 Aquatic Habitat

4.1.1 Aquatic Habitat of the Region

Natural waterways in the region are typically temporary or ephemeral streams, which are dry for most of the year and flow for a short time following rainfall events that are more common in the wet season (DPM Envirosciences 2018). Intermittent pools that persist for several months may be present in certain reaches of these ephemeral waterways, particularly where clay substrates dominate the bed. During the dry season, larger permanent waterholes provide a refuge for aquatic flora and fauna.

Land use within the Isaac River sub-basin is primarily cattle grazing and coal mining (Burgess 2003, Rollason & Howell 2012, DPM Envirosciences 2018). Although broad-scale clearing is evident throughout the wider catchment, the riparian zone is typically in good condition, with moderate coverage of vegetation and minimal erosion.

Aquatic habitat assessments recently completed at sites on Cherwell Creek, Harrow Creek and the Isaac River as part of the CVM REMP and AEHP show that physical habitat conditions are fair to good (Gauge Industrial & Environmental 2018, 2020; CQU 2018, 2019). Bank stability and vegetative cover were typically good to excellent, and there was little channel alteration or bottom scouring. However, the availability of bottom substrates was poor (mostly fine sediments with less than 10 per cent rubble, gravel, or stable habitat), and habitat was dominated by stagnant pools. This is reflective of the ephemeral nature of waterways in the region, which typically flow for short periods during high rainfall events, before receding to shallow pools.

4.1.2 Aquatic Habitat in the Vicinity of the Project

A detailed description of aquatic habitat condition at all sites is presented in **Attachment C**.

4.1.2.1 Waterways

Aquatic habitat condition was fairly consistent across sites located on waterways, with poor to fair conditions in the minor (low stream-order) waterways but better conditions in the major (higher stream order) waterways (**Figure 4.1**). All sites on waterways were dry in December 2019; all sites except one were dry in November 2020; and, six sites contained water in April 2020 (typically sites on higher stream orders). Sites that contained water in April 2020 were characterised by pool habitat that would typically persist intermittently following high rainfall events; other sites were characteristic of highly ephemeral waterways that channel water and potentially provide for aquatic fauna passage during periods of high rainfall, but do not hold significant pools for extended periods. The site that contained water in November 2020 (GC01) was a dry season refuge, but it was unclear if the site consistently endured water in the dry season or if current land use practices (e.g. water releases from upstream or damming from downstream earthworks) were influencing water levels.

In minor waterways and drainage channels, which were typically dry during all three surveys, aquatic habitat features were limited (**Figure 4.2**). Potential aquatic habitat in the dry

channels included a low to moderate abundance of terrestrial detritus and woody debris, overhanging vegetation, and some rocky outcrops. Moderate to high disturbances to bed and bank stability were evident as a result of cattle access and land clearing associated with the adjacent land uses.

In major waterways, in-stream features were more abundant with shallow and deep pools, variable substrate (dominated by sand but with larger substrate types present in low abundance), in-stream woody debris and moderate to high coverage of trailing and overhanging bankside vegetation (**Figure 4.3**). Bed and bank stability were low to moderately disturbed from cattle access, terrestrial weeds and feral animals. Although riparian vegetation was reduced as a result of land clearing associated with the adjacent land uses, the banks remained moderately vegetated by predominantly mature native trees (namely *Eucalyptus*, *Casuarina* and *Acacia*) with a sparse to moderate groundcover of grasses.

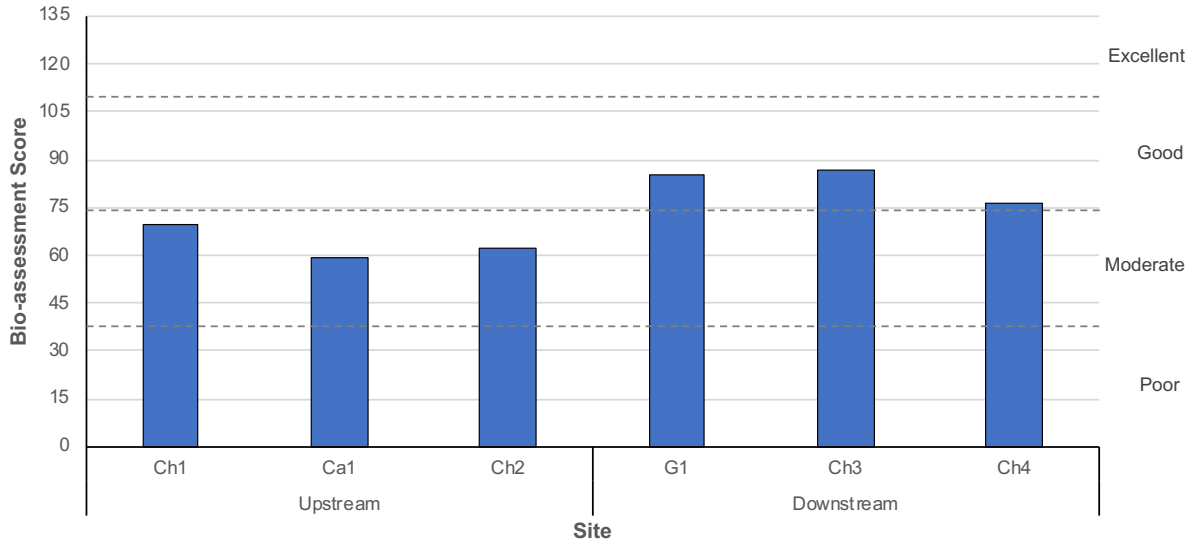

Figure 4.1 Bioassessment scores at wet waterway sites in April 2020

Figure 4.2 Dry channel at site H1 (unnamed tributary of Horse Creek downstream of the Project footprint) in April 2020

Figure 4.3 Pool habitat at site Ch2 (Cherwell Creek downstream of CVM and upstream of the Project footprint) in April 2020

4.1.2.2 Lacustrine Wetlands and Farm Dams

Two mapped lacustrine wetlands were assessed during the field surveys: site LW1 at the confluence of Horse Creek and Grosvenor Creek, downstream of the Project footprint; and site LW2 on an unnamed tributary upstream of Cherwell Creek (**Figure 3.4**). Both lacustrine wetlands were modified by the presence of a dam for agriculture / stock watering. Two unmapped farm dams on unnamed tributaries of Horse Creek were also assessed during the field surveys: site HT1D within the Project footprint, and site U1D upstream of the Project footprint (**Figure 3.4**).

The field assessment confirmed that the State-mapped wetlands meet the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline* (DERM 2011a), which includes artificial wetlands.

Aquatic habitat at the mapped lacustrine wetlands and unmapped farm dams were relatively similar, and consisted of shallow and deep pools with some terrestrial woody debris, emergent aquatic plants, filamentous algae, trailing bank vegetation and detritus. Instream sediments were typically dominated by sand and blanketing fine silt / clay, with some rocky areas. The sites typically contained moderately abundant and diverse aquatic plant communities, including floating and submerged species, indicating that they hold water for extended periods and provide relatively favourable conditions for aquatic flora (**Figure 4.4**). These sites were highly impacted by cattle access, resulting in extensive vegetation clearing of the riparian zone, eroded banks and trampling.

Although connectivity to downstream habitats was typically limited due to the construction of dam walls, these sites contained water during the December 2019 (LW1, HT1D and U1D) or November 2020 (LW2) surveys, and would therefore provide dry season refuges for aquatic flora and fauna.

Figure 4.4 Aquatic plant communities at site HT1D in April 2020

4.1.2.3 Palustrine Wetlands

Two mapped palustrine wetlands were assessed during the field surveys: site PW1 on Cherwell Creek near its confluence with the Isaac River, approximately 20 km downstream of the Project; and site PW2 adjacent to Cherwell Creek, approximately 7 km downstream of the Project (**Figure 3.4**).

Site PW1 is a mapped HES wetland area and a WPA, and is discussed further below. The field assessment confirmed that this site met the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline* (DERM 2011a).

Site PW2 did not contain any features indicative of wetland habitat, and is likely incorrectly mapped as a palustrine wetland; therefore, site PW2 is not considered further as a palustrine wetland.

Mapped High Ecological Significance Wetlands

HES Wetlands are wetlands that have been assigned a “high” conservation value according to the AquaBAMM assessments, which were based primarily on a desktop review, and no field surveys (Rollason & Howell 2012). The “high” conservation value for the HES wetland downstream of the Project footprint (i.e. site PW1) was based on:

- a very high score for the ‘naturalness’ criteria
- a medium score for the ‘diversity and richness’ criteria
- a high score for the ‘threatened species and ecosystems’ criteria
- a high score for the ‘priority species and ecosystems’ criteria, and
- a high score for the ‘representativeness’ criteria.

During the field survey in December 2019, the wetland was dry (**Figure 4.5**). The dry bed contained some potential habitat features, including emergent aquatic plants, some overhanging and trailing vegetation, terrestrial detritus and woody debris. Canopy cover and shading was limited throughout the site. The riparian zone was reduced due to vegetation clearing, but a continuous band of trees and grasses with some shrubs bordered the wetland. There were some terrestrial weeds growing in the dry bed, but otherwise disturbance was relatively low.

Based on the December 2019 survey, the wetland did not provide substantial aquatic habitat. This site was unable to be surveyed in April 2020 due to property access issues. However, it is possible that this wetland provides habitat for aquatic fauna during and after high rainfall / flow events.

Figure 4.5 Site PW1 (HES wetland and WPA) in December 2019

4.2 Water Quality

4.2.1 Environmental Values

The quality of natural waters in Queensland is protected under the EPP (WWB). The purpose of the EPP (WWB) is to achieve the objectives of the EP Act in relation to water quality while allowing for ecologically sustainable development.

The EPP (WWB) outlines the EVs that may apply to waters in Queensland, and for ecological values describe various levels of protection for high ecological value (HEV), slightly disturbed, moderately disturbed and highly disturbed waters as well as associated WQOs.

Under the EPP (WWB) for the Isaac River sub-basin, the waterways in the vicinity of the Project are scheduled as moderately disturbed freshwaters within the Upper Isaac River catchment and fall within the Isaac and lower Connors River main channel and Isaac western upland tributaries (DEHP 2011b; **Figure 1.1**). The following EVs have been assigned for these sub-catchments (DEHP 2013a):

- aquatic ecosystems (moderately disturbed)
- irrigation
- farm supply/use
- stock water
- aquaculture (assigned to Isaac western upland tributaries only)
- human consumer
- primary recreation
- secondary recreation

- visual recreation
- drinking water
- industrial use, and
- cultural and spiritual use.

4.2.2 Water Quality of the Region

Water quality in the Isaac River sub-basin can be highly variable over time, primarily due to the ephemeral nature of the waterways. Water quality in the Isaac River sub-basin is typically characterised by (URS 2009b, Hatch 2018):

- neutral pH, although some strongly alkaline waters have been recorded at wetlands (attributed to the higher biomass of algae and / macrophytes releasing oxygen during photosynthesis)
- low electrical conductivity, which is typically within the WQOs
- variable dissolved oxygen saturation, which is often below the WQO
- high turbidity and total suspended solids, which are variable and likely dependent on conditions at the time of sampling (e.g. recent flow events may increase suspended sediments and / or disturbance from cattle access), but are typically above WQOs
- low concentrations of ions (fluoride and sulfate)
- high concentrations of some nutrients (total nitrogen and total phosphorus), which typically exceed the WQOs
- low concentrations of TPHs, which are typically below the WQOs, and
- low concentrations of most metal parameters, although concentrations of total and dissolved aluminium, dissolved zinc, total cobalt and iron can be high.

Results from water quality surveys recently completed at sites on Harrow Creek, Cherwell Creek and the Isaac River as part of the CVM REMP are generally consistent with results from the broader region (Gauge Industrial & Environmental 2018, 2020; CQU 2018, 2019). Overall, water quality during sampling completed from 2018 to 2019 showed:

- neutral pH, typically within the WQO range
- low electrical conductivity, typically below the WQO
- variable dissolved oxygen, frequently below the WQO range
- high turbidity and total suspended solids, typically above the WQOs
- low concentrations of ions, typically below the WQOs
- high concentrations of some nutrients, including ammonia and total phosphorus, which were frequently above the WQOs, and
- low concentrations of most metal parameters, although concentrations of total and dissolved aluminium and iron, total manganese and dissolved copper can be high.

4.2.3 Water Quality in the Vicinity of the Project

Water quality in the vicinity of the Project was in moderate condition, likely influenced to some degree by surrounding land-use and local geomorphology, which is characteristic of a moderately disturbed ecosystem. Surface water of waterways and wetlands within the vicinity of the Project were highly variable, as is typical of ephemeral systems in the region, and were characterised by (**Table 4.1**):

- neutral to slightly alkaline pH, which frequently exceeded the WQO range
- moderate to high electrical conductivity (EC), which frequently exceeded the WQO
- variable dissolved oxygen levels, which were frequently outside of the WQO range
- moderate to high turbidity, which frequently exceeded the WQO
- low concentrations of most ions, except at upstream site Ca1 in April 2020
- high concentrations of nutrients, which frequently exceeded the WQO, although generally remained below the REMP WQOs for ammonia and nitrate, and
- low concentrations of most metals, with concentrations of most dissolved metals at most sites less than the laboratory limit of reporting (<LOR) or below the relevant WQO; except for aluminium (which has historically been high in the region; URS 2009b), copper (which was generally equal to or lower than the REMP WQO except at downstream site G1 where it exceeded the REMP WQO) and uranium, which had high concentrations at more than one site in April 2020.

Table 4.1 Water quality at comprehensive assessment sites sampled during aquatic ecology surveys completed in December 2019 and April 2020

		Dec-19			Apr-20								
		Up-stream	Within Project Footprint	Down-stream	Upstream				Within Project Footprint	Downstream			
Parameter	Unit	U1D	HT1D	LW1	U1D	Ch1	Ca1	Ch2	HT1D	LW1	G1	Ch3	Ch4
Physical													
Temperature	°C	32.5	28.9	28.7	26.7	28.2	26.3	23	25.3	26	28.9	29	24.8
pH	pH units	8.88	8.53	9.40	7.56	8.03	7.84	7.32	8.38	8.47	8.02	8.00	8.12
EC	µS/cm	1664	485.2	561	466	447.7	7403	367.9	355.1	320.6	184.1	184	456.6
Dissolved oxygen	%Sat	181.0	100.4	111.5	76.4	85.5	72.9	11.3	84.0	113.1	111.3	111.0	63.8
Turbidity	NTU	190	32.8	12.0	54.2	33.2	44.5	120.3	17.9	54.9	66.9	67.0	32.4
TDS	mg/L	994	289	317	262	260	4980	297	207	227	207	280	271
TSS	mg/L	384	33	<LOR	18	17	39	33	17	30	21	6	32
Major Ions													
Hardness	mg/L	236	145	99	102	144	1060	106	99	86	54	140	143
Sulfate	mg/L	11	4	9	2	17	1260	9	3	5	4	14	24
Calcium	mg/L	32	25	15	18	38	247	26	20	18	10	33	31
Magnesium	mg/L	38	20	15	14	12	109	10	12	10	7	14	16
Sodium	mg/L	216	47	78	54	30	1220	26	34	35	22	38	38
Potassium	mg/L	44	9	9	16	10	18	9	6	6	6	10	21
Fluoride	mg/L	0.8	0.7	0.7	0.2	0.2	0.2	0.2	0.5	0.3	0.1	0.3	0.2
Nutrients													
Ammonia	µg/L	50	10	<LOR	20	<LOR	260	<LOR	10	20	10	20	260
Nitrite	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	340	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

		Dec-19			Apr-20								
		Up-stream	Within Project Footprint	Down-stream	Upstream				Within Project Footprint	Downstream			
Parameter	Unit	U1D	HT1D	LW1	U1D	Ch1	Ca1	Ch2	HT1D	LW1	G1	Ch3	Ch4
Nitrate	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	9290	<LOR	<LOR	60	<LOR	<LOR	40
Oxides of nitrogen	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	9630	<LOR	<LOR	60	<LOR	<LOR	40
TKN	µg/L	3900	1100	800	1200	500	1100	1300	600	800	1100	500	2000
Total nitrogen	µg/L	3900	1100	800	1200	500	10700	1300	600	900	1100	500	2000
FRP	µg/L	50	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total phosphorus	µg/L	330	60	20	80	30	40	130	40	80	130	30	90
Total Metals													
Aluminium	µg/L	2210	800	380	280	760	1080	3070	590	670	2560	200	520
Arsenic	µg/L	2	2	2	<LOR	1	1	4	1	2	1	1	2
Cadmium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	5	<LOR	<LOR	<LOR	1	2	4	<LOR	1	7	<LOR	<LOR
Cobalt	µg/L	6	1	1	2	1	8	3	<LOR	1	2	<LOR	1
Copper	µg/L	3	2	2	<LOR	2	1	2	1	2	5	2	2
Lead	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	3	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese	µg/L	856	363	18	187	70	144	209	156	82	40	13	93
Molybdenum	µg/L	2	2	2	<LOR	<LOR	65	1	1	<LOR	<LOR	2	1
Nickel	µg/L	12	4	3	5	3	23	7	3	6	7	1	3
Selenium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	10	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	1	<LOR	<LOR	<LOR	<LOR	12	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

		Dec-19			Apr-20								
		Up-stream	Within Project Footprint	Down-stream	Upstream				Within Project Footprint	Downstream			
Parameter	Unit	U1D	HT1D	LW1	U1D	Ch1	Ca1	Ch2	HT1D	LW1	G1	Ch3	Ch4
Zinc	µg/L	8	<LOR	<LOR	<LOR	9	7	10	<LOR	<LOR	6	<LOR	<LOR
Boron	µg/L	310	110	130	90	50	140	60	70	<LOR	<LOR	<LOR	<LOR
Iron	µg/L	3640	1000	310	1550	1100	1310	5380	760	1200	3400	150	620
Mercury	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	0.01	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Dissolved Metals													
Aluminium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	60	<LOR	<LOR	70	<LOR	<LOR
Arsenic	µg/L	2	2	2	1	<LOR	<LOR	2	1	1	<LOR	1	1
Cadmium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cobalt	µg/L	3	<LOR	<LOR	2	<LOR	7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper	µg/L	<LOR	<LOR	2	1	1	<LOR	<LOR	1	2	4	<LOR	2
Lead	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese	µg/L	467	24	<LOR	126	6	133	114	<LOR	<LOR	4	7	10
Molybdenum	µg/L	2	2	2	<LOR	<LOR	54	2	1	<LOR	<LOR	1	2
Nickel	µg/L	9	3	3	5	2	20	3	2	5	3	1	2
Selenium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	10	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	1	<LOR	<LOR	<LOR	<LOR	11	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

		Dec-19			Apr-20								
		Up-stream	Within Project Footprint	Down-stream	Upstream				Within Project Footprint	Downstream			
Parameter	Unit	U1D	HT1D	LW1	U1D	Ch1	Ca1	Ch2	HT1D	LW1	G1	Ch3	Ch4
Boron	µg/L	370	140	170	150	90	160	60	100	80	<LOR	90	90
Iron	µg/L	<LOR	<LOR	<LOR	230	<LOR	<LOR	310	<LOR	<LOR	130	<LOR	<LOR
Mercury	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	0.03	<LOR	<LOR	<LOR	0.01	<LOR	<LOR
Hydrocarbons													
C6 - C9	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C15 - C28	µg/L	230	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C29 - C36	µg/L	60	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C36 (sum)	µg/L	290	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BTEXN													
Benzene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Toluene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ethylbenzene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
meta- & para-Xylene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
ortho-Xylene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Xylenes	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Sum of BTEX	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	µg/L	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values above the relevant WQO / WQO range (**Table 3.2**); blue shading denotes values below the relevant WQO range (**Table 3.2**);
<LOR denotes result less than the laboratory limit of reporting.

4.3 Sediment Quality

4.3.1 Sediment Quality of the Region

Sediment quality in the vicinity of CVM is routinely monitored as part of the REMP and AEHP. Recent sediment sampling in 2018 and 2019 showed that sediment quality in Harrow Creek, Cherwell Creek and the Isaac River in the vicinity of the Project was good, and typically characterised by (Gauge Industrial & Environmental 2018, 2020; CQU 2018, 2019):

- bed sediments dominated by fine particles, including silt, clay and sand, with small amounts of gravel, and
- low concentrations of metals, typically below the relevant DGVs.

4.3.2 Sediment Quality in the Vicinity of the Project

Sediment quality in the vicinity of the Project was in moderate to good condition, and likely influenced to some degree by surrounding land-use and local geomorphology, which is characteristic of a moderately disturbed system.

In December 2019 and April 2020, sediments were characterised by a variety of metals and metalloids, including the following (commonly detected in samples at all or most sites): aluminium, chromium, cobalt, iron, manganese, nickel, vanadium and zinc (**Table 4.2** and **Table 4.3**).

Several metals and metalloids were not detected (i.e. concentrations were equal to or below the LOR) at most sites during the surveys, including: arsenic, boron, cadmium, molybdenum, selenium, silver, mercury, total petroleum hydrocarbons, and BTEXN chemicals (**Table 4.2** and **Table 4.3**).

Concentrations of most parameters were below the relevant DGVs except for the following, which exceeded either the DGV or the GV-high value at several sites:

- chromium, which exceeded the DGV at sites UD1 and H1 in December 2019 and site U1 in April 2020, and
- nickel, which exceeded the DGV at sites UD1, HT1D and H1 in December 2019 and sites HT1D, H1 and LW1 in April 2020; and was equal to the GV-high value at site U1 in April 2020.

Bed sediments were mostly fine at all sites, and dominated by either silt / clay or sand, with smaller amounts of gravel (**Table 4.2** and **Table 4.3**).

Table 4.2 Sediment quality at Horse Pit sites sampled during aquatic ecology surveys completed in December 2019

		Upstream					Within Project Footprint	Downstream					
Parameter	**Unit**	**U1D**	**U2**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**LW1**	**G1**	**Ch3**	**Ch4**	**PW1**
Particle Size Distribution													
Fines (<75 µm)	%	56	11	11	16	60	76	9	9	8	2	1	88
Sand (>75 µm)	%	40	87	87	81	38	19	46	74	80	96	98	11
Gravel (>2mm)	%	4	2	2	3	2	5	45	17	12	2	1	1
Cobbles (>6cm)	%	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Metals and Metalloids													
Aluminium	mg/kg	4910	870	810	1320	3210	7360	4250	2040	1360	520	740	5100
Arsenic	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Boron	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	mg/kg	107	15	4	9	9	21	107	11	23	4	3	14
Cobalt	mg/kg	20	12	<LOR	8	6	18	19	4	6	<LOR	<LOR	8
Copper	mg/kg	12	<LOR	<LOR	<LOR	7	16	11	<LOR	<LOR	<LOR	<LOR	14
Iron	mg/kg	51300	9160	4900	5840	12900	22700	46500	6330	14300	3790	3390	11700
Lead	mg/kg	5	<LOR	<LOR	5	8	9	10	<LOR	<LOR	<LOR	<LOR	13
Manganese	mg/kg	447	165	38	309	158	422	506	53	131	33	48	268
Molybdenum	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	mg/kg	29	7	2	8	12	31	39	8	12	<LOR	<LOR	13
Selenium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

		Upstream					Within Project Footprint	Downstream					
Parameter	**Unit**	**U1D**	**U2**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**LW1**	**G1**	**Ch3**	**Ch4**	**PW1**
Vanadium	mg/kg	67	14	6	12	15	34	63	12	24	6	5	27
Zinc	mg/kg	26	6	8	7	21	30	25	8	8	<LOR	5	36
Silver	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	mg/kg	0.4	<LOR	<LOR	<LOR	0.3	0.3	0.3	<LOR	0.1	<LOR	<LOR	0.5
Mercury	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Organic Carbon	%	1.82	0.35	0.33	0.25	0.92	0.73	0.16	0.25	0.07	0.05	0.1	1.74
Total Petroleum Hydrocarbons													
C6 - C9 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C15 - C28 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	100
C29 - C36 Fraction	mg/kg	200	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C36 Fraction (sum)	mg/kg	200	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	100
BTEXN													
Benzene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Toluene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ethylbenzene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
meta- & para-Xylene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
ortho-Xylene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Xylenes	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Sum of BTEX	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

		Upstream					Within Project Footprint	Downstream					
Parameter	Unit	U1D	U2	Ch1	Ca1	Ch2	HT1D	H1	LW1	G1	Ch3	Ch4	PW1
Naphthalene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values that are above the relevant DGV (**Table 3.3**); blue shading denotes values that are above the relevant DGV – high (**Table 3.3**)
<LOR result less than the laboratory limit of reporting

Table 4.3 Sediment quality at Horse Pit sites sampled during aquatic ecology surveys completed in April 2020

		Upstream						Within Project Footprint	Downstream				
Parameter	Unit	U1	U1D	U2	Ch1	Ca1	Ch2	HT1D	H1	LW1	G1	Ch3	Ch4
Particle Size Distribution													
Fines (<75 µm)	%	65	44	2	4	11	37	68	25	54	38	3	2
Sand (>75 µm)	%	29	49	96	95	88	63	25	62	42	53	93	98
Gravel (>2mm)	%	6	7	2	1	1	<LOR	7	13	5	9	4	<LOR
Cobbles (>6cm)	%	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Metals and Metalloids													
Aluminium	mg/kg	7030	3820	470	550	1800	2390	7350	6420	9030	2260	600	680
Arsenic	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Boron	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	mg/kg	82	64	6	3	8	7	20	42	31	16	3	3
Cobalt	mg/kg	57	9	2	<LOR	5	4	17	29	17	7	<LOR	<LOR

		Upstream						Within Project Footprint	Downstream				
Parameter	**Unit**	**U1**	**U1D**	**U2**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**LW1**	**G1**	**Ch3**	**Ch4**
Copper	mg/kg	16	17	<LOR	<LOR	<LOR	6	16	15	18	<LOR	<LOR	<LOR
Iron	mg/kg	38000	26400	3300	3170	5760	7560	20100	30700	19300	8670	2810	3120
Lead	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	6	11	7	<LOR	<LOR	<LOR	<LOR
Manganese	mg/kg	1370	171	31	18	224	106	543	941	322	167	43	39
Molybdenum	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	mg/kg	52	17	<LOR	<LOR	11	8	25	49	29	10	<LOR	2
Selenium	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	mg/kg	55	44	7	<LOR	11	12	32	40	46	22	<LOR	<LOR
Zinc	mg/kg	29	30	<LOR	<LOR	7	12	22	25	18	7	<LOR	<LOR
Silver	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	mg/kg	0.4	0.2	0.7	0.1	0.6	0.1	0.7	<LOR	0.6	0.1	0.1	0.5
Mercury	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Organic Carbon	%	0.93	2.52	0.08	0.09	0.2	0.6	0.39	0.26	2.3	0.64	0.05	0.07
Total Petroleum Hydrocarbons													
C6 - C9 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C15 - C28 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C29 - C36 Fraction	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C36 Fraction (sum)	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BTEXN													

		Upstream						Within Project Footprint	Downstream				
Parameter	**Unit**	**U1**	**U1D**	**U2**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**LW1**	**G1**	**Ch3**	**Ch4**
Benzene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Toluene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ethylbenzene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
meta- & para-Xylene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
ortho-Xylene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Xylenes	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Sum of BTEX	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	mg/kg	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

grey shading denotes values that are above the relevant DGV (**Table 3.3**); blue shading denotes values that are above the relevant DGV – high (**Table 3.3**)
<LOR result less than the laboratory limit of reporting

4.4 Aquatic Plants

4.4.1 Aquatic Plants of the Region

A total of 108 aquatic plants species (i.e. species listed as wetland indicator species) are known to occur in the Isaac River sub-basin (DES 2020a). All species recorded from the Isaac River sub-basin are considered Least Concern under the NC Act. There are no published records of any aquatic plant species that are listed as threatened under the NC Act and the EPBC Act within 50 km of the Project footprint (DoEE 2019, DES 2019a).

There is a low diversity and coverage of aquatic plants in the region, typically due to variable water availability, harsh habitat conditions, and cattle grazing and trampling. Aquatic plant communities in the waterways adjacent to the Project footprint were typically dominated by emergent species such as rushes, sedges and grasses with a greater diversity and abundance typically recorded in the wet season (DPM Enviros ciences 2018). Palustrine wetlands that retained water for the majority of the year supported a higher diversity of aquatic plants compared to waterways.

A total of seven introduced aquatic plant species have been recorded in the Isaac River sub-basin (DES 2020b):

- white eclipta (*Eclipta prostrata*)
- watercress (*Rorippa nasturtium-aquaticum*)
- yellow nutgrass (*Cyperus exculentus*)
- toad rush (*Juncus bufonius*)
- awnless barnyard grass (*Echinochloa colona*)
- olive hymenachne (*Hymenachne amplexicaulis*), and
- para grass (*Urochloa mutica*).

Of these, one species, olive hymenachne, is a Weed of National Significance and a restricted invasive plant under Queensland's *Biosecurity Act 2014.*

4.4.2 Aquatic Plants in the Vicinity of the Project

A total of 19 native aquatic plant species from 13 families were recorded at sites in the vicinity of the Project across the December 2019 and April 2020 surveys. In December 2019, a total of six native aquatic plant species from five families were recorded (**Table 4.4**), and in April 2020, a total of 17 native aquatic plant species from 13 families were recorded (**Table 4.5**). No plant species recorded are listed as threatened under the EPBC Act and the NC Act.

All native species recorded are recognised as wetland indicator species (DES 2020b). Emergent species, namely sedges (*Cyperus* spp.), were the most widespread aquatic plants and were growing on the banks or in the shallow margins of the sites where they were recorded. Submerged and floating species were only recorded at sites that had been dammed.

Overall, aquatic plant diversity and coverage was low at most waterways (creeks) and mapped palustrine wetland sites. Coverage at these sites ranged from approximately zero to

24 per cent, with a low diversity of species and growth forms (emergent plants only, and very little in-stream aquatic plant growth). Aquatic plant coverage was higher at unmapped farm dams and mapped lacustrine wetland sites (all of which were dammed), which ranged from approximately 9 to 79 per cent coverage, with a higher diversity of species and growth forms recorded (particularly in-stream, and including submerged and floating species).

There was seasonal variation seen at most sites, with lower diversity and abundance of species recorded in December 2019 compared to April 2020. The rainfall and flows leading up to the April 2020 survey promoted the distribution and growth of aquatic plants along the waterways within the vicinity of the Project. In contrast, aquatic plants died due to the dry conditions prior to the December 2019 survey.

Table 4.4 Total coverage and taxonomic richness of aquatic plants recorded at Horse Pit sites in December 2019

		Upstream						Within Project Footprint		Downstream						
Family *Species Name*	**Common Name**	**U1**	**U1D**	**U2**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**LW1**	**G1**	**Ch3**	**Ch4**	**PW1**	**PW2**	**Total**
Haloragaceae																
Myriophyllum verrucosum	red water milfoil	–	–	–	–	–	–	10	–	15	–	–	–	–	–	**25**
Juncaceae																
Juncus usitatus	rush	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Onagraceae																
Ludwigia peploides	water primrose	–	1	–	–	–	–	1	–	1	–	–	–	–	–	**3**
Polygonaceae																
Persicaria decipiens	slender knotweed	–	–	–	–	–	–	–	–	1	–	–	–	–	–	**1**
Persicaria orientalis	princes feathers	–	–	–	–	–	–	–	–	–	–	–	–	5	–	**5**
Typhaceae																
Typha sp.	cumbungi	–	–	–	–	–	–	1	–	1	–	–	–	–	–	**2**
***Native Species Coverage* (%)**		**0**	**2**	**0**	**0**	**0**	**0**	**12**	**0**	**18**	**0**	**0**	**0**	**5**	**0**	
Native Species Richness		**0**	**2**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**	**0**	**1**	**0**	**6**

– Species not recorded

Table 4.5 Total coverage and taxonomic richness of aquatic plants recorded at Horse Pit sites in April 2020

		Upstream							Within Project Footprint	Downstream							
Family **Species Name**	**Common Name**	**U1**	**U1D**	**U2**	**U3**	**Ch1**	**Ca1**	**Ch2**	**HT1D**	**H1**	**ChT1**	**LW1**	**G1**	**Ch3**	**Ch4**	**PW2**	**Total**
Alistmataceae																	
Caldesia oligococca	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	–	–	**0.2**
Cyperaceae																	
Cyperus difformis	rice sedge	1.1	–	–	7.7	0.2	–	–	4.5	1.5	–	–	0.1	–	–	–	**14**
Cyperus digitatus	flat sedge	–	28.5	–	–	–	–	–	–	–	–	–	–	–	–	–	**28.5**
Cyperus lucidus	leafy flat sedge	–	–	–	–	–	–	–	–	–	–	2	0.1	–	–	–	**2.1**
Cyperus polystachyos	bunchy sedge	0.1	–	–	0.2	–	–	–	–	–	–	–	–	–	–	–	**0.2**
Fimbristylis quinquangularis	–	–	–	–	16	–	–	–	–	–	–	–	–	–	–	–	**16**
Haloragaceae																	
Myriophyllum verrucosum	red water milfoil	–	–	–	–	–	–	–	7	–	–	–	–	–	–	–	**7**
Hydrocharitaceae																	
Ottelia ovalifolia	swamp lily	–	26.6	–	–	–	–	–	–	–	–	–	–	–	–	–	**26.6**
Juncaceae																	
Juncus usitatus	rush	–	–	–	–	–	–	–	–	5.1	–	1	–	–	–	–	**6.1**
Marsileaceae																	
Marsilea hirsuta	hairy nardoo	–	–	–	–	–	–	–	0.2	–	–	–	–	–	–	–	**0.2**

Family Species Name	Common Name	Upstream							Within Project Footprint	Downstream							
		U1	U1D	U2	U3	Ch1	Ca1	Ch2	HT1D	H1	ChT1	LW1	G1	Ch3	Ch4	PW2	Total
Najadaceae																	
Najas tenuifolia	water nymph	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	**4**
Ludwigia peploides	water primrose	–	12	–	–	–	–	–	13.5	–	–	–	–	–	–	–	**25.5**
Polygonaceae																	
Persicaria attenuata	smartweed	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	**5**
Pontederiaceae																	
Monochoria cyanea	blue hyacinth	–	7.1	–	–	–	–	–	0.7	–	–		–	–	–	–	**7.8**
Potamogetonaceae																	
Potamogeton crispus	curly pondweed	–	0.2	–	–	–	–	–	3.2	–	–	–	–	–	–	–	**3.4**
Streptophyceae																	
Nitella spp.	Nitella	–	–	–	–	–	–	–	4.9	–	–	–	–	–	–	–	**4.9**
Typhaceae																	
Typha sp.	cumbungi	–	–	–	–	–	–	–	16.5	–	–	1	–	–	–	–	**17.5**
Native Species Coverage* (%)		**1.2**	**78.6**	**0**	**23.9**	**0.2**	**0**	**0**	**50.5**	**6.6**	**0**	**9**	**0.2**	**0**	**0**	**0**	
Native Species Richness		**2**	**7**	**3**	**3**	**1**	**0**	**0**	**8**	**2**	**0**	**4**	**2**	**0**	**0**	**0**	**17**

– Species not recorded

4.5 Aquatic Macroinvertebrates

4.5.1 Macroinvertebrate Communities of the Region

Macroinvertebrate communities in the region are considered to be in moderate to good condition, although community health and composition can be variable and are influenced by surrounding land-use and habitat conditions as well as seasonality (URS 2013, DPM Enviros ciences 2018). Taxonomic richness, PET richness and SIGNAL 2 scores of macroinvertebrate communities are generally within or above the biological objectives outlined in the EPP (WWB), indicating diverse and healthy communities. Communities typically consist of a number of pollutant-tolerant and sensitive taxa, indicating waterways and wetlands in the region have suitable water and habitat quality to support diverse communities. Assemblages are typically dominated by tolerant taxa, primarily beetles (Coleoptera), true bugs (Hemiptera) and true flies (Diptera). However, sensitive taxa from orders Ephemeroptera (mayflies) and Trichoptera (caddisflies) are typically moderately abundant, while taxa from order Plecoptera (stoneflies) are rare (URS 2013, DPM Enviros ciences 2018). No records of threatened macroinvertebrate or macrocrustaceans are known from the Fitzroy River basin and Isaac River sub-basin (DES 2020b, URS 2013).

Macroinvertebrate communities in Harrow Creek, Cherwell Creek and the Isaac River in the vicinity of the Project footprint are routinely monitored as part of the CVM REMP and AEHP. Sampling from 2011 to 2019 shows that the condition of macroinvertebrate communities is highly variable over time, and monitoring sites are often dry (particularly on Cherwell and Harrow creeks) (Gauge Industrial & Environmental 2018, 2020; CQU 2018, 2019). Monitoring sites include:

- two sites on Cherwell Creek, one upstream of CVM (which was monitored four times between May 2011 and March 2018) and one downstream of CVM (which was monitored three times between May 2011 and March 2015)
- two sites on Harrow Creek, one upstream of CVM (which was monitored seven times between May 2011 and May 2016) and one downstream of CVM (which was monitored three times between May 2011 and May 2012), and
- six regional sites on the Isaac River downstream of CVM (each of which was monitored from three to eight times between May 2011 and April 2019).

Monitoring typically occurred more frequently at sites on the Isaac River as it is a major waterway, which is more likely to contain pools following high rainfall and flows than the smaller waterways higher in the catchment (i.e. Cherwell and Harrow creeks).

Historically, indices recorded for macroinvertebrate communities in the vicinity of CVM have generally been within the biological objectives outlined in the EPP (WWB), indicating diverse and healthy communities (Gauge Industrial & Environmental 2018, 2020). Recent sampling in 2018 and 2019 indicated that macroinvertebrate communities were in moderate condition. Taxonomic richness and PET richness were typically within the biological objectives. However, SIGNAL 2 scores were frequently below the biological objectives and sensitive taxa were typically low in abundance (CQU 2018, 2019). This may be attributed to the highly ephemeral nature of waterways in the vicinity of CVM, which are subject to harsh environmental conditions.

4.5.2 Macroinvertebrate Communities in the Vicinity of the Project

4.5.2.1 Community Composition

A total of 2,423 individuals from 52 taxa were collected in samples collected across all sites in December 2019 and April 2020. In both bed and edge habitats, macroinvertebrate communities were typically dominated by several major groups that were common across the majority of sites in moderate to high abundance, including:

- flies (order Diptera) with high abundances of non-biting midges (subfamilies Chironominae and Tanypodinae) and biting midges (family Ceratopogonidae) common in samples
- beetles (order Coleoptera) with high abundances of diving beetles (family Dytiscidae) common in samples
- crustaceans, with high abundances of freshwater shrimp (family Atyidae) and seed shrimp (class Ostracoda) common in samples, and
- true bugs (order Hemiptera), with high abundances of pygmy water boatmen (family Micronectidae) common in samples.

All of these taxa are common in the region and are considered to be tolerant to a range of environmental conditions (where sensitivity ratings are available).

Overall, the community composition of the samples is representative of macroinvertebrate communities of the wider region with similar taxa recorded (DPM Enviroscience 2018).

4.5.2.2 Taxonomic Richness

Bed Habitat

Overall, total taxonomic richness of macroinvertebrate communities in bed habitat was low to moderate (**Figure 4.6**). In December 2019, total taxonomic richness was equal to or within the WQO range at all sites, indicating that it was within the range expected from the broader region. In April 2020, total taxonomic richness was below the WQO range at most sites, except site Ch2 on Cherwell Creek (where it was within the WQO range) and G1 on Grosvenor Creek (where it was equal to the WQO lower trigger). Most sites consisted of small, isolated pools in April 2020, which do not provide ideal or varied habitat for a range of macroinvertebrate taxa.

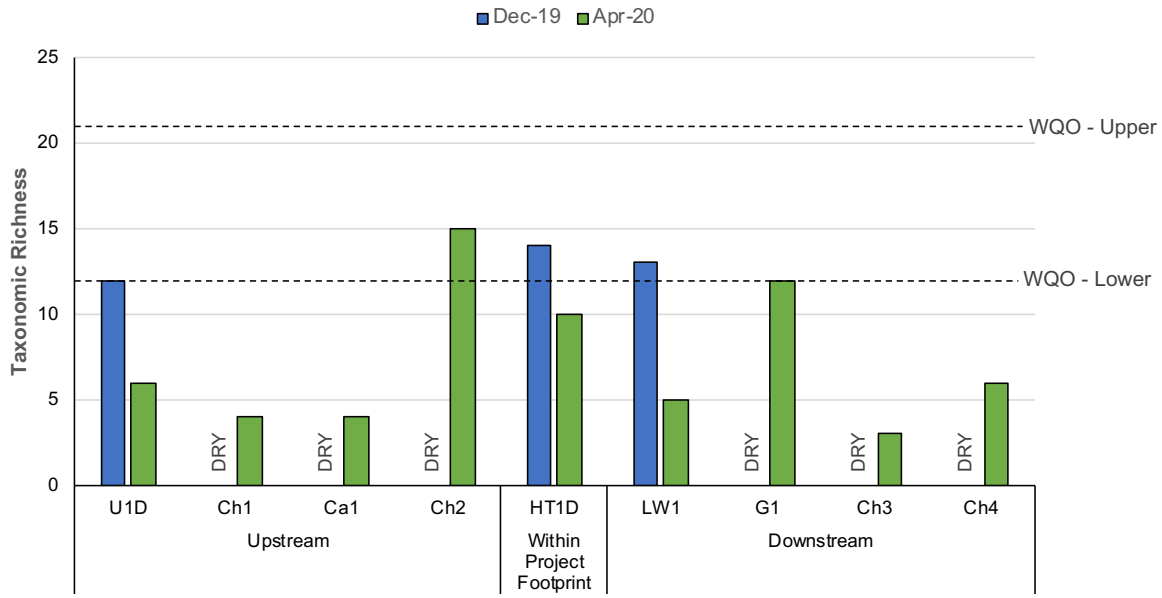

Figure 4.6 Total taxonomic richness of macroinvertebrates in bed habitat at each site; DRY indicates the site was dry and could not be surveyed

Edge Habitat

Total taxonomic richness of macroinvertebrate communities in edge habitat was low, and was equal to or below the WQO range at all sites during December 2019 and April 2020 (**Figure 4.7**). The water level was low at most sites during these surveys, resulting in poor quality, homogeneous edge habitat for macroinvertebrates.

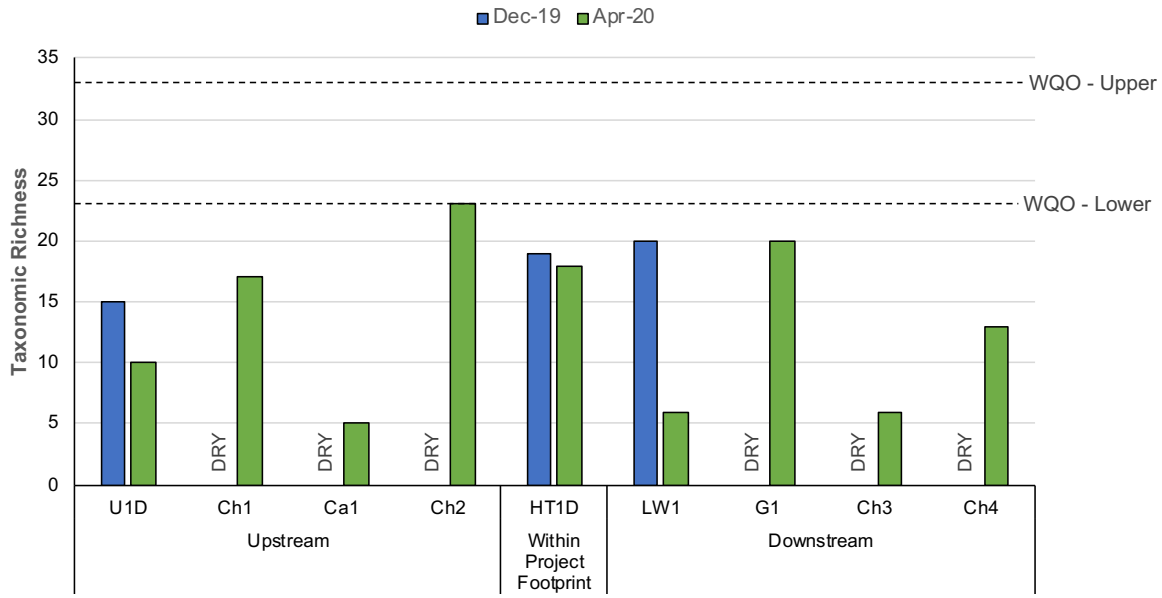

Figure 4.7 Total taxonomic richness of macroinvertebrates in edge habitat at each site; DRY indicates the site was dry and could not be surveyed

4.5.2.3 PET Richness

Bed Habitat

Overall, total PET richness of macroinvertebrate communities in bed habitat was low to moderate (**Figure 4.8**). Sensitive PET taxa were recorded at all sites during the December 2019 and April 2020 surveys. In December 2019, total PET richness was equal to or below the WQO range at all sites. In contrast, in April 2020, total taxonomic richness was within the WQO range at all sites.

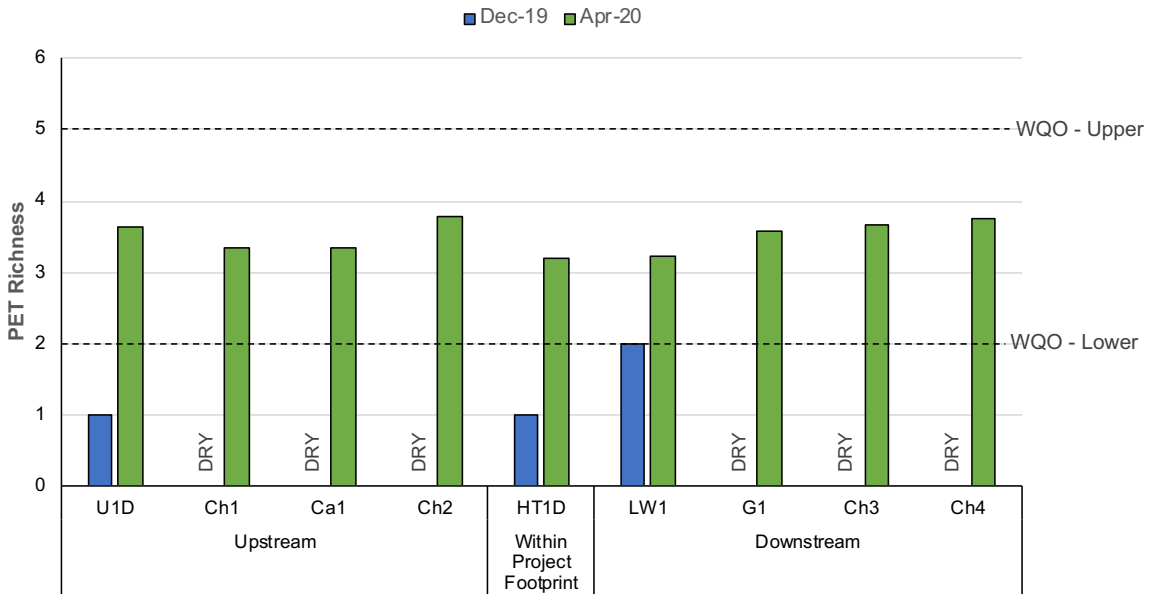

Figure 4.8 Total PET richness of macroinvertebrates in bed habitat at each site; DRY indicates the site was dry and could not be surveyed

Edge Habitat

Overall, total PET richness of macroinvertebrate communities in edge habitat was low to moderate (**Figure 4.9**). Total PET richness in edge habitat showed the opposite seasonal pattern to bed habitat, and was within the WQO range at all sites in December 2019, and equal to or below the WQO range at most sites in April 2020. No sensitive PET taxa were recorded in edge habitat at sites Ca1 (Caval Creek), LW1 (lacustrine wetland on Horse Creek) or Ch4 (Cherwell Creek) in April 2020. The water level was low at most sites in April 2020, resulting in poor quality, homogeneous edge habitat, which does not provide ideal habitat for PET taxa.

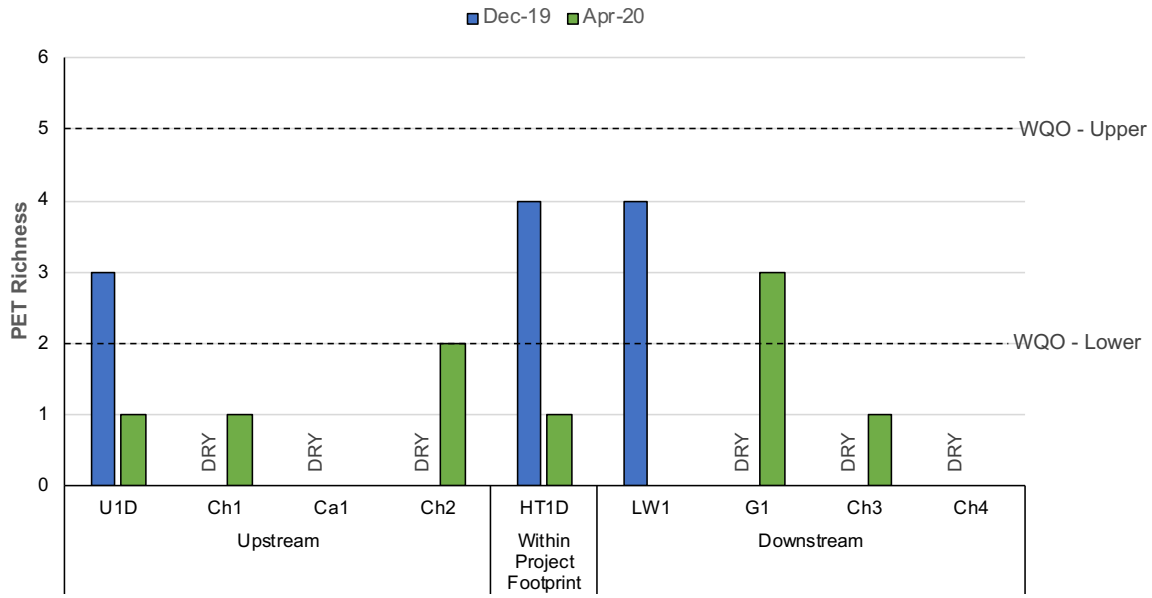

Figure 4.9 Total PET richness of macroinvertebrates in edge habitat at each site; DRY indicates the site was dry and could not be surveyed

4.5.2.4 SIGNAL 2 Scores

Bed Habitat

Overall, total SIGNAL 2 scores of macroinvertebrate communities in bed habitat were moderate to good, and did not vary substantially between surveys (**Figure 4.10**). Total SIGNAL 2 scores were within or slightly below the WQO range at all sites during the December 2019 and April 2020 surveys, indicating that a range of sensitive taxa were present in bed habitat at each site, and that communities were in similar condition to that expected from the broader region.

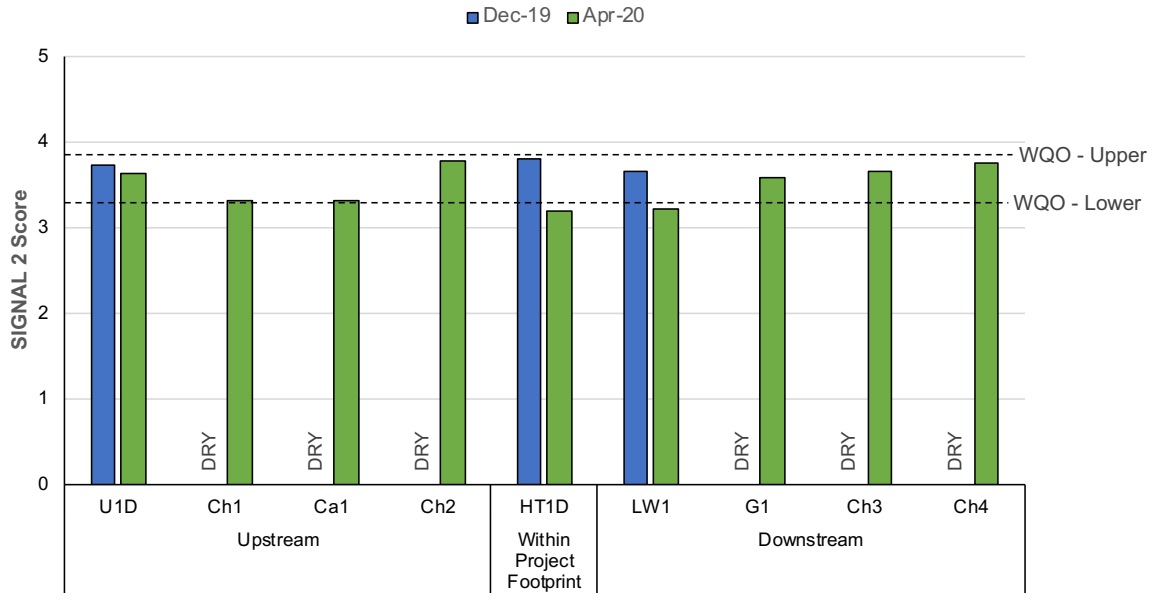

Figure 4.10 Total SIGNAL 2 scores of macroinvertebrates in bed habitat at each site; DRY indicates the site was dry and could not be surveyed

Edge Habitat

Overall, total SIGNAL 2 scores of macroinvertebrate communities in edge habitat was low to moderate (**Figure 4.11**). Total SIGNAL 2 scores in edge habitat was within the WQO range at all sites in December 2019, and within or below the WQO range at all sites in April 2020. The water level was low at most waterway sites in April 2020, resulting in poor quality, homogeneous edge habitat, which does not provide ideal habitat for sensitive taxa.

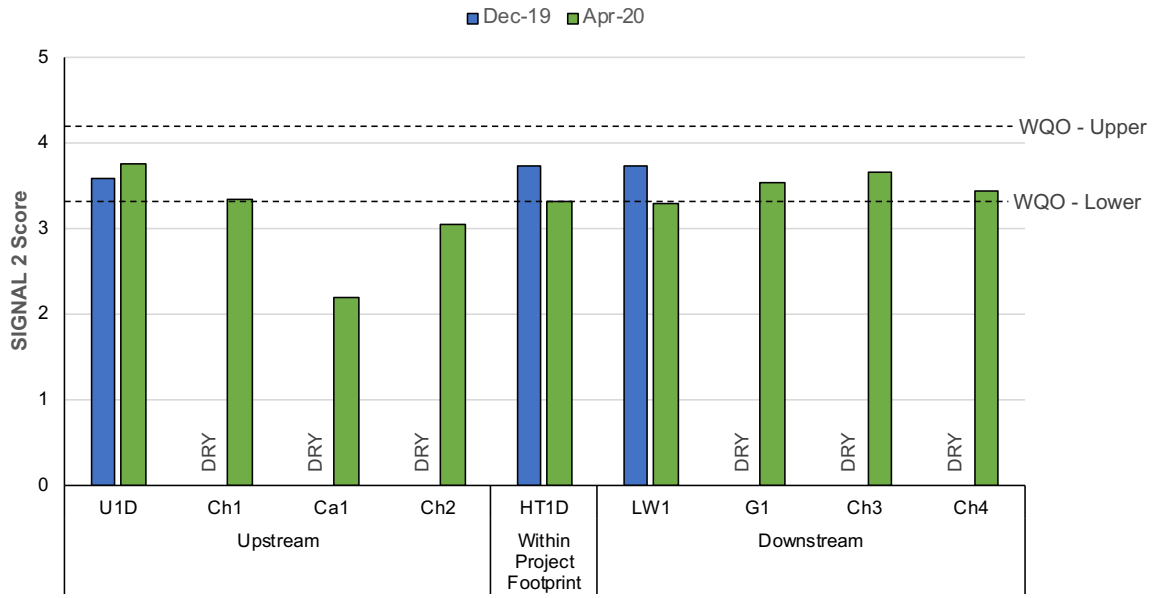

Figure 4.11 Total SIGNAL 2 scores of macroinvertebrates in edge habitat at each site; DRY indicates the site was dry and could not be surveyed

4.5.2.5 SIGNAL 2 Score / Family Bi-plots

Bed Habitat

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in bed habitat (Chessman 2003), all sites in December 2019 were within or on the border of quadrant one (refer to **Figure 3.5**; **Figure 4.12**). This indicates that sites contained favourable habitat, typically with chemically dilute waters. Site U1D, on an unmapped dam upstream of the Project (and upstream of CVM), was on the border of quadrants one and three, indicating that this site was also influenced by a combination of harsh physical conditions (given the low water level at this site during the survey) and poor water quality (with several physicochemical, nutrient and metals parameters exceeding relevant WQOs; **Table 4.1**).

In April 2020, most sites were within quadrant three, indicating that they were likely influenced primarily by a combination of harsh physical conditions, and also poor water quality. The exceptions were:

- site Ch2 on Cherwell Creek (upstream of the Project footprint and downstream of CVM), which was in quadrant one indicating favourable habitat conditions
- site G1 on Grosvenor Creek, which was on the border of quadrants one and three indicating that this site had relatively favourable habitat, but was also likely influenced by a combination of harsh physical conditions and poor water quality (though the

concentrations of dissolved copper and aluminium, total phosphorus, total nitrogen, ammonia and turbidity were also high at other sites during the survey; **Table 4.1**)

- sites LW1 and HT1D, dams in the Horse Creek catchment, which were on the border of quadrants three and four, which is indicative of communities exposed to toxic pollution or harsh physical conditions, and industrial or agricultural pollution. Given the aquatic habitat condition and water quality results at these sites, it is likely that a combination of harsh physical conditions and agricultural pollution contributed to this result. These sites were impacted by cattle access and trampling, with high concentrations of nutrients and some metals and metalloids present in the water. These parameters were also high at other sites during the survey, including sites upstream of the Project footprint and CVM, and throughout the broader region in historical surveys (URS 2009b), which may be related to the ephemeral nature of the waterways (**Table 4.1**).

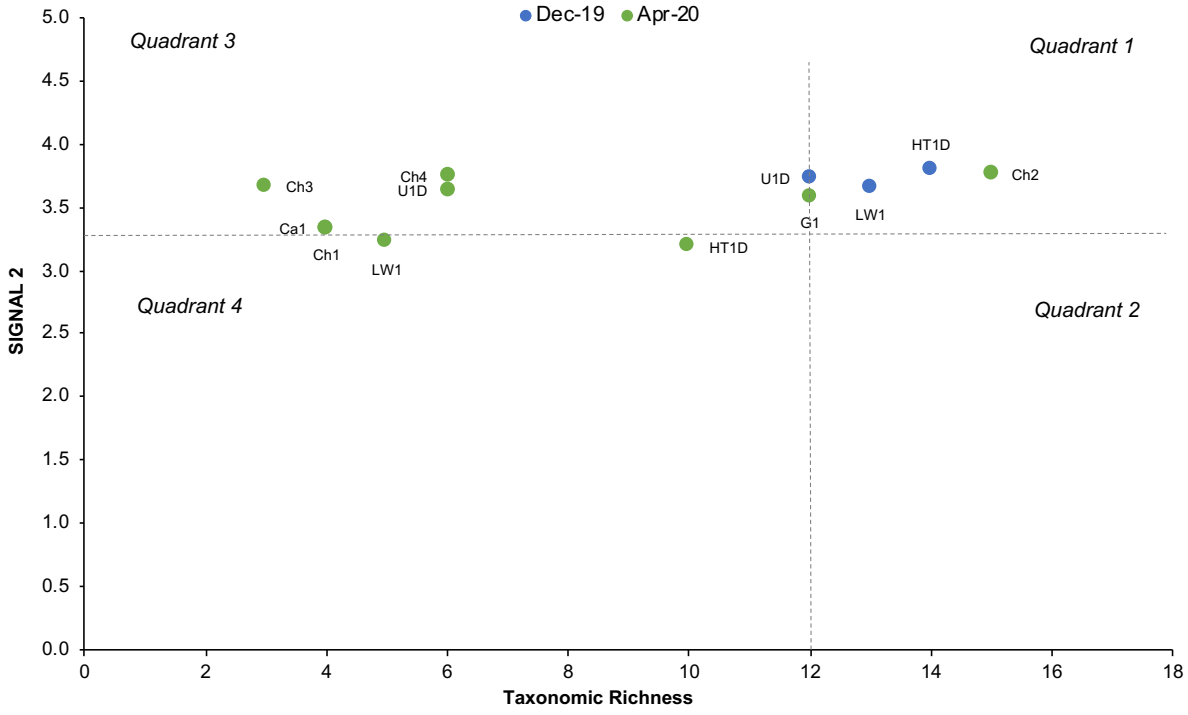

Figure 4.12 SIGNAL 2 / family bi-plot of macroinvertebrates in bed habitat at each site

Edge Habitat

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in edge habitat, most sites were in quadrant three during the December 2019 and April 2020 surveys (refer to **Figure 3.5**; **Figure 4.13**), indicating toxic pollution or harsh physical conditions. Sites in quadrant three were likely influenced primarily by a combination of harsh physical conditions (given the ephemeral nature of the waterways assessed), and also poor water quality (with several physicochemical, nutrient and metals parameters exceeding relevant WQOs at the relevant sites; **Table 4.1**). The exceptions were:

- Site Ch2 on Cherwell Creek, which was on the border of quadrants two and four, which is indicative of communities exposed to industrial or agricultural pollution and / or high salinity or nutrient concentrations. Water quality results showed relatively high

concentrations of some metals, nutrients and physicochemical parameters at this site, though the concentrations of these parameters were also high at other sites during the current survey, including sites upstream of the Project footprint and CVM, and throughout the broader region in historical surveys (URS 2009b), which may be related to the ephemeral nature of the waterways (**Table 4.1**). This site was located upstream of the Project footprint and immediately downstream of existing CVM infrastructure and consisted of a small, shallow pool during the survey.

- Site Ca1 on Caval Creek, within quadrant four, is indicative of communities exposed to industrial or agricultural pollution. Water quality was also relatively poor at this site, including high electrical conductivity and high nutrient levels (CQU 2018; **Table 4.1**); however, low water levels during this survey are likely to have also influenced this result, as the site consisted of a shallow isolated pool (where nutrients may concentrate, leading to higher concentrations than flowing environments).

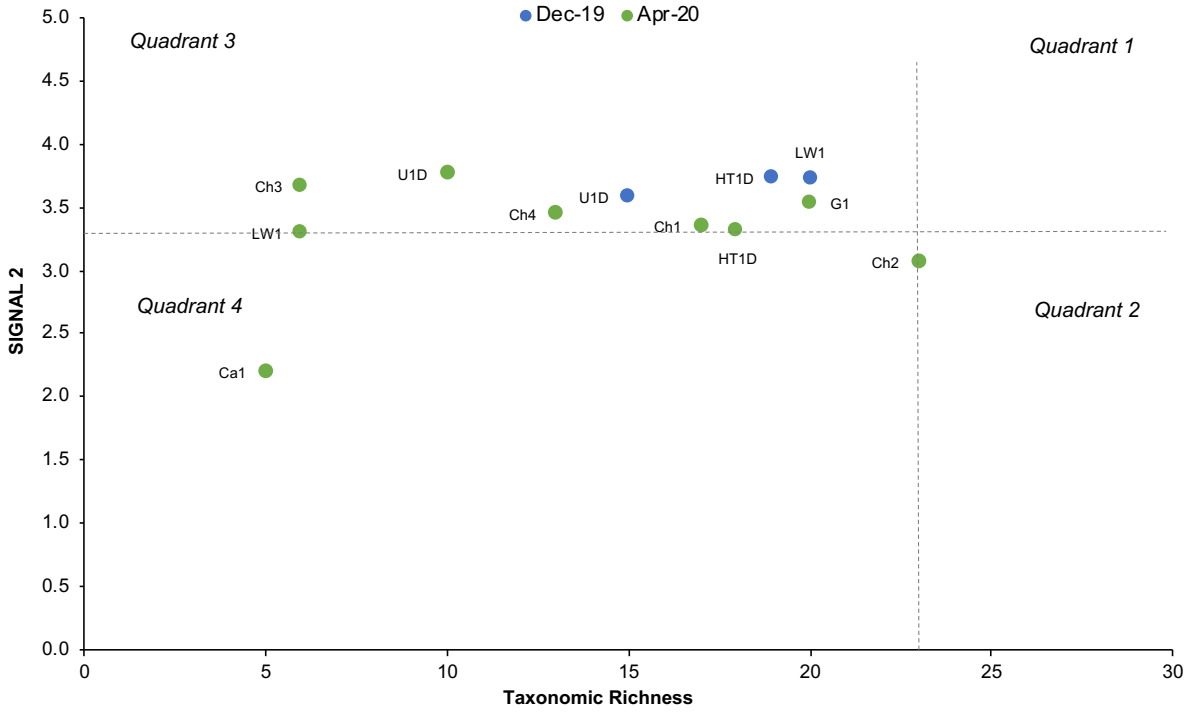

Figure 4.13 SIGNAL 2 / family bi-plot of macroinvertebrates in edge habitat at each site

4.5.2.6 Macrocrustaceans

Five species of macrocrustaceans were recorded during fish sampling (**Table 4.6**). All species have been recorded in previous surveys completed in waterways in the Isaac River catchment (DPM Enviroscience 2018, ALA 2020). Freshwater prawns (*Macrobrachium* sp.) were particularly abundant and were recorded at most sites. In contrast, only one redclaw yabby (*Cherax quadricarinatus*) was recorded at one site in a farm dam on a tributary of Horse Creek (i.e. site HT1D) in December 2019. This species is not naturally occurring within the Isaac River sub-basin, and has been historically translocated from northern Australia to become naturalised.

Table 4.6 Macrocrustaceans recorded during December 2019 and April 2020

Family *Species*	Common Name	December 2019				April 2020							
		Up-stream	Within	Down-stream		Upstream				Within	Downstream		
		U1D	HT1D	LW1	*Total Dec-19*	U1D	Ch1	Ca1	Ch2	HTD1	LW1	G1	*Total Apr-20*
Gecarcinucidae													
Austrothelphusa transversa	freshwater crab	–	–	–	**–**	1	8	1	18	–	–	9	***37***
Palaemonidae													
Macrobrachium sp.	freshwater prawn	–	50	50	***100***	–	–	–	–	22	44	–	***66***
Parastacidae													
Cherax depressus	orange-fingered yabby	–	–	–	**–**	–	–	–	–	3	6	–	***9***
Cherax destructor	common yabby	3	–	–	***3***	–	7	–	–	–	–	–	***7***
Cherax quadricarinatus	redclaw yabby	–	1	–	***1***	–	–	–	–	–	–	–	**–**
Total Abundance		**3**	**51**	**50**	***104***	**1**	**15**	**1**	**18**	**25**	**50**	**9**	***119***

– Species not recorded

4.6 Aquatic Vertebrates

4.6.1 Fish

4.6.1.1 Fish Communities of the Region

There are 29 native species of fish known from the waterways of the Isaac River sub-basin (DES 2020b) (**Table 4.7**). Of these taxa, three are considered endemic to the Fitzroy region: southern saratoga (*Scleropages leichardti*), leathery grunter (*Scortum hilli*) and golden perch (*Macquaria ambigua*) (DERM 2011b).

No exotic species are listed by the Department of Environment and Science (DES) as occurring in the Isaac River sub-basin (DES 2020b); however, tilapia (*Oreochromus mossambicus*), mosquitofish (*Gambusia holbrooki*) and platy (*Xiphophorus maculatus*) have been recorded in waterways within the region in the Isaac River around Moranbah during previous surveys (Catchment Solutions 2015, DPM Enviros ciences 2018). Tilapia and mosquitofish are restricted noxious fish under the *Biosecurity Act 2014,* and platy are a non-indigenous fish that are declared a pest fish when in the wild.

One threatened species of fish listed under the EPBC Act was identified as possibly occurring in the Isaac River sub-basin: silver perch (*Bidyanus bidyanus*). The habitat preferences and ecology of this species is discussed in **Section 4.9.1.1** below.

Table 4.7 Freshwater fish recorded from the region

Family Species Name	Common Name	Fitzroy River Basin [a]	Isaac River Sub-Basin [a]
Ambassidae			
Ambassis agassizii	Agassiz's glassfish	Yes	Yes
Anguillidae			
Anguilla reinhardtii	longfin eel	Yes	Yes
Apogonidae			
Glossamia aprion	mouth almighty	Yes	Yes
Ariidae			
Neoarius graeffei	blue catfish	Yes	Yes
Atherinidae			
Craterocephalus marjoriae	silverstreak hardyhead	Yes	No
Craterocephalus stercusmuscarum	flyspecked hardyhead	Yes	Yes
Belonidae			
Strongylura krefftii	freshwater longtom	Yes	Yes
Centropomidae			
Lates calcarifer	barramundi	Yes	No
Ceratodontidae			
*Neoceratodus forsteri***	Australian lungfish	Yes	No
Cichlidae			
*Oreochromis mossambicus***	tilapia	Yes [b]	Yes [b]

Family Species Name	Common Name	Fitzroy River Basin [a]	Isaac River Sub-Basin [a]
Clupeidae			
Nematalosa erebi	bony bream	Yes	Yes
Cyprinidae			
*Carassius auratus**	goldfish	Yes	No
*Cyprinus carpio***	European carp	Yes	No
Eleotridae			
Gobiomorphus australis	striped gudgeon	Yes	No
Hypseleotris compressa	empire gudgeon	Yes	Yes
Hypseleotris galii	firetail gudgeon	Yes	Yes
Hypseleotris klunzingeri	western carp gudgeon	Yes	Yes
Hypseleotris spp.	common carp gudgeon	Yes	Yes
Mogurnda adspersa	southern purple-spotted gudgeon	Yes	Yes
Oxyeleotris aruensis	Aru gudgeon	Yes	Yes
Oxyeleotris lineolata	sleepy cod	Yes	Yes
Philypnodon grandiceps	flathead gudgeon	Yes	Yes
Gobiidae			
Redigobius bikolanus	speckled goby	Yes	No
Hemiramphidae			
Arrhamphus sclerolepis	snubnose garfish	Yes	Yes
Megalopidae			
Megalops cyprinoides	oxeye herring	Yes	No
Melanotaeniidae			
Melanotaenia splendida splendida	eastern rainbowfish	Yes	Yes
Rhadinocentrus ornatus	ornate rainbowfish	Yes	No
Mugilidae			
Mugil cephalus	sea mullet	Yes	No
Trachystoma petardi	freshwater mullet	Yes	No
Osteoglossidae			
Scleropages leichardti	southern saratoga	Yes	Yes
Percichthyidae			
*Maccullochella peelii****	Murray cod	Yes	No
Macquaria ambigua	golden perch	Yes	Yes
Plotosidae			
Neosilurus ater	black catfish	Yes	Yes
Neosilurus hyrtlii	Hyrtl's catfish	Yes	Yes
Porochilus rendahli	Rendahl's tandan	Yes	Yes [d]
Tandanus tandanus	freshwater catfish	Yes	Yes
Poeciliidae			
*Gambusia holbrooki***	mosquitofish	Yes	Yes [c]
*Poecilia reticulata**	guppy	Yes	No
*Xiphophorus maculatus**	platy	Yes [b]	Yes [b]

Family Species Name	Common Name	Fitzroy River Basin [a]	Isaac River Sub-Basin [a]
Pseudomugilidae			
Pseudomugil signifer	Pacific blue eye	Yes	Yes
Retropinnidae			
Retropinna semoni	Australian smelt	Yes	Yes [c]
Scorpaenidae			
Notesthes robusta	bullrout	Yes	No
Terapontidae			
Amniataba percoides	barred grunter	Yes	Yes
*Bidyanus bidyanus***	silver perch	Yes	Yes
Hephaestus fuliginosus	sooty grunter	Yes	Yes [b]
Leiopotherapon unicolor	spangled perch	Yes	Yes
Scortum hillii	leathery grunter	Yes	Yes
Terapon jarbua	crescent grunter	Yes	No
Grand Total		**48**	**33**

* indicates introduced species
** indicates restricted noxious pest species under the *Biosecurity Act 2014*
*** indicates listed threatened species under the EPBC Act
[a] Source: DES 2020b
[b] Source: Catchment Solutions 2015
[c] Source: DPM Enviros ciences 2018
[d] Source: URS 2014

4.6.1.2 Fish Communities in the Vicinity of the Project

A total of 2,374 native fish, comprising seven species from six families, were recorded from the waterways and wetlands within the vicinity of the Project across the December 2019 and April 2020 surveys (**Table 4.8**). Fish communities were dominated by small bodied species, with the lack of large-bodied fish likely due to the paucity of deep pool habitat. Most sites contained fish communities, except for site Ca1 (Caval Creek upstream of the Project footprint) where no fish were recorded. This site consisted of small, isolated pools that provided poor habitat for fish communities.

Overall, the abundance and diversity of fish was relatively similar between surveys. Agassiz's glassfish (*Ambassis agassizii*), carp gudgeons (*Hypseloetris* spp.) and eastern rainbowfish (*Melanotaenia splendida splendida*) were the most abundant native species recorded during the December 2019 and April 2020 surveys, although bony bream (*Nematalosa erebi*) were also relatively abundant in December 2019. These species were also widespread in both the December 2019 and April 2020 surveys, occurring at all or most sites. In surveys, predominantly adult and intermediate fish were caught; though juveniles were also caught at most sites (**Figure 4.14** and **Figure 4.15**).

One threatened species of fish listed under the EPBC Act was identified as possibly occurring in the Isaac River sub-basin: silver perch (*Bidyanus bidyanus*) (DES 2020b). This species was not captured during the surveys.

Two pest species of fish were recorded downstream of the Project in April 2020: tilapia and platy (**Table 4.8**). Tilapia were caught at one waterway site on Cherwell Creek (i.e. Ch4) and

one lacustrine wetland site (i.e. LW1) on Horse Creek. Platy were caught at one site on Grosvenor Creek (i.e. G1). The abundance of pest species was low at most sites where they were caught relative to the abundance of native species (total abundance contributed to approximately 2 per cent and 7 per cent of total catch at sites Ch4 and G1, respectively), except at the lacustrine wetland (i.e. LW1), where total abundance of tilapia contributed to approximately 30 per cent of the total catch (**Table 4.8**).

Overall, the species (native and pest species) caught in December 2019 and April 2020 are known to occur in the region and have been recorded in previous surveys (BAAM 2009; DPM Enviroscienses 2018; **Table 4.7**). The native species recorded have a wide range of habitat preferences (e.g. smaller drainage lines, larger rivers and wetlands) and are tolerant of a range of water quality conditions (pH, salinity and dissolved oxygen concentrations).

Photos of representative fish from each species are presented in **Table D2, Attachment D**.

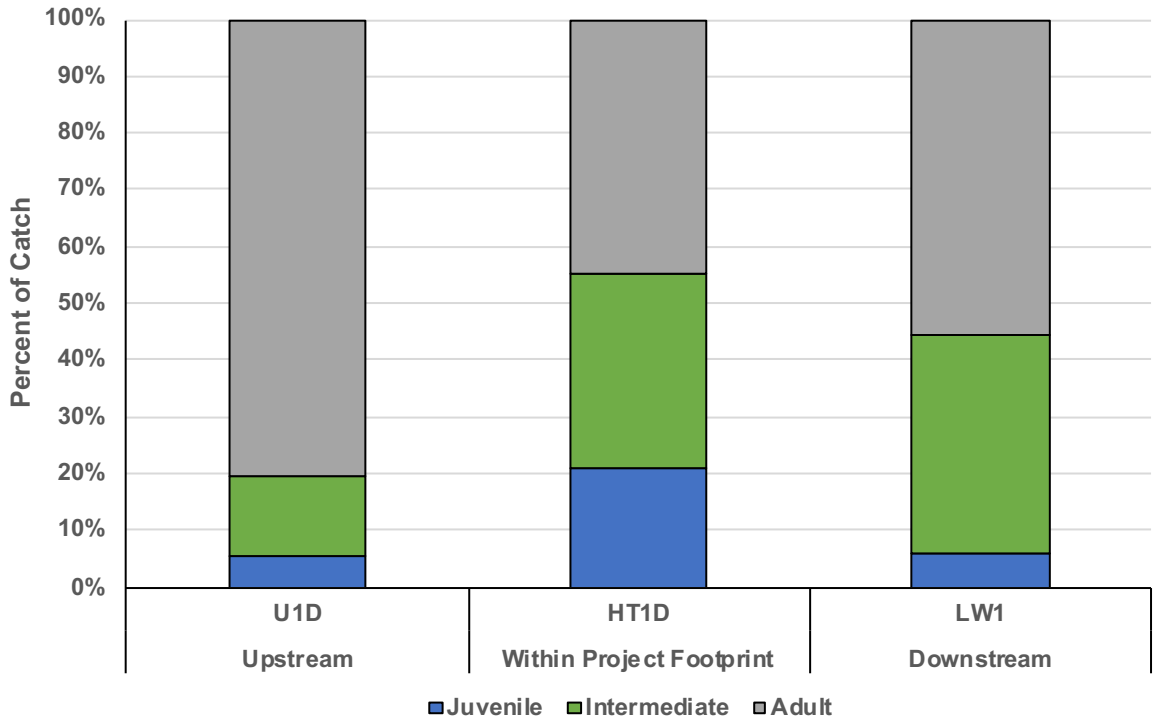

Figure 4.14 Proportion of native fish from juvenile, intermediate and adult life stages caught at sites in December 2019

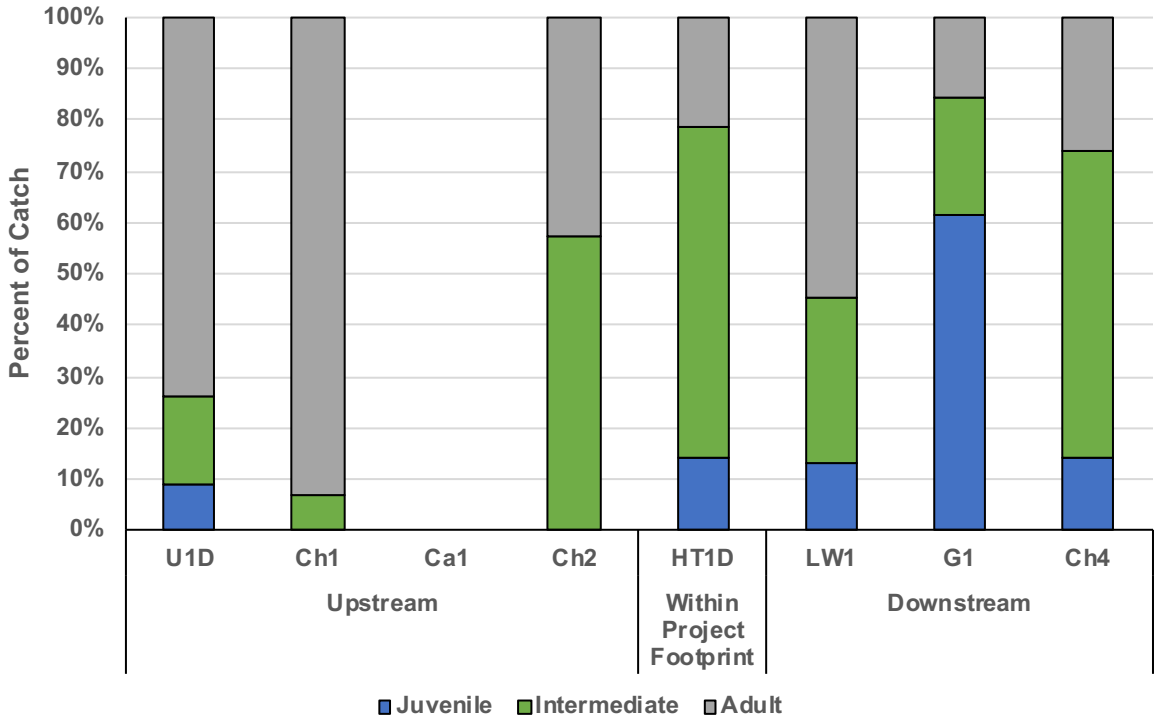

Figure 4.15 Proportion of native fish from juvenile, intermediate and adult life stages caught at sites in April 2020

Table 4.8 Fish species abundance and richness recorded during aquatic ecology surveys completed in December 2019 and April 2020

Family / *Species Name*	Common Name	December 2019 Up^ U1D	Within^ HT1D	Down^ LW1	*Total 2019*	April 2020 Upstream Ca1	Ch1	Ch2	Within^ U1D	HT1D	Downstream Ch4	G1	LW1	Total 2020
Ambassidae														
Ambassis agassizi	Agassiz's glassfish	166	145	439	**750**	–	–	3	465	4	70	1	100	**643**
Cichlidae														
*Oreochromis mossambicus**	Mozambique mouthbrooder / tilapia*	–	–	–	–	–	–	–	–	–	4	–	85	**89**
Clupeidae														
Nematalosa erebi	bony bream	–	126	19	**145**	–	3	–	–	4	58	1	4	**70**
Eleotridae														
Hypseleotris spp.	carp gudgeon	91	20	77	**188**	–	–	–	26	24	2	–	90	**142**
Mogurnda adspersa	purple-spotted gudgeon	12	1	–	**13**	–	–	–	–	–	–	–	–	–
Melanotaeniidae														
Melanotaenia splendida splendida	eastern rainbowfish	5	73	60	**138**	–	2	–	109	3	100	9	4	**227**
Plotosidae														
Neosilurus hyrtlii	Hyrtl's tandan	–	6	2	**8**	–	–	–	–	–	2	1	–	**3**
Poeciliidae														
*Xiphophorus maculatus**	Platy*	–	–	–	–	–	–	–	–	–	–	1	–	**1**
Terapontidae														
Leiopotherapon unicolor	spangled perch	–	–	2	**2**	–	9	4	7	–	24	1	–	**45**
Native Species Abundance		**274**	**371**	**599**	**1244**	**0**	**14**	**7**	**607**	**35**	**256**	**13**	**198**	**1130**
Exotic Species Abundance		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**1**	**85**	**90**
Native Species Richness		**4**	**6**	**6**	**7**	**0**	**3**	**2**	**4**	**4**	**6**	**5**	**4**	**6**
Exotic Species Richness		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**2**

^ Up = Upstream, Within = Within Project Footprint, Down = Downstream; * Pest species; – Species not recorded

4.6.2 Turtles

4.6.2.1 Freshwater Turtles of the Region

Five species of native freshwater turtles are known to occur in the Isaac River sub-basin (DES 2020b):

- broad-shelled river turtle (*Chelodina expansa*)
- eastern snake-necked turtle (*Chelodina longicollis*)
- Krefft's river turtle (*Emydura macquarii krefftii*)
- white throated snapping turtle (*Elseya albagula*), and
- Fitzroy River turtle (*Rheodytes leukops*).

The broad-shelled river turtle, eastern snake-necked turtle and Krefft's river turtle are widely distributed on the east coast of Australia in rivers and wetlands. These turtle species are not listed under the EPBC Act and are listed as least concern under the NC Act (ALA 2020, DES 2020b). These species have been recorded within approximately 30 km of the Project in previous surveys (DPM Enviros ciences 2018).

The white-throated snapping turtle is listed as critically endangered under the EPBC Act and endangered under the NC Act, while the Fitzroy River turtle is listed as vulnerable under both the EPBC Act and the NC Act. Their preferred habitat, distribution and ecology is discussed in **Section 4.8.3.1** below.

4.6.2.2 Freshwater Turtles in the Vicinity of the Project

Turtles were not particularly abundant or widespread throughout the waterways and wetlands in the vicinity of the Project, which is likely a reflection of the ephemeral nature of the region, where only isolated pools persist year-round and act as refugia for turtles.

One species of turtle was recorded across the December 2019 and April 2020 surveys: Krefft's river turtle (**Figure 4.16**; **Table 4.9**). This species was caught in a mapped lacustrine wetland on Horse Creek downstream of the Project footprint. A higher number of individuals were caught in the late wet season (i.e. April 2020) than in the early wet season (i.e. December 2019).

Krefft's river turtle is considered widespread and common throughout waterways in Queensland. This turtle species occurs in the region, and has been caught during previous surveys completed on the Isaac River, surrounding waterways and wetlands (DPM Enviros ciences 2018).

Figure 4.16 Photograph taken of a Krefft's river turtle at site LW1

Table 4.9 Turtles recorded during aquatic ecology surveys completed in December 2019 and April 2020

Family *Species Name*	Common Name	Dec-19 LW1 (Downstream)	Apr-20 LW1 (Downstream)	Total
Chelidae				
Emydura macquarii krefftii	Krefft's river turtle	2	7	**9**

4.6.3 Other Vertebrates

4.6.3.1 Platypus of the Region

Platypus (*Ornithorhynchus anatinus*) are listed as occurring within the Isaac River sub-basin (DES 2020b). This species is not listed as threatened under the EPBC Act. Under the NC Act platypus are considered to be an iconic species and are protected generally as 'Special Least Concern' under the NC Act. Their preferred habitat, distribution and ecology is discussed in **Section 4.8.3.2** below.

Platypus populations and habitat are found within the Fitzroy basin. However, there are no records of platypus from within 50 km of the Project (ALA 2020; DES 2019a). No platypus or potential habitat for this species were recorded during field surveys or during previous surveys in the broader region (DPM Enviros ciences 2018).

4.7 Groundwater-Dependent Ecosystems

Groundwater-dependent ecosystems (GDEs) are ecosystems whose species and ecological processes rely on groundwater, either entirely or intermittently (Doody et al 2019). Several riverine and wetland systems within the vicinity of the Project are mapped as low, moderate and high potential to be dependent on surface-expression of groundwater (BOM 2019c; **Figure 4.17**). No potential surface expression GDEs are mapped within the Project footprint.

Overall, field assessments concluded that aquatic habitat condition at mapped potential surface-expression GDE sites in the vicinity of the Project was representative of ephemeral waterway and wetland sites in the broader area (as summarised in **Sections 4.1** to **4.6**). The field assessment concluded that the aquatic ecological value of mapped potential surface-expression GDEs was low to moderate at wetland and waterway sites. No consistent differences in aquatic ecological indicators were observed between wetland and waterway sites mapped as potential surface-expression GDEs compared with those that are not mapped; though the value of sites on Grosvenor and Cherwell Creek was higher than at other riverine sites as these waterways have a higher stream order (and therefore provide greater value in terms of fish passage, connectivity and aquatic habitat availability and quality).

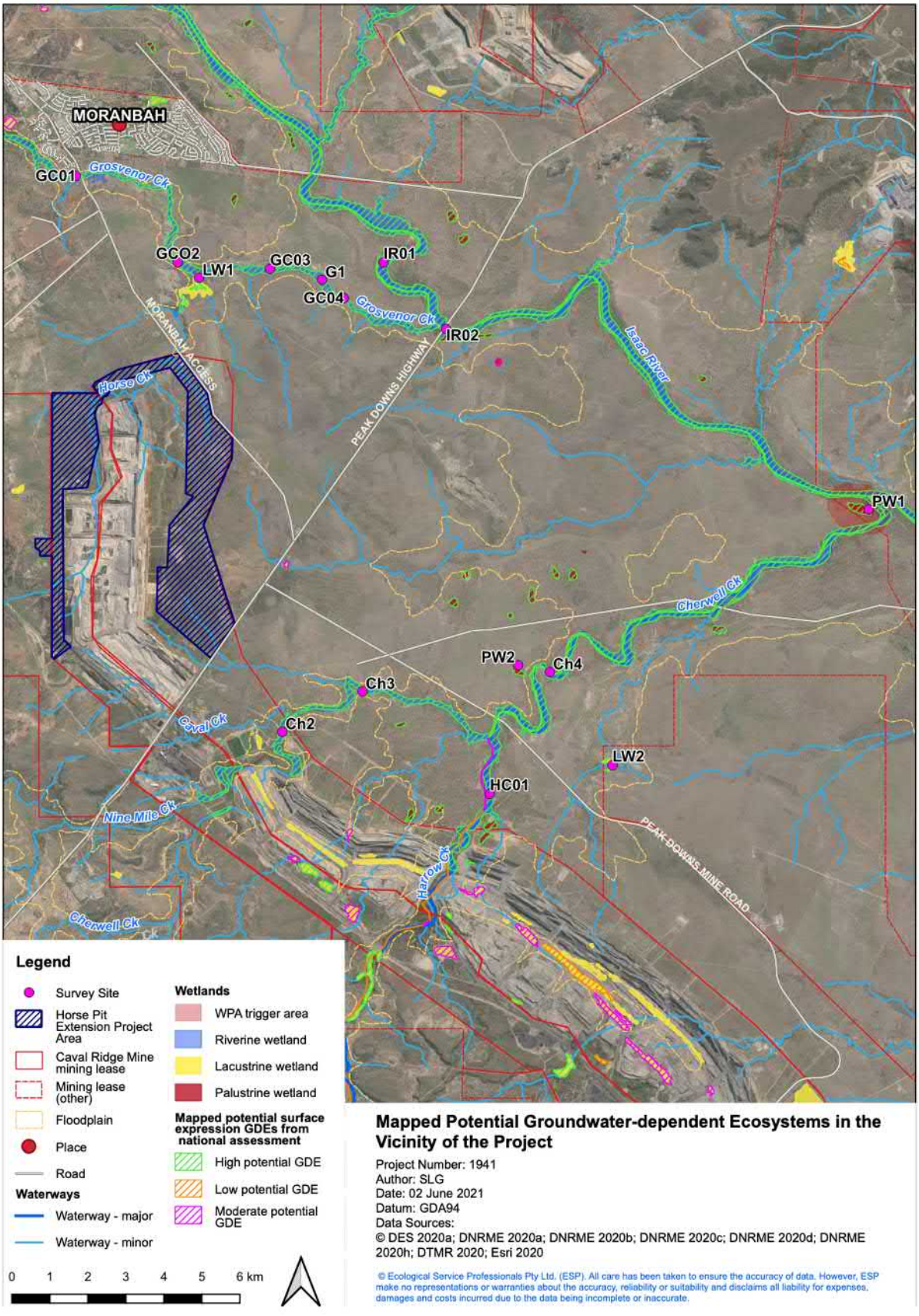

Figure 4.17 Waterways mapped as low, moderate and high potential to be dependent on surface-expression of groundwater (GDEs) in the vicinity of the Project and sites surveyed in the aquatic ecology assessment

4.8 Matters of State Environmental Significance

Several MSES relevant to aquatic ecology occur or have the potential to occur in the vicinity of the Project, including:

- HES wetlands, which are also WPAs in Great Barrier Reef catchments (i.e. including the Fitzroy basin)
- waterways providing for fish passage, and
- listed threatened species.

These matters are discussed in more detail in the sections below. No other aquatic MSES occur in the vicinity of the Project.

4.8.1 HES Wetlands

No HES wetlands are present within the Project footprint. There is one HES palustrine wetland (also a WPA) mapped approximately 20 km east and downstream of the Project footprint in the Isaac River floodplain. Although mapped as an HES wetland, no aquatic habitat or aquatic fauna species were recorded in the December 2019 survey. Aquatic habitat condition at this wetland is discussed in detail in **Section 4.1.2.3**.

4.8.2 Waterways Providing for Fish Passage

Many species of native fish known from the region migrate upstream and downstream, and between different aquatic habitats, at different stages of their life cycle (Marsden & Power 2007). Stimuli for movement include small and large flow events and increases in water temperature. Spring and summer are generally the most important months for migration; however, maintaining fish passage is important throughout the year (Marsden & Power 2007). The waterways in the vicinity of the Project provide temporary habitat and aquatic fauna movement corridors during flow events.

The DAF (2020) Queensland Waterways for Waterway Barrier Works mapping indicates the level of 'risk' associated with undertaking waterway barrier works within Queensland waterways with regards to fish passage. This dataset represents pre-development conditions, and shows waterways which have been affected by mining activities in the region (and therefore does not reflect the current locations of waterways in the area).

Where the works associated with the Project are undertaken on the mining lease under the conditions of an EA (and not a development approval), a waterway barrier works approval under the *Fisheries Act 1994* will not be required; however, fish passage requirements in the study area need to be considered. In the vicinity of the Project:

- the Isaac River, Grosvenor Creek, Harrow Creek and Cherwell Creek are mapped as major risk (purple) of adverse impact to fish movement
- Horse Creek is mapped as high risk (red) of adverse impact to fish movement, and
- all other waterways are mapped as moderate risk (amber) or low risk (green) of adverse impact to fish movement (**Figure 4.18**).

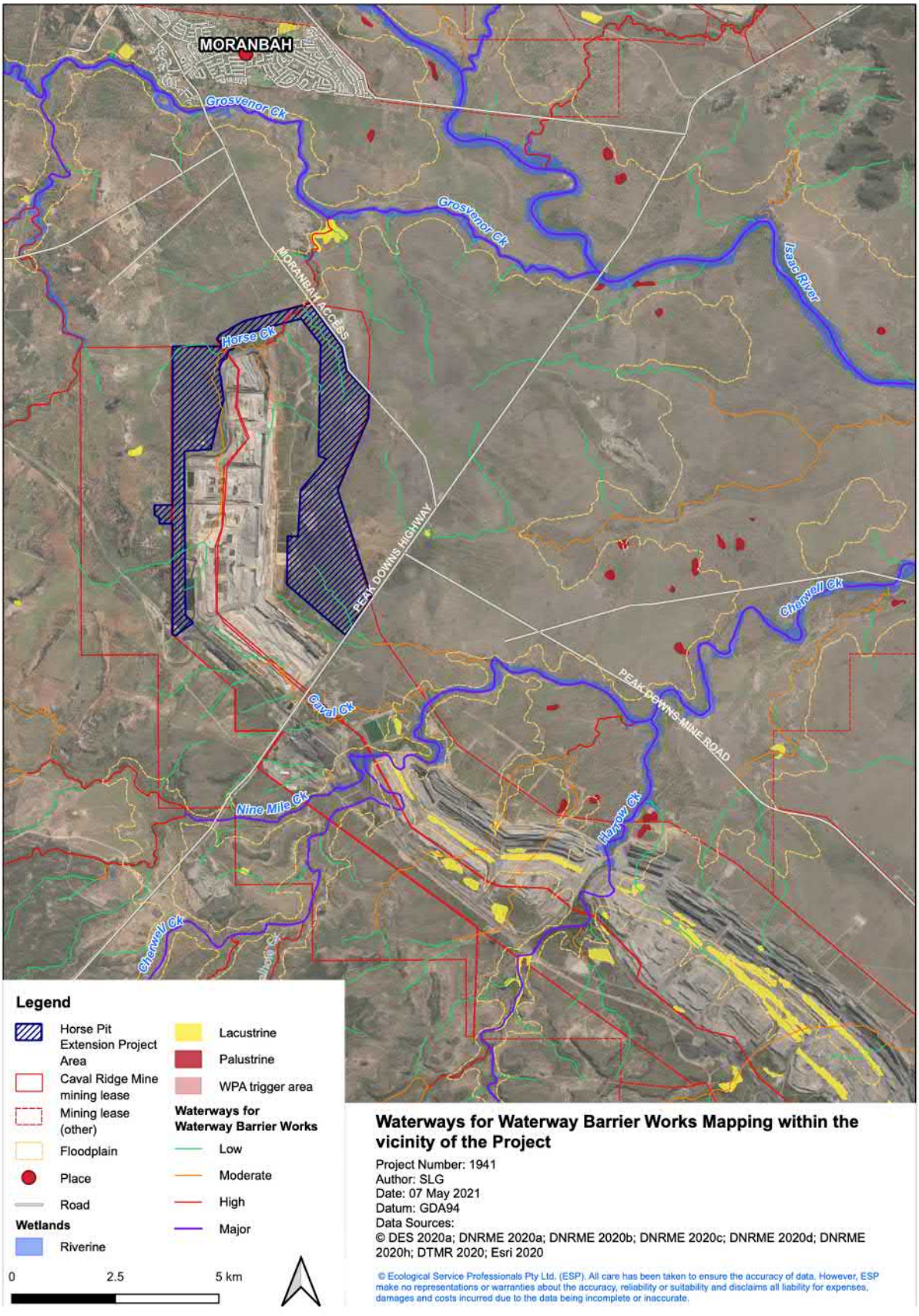

Figure 4.18 Waterway Barrier Works mapping in the vicinity of the Project

4.8.3 Listed Threatened Species

4.8.3.1 Turtles

Two species of turtle listed as potentially occurring within 30 km of the Project footprint are threatened under the EPBC Act: Fitzroy River turtle and white-throated snapping turtle.

The Fitzroy River turtle is endemic to the natural, permanent riverine habitats in the middle to lower areas of the Fitzroy River basin in Queensland (Limpus et al 2011, DAWE 2020a), and has an estimated occurrence in a range of less than 10,000 km^2 (Cogger et al 1993). This species prefers permanent freshwater riverine reaches (particularly deep pools interspersed with areas of riffle habitat) and large, isolated permanent waterholes (Cogger 2000). Preferred areas have high water clarity, and are often associated with ribbonweed (*Vallisneria* sp.) beds (Cogger et al 1993, DAWE 2020a). Their distribution extends from the Fitzroy Barrage to the upper areas of the Dawson, Nogoa and Connors rivers. Known sites include Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (Cogger et al 1993). Known key sites for the Fitzroy River turtle include Glenroy and Redbank crossings on the Fitzroy River, Theodore Weir on the Dawson River, Cardowan pump pool on the Connors River and Marlborough Creek (Limpus et al 2011).

The white-throated snapping turtle is endemic to New Guinea and south-eastern Queensland, where it occurs in the Fitzroy, Mary and Burnett River basins and associated smaller drainages in south eastern Queensland (Limpus et al 2011, DAWE 2020b). This species prefers clear, flowing and well oxygenated rivers with sandy-gravel substrate that have suitable shelters and refuges (e.g. submerged rock crevices, undercut banks and/or submerged logs and fallen tree (Limpus et al 2011)). During the day, turtles are affiliated with habitats of high shade (i.e. submerged logs, overhanging riparian vegetation), and at night they inhabit shallow riffles. White-throated snapping turtles are well-adapted for maintaining their position at specific foraging sites in very structured habitats such as log tangles and rocky outcrops with or without currents (Limpus et al 2011).

Both of these species were listed as potentially occurring within 30 km of the Project (DoEE 2019, **Attachment A**). However, none of the waterways in the vicinity of the Project contain suitable habitat for these species (such as permanent riverine flowing and pool habitat), and there are no records of either species in the vicinity of the Project (ALA 2020, Limpus et al 2011). The closest known records for both species are from tributaries in the Connors River catchment in the Isaac River sub-basin, approximately 80 km east north-east of the Project. Therefore, based on desktop review of known distribution, habitat preferences, and field assessments in the dry and wet season surveys, individual turtles are unlikely to occur in the vicinity of the Project, and no core foraging or nesting habitat for these species exists. This conclusion is consistent with results from other recent assessments in the Isaac River catchment (DPM Enviros ciences 2018).

4.8.3.2 Platypus

Platypus are considered to be an iconic species and are protected generally as ‘Special Least Concern’ under the NC Act.

Platypus occur in eastern Australia from Cooktown in north Queensland to Victoria and Tasmania. Platypus inhabit freshwater streams, rivers, lakes and dams. Platypus are

typically nocturnal, feeding on aquatic invertebrates along the stream bed from dusk until dawn (Carrick et al 2008). When not active, platypus rest in burrows in the river bank that typically open at the water's edge amongst tree roots and overhanging vegetation. Platypus can tolerate a relatively wide range of environmental conditions, but prefer habitat that has an abundance of invertebrate prey, permanent pools and runs, moderate to good water quality, and steep well-vegetated banks for burrows. In Queensland, platypus are usually found in rivers east of the Great Dividing Range, but do occur in some western-flowing streams (ALA 2020).

There are no records of platypus from within 30 km of the Project (ALA 2019; DES 2019a), and no platypus or potential habitat for this species were recorded during the field surveys or previous surveys in the broader region (DPM Enviroscences 2018). Therefore, platypus are considered highly unlikely to occur in the vicinity of the Project.

4.9 Matters of National Environmental Significance

Two controlling provisions relevant to aquatic ecology have been identified for this Project under the EPBC Act and are discussed in more detail in the subsections below, specifically:

- listed threatened species, and
- a water resource, in relation to coal seam has and large coal mining.

No other MNES occur or are likely to occur within the vicinity of the Project.

4.9.1 Listed Threatened Species

4.9.1.1 Fish

One listed threatened fish species was recorded as occurring in the Isaac River sub-basin under the Wetland*Info* database (DES 2020b): silver perch, listed as Critically Endangered under the EPBC Act. The natural distribution of the silver perch is limited to the Murray-Darling basin and their preferred habitat is high flowing rivers (DoE 2013; DAWE 2020c), although it has been frequently translocated across Queensland (Pusey et al 2004). This species was not listed in the EPBC Protected Matters Search Tool Report (**Attachment A**) as potentially occurring within 50 km of the Project. It was listed as occurring approximately 50 km from the Project in the Wildlife Online database; however, this is likely an erroneous waypoint coordinate as the location description of this record is Bundoora Dam near Middlemount, in the Mackenzie River sub-basin (approximately 100 km southeast of the Project). There are no known records of this species occurring in the vicinity of the Project footprint (DES 2019, DPM Enviroscences 2018, ALA 2020). The Project footprint does not provide the preferred habitat of this species (i.e. flowing riverine habitat).

4.9.1.2 Turtles

Two species of turtle listed as potentially occurring within 30 km of the Project footprint are threatened under the NC Act: Fitzroy River turtle and white-throated snapping turtle. These species are considered unlikely to occur in the vicinity of the Project, as discussed above in **Section 4.8.3.1**.

4.9.2 Water Resources

Water resources were recorded within the vicinity of the Project footprint during the field surveys, including:

- waterways (which were generally ephemeral in nature, except sites GC01 located on Grosvenor Creek upstream of the Project); see **Section 4.1.2.1**)
- lacustrine wetlands and farm dams (all if which were modified by the presence of dams; see **Section 4.1.2.2**)
- palustrine wetlands (all of which were dry during the field surveys (although PW1 was not assessed in the wet season due to access restrictions); see **Section 4.1.2.3**)
- mapped potential aquatic (i.e. surface expression) groundwater dependent ecosystems (see **Section 4.7** and **Figure 4.17**), and
- subterranean groundwater-dependent ecosystems, for example aquifers that may support stygofauna (see **Section 5** and **Figure 4.17**).

4.10 Summary of Aquatic Ecosystem Values

Overall, aquatic ecosystem values in the vicinity of the Project were low to moderate. Aquatic ecosystem values of waterway and wetlands are summarised in the sections below.

4.10.1 Waterways

Aquatic ecosystem value of Grosvenor Creek and Cherwell Creek was assessed as moderate due to:

- a wide variety of instream habitat types during the late-wet season, which provided habitat for a range of aquatic flora and fauna typical of ephemeral systems in the region
- provision of breeding habitat during the wet season, with juvenile, intermediate and adult fish recorded at most sites
- provision of important connectivity and fauna passage to upstream and downstream habitats during periods of high rainfall and flow
- absence of dry season refugia for aquatic flora and fauna, with no water present at sites in the dry season even at sites located on potential surface expression GDEs (except at site GC01 located on Grosvenor Creek upstream of the Project), and
- absence of listed protected species, communities, areas and habitats.

Aquatic ecological value of smaller creeks and drainage channels (including Caval Creek, Horse Creek, and unnamed tributaries in the upper reaches of Cherwell Creek, Caval Creek and Horse Creek) was lower than at Cherwell and Grosvenor creeks, and was assessed as low due to:

- low to moderate variety of instream habitat types (shallow pools only at the site on Caval Creek, with sites on Horse Creek and unnamed tributaries dry), which provided habitat for aquatic flora and fauna typical of ephemeral systems in the region for short periods following high rainfall
- no provision of fish habitat, with no fish recorded during the late-wet season at Caval Creek (with sites on Horse Creek and unnamed tributaries dry during December 2019 and April 2020 surveys)
- limited potential to provide connectivity or fauna passage to upstream habitats, except during brief periods of high rainfall and flow
- absence of dry season refugia for aquatic flora and fauna, with no water present at sites surveyed in the dry season, and
- absence of listed protected species, communities, areas and habitats.

4.10.2 Mapped Lacustrine Wetlands and Farm Dams

Aquatic ecosystem value of State-mapped lacustrine wetlands (i.e. site LW1 and LW2) and unmapped farm dams (i.e. sites HT1D and U1D) in the vicinity of the Project was assessed as moderate due to:

- a moderate variety of instream habitat types, including deep pools which provided habitat for a range of aquatic flora and fauna common in the region
- provision of breeding habitat during the wet season, with juvenile, intermediate and adult fish recorded
- limited potential to provide connectivity or fauna passage to upstream habitats, due to locations on waterways in the catchment
- provision of dry season refugia for aquatic flora and fauna, and
- absence of listed protected species, communities, areas and habitats.

4.10.3 Mapped Palustrine Wetlands

Aquatic ecosystem value of State mapped palustrine wetlands in the vicinity of the Project was moderate. The field assessment confirmed that site PW1 met the definition of a wetland under the *Queensland Wetland Definition and Delineation Guideline* (DERM 2011a). In contrast, site PW2 did not contain any aquatic habitat features, and therefore was only of terrestrial ecological value and is not considered further.

Although designated as a HES wetland, site PW1 was assessed in December 2019 as having low aquatic ecosystem value due to:

- a low to moderate variety of potential instream habitat types (noting that this site was dry during the field survey), which would provide habitat for aquatic flora and fauna common in the region during periods of high rainfall
- would likely only hold water (and therefore provide aquatic habitat) for short periods during flood events or periods of high rainfall
- would occasionally connect to the Isaac River floodplain during periods of high flow, but has limited potential to provide connectivity or fauna passage to upstream habitats due to its location
- absence of dry season refugia for aquatic flora and fauna, with no water present during the dry season, and
- absence of listed protected species, communities, areas and habitats.

5 Stygofauna Communities

5.1 Desktop Literature Review

5.1.1 Stygofauna Overview

Stygofauna are subterranean aquatic fauna that live part of or all of their lives in groundwater systems (DES 2018c). Stygofauna are thought to play key roles in nutrient and organic matter cycling (Danielopol et al 2003), water filtration (Asmyhr et al 2014), and modification of water flow though changes to interstitial pore spaces and mineral formation (Murray et al 2006). Stygofauna are key contributors to Australia's biodiversity (Humphreys 2006), and can act as indicators of groundwater ecosystem health (Tomlinson et al 2007).

Habitats for stygofauna include underground aquifers and caves, where they occur in water filled pore spaces and voids. Depending on where they occur, stygofauna are also referred to as (Glanville et al 2016, Tomlinson 2011):

- stygophilic fauna, which inhabit surface water and groundwater environments
- stygoxenic fauna, which inhabit mostly surface environments, and only inhabit groundwater inadvertently and are unable to establish subterranean populations, and
- stygobitic fauna, which live exclusively in groundwater throughout their entire lifecycle.

The lithologies where most stygofauna taxa are found include alluvium, basalt and coal, gravel and sands, and sandstones (Glanville et al 2016, DES 2018c). These habitats are typically restricted in their distribution (Eberhard et al 2005, Glanville et al 2016 and references within) and unchanged over long time periods (Humphreys 2006). These factors contribute to the high degree of endemism and narrow distribution of stygofauna (Humphreys 2006).

Stygofauna communities in Australia are dominated by crustaceans, however oligochaetes, insects, molluscs, rotifers and fish have also been recorded (4T 2012, DES 2018c, frc environmental 2013, Glanville et al 2016). The majority of stygofauna species identified in Australia are not found anywhere else in the world (Humphreys 2006). Common adaptations of stygofauna to the absence of light and restricted space are:

- small body size (<1 mm total body length)
- lack of pigmentation
- absence of eyes, and
- elongated appendages for tactile sensing.

In Australia, most studies on the composition of stygofauna communities and description of taxa to date have been in the Pilbara (where a highly diverse and regionally endemic community exists), New South Wales and Tasmania. In Queensland, comparatively fewer studies have been undertaken, with the majority of studies conducted in the Surat, Bowen, Fitzroy and Galilee basins in the context of Environmental Impact Studies (Hose et al 2015, Glanville et al 2016). Subsequently, knowledge of the biodiversity and value of stygofauna

communities is relatively poor but is expected to increase as more studies are conducted and taxonomic knowledge improves.

5.1.2 Habitat Preferences and Ecology

Stygofauna are tolerant of a relatively wide range of environmental conditions and can occur in a variety of aquifer types, however they require favourable conditions to survive and not all aquifers are suitable (Doody et al 2019). Important habitat characteristics known to influence the presence of stygofauna include:

- aquifer type
- hydraulic conductivity
- groundwater quality
- food supply
- water extraction and use, and
- depth to groundwater.

Stygofauna are most commonly found in karstic and alluvial aquifers, which have high porosity. These large pores and fractures allow stygofauna to pass through them and facilitate water movement and connectivity, which is important in supplying dissolved oxygen and nutrients (Strayer 1994, Hahn & Fuchs 2009, Hose et al 2015). Although stygofauna have also been recorded from fractured rock aquifers (such as sandstone, coal and basalt), these will often only contain stygofauna when there is sufficient hydrological connection to either limestone or alluvial aquifers (Doody et al 2019).

Stygofauna can occur across a range of depths, however a higher diversity and abundance of stygofauna is typically found near the water table (when the water table is shallower than 20 to 30 m) (Datry et al 2005). Stygofauna are also more likely to occur in aquifer recharge areas where the water table is close to the land surface (<10 m), and near deep rooted trees (Humphries 2000, Hancock and Boulton 2008). This is because these areas generally have higher concentrations of organic matter and dissolved oxygen (Hyde et al 2018). Diversity and abundance of stygofauna communities then decline with depth (Datry 2005).

Water quality can be an important determinant in the presence and abundance of stygofauna. Stygofauna are typically most likely to occur where electrical conductivity is less than 5,000 microsiemens/cm (µS/cm). Although stygofauna have been collected from aquifers with electrical conductivity of up to 56,000 µS/cm, the diversity and abundance of stygofauna typically decreases with increasing electrical conductivity above 5,000 µS/cm (Hancock & Boulton 2008, Watts & Humphreys 2009, Schulz et al 2013, Glanville et al 2016). Stygofauna can also tolerate a pH range of 3.5 to 10.3, but a higher diversity is likely to occur in aquifers with a pH range of 6.5 to 7.5 (4T 2012).

The occurrence of stygofauna communities within the Bowen basin is poorly understood. A previous review of stygofauna studies in the Bowen basin concluded that stygofauna are rare or unlikely to occur within the bedrock (4T 2012). However, they are considered likely to occur in some of the unconsolidated sandy sediments associated with the Isaac River floodplain due to the high porosity, suitable hydraulic conductivity and interconnectivity. In alluvial sediments, stygofauna are typically found in shallow depths (<20 m), and at electrical

conductivity levels of less than 2,000 µS/cm, though they still may occur outside of this range (4T 2012).

5.1.3 Hydrogeology in the Vicinity of the Project

The Bowen basin in the vicinity of the Project is characterised by a relatively thin accumulation of consolidated sediments, gentle easterly dips and minor to moderate deformation (URS 2009a). The litho-stratigraphy of the region is shown in the **Groundwater Chapter**. Three distinct units occur within the Project site, including Cainozoic sediments (alluvium and regolith), Cainozoic basalt and Permian coal measures. The Quaternary alluvial formations, Tertiary sediment and basalt formations, and the Permian coal measures, generally yield low sustainable volumes of poor quality groundwater, and are not recognised aquifers of the area.

Alluvial deposits in the vicinity of the Project occur predominantly along creeks such as Horse Creek, Grosvenor Creek and Cherwell Creek (URS 2009a). The Quaternary alluvial aquifers are not extensive in the vicinity of the Project; however, they become more significant along and adjacent to the Isaac River main channel. The minimum distance between the Project open cut pit and the Isaac River alluvium is approximately 9 km (SLR 2021a). Tertiary to Quaternary aged alluvium deposits are distributed along the courses of Cherwell Creek and Harrow Creek, located 1.7 km to the south of Horse Pit, extending to the south and south east. Within the Project site the Cherwell Creek alluvium extends from the creek approximately 1.7 km north towards Horse Pit. Adjacent to Cherwell Creek the alluvium comprises between 6 to 9 m of clay and silt, which is underlain by up to 10 m of fine to coarse sand and gravel. The thickness of the alluvium decreases towards Horse Pit. Alluvial deposits located adjacent to Harrow Creek extend approximately 3 km south and 1 km south east, and comprise 2 m of silt and clay, overlying 6 m of sands and gravels with bands of silt and clay (SLR 2021a). While there is potential for groundwater to exist within the sand and gravel deposits of the alluvium close to the Project, the alluvium is not considered a significant aquifer due to the shallow depth (approximately 10 to 20 m below ground level, where saturated), limited extent and continuity. The aquifer is likely to only become temporarily saturated in the vicinity of the Project following significant creek flow events (URS 2009).

Regolith material in the vicinity of the Project comprises Cainozoic (Quaternary to Tertiary) aged sediments, including alluvium and colluvium. The regolith in the Project site comprises a heterogeneous distribution of fine to coarse grained sand, clay, sandstone and claystone, with regolith material generally 15 m to 45 m thick. The regolith is considered to be densely compacted and largely unsaturated, with the presence of water restricted to lower elevation areas along the Isaac River and the lower reaches of its tributaries (i.e. Cherwell Creek and Ripstone Creek). Flow within the regolith where it is saturated is a reflection of topography, flowing towards nearby drainage lines (SLR 2021a).

Tertiary basalts mapped in the vicinity of the Project are not regionally extensive, occurring only along the western edge of the Project site. The occurrence is generally discontinuous and isolated. Recharge to the basalt aquifers is likely to be via surface infiltration and overland flow in areas where the basalt is exposed and/or no substantial clay barriers occur in the shallow subsurface. Recharge may also occur via vertical seepage from overlying alluvium aquifers. Exploration boreholes and monitoring wells across the Project site found

the basalt ranged from fresh to highly weathered with variable clay, and to be up to 35 m thick (SLR 2021a).

Permian sequences consist of coal seam aquifers confined above and below by very low permeability geological formations. Faulting and seam splitting is common throughout the region. Due to the clay characteristics of the regolith overlying the coal seams in the vicinity of the Project, it is considered that recharge is limited. Any leakage between aquifers through the faults is dictated by a variety of factors, including the hydraulic conductivity of the fault, the interburden thickness between the aquifers, and the piezometric level in the aquifers. Monitoring of groundwater levels in the Permian aquifers in the vicinity of CVM indicates drawdown in response to current mining activities in both Horse and Heyford Pits, as well as the adjacent Peak Downs Mine (URS 2009a).

Overall, the Project site comprises the following key hydrogeological units (SLR 2021a):

- Cainozoic sediments:
    - Quaternary alluvium – unconfined aquifer (water-bearing strata of permeable rock, sand, or gravel) localised along Cherwell Creek and the Isaac River.
    - Quaternary to Tertiary colluvium and weathered units (regolith) – unconfined and largely unsaturated unit bordering alluvium.
- Tertiary Basalt – unconfined, heterogenous and discontinuous and highly variable permeability, dependant on degree of weathering and nature of fracturing / vesicularity.
- Permian coal measures – low permeability interburden units with aquitard properties, and coal sequences that exhibit water bearing properties associated with secondary porosity through cracks and fissures.

5.1.4 Stygofauna Communities in the Vicinity of the Project

Overall, aquifers within the Project site are considered to have a low likelihood of supporting stygofauna communities. Although stygofauna have been recorded from fractured rock aquifers (e.g. basalt and coal), they are less likely to occur where there is insufficient hydrological connection to limestone or alluvial aquifers (Doody 2019). The alluvium aquifer is unconfined and likely fed by surface water; as such groundwater available for stygofauna communities is likely to be limited and spatially sporadic.

Stygofauna may be present in the Quaternary alluvial aquifers in the wider vicinity of the Project. The Isaac River and its tributaries are ephemeral, particularly in the upper reaches (which often experience prolonged dry periods) (4T 2012). Along with varied permeability, this indicates that the distribution of stygofauna in the upper reaches of the alluvium further from the main rivers, may only be highly localised (i.e. where there is sufficient groundwater storage to sustain populations) (4T 2012). In the lower reaches, and where there are confluences and extensive river alluvium deposits, the likelihood of saturation and therefore the likelihood of occurrence of stygofauna is greater.

Of the 33 bores that have been sampled within 30 km of the Project, none have recorded true stygofauna present. Eight of these bores have stygoxene recorded, including bores downstream of the Project site (Queensland Herbarium 2021).

Two bores in the Isaac River alluvium were sampled recently as part of a stygofauna pilot study completed for the Olive Downs Coking Coal Project EIS (DPM Enviros ciences 2018). No stygofauna were recorded from bore sampling during the assessment. However, stygofauna are known to occur in unconsolidated sediments, where they are most likely to occur in shallow depths (< 20 m, though often up to 50 m). Therefore, they were considered likely to occur in the unconsolidated sediments of the Isaac River alluvium, in the lower reaches of the Isaac River and at the confluences of larger tributaries (DPM Enviros ciences 2018).

5.2 Field Survey Results

5.2.1 In Situ Water Quality

Electrical conductivity and pH of groundwater was within the range known to support stygofauna at most bores. The exceptions were:

- pH at bores MB19CVM08P (11.82 pH units) and MB19CVM10P (11.35 pH units), which was high and alkaline, and therefore unlikely to support diverse stygofauna communities (**Table 5.1**). Elevated pH at these two bores may be indicative of underdeveloped bores (i.e. the bores are compromised by residual drilling fluids or a lack of adequate purging).
- Electrical conductivity at bores PZ09 (13,919 µS/cm) and PZ01 (13,623 µS/cm), which was high and above the range known to support stygofauna communities (< 5,000 µS/cm preferred but also occur regularly at < 10,000 µS/cm) (**Table 5.1**).

Table 5.1 In situ water quality recorded at each bore during the pilot studies

Bore ID	pH (pH units)	EC (µS/cm)
MB19CVM03T	9.76	–
MB19CVM05T	7.56	1,455
MB19CVMO6P	6.84	9,226
MB19CVMP07T	7.59	1,216
MB19CVM08P	11.82	7,046
MB19CVMP09A	6.70	3,013
MB19CVM10P	11.35	3,050
PZ07D	6.92	6,020
PZ09	7.00	13,919
162145	6.61	3,120
162807	7.52	3,147
162144	6.66	2,363

Bore ID	pH (pH units)	EC (µS/cm)
162044	7.44	2,427
162142	7.46	9,350
162816	6.97	686
162045	6.99	2,049
182164	7.23	983
162043	7.29	1,369
182048	7.25	1,447
PZ01	6.99	13,623
PZ04	6.52	5,581
PZ12D	6.82	5,355
PZ12S	6.82	6,206

– reading not available

5.2.2 Bore Depth

Bores sampled included a variety of aquifers from available lithologies, although alluvium bores were generally dry, with only two bores sampled (**Table 5.2**). A range of bore depths were sampled, including bores within the range known to support higher diversity and abundance (i.e. when the water table is shallower than 20 to 30 m; Datry et al. 2005). Some bores were deep, which may limit stygofauna communities (**Table 5.2**). Stygofauna are known to occur across a range of depths including, though rarely, at depths beyond 100 m below ground level (Hose et al. 2015).

Table 5.2 Depths and strata of each bore sampled during the pilot studies

Bore ID	Bore depth (mBGL)	Depth to water level (mBGL)	Slotting / Screen Unit ^
MB19CVM03T	35	20	Basalt
MB19CVM05T	44	35	Basalt / basal sands
MB19CVMO6P	72	38	Coal / siltstone
MB19CVMP07T	27	12	Basalt
MB19CVM08P	164	28	Coal / siltstone
MB19CVMP09A	18	15	Alluvium
MB19CVM10P	128	57	Coal / siltstone
PZ07D	44	16	Coal seam

Bore ID	Bore depth (mBGL)	Depth to water level (mBGL)	Slotting / Screen Unit ^
PZ09	70	40	Coal seam
162145	23	21	Coal / sandstone
162807	12	10	Unknown
162144	17	12	Alluvium
162044	72	30	Basalt
162142	137	38	Coal / sandstone
162816	67	8	Unknown
162045	83	22	Sandstone
182164	63	2	Basalt
162043	73	23	Basalt
182048	73	17	Basalt
PZ01	85	17	Coal seam
PZ04	93 ^	68 ^	Coal seam
PZ12D	57	30	Non-coal Permian - siltstone
PZ12S	31	26	Regolith - sandstone / siltstone

– reading not available
^ information from bore records

5.2.3 Stygofauna Communities

No stygofauna specimens were recorded from bores sampled during the field survey. Of the 13 bores sampled in May 2020 and 10 bores sampled in November 2020, eight bores from each survey contained invertebrates. Most taxa identified were terrestrial specimens, including species of Araneae (spiders), Acarina (mites), Collembola (springtail), Ixodidae (ticks), Culicidae (mosquito larvae), Thysanoptera (thrips), Formicidae (ants), Polyxenida (millipede), Coleoptera (beetles) and Hemiptera (true bugs).

One Oligochaeta species, two Acarina (mites) species and a cyclopoid copepod were identified as potentially being stygofauna in bores. However, as outlined below, these were generally likely to be stygoxene and not true stygofauna.

Oligocheates were identified in bores 162044, 162048, 162043 and 162807 in November 2020. There is a taxonomic and ecological knowledge gap for oligochaetes (Eco Logical Australia 2015) and further identification, even to species level, does not guarantee confirmation as stygofauna. While oligochaetes can occur within the stygofauna community, many consider them obligates of groundwater, and their presence in groundwater is usually linked to adjacent soil communities (Eco Logical Australia 2015, Halse and Pearson 2014). The oligochaetes sampled were in low numbers (1 to 14 individuals per sample) and the only other taxa found in the same bore were terrestrial. This suggests the oligochaetes collected,

while possibly stygal (e.g. stygoxenic), are unlikely to be a groundwater dependent (stygobitic) species.

Eight individual mites with reduced pigmentation, classified as belonging to the order Oribatida, were found in bore 162816 in November 2020. Most oribatid mites are terrestrial, with less than 1% of species being truly aquatic (Schatz and Behan-Pelletier 2008, Schuppenhauer et al. 2019). Some of these aquatic oribatid species have been referred to as stygofauna in other studies (Bennelongia Pty Ltd 2007, Biota Environmental Sciences 2010). Terrestrial oribatids have high tolerance to submersion, with some species demonstrating survival for up to a year when submerged in flowing waters (Schuppenhauer et al. 2019). There were also terrestrial ants within this bore. As such the Acarina with reduced pigmentation were most likely a stygoxene rather than a stygobitic groundwater obligate. One individual mite was also found in bore 182164. This mite had a dark eye spot, and as such unlikely to be stygobitic (there were also several terrestrial specimens in this bore).

One individual cyclopoid copepod was found in bore 182164 in November 2020. Copepods are among the most abundant type of stygofauna, but can also be washed into bores in floods or blown in as eggs. Several terrestrial specimens also occurred within this bore indicating the potential for this copepod to be derived from surface waters. While the origin of this cyclopoid copepod is unknown, given the only other specimens detected in the bore were terrestrial, it is likely that this copepod is a stygoxene rather than true stygobitic fauna.

The results of the pilot studies were consistent with the findings of the desktop assessment, which concluded that the aquifer formations within the Project footprint are unlikely to support stygofauna communities. Invertebrate communities were generally either terrestrial or stygoxene (i.e. inhabit mostly surface environments, only inhabit groundwater inadvertently and are unable to establish subterranean populations). Stygofauna communities are highly likely to be present further downstream of the Project, in the alluvium associated with the Isaac River, and the lower reaches of its major tributaries.

6 Impact Assessment and Proposed Mitigation Measures

6.1 Habitat Modification and Loss

The Project would directly remove or modify waterways and associated aquatic habitat within the pit extension area and zone for dragline crossing (**Figure 6.1**), including:

- upper reaches of Horse Creek within the pit extension area to the north
- upper reaches of Cherwell Creek within the pit extension area and zone for dragline crossing to the south, and
- an unmapped (artificial) farm dam (Site HTD1) within the pit extension area to the north.

Waterways within the pit extension area are located high in the catchment at the headwaters of Horse Creek and Cherwell Creek and are stream order 1. They are ephemeral, only likely to flow during periods of high rainfall, and are unlikely to hold water for extended periods of time following rainfall events. As such, these waterways do not provide aquatic habitat for the majority of the year. Aquatic flora and fauna in the upper reaches of Horse Creek and Cherwell Creek were limited and aquatic ecological value was low.

The unmapped (artificial) farm dam within the Project site was of moderate aquatic ecological value. It provided a dry season refuge but was poorly connected (isolated from the main waterway). Aquatic plants, freshwater prawns, yabbies and fish were caught in the dam and macroinvertebrate richness was moderate, with some sensitive taxa present and communities indicative of harsh physical conditions and agricultural impacts.

Waterways within the Project site have been either defined as drainage features (upstream reaches of Cherwell Creek) or are unmapped (upstream reaches of Horse Creek and the artificial dam) under the Water Act (refer to **Section 1.3.1**). All aquatic species within this area were considered common to the region (no aquatic species listed under the EPBC Act or NC Act were detected or considered likely to occur in this area). No wetlands are mapped within the Project site. The aquatic habitats, flora and fauna of waterways within the Project site are common and typical of the region. While their removal will mean a direct loss of available aquatic habitat, this is not expected to impact aquatic ecology on a regional scale, but rather on a very localised scale within the Project site.

Key management measures for the removal or modification of habitat include:

- Limiting the area disturbed at any one time by careful mine stage planning, which minimises the area of the overall disturbed landform (notably the area of the operating pits).
- Progressive and timely re-instatement and rehabilitation of the disturbed landform, where practical. As the front of the mined pit advances, waste spoil overburden material and coarse rejects are initially placed in OOPDs, and then progressively placed into the already worked pit void as mining advances further to the east. The landforms of the spoil material placed in OOPDs and in-pit spoil dumps are then shaped and reinstated in a timely manner.

- A final void will remain in the far east of ML 1775 at the conclusion of mining, which will provide a useable water storage or biologically viable water resource (although potentially high salinity levels will need to be considered, refer to **Section 6.9**).

6.2 Relocation of Minor Waterway

There are no proposed watercourse diversions or modifications to existing watercourse diversions required to facilitate the Project. There is a minor waterway (not mapped under the Water Act) that intercepts with the north-west corner of the proposed OOPD that will be realigned around the toe of the OOPD (**Figure 6.1**). This waterway is located high in the catchment at the headwaters of Horse Creek, rarely holds water and is of low aquatic ecological value. The relocation is this waterway is expected to have a temporary and low risk of potential impact to aquatic ecology. The low aquatic ecological value is expected to be reinstated within the realigned waterway.

6.3 Changes to Habitat

Vegetation removal and earthworks associated with the Project may reduce or limit aquatic habitat available to fauna (e.g. woody debris, tree roots or undercut banks) in downstream areas (as the source of habitat material is removed), indirectly impacting aquatic fauna. These aquatic habitats can provide shelter, contribute organic matter and be important for reproduction and feeding areas for aquatic fauna. However, while these aquatic habitats (e.g. woody debris, tree roots or undercut banks) occur in some areas in the vicinity of the Project site, they are generally limited and unlikely to be significantly impacted.

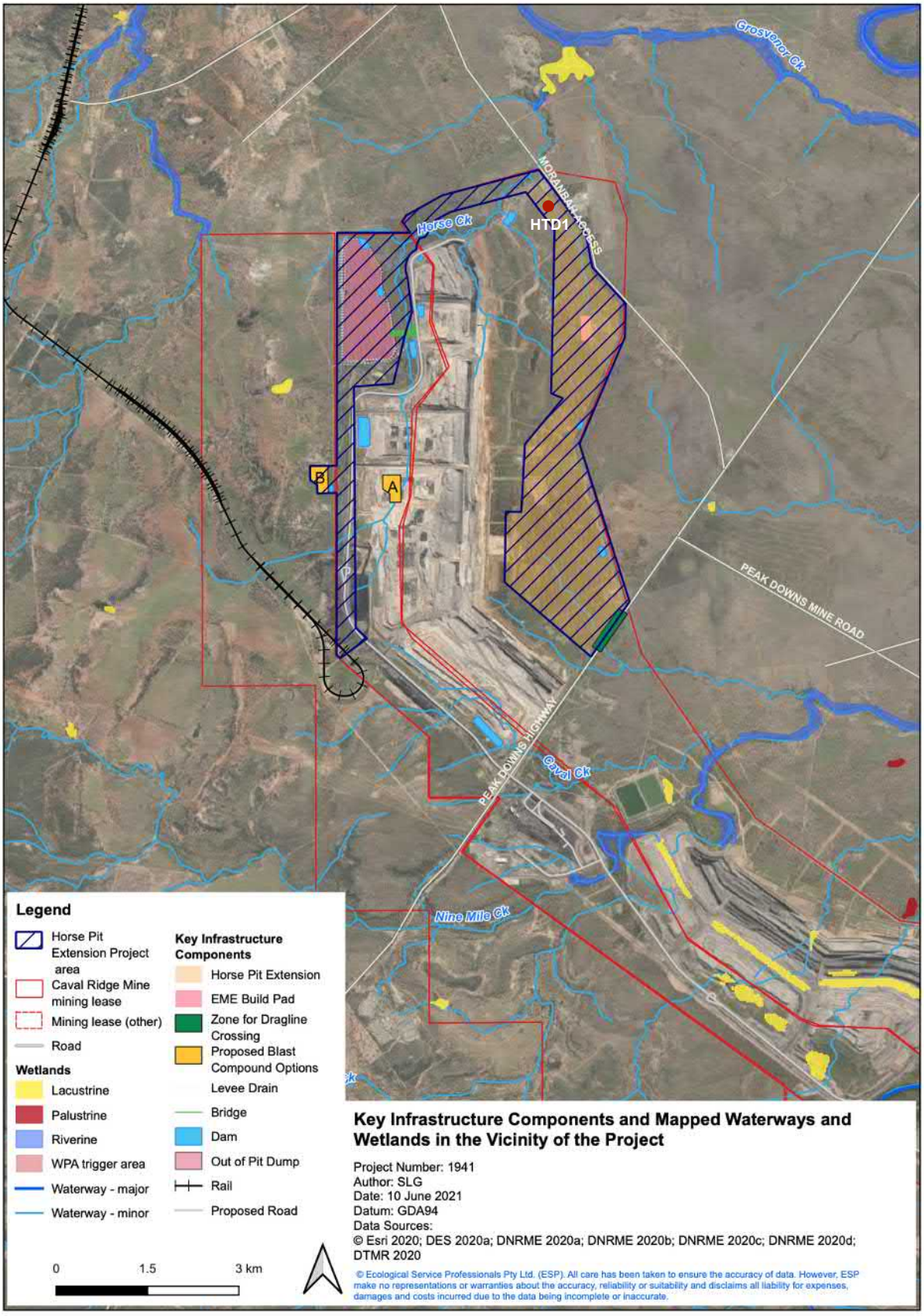

Figure 6.1 Key infrastructure components and mapped waterways and wetlands in the vicinity of the Project

6.4 Restriction of Fish Passage

The removal of sections of waterways and the installation of waterway crossings has the potential to prevent or restrict the movement of aquatic fauna, such as fish (**Section 4.8.2** outlines the importance of fish passage).

The Project will result in the removal of sections of the headwaters of Horse Creek and Cherwell Creek within the pit extension area and zone for dragline crossing (as discussed in **Section 6.1** and shown on **Figure 6.1**). These sections of waterways are classified as low risk of adverse impacts to fish movements (refer to **Section 4.8.2**). Based on the results of the field survey, waterways within the pit extension area provide low to moderate aquatic ecological value and are largely disturbed by surrounding land use, including existing mine operations, and agricultural operations. They are low stream-order waterways that do not connect to important fish habitat upstream (while the farm dam, site HTD1, provided some dry season refuge it was poorly connected to the waterway).

There will be two potential waterway crossings associated with the Project, specifically:

- the extension of the haul road will include a bridge over Horse Creek required to access the proposed OOPD to the northwest of Horse Pit, and
- where the location B option is selected for the blasting compound, a medium vehicle access road to the relocated blasting compound over the existing Horse Creek diversion (noting that this section of Horse Creek is not a mapped watercourse under the Water Act and therefore did not require approval for diversion).

The reaches of Horse Creek crossed by the haul road extension and medium vehicle access road are classified as medium risk of adverse impacts to fish movement (refer to **Section 4.8.2**). Based on the results of the field survey, these waterways provide low aquatic ecological value, and are largely disturbed by surrounding land use, including existing mine operations. These upper reaches are low stream-order waterways that do not connect to important fish habitat upstream (while the upstream farm dam in the Horse Creek catchment provides some dry season refuge it was poorly connected to the waterway).

Results of the flood modelling indicate the culvert crossing on Horse Creek will generally cause minor changes to surface water hydrology and flows under most scenarios. For example, there will be minor localised changes to surface water inundation and stream velocity will increase slightly from 1.0–1.5 m/s to 1.0–1.8 m/s post levee construction for the 2 per cent Annual Exceedance Probability (AEP) event. However, it will cause flood affluxes upstream that are contained within the extents of the Horse Creek floodplain (SLR 2021b) and higher flows for the 0.1 per cent AEP event. The haul road bridge over Horse Creek should be constructed and designed to minimise direct impacts, including designing the waterway crossings (e.g. culverts) in consideration of fish passage and water flow (during high flow events) to the extent practical. The use of temporary waterway barriers during construction of any road crossings will also include the provision to transfer flows from upstream of the works to the downstream channel without passing though the disturbed construction site.

There are two access route options associated with the location B site option for the relocated blasting compound. The most direct route option requires crossing of Horse Creek and as a result there is a potential impact to fish passage. The alternative route option runs

south to connect with an existing access road that avoids the crossing of the Horse Creek diversion. Where possible, the access route option that avoids the crossing of the Horse Creek diversion should be considered, where the location B site option for the blasting compound is selected.

No other infrastructure (e.g. roads, substations, drains or pipelines) or equipment (e.g. dragline or vehicles) associated with the Project will traverse waterways (SLR 2020), including the small section of Horse Creek within the Project Site classified as high risk of adverse impacts to fish movement.

Overall, connectivity through the waterways and wetlands within and upstream of the Project site is currently very limited due to the ephemeral nature of the area, and there are no important upstream breeding, feeding or refuge areas to consider (e.g. for threatened or priority species). Species that are found within the Project site are common within the region, are resilient, and have likely established communities that are not reliant on connections throughout the Project site. Therefore, removal and crossing of these waterways will have an insignificant direct impact on fish habitat and fish passage, particularly where the design of crossings considers fish passage and water flow to the extent practical.

6.5 Changes in Flow and Surface Water Hydrology

Changes to the flood regime, and the timing and magnitude of flows in watercourses, have the potential to directly and indirectly impact on aquatic ecosystems by (Bunn and Arthington 2002, Poff and Zimmerman 2010, Rolls et al. 2012):

- influencing the success of the life cycles of aquatic species that have adapted to natural flow regimes and have evolved in response to natural variation (i.e. affecting cues for movement, migration and breeding)
- changing the diversity and structure of instream physical habitats, which can influence the composition of biotic communities
- affecting water quality through changes to the flushing of water
- increasing scouring and erosion of watercourses influences habitat conditions and further affects water quality
- changing the variation in connectivity along the length of rivers and between rivers and floodplains, and
- decreasing the successful invasion of exotic and pest species.

General presumptive standards have been developed to provide riverine ecosystems protection, with a less than 10 per cent change in flows likely to achieve a high level of ecosystem protection; and 11 to 20 per cent change in flows likely to achieve a moderate level of ecosystem protection (Richter et al 2011).

There are no diversions (refer to **Section 6.2**) or water extractions proposed for the Project (with water mainly reused or sourced from the Sunwater owned Eungella-Bingegang pipeline). The water balance modelling indicated that the Project water management infrastructure is sufficient to manage mine affected water (MAW) within the current EA conditions (SLR 2021b; refer to **Section 6.8.3**). As such, changes in flow and surface water hydrology as a result of the Project are largely restricted to those caused by changes in the

catchment area in the upper reaches of waterways (i.e. catchment loss of 7 per cent of Horse Creek; 0.5 per cent of Grosvenor Creek; and 0.4 per cent of Cherwell Creek) and those caused by the construction of the bridge over Horse Creek and two proposed flood levees (Horse Pit North and Horse Pit West levees). Given minor changes are expected, a basic risk assessment framework for assessing the level of potential impact of changes in flow as a result of the Project on aquatic ecosystems was developed based on the Richter et al 2011 presumptive standards as outlined in **Table 6.1**.

Table 6.1 Criteria for assessing potential impacts to flow for the Project (based on the presumptive standards outlined in Richter et al 2011)

Aquatic Ecological Value	Required Level of Protection	Acceptable Reduction in Flow
Low	Low	> 20 per cent change
Moderate	Moderate	11 – 20 per cent change
High	High	< 10 per cent change

Very minor changes in water flows are expected in the Isaac River, with the Project resulting in a very small reduction (0.2 per cent) in catchment area at the confluence of Grosvenor Creek (SLR 2021b). Groundwater modelling also estimated that there will be an increase in seepage of less than 0.1 per cent from the Isaac River to the alluvium as a result of mining for the Project (due to the increased hydraulic gradient between the Isaac River and the underlying alluvium) (SLR 2021a). This increase represents an insignificant potential for flow rate changes in the Isaac River (SLR 2021a).

Minor changes to the timing of flows and time of inundation for an event are expected as a result of the Project. There will be minor to moderate changes (< 20 per cent) to the occurrence (number of events) and duration (number of days) during higher or medium flows (greater than 1 m^3/s but less than 3 m^3/s) as a result of the Project (SLR 2021b; **Table 6.2**). Further, changes to the volume and peak discharge during 1 and 10 percent AEP events are expected to be moderate (< 20 per cent change) for Cherwell Creek near the Peak Downs Highway and very low (≤ 1 per cent change) for Horse Creek approximately 500 m downstream of the Moranbah Access Road (**Table 6.3**). Given Cherwell Creek was assessed as having moderate aquatic ecosystem value and Horse Creek was assessed as having low aquatic ecosystem value, these changes in flow are considered acceptable for protecting the environmental values.

Modelling indicates flood immunity for the Project is achieved for flood events up to and including 0.1 per cent AEP events. The haul road over Horse Creek and levees will cause affluxes that are contained within the Horse Creek floodplain, particularly during 0.1 percent AEP events. Results of the flood model indicate that the confinement of the floodplain due to the levees construction does not result in adverse impacts to Horse Creek largely due to some reduction in retardment of flows due to the construction of the Haul Road crossing to the OOPD. However, the construction of the levee has the potential to increase scour and erosion particularly given the sodic soils in the region. At the conclusion of mining, the final landform is free draining and designed to be a stable landform, with the final void (643 ha

and approximately 125 m deep) expected to contain water that is approximately 25 m deep (SLR 2021b).

Overall, potential impacts to flows and surface water hydrology are expected to be acceptable and can be further reduced by:

- Limiting the area disturbed at any one time by careful mine stage planning, which minimises the area of catchment loss.
- Progressive and timely re-instatement and rehabilitation of the disturbed landform where practical (refer to **Section 6.1**).
- Design and construct the bridge over Horse Creek to minimise impacts to water flow and surface water hydrology (refer to **Section 6.4**).

Table 6.2 Summary of changes to average flow duration in days (with days of flow shown in brackets) in Horse Creek (at the confluence of Grosvenor Creek and Horse Creek) and Cherwell Creek (at the confluence of Cherwell Creek and the Isaac River) for flows greater than 1 m^3/s but less than 3 m^3/s

	Horse Creek			Cherwell Creek		
	Existing	Project	Per cent change	Existing	Project	Per cent change
Jan	46 (1.65)	43 (1.70)	7 (-3)	59 (2.24)	60 (2.27)	2 (-1)
Feb	13 (1.31)	11 (1.36)	15 (-4)	44 (1.91)	44 (1.91)	0 (0)
Mar	7 (1.14)	7 (1.14)	0 (0)	24 (2.33)	24 (2.33)	0 (0)
Apr	6 (1.50)	5 (1.60)	17 (-7)	11 (1.91)	11 (1.91)	0 (0)
May	4 (1.25)	4 (1.25)	0 (0)	18 (2.06)	19 (2.26)	-6 (-10)
Jun	0 (0.00)	0 (0.00)	–	9 (1.67)	9 (1.67)	0 (0)
Jul	0 (0.00)	0 (0.00)	–	0 (0)	0 (0)	–
Aug	0 (0.00)	0 (0.00)	–	3 (1.33)	3 (1.33)	0 (0)
Sep	0 (0.00)	0 (0.00)	–	0 (0)	0 (0)	–
Oct	6 (1.50)	5 (1.20)	17 (20)	20 (1.75)	20 (1.75)	0 (0)
Nov	5 (1.20)	4 (1.25)	20 (4)	33 (1.33)	33 (1.33)	0 (0)
Dec	32 (1.28)	32 (1.34)	0 (-5)	42 (1.29	42 (1.29)	0 (0)
Total	**119 (0.90)**	**111 (0.90)**	**7 (0)**	**263 (1.48)**	**265 (1.5)**	**-1 (-1)**

Table 6.3 Summary of changes to volume and peak flows in Horse Creek (approx. 500 m downstream of the Moranbah Access Road) and Cherwell Creek (near the Peak Downs Highway) during 1% and 10% AEP (results provided by SLR)

	Horse Creek			Cherwell Creek		
Indicator	**Existing**	**Project**	**Per cent change**	**Existing**	**Project**	**Per cent change**
Volume						
1% AEP (m^3)	769,720	773,142	0	289,145.21	252,979.32	13
10% AEP (m^3)	663,189	659,971	0	120,299	102,348	15
Peak flow						
1% AEP (m^3/s)	74.0	74.8	1	18.2	14.7	19
10% AEP (m^3/s)	35.4	35.3	0	7.6	6.3	17

6.6 Bank Stability, Erosion and Stormwater Runoff

Vegetation clearing and earthworks (e.g. topsoil stripping) for the Project has the potential to influence bank stability and erosion, which, in turn, can increase turbidity, sedimentation and nutrients in downstream waterways. Risks are greater during times of high flow (when there is a greater risk of erosion and stormwater runoff) and close to the disturbed area, and decrease with distance downstream.

Increased suspended sediment and/or sedimentation can potentially impact the health, composition and resilience of aquatic fauna and flora indirectly, by affecting respiration, breeding and feeding (e.g. clogging fish gills), or directly, by burying benthic communities. High levels of turbidity can impact growth and diversity of aquatic plants and algae as light required for photosynthesis is reduced (although aquatic plants were not highly abundant in the receiving environment; see **Section 4.4.2**). Increased nutrients can also lead to aquatic plant and algal blooms, potentially resulting in high dissolved oxygen concentrations during the day (during net photosynthesis), but very low dissolved oxygen concentrations during the night and early morning (when there is a net consumption of oxygen during respiration). In extreme cases, this can lead to eutrophication and fish kills. However, species in the area are tolerant of variable water quality conditions, including periods of high suspended sediments, sedimentation, turbidity, and nutrients.

CVM has an existing Erosion and Sediment Control Plan (ESCP) for the site. Key guiding principles of the ESCP are derived from the Best Practice Erosion and Sediment Control Guidelines (International Erosion Control Association (IECA)).

The risk of bank stability, erosion and stormwater runoff due to vegetation clearing and earthworks on the aquatic ecology will be reduced where:

- The existing CVM ESCP and Mine Water Management Plan (MWMP) are expanded to incorporate construction and operation of the Project, including:

  - appropriate sediment control measures (e.g. sediment fences and sediment filters) established as required to reduce the amount of runoff from disturbed areas in accordance with industry standards and guidelines, and
  - stormwater runoff directed away from the waterways (e.g. by levees or ditches).
- A water quality monitoring program for the construction phase of the Project is developed to ensure the MWMP is effective and downstream water quality (physico-chemical parameters at a minimum) is not adversely impacted.
- Construction adjacent to waterways and waterway crossings occurs over the dry season, where possible, to minimise soil disturbance on adjacent waterways.
- Earthworks and stockpiles are planned prior to works and are minimised where possible in accordance with the existing Topsoil Management Plan and the EA.
- The Project is completed over stages over the life of the mine and land is progressively rehabilitated in accordance with the requirements of the EA.

The management plans outlined above have been unitised to control erosion and sediment-laden runoff of existing operations. Potential impacts to aquatic ecology are expected to be minor where the existing ESCP, MWMP and measures to reduce impacts outlined above are implemented.

6.7 Dust and Particulate Matter

Dust from increased mining activities may enter waterways and increase turbidity, sedimentation, nutrients and contaminants (e.g. from mining waste) in downstream and / or adjacent waterways. Potential impacts of these changes to water quality to the aquatic ecology are outlined in **Section 6.6**. The release of dust and / or particulate matter from the mining activities at CVM is managed under the EA and Air Emissions Management Plan. As such, potential impacts to aquatic ecology are expected to be low.

6.8 Water Releases

Surface water runoff from mining or waste disposal areas (e.g. the proposed OOPD) and the release of MAW and associated contaminants (typically metals and hydrocarbons) can indirectly impact downstream environmental values. MAW releases can influence the health, reproduction and, at high enough concentrations, can cause direct mortality of aquatic flora and fauna. The type, volume and concentration of contaminants, along with environmental factors (e.g. dilution, mixing, existing exposure levels), determines the severity of impact. Risks are likely to be greater:

- close to the release point and decrease with distance downstream, and
- during periods of low flow, as releases during high flows are mixed with natural waterway flows and diluted.

The existing water management strategy at CVM involves surface water infrastructure (such as drains, pipelines, sediment dams and MAW dams) to separate, transfer and store clean and dirty water for reuse or release, which is managed under the MWMP. No changes to the

water demand or the existing supplies, including sewage treatment management, are required (SLR 2020). However, relocation of MAW dams and additional water management infrastructure will be required to facilitate the Project.

6.8.1 Clean Water Management

The Project will require additional surface water drains to manage separation of clean water and MAW in addition to the existing drains at CVM. There is one proposed clean water drain designed to convey a 100-year average recurrence interval (ARI) flood immunity and capture the clean water catchment to the west of the proposed OOPD. The clean water drain flows south to north and parallel to the proposed OOPD in the west. The drain will direct flow to a natural drainage feature north of the proposed OOPD and outflow to Horse Creek approximately 1 km to the east. Clean water captured on site in clean water storages is expected to have the same water quality as the receiving environment waterways. This is not expected to have any impacts to the water quality, and therefore aquatic ecological values of the receiving environment.

6.8.2 Dirty Water Management

The Project will require additional surface water drains to manage dirty water in addition to the existing drains at CVM. There are four proposed MAW drains that bound the outer extents of the proposed OOPD. The MAW drains are designed to convey a 10-year ARI flood immunity capturing all MAW within the stockpile area and directing flow to sediment dams. Four new sediment dams and the extension of five existing sediment dams are proposed as part of the Project. These dams will capture runoff from the mining lease, the proposed OOPD and / or the proposed blasting compound (location B option only). The majority of these sediment dams will overflow to Horse Creek in an emergency, with the exception being one expanded sediment dam, which will overflow to Caval Creek in an emergency. Each sediment dam will have permanent pump and pipeline infrastructure to enable dewatering to a larger storage as required (SLR 2020). It is expected that any emergency overflow would be in conjunction with high rainfall and flow, which would dilute any contaminants in the receiving environment. This overflow is an existing feature of the water management system at CVM in accordance with Condition F19 of the EA.

6.8.3 Release of MAW

The volume of MAW is not expected to increase from current operations at CVM as a result of the Project. Therefore, no extension to volumes or additional MAW dams are required. The existing water management strategy involves the use of the MAW dams as transfer points, with MAW from CVM ultimately being directed towards 12N Dam south of the Peak Downs Highway. MAW will continue to be dewatered from Horse Pit over the highwall and piped into either N1 dam or N2 dam, which will be progressively relocated (along with the associated pipelines). These dams may overflow to Cherwell Creek in an emergency (SLR 2021b), which is part of the current water management system.

Under the existing CVM EA, the release of MAW can occur from 12N Dam into the receiving waters of Cherwell Creek at release point RP1 or via overflow of the MAW dams to receiving waters. The release of MAW at release point RP1 must only take place during periods of natural flow events (as per specified minimum receiving water flow criteria for discharge in

the EA). The CVM EA includes water contaminant limits for pH, electrical conductivity and release contaminant trigger investigation levels for a suite of metals and metalloids, to protect the aquatic ecosystem of Cherwell Creek downstream of active mining areas.

The CVM REMP has been developed and implemented to monitor and assess the potential impacts that releases of MAW and associated contaminants have on the receiving environment. Previous studies have found that CVM MAW releases are likely to be of low risk to the Cherwell Creek receiving environment, and that local environmental values in the receiving environment are not being adversely impacted by mining operations (Gauge Industrial & Environmental 2018, 2020). This demonstrates that the discharge limits that are implemented at the mine are sufficient to protect the downstream environmental values. The results of the water balance modelling indicate that the Project water management infrastructure is sufficient to manage MAW within the current EA conditions (SLR 2021b). The controlled release regime aims to minimise impacts to downstream water users and the environment through (SLR 2021b):

- allowing discharge of good quality water when appropriate baseflow conditions exist in Cherwell Creek and the Isaac River, and
- a release regime that is based on known flow and water quality thresholds, minimising the risk of uncontrolled releases.

Overall, potential impacts to aquatic ecology resulting from water releases can be minimised by:

- Expanding the existing water management strategy and MWMP to incorporate the construction and operational phase of the Project to ensure the separation and management of clean and dirty water catchments, including:
    - diverting water captured within the clean areas around operational areas and where practical and discharge off site as part of normal overland flow, and
    - diverting water from disturbed areas to sediment dams for treatment and possible reuse for dust suppression and process water requirements.
- Expanding the current REMP and associated water quality monitoring program to incorporate the construction, operation and decommissioning phases of the Project to ensure the water management strategy is effective, to demonstrate compliance with the discharge limits specified in the EA, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted.
- Design, construct and manage the proposed OOPD, levees, sediment dams, pit water storage and other water management structures (e.g. bunds and drains) in accordance with the water management strategy and EA (including regulated structures, where relevant) to ensure that any surface water runoff is contained within the mine affected water management system and managed in accordance with the existing MWMP and EA.
- Manage overflow released from new and expanded dams and MAW releases in accordance with the existing EA.
- Install additional monitoring points to monitor controlled releases from the water management system

- Establish additional monitoring locations in Horse Creek into Table F7 of the EA for the new sediment dams proposed to overflow to this reach.

Where water releases remain in accordance with existing EA Conditions and potential impacts are assessed in the existing CVM REMP (including measures outlined above), the potential impacts to flora, fauna and environmental values of the receiving environment from releases of MAW as a result of the Project, are not expected.

6.9 Saline or Acid Drainage

There is a potential risk of saline or acid drainage from mining activities within the site or seepage generated by the proposed OOPD. Where saline or acid drainage or seepage reaches the receiving environment, impacts to aquatic ecology can include (Commonwealth of Australia 2016, Dunlop et al 2005):

- contamination of water quality and sediment quality
- poor health and possible death of fish and other aquatic organisms
- reduction of in-stream and riparian vegetation
- promotion of noxious plant growth
- visual changes to waterways: waterways can become red coloured or unnaturally clear, or introduce precipitates on the surface or water or bank edges, and
- loss of EVs associated with the waterways.

The geochemical characteristics of mineral waste materials associated with the Project are mostly non-acid forming, with less than 1.5 per cent of samples classified as potentially acid forming (Terrenus Earth Sciences 2021). Non-carbonaceous overburden / interburden is expected to generate low to medium salinity run-off and seepage; due to very low total sulfur concentrations, the potential for sulfate-derived salinity is negligible (Terrenus Earth Sciences 2021). Furthermore, potential impacts of saline or acid drainage and seepage at CVM are currently managed by maintaining compliance with the EA. Therefore, potential indirect (e.g. impacts to environmental values, health and reproduction of aquatic species) and direct (e.g. mortality of aquatic species due to toxicity) impacts from saline or acid drainage and seepage, are expected to be low risk where they are managed under the existing EA, including the MWMP.

The salinity of water in the final void at the conclusion of mining is predicted to increase significantly post closure due to the constant inflow from highly saline groundwater, with predicted salinity values increasing in excess of 35,000 µs/cm over 100 years post closure (SLR 2021b). A final void closure monitoring and management plan will be developed to identify management measures to reduce the impacts of the final void water quality on the environment (including aquatic ecology) and any potential water users.

6.10 Spills of Hydrocarbons and Other Contaminants

There is a potential risk of fuels, oils and other chemicals required for vehicles and equipment used during the Project (including chemicals for blasting) to spill and enter

waterways, impacting water quality and aquatic ecology (as outlined for MAW in **Section 6.8**). Where spills are small and short-term, aquatic ecosystems are likely to recover.

Provided the appropriate management of chemicals is maintained through the existing CVM EA requirements and Waste Management Plan during pre-mining and operational activities, the Project is unlikely to result in leaks / spills that would eventuate in serious environmental harm to aquatic species or their habitat. Appropriate management may include:

- Management of fuel, dangerous goods and hazardous chemicals in accordance with current standards, guidelines and in compliance with statutory requirements, including:
    - storage, transportation and use of explosives will be in accordance with Australian Standard AS 2187.2-2006 Explosives - Storage and use - Use of explosives, the *Explosives Act 1999*, BMA's policies and procedures including the CVM Standard Work Instruction (SWI) Blast Control & Blast Guard (CVM-SWI-0275), and all other relevant legislation, and
    - appropriate storage of chemicals and hydrocarbons, including bunding and storage of fuels and other hazardous and flammable materials in accordance with AS1940:2004, and where practical, will be located away from any waterbodies.
- Expanding the existing Standard Operating Procedures (SOP) for spills and emergency response to incorporate the Project activities.
- Ensuring spill recovery and containment equipment is available when working adjacent to waterways, drainage channels and within other high risk areas, such as workshops, and spill kits are available to construction crews conducting activities with the potential for spills.
- Ensuring refueling locations and handling of fuels are undertaken away from waterbodies.

Where these measures are implemented, any potential indirect (e.g. impacts to environmental values, health and reproduction of aquatic species) and direct (e.g. mortality of aquatic species due to toxicity) impacts associated with leaks and spills are likely to be low.

6.11 Litter and Waste

Where litter and waste associated with pre-mining activities, vehicle maintenance and mining operations enter aquatic ecosystems they have the potential to directly impact aquatic fauna due to entanglement. They can also indirectly impact aquatic flora and fauna by contributing to the degradation of water and sediment quality. Where appropriate controls are in place, including the existing CVM Waste Management Plan, ESCP and EA requirements, the risk to aquatic ecology from litter and spilt waste from the Project is likely to be very low.

6.12 Proliferation of Aquatic Pests

Increases in invasive species can lead to significant indirect impacts to the community structure and health of aquatic ecosystems through:

- out-competing native species for resources and space
- degrading habitat conditions as a result of feeding behaviors (fish) and growth patterns (plants)
- reducing water quality (e.g. changing dissolved oxygen levels or increasing turbidity), and
- resulting in the decline and/or displacement of species reducing the overall diversity of the community.

However, the Project is unlikely to result in the addition of new invasive species of aquatic flora or fauna, or the growth and spread of aquatic pest species. This is due to its location within the catchment; because it does not involve the diversion of waterways into adjacent catchments; and because it does not result in additional habitat for invasive species. Provided that standard weed hygiene protocols are implemented for vehicles and machinery during pre-mining and operational activities (in accordance with the existing CVM Land and Biodiversity Management Plan), no impacts are expected.

6.13 Changes to Groundwater

Although no true stygofauna were recorded during the pilot study and they are considered unlikely to occur within the Project site, stygofauna communities may occur in the broader region, particularly in the unconsolidated sediments of the Isaac River alluvium, and therefore potential impacts associated with the Project were considered to the extent the Project may impact these areas.

6.13.1 Physical Disruption of Aquifers

The physical disruption of aquifers can directly impact stygofauna communities inhabiting them. This can be due to excavation of mining pits and compaction of aquifer sediments by heavy machinery and equipment. Physical disruption of aquifers can reduce the amount of favourable subterranean aquatic habitat available for stygofauna communities.

As stygofauna are considered unlikely to occur within the Project site (as discussed in **Section 5.1**), direct impacts to stygofauna from physical disruption of aquifers are not relevant to the Project.

6.13.2 Changes to Water Quantity

Changes to groundwater quantity have the potential to directly and indirectly influence stygofauna communities. These can result from alterations in groundwater level, pressures, and fluxes that may be associated with:

- vegetation clearing (which can reduce evapotranspiration and increase recharge rates)
- surface compaction (which can elevate runoff and reduce recharge rates)
- dewatering of groundwater (which reduces quantity, pressure and flows), and
- evaporative discharge.

Where recharge rates are less than extraction rates, stygofauna communities can be directly affected, particularly as they prefer shallow aquifer systems. A reduction in hydraulic pressure (e.g. from depressurising coal seams) can also potentially result in induced flow from overlying aquifers, potentially resulting in decreased available groundwater resources and indirectly impacting stygofauna communities. Stygofauna can often cope with small and slow declines in aquifer storage levels, but rapid declines can have detrimental impacts. The extent to which they are impacted depends on the timing, frequency, duration, extent and depth of water extraction (Car 2010).

Groundwater modelling demonstrated that changes to groundwater quantity due to drawdown associated with the Project are likely to be localised, with no predicted direct or indirect interference with alluvial groundwater as a result of the Project (refer to the **Groundwater Chapter;** SLR 2021a). Changes to groundwater quantity are not expected in the unconsolidated sediments of the Isaac River alluvium, in the lower reaches of the Isaac River and at the confluences of larger tributaries (i.e. where stygofauna communities are likely to occur). Therefore, no impacts to stygofauna communities as a result of changes in groundwater quantity are expected as a result of the Project.

6.13.3 Changes to Water Quality

Many stygofauna taxa have strict water quality requirements to survive, and therefore require stable conditions within a narrow physico-chemical range. Although they can tolerate fluctuations in water quality to a certain extent, major changes in water chemistry (e.g. due to pollution plumes) can directly impact the biodiversity and community composition of stygofauna (Eamus et al 2005). Changes to water quality (including any increased concentrations of salts or contaminants associated with mining) of groundwater systems therefore have the potential to influence stygofauna communities.

Impacts to groundwater quality may result from saline or acid drainage, seepage, tailings disposal, hazardous and dangerous goods storage, and hydrocarbon and chemical spills (e.g. from fuels, lubricants and oils required for the operation of vehicles and machinery). Where these are managed in accordance with existing Management Plans and the EA, any impacts are expected to be low risk.

6.13.4 Changes to Groundwater Interactions

Groundwater systems require connectivity to the surface to provide organic matter and oxygen. Organic carbon in aquifers is sourced externally due to the lack of photosynthesis and enters the aquifers through recharge waters passing through shallow geological units (Nevill et al 2010). If this connection is disrupted and nutrients and oxygen are not replenished, habitat condition declines and stygofauna communities can be indirectly impacted over time.

Stygofauna are highly endemic due to the natural hydrological barriers within aquifer matrices that can restrict their movement. While natural barriers lead to genetic diversity, artificial barriers created by rapid changes in water level or chemistry can limit connectivity between aquifers and prevent dispersal or recolonization of the habitat following disturbances. Changes to the interactions between groundwater systems, and between groundwater and surface systems can therefore indirectly impact stygofauna communities.

Impacts to groundwater interactions may result from:

- reduced catchment area
- vegetation clearing, particularly where the depth to the water table is less than 20 m (which can reduce potential habitat for stygofauna associated with root systems)
- decreased and / or increased surface flows
- surface sealing and / or compaction, and
- backfilling and rehabilitation works.

Areas potentially impacted by vegetation clearing, surface sealing / compaction, backfilling and rehabilitation works are within the Project site where stygofauna are unlikely to occur. Further, as discussion in **Section 6.5**, changes in catchment area and surface flow are likely to be localised and not expected to impact areas where stygofauna are likely to occur (i.e. unconsolidated sediments of the Isaac River alluvium, lower reaches of the Isaac River and at the confluences of larger tributaries). As such, any potential impacts are expected to be low risk.

6.14 Matters of National Environmental Significance

No significant impacts to aquatic ecosystem function as a result of impacts to hydrology or water quality are predicted (refer to **Sections 6.5** and **6.8**). Potential impacts to downstream waterways and wetlands are expected to be low risk. Any actions that impact water resources (including the interaction between surface and groundwaters) may have the potential to influence stygofauna communities; however, the stygofauna assessment indicated that stygofauna are unlikely to be present within the Project site and therefore no impacts are expected. Stygofauna communities are highly likely to occur in the unconsolidated sediments of the Isaac River alluvium, in the lower reaches of the Isaac River and at the confluences of larger tributaries. However, these areas are unlikely to be impacted by the Project (refer to **Section 6.13**).

More substantial water resources (including waterways and wetlands) are present downstream of the Project in the broader study area, including the Isaac River. These waterways are also mapped as potential surface expression GDEs (refer to **Section 4.7**). However, provided that appropriate mitigation measures are implemented to maintain water quality downstream of the Project (i.e. maintain compliance with existing CVM EA conditions (including the REMP), Waste Management Plan and ESCP), impacts to these water resources are not expected as a result of the Project (refer to **Section 7**).

There were no MNES aquatic flora or fauna species recorded within the Project site or the broader study area, and they are highly unlikely to occur given the lack of aquatic habitat and the low value of these waterways (refer to **Section 4.9.1**). Therefore, no direct or indirect impacts to these species as a result of the Project are expected.

6.15 Matters of State Environmental Significance

Drainage features (i.e. tributaries of Horse and Cherwell creeks) and watercourses (i.e. Horse Creek) are mapped within the Project site under the Water Act. These channels are mostly mapped as having low and moderate impact to fish passage in the *Waterway Barrier*

Works mapping layer, except for Horse Creek, which is mapped as high impact (although operational works approvals for waterway barrier works are not required within the ML). The waterways are considered to be of low aquatic ecological value based on the field assessment, and were dry, except for an unmapped farm dam (which was considered to be of moderate aquatic ecological value due to provision of a dry season refuge, though connectivity was poor). The Project waterways are also unlikely to flow and connect to downstream waterways, except for short periods during very high rainfall, when they would convey surface flows. Impacts to aquatic ecology as a result of removal of these channels are considered insignificant in a regional context (refer to **Section 6.4** for potential impacts to fish passage).

There also are mapped waterways under the Water Act downstream of the Project site and the CVM. These waterways include Cherwell and Grosvenor creeks, and the Isaac River. However, provided that appropriate mitigation measures (refer to **Sections 6.1** and **6.13**) are implemented, impacts to these waterways are not expected as a result of the Project.

No HES wetlands are present within the Project footprint. There is one HES palustrine wetland (also a WPA) mapped approximately 20 km east and downstream of the Project footprint in the Isaac River floodplain. Releases of MAW will occur in compliance with current EA conditions, and will be monitored as part of the existing REMP requirements for the CVM. Therefore, no adverse impacts to water quality in these wetlands are expected as a result of the Project.

There were no MSES aquatic flora or fauna species recorded within the Project site and broader study area, and they are highly unlikely to occur given the lack of aquatic habitat and the low value of these waterways. Therefore, no direct or indirect impacts to these species as a result of the Project are expected.

7 Risk Assessment

7.1 Risk Assessment and Mitigation Measures

Risks of potential impacts were assessed according to the criteria outlined in **Table 7.1**, **Table 7.2** and **Table 7.3**. The unmitigated risks were assessed as well as the mitigated risks. The outcomes of the assessments, including a summary of the appropriate mitigation measures, are presented in **Table 7.4**.

Table 7.1 Risk matrix, including likelihood of an impact occurring, and the severity of subsequent consequences

Likelihood of Consequence	Severity of Consequence						
	Insignificant	**Minor**	**Moderate**	**Major**	**Serious**	**Severe**	**Permanent Severe**
Almost Certain	Low	Medium	High	Very High	Very High	Very High	Very High
Likely	Low	Medium	High	High	Very High	Very High	Very High
Possible	Low	Medium	Medium	High	High	Very High	Very High
Unlikely	Low	Low	Medium	Medium	High	High	Very High
Rare	Low	Low	Low	Medium	Medium	High	High
Very Rare	Low	Low	Low	Low	Medium	Medium	High

Table 7.2 Definitions of likelihood for the risk assessment

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances (the event is expected to occur multiple times a year or incident is clearly imminent).
Likely	The event will probably occur in most circumstances (the event is expected to occur approximately once per year).
Possible	The event may occur at some time (the event is likely to occur approximately once every five years).
Unlikely	The event is not expected to occur (the event is likely to occur approximately once every five to 10 years).
Rare	The event may occur only in exceptional circumstances (the event is likely to occur approximately once every 10 to 20 years).
Very rare	The event may occur only in highly exceptional circumstances (the event is likely to occur less than once every 20 years).

Table 7.3 Definitions of consequence for the risk assessment

Severity of Consequence	Definitions
Permanent severe	Extensive long-term environment harm and / or harm that is extremely widespread. Impacts considered to be permanent.
Severe	Extensive long-term environment harm and / or harm that is extremely widespread. Damage caused may take more than 20 years to recover
Serious	Serious or widespread major effect. Significant resources required to respond and rehabilitate, and damage caused may take 15 to 20 years to recover with long-term evidence of the incident resulting.
Major	Major or widespread moderate effect. Significant resources required to respond and rehabilitate, and damage caused may take 10 to 15 years to recover with long-term evidence of the incident resulting.
Moderate	Localised, short-term to moderate unplanned environmental impact. Moderate but repairable damage that may take up to 10 years to recover.
Minor	Localised short-term effect. Minor environmental impact that is contained on-site. It will take less than two years for the asset to fully recover or it will only require minor repair.
Insignificant	No impact or no lasting effect. Negligible damage that is contained on-site and is fully recoverable with no permanent effects, taking less than six months to fully recover.

7.2 Significant Residual Impacts and Offsets

The Project is not expected to have any significant residual impacts on aquatic MNES or MSES where appropriate mitigation and management measures are implemented (refer to **Table 7.4**) during construction and operation.

Table 7.4 Risk assessment and proposed mitigation measures

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Direct modification and loss of aquatic habitat resulting in removal of aquatic flora and fauna species.	Direct and permanent loss of available aquatic habitat associated with two unnamed tributaries of Horse Creek and Cherwell Creeks and an unmapped artificial farm dam. The tributaries are highly ephemeral and considered to be habitat types common to the region, did not provide fish habitat during the field surveys, and have low aquatic ecological value. The farm dam provides a dry season refuge for aquatic flora and fauna and is of moderate aquatic ecological value.	Limit the area disturbed at any one time; progressive and timely reinstatement of the disturbed landform; and grading the finished surface slopes of all re-shaped landforms to allow for natural runoff to drain freely.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**
Relocation of minor waterway resulting in the modification of aquatic habitat	Direct temporary loss of aquatic habitat, flora and fauna within minor waterway (unnamed tributaries of Horse Creek). This reach is highly ephemeral and of low aquatic ecological value.	None.	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**	NA
Removing sources of habitat material resulting in reduced habitat available to aquatic fauna.	Reduce or limit aquatic habitat (e.g. woody debris, tree roots or undercut banks) available to fauna in downstream areas (as the source of habitat material is removed). While aquatic habitats occur in some areas in the vicinity of the Project, they are generally ephemeral and unlikely to be significantly impacted.	None.	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**	NA
Loss of the waterways or waterway crossings preventing or restricting movement of fish.	Loss of fish passage to waterways within and upstream of the Project site. The waterways do not connect to any important breeding, feeding or refuge areas and fish habitat and passage is currently very limited due to the ephemeral waterways.	Design waterway crossings to consider fish passage and flow.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Changes in flow or surface water hydrology in Cherwell Creek and Horse Creek influencing aquatic habitat and communities downstream.	Minor loss of catchment area may reduce flow in Cherwell Creek and Horse Creek causing localised changes to habitat and biotic communities downstream. Changes in surface water hydrology are restricted to the floodplain areas. Modelling indicates that loss in catchment will result in acceptable changes to hydrology or hydraulics of Cherwell and Horse creeks. All releases will occur in compliance with existing EA Conditions.	Consider limiting the area disturbed at any one time by careful mine stage planning, which minimises the area of catchment loss; progressive and timely re-instatement and rehabilitation of the disturbed landform where practical and design and constructed the bridge over Horse Creek to minimise impacts to water flow and surface water hydrology.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**
Decreased bank stability, increased erosion and stormwater runoff influencing water quality downstream.	Reduced water quality, including high suspended sediments, sedimentation, turbidity, and nutrients concentrations. Potential impacts to health, composition and resilience of flora and fauna; respiration and feeding of fauna; reduce growth and diversity in aquatic plants and algae; and/or bury benthic communities.	Expand the CVM ESCP and MWMP to include construction and operation of the Project, including sediment control measures and directing runoff away from waterways; monitor the downstream water quality during construction; complete construction adjacent to waterways and of waterway crossings during the dry season, where possible; plan earthworks and stockpiles prior to works and minimised, where possible; complete the Project over stages over the life of the mine; and, rehabilitate and, where appropriate.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Dust and particulate matter entering waterways and influencing water quality, potentially impacting aquatic habitat value, flora and fauna.	Dust from increased mining activities may enter waterways and increase turbidity, sedimentation, nutrients and contaminants (e.g. from mining waste) in downstream and / or adjacent waterways, potentially reducing aquatic ecosystem value and directly and indirectly impacting flora and fauna.	Manage under the existing EA requirements and Air Emissions Management Plan.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Release of water resulting in declines in water and sediment quality downstream.	Direct impacts to water quality and sediment quality and indirect impacts to aquatic habitat, flora and fauna in the receiving environment. MAW released through the CVM water management system will be managed in accordance with the requirements of the CVM EA. Ongoing monitoring of MAW releases will continue to occur as part of the existing CVM REMP. Additional MAW volume as a result of the Project are not expected. Uncontrolled releases from new sediment dams will be managed in accordance with existing EA conditions. Clean water releases from proposed drains are unlikely to influence water quality in Horse Creek.	Designing water management infrastructure and structures in accordance with the water management strategy and EA; expanding the existing water management strategy and MWMP to incorporate the construction and operational phase of the Project; expanding the current REMP to incorporate the construction, operation and decommissioning phases of the Project; manage overflow and MAW releases in accordance with the existing EA; install additional monitoring points to monitor controlled releases from the water management system; and, establish additional monitoring locations in Horse Creek to assess overflows to this reach.	Likelihood: Likely Consequence: Minor **Risk: Medium**	Likelihood: Likely Consequence: Insignificant **Risk: Low**
Saline and acid mine drainage and seepage resulting in declines in water quality.	Potential changes to seepage (e.g. pH, salinity, risk of PAF from in-pit or out of pit spoil dumps) that could influence water quality. Seepage to be managed under the existing EA Conditions.	Continuation of current management procedures in place at the CVM to control the risk of acid drainage generation; and, develop final void closure monitoring and management plan.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Leaks and spills of hydrocarbons and other contaminants resulting in declines in water quality or direct toxicity to aquatic flora and fauna.	Direct impact to water quality and indirect impacts to aquatic ecology in the receiving environment (e.g. toxicity to flora and fauna).	Implement measures outlined in existing Waste Management Plan*;* appropriate storage of chemicals and hydrocarbons; implementation of appropriate containment and spill response procedures and, ensure refueling location and handling of fuels are undertaken away from waterways.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Litter and waste resulting in reduces habitat quality and mortality of aquatic fauna.	Potentially be ingested by fauna; entangle or entrap aquatic flora and fauna and / or negatively impact water quality.	Implement measures outlined in existing Waste Management Plan, Erosion and Sediment Control Plan and EA requirements.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Introduction of invasive species reducing habitat quality and availability for native aquatic species.	Changes in community structure and general health of aquatic fauna and flora in downstream and / or adjacent waterways.	Implement measures outlined in existing Land and Biodiversity Management Plan. Existing weed hygiene protocols are implemented for vehicles and machinery during pre-mining and operational activities.	Likelihood: Possible Consequence: Moderate **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Physical disruption of aquifers influencing habitat quality and availability for stygofauna.	Modification or removal of aquifers can reduce the amount of favourable subterranean aquatic habitat available for stygofauna communities. Stygofauna are considered unlikely to occur within the Project site as this area contains units unlikely to support communities. As such, impacts to stygofauna from physical disruption of aquifers are considered unlikely.	None.	Likelihood: Unlikely Consequence: Insignificant **Risk: Low**	NA
Changes to groundwater quantity influencing habitat quality and availability for stygofauna.	Where recharge rates are less than extraction rates, stygofauna communities can be affected. A reduction in hydraulic pressure can also result in induced flow from overlying aquifers, potentially resulting in decreased available groundwater resources. Stygofauna are considered unlikely to occur within the Project site as this area contains units unlikely to support communities. As such, impacts to stygofauna from drawdown are	None.	Likelihood: Unlikely Consequence: Insignificant **Risk: Low**	NA

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
	considered unlikely. Changes to groundwater quantity are not expected outside of the Project site in the Isaac River alluvium where stygofauna are likely to occur.			
Changes to groundwater quality influencing habitat quality and availability for stygofauna.	Changes to water quality of groundwater dependent ecosystems have the potential to influence stygofauna communities due to increased concentrations of salts and contaminants due to mining. Stygofauna are considered unlikely to occur within the Project site as this area contains units unlikely to support communities.	Managed in accordance with existing Management Plans and the EA conditions.	Likelihood: Unlikely Consequence: Minor **Risk: Low**	Likelihood: Unlikely Consequence: Insignificant **Risk: Low**
Changes to groundwater interactions influencing habitat quality and availability for stygofauna.	Disruption of provision and replenishment of nutrients and oxygen, leading to habitat condition decline. Creation of artificial barriers caused by rapid changes in water level or chemistry, limiting connectivity between aquifers and preventing dispersal or recolonization of the habitat following disturbances. Areas potentially impacted by vegetation clearing, surface sealing / compaction and backfilling rehabilitation works are within the Project site where stygofauna are unlikely to occur. Changes in catchment area and surface flow are unlikely to significantly impact the Isaac River. As such, any potential stygofauna communities within the alluvium in this area is unlikely to be impacted.	None.	Likelihood: Unlikely Consequence: Minor **Risk: Low**	NA

8 Summary and Conclusions

8.1 Aquatic Ecology

Aquatic habitat in waterways and wetlands in the vicinity of the Project was typical of ephemeral systems in the broader region, with seasonal patterns in habitat availability and quality evident at all sites. During the early-wet season survey in December 2019, sites located on waterways (i.e. creeks and tributaries) were generally dry; some isolated dry season refuges were recorded at mapped lacustrine wetlands and unmapped farm dams. During the late-wet season survey in April 2020, most sites in both higher stream order waterways and wetlands contained isolated pools, which would only connect and flow during and following periods of heavy rainfall.

Water quality in waterways and wetlands in the vicinity of the Project was highly variable, which is typical of ephemeral systems in the region. Overall, water quality measured in situ was characterised by neutral to slightly alkaline pH, moderate to high electrical conductivity, variable saturation of dissolved oxygen, and high turbidity. Laboratory-analysed results also indicated moderate to high concentrations of nutrients and some metals (particularly aluminium and copper). Concentrations of these parameters were outside of the relevant WQOs at several sites during the field surveys.

Sediment quality was moderate to good in the vicinity of the Project. Concentrations of most parameters were below the relevant DGVs during the surveys, except for chromium and nickel, which exceeded the DGVs or the GV-high at some sites in the vicinity of the Project in some surveys.

Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded at sites in the vicinity of the Project were typical of ephemeral systems in central Queensland. All taxa recorded were common in the broader region, and no listed threatened species known from the catchment (or potential habitat for these species) were identified.

Emergent growth forms dominated aquatic plant communities, with few submerged and floating species, indicating that water is not likely to persist for the majority of the year (except at wetland and farm dam sites). Macroinvertebrate communities were in low to moderate condition relative to those expected in the broader region, and results indicated that a range of factors influenced communities at most sites (including anthropogenic factors such as mining, industrial and / or agricultural pollution, high concentrations of nutrients, and harsh environmental conditions).

Most sites that contained water provided habitat for fish from a range of life-history stages during the late-wet season, including adults, intermediates and juveniles. Two exotic species of fish were also recorded in the April 2020 survey: Mozambique tilapia (*Oreochromis mossambicus*) and platy (*Xiphophorus maculatus*). Tilapia is listed as a restricted biosecurity matter and a noxious fish under the *Biosecurity Act 2014*; platy is a pest species, but is not restricted or prohibited under Queensland legislation.

Turtles were not particularly abundant or widespread in the vicinity of the Project and were only caught in the mapped lacustrine wetland. The species captured (Krefft's river turtle) is

considered widespread and common throughout waterways in Queensland. No potential habitat for platypus (*Ornithorhynchus anatinus*) was identified.

Results of all aquatic indicators surveyed as part of this assessment were consistent with results from previous aquatic ecology surveys at CVM and in the broader region. No differences were observed in aquatic ecological indicators between sites on mapped potential surface-expression GDEs and sites on other waterways and wetlands in the region.

Overall, aquatic ecosystem values of waterways and wetlands in the vicinity of the Project were low to moderate, and were considered to be similar to and representative of ephemeral systems in the broader region. Sites on waterways with higher stream orders (i.e. Cherwell Creek and Grosvenor Creek) typically had higher ecological value than sites on waterways with low stream orders (i.e. Horse Creek, Caval Creek and unnamed tributaries). Mapped lacustrine wetlands were assessed as having moderate aquatic ecological value (particularly due to their provision of dry season refuge for aquatic flora and fauna) and palustrine wetlands were assessed as having low aquatic ecological value (as they were dry during the field surveys). The value of wetlands in the vicinity of the Project to terrestrial flora and fauna was limited to riverine wetland areas within ML 1775 and ML 70403 along Nine Mile Creek and Cherwell Creek (E2M 2020).

Of the aquatic listed threatened species known to occur in the broader catchment, none were considered likely to occur in the vicinity of the Project. One HES palustrine wetland, also mapped as a WPA, is present approximately 20 km downstream of the Project. This wetland is a MSES. However, it was dry during the field survey and was assessed as having low habitat value for aquatic flora and fauna, as it was in similar condition to other mapped palustrine wetlands in the vicinity area and would rarely be inundated (and therefore would rarely provide aquatic habitat).

Waterways in the vicinity of the Project are mapped as waterways providing for fish passage in the *Waterway Barrier Works* spatial layer, a MSES, with a low, moderate, high and major risk of adverse impacts to fish passage as a result of waterway barrier works. Water resources were recorded within the vicinity of the Project during the field surveys, which are a MNES in relation to coal seam gas and large coal mining development. These included: waterways (all of which were ephemeral in nature), lacustrine wetlands and farm dams (all of which were modified by the presence of dams), palustrine wetlands (all of which were dry during the field surveys), mapped potential aquatic (i.e. surface expression) GDEs, and subterranean GDEs.

No other MNES or MSES were identified within the vicinity of the Project.

8.2 Stygofauna

No true stygofauna specimens were recorded from bores sampled during two pilot study surveys. This is consistent with the findings of the desktop assessment, which concluded that the aquifer formations within the Project site are unlikely to support diverse stygofauna communities. Stygofauna communities may be present further downstream of the Project, in the alluvium associated with the Isaac River and the lower reaches of its major tributaries.

8.3 Potential Impacts and Proposed Mitigation Measures

The Project has the potential to directly and indirectly impact aquatic ecosystems through:

- loss or modification of aquatic habitat, flora and fauna within the pit extension area and zone for dragline crossing
- temporary loss of minor waterway to be relocated
- changes to aquatic habitat (e.g. loss of habitat features) adjacent to and downstream of the Project
- altering fish passage via loss of sections of waterways and at water crossings, specifically the extension of the haul road requiring a bridge over Horse Creek and (where the location B option is selected for the blasting compound) a medium vehicle access road to the relocated blasting compound requiring a crossing over the existing Horse Creek diversion (although there is another road route option being considered where location B for the blasting compound is selected)
- changes to flow and flood regimes or waterways and wetlands downstream of the Project as a result of loss of catchment
- changes to water and sediment quality associated with vegetation and excavation works, dust and particulate matter, surface water run-off, controlled and emergency releases, seepage and saline or acid drainage
- leaks and spills of contaminants
- production of litter and waste, and
- proliferation of aquatic pests.

The Project is an extension of an existing operational mine. As such, these potential impacts will largely be managed and mitigated through implementation of existing EA conditions (including the CVM REMP) and existing management plans developed for the management of water, waste, hydrocarbons and contaminants, and pests. Potential impacts to aquatic ecosystems will further be minimised through the following mitigation measures:

- limiting area disturbed at any one time; progressive and timely reinstatement of the disturbed landform
- avoiding waterway crossings, where possible, or to consider fish passage and flow in crossing designs
- ensuring earthworks and stockpile are planned (and minimise where possible), including stormwater directed away from waterways
- design and construct infrastructure in accordance with the principles in existing strategies and management plans as well as best practice procedures
- adhering to and / or expanding exiting EA, REMP, water management systems and management plans developed for the management of water, waste, hydrocarbons and contaminants and pests.

Changes to groundwater quantity, quality, and interactions are not expected in the unconsolidated sediments of the Isaac River alluvium, in the lower reaches of the Isaac River

and at the confluences of larger tributaries (i.e. where stygofauna communities are likely to occur). Therefore, no impacts to stygofauna communities are expected as a result of the Project.

Overall, where these mitigation measures are implemented, potential direct and indirect impacts were considered acceptable, with a low risk of impacts to aquatic ecosystem values on a local and regional scale. Furthermore, no significant impacts to water resources are expected as a result of the Project.

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Attachment A Database Search Results

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: All
Type: All
Status: All
Records: All
Date: All
Latitude: -22.1343
Longitude: 148.0704
Distance: 50
Email: kkeating@ecosp.com.au
Date submitted: Tuesday 08 Oct 2019 08:54:38
Date extracted: Tuesday 08 Oct 2019 09:00:02

The number of records retrieved = 1287

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	amphibians	Bufonidae	*Rhinella marina*	cane toad	Y			47
animals	amphibians	Hylidae	*Cyclorana alboguttata*	greenstripe frog		C		14
animals	amphibians	Hylidae	*Litoria latopalmata*	broad palmed rocketfrog		C		13
animals	amphibians	Hylidae	*Litoria nasuta*	striped rocketfrog		C		1
animals	amphibians	Hylidae	*Cyclorana verrucosa*	rough collared frog		C		2/1
animals	amphibians	Hylidae	*Litoria inermis*	bumpy rocketfrog		C		8
animals	amphibians	Hylidae	*Litoria rubella*	ruddy treefrog		C		18
animals	amphibians	Hylidae	*Litoria caerulea*	common green treefrog		C		86
animals	amphibians	Hylidae	*Cyclorana brevipes*	superb collared frog		C		6
animals	amphibians	Hylidae	*Cyclorana cultripes*	grassland collared frog		C		1
animals	amphibians	Hylidae	*Cyclorana novaehollandiae*	eastern snapping frog		C		27
animals	amphibians	Hylidae	*Litoria rothii*	northern laughing treefrog		C		2
animals	amphibians	Limnodynastidae	*Limnodynastes terraereginae*	scarlet sided pobblebonk		C		7
animals	amphibians	Limnodynastidae	*Limnodynastes tasmaniensis*	spotted grassfrog		C		25
animals	amphibians	Limnodynastidae	*Limnodynastes peronii*	striped marshfrog		C		4
animals	amphibians	Limnodynastidae	*Limnodynastes salmini*	salmon striped frog		C		10
animals	amphibians	Limnodynastidae	*Platyplectrum ornatum*	ornate burrowing frog		C		62
animals	amphibians	Myobatrachidae	*Uperoleia sp.*					1
animals	birds	Acanthizidae	*Acanthiza chrysorrhoa*	yellow-rumped thornbill		C		5
animals	birds	Acanthizidae	*Sericornis frontalis*	white-browed scrubwren		C		5
animals	birds	Acanthizidae	*Acanthiza reguloides*	buff-rumped thornbill		C		11
animals	birds	Acanthizidae	*Acanthiza apicalis*	inland thornbill		C		6
animals	birds	Acanthizidae	*Smicrornis brevirostris*	weebill		C		151
animals	birds	Acanthizidae	*Acanthiza pusilla*	brown thornbill		C		2
animals	birds	Acanthizidae	*Acanthiza nana*	yellow thornbill		C		12
animals	birds	Acanthizidae	*Pyrrholaemus sagittatus*	speckled warbler		C		12
animals	birds	Acanthizidae	*Gerygone olivacea*	white-throated gerygone		C		63
animals	birds	Accipitridae	*Aquila audax*	wedge-tailed eagle		C		25
animals	birds	Accipitridae	*Circus assimilis*	spotted harrier		C		3
animals	birds	Accipitridae	*Milvus migrans*	black kite		C		16
animals	birds	Accipitridae	*Elanus axillaris*	black-shouldered kite		C		8
animals	birds	Accipitridae	*Accipiter cirrocephalus*	collared sparrowhawk		C		7
animals	birds	Accipitridae	*Hieraaetus morphnoides*	little eagle		C		1
animals	birds	Accipitridae	*Haliaeetus leucogaster*	white-bellied sea-eagle		C		5
animals	birds	Accipitridae	*Haliastur sphenurus*	whistling kite		C		46
animals	birds	Accipitridae	*Aviceda subcristata*	Pacific baza		C		3
animals	birds	Accipitridae	*Accipiter fasciatus*	brown goshawk		C		4
animals	birds	Accipitridae	*Lophoictinia isura*	square-tailed kite		C		1
animals	birds	Accipitridae	*Circus approximans*	swamp harrier		C		1
animals	birds	Acrocephalidae	*Acrocephalus australis*	Australian reed-warbler		C		11
animals	birds	Aegothelidae	*Aegotheles cristatus*	Australian owlet-nightjar		C		18
animals	birds	Alaudidae	*Mirafra javanica*	Horsfield's bushlark		C		5
animals	birds	Anatidae	*Malacorhynchus membranaceus*	pink-eared duck		C		2
animals	birds	Anatidae	*Nettapus coromandelianus*	cotton pygmy-goose		C		10
animals	birds	Anatidae	*Dendrocygna arcuata*	wandering whistling-duck		C		6
animals	birds	Anatidae	*Dendrocygna eytoni*	plumed whistling-duck		C		16

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Anatidae	*Chenonetta jubata*	Australian wood duck		C		37
animals	birds	Anatidae	*Anas superciliosa*	Pacific black duck		C		41
animals	birds	Anatidae	*Oxyura australis*	blue-billed duck		C		1
animals	birds	Anatidae	*Aythya australis*	hardhead		C		24
animals	birds	Anatidae	*Cygnus atratus*	black swan		C		15
animals	birds	Anatidae	*Anas castanea*	chestnut teal		C		2
animals	birds	Anatidae	*Anas gracilis*	grey teal		C		31
animals	birds	Anhingidae	*Anhinga novaehollandiae*	Australasian darter		C		24
animals	birds	Ardeidae	*Egretta novaehollandiae*	white-faced heron		C		26
animals	birds	Ardeidae	*Bubulcus ibis*	cattle egret		C		3
animals	birds	Ardeidae	*Ardea pacifica*	white-necked heron		C		18
animals	birds	Ardeidae	*Ardea intermedia*	intermediate egret		C		14
animals	birds	Ardeidae	*Egretta garzetta*	little egret		C		4
animals	birds	Ardeidae	*Ardea alba modesta*	eastern great egret		C		22
animals	birds	Ardeidae	*Nycticorax caledonicus*	nankeen night-heron		C		5
animals	birds	Artamidae	*Cracticus nigrogularis*	pied butcherbird		C		161
animals	birds	Artamidae	*Artamus minor*	little woodswallow		C		2
animals	birds	Artamidae	*Artamus cinereus*	black-faced woodswallow		C		13
animals	birds	Artamidae	*Gymnorhina tibicen*	Australian magpie		C		162
animals	birds	Artamidae	*Strepera graculina*	pied currawong		C		60
animals	birds	Artamidae	*Cracticus torquatus*	grey butcherbird		C		104
animals	birds	Artamidae	*Artamus leucorynchus*	white-breasted woodswallow		C		26
animals	birds	Burhinidae	*Burhinus grallarius*	bush stone-curlew		C		5
animals	birds	Cacatuidae	*Eolophus roseicapilla*	galah		C		61
animals	birds	Cacatuidae	*Cacatua galerita*	sulphur-crested cockatoo		C		83
animals	birds	Cacatuidae	*Nymphicus hollandicus*	cockatiel		C		10
animals	birds	Campephagidae	*Lalage tricolor*	white-winged triller		C		16
animals	birds	Campephagidae	*Coracina papuensis*	white-bellied cuckoo-shrike		C		10
animals	birds	Campephagidae	*Coracina tenuirostris*	cicadabird		C		31
animals	birds	Campephagidae	*Coracina novaehollandiae*	black-faced cuckoo-shrike		C		84
animals	birds	Campephagidae	*Coracina maxima*	ground cuckoo-shrike		C		4
animals	birds	Casuariidae	*Dromaius novaehollandiae*	emu		C		20
animals	birds	Charadriidae	*Vanellus miles novaehollandiae*	masked lapwing (southern subspecies)		C		9
animals	birds	Charadriidae	*Elseyornis melanops*	black-fronted dotterel		C		15
animals	birds	Charadriidae	*Vanellus tricolor*	banded lapwing		C		1
animals	birds	Charadriidae	*Vanellus miles*	masked lapwing		C		18
animals	birds	Ciconiidae	*Ephippiorhynchus asiaticus*	black-necked stork		C		4
animals	birds	Cisticolidae	*Cisticola exilis*	golden-headed cisticola		C		19
animals	birds	Climacteridae	*Climacteris picumnus*	brown treecreeper		C		2
animals	birds	Columbidae	*Ocyphaps lophotes*	crested pigeon		C		38
animals	birds	Columbidae	*Geopelia striata*	peaceful dove		C		41
animals	birds	Columbidae	*Geopelia cuneata*	diamond dove		C		2
animals	birds	Columbidae	*Phaps chalcoptera*	common bronzewing		C		13
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	59
animals	birds	Columbidae	*Geopelia humeralis*	bar-shouldered dove		C		21
animals	birds	Coraciidae	*Eurystomus orientalis*	dollarbird		C		55

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Corcoracidae	*Corcorax melanorhamphos*	white-winged chough		C		12
animals	birds	Corcoracidae	*Struthidea cinerea*	apostlebird		C		77
animals	birds	Corvidae	*Corvus bennetti*	little crow		C		1
animals	birds	Corvidae	*Corvus orru*	Torresian crow		C		247
animals	birds	Corvidae	*Corvus coronoides*	Australian raven		C		1
animals	birds	Cuculidae	*Chalcites minutillus*	little bronze-cuckoo		C		5
animals	birds	Cuculidae	*Cacomantis flabelliformis*	fan-tailed cuckoo		C		6
animals	birds	Cuculidae	*Scythrops novaehollandiae*	channel-billed cuckoo		C		21
animals	birds	Cuculidae	*Cacomantis pallidus*	pallid cuckoo		C		11
animals	birds	Cuculidae	*Chalcites osculans*	black-eared cuckoo		C		1
animals	birds	Cuculidae	*Centropus phasianinus*	pheasant coucal		C		36
animals	birds	Cuculidae	*Chalcites basalis*	Horsfield's bronze-cuckoo		C		7
animals	birds	Cuculidae	*Chalcites minutillus barnardi*	Eastern little bronze-cuckoo		C		2
animals	birds	Cuculidae	*Eudynamys orientalis*	eastern koel		C		10
animals	birds	Cuculidae	*Cacomantis variolosus*	brush cuckoo		C		1
animals	birds	Cuculidae	*Chalcites lucidus*	shining bronze-cuckoo		C		8
animals	birds	Dicruridae	*Dicrurus bracteatus*	spangled drongo		C		9
animals	birds	Estrildidae	*Neochmia modesta*	plum-headed finch		C		2
animals	birds	Estrildidae	*Neochmia temporalis*	red-browed finch		C		1
animals	birds	Estrildidae	*Taeniopygia guttata*	zebra finch		C		4
animals	birds	Estrildidae	*Taeniopygia bichenovii*	double-barred finch		C		52
animals	birds	Estrildidae	*Lonchura castaneothorax*	chestnut-breasted mannikin		C		4
animals	birds	Eurostopodidae	*Eurostopodus mystacalis*	white-throated nightjar		C		5
animals	birds	Falconidae	*Falco berigora*	brown falcon		C		23
animals	birds	Falconidae	*Falco subniger*	black falcon		C		1
animals	birds	Falconidae	*Falco longipennis*	Australian hobby		C		6
animals	birds	Falconidae	*Falco cenchroides*	nankeen kestrel		C		39
animals	birds	Falconidae	*Falco peregrinus*	peregrine falcon		C		1
animals	birds	Gruidae	*Antigone rubicunda*	brolga		C		28
animals	birds	Halcyonidae	*Dacelo leachii*	blue-winged kookaburra		C		22
animals	birds	Halcyonidae	*Dacelo novaeguineae*	laughing kookaburra		C		90
animals	birds	Halcyonidae	*Todiramphus pyrrhopygius*	red-backed kingfisher		C		9
animals	birds	Halcyonidae	*Todiramphus macleayii*	forest kingfisher		C		19
animals	birds	Halcyonidae	*Todiramphus sanctus*	sacred kingfisher		C		25
animals	birds	Hirundinidae	*Hirundo neoxena*	welcome swallow		C		11
animals	birds	Hirundinidae	*Petrochelidon ariel*	fairy martin		C		13
animals	birds	Hirundinidae	*Petrochelidon nigricans*	tree martin		C		16
animals	birds	Jacanidae	*Irediparra gallinacea*	comb-crested jacana		C		4
animals	birds	Laridae	*Chlidonias hybrida*	whiskered tern		C		1
animals	birds	Laridae	*Chroicocephalus novaehollandiae*	silver gull		C		2
animals	birds	Laridae	*Gelochelidon nilotica*	gull-billed tern		SL		1
animals	birds	Maluridae	*Malurus cyaneus*	superb fairy-wren		C		1
animals	birds	Maluridae	*Malurus lamberti*	variegated fairy-wren		C		33
animals	birds	Maluridae	*Malurus melanocephalus*	red-backed fairy-wren		C		79
animals	birds	Megaluridae	*Megalurus gramineus*	little grassbird		C		1
animals	birds	Megaluridae	*Megalurus timoriensis*	tawny grassbird		C		3

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Megaluridae	*Cincloramphus mathewsi*	rufous songlark		C		6
animals	birds	Megapodiidae	*Alectura lathami*	Australian brush-turkey		C		5
animals	birds	Meliphagidae	*Meliphaga lewinii*	Lewin's honeyeater		C		17
animals	birds	Meliphagidae	*Plectorhyncha lanceolata*	striped honeyeater		C		47
animals	birds	Meliphagidae	*Melithreptus albogularis*	white-throated honeyeater		C		108
animals	birds	Meliphagidae	*Acanthagenys rufogularis*	spiny-cheeked honeyeater		C		6
animals	birds	Meliphagidae	*Philemon citreogularis*	little friarbird		C		76
animals	birds	Meliphagidae	*Manorina melanocephala*	noisy miner		C		44
animals	birds	Meliphagidae	*Myzomela obscura*	dusky honeyeater		C		1
animals	birds	Meliphagidae	*Caligavis chrysops*	yellow-faced honeyeater		C		3
animals	birds	Meliphagidae	*Entomyzon cyanotis*	blue-faced honeyeater		C		72
animals	birds	Meliphagidae	*Manorina flavigula*	yellow-throated miner		C		50
animals	birds	Meliphagidae	*Gavicalis virescens*	singing honeyeater		C		44
animals	birds	Meliphagidae	*Lichmera indistincta*	brown honeyeater		C		28
animals	birds	Meliphagidae	*Melithreptus gularis*	black-chinned honeyeater		C		1
animals	birds	Meliphagidae	*Melithreptus lunatus*	white-naped honeyeater		C		1
animals	birds	Meliphagidae	*Philemon corniculatus*	noisy friarbird		C		111
animals	birds	Meropidae	*Merops ornatus*	rainbow bee-eater		C		82
animals	birds	Monarchidae	*Monarcha melanopsis*	black-faced monarch		SL		1
animals	birds	Monarchidae	*Grallina cyanoleuca*	magpie-lark		C		92
animals	birds	Monarchidae	*Myiagra rubecula*	leaden flycatcher		C		36
animals	birds	Monarchidae	*Myiagra inquieta*	restless flycatcher		C		4
animals	birds	Motacillidae	*Anthus novaeseelandiae*	Australasian pipit		C		18
animals	birds	Nectariniidae	*Dicaeum hirundinaceum*	mistletoebird		C		52
animals	birds	Neosittidae	*Daphoenositta chrysoptera*	varied sittella		C		27
animals	birds	Oriolidae	*Oriolus sagittatus*	olive-backed oriole		C		16
animals	birds	Oriolidae	*Sphecotheres vieilloti*	Australasian figbird		C		9
animals	birds	Otididae	*Ardeotis australis*	Australian bustard		C		23
animals	birds	Pachycephalidae	*Pachycephala rufiventris*	rufous whistler		C		54
animals	birds	Pachycephalidae	*Colluricincla harmonica*	grey shrike-thrush		C		57
animals	birds	Pachycephalidae	*Colluricincla megarhyncha*	little shrike-thrush		C		1
animals	birds	Pardalotidae	*Pardalotus punctatus*	spotted pardalote		C		1
animals	birds	Pardalotidae	*Pardalotus striatus*	striated pardalote		C		156
animals	birds	Passeridae	*Passer domesticus*	house sparrow	Y			1
animals	birds	Pelecanidae	*Pelecanus conspicillatus*	Australian pelican		C		12
animals	birds	Petroicidae	*Eopsaltria australis*	eastern yellow robin		C		1
animals	birds	Petroicidae	*Microeca fascinans*	jacky winter		C		11
animals	birds	Petroicidae	*Petroica goodenovii*	red-capped robin		C		2
animals	birds	Phalacrocoracidae	*Phalacrocorax carbo*	great cormorant		C		1
animals	birds	Phalacrocoracidae	*Phalacrocorax varius*	pied cormorant		C		4
animals	birds	Phalacrocoracidae	*Microcarbo melanoleucos*	little pied cormorant		C		29
animals	birds	Phalacrocoracidae	*Phalacrocorax sulcirostris*	little black cormorant		C		18
animals	birds	Phasianidae	*Coturnix pectoralis*	stubble quail		C		2
animals	birds	Phasianidae	*Coturnix sp.*					1
animals	birds	Phasianidae	*Coturnix ypsilophora*	brown quail		C		12
animals	birds	Podargidae	*Podargus strigoides*	tawny frogmouth		C		30

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian grebe		C		24
animals	birds	Podicipedidae	*Podiceps cristatus*	great crested grebe		C		8
animals	birds	Pomatostomidae	*Pomatostomus temporalis*	grey-crowned babbler		C		81
animals	birds	Psittacidae	*Trichoglossus haematodus moluccanus*	rainbow lorikeet		C		90
animals	birds	Psittacidae	*Platycercus adscitus palliceps*	pale-headed rosella (southern form)		C		5
animals	birds	Psittacidae	*Platycercus adscitus*	pale-headed rosella		C		120
animals	birds	Psittacidae	*Trichoglossus chlorolepidotus*	scaly-breasted lorikeet		C		2
animals	birds	Psittacidae	*Aprosmictus erythropterus*	red-winged parrot		C		53
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	great bowerbird		C		2
animals	birds	Ptilonorhynchidae	*Ptilonorhynchus maculatus*	spotted bowerbird		C		11
animals	birds	Rallidae	*Fulica atra*	Eurasian coot		C		13
animals	birds	Rallidae	*Porzana fluminea*	Australian spotted crake		C		1
animals	birds	Rallidae	*Gallinula tenebrosa*	dusky moorhen		C		14
animals	birds	Rallidae	*Porphyrio melanotus*	purple swamphen		C		13
animals	birds	Rallidae	*Gallirallus philippensis*	buff-banded rail		C		1
animals	birds	Recurvirostridae	*Himantopus himantopus*	black-winged stilt		C		9
animals	birds	Rhipiduridae	*Rhipidura albiscapa*	grey fantail		C		49
animals	birds	Rhipiduridae	*Rhipidura rufifrons*	rufous fantail		SL		1
animals	birds	Rhipiduridae	*Rhipidura leucophrys*	willie wagtail		C		53
animals	birds	Scolopacidae	*Tringa nebularia*	common greenshank		SL		1
animals	birds	Scolopacidae	*Calidris acuminata*	sharp-tailed sandpiper		SL		1
animals	birds	Scolopacidae	*Tringa stagnatilis*	marsh sandpiper		SL		3
animals	birds	Strigidae	*Ninox boobook*	southern boobook		C		30
animals	birds	Strigidae	*Ninox connivens*	barking owl		C		2
animals	birds	Threskiornithidae	*Plegadis falcinellus*	glossy ibis		SL		1
animals	birds	Threskiornithidae	*Threskiornis molucca*	Australian white ibis		C		8
animals	birds	Threskiornithidae	*Platalea flavipes*	yellow-billed spoonbill		C		5
animals	birds	Threskiornithidae	*Platalea regia*	royal spoonbill		C		12
animals	birds	Threskiornithidae	*Threskiornis spinicollis*	straw-necked ibis		C		16
animals	birds	Timaliidae	*Zosterops lateralis*	silvereye		C		1
animals	birds	Turnicidae	*Turnix varius*	painted button-quail		C		4
animals	birds	Tytonidae	*Tyto delicatula*	eastern barn owl		C		8
animals	insects	Lycaenidae	*Zizina otis labradus*	common grass-blue (Australian subspecies)				1
animals	insects	Nymphalidae	*Junonia orithya albicincta*	blue argus				4
animals	insects	Nymphalidae	*Hypolimnas bolina nerina*	varied eggfly				1
animals	insects	Nymphalidae	*Junonia villida villida*	meadow argus				7
animals	insects	Nymphalidae	*Melanitis leda bankia*	evening brown				1
animals	insects	Nymphalidae	*Danaus petilia*	lesser wanderer				2
animals	insects	Nymphalidae	*Euploea corinna*	common crow				9
animals	insects	Nymphalidae	*Acraea andromacha andromacha*	glasswing				2
animals	insects	Nymphalidae	*Tirumala hamata hamata*	blue tiger				3
animals	insects	Papilionidae	*Cressida cressida cressida*	clearwing swallowtail				1
animals	insects	Papilionidae	*Papilio demoleus sthenelus*	chequered swallowtail				2
animals	insects	Papilionidae	*Graphium choredon*	blue triangle				1
animals	insects	Papilionidae	*Papilio anactus*	dainty swallowtail				2

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animals	insects	Pieridae	*Eurema smilax*	small grass-yellow				5
animals	insects	Pieridae	*Elodina parthia*	striated pearl-white				1
animals	insects	Pieridae	*Catopsilia pomona*	lemon migrant				7
animals	insects	Pieridae	*Belenois java teutonia*	caper white				11
animals	insects	Pieridae	*Cepora perimale scyllara*	caper gull (Australian subspecies)				1
animals	mammals	Bovidae	*Capra hircus*	goat	Y			1
animals	mammals	Bovidae	*Bos taurus*	European cattle	Y			1
animals	mammals	Canidae	*Canis lupus familiaris*	dog	Y			5
animals	mammals	Canidae	*Vulpes vulpes*	red fox	Y			3
animals	mammals	Canidae	*Canis sp.*		Y			15
animals	mammals	Canidae	*Canis lupus dingo*	dingo				2
animals	mammals	Cervidae	*Axis axis*	chital	Y			3
animals	mammals	Cervidae	*Cervus timorensis*	rusa deer	Y			1
animals	mammals	Dasyuridae	*Planigale ingrami*	long-tailed planigale		C		3
animals	mammals	Dasyuridae	*Planigale tenuirostris*	narrow-nosed planigale		C		2
animals	mammals	Dasyuridae	*Sminthopsis macroura*	stripe-faced dunnart		C		19
animals	mammals	Dasyuridae	*Dasyurus hallucatus*	northern quoll		C	E	1
animals	mammals	Dasyuridae	*Sminthopsis crassicaudata*	fat-tailed dunnart		C		1
animals	mammals	Dasyuridae	*Planigale sp.*					2
animals	mammals	Emballonuridae	*Saccolaimus flaviventris*	yellow-bellied sheathtail bat		C		38
animals	mammals	Emballonuridae	*Taphozous australis*	coastal sheathtail bat		NT		3
animals	mammals	Emballonuridae	*Taphozous troughtoni*	Troughton's sheathtail bat		C		10
animals	mammals	Felidae	*Felis catus*	cat	Y			10
animals	mammals	Leporidae	*Oryctolagus cuniculus*	rabbit	Y			18
animals	mammals	Macropodidae	*Lagorchestes conspicillatus*	spectacled hare-wallaby		C		1
animals	mammals	Macropodidae	*Petrogale inornata*	unadorned rock-wallaby		C		6
animals	mammals	Macropodidae	*Petrogale herberti*	Herbert's rock-wallaby		C		3
animals	mammals	Macropodidae	*Macropus giganteus*	eastern grey kangaroo		C		32
animals	mammals	Macropodidae	*Macropus robustus*	common wallaroo		C		6
animals	mammals	Macropodidae	*Macropus dorsalis*	black-striped wallaby		C		3
animals	mammals	Macropodidae	*Wallabia bicolor*	swamp wallaby		C		5
animals	mammals	Macropodidae	*Macropus parryi*	whiptail wallaby		C		2
animals	mammals	Macropodidae	*Macropus rufus*	red kangaroo		C		3
animals	mammals	Miniopteridae	*Miniopterus australis*	little bent-wing bat		C		13
animals	mammals	Miniopteridae	*Miniopterus schreibersii oceanensis*	eastern bent-wing bat		C		7
animals	mammals	Molossidae	*Mormopterus lumsdenae*	northern free-tailed bat		C		17
animals	mammals	Molossidae	*Chaerephon jobensis*	northern freetail bat		C		22
animals	mammals	Molossidae	*Tadarida australis*	white-striped freetail bat		C		1
animals	mammals	Molossidae	*Mormopterus ridei*	eastern free-tailed bat		C		9
animals	mammals	Molossidae	*Mormopterus sp.*					2
animals	mammals	Molossidae	*Mormopterus norfolkensis*	east coast freetail bat		C		1
animals	mammals	Muridae	*Pseudomys delicatulus*	delicate mouse		C		7
animals	mammals	Muridae	*Pseudomys gracilicaudatus*	eastern chestnut mouse		C		5
animals	mammals	Muridae	*Hydromys chrysogaster*	water rat		C		7
animals	mammals	Muridae	*Mus musculus*	house mouse	Y			12
animals	mammals	Muridae	*Rattus rattus*	black rat	Y			1

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animals	mammals	Muridae	*Rattus fuscipes*	bush rat		C		3
animals	mammals	Muridae	*Pseudomys patrius*	eastern pebble-mound mouse		C		22/1
animals	mammals	Peramelidae	*Isoodon macrourus*	northern brown bandicoot		C		3
animals	mammals	Petauridae	*Petaurus norfolcensis*	squirrel glider		C		3
animals	mammals	Petauridae	*Petaurus sp.*					1
animals	mammals	Petauridae	*Petaurus breviceps*	sugar glider		C		13
animals	mammals	Phalangeridae	*Trichosurus vulpecula*	common brushtail possum		C		14
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	118
animals	mammals	Potoroidae	*Aepyprymnus rufescens*	rufous bettong		C		16
animals	mammals	Pseudocheiridae	*Petauroides volans minor*	northern greater glider		V	V	43
animals	mammals	Pseudocheiridae	*Petauroides volans*	greater glider		V	V	57
animals	mammals	Pteropodidae	*Pteropus scapulatus*	little red flying-fox		C		4
animals	mammals	Suidae	*Sus scrofa*	pig	Y			13
animals	mammals	Tachyglossidae	*Tachyglossus aculeatus*	short-beaked echidna		SL		20
animals	mammals	Vespertilionidae	*Chalinolobus gouldii*	Gould's wattled bat		C		55
animals	mammals	Vespertilionidae	*Chalinolobus picatus*	little pied bat		C		20
animals	mammals	Vespertilionidae	*Scotorepens balstoni*	inland broad-nosed bat		C		11
animals	mammals	Vespertilionidae	*Scotorepens sanborni*	northern broad-nosed bat		C		3
animals	mammals	Vespertilionidae	*Vespadelus troughtoni*	eastern cave bat		C		18
animals	mammals	Vespertilionidae	*Vespadelus baverstocki*	inland forest bat		C		14
animals	mammals	Vespertilionidae	*Chalinolobus nigrogriseus*	hoary wattled bat		C		21
animals	mammals	Vespertilionidae	*Scotorepens sp. (Parnaby)*	central-eastern broad-nosed bat		C		1
animals	mammals	Vespertilionidae	*Chalinolobus dwyeri*	large-eared pied bat		V	V	1
animals	mammals	Vespertilionidae	*Scotorepens greyii*	little broad-nosed bat		C		31
animals	mammals	Vespertilionidae	*Nyctophilus gouldi*	Gould's long-eared bat		C		9
animals	mammals	Vespertilionidae	*Nyctophilus bifax*	northern long-eared bat		C		1
animals	mammals	Vespertilionidae	*Chalinolobus sp.*					15
animals	mammals	Vespertilionidae	*Scotorepens sp.*					2
animals	mammals	Vespertilionidae	*Nyctophilus sp.*					7
animals	mammals	Vespertilionidae	*Vespadelus sp.*					1
animals	mammals	Vespertilionidae	*Chalinolobus morio*	chocolate wattled bat		C		15
animals	ray-finned fishes	Ambassidae	*Ambassis agassizii*	Agassiz's glassfish				1
animals	ray-finned fishes	Ariidae	*Neoarius graeffei*	blue catfish				1
animals	ray-finned fishes	Atherinidae	*Craterocephalus stercusmuscarum*	flyspecked hardyhead				1
animals	ray-finned fishes	Clupeidae	*Nematalosa erebi*	bony bream				1
animals	ray-finned fishes	Eleotridae	*Oxyeleotris lineolata*	sleepy cod				1
animals	ray-finned fishes	Eleotridae	*Mogurnda adspersa*	southern purplespotted gudgeon				1
animals	ray-finned fishes	Eleotridae	*Hypseleotris species 1*	Midgley's carp gudgeon				1
animals	ray-finned fishes	Melanotaeniidae	*Melanotaenia splendida splendida*	eastern rainbowfish				1
animals	ray-finned fishes	Osteoglossidae	*Scleropages leichardti*	southern saratoga				1
animals	ray-finned fishes	Percichthyidae	*Macquaria ambigua*	golden perch				1
animals	ray-finned fishes	Terapontidae	*Bidyanus bidyanus*	silver perch			CE	1
animals	ray-finned fishes	Terapontidae	*Leiopotherapon unicolor*	spangled perch				1
animals	reptiles	Agamidae	*Pogona vitticeps*	central bearded dragon		C		2
animals	reptiles	Agamidae	*Amphibolurus burnsi*	Burns's dragon		C		5
animals	reptiles	Agamidae	*Chlamydosaurus kingii*	frilled lizard		C		3

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animals	reptiles	Agamidae	*Diporiphora australis*	tommy roundhead		C		20/1
animals	reptiles	Agamidae	*Lophognathus gilberti sensu lato*	Gilbert's dragon		C		1
animals	reptiles	Agamidae	*Pogona barbata*	bearded dragon		C		40
animals	reptiles	Boidae	*Aspidites melanocephalus*	black-headed python		C		11
animals	reptiles	Boidae	*Antaresia maculosa*	spotted python		C		46
animals	reptiles	Carphodactylidae	*Nephrurus asper*	spiny knob-tailed gecko		C		15
animals	reptiles	Chelidae	*Chelodina sp.*					1
animals	reptiles	Chelidae	*Emydura sp.*					1
animals	reptiles	Chelidae	*Chelodina longicollis*	eastern snake-necked turtle		C		2
animals	reptiles	Colubridae	*Dendrelaphis punctulatus*	green tree snake		C		4
animals	reptiles	Colubridae	*Tropidonophis mairii*	freshwater snake		C		8
animals	reptiles	Colubridae	*Boiga irregularis*	brown tree snake		C		7
animals	reptiles	Diplodactylidae	*Oedura monilis*	ocellated velvet gecko		C		51/1
animals	reptiles	Diplodactylidae	*Amalosia rhombifer*	zig-zag gecko		C		1
animals	reptiles	Diplodactylidae	*Diplodactylus platyurus*	eastern fat-tailed gecko		C		38
animals	reptiles	Diplodactylidae	*Diplodactylus vittatus*	wood gecko		C		22/1
animals	reptiles	Diplodactylidae	*Lucasium steindachneri*	Steindachner's gecko		C		41
animals	reptiles	Diplodactylidae	*Strophurus williamsi*	soft-spined gecko		C		37
animals	reptiles	Elapidae	*Suta suta*	myall snake		C		43
animals	reptiles	Elapidae	*Furina diadema*	red-naped snake		C		4
animals	reptiles	Elapidae	*Denisonia maculata*	ornamental snake		V	V	62
animals	reptiles	Elapidae	*Cryptophis boschmai*	Carpentaria whip snake		C		37
animals	reptiles	Elapidae	*Hoplocephalus bitorquatus*	pale-headed snake		C		10
animals	reptiles	Elapidae	*Pseudonaja textilis*	eastern brown snake		C		24
animals	reptiles	Elapidae	*Vermicella annulata*	bandy-bandy		C		2
animals	reptiles	Elapidae	*Acanthophis antarcticus*	common death adder		V		1
animals	reptiles	Elapidae	*Brachyurophis australis*	coral snake		C		9
animals	reptiles	Elapidae	*Demansia psammophis*	yellow-faced whipsnake		C		27
animals	reptiles	Gekkonidae	*Gehyra sp.*					1
animals	reptiles	Gekkonidae	*Gehyra dubia*	dubious dtella		C		163/2
animals	reptiles	Gekkonidae	*Heteronotia binoei*	Bynoe's gecko		C		118/1
animals	reptiles	Gekkonidae	*Gehyra versicolor*			C		30
animals	reptiles	Gekkonidae	*Gehyra catenata*	chain-backed dtella		C		24
animals	reptiles	Pygopodidae	*Delma tincta*	excitable delma		C		1
animals	reptiles	Pygopodidae	*Paradelma orientalis*	brigalow scaly-foot		C		1
animals	reptiles	Pygopodidae	*Pygopus schraderi*	eastern hooded scaly-foot		C		3
animals	reptiles	Pygopodidae	*Lialis burtonis*	Burton's legless lizard		C		48
animals	reptiles	Scincidae	*Carlia sp.*					2
animals	reptiles	Scincidae	*Cryptoblepharus virgatus sensu lato*			C		8
animals	reptiles	Scincidae	*Carlia munda*	shaded-litter rainbow-skink		C		7
animals	reptiles	Scincidae	*Carlia vivax*	tussock rainbow-skink		C		4
animals	reptiles	Scincidae	*Morethia sp.*					2
animals	reptiles	Scincidae	*Carlia rubigo*	orange-flanked rainbow skink		C		103
animals	reptiles	Scincidae	*Eulamprus sp.*					2
animals	reptiles	Scincidae	*Lygisaurus sp.*					1
animals	reptiles	Scincidae	*Menetia greyii*	common dwarf skink		C		18

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	reptiles	Scincidae	*Tiliqua rugosa*	shingle-back		C		1
animals	reptiles	Scincidae	*Lerista allanae*	Allan's lerista		E	E	1/1
animals	reptiles	Scincidae	*Ctenotus ingrami*	unspotted yellow-sided ctenotus		C		16
animals	reptiles	Scincidae	*Lerista fragilis*	eastern mulch slider		C		24/1
animals	reptiles	Scincidae	*Carlia schmeltzii*	robust rainbow-skink		C		8/1
animals	reptiles	Scincidae	*Egernia striolata*	tree skink		C		2
animals	reptiles	Scincidae	*Bellatorias frerei*	major skink		C		1
animals	reptiles	Scincidae	*Concinnia sokosoma*	stout bar-sided skink		C		1
animals	reptiles	Scincidae	*Ctenotus spaldingi*	straight-browed ctenotus		C		49
animals	reptiles	Scincidae	*Ctenotus strauchii*	eastern barred wedgesnout ctenotus		C		3
animals	reptiles	Scincidae	*Tiliqua scincoides*	eastern blue-tongued lizard		C		4
animals	reptiles	Scincidae	*Cryptoblepharus sp.*					1
animals	reptiles	Scincidae	*Ctenotus allotropis*	brown-blazed wedgesnout ctenotus		C		1
animals	reptiles	Scincidae	*Lygisaurus foliorum*	tree-base litter-skink		C		51/1
animals	reptiles	Scincidae	*Morethia boulengeri*	south-eastern morethia skink		C		48
animals	reptiles	Scincidae	*Concinnia brachysoma*	northern bar-sided skink		C		1
animals	reptiles	Scincidae	*Ctenotus taeniolatus*	copper-tailed skink		C		23
animals	reptiles	Scincidae	*Morethia taeniopleura*	fire-tailed skink		C		9
animals	reptiles	Scincidae	*Anomalopus brevicollis*	short-necked worm-skink		C		3
animals	reptiles	Scincidae	*Pygmaeascincus timlowi*	dwarf litter-skink		C		9
animals	reptiles	Scincidae	*Lerista punctatovittata*	eastern robust slider		C		2
animals	reptiles	Scincidae	*Cryptoblepharus pannosus*	ragged snake-eyed skink		C		5
animals	reptiles	Scincidae	*Eremiascincus fasciolatus*	narrow-banded sand swimmer		C		1
animals	reptiles	Scincidae	*Glaphyromorphus punctulatus*	fine-spotted mulch-skink		C		6/1
animals	reptiles	Scincidae	*Carlia pectoralis sensu lato*			C		30/1
animals	reptiles	Scincidae	*Cryptoblepharus pulcher pulcher*	elegant snake-eyed skink		C		25
animals	reptiles	Scincidae	*Lerista sp.*					1
animals	reptiles	Typhlopidae	*Anilios sp.*					1
animals	reptiles	Typhlopidae	*Anilios unguirostris*	claw-snouted blind snake		C		2
animals	reptiles	Typhlopidae	*Anilios ligatus*	robust blind snake		C		15
animals	reptiles	Typhlopidae	*Anilios affinis*	small-headed blind snake		C		2
animals	reptiles	Varanidae	*Varanus tristis*	black-tailed monitor		C		15
animals	uncertain	Indeterminate	*Indeterminate*	Unknown or Code Pending		C		2
fungi	lecanoromycetes	Cladoniaceae	*Cladia muelleri*			C		1/1
fungi	lecanoromycetes	Cladoniaceae	*Ramalinora glaucolivida*			C		1/1
fungi	lecanoromycetes	Lecideaceae	*Lecidea*			C		3/3
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia ballingalliana*			C		2/2
fungi	lecanoromycetes	Parmeliaceae	*Xanthoparmelia exuviata*			C		1/1
fungi	lecanoromycetes	Physciaceae	*Rinodina*			C		1/1
fungi	lecanoromycetes	Porinaceae	*Porina subargillacea*			C		1/1
fungi	lecanoromycetes	Teloschistaceae	*Caloplaca cinnabarina*			C		1/1
fungi	lichinomycetes	Peltulaceae	*Peltula placodizans*			C		1/1
plants	land plants	Acanthaceae	*Dipteracanthus australasicus subsp. corynothecus*			C		3/3
plants	land plants	Acanthaceae	*Dipteracanthus australasicus subsp. australasicus*			C		1/1
plants	land plants	Acanthaceae	*Brunoniella australis*	blue trumpet		C		34/1
plants	land plants	Acanthaceae	*Rostellularia adscendens*			C		37/2

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plants	land plants	Acanthaceae	*Rostellularia adscendens var. clementii*			C		1/1
plants	land plants	Acanthaceae	*Harnieria sp. (Lornesleigh E.J.Thompson+ CHA75)*			C		1/1
plants	land plants	Acanthaceae	*Pseuderanthemum variabile*	pastel flower		C		2/1
plants	land plants	Acanthaceae	*Rostellularia adscendens var. hispida*			C		1/1
plants	land plants	Acanthaceae	*Pseuderanthemum tenellum*			C		13
plants	land plants	Aizoaceae	*Trianthema triquetra*	red spinach		C		3
plants	land plants	Aizoaceae	*Trianthema portulacastrum*	black pigweed	Y			4
plants	land plants	Aizoaceae	*Zaleya galericulata*			C		1/1
plants	land plants	Amaranthaceae	*Alternanthera denticulata var. micrantha*			C		6
plants	land plants	Amaranthaceae	*Alternanthera denticulata*	lesser joyweed		C		3
plants	land plants	Amaranthaceae	*Alternanthera nodiflora*	joyweed		C		1
plants	land plants	Amaranthaceae	*Ptilotus polystachyus*			C		2/2
plants	land plants	Amaranthaceae	*Gomphrena celosioides*	gomphrena weed	Y			8
plants	land plants	Amaranthaceae	*Ptilotus uncinellus*			E		1/1
plants	land plants	Amaranthaceae	*Alternanthera nana*	hairy joyweed		C		18/2
plants	land plants	Amaranthaceae	*Achyranthes aspera*			C		6
plants	land plants	Amaranthaceae	*Ptilotus*			C		1
plants	land plants	Amaranthaceae	*Nyssanthes erecta*			C		1/1
plants	land plants	Amaryllidaceae	*Proiphys cunninghamii*	Moreton Bay lily		C		1/1
plants	land plants	Amaryllidaceae	*Crinum flaccidum*	Murray lily		C		1
plants	land plants	Amaryllidaceae	*Crinum*			C		1
plants	land plants	Anacardiaceae	*Pleiogynium timorense*	Burdekin plum		C		1
plants	land plants	Apiaceae	*Eryngium plantagineum*	long eryngium		C		2/2
plants	land plants	Apocynaceae	*Cerbera dumicola*			NT		8/5
plants	land plants	Apocynaceae	*Wrightia saligna*			C		1/1
plants	land plants	Apocynaceae	*Alyxia ruscifolia*			C		2/2
plants	land plants	Apocynaceae	*Carissa lanceolata*			C		1
plants	land plants	Apocynaceae	*Secamone elliptica*			C		2/1
plants	land plants	Apocynaceae	*Alstonia constricta*	bitterbark		C		4/1
plants	land plants	Apocynaceae	*Marsdenia australis*	doubah		C		1
plants	land plants	Apocynaceae	*Parsonsia straminea*	monkey rope		C		1
plants	land plants	Apocynaceae	*Wrightia versicolor*			C		1/1
plants	land plants	Apocynaceae	*Marsdenia microlepis*			C		3
plants	land plants	Apocynaceae	*Parsonsia lanceolata*	northern silkpod		C		16/3
plants	land plants	Apocynaceae	*Asclepias curassavica*	red-head cottonbush	Y			1
plants	land plants	Apocynaceae	*Marsdenia viridiflora*			C		1
plants	land plants	Apocynaceae	*Gomphocarpus physocarpus*	balloon cottonbush	Y			1
plants	land plants	Apocynaceae	*Parsonsia eucalyptophylla*	gargaloo		C		1
plants	land plants	Apocynaceae	*Hoya australis subsp. australis*			C		1/1
plants	land plants	Apocynaceae	*Cynanchum viminale subsp. brunonianum*			C		7
plants	land plants	Apocynaceae	*Marsdenia viridiflora subsp. viridiflora*			C		6/1
plants	land plants	Apocynaceae	*Marsdenia*			C		1
plants	land plants	Apocynaceae	*Carissa ovata*	currantbush		C		31/1
plants	land plants	Araliaceae	*Astrotricha biddulphiana*			C		1/1
plants	land plants	Araliaceae	*Polyscias elegans*	celery wood		C		1/1
plants	land plants	Asphodelaceae	*Bulbine bulbosa*	golden lily		C		2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Asteraceae	*Calotis cuneifolia*	burr daisy		C		7/2
plants	land plants	Asteraceae	*Senecio pinnatifolius var. pinnatifolius*			C		2
plants	land plants	Asteraceae	*Pterocaulon serrulatum var. serrulatum*			C		1/1
plants	land plants	Asteraceae	*Peripleura hispidula var. hispidula*			C		1
plants	land plants	Asteraceae	*Apowollastonia spilanthoides*			C		20/4
plants	land plants	Asteraceae	*Sphaeromorphaea subintegra*			C		1/1
plants	land plants	Asteraceae	*Sphaeromorphaea australis*			C		5/1
plants	land plants	Asteraceae	*Chrysocephalum apiculatum*	yellow buttons		C		5
plants	land plants	Asteraceae	*Symphyotrichum subulatum*		Y			1
plants	land plants	Asteraceae	*Streptoglossa adscendens*	desert daisy		C		1/1
plants	land plants	Asteraceae	*Parthenium hysterophorus*	parthenium weed	Y			55/1
plants	land plants	Asteraceae	*Pterocaulon sphacelatum*	applebush		C		2
plants	land plants	Asteraceae	*Gamochaeta pensylvanica*		Y			1/1
plants	land plants	Asteraceae	*Acanthospermum hispidum*	star burr	Y			3/1
plants	land plants	Asteraceae	*Bidens pilosa*		Y			2
plants	land plants	Asteraceae	*Calotis dentex*	white burr daisy		C		1/1
plants	land plants	Asteraceae	*Pluchea dentex*	bowl daisy		C		1/1
plants	land plants	Asteraceae	*Calotis cuneata*			C		1/1
plants	land plants	Asteraceae	*Bidens bipinnata*	bipinnate beggar's ticks	Y			1
plants	land plants	Asteraceae	*Blumea axillaris*			C		2/2
plants	land plants	Asteraceae	*Camptacra barbata*			C		1/1
plants	land plants	Asteraceae	*Eclipta prostrata*	white eclipta	Y			1/1
plants	land plants	Asteraceae	*Olearia xerophila*			C		2/1
plants	land plants	Asteraceae	*Sonchus oleraceus*	common sowthistle	Y			9/1
plants	land plants	Asteraceae	*Tridax procumbens*	tridax daisy	Y			3/2
plants	land plants	Asteraceae	*Trioncinia patens*			E		1/1
plants	land plants	Asteraceae	*Xerochrysum bracteatum subsp. (Mount Elliot A.R.Bean 3593)*			C		1/1
plants	land plants	Asteraceae	*Calotis lappulacea*	yellow burr daisy		C		2/2
plants	land plants	Asteraceae	*Emilia sonchifolia*		Y			8
plants	land plants	Asteraceae	*Vittadinia sulcata*	native daisy		C		1/1
plants	land plants	Asteraceae	*Coronidium rupicola*			C		1/1
plants	land plants	Asteraceae	*Minuria integerrima*	smooth minuria		C		1/1
plants	land plants	Asteraceae	*Praxelis clematidea*		Y			1/1
plants	land plants	Asteraceae	*Rutidosis leucantha*			C		1/1
plants	land plants	Asteraceae	*Lagenophora gracilis*			C		2
plants	land plants	Asteraceae	*Peripleura hispidula*			C		2
plants	land plants	Asteraceae	*Pterocaulon redolens*			C		7
plants	land plants	Asteraceae	*Vittadinia pustulata*			C		1/1
plants	land plants	Asteraceae	*Xanthium occidentale*		Y			1
plants	land plants	Asteraceae	*Ageratum houstonianum*	blue billygoat weed	Y			1
plants	land plants	Asteraceae	*Cyanthillium cinereum*			C		16/2
plants	land plants	Asteraceae	*Euchiton involucratus*			C		3
plants	land plants	Asteraceae	*Senecio brigalowensis*			C		1/1
plants	land plants	Bignoniaceae	*Pandorea jasminoides*			C		1
plants	land plants	Bignoniaceae	*Pandorea pandorana*	wonga vine		C		2

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plants	land plants	Bignoniaceae	*Pandorea*			C		1/1
plants	land plants	Boraginaceae	*Ehretia membranifolia*	weeping koda		C		18/2
plants	land plants	Boraginaceae	*Trichodesma zeylanicum*			C		8
plants	land plants	Boraginaceae	*Heliotropium brachygyne*			C		1/1
plants	land plants	Boraginaceae	*Heliotropium tenuifolium*			C		1/1
plants	land plants	Boraginaceae	*Heliotropium*			C		1
plants	land plants	Byttneriaceae	*Waltheria indica*			C		8/1
plants	land plants	Byttneriaceae	*Hannafordia shanesii*			C		1/1
plants	land plants	Cactaceae	*Opuntia stricta*		Y			4
plants	land plants	Cactaceae	*Harrisia martinii*		Y			22
plants	land plants	Cactaceae	*Opuntia tomentosa*	velvety tree pear	Y			20
plants	land plants	Cactaceae	*Opuntia*			C		4
plants	land plants	Caesalpiniaceae	*Lysiphyllum hookeri*	Queensland ebony		C		9
plants	land plants	Caesalpiniaceae	*Senna coronilloides*			C		2/1
plants	land plants	Caesalpiniaceae	*Lysiphyllum carronii*	ebony tree		C		7
plants	land plants	Caesalpiniaceae	*Chamaecrista concinna*			C		2
plants	land plants	Caesalpiniaceae	*Petalostylis labicheoides*			C		1/1
plants	land plants	Caesalpiniaceae	*Chamaecrista absus var. absus*			C		2/2
plants	land plants	Caesalpiniaceae	*Senna artemisioides subsp. zygophylla*			C		1
plants	land plants	Caesalpiniaceae	*Senna*			C		2
plants	land plants	Caesalpiniaceae	*Lysiphyllum*			C		3
plants	land plants	Caesalpiniaceae	*Senna costata*			C		1/1
plants	land plants	Caesalpiniaceae	*Cassia brewsteri*			C		20
plants	land plants	Caesalpiniaceae	*Senna barclayana*			C		4/2
plants	land plants	Caesalpiniaceae	*Cassia tomentella*			C		10
plants	land plants	Caesalpiniaceae	*Chamaecrista absus*			C		5
plants	land plants	Campanulaceae	*Wahlenbergia*			C		1
plants	land plants	Campanulaceae	*Lobelia concolor*			C		1
plants	land plants	Campanulaceae	*Lobelia leucotos*			C		2/1
plants	land plants	Campanulaceae	*Lobelia purpurascens*	white root		C		1
plants	land plants	Campanulaceae	*Wahlenbergia gracilis*	sprawling bluebell		C		8
plants	land plants	Campanulaceae	*Wahlenbergia queenslandica*			C		1/1
plants	land plants	Capparaceae	*Capparis loranthifolia*			C		1
plants	land plants	Capparaceae	*Capparis loranthifolia var. bancroftii*			C		1/1
plants	land plants	Capparaceae	*Capparis shanesiana*			C		1/1
plants	land plants	Capparaceae	*Capparis mitchellii*			C		1
plants	land plants	Capparaceae	*Capparis humistrata*			E		1/1
plants	land plants	Capparaceae	*Apophyllum anomalum*	broom bush		C		8
plants	land plants	Capparaceae	*Capparis*			C		2
plants	land plants	Capparaceae	*Capparis umbonata*			C		1/1
plants	land plants	Capparaceae	*Capparis canescens*			C		5
plants	land plants	Capparaceae	*Capparis lasiantha*	nipan		C		21
plants	land plants	Caryophyllaceae	*Polycarpaea longiflora*			C		5
plants	land plants	Caryophyllaceae	*Polycarpaea corymbosa*			C		2/1
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana subsp. cunninghamiana*			C		6
plants	land plants	Casuarinaceae	*Casuarina cunninghamiana*			C		1

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plants	land plants	Casuarinaceae	*Allocasuarina luehmannii*	bull oak		C		5
plants	land plants	Casuarinaceae	*Casuarina cristata*	belah		C		14
plants	land plants	Celastraceae	*Elaeodendron australe var. australe*			C		1/1
plants	land plants	Celastraceae	*Denhamia disperma*			C		4/1
plants	land plants	Celastraceae	*Denhamia oleaster*			C		2
plants	land plants	Celastraceae	*Denhamia bilocularis*			C		1
plants	land plants	Celastraceae	*Denhamia cunninghamii*			C		13/1
plants	land plants	Celastraceae	*Elaeodendron australe*			C		3
plants	land plants	Centrolepidaceae	*Centrolepis exserta*			C		1/1
plants	land plants	Chenopodiaceae	*Einadia nutans*			C		1/1
plants	land plants	Chenopodiaceae	*Dysphania kalpari*			C		1/1
plants	land plants	Chenopodiaceae	*Salsola australis*			C		5
plants	land plants	Chenopodiaceae	*Rhagodia parabolica*			C		1/1
plants	land plants	Chenopodiaceae	*Einadia polygonoides*	knotweed goosefoot		C		1
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa*			C		16
plants	land plants	Chenopodiaceae	*Dysphania melanocarpa forma melanocarpa*			C		2
plants	land plants	Chenopodiaceae	*Sclerolaena tetracuspis*	brigalow burr		C		1/1
plants	land plants	Chenopodiaceae	*Einadia nutans subsp. linifolia*			C		1/1
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. villosa*			C		3
plants	land plants	Chenopodiaceae	*Sclerolaena muricata var. muricata*			C		3/1
plants	land plants	Chenopodiaceae	*Enchylaena tomentosa var. tomentosa*			C		7/1
plants	land plants	Chenopodiaceae	*Maireana microphylla*			C		5/1
plants	land plants	Cleomaceae	*Cleome viscosa*	tick-weed		C		7/1
plants	land plants	Clusiaceae	*Hypericum gramineum*			C		4/4
plants	land plants	Combretaceae	*Terminalia oblongata subsp. oblongata*			C		4/1
plants	land plants	Combretaceae	*Terminalia oblongata*			C		13
plants	land plants	Commelinaceae	*Commelina ensifolia*	scurvy grass		C		1/1
plants	land plants	Commelinaceae	*Murdannia graminea*	murdannia		C		6/1
plants	land plants	Commelinaceae	*Cyanotis axillaris*			C		7/2
plants	land plants	Commelinaceae	*Commelina diffusa*	wandering jew		C		14
plants	land plants	Commelinaceae	*Commelina*			C		2
plants	land plants	Convolvulaceae	*Polymeria longifolia*	polymeria		C		22
plants	land plants	Convolvulaceae	*Xenostegia tridentata*			C		1/1
plants	land plants	Convolvulaceae	*Convolvulus erubescens*	Australian bindweed		C		1
plants	land plants	Convolvulaceae	*Jacquemontia paniculata*			C		18/2
plants	land plants	Convolvulaceae	*Convolvulus graminetinus*			C		1/1
plants	land plants	Convolvulaceae	*Evolvulus alsinoides var. decumbens*			C		2
plants	land plants	Convolvulaceae	*Jacquemontia paniculata var. tomentosa*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea lonchophylla*			C		31/1
plants	land plants	Convolvulaceae	*Evolvulus alsinoides*			C		19
plants	land plants	Convolvulaceae	*Polymeria pusilla*			C		7
plants	land plants	Convolvulaceae	*Jacquemontia paniculata var. paniculata*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea coptica*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea calobra*			C		1/1
plants	land plants	Convolvulaceae	*Ipomoea brownii*			C		2/1
plants	land plants	Convolvulaceae	*Ipomoea plebeia*	bellvine		C		9

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plants	land plants	Cucurbitaceae	*Cucumis melo*			C		6/1
plants	land plants	Cucurbitaceae	*Cucurbitaceae*			C		1
plants	land plants	Cucurbitaceae	*Cucumis anguria var. anguria*	West Indian gherkin	Y			4
plants	land plants	Cucurbitaceae	*Diplocyclos palmatus*			C		1/1
plants	land plants	Cucurbitaceae	*Cucumis argenteus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus*			C		2
plants	land plants	Cyperaceae	*Cyperus cunninghamii subsp. cunninghamii*			C		1/1
plants	land plants	Cyperaceae	*Cyperus bifax*	western nutgrass		C		3/3
plants	land plants	Cyperaceae	*Gahnia aspera*			C		2/1
plants	land plants	Cyperaceae	*Cyperus fulvus*			C		5/2
plants	land plants	Cyperaceae	*Cyperus betchei*			C		2
plants	land plants	Cyperaceae	*Cyperus distans*			C		2
plants	land plants	Cyperaceae	*Cyperus gilesii*			C		26/1
plants	land plants	Cyperaceae	*Scleria brownii*			C		2/2
plants	land plants	Cyperaceae	*Cyperus flavidus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus gracilis*			C		13/1
plants	land plants	Cyperaceae	*Cyperus rotundus*	nutgrass	Y			1
plants	land plants	Cyperaceae	*Cyperus concinnus*			C		6/2
plants	land plants	Cyperaceae	*Cyperus difformis*	rice sedge		C		3
plants	land plants	Cyperaceae	*Cyperus exaltatus*	tall flatsedge		C		8
plants	land plants	Cyperaceae	*Cyperus javanicus*			C		1/1
plants	land plants	Cyperaceae	*Cyperus scariosus*			C		1
plants	land plants	Cyperaceae	*Fimbristylis nuda*			C		1
plants	land plants	Cyperaceae	*Abildgaardia ovata*			C		5/1
plants	land plants	Cyperaceae	*Cyperus compressus*		Y			1/1
plants	land plants	Cyperaceae	*Cyperus cyperoides*			C		3
plants	land plants	Cyperaceae	*Cyperus esculentus*	yellow nutgrass	Y			1/1
plants	land plants	Cyperaceae	*Cyperus leiocaulon*			C		3/3
plants	land plants	Cyperaceae	*Cyperus rigidellus*			C		10
plants	land plants	Cyperaceae	*Cyperus squarrosus*	bearded flatsedge		C		7
plants	land plants	Cyperaceae	*Scleria sphacelata*			C		4/3
plants	land plants	Cyperaceae	*Cyperus cristulatus*			C		3
plants	land plants	Cyperaceae	*Cyperus isabellinus*			C		2/2
plants	land plants	Cyperaceae	*Cyperus perangustus*			C		1
plants	land plants	Cyperaceae	*Fimbristylis nutans*			C		1
plants	land plants	Cyperaceae	*Cyperus sesquiflorus*		Y			1/1
plants	land plants	Cyperaceae	*Cyperus victoriensis*			C		1/1
plants	land plants	Cyperaceae	*Scleria mackaviensis*			C		14/1
plants	land plants	Cyperaceae	*Cyperus alopecuroides*			C		1/1
plants	land plants	Cyperaceae	*Fimbristylis dichotoma*	common fringe-rush		C		14/1
plants	land plants	Cyperaceae	*Fimbristylis microcarya*			C		1/1
plants	land plants	Cyperaceae	*Fimbristylis sieberiana*			C		1/1
plants	land plants	Cyperaceae	*Lipocarpha microcephala*			C		2
plants	land plants	Cyperaceae	*Eleocharis philippinensis*			C		1/1
plants	land plants	Cyperaceae	*Fimbristylis quinquangularis*			C		1/1
plants	land plants	Cyperaceae	*Schoenoplectiella dissachantha*			C		4/1

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plants	land plants	Cyperaceae	*Cyperus dietrichiae var. dietrichiae*			C		1/1
plants	land plants	Cyperaceae	*Cyperus polystachyos var. polystachyos*			C		1/1
plants	land plants	Cyperaceae	*Cyperus iria*			C		4/2
plants	land plants	Droseraceae	*Drosera*			C		5
plants	land plants	Ebenaceae	*Diospyros humilis*	small-leaved ebony		C		13/2
plants	land plants	Erpodiaceae	*Venturiella hodgkinsoniae*			C		1/1
plants	land plants	Erythroxylaceae	*Erythroxylum australe*	cocaine tree		C		30/2
plants	land plants	Euphorbiaceae	*Ricinus communis*	castor oil bush	Y			1
plants	land plants	Euphorbiaceae	*Acalypha eremorum*	soft acalypha		C		3
plants	land plants	Euphorbiaceae	*Bertya pedicellata*			NT		20/19
plants	land plants	Euphorbiaceae	*Euphorbia tannensis subsp. eremophila*			C		4
plants	land plants	Euphorbiaceae	*Euphorbia biconvexa*			C		1/1
plants	land plants	Euphorbiaceae	*Euphorbia coghlanii*			C		6
plants	land plants	Euphorbiaceae	*Alchornea ilicifolia*	native holly		C		1
plants	land plants	Euphorbiaceae	*Euphorbia drummondii*			C		19
plants	land plants	Euphorbiaceae	*Mallotus philippensis*	red kamala		C		1
plants	land plants	Euphorbiaceae	*Euphorbia hyssopifolia*		Y			9
plants	land plants	Euphorbiaceae	*Excoecaria dallachyana*	scrub poison tree		C		1
plants	land plants	Euphorbiaceae	*Euphorbia sarcostemmoides*	climbing caustic		C		1/1
plants	land plants	Euphorbiaceae	*Adriana tomentosa var. tomentosa*			C		1/1
plants	land plants	Euphorbiaceae	*Croton insularis*	Queensland cascarilla		C		5/3
plants	land plants	Euphorbiaceae	*Euphorbia hirta*		Y			2
plants	land plants	Euphorbiaceae	*Euphorbia*			C		1/1
plants	land plants	Euphorbiaceae	*Croton phebalioides*	narrow-leaved croton		C		7/4
plants	land plants	Fabaceae	*Zornia muelleriana subsp. muelleriana*			C		1/1
plants	land plants	Fabaceae	*Crotalaria mitchellii subsp. mitchellii*			C		2
plants	land plants	Fabaceae	*Macroptilium lathyroides var. semierectum*		Y			3
plants	land plants	Fabaceae	*Tephrosia sp. (Miriam Vale E.J.Thompson+ MIR33)*			C		1/1
plants	land plants	Fabaceae	*Crotalaria novae-hollandiae subsp. novae-hollandiae*			C		1
plants	land plants	Fabaceae	*Tephrosia filipes var. (Mt Blackjack A.R.Bean+ 7332)*			C		2/2
plants	land plants	Fabaceae	*Zornia*			C		1
plants	land plants	Fabaceae	*Glycine*			C		1
plants	land plants	Fabaceae	*Desmodium*			C		1
plants	land plants	Fabaceae	*Tephrosia*			C		1/1
plants	land plants	Fabaceae	*Crotalaria*			C		1
plants	land plants	Fabaceae	*Indigofera*			C		1
plants	land plants	Fabaceae	*Cullen tenax*	emu-foot		C		9
plants	land plants	Fabaceae	*Stylosanthes*			C		1
plants	land plants	Fabaceae	*Hovea longipes*	brush hovea		C		1
plants	land plants	Fabaceae	*Glycine falcata*			C		14
plants	land plants	Fabaceae	*Lotus australis*	Australian trefoil		C		3/3
plants	land plants	Fabaceae	*Glycine tabacina*	glycine pea		C		18
plants	land plants	Fabaceae	*Lablab purpureus*	lablab	Y			1/1
plants	land plants	Fabaceae	*Tephrosia juncea*			C		5
plants	land plants	Fabaceae	*Vigna lanceolata*			C		36

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plants	land plants	Fabaceae	*Canavalia papuana*	wild jack bean		C		1/1
plants	land plants	Fabaceae	*Clitoria ternatea*	butterfly pea	Y			1
plants	land plants	Fabaceae	*Crotalaria juncea*	sunhemp	Y			17/1
plants	land plants	Fabaceae	*Desmodium varians*	slender tick trefoil		C		3
plants	land plants	Fabaceae	*Galactia muelleri*			C		7
plants	land plants	Fabaceae	*Glycine latifolia*			C		3/1
plants	land plants	Fabaceae	*Rhynchosia minima*			C		19
plants	land plants	Fabaceae	*Tephrosia filipes*			C		3
plants	land plants	Fabaceae	*Zornia muriculata*			C		8
plants	land plants	Fabaceae	*Crotalaria montana*			C		8
plants	land plants	Fabaceae	*Glycine tomentella*	woolly glycine		C		12/2
plants	land plants	Fabaceae	*Indigofera colutea*	sticky indigo		C		6
plants	land plants	Fabaceae	*Indigofera hirsuta*	hairy indigo		C		1/1
plants	land plants	Fabaceae	*Indigofera linnaei*	Birdsville indigo		C		7/1
plants	land plants	Fabaceae	*Sesbania cannabina*			C		9
plants	land plants	Fabaceae	*Zornia muelleriana*			C		2
plants	land plants	Fabaceae	*Aeschynomene indica*	budda pea		C		2
plants	land plants	Fabaceae	*Desmodium filiforme*			C		2/2
plants	land plants	Fabaceae	*Desmodium tortuosum*	Florida beggar-weed	Y			1/1
plants	land plants	Fabaceae	*Galactia tenuiflora*			C		4
plants	land plants	Fabaceae	*Stylosanthes hamata*		Y			14/1
plants	land plants	Fabaceae	*Stylosanthes scabra*		Y			23
plants	land plants	Fabaceae	*Tephrosia barbatala*			C		1/1
plants	land plants	Fabaceae	*Alysicarpus muelleri*			C		1/1
plants	land plants	Fabaceae	*Indigofera linifolia*			C		12
plants	land plants	Fabaceae	*Tephrosia leptoclada*			C		3
plants	land plants	Fabaceae	*Desmodium brachypodum*	large ticktrefoil		C		9/1
plants	land plants	Fabaceae	*Desmodium macrocarpum*			C		9/7
plants	land plants	Fabaceae	*Tephrosia dietrichiae*			C		3/1
plants	land plants	Fabaceae	*Tephrosia flagellaris*			C		2/2
plants	land plants	Fabaceae	*Crotalaria medicaginea*	trefoil rattlepod		C		5
plants	land plants	Fabaceae	*Crotalaria dissitiflora*			C		1
plants	land plants	Fabaceae	*Crotalaria sessiliflora*					8
plants	land plants	Fabaceae	*Desmodium campylocaulon*			C		9
plants	land plants	Fabaceae	*Indigofera queenslandica*			C		1/1
plants	land plants	Fabaceae	*Indigofera sericovexilla*			C		2
plants	land plants	Fabaceae	*Macroptilium atropurpureum*	siratro	Y			7
plants	land plants	Fabaceae	*Vigna radiata var. sublobata*			C		8/3
plants	land plants	Fabaceae	*Rhynchosia minima var. minima*			C		18
plants	land plants	Fabaceae	*Crotalaria incana subsp. incana*		Y			1/1
plants	land plants	Fabaceae	*Galactia tenuiflora var. lucida*			C		2/2
plants	land plants	Fabaceae	*Zornia prostrata var. prostrata*			C		1/1
plants	land plants	Fabaceae	*Rhynchosia minima var. australis*			C		12
plants	land plants	Fabaceae	*Sesbania cannabina var. cannabina*			C		4/1
plants	land plants	Fabaceae	*Zornia dyctiocarpa var. filifolia*			C		1/1
plants	land plants	Fabaceae	*Zornia muriculata subsp. angustata*			C		1/1

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plants	land plants	Fabaceae	*Zornia muriculata subsp. muriculata*			C		1/1
plants	land plants	Fabaceae	*Tephrosia brachyodon var. longifolia*			C		2
plants	land plants	Fabaceae	*Indigofera australis subsp. australis*			C		1/1
plants	land plants	Fabroniaceae	*Fabronia australis*			C		1/1
plants	land plants	Frullaniaceae	*Frullania*			C		2/2
plants	land plants	Gentianaceae	*Schenkia australis*			C		1/1
plants	land plants	Goodeniaceae	*Goodenia*			C		2
plants	land plants	Goodeniaceae	*Goodenia glabra*			C		20
plants	land plants	Goodeniaceae	*Goodenia sp. (Mt Castletower M.D.Crisp 2753)*			C		2/2
plants	land plants	Goodeniaceae	*Goodenia gracilis*			C		1/1
plants	land plants	Goodeniaceae	*Brunonia australis*	blue pincushion		C		1
plants	land plants	Goodeniaceae	*Goodenia grandiflora*			C		3/3
plants	land plants	Goodeniaceae	*Goodenia rotundifolia*			C		1
plants	land plants	Goodeniaceae	*Velleia*			C		5
plants	land plants	Goodeniaceae	*Goodenia hirsuta*			C		1/1
plants	land plants	Haloragaceae	*Haloragis aspera*	raspweed		C		1/1
plants	land plants	Haloragaceae	*Haloragis stricta*			C		13
plants	land plants	Hemerocallidaceae	*Dianella longifolia*			C		3
plants	land plants	Hemerocallidaceae	*Dianella nervosa*			C		1
plants	land plants	Hemerocallidaceae	*Dianella*			C		3
plants	land plants	Hypoxidaceae	*Hypoxis pratensis var. pratensis*			C		4
plants	land plants	Hypoxidaceae	*Hypoxis arillacea*			C		2/2
plants	land plants	Johnsoniaceae	*Tricoryne elatior*	yellow autumn lily		C		4
plants	land plants	Johnsoniaceae	*Caesia parviflora var. parviflora*			C		1/1
plants	land plants	Juncaceae	*Juncus usitatus*			C		2
plants	land plants	Juncaceae	*Juncus subglaucus*			C		1/1
plants	land plants	Lamiaceae	*Mentha*			C		1
plants	land plants	Lamiaceae	*Clerodendrum*			C		1
plants	land plants	Lamiaceae	*Plectranthus*			C		2/1
plants	land plants	Lamiaceae	*Teucrium junceum*			C		2/1
plants	land plants	Lamiaceae	*Ocimum tenuiflorum*			C		3
plants	land plants	Lamiaceae	*Prostanthera collina*			C		2/2
plants	land plants	Lamiaceae	*Plectranthus parviflorus*			C		4
plants	land plants	Lamiaceae	*Ocimum caryophyllinum*			C		1/1
plants	land plants	Lamiaceae	*Plectranthus diversus*			C		1/1
plants	land plants	Lamiaceae	*Basilicum polystachyon*			C		7/2
plants	land plants	Lamiaceae	*Teucrium integrifolium*			C		1/1
plants	land plants	Lamiaceae	*Plectranthus graveolens*	flea bush		C		1/1
plants	land plants	Lamiaceae	*Clerodendrum floribundum*			C		8
plants	land plants	Lamiaceae	*Leucas lavandulifolia*		Y			1/1
plants	land plants	Lauraceae	*Cassytha pubescens*	downy devil's twine		C		1
plants	land plants	Lauraceae	*Cassytha filiformis*	dodder laurel		C		1
plants	land plants	Laxmanniaceae	*Laxmannia gracilis*	slender wire lily		C		2/1
plants	land plants	Laxmanniaceae	*Lomandra multiflora subsp. multiflora*			C		1
plants	land plants	Laxmanniaceae	*Lomandra confertifolia subsp. pallida*			C		3
plants	land plants	Laxmanniaceae	*Eustrephus latifolius*	wombat berry		C		11/1

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plants	land plants	Laxmanniaceae	*Lomandra multiflora*			C		5
plants	land plants	Laxmanniaceae	*Lomandra longifolia*			C		8/3
plants	land plants	Laxmanniaceae	*Lomandra filiformis*			C		1
plants	land plants	Lecythidaceae	*Planchonia careya*	cockatoo apple		C		1
plants	land plants	Loganiaceae	*Mitrasacme alsinoides*			C		5
plants	land plants	Loganiaceae	*Mitrasacme pygmaea*			C		9/1
plants	land plants	Loganiaceae	*Mitrasacme*			C		1/1
plants	land plants	Loranthaceae	*Lysiana subfalcata*			C		2/2
plants	land plants	Lythraceae	*Ammannia multiflora*	jerry-jerry		C		3
plants	land plants	Lythraceae	*Lythrum paradoxum*			C		1
plants	land plants	Lythraceae	*Rotala mexicana*			C		1/1
plants	land plants	Malvaceae	*Hibiscus sp. (Emerald S.L.Everist 2124)*			C		1/1
plants	land plants	Malvaceae	*Malvastrum americanum var. americanum*		Y			1
plants	land plants	Malvaceae	*Sida sp. (Charters Towers E.J.THompson+ CHA456)*			C		2/2
plants	land plants	Malvaceae	*Sida sp. (Musselbrook M.B.Thomas+ MRS437)*			C		3
plants	land plants	Malvaceae	*Sida*			C		21
plants	land plants	Malvaceae	*Abutilon*			C		2/1
plants	land plants	Malvaceae	*Sida spinosa*	spiny sida	Y			29/3
plants	land plants	Malvaceae	*Sida rohlenae*			C		7
plants	land plants	Malvaceae	*Sida corrugata*			C		23/1
plants	land plants	Malvaceae	*Abutilon hannii*			C		2
plants	land plants	Malvaceae	*Abutilon nobile*			C		1/1
plants	land plants	Malvaceae	*Sida cordifolia*		Y			21
plants	land plants	Malvaceae	*Sida fibulifera*			C		2/2
plants	land plants	Malvaceae	*Sida trichopoda*			C		18/2
plants	land plants	Malvaceae	*Abutilon fraseri*	dwarf lantern flower		C		1
plants	land plants	Malvaceae	*Hibiscus sturtii*			C		4/2
plants	land plants	Malvaceae	*Hibiscus trionum*					29
plants	land plants	Malvaceae	*Sida atherophora*			C		2/1
plants	land plants	Malvaceae	*Sida everistiana*			C		2/1
plants	land plants	Malvaceae	*Sida hackettiana*			C		11
plants	land plants	Malvaceae	*Sida rhombifolia*		Y			13
plants	land plants	Malvaceae	*Sida cunninghamii*			C		5
plants	land plants	Malvaceae	*Abutilon guineense*		Y			2/2
plants	land plants	Malvaceae	*Gossypium australe*			C		2/2
plants	land plants	Malvaceae	*Hibiscus splendens*	pink hibiscus		C		2/2
plants	land plants	Malvaceae	*Abutilon malvifolium*	bastard marshmallow		C		1
plants	land plants	Malvaceae	*Abutilon subviscosum*			C		1/1
plants	land plants	Malvaceae	*Gossypium sturtianum*			C		2/1
plants	land plants	Malvaceae	*Hibiscus divaricatus*			C		2/2
plants	land plants	Malvaceae	*Hibiscus meraukensis*	Merauke hibiscus		C		2
plants	land plants	Malvaceae	*Hibiscus verdcourtii*			C		1/1
plants	land plants	Malvaceae	*Abelmoschus ficulneus*	native rosella		C		12/1
plants	land plants	Malvaceae	*Abutilon leucopetalum*			C		12
plants	land plants	Malvaceae	*Abutilon micropetalum*			C		2/2
plants	land plants	Malvaceae	*Malvastrum americanum*		Y			37

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plants	land plants	Malvaceae	*Hibiscus heterophyllus*			C		1/1
plants	land plants	Malvaceae	*Hibiscus krichauffianus*			C		1/1
plants	land plants	Malvaceae	*Sida aprica var. aprica*			C		1/1
plants	land plants	Malvaceae	*Hibiscus sturtii var. sturtii*			C		10/2
plants	land plants	Malvaceae	*Sida filiformis - S.macropoda*			C		1
plants	land plants	Malvaceae	*Sida rohlenae subsp. rohlenae*			C		2
plants	land plants	Malvaceae	*Abutilon fraseri subsp. fraseri*			C		2/2
plants	land plants	Malvaceae	*Abutilon oxycarpum var. incanum*			C		1/1
plants	land plants	Malvaceae	*Abutilon oxycarpum var. oxycarpum*			C		1
plants	land plants	Malvaceae	*Malvastrum americanum var. stellatum*			C		2/2
plants	land plants	Malvaceae	*Abutilon oxycarpum var. subsagittatum*			C		16
plants	land plants	Malvaceae	*Sida sp. (Aramac E.J.Thompson+ JER192)*			C		1/1
plants	land plants	Marsileaceae	*Marsilea drummondii*	common nardoo		C		1
plants	land plants	Marsileaceae	*Marsilea mutica*	shiny nardoo		C		3
plants	land plants	Marsileaceae	*Marsilea exarata*	sway-back nardoo		C		1/1
plants	land plants	Meliaceae	*Owenia x reliqua*			C		1/1
plants	land plants	Meliaceae	*Owenia acidula*	emu apple		C		12
plants	land plants	Menispermaceae	*Tinospora smilacina*	snakevine		C		3
plants	land plants	Mimosaceae	*Vachellia farnesiana*		Y			23
plants	land plants	Mimosaceae	*Archidendropsis basaltica*	red lancewood		C		15
plants	land plants	Mimosaceae	*Archidendropsis thozetiana*			C		1
plants	land plants	Mimosaceae	*Acacia blakei subsp. blakei*			C		1/1
plants	land plants	Mimosaceae	*Acacia crassa subsp. crassa*			C		1
plants	land plants	Mimosaceae	*Acacia excelsa subsp. excelsa*			C		2
plants	land plants	Mimosaceae	*Acacia julifera subsp. julifera*			C		1/1
plants	land plants	Mimosaceae	*Neptunia gracilis forma gracilis*			C		34/2
plants	land plants	Mimosaceae	*Acacia leiocalyx subsp. leiocalyx*			C		3
plants	land plants	Mimosaceae	*Acacia julifera subsp. curvinervia*			C		6/6
plants	land plants	Mimosaceae	*Acacia*			C		5/1
plants	land plants	Mimosaceae	*Acacia crassa*			C		1
plants	land plants	Mimosaceae	*Acacia aprepta*	Miles mulga		C		1/1
plants	land plants	Mimosaceae	*Acacia arbiana*			NT		1/1
plants	land plants	Mimosaceae	*Acacia excelsa*			C		9
plants	land plants	Mimosaceae	*Acacia faucium*			C		1/1
plants	land plants	Mimosaceae	*Acacia cambagei*	gidgee		C		1
plants	land plants	Mimosaceae	*Acacia conferta*			C		5/5
plants	land plants	Mimosaceae	*Acacia cowleana*			C		1/1
plants	land plants	Mimosaceae	*Acacia oswaldii*	miljee		C		6/4
plants	land plants	Mimosaceae	*Acacia salicina*	doolan		C		11
plants	land plants	Mimosaceae	*Acacia shirleyi*	lancewood		C		46/2
plants	land plants	Mimosaceae	*Acacia tephrina*			C		1/1
plants	land plants	Mimosaceae	*Acacia amblygona*	fan-leaf wattle		C		2/1
plants	land plants	Mimosaceae	*Acacia fodinalis*			C		3/3
plants	land plants	Mimosaceae	*Acacia leiocalyx*			C		1
plants	land plants	Mimosaceae	*Prosopis pallida*		Y			1/1
plants	land plants	Mimosaceae	*Acacia catenulata*	bendee		C		2

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plants	land plants	Mimosaceae	*Acacia flavescens*	toothed wattle		C		6
plants	land plants	Mimosaceae	*Acacia rhodoxylon*	ringy rosewood		C		18
plants	land plants	Mimosaceae	*Albizia canescens*			C		4/2
plants	land plants	Mimosaceae	*Acacia burdekensis*			C		6/1
plants	land plants	Mimosaceae	*Acacia falciformis*	broad-leaved hickory		C		2
plants	land plants	Mimosaceae	*Acacia harpophylla*	brigalow		C		16
plants	land plants	Mimosaceae	*Acacia holosericea*			C		2
plants	land plants	Mimosaceae	*Acacia sparsiflora*			C		1/1
plants	land plants	Mimosaceae	*Neptunia monosperma*			C		1/1
plants	land plants	Mimosaceae	*Vachellia bidwillii*			C		5/2
plants	land plants	Mimosaceae	*Acacia bancroftiorum*			C		4/4
plants	land plants	Molluginaceae	*Glinus lotoides*	hairy carpet weed		C		2/2
plants	land plants	Moraceae	*Ficus rubiginosa forma rubiginosa*			C		1/1
plants	land plants	Moraceae	*Ficus opposita*			C		5/1
plants	land plants	Moraceae	*Ficus coronata*	creek sandpaper fig		C		1
plants	land plants	Myrsinaceae	*Myrsine variabilis*			C		1/1
plants	land plants	Myrtaceae	*Corymbia tessellaris*	Moreton Bay ash		C		22
plants	land plants	Myrtaceae	*Melaleuca hemisticta*			C		1/1
plants	land plants	Myrtaceae	*Corymbia clarksoniana*			C		40/4
plants	land plants	Myrtaceae	*Eucalyptus cambageana*	Dawson gum		C		8/1
plants	land plants	Myrtaceae	*Eucalyptus persistens*			C		5/4
plants	land plants	Myrtaceae	*Eucalyptus thozetiana*			C		6/5
plants	land plants	Myrtaceae	*Melaleuca fluviatilis*			C		2/2
plants	land plants	Myrtaceae	*Melaleuca leucadendra*	broad-leaved tea-tree		C		2
plants	land plants	Myrtaceae	*Melaleuca viridiflora*			C		2
plants	land plants	Myrtaceae	*Corymbia erythrophloia*	variable-barked bloodwood		C		6/1
plants	land plants	Myrtaceae	*Eucalyptus orgadophila*	mountain coolibah		C		1
plants	land plants	Myrtaceae	*Eucalyptus platyphylla*	poplar gum		C		3
plants	land plants	Myrtaceae	*Eucalyptus raveretiana*	black ironbox		C	V	2/2
plants	land plants	Myrtaceae	*Eucalyptus tholiformis*			C		3/3
plants	land plants	Myrtaceae	*Leptospermum neglectum*			C		3/3
plants	land plants	Myrtaceae	*Thryptomene parviflora*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus melanophloia*			C		1
plants	land plants	Myrtaceae	*Eucalyptus tereticornis*			C		3
plants	land plants	Myrtaceae	*Corymbia intermedia*	pink bloodwood		C		1
plants	land plants	Myrtaceae	*Eucalyptus apothalassica*			C		4
plants	land plants	Myrtaceae	*Eucalyptus camaldulensis*			C		1
plants	land plants	Myrtaceae	*Eucalyptus drepanophylla*			C		2/1
plants	land plants	Myrtaceae	*Lysicarpus angustifolius*	budgeroo		C		2/2
plants	land plants	Myrtaceae	*Corymbia citriodora subsp. citriodora*			C		34
plants	land plants	Myrtaceae	*Eucalyptus camaldulensis subsp. acuta*			C		5
plants	land plants	Myrtaceae	*Eucalyptus crebra x Eucalyptus populnea*			C		5
plants	land plants	Myrtaceae	*Corymbia trachyphloia subsp. trachyphloia*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus crebra x Eucalyptus orgadophila*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus crebra x Eucalyptus melanophloia*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus tereticornis subsp. tereticornis*			C		17

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plants	land plants	Myrtaceae	*Corymbia*			C		3
plants	land plants	Myrtaceae	*Melaleuca*			C		1
plants	land plants	Myrtaceae	*Myrtaceae*			C		2
plants	land plants	Myrtaceae	*Eucalyptus*			C		5
plants	land plants	Myrtaceae	*Corymbia aureola*			C		9/9
plants	land plants	Myrtaceae	*Gossia bidwillii*			C		1/1
plants	land plants	Myrtaceae	*Eucalyptus crebra*	narrow-leaved red ironbark		C		19/4
plants	land plants	Myrtaceae	*Melaleuca nervosa*			C		7/1
plants	land plants	Myrtaceae	*Calytrix tetragona*	fringe myrtle		C		1/1
plants	land plants	Myrtaceae	*Eucalyptus brownii*	Reid River box		C		2
plants	land plants	Myrtaceae	*Eucalyptus exserta*	Queensland peppermint		C		4/2
plants	land plants	Myrtaceae	*Corymbia dallachiana*			C		11
plants	land plants	Myrtaceae	*Melaleuca bracteata*			C		2
plants	land plants	Myrtaceae	*Eucalyptus tenuipes*	narrow-leaved white mahogany		C		1/1
plants	land plants	Myrtaceae	*Eucalyptus populnea*	poplar box		C		54
plants	land plants	Myrtaceae	*Corymbia terminalis*			C		1/1
plants	land plants	Myrtaceae	*Micromyrtus capricornia*			C		1/1
plants	land plants	Nyctaginaceae	*Boerhavia*			C		2
plants	land plants	Nyctaginaceae	*Boerhavia dominii*			C		11
plants	land plants	Nyctaginaceae	*Boerhavia sp. (St George A.Hill AQ399299)*			C		3/3
plants	land plants	Nyctaginaceae	*Boerhavia burbidgeana*			C		1
plants	land plants	Nyctaginaceae	*Boerhavia sp. (Bargara L.Pedley 5382)*			C		1/1
plants	land plants	Nyctaginaceae	*Boerhavia pubescens*			C		1/1
plants	land plants	Oleaceae	*Jasminum simplicifolium subsp. australiense*			C		1/1
plants	land plants	Oleaceae	*Jasminum didymum subsp. lineare*			C		7
plants	land plants	Oleaceae	*Notelaea microcarpa*			C		1
plants	land plants	Oleaceae	*Jasminum didymum*			C		1
plants	land plants	Onagraceae	*Ludwigia*			C		1/1
plants	land plants	Onagraceae	*Ludwigia octovalvis*	willow primrose		C		4
plants	land plants	Orchidaceae	*Cymbidium canaliculatum*			C		8
plants	land plants	Orthotrichaceae	*Macromitrium aurescens*			C		2/2
plants	land plants	Oxalidaceae	*Oxalis radicosa*			C		4/1
plants	land plants	Oxalidaceae	*Oxalis*			C		2
plants	land plants	Passifloraceae	*Passiflora foetida*		Y			1/1
plants	land plants	Phrymaceae	*Glossostigma diandrum*			C		1/1
plants	land plants	Phyllanthaceae	*Breynia oblongifolia*			C		14
plants	land plants	Phyllanthaceae	*Phyllanthus virgatus*			C		30
plants	land plants	Phyllanthaceae	*Bridelia leichhardtii*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus lacerosus*			C		1/1
plants	land plants	Phyllanthaceae	*Notoleptopus decaisnei*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus mitchellii*			C		1
plants	land plants	Phyllanthaceae	*Phyllanthus fuernrohrii*			C		1
plants	land plants	Phyllanthaceae	*Flueggea leucopyrus*			C		2/1
plants	land plants	Phyllanthaceae	*Phyllanthus*			C		2/1
plants	land plants	Phyllanthaceae	*Phyllanthus carpentariae*			C		1/1
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis var. maderaspatensis*			C		5/1

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plants	land plants	Phyllanthaceae	*Phyllanthus sp. (Pentland R.J.Cumming 9742)*			C		2
plants	land plants	Phyllanthaceae	*Phyllanthus maderaspatensis*			C		10/1
plants	land plants	Phyllanthaceae	*Synostemon rhytidospermus*			C		1/1
plants	land plants	Picrodendraceae	*Petalostigma pubescens*	quinine tree		C		23
plants	land plants	Pittosporaceae	*Bursaria incana*			C		11/1
plants	land plants	Pittosporaceae	*Pittosporum spinescens*			C		2/1
plants	land plants	Pittosporaceae	*Bursaria spinosa subsp. spinosa*			C		2
plants	land plants	Pittosporaceae	*Pittosporum angustifolium*			C		5
plants	land plants	Plantaginaceae	*Stemodia pubescens*			C		1/1
plants	land plants	Plantaginaceae	*Scoparia dulcis*	scoparia	Y			7/1
plants	land plants	Poaceae	*Bothriochloa decipiens var. decipiens*			C		11/3
plants	land plants	Poaceae	*Aristida queenslandica var. dissimilis*			C		1
plants	land plants	Poaceae	*Panicum decompositum var. decompositum*			C		25/2
plants	land plants	Poaceae	*Panicum queenslandicum var. acuminatum*			C		2/2
plants	land plants	Poaceae	*Urochloa holosericea subsp. holosericea*			C		3
plants	land plants	Poaceae	*Aristida jerichoensis var. subspinulifera*			C		13/5
plants	land plants	Poaceae	*Bothriochloa decipiens var. cloncurrensis*			C		1
plants	land plants	Poaceae	*Calyptochloa gracillima subsp. gracillima*			C		10/4
plants	land plants	Poaceae	*Panicum queenslandicum var. queenslandicum*			C		2/2
plants	land plants	Poaceae	*Digitaria divaricatissima var. divaricatissima*			C		1/1
plants	land plants	Poaceae	*Eriachne mucronata forma (Alpha C.E.Hubbard 7882)*			C		4/4
plants	land plants	Poaceae	*Heteropogon contortus*	black speargrass		C		47/2
plants	land plants	Poaceae	*Heteropogon triticeus*	giant speargrass		C		5
plants	land plants	Poaceae	*Iseilema membranaceum*	small flinders grass		C		1/1
plants	land plants	Poaceae	*Iseilema vaginiflorum*	red flinders grass		C		34/1
plants	land plants	Poaceae	*Pseudoraphis paradoxa*	slender mudgrass		C		1/1
plants	land plants	Poaceae	*Schizachyrium fragile*	firegrass		C		1/1
plants	land plants	Poaceae	*Sporobolus natalensis*		Y			1/1
plants	land plants	Poaceae	*Alloteropsis semialata*	cockatoo grass		C		7/1
plants	land plants	Poaceae	*Aristida caput-medusae*			C		1
plants	land plants	Poaceae	*Aristida queenslandica*			C		1
plants	land plants	Poaceae	*Arundinella nepalensis*	reedgrass		C		1/1
plants	land plants	Poaceae	*Bothriochloa decipiens*			C		1
plants	land plants	Poaceae	*Bothriochloa ewartiana*	desert bluegrass		C		40/4
plants	land plants	Poaceae	*Brachyachne convergens*	common native couch		C		37/2
plants	land plants	Poaceae	*Chionachne hubbardiana*			C		1/1
plants	land plants	Poaceae	*Cleistochloa subjuncea*			C		1
plants	land plants	Poaceae	*Enneapogon lindleyanus*			C		1
plants	land plants	Poaceae	*Enneapogon polyphyllus*	leafy nineawn		C		2/2
plants	land plants	Poaceae	*Enteropogon acicularis*	curly windmill grass		C		6
plants	land plants	Poaceae	*Enteropogon unispiceus*			C		14/1
plants	land plants	Poaceae	*Moorochloa eruciformis*		Y			9/1
plants	land plants	Poaceae	*Panicum queenslandicum*			C		9
plants	land plants	Poaceae	*Paspalidium criniforme*			C		3/2
plants	land plants	Poaceae	*Paspalidium globoideum*	sago grass		C		23/1
plants	land plants	Poaceae	*Setaria paspalidioides*			C		3/3

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plants	land plants	Poaceae	*Thyridolepis xerophila*			C		1/1
plants	land plants	Poaceae	*Urochloa mosambicensis*	sabi grass	Y			11/1
plants	land plants	Poaceae	*Ancistrachne uncinulata*	hooky grass		C		13/2
plants	land plants	Poaceae	*Dactyloctenium radulans*	button grass		C		7
plants	land plants	Poaceae	*Digitaria hystrichoides*	umbrella grass		C		2/2
plants	land plants	Poaceae	*Eragrostis leptostachya*			C		13/1
plants	land plants	Poaceae	*Eragrostis megalosperma*			C		4/4
plants	land plants	Poaceae	*Paspalidium caespitosum*	brigalow grass		C		12/1
plants	land plants	Poaceae	*Paspalidium constrictum*			C		15/1
plants	land plants	Poaceae	*Sporobolus actinocladus*	katoora grass		C		2/1
plants	land plants	Poaceae	*Capillipedium spicigerum*	spicytop		C		3
plants	land plants	Poaceae	*Cenchrus pennisetiformis*		Y			1/1
plants	land plants	Poaceae	*Paspalidium albovillosum*			C		3/2
plants	land plants	Poaceae	*Sporobolus australasicus*			C		1
plants	land plants	Poaceae	*Thaumastochloa pubescens*			C		1/1
plants	land plants	Poaceae	*Bothriochloa erianthoides*	satintop grass		C		3/1
plants	land plants	Poaceae	*Capillipedium parviflorum*	scented top		C		1/1
plants	land plants	Poaceae	*Cymbopogon queenslandicus*			C		3/2
plants	land plants	Poaceae	*Digitaria divaricatissima*	spreading umbrella grass		C		7/2
plants	land plants	Poaceae	*Thyridolepis mitchelliana*	mulga mitchell grass		C		1
plants	land plants	Poaceae	*Dichanthium queenslandicum*			V	E	8/8
plants	land plants	Poaceae	*Diplachne fusca var. fusca*			C		2/2
plants	land plants	Poaceae	*Eriochloa pseudoacrotricha*			C		37/2
plants	land plants	Poaceae	*Eragrostis longipedicellata*			C		3/3
plants	land plants	Poaceae	*Dinebra panicea var. panicea*		Y			1/1
plants	land plants	Poaceae	*Hyparrhenia rufa subsp. rufa*		Y			3/3
plants	land plants	Poaceae	*Cynodon dactylon var. dactylon*		Y			3
plants	land plants	Poaceae	*Aristida calycina var. calycina*			C		11/1
plants	land plants	Poaceae	*Dinebra decipiens var. asthenes*			C		1
plants	land plants	Poaceae	*Dinebra decipiens var. decipiens*			C		6
plants	land plants	Poaceae	*Dinebra decipiens var. peacockii*			C		1/1
plants	land plants	Poaceae	*Megathyrsus maximus var. maximus*		Y			1
plants	land plants	Poaceae	*Aristida benthamii var. benthamii*			C		4/2
plants	land plants	Poaceae	*Aristida holathera var. holathera*			C		10/4
plants	land plants	Poaceae	*Panicum decompositum var. tenuius*			C		11/1
plants	land plants	Poaceae	*Chloris divaricata var. divaricata*	slender chloris		C		3/1
plants	land plants	Poaceae	*Bothriochloa bladhii subsp. bladhii*			C		7/1
plants	land plants	Poaceae	*Megathyrsus maximus var. pubiglumis*		Y			5
plants	land plants	Poaceae	*Dichanthium sericeum subsp. sericeum*			C		7/4
plants	land plants	Poaceae	*Aristida contorta*	bunched kerosene grass		C		1
plants	land plants	Poaceae	*Astrebla lappacea*	curly mitchell grass		C		10/3
plants	land plants	Poaceae	*Cenchrus ciliaris*		Y			85/1
plants	land plants	Poaceae	*Chloris pectinata*	comb chloris		C		1/1
plants	land plants	Poaceae	*Cymbopogon gratus*			C		1/1
plants	land plants	Poaceae	*Dichanthium tenue*	small bluegrass		C		2
plants	land plants	Poaceae	*Digitaria brownii*			C		14/1

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plants	land plants	Poaceae	*Dinebra decipiens*			C		1
plants	land plants	Poaceae	*Enneapogon virens*			C		3/2
plants	land plants	Poaceae	*Entolasia stricta*	wiry panic		C		2
plants	land plants	Poaceae	*Eriochloa procera*	slender cupgrass		C		4
plants	land plants	Poaceae	*Paspalidium rarum*			C		1/1
plants	land plants	Poaceae	*Phalaris paradoxa*	paradoxa grass	Y			1/1
plants	land plants	Poaceae	*Sorghum halepense*	Johnson grass	Y			1
plants	land plants	Poaceae	*Sporobolus caroli*	fairy grass		C		14
plants	land plants	Poaceae	*Sporobolus creber*			C		15
plants	land plants	Poaceae	*Thellungia advena*	coolibah grass		C		8/4
plants	land plants	Poaceae	*Urochloa piligera*			C		3
plants	land plants	Poaceae	*Urochloa pubigera*			C		8
plants	land plants	Poaceae	*Aristida benthamii*			C		3
plants	land plants	Poaceae	*Aristida holathera*			C		3
plants	land plants	Poaceae	*Enneapogon gracilis*	slender nineawn		C		1/1
plants	land plants	Poaceae	*Enneapogon pallidus*	conetop nineawn		C		7
plants	land plants	Poaceae	*Enteropogon ramosus*			C		6/2
plants	land plants	Poaceae	*Eragrostis elongata*			C		17/2
plants	land plants	Poaceae	*Eragrostis speciosa*			C		2/2
plants	land plants	Poaceae	*Imperata cylindrica*	blady grass		C		1
plants	land plants	Poaceae	*Leptochloa digitata*			C		4/1
plants	land plants	Poaceae	*Megathyrsus maximus*		Y			5
plants	land plants	Poaceae	*Oxychloris scariosa*	winged chloris		C		1/1
plants	land plants	Poaceae	*Panicum larcomianum*			C		1
plants	land plants	Poaceae	*Paspalidium distans*	shotgrass		C		4
plants	land plants	Poaceae	*Paspalidium gracile*	slender panic		C		3/1
plants	land plants	Poaceae	*Sporobolus sessilis*			C		2/1
plants	land plants	Poaceae	*Tragus australianus*	small burr grass		C		4
plants	land plants	Poaceae	*Bothriochloa bladhii*			C		1
plants	land plants	Poaceae	*Bothriochloa pertusa*		Y			33/2
plants	land plants	Poaceae	*Cymbopogon refractus*	barbed-wire grass		C		10
plants	land plants	Poaceae	*Dichanthium fecundum*	curly bluegrass		C		8/4
plants	land plants	Poaceae	*Dichanthium sericeum*			C		36
plants	land plants	Poaceae	*Digitaria lanceolata*			C		1/1
plants	land plants	Poaceae	*Enneapogon nigricans*	niggerheads		C		1
plants	land plants	Poaceae	*Enneapogon truncatus*			C		36
plants	land plants	Poaceae	*Eragrostis lacunaria*	purple lovegrass		C		17/3
plants	land plants	Poaceae	*Eragrostis tenellula*	delicate lovegrass		C		13/1
plants	land plants	Poaceae	*Iseilema macratherum*			C		3/3
plants	land plants	Poaceae	*Panicum decompositum*			C		8
plants	land plants	Poaceae	*Paspalum mandiocanum*		Y			1/1
plants	land plants	Poaceae	*Sporobolus elongatus*			C		1
plants	land plants	Poaceae	*Sporobolus scabridus*			C		3/2
plants	land plants	Poaceae	*Themeda quadrivalvis*	grader grass	Y			1
plants	land plants	Poaceae	*Tripogon loliiformis*	five minute grass		C		3/1
plants	land plants	Poaceae	*Urochloa praetervisa*			C		2

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plants	land plants	Poaceae	*Whiteochloa airoides*			C		2
plants	land plants	Poaceae	*Alloteropsis cimicina*			C		5/2
plants	land plants	Poaceae	*Cymbopogon bombycinus*	silky oilgrass		C		5/1
plants	land plants	Poaceae	*Dichanthium annulatum*	sheda grass	Y			1
plants	land plants	Poaceae	*Dichanthium aristatum*	angleton grass	Y			5/3
plants	land plants	Poaceae	*Dichanthium caricosum*		Y			1/1
plants	land plants	Poaceae	*Digitaria breviglumis*			C		1
plants	land plants	Poaceae	*Elytrophorus spicatus*			C		5/1
plants	land plants	Poaceae	*Eragrostis leptocarpa*	drooping lovegrass		C		5
plants	land plants	Poaceae	*Eragrostis parviflora*	weeping lovegrass		C		8/1
plants	land plants	Poaceae	*Eremochloa bimaculata*	poverty grass		C		2/1
plants	land plants	Poaceae	*Aristida latifolia*	feathertop wiregrass		C		33/4
plants	land plants	Poaceae	*Aristida leptopoda*	white speargrass		C		14/1
plants	land plants	Poaceae	*Aristida personata*			C		6
plants	land plants	Poaceae	*Astrebla elymoides*	hoop mitchell grass		C		6/1
plants	land plants	Poaceae	*Astrebla squarrosa*	bull mitchell grass		C		29/2
plants	land plants	Poaceae	*Chloris divaricata*			C		2/2
plants	land plants	Poaceae	*Chloris ventricosa*	tall chloris		C		12
plants	land plants	Poaceae	*Chrysopogon fallax*			C		26/3
plants	land plants	Poaceae	*Digitaria bicornis*			C		6/1
plants	land plants	Poaceae	*Digitaria ciliaris*	summer grass	Y			2/1
plants	land plants	Poaceae	*Echinochloa colona*	awnless barnyard grass	Y			7/2
plants	land plants	Poaceae	*Eragrostis brownii*	Brown's lovegrass		C		4/2
plants	land plants	Poaceae	*Eragrostis sororia*			C		15/5
plants	land plants	Poaceae	*Eriachne mucronata*			C		2
plants	land plants	Poaceae	*Ophiuros exaltatus*			C		3
plants	land plants	Poaceae	*Paspalum dilatatum*	paspalum	Y			1
plants	land plants	Poaceae	*Triodia mitchellii*	buck spinifex		C		1/1
plants	land plants	Poaceae	*Cymbopogon ambiguus*	lemon grass		C		3/1
plants	land plants	Poaceae	*Cymbopogon obtectus*			C		1/1
plants	land plants	Poaceae	*Digitaria ammophila*	silky umbrella grass		C		17/4
plants	land plants	Poaceae	*Digitaria ramularis*			C		1/1
plants	land plants	Poaceae	*Poaceae*			C		5
plants	land plants	Poaceae	*Setaria*			C		1
plants	land plants	Poaceae	*Aristida*			C		8
plants	land plants	Poaceae	*Astrebla*			C		1
plants	land plants	Poaceae	*Paspalum*			C		1
plants	land plants	Poaceae	*Urochloa*			C		1
plants	land plants	Poaceae	*Enneapogon*			C		1
plants	land plants	Poaceae	*Eragrostis*			C		7
plants	land plants	Poaceae	*Dichanthium*			C		6/6
plants	land plants	Poaceae	*Paspalidium*			C		2
plants	land plants	Poaceae	*Bothriochloa*			C		1
plants	land plants	Poaceae	*Perotis rara*	comet grass		C		3/1
plants	land plants	Poaceae	*Eriachne rara*			C		7/3
plants	land plants	Poaceae	*Eulalia aurea*	silky browntop		C		15/2

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plants	land plants	Poaceae	*Chloris gayana*	rhodes grass	Y			8
plants	land plants	Poaceae	*Melinis repens*	red natal grass	Y			38
plants	land plants	Poaceae	*Sarga plumosum*			C		1/1
plants	land plants	Poaceae	*Aristida ramosa*	purple wiregrass		C		16/2
plants	land plants	Poaceae	*Aristida spuria*			C		1/1
plants	land plants	Poaceae	*Chloris inflata*	purpletop chloris	Y			21
plants	land plants	Poaceae	*Chloris virgata*	feathertop rhodes grass	Y			11
plants	land plants	Poaceae	*Eriachne obtusa*			C		4/1
plants	land plants	Poaceae	*Panicum effusum*			C		21/2
plants	land plants	Poaceae	*Sehima nervosum*			C		1/1
plants	land plants	Poaceae	*Setaria surgens*			C		7/2
plants	land plants	Poaceae	*Aristida ingrata*			C		1/1
plants	land plants	Poaceae	*Aristida lignosa*			C		3/2
plants	land plants	Poaceae	*Chloris truncata*			C		5
plants	land plants	Poaceae	*Cynodon dactylon*		Y			2
plants	land plants	Poaceae	*Digitaria blakei*			C		1/1
plants	land plants	Poaceae	*Digitaria minima*			C		2/1
plants	land plants	Poaceae	*Digitaria orbata*			C		1
plants	land plants	Poaceae	*Eriochloa crebra*	spring grass		C		36/1
plants	land plants	Poaceae	*Sarga leiocladum*			C		1/1
plants	land plants	Poaceae	*Themeda avenacea*			C		3
plants	land plants	Poaceae	*Themeda triandra*	kangaroo grass		C		37/2
plants	land plants	Poaceae	*Triraphis mollis*	purple plumegrass		C		1/1
plants	land plants	Poaceae	*Urochloa foliosa*			C		2/2
plants	land plants	Poaceae	*Urochloa reptans*			C		1
plants	land plants	Poaceae	*Aristida calycina*			C		3
plants	land plants	Polygalaceae	*Polygala pycnantha*			C		1/1
plants	land plants	Polygalaceae	*Polygala crassitesta*			C		14/1
plants	land plants	Polygonaceae	*Persicaria attenuata*			C		1/1
plants	land plants	Polygonaceae	*Rumex hypogaeus*		Y			7
plants	land plants	Polygonaceae	*Fallopia convolvulus*	black bindweed	Y			1
plants	land plants	Pontederiaceae	*Monochoria cyanea*			C		5
plants	land plants	Portulacaceae	*Portulaca filifolia*			C		8
plants	land plants	Portulacaceae	*Portulaca pilosa*		Y			3
plants	land plants	Portulacaceae	*Calandrinia pickeringii*			C		3/1
plants	land plants	Portulacaceae	*Portulaca oleracea*	pigweed	Y			6
plants	land plants	Potamogetonaceae	*Potamogeton tepperi*			C		1/1
plants	land plants	Pottiaceae	*Trichostomum brachydontium*			C		1/1
plants	land plants	Proteaceae	*Hakea lorea subsp. lorea*			C		3
plants	land plants	Proteaceae	*Grevillea pteridifolia*	golden parrot tree		C		2/1
plants	land plants	Proteaceae	*Grevillea juncifolia*	honeysuckle spider flower		C		1
plants	land plants	Proteaceae	*Grevillea parallela*			C		2
plants	land plants	Proteaceae	*Hakea chordophylla*			C		1
plants	land plants	Proteaceae	*Persoonia falcata*			C		5
plants	land plants	Proteaceae	*Persoonia amaliae*			C		3/2
plants	land plants	Proteaceae	*Grevillea striata*	beefwood		C		2

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plants	land plants	Proteaceae	*Grevillea*			C		2
plants	land plants	Pteridaceae	*Cheilanthes nudiuscula*			C		1/1
plants	land plants	Pteridaceae	*Cheilanthes distans*	bristly cloak fern		C		1/1
plants	land plants	Pteridaceae	*Adiantum atroviride*			C		1/1
plants	land plants	Pteridaceae	*Cheilanthes sieberi subsp. sieberi*			C		11/1
plants	land plants	Ptychomitriaceae	*Ptychomitrium australe*			C		1/1
plants	land plants	Putranjivaceae	*Drypetes deplanchei*	grey boxwood		C		1
plants	land plants	Ranunculaceae	*Ranunculus meristus*			C		1/1
plants	land plants	Rhamnaceae	*Ventilago viminalis*	supplejack		C		19/1
plants	land plants	Rhamnaceae	*Alphitonia excelsa*	soap tree		C		20
plants	land plants	Rubiaceae	*Psydrax oleifolia*			C		4
plants	land plants	Rubiaceae	*Pavetta australiensis var. australiensis var. australiensis - Pavetta granitica*			C		1/1
plants	land plants	Rubiaceae	*Oldenlandia mitrasacmoides subsp. trachymenoides*			C		7/1
plants	land plants	Rubiaceae	*Everistia vacciniifolia forma vacciniifolia*			C		2
plants	land plants	Rubiaceae	*Everistia vacciniifolia forma crassa*			C		1/1
plants	land plants	Rubiaceae	*Psydrax odorata subsp. australiana*			C		2/2
plants	land plants	Rubiaceae	*Psydrax odorata forma buxifolia*			C		7
plants	land plants	Rubiaceae	*Psydrax saligna forma saligna*			C		1/1
plants	land plants	Rubiaceae	*Oldenlandia coerulescens*			C		1/1
plants	land plants	Rubiaceae	*Spermacoce multicaulis*			C		15
plants	land plants	Rubiaceae	*Spermacoce brachystema*			C		4/2
plants	land plants	Rubiaceae	*Psydrax odorata*			C		2
plants	land plants	Rubiaceae	*Psydrax forsteri*			C		1/1
plants	land plants	Rubiaceae	*Pavetta granitica*			C		2/2
plants	land plants	Rubiaceae	*Psydrax attenuata*			C		4
plants	land plants	Rubiaceae	*Larsenaikia ochreata*			C		6/3
plants	land plants	Rubiaceae	*Richardia brasiliensis*	white eye	Y			1/1
plants	land plants	Rutaceae	*Citrus glauca*			C		2
plants	land plants	Rutaceae	*Phebalium nottii*	pink phebalium		C		2
plants	land plants	Rutaceae	*Geijera*					1
plants	land plants	Rutaceae	*Phebalium glandulosum subsp. glandulosum*			C		1/1
plants	land plants	Rutaceae	*Murraya ovatifoliolata*			C		2/2
plants	land plants	Rutaceae	*Acronychia laevis*	glossy acronychia		C		1/1
plants	land plants	Rutaceae	*Flindersia australis*	crow's ash		C		2
plants	land plants	Rutaceae	*Geijera salicifolia*	brush wilga		C		16/3
plants	land plants	Rutaceae	*Flindersia maculosa*	leopardwood		C		1
plants	land plants	Rutaceae	*Geijera parviflora*	wilga		C		3
plants	land plants	Rutaceae	*Flindersia dissosperma*			C		20/1
plants	land plants	Santalaceae	*Santalum lanceolatum*			C		6
plants	land plants	Sapindaceae	*Dodonaea lanceolata*			C		2
plants	land plants	Sapindaceae	*Diploglottis macrantha*			C		1
plants	land plants	Sapindaceae	*Dodonaea stenophylla*			C		2/2
plants	land plants	Sapindaceae	*Alectryon oleifolius subsp. elongatus*			C		5
plants	land plants	Sapindaceae	*Cupaniopsis anacardioides*	tuckeroo		C		1/1
plants	land plants	Sapindaceae	*Alectryon diversifolius*	scrub boonaree		C		12/1

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plants	land plants	Sapindaceae	*Atalaya hemiglauca*			C		21
plants	land plants	Sapindaceae	*Alectryon connatus*	grey birds-eye		C		1/1
plants	land plants	Sapindaceae	*Dodonaea viscosa*			C		1
plants	land plants	Sapindaceae	*Atalaya*			C		6
plants	land plants	Sapindaceae	*Dodonaea viscosa subsp. spatulata*			C		1/1
plants	land plants	Sapotaceae	*Planchonella pohlmaniana var. (Gilbert River C.T.White 1409)*			C		1/1
plants	land plants	Sapotaceae	*Planchonella pohlmaniana*			C		2/2
plants	land plants	Scrophulariaceae	*Eremophila debilis*	winter apple		C		9
plants	land plants	Scrophulariaceae	*Myoporum acuminatum*	coastal boobialla		C		8/3
plants	land plants	Scrophulariaceae	*Eremophila deserti*			C		6/1
plants	land plants	Scrophulariaceae	*Eremophila longifolia*	berrigan		C		2/1
plants	land plants	Scrophulariaceae	*Eremophila mitchellii*			C		19
plants	land plants	Scrophulariaceae	*Eremophila bignoniiflora*	eurah		C		1
plants	land plants	Scrophulariaceae	*Eremophila maculata subsp. maculata*			C		1/1
plants	land plants	Solanaceae	*Datura leichhardtii*	native thornapple	Y			1/1
plants	land plants	Solanaceae	*Solanum adenophorum*			E		4/4
plants	land plants	Solanaceae	*Physalis lanceifolia*		Y			2/2
plants	land plants	Solanaceae	*Solanum parvifolium subsp. parvifolium*			C		7/4
plants	land plants	Solanaceae	*Solanum*			C		1
plants	land plants	Solanaceae	*Nicotiana forsteri*			C		1/1
plants	land plants	Solanaceae	*Datura stramonium*	common thornapple	Y			3
plants	land plants	Solanaceae	*Solanum esuriale*	quena		C		9
plants	land plants	Solanaceae	*Solanum opacum*	green berry nightshade		C		1/1
plants	land plants	Solanaceae	*Solanum ellipticum*	potato bush		C		5/1
plants	land plants	Sparrmanniaceae	*Corchorus trilocularis*			C		24/4
plants	land plants	Sparrmanniaceae	*Grewia savannicola*			C		1/1
plants	land plants	Sparrmanniaceae	*Grewia retusifolia*			C		12
plants	land plants	Sparrmanniaceae	*Grewia latifolia*	dysentery plant		C		25/1
plants	land plants	Sparrmanniaceae	*Corchorus aestuans*			C		1/1
plants	land plants	Sterculiaceae	*Brachychiton populneus subsp. trilobus*			C		1/1
plants	land plants	Sterculiaceae	*Brachychiton australis*	broad-leaved bottle tree		C		1
plants	land plants	Sterculiaceae	*Brachychiton rupestris*			C		2
plants	land plants	Stereophyllaceae	*Stereophyllum radiculosum*			C		1/1
plants	land plants	Stylidiaceae	*Stylidium eglandulosum*			C		2/2
plants	land plants	Thymelaeaceae	*Wikstroemia indica*	tie bush		C		1
plants	land plants	Thymelaeaceae	*Pimelea linifolia subsp. linifolia*			C		4/1
plants	land plants	Thymelaeaceae	*Pimelea haematostachya*			C		22/3
plants	land plants	Thymelaeaceae	*Pimelea microcephala*			C		2/1
plants	land plants	Verbenaceae	*Lantana camara*	lantana	Y			2
plants	land plants	Verbenaceae	*Glandularia aristigera*		Y			1
plants	land plants	Verbenaceae	*Verbena macrostachya*			C		1
plants	land plants	Verbenaceae	*Stachytarpheta jamaicensis*	Jamaica snakeweed	Y			1
plants	land plants	Verbenaceae	*Verbena gaudichaudii*			C		1/1
plants	land plants	Violaceae	*Afrohybanthus stellarioides*			C		3
plants	land plants	Violaceae	*Afrohybanthus enneaspermus*			C		13/2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
plants	land plants	Vitaceae	*Clematicissus opaca*			C		1
plants	land plants	Zygophyllaceae	*Tribulus terrestris*	caltrop		C		1
plants	land plants	Zygophyllaceae	*Tribulus eichlerianus*	bull head		C		1
plants	land plants	Zygophyllaceae	*Tribulus micrococcus*	yellow vine		C		1/1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Australian Government
Department of the Environment and Energy

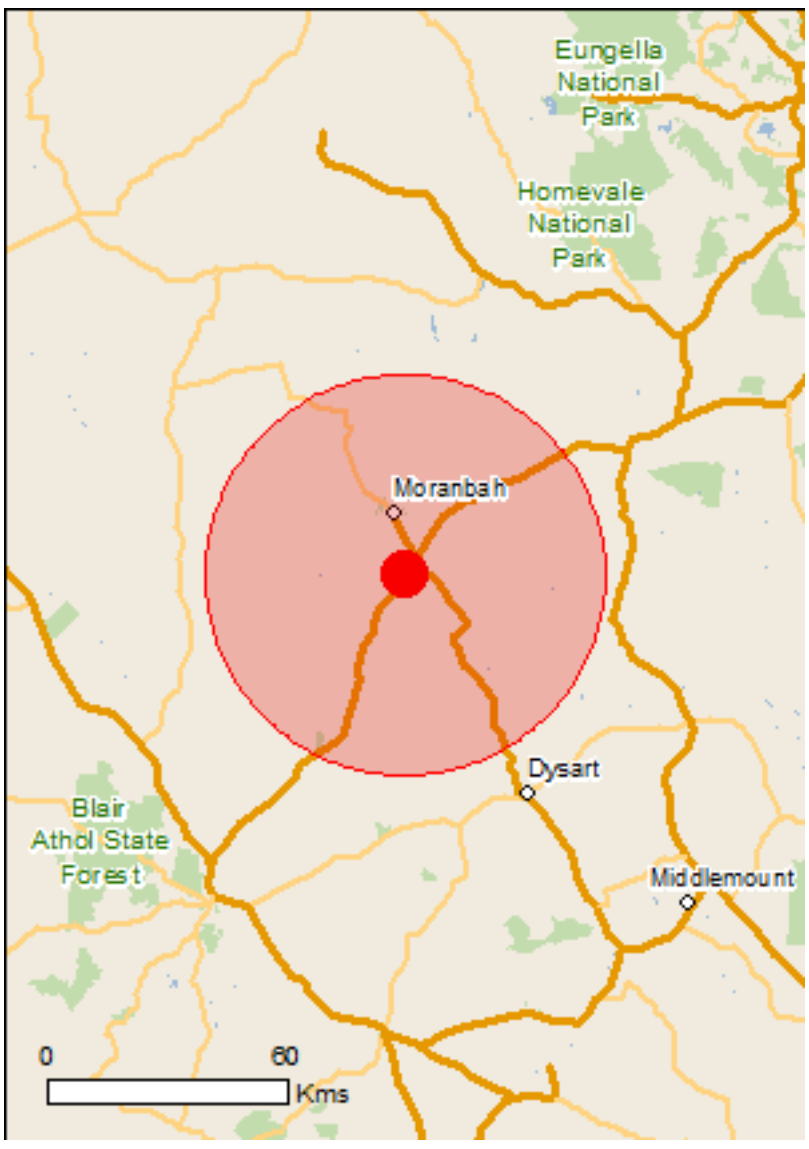
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

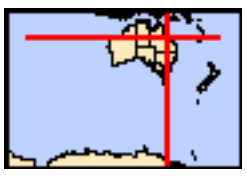
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 08/10/19 09:55:31



Coordinates
Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	26
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	26
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Nyctophilus corbeni		
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Aristida annua		
[17906]	Vulnerable	Species or species habitat likely to occur within area
Cadellia pentastylis		
Ooline [9828]	Vulnerable	Species or species habitat may occur within area
Cycas ophiolitica		
[55797]	Endangered	Species or species habitat likely to occur within area
Dichanthium queenslandicum		
King Blue-grass [5481]	Endangered	Species or species habitat known to occur within area
Dichanthium setosum		
bluegrass [14159]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus raveretiana		
Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area
Samadera bidwillii		
Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area
Elseya albagula		
Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat likely to occur within area
Lerista allanae		
Allan's Lerista, Retro Slider [1378]	Endangered	Species or species habitat likely to occur within area
Rheodytes leukops		
Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Peak Range	QLD

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-22.1343 148.0704

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Attachment B Laboratory Certificates of Analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1933691**	Page	: 1 of 15
Amendment	: **1**		
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: REBECCA KING	Contact	: David Buckley
Address	: Unit 1 / 16 Industry Place, Wynnum, QLD, 4178 PO Box 5815, Manly, QLD, 4179 MANLY NSW, AUSTRALIA 4178	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: 1941 Caval Ridge	Date Samples Received	: 13-Dec-2019 12:30
Order number	: ----	Date Analysis Commenced	: 14-Dec-2019
C-O-C number	: ----	Issue Date	: 14-Jan-2020 16:14
Sampler	: REBECCA KING		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 18		
No. of samples analysed	: 18		

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. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Matt Frost	Assistant Laboratory Manager	Brisbane Organics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by 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.

- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS). However, the difference is within experimental variation of the methods.
- EG005T (Total Metals by ICP-AES): Sample EB1933418-001 shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): Sample CA1 (EB1933691-010) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- Amendment (14/01/2020): This report has been amended following changes to the EB1933691 - 018 (U1-Dam R2) Total Al & Mn results due to a carry-over error. The quality system is being utilised to resolve this issue. All details are recorded in client query 20BNCC026.
- 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: SEDIMENT (Matrix: SOIL)			Client sample ID	LW1	HT1-R1	HT1-R2	CH4	PW1
			Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB1933691-001	EB1933691-002	EB1933691-003	EB1933691-004	EB1933691-005
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	20.9	30.1	39.8	<1.0	1.6
EA150: Particle Sizing								
+75µm	----	1	%	91	24	22	99	12
+150µm	----	1	%	90	20	18	98	3
+300µm	----	1	%	79	16	10	85	2
+425µm	----	1	%	63	13	8	53	2
+600µm	----	1	%	46	11	6	21	1
+1180µm	----	1	%	25	8	3	2	<1
+2.36mm	----	1	%	13	4	<1	<1	<1
+4.75mm	----	1	%	8	<1	<1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	9	76	78	1	88
Sand (>75 µm)	----	1	%	74	19	22	98	11
Gravel (>2mm)	----	1	%	17	5	1	1	1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	2040	7360	8500	740	5100
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	30	220	240	10	130
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	11	21	22	3	14
Cobalt	7440-48-4	2	mg/kg	4	18	19	<2	8
Copper	7440-50-8	5	mg/kg	<5	16	18	<5	14
Iron	7439-89-6	50	mg/kg	6330	22700	26800	3390	11700
Lead	7439-92-1	5	mg/kg	<5	9	10	<5	13
Manganese	7439-96-5	5	mg/kg	53	422	531	48	268
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	8	31	34	<2	13

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	LW1	HT1-R1	HT1-R2	CH4	PW1
				Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933691-001	EB1933691-002	EB1933691-003	EB1933691-004	EB1933691-005
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		**12**	**34**	**36**	**5**	**27**
Zinc	7440-66-6	5	mg/kg		**8**	**30**	**36**	**5**	**36**
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		<0.1	**0.3**	**0.3**	<0.1	**0.5**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.25**	**0.73**	**0.91**	**0.10**	**1.74**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	----	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	----	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	----	<100	**100**
C29 - C36 Fraction	----	100	mg/kg		<100	<100	----	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	----	<50	**100**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	----	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	----	<10	<10
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	----	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	----	<100	**130**
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	----	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	<50	----	<50	**130**
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	----	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	----	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	----	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	----	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	----	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	----	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg		<0.2	<0.2	----	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg		<0.5	<0.5	----	<0.5	<0.5

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)				Client sample ID	**LW1**	**HT1-R1**	**HT1-R2**	**CH4**	**PW1**
				Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1933691-001**	**EB1933691-002**	**EB1933691-003**	**EB1933691-004**	**EB1933691-005**
					Result	Result	Result	Result	Result
EP080: BTEXN - Continued									
Naphthalene	91-20-3	1	mg/kg		<1	<1	----	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**92.4**	**103**	----	**123**	**120**
Toluene-D8	2037-26-5	0.2	%		**88.2**	**86.2**	----	**94.1**	**105**
4-Bromofluorobenzene	460-00-4	0.2	%		**91.6**	**90.4**	----	**101**	**108**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	G1	U1 Dam	U2	H1	CA1
			Client sampling date / time	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB1933691-006	EB1933691-007	EB1933691-008	EB1933691-009	EB1933691-010
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	37.8	<1.0	<1.0	1.7
EA150: Particle Sizing								
+75µm	----	1	%	92	44	89	91	84
+150µm	----	1	%	88	31	74	90	76
+300µm	----	1	%	82	18	38	81	54
+425µm	----	1	%	75	14	18	74	33
+600µm	----	1	%	60	11	8	68	18
+1180µm	----	1	%	24	7	3	57	6
+2.36mm	----	1	%	7	3	1	40	2
+4.75mm	----	1	%	2	2	<1	17	1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	8	56	11	9	16
Sand (>75 µm)	----	1	%	80	40	87	46	81
Gravel (>2mm)	----	1	%	12	4	2	45	3
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	1360	4910	870	4250	1320
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	40	80	20	150	60
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	23	107	15	107	9
Cobalt	7440-48-4	2	mg/kg	6	20	12	19	8
Copper	7440-50-8	5	mg/kg	<5	12	<5	11	<5
Iron	7439-89-6	50	mg/kg	14300	51300	9160	46500	5840
Lead	7439-92-1	5	mg/kg	<5	5	<5	10	5
Manganese	7439-96-5	5	mg/kg	131	447	165	506	309
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	12	29	7	39	8

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	G1	U1 Dam	U2	H1	CA1
				Client sampling date / time	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933691-006	EB1933691-007	EB1933691-008	EB1933691-009	EB1933691-010
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		**24**	**67**	**14**	**63**	**12**
Zinc	7440-66-6	5	mg/kg		**8**	**26**	**6**	**25**	**7**
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	7440-61-1	0.1	mg/kg		**0.1**	**0.4**	<0.1	**0.3**	<0.1
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.07**	**1.82**	**0.35**	**0.16**	**0.25**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	**200**	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	**200**	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	**220**	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	**100**	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	**320**	<50	<50	<50
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)				Client sample ID	G1	U1 Dam	U2	H1	CA1
				Client sampling date / time	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1933691-006**	**EB1933691-007**	**EB1933691-008**	**EB1933691-009**	**EB1933691-010**
					Result	Result	Result	Result	Result
EP080: BTEXN - Continued									
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**113**	**71.4**	**89.6**	**86.4**	**88.2**
Toluene-D8	2037-26-5	0.2	%		**100**	**63.0**	**80.9**	**81.1**	**81.6**
4-Bromofluorobenzene	460-00-4	0.2	%		**107**	**69.3**	**87.4**	**86.3**	**88.9**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	CH1	CH2	CH3	----	----
			Client sampling date / time	12-Dec-2019 00:00	11-Dec-2019 00:00	12-Dec-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EB1933691-011	EB1933691-012	EB1933691-013	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	<1.0	<1.0	<1.0	----	----
EA150: Particle Sizing								
+75µm	----	1	%	89	40	98	----	----
+150µm	----	1	%	79	38	95	----	----
+300µm	----	1	%	46	35	67	----	----
+425µm	----	1	%	24	24	42	----	----
+600µm	----	1	%	12	12	24	----	----
+1180µm	----	1	%	5	3	7	----	----
+2.36mm	----	1	%	<1	1	<1	----	----
+4.75mm	----	1	%	<1	<1	<1	----	----
+9.5mm	----	1	%	<1	<1	<1	----	----
+19.0mm	----	1	%	<1	<1	<1	----	----
+37.5mm	----	1	%	<1	<1	<1	----	----
+75.0mm	----	1	%	<1	<1	<1	----	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	11	60	2	----	----
Sand (>75 µm)	----	1	%	87	38	96	----	----
Gravel (>2mm)	----	1	%	2	2	2	----	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	810	3210	520	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	----	----
Barium	7440-39-3	10	mg/kg	20	100	10	----	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	4	9	4	----	----
Cobalt	7440-48-4	2	mg/kg	<2	6	<2	----	----
Copper	7440-50-8	5	mg/kg	<5	7	<5	----	----
Iron	7439-89-6	50	mg/kg	4900	12900	3790	----	----
Lead	7439-92-1	5	mg/kg	<5	8	<5	----	----
Manganese	7439-96-5	5	mg/kg	38	158	33	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	----	----
Nickel	7440-02-0	2	mg/kg	2	12	<2	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	CH1	CH2	CH3	----	----
			Client sampling date / time	12-Dec-2019 00:00	11-Dec-2019 00:00	12-Dec-2019 00:00	----	----
Compound	CAS Number	LOR	Unit	EB1933691-011	EB1933691-012	EB1933691-013	--------	--------
				Result	Result	Result	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued								
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	----	----
Vanadium	7440-62-2	5	mg/kg	**6**	**15**	**6**	----	----
Zinc	7440-66-6	5	mg/kg	**8**	**21**	<5	----	----
EG020T: Total Metals by ICP-MS								
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Uranium	7440-61-1	0.1	mg/kg	<0.1	**0.3**	<0.1	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	**0.33**	**0.92**	**0.05**	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	----	----
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	----	----
C15 - C28 Fraction	----	100	mg/kg	<100	<100	<100	----	----
C29 - C36 Fraction	----	100	mg/kg	<100	<100	<100	----	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	<10	<10	----	----
>C10 - C16 Fraction	----	50	mg/kg	<50	<50	<50	----	----
>C16 - C34 Fraction	----	100	mg/kg	<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	mg/kg	<100	<100	<100	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg	<50	<50	<50	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg	<50	<50	<50	----	----
EP080: BTEXN								
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
^ **Sum of BTEX**	----	0.2	mg/kg	<0.2	<0.2	<0.2	----	----
^ **Total Xylenes**	----	0.5	mg/kg	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)				Client sample ID	**CH1**	**CH2**	**CH3**	**----**	**----**
				Client sampling date / time	12-Dec-2019 00:00	11-Dec-2019 00:00	12-Dec-2019 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB1933691-011**	**EB1933691-012**	**EB1933691-013**	**--------**	**--------**
					Result	Result	Result	----	----
EP080: BTEXN - Continued									
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	**----**	**----**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**114**	**114**	**109**	**----**	**----**
Toluene-D8	2037-26-5	0.2	%		**91.2**	**101**	**99.1**	**----**	**----**
4-Bromofluorobenzene	460-00-4	0.2	%		**102**	**105**	**104**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	LW1	HT1-R1	HT1-R2	U1-Dam R1	U1-Dam R2
			Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	CAS Number	LOR	Unit	EB1933691-014	EB1933691-015	EB1933691-016	EB1933691-017	EB1933691-018
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	317	289	293	994	<10
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	33	30	384	<5
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	99	145	145	236	<1
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	9	4	4	11	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	15	25	25	32	<1
Magnesium	7439-95-4	1	mg/L	15	20	20	38	<1
Sodium	7440-23-5	1	mg/L	78	47	47	216	<1
Potassium	7440-09-7	1	mg/L	9	9	9	44	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.002	0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.002	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.003	<0.001
Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.002	0.009	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L	<0.001	0.024	0.023	0.467	<0.001
Molybdenum	7439-98-7	0.001	mg/L	0.002	0.002	0.002	0.002	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L	0.17	0.14	0.14	0.37	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.38	0.80	0.78	2.21	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.002	0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.001	0.005	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LW1	HT1-R1	HT1-R2	U1-Dam R1	U1-Dam R2
				Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933691-014	EB1933691-015	EB1933691-016	EB1933691-017	EB1933691-018
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.002**	**0.002**	**0.003**	<0.001
Cobalt	7440-48-4	0.001	mg/L		**0.001**	**0.001**	**0.001**	**0.006**	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.003**	**0.004**	**0.004**	**0.012**	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	**0.008**	<0.005
Manganese	7439-96-5	0.001	mg/L		**0.018**	**0.363**	**0.380**	**0.856**	<0.001
Molybdenum	7439-98-7	0.001	mg/L		**0.002**	**0.002**	**0.002**	**0.002**	<0.001
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		**0.13**	**0.11**	**0.11**	**0.31**	<0.05
Iron	7439-89-6	0.05	mg/L		**0.31**	**1.00**	**1.03**	**3.64**	<0.05
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.7**	**0.7**	**0.7**	**0.8**	<0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.01**	**0.12**	**0.05**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.8**	**1.1**	**1.0**	**3.9**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LW1	HT1-R1	HT1-R2	U1-Dam R1	U1-Dam R2
				Client sampling date / time	09-Dec-2019 00:00	10-Dec-2019 00:00	10-Dec-2019 00:00	11-Dec-2019 00:00	11-Dec-2019 00:00
Compound	CAS Number	LOR	Unit		EB1933691-014	EB1933691-015	EB1933691-016	EB1933691-017	EB1933691-018
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**0.8**	**1.1**	**1.0**	**3.9**	<0.1
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	**0.06**	**0.06**	**0.33**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.05**	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	**230**	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	**60**	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	**290**	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	**270**	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	**270**	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	**4**
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	**4**
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**98.3**	**107**	**99.4**	**97.2**	**96.6**
Toluene-D8	2037-26-5	2	%		**95.6**	**98.1**	**94.8**	**95.0**	**100**
4-Bromofluorobenzene	460-00-4	2	%		**102**	**108**	**104**	**104**	**107**

Surrogate Control Limits

Sub-Matrix: **SEDIMENT**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2009561**	Page	: 1 of 21
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: REBECCA KING	Contact	: David Buckley
Address	: Unit 1 / 16 Industry Place, Wynnum, QLD, 4178 PO Box 5815, Manly, QLD, 4179 MANLY NSW, AUSTRALIA 4178	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61 7 3552 8659
Project	: 1941 Caval Ridge	Date Samples Received	: 06-Apr-2020 14:10
Order number	: ----	Date Analysis Commenced	: 07-Apr-2020
C-O-C number	: ----	Issue Date	: 24-Apr-2020 08:16
Sampler	: REBECCA KING		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 24		
No. of samples analysed	: 24		

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. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Morgan Lennox		Brisbane Organics, Stafford, QLD
Santusha Pandra	Senior Chemist	Brisbane Inorganics, Stafford, QLD

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.

- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- It is recognised that EG020T (Total Metals) is less than EG020F (Dissolved Metals) for some samples. However, the difference is within experimental variation of the methods.
- 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: SOIL (Matrix: SOIL)			Client sample ID	G1	G1 R2	LW1	CH3	CH4
			Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit	EB2009561-012	EB2009561-013	EB2009561-014	EB2009561-015	EB2009561-016
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	18.6	17.7	35.3	20.0	19.8
EA150: Particle Sizing								
+75µm	----	1	%	62	94	46	97	98
+150µm	----	1	%	57	92	39	94	93
+300µm	----	1	%	52	84	25	87	37
+425µm	----	1	%	40	62	17	71	17
+600µm	----	1	%	29	33	12	41	7
+1180µm	----	1	%	14	10	7	9	<1
+2.36mm	----	1	%	6	3	5	2	<1
+4.75mm	----	1	%	4	2	2	<1	<1
+9.5mm	----	1	%	2	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	38	6	54	3	2
Sand (>75 µm)	----	1	%	53	88	42	93	98
Gravel (>2mm)	----	1	%	9	5	5	4	<1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	2260	1240	9030	600	680
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	70	30	190	10	10
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	16	17	31	3	3
Cobalt	7440-48-4	2	mg/kg	7	4	17	<2	<2
Copper	7440-50-8	5	mg/kg	<5	<5	18	<5	<5
Iron	7439-89-6	50	mg/kg	8670	6270	19300	2810	3120
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Manganese	7439-96-5	5	mg/kg	167	103	322	43	39
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	10	7	29	<2	2

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	G1	G1 R2	LW1	CH3	CH4
				Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-012	EB2009561-013	EB2009561-014	EB2009561-015	EB2009561-016
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		**22**	**16**	**46**	<5	<5
Zinc	7440-66-6	5	mg/kg		**7**	<5	**18**	<5	<5
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.64**	**0.08**	**2.30**	**0.05**	**0.07**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**91.8**	**90.2**	**69.8**	**81.6**	**83.9**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	G1	G1 R2	LW1	CH3	CH4
				Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-012	EB2009561-013	EB2009561-014	EB2009561-015	EB2009561-016
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	0.2	%		**98.5**	**95.9**	**72.6**	**81.6**	**82.3**
4-Bromofluorobenzene	460-00-4	0.2	%		**119**	**114**	**93.4**	**98.6**	**102**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	HT1	U1 Dam	CH1	H1	CA1
			Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00
Compound	CAS Number	LOR	Unit	EB2009561-017	EB2009561-018	EB2009561-019	EB2009561-020	EB2009561-021
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	29.2	30.6	20.8	3.8	19.9
EA150: Particle Sizing								
+75µm	----	1	%	32	56	96	75	89
+150µm	----	1	%	28	43	92	72	84
+300µm	----	1	%	20	29	57	64	63
+425µm	----	1	%	16	23	26	54	41
+600µm	----	1	%	14	19	9	43	21
+1180µm	----	1	%	10	12	3	22	4
+2.36mm	----	1	%	6	5	<1	9	<1
+4.75mm	----	1	%	3	1	<1	<1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	68	44	4	25	11
Sand (>75 µm)	----	1	%	25	49	95	62	88
Gravel (>2mm)	----	1	%	7	7	1	13	1
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	7350	3820	550	6420	1800
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg	320	60	10	220	50
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	20	64	3	42	8
Cobalt	7440-48-4	2	mg/kg	17	9	<2	29	5
Copper	7440-50-8	5	mg/kg	16	17	<5	15	<5
Iron	7439-89-6	50	mg/kg	20100	26400	3170	30700	5760
Lead	7439-92-1	5	mg/kg	11	<5	<5	7	<5
Manganese	7439-96-5	5	mg/kg	543	171	18	941	224
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg	25	17	<2	49	11

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	HT1	U1 Dam	CH1	H1	CA1
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-017	EB2009561-018	EB2009561-019	EB2009561-020	EB2009561-021
					Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		**32**	**44**	<5	**40**	**11**
Zinc	7440-66-6	5	mg/kg		**22**	**30**	<5	**25**	**7**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.39**	**2.52**	**0.09**	**0.26**	**0.20**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	<10	<10
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg		<10	<10	<10	<10	<10
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	<50	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	<50	<50	<50	<50
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	<50	<50	<50
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of BTEX	----	0.2	mg/kg		<0.2	<0.2	<0.2	<0.2	<0.2
^ Total Xylenes	----	0.5	mg/kg		<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	<1	<1
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**82.9**	**84.2**	**87.0**	**98.4**	**89.2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	HT1	U1 Dam	CH1	H1	CA1
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-017	EB2009561-018	EB2009561-019	EB2009561-020	EB2009561-021
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	0.2	%		**89.5**	**84.2**	**86.7**	**104**	**93.9**
4-Bromofluorobenzene	460-00-4	0.2	%		**107**	**104**	**105**	**119**	**112**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	CH2	U2	U1	----	----
			Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	EB2009561-022	EB2009561-023	EB2009561-024	--------	--------
				Result	Result	Result	----	----
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	1.0	%	22.6	<1.0	4.7	----	----
EA150: Particle Sizing								
+75µm	----	1	%	63	98	35	----	----
+150µm	----	1	%	32	94	31	----	----
+300µm	----	1	%	10	65	26	----	----
+425µm	----	1	%	6	37	22	----	----
+600µm	----	1	%	4	16	18	----	----
+1180µm	----	1	%	<1	4	10	----	----
+2.36mm	----	1	%	<1	<1	4	----	----
+4.75mm	----	1	%	<1	<1	<1	----	----
+9.5mm	----	1	%	<1	<1	<1	----	----
+19.0mm	----	1	%	<1	<1	<1	----	----
+37.5mm	----	1	%	<1	<1	<1	----	----
+75.0mm	----	1	%	<1	<1	<1	----	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	37	2	65	----	----
Sand (>75 µm)	----	1	%	63	96	29	----	----
Gravel (>2mm)	----	1	%	<1	2	6	----	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	2390	470	7030	----	----
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	----	----
Barium	7440-39-3	10	mg/kg	70	10	350	----	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	1	----	----
Boron	7440-42-8	50	mg/kg	<50	<50	<50	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	7	6	82	----	----
Cobalt	7440-48-4	2	mg/kg	4	2	57	----	----
Copper	7440-50-8	5	mg/kg	6	<5	16	----	----
Iron	7439-89-6	50	mg/kg	7560	3300	38000	----	----
Lead	7439-92-1	5	mg/kg	6	<5	<5	----	----
Manganese	7439-96-5	5	mg/kg	106	31	1370	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	----	----
Nickel	7440-02-0	2	mg/kg	8	<2	52	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	CH2	U2	U1	----	----
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EB2009561-022	EB2009561-023	EB2009561-024	--------	--------
					Result	Result	Result	----	----
EG005(ED093)T: Total Metals by ICP-AES - Continued									
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	----	----
Vanadium	7440-62-2	5	mg/kg		**12**	**7**	**55**	----	----
Zinc	7440-66-6	5	mg/kg		**12**	<5	**29**	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	----	----
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		**0.60**	**0.08**	**0.93**	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	----	----
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	----	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	<10	<10	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg		<10	<10	<10	----	----
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<50	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<50	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	<0.2	<0.2	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	<0.2	<0.2	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	<0.5	<0.5	----	----
Naphthalene	91-20-3	1	mg/kg		<1	<1	<1	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**79.7**	**95.2**	**91.0**	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	CH2	U2	U1	----	----
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	----	----
Compound	CAS Number	LOR	Unit		EB2009561-022	EB2009561-023	EB2009561-024	--------	--------
					Result	Result	Result	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	0.2	%		**87.6**	**102**	**102**	**----**	**----**
4-Bromofluorobenzene	460-00-4	0.2	%		**106**	**120**	**122**	**----**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	G1	G1 R2	LW1	CH3	CH4
				Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-001	EB2009561-002	EB2009561-003	EB2009561-004	EB2009561-005
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		207	201	227	280	271
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		21	12	30	6	32
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		54	52	86	140	143
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		4	3	5	14	24
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		10	11	18	33	31
Magnesium	7439-95-4	1	mg/L		7	6	10	14	16
Sodium	7440-23-5	1	mg/L		22	20	35	38	38
Potassium	7440-09-7	1	mg/L		6	5	6	10	21
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.07	0.09	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	0.001	0.001	0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.004	0.003	0.002	<0.001	0.002
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		0.003	0.003	0.005	0.001	0.002
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		0.004	0.007	<0.001	0.007	0.010
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	0.001	0.002
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		<0.05	0.06	0.08	0.09	0.09
Iron	7439-89-6	0.05	mg/L		0.13	0.16	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		2.56	2.32	0.67	0.20	0.52
Arsenic	7440-38-2	0.001	mg/L		0.001	<0.001	0.002	0.001	0.002
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		0.007	0.006	0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	G1	G1 R2	LW1	CH3	CH4
				Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-001	EB2009561-002	EB2009561-003	EB2009561-004	EB2009561-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.005**	**0.004**	**0.002**	**0.002**	**0.002**
Cobalt	7440-48-4	0.001	mg/L		**0.002**	**0.001**	**0.001**	<0.001	**0.001**
Nickel	7440-02-0	0.001	mg/L		**0.007**	**0.006**	**0.006**	**0.001**	**0.003**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.006**	**0.008**	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		**0.040**	**0.035**	**0.082**	**0.013**	**0.093**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.002**	**0.001**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**3.40**	**3.29**	**1.20**	**0.15**	**0.62**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		**0.01**	<0.01	<0.01	<0.01	<0.01
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	<0.1	**0.3**	**0.3**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.01**	<0.01	**0.02**	**0.02**	**0.26**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	**0.06**	<0.01	**0.04**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.06**	<0.01	**0.04**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.1**	**0.8**	**0.8**	**0.5**	**2.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	G1	G1 R2	LW1	CH3	CH4
				Client sampling date / time	31-Mar-2020 00:00	31-Mar-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00	01-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-001	EB2009561-002	EB2009561-003	EB2009561-004	EB2009561-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		**1.1**	**0.8**	**0.9**	**0.5**	**2.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.13**	**0.06**	**0.08**	**0.03**	**0.09**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**85.4**	**86.7**	**90.2**	**90.4**	**90.2**
Toluene-D8	2037-26-5	2	%		**101**	**102**	**102**	**101**	**101**
4-Bromofluorobenzene	460-00-4	2	%		**116**	**118**	**114**	**114**	**115**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	HT1	U1 Dam	CH1	CA1	CH2
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	03-Apr-2020 00:00	03-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-006	EB2009561-007	EB2009561-008	EB2009561-009	EB2009561-010
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		207	262	260	4980	297
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		17	18	17	39	33
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		99	102	144	1060	106
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		3	2	17	1260	9
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		20	18	38	247	26
Magnesium	7439-95-4	1	mg/L		12	14	12	109	10
Sodium	7440-23-5	1	mg/L		34	54	30	1220	26
Potassium	7440-09-7	1	mg/L		6	16	10	18	9
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.06
Arsenic	7440-38-2	0.001	mg/L		0.001	0.001	<0.001	<0.001	0.002
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.001	0.001	0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	0.002	<0.001	0.007	<0.001
Nickel	7440-02-0	0.001	mg/L		0.002	0.005	0.002	0.020	0.003
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		<0.001	0.126	0.006	0.133	0.114
Molybdenum	7439-98-7	0.001	mg/L		0.001	<0.001	<0.001	0.054	0.002
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	0.011	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		0.10	0.15	0.09	0.16	0.06
Iron	7439-89-6	0.05	mg/L		<0.05	0.23	<0.05	<0.05	0.31
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.59	0.28	0.76	1.08	3.07
Arsenic	7440-38-2	0.001	mg/L		0.001	<0.001	0.001	0.001	0.004
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	0.001	0.002	0.004

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	HT1	U1 Dam	CH1	CA1	CH2
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	03-Apr-2020 00:00	03-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-006	EB2009561-007	EB2009561-008	EB2009561-009	EB2009561-010
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	**0.002**	**0.001**	**0.002**
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.002**	**0.001**	**0.008**	**0.003**
Nickel	7440-02-0	0.001	mg/L		**0.003**	**0.005**	**0.003**	**0.023**	**0.007**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.003**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	**0.01**	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.009**	**0.007**	**0.010**
Manganese	7439-96-5	0.001	mg/L		**0.156**	**0.187**	**0.070**	**0.144**	**0.209**
Molybdenum	7439-98-7	0.001	mg/L		**0.001**	<0.001	<0.001	**0.065**	**0.001**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	**0.012**	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Boron	7440-42-8	0.05	mg/L		**0.07**	**0.09**	**0.05**	**0.14**	**0.06**
Iron	7439-89-6	0.05	mg/L		**0.76**	**1.55**	**1.10**	**1.31**	**5.38**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	**0.01**	<0.01
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	<0.01	<0.01	**0.03**	<0.01
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**0.2**	**0.2**	**0.2**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.01**	**0.02**	<0.01	**0.26**	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	**0.34**	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	**9.29**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	**9.63**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.6**	**1.2**	**0.5**	**1.1**	**1.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	HT1	U1 Dam	CH1	CA1	CH2
				Client sampling date / time	02-Apr-2020 00:00	02-Apr-2020 00:00	02-Apr-2020 00:00	03-Apr-2020 00:00	03-Apr-2020 00:00
Compound	CAS Number	LOR	Unit		EB2009561-006	EB2009561-007	EB2009561-008	EB2009561-009	EB2009561-010
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.6**	**1.2**	**0.5**	**10.7**	**1.3**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	**0.08**	**0.03**	**0.04**	**0.13**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**88.8**	**91.0**	**89.7**	**90.7**	**92.1**
Toluene-D8	2037-26-5	2	%		**102**	**101**	**101**	**102**	**102**
4-Bromofluorobenzene	460-00-4	2	%		**118**	**116**	**117**	**120**	**117**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CH2 R2	----	----	----	----
				Client sampling date / time	03-Apr-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2009561-011	--------	--------	--------	--------
					Result	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		<10	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		<5	----	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		<1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	----	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	----	----	----	----
Sodium	7440-23-5	1	mg/L		<1	----	----	----	----
Potassium	7440-09-7	1	mg/L		<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CH2 R2	----	----	----	----
				Client sampling date / time	03-Apr-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2009561-011	--------	--------	--------	--------
					Result	----	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	----	----	----	----
Uranium	7440-61-1	0.001	mg/L		<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	----	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		<0.01	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	CH2 R2	----	----	----	----
				Client sampling date / time	03-Apr-2020 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB2009561-011	--------	--------	--------	--------
					Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		<0.1	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ **Total Xylenes**	----	2	µg/L		<2	----	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**89.0**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**102**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**113**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **SOIL**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	53	134
Toluene-D8	2037-26-5	60	131
4-Bromofluorobenzene	460-00-4	59	127

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118

Attachment C Aquatic Habitat Assessment Tables

Table C1 Aquatic habitat descriptions from each site during the field surveys; grey/blue highlighted water quality cells indicate values that are outside of the relevant WQOs

<table>
<tr><th colspan="2">Site: U1</th><th>Location: Upstream</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of Horse Creek</th></tr>
<tr><td colspan="2">Upstream: December 2019
  </td><td>Downstream: December 2019
  </td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td colspan="2">Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited due to location in catchment and presence of CVM downstream</td></tr>
<tr><td colspan="2">In-stream condition: Fair
Key potential habitat features included:
• small amounts of small and large woody debris and detritus
• a limited range of sediment grain sizes (predominately silt/clay with some sand), and
• little trailing and overhanging bank vegetation.
The site was dry during both the December and April surveys.</td><td>Riparian condition: Poor
The riparian zone was semi-continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced due to historic clearing. Vegetation consisted of grass, shrubs and some trees (predominantly eucalyptus and casuarina). Banks were low (1 m – 1.5 m high) and gently sloping with minimal erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing.</td><td colspan="2">Water Quality: N/A
Survey: | Dec-19 | Apr-20
Condition: | Dry | Dry
Temp (ºC): | — | —
EC (µS/cm): | — | —
DO (% sat): | — | —
pH (pH units): | — | —
Turbidity (NTU): | — | —</td></tr>
</table>

Site: U1D	Location: Upstream	Stream Order: 1	Waterway: Unmapped farm dam
Upstream: December 2019 	Downstream: December 2019 	Upstream: April 2020 	Downstream: April 2020 
Aquatic Ecosystem Value: Moderate	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** Yes	**Connectivity:** Poor due to high dam walls, location in catchment and presence of CVM downstream
In-stream condition: Fair Key habitat features included: • diverse and abundant aquatic plants • a variety of woody debris • periphyton • sediment grain sizes predominately silt/clay, and sandy gravel • shallow & deep pools, and • trailing and overhanging bank vegetation.	**Riparian condition:** Poor The riparian zone was continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced. Vegetation consisted of grass, ferns and weeds. Banks were low (1.5 m – 2 m high) and gently sloping with some erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** High External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock • feral animals, and • the presence of an artificial dam.	**Water Quality:** Poor

Survey:	Dec-19	Apr-20
Condition:	Wet	Wet
Temp (ºC):	32.4	26.7
EC (µS/cm):	1664	466
DO (% sat):	181	76.4
pH (pH units):	8.88	7.56
Turbidity (NTU):	190	54.2

<table>
<tr><th>Site: U2</th><th>Location: Upstream</th><th>Stream Order: 1</th><th>Waterway: Unnamed tributary of Caval Creek</th></tr>
<tr><td>Upstream: December 2019
  </td><td>Downstream: December 2019
  </td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Limited due to location in catchment and presence of CVM downstream</td></tr>
<tr><td>In-stream condition: Fair
Key potential habitat features included:
• ephemeral channel
• some woody debris
• predominately sandy sediments with some cobbles and boulders, and
• little trailing and overhanging bank vegetation.
The site was dry during both the December and April surveys.</td><td>Riparian condition: Poor
The riparian zone was semi-continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced due to historic clearing. Vegetation consisted of trees, grasses and weeds. Banks were low (approximately 1 m high) and gently sloping with some erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="3">Water Quality: N/A
Survey: | Dec-19 | Apr-20
Condition: | Dry | Dry
Temp (ºC): | — | —
EC (µS/cm): | — | —
DO (% sat): | — | —
pH (pH units): | — | —
Turbidity (NTU): | — | —</td></tr>
</table>

<table>
<tr><th>Site: U3</th><th>Location: Upstream</th><th>Stream Order: 2</th><th>Waterway: Unnamed Tributary of Cherwell Creek</th></tr>
<tr><td>Upstream: December 2019
N/A</td><td>Downstream: December 2019
N/A</td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited due to location in catchment and presence of CVM downstream</td></tr>
<tr><td>In-stream condition: Fair
Key potential habitat features in April included:
• well defined ephemeral channel
• some woody debris
• predominately sandy sediments with some cobbles and boulders, and
• little trailing and overhanging bank vegetation.
The site was not sampled during the December survey and was dry during the April survey.</td><td>Riparian condition: Fair
The riparian zone was continuous around the perimeter of the waterway, although the extent of the vegetation in the broader region had been reduced due to historic clearing. Vegetation consisted of trees, grasses and weeds. Banks were low (approximately 0.5 m high) and gently sloping with some erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• grazing by livestock
• feral animals, and
• vehicle track crossing.</td><td>Water Quality: N/A
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>N/A</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

Site: Ca1	Location: Upstream	Stream Order: 2	Waterway: Caval Creek
Upstream: December 2019 	Downstream: December 2019 	Upstream: April 2020 	Downstream: April 2020 
Aquatic Ecosystem Value: Low	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** No	**Connectivity:** Moderate, during periods of flow
In-stream condition: Fair Key habitat features in April included: • sandy ephemeral channel • shallow pools • some woody debris & detritus • predominately sand and silt/clay sediments with some pebbles & gravel, and • some trailing and overhanging bank vegetation. The site was dry during the December survey.	**Riparian condition:** Fair The riparian zone was semi-continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced due to historic clearing. Vegetation consisted of trees, grasses, shrubs, ferns/sedges and weeds. Banks were low (1.8 m – 2 m high) and gently sloping with moderate levels erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** High External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** Fair

Survey:	Dec-19	Apr-20
Condition:	Dry	Wet
Temp (ºC):	—	26.3
EC (µS/cm):	—	7403
DO (% sat):	—	72.9
pH (pH units):	—	7.84
Turbidity (NTU):	—	44.5

<table>
<tr><th>Site: Ch1</th><th>Location: Upstream</th><th>Stream Order: 4</th><th>Waterway: Cherwell Creek</th></tr>
<tr><td>Upstream: December 2019
  </td><td>Downstream: December 2019
  </td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Good, during periods of flow</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in April included:
• some woody debris
• shallow pools
• predominately sand and silt/clay sediments with some boulders, and
• some trailing and overhanging bank vegetation.
The site was dry during the December survey.</td><td>Riparian condition: Good
The riparian zone was semi-continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced due to historic clearing. Vegetation consisted of trees, grasses, shrubs, ferns and weeds. Banks were low (3.5 m – 2 m high) and gently sloping with some erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock
• feral animals, and
• vehicle track crossing.</td><td>Water Quality: Good
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>Dry</td><td>Wet</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>28.2</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>447.7</td></tr><tr><td>DO (% sat):</td><td>—</td><td>85.5</td></tr><tr><td>pH (pH units):</td><td>—</td><td>8.03</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>33.2</td></tr></table></td></tr>
</table>

Site: Ch2	Location: Upstream	Stream Order: 5	Waterway: Cherwell Creek
Upstream: December 2019 	Downstream: December 2019 	Upstream: April 2020 	Downstream: April 2020 
Aquatic Ecosystem Value: Moderate	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** No	**Connectivity:** Good, during periods of flow.
In-stream condition: Fair Key habitat features in April included: • wide sandy ephemeral channel • some woody debris & detritus • predominately sandy sediments with some silt/clay, and • some overhanging and trailing bank vegetation. The site was dry during the December survey.	**Riparian condition:** Fair The riparian zone was semi-continuous around the perimeter of the waterway, although the extent of the vegetation had been reduced due to historic clearing. Vegetation consisted of trees, grasses and weeds. Banks were intermediate (3 m – 4 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** High External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** Fair

Survey:	Dec-19	Apr-20
Condition:	Dry	Wet
Temp (ºC):	—	23
EC (µS/cm):	—	367.9
DO (% sat):	—	11.3
pH (pH units):	—	7.63
Turbidity (NTU):	—	120.3

<table>
<tr><th>Site: GCO1</th><th>Location: Upstream</th><th>Stream Order: 5</th><th colspan="2">Waterway: Grosvenor Creek</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td colspan="2"></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Potential</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in November 2020 included:
• wetted channel
• silty/clay/muddy sediments
• some shading of reach
• some snags, woody debris & branches, and
• little detritus in stream.
The site was wet during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was narrow with surrounding agricultural land upstream. Some sedges were around the perimeter of the waterway. Evidence of deer, pig and horse disturbance was present in the surrounding riparian zone. Left and right bank height was low (approximately 2 m high) and steeply sloping on the left and gently sloping on some areas on the right near the bridge. Site was approximately 10 m wide. The wetted area was a still pool not connected downstream. The water appeared to be receding in subsequent survey days. It was unclear where water was fed from (e.g. upstream farm dam releases, groundwater etc.) and it was also unclear whether downstream earthworks were influencing water levels (e.g. damming water or restricting flow). While the waterway was a dry season refuge during the survey, it was unclear if water consistently endured the entire dry season or whether it was influenced by current land use and earthworks that occurred during the surveys.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Wet
Temp (ºC): 26.6
EC (µS/cm): 415.8
DO (% sat): 50.8
pH (pH units): 7.37
Turbidity (NTU): 137</td></tr>
</table>

<table>
<tr><th>Site: GCO2</th><th>Location: Upstream</th><th>Stream Order: 5</th><th>Waterway: Grosvenor Creek</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td></td></tr>
<tr><td>Aquatic Ecosystem Value: Poor</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in November 2020 included:
• ephemeral channel
• consolidated dry sediments
• some shading of reach
• some snags, woody debris & branches, and
• little detritus.
• eroded bank
The site was dry during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was a scattered semi-continuous/continuous mix of grasses, trees, and weeds. A dead eel was in the vicinity of the site. There was a road crossing downstream of the site, and there was water present approximately 200 m downstream of the site. Left and right banks were approximately 4 m high and steep. Channel was approximately 10 m wide.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): –
EC (µS/cm): –
DO (% sat): –
pH (pH units): –
Turbidity (NTU): –</td></tr>
</table>

<table>
<tr><th>Site: IR01</th><th>Location: Upstream</th><th>Stream Order: 5</th><th colspan="2">Waterway: Isaac River</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td colspan="2"></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in November 2020 included:
• ephemeral channel
• predominately sandy sediments with some pebbles, gavel and clay/silt
• little shading of reach
• no trailing vegetation, and
• some large snags, woody debris & branches.
The site was dry during the November survey.</td><td>Riparian condition: Good
The riparian zone was a scattered semi-continuous/continuous mix around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, trees, and weeds. Left bank height was low (approximately 0.5 m high) and gently sloping; the right bank was higher (approximately 15 m high), steep banks with moderate erosion. There were some exotic terrestrial riparian species at the site. Site was wide (approximately 60 m wide).</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): —
EC (µS/cm): —
DO (% sat): —
pH (pH units): —
Turbidity (NTU): —</td></tr>
</table>

<table>
<tr><th>Site: HC01</th><th>Location: Downstream</th><th>Stream Order: 4</th><th>Waterway: Harrow Creek</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Moderate
Key habitat features in November 2020 included:
• ephemeral channel
• unconsolidated sand sediments
• established terrestrial weeds in the channel
• some shading of reach
• little snags, woody debris & branches, and
• little detritus.
The site was dry during the November 2020 survey.</td><td>Riparian condition: Fair
The riparian zone was a scattered semi-continuous/continuous mix of grasses, trees, and weeds. Left and right bank height was approximately 5 m high, with moderate sloping on the left bank, and steep slopes on the right. Channel was approximately 20 m wide.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): –
EC (µS/cm): –
DO (% sat): –
pH (pH units): –
Turbidity (NTU): –</td></tr>
</table>

<table>
<tr><th>Site: LW2</th><th>Location: Upstream</th><th>Stream Order: 2</th><th colspan="2">Waterway: Wetland</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td colspan="2"></td></tr>
<tr><td>Aquatic Ecosystem Value: Poor</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td colspan="2">Connectivity: Not connected</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in November 2020 included:
• shallow & deep pools
• aquatic plants
• predominately fine sediments (sand & silt/clay)
• little trailing & overhanging vegetation, and
• some snags, woody debris & detritus.
The site was wet during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was a scattered continuous mix with isolated trees around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted of grasses, shrubs, trees and weeds. Banks were generally low (approximately 1 m high) and gently sloping with moderate erosion. Damming side of the waterway had a more steeply sloping bank, approximately 5 m high. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
feral animals.</td><td colspan="2">Water Quality:
Survey: Nov-20
Condition: Wet
Temp (ºC): 26.8
EC (µS/cm): 382.9
DO (% sat): 94.2
pH (pH units): 8.63
Turbidity (NTU): 43.1</td></tr>
</table>

Site: HT1D	Location: Within Project Footprint	Stream Order: 1	Waterway: Unmapped farm dam
Upstream: December 2019	Downstream: December 2019	Upstream: April 2020	Downstream: April 2020
			
Aquatic Ecosystem Value: Moderate	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** Yes	**Connectivity:** Poor, isolated from main watercourse by dam
In-stream condition: Fair Key habitat features included: • farm dam on ephemeral channel • aquatic plants lining channel • shallow & deep pools • predominately silt/clay sediments • little trailing bank vegetation and woody debris, and • some detritus.	**Riparian condition:** Poor The riparian zone was isolated around the perimeter of the waterway, and the extent of the vegetation had been reduced due to historical clearing for agriculture. Vegetation consisted grasses, ferns and weeds. Banks were low (approximately 2.5 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** Extreme External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock • feral animals, and • the presence of an artificial dam.	**Water Quality:** Poor

Survey:	Dec-19	Apr-20
Condition:	Wet	Wet
Temp (ºC):	28.9	25.3
EC (µS/cm):	485.2	355.1
DO (% sat):	100.4	84
pH (pH units):	8.5	8.3
Turbidity (NTU):	32.8	17.9

Site: H1	Location: Downstream	Stream Order: 2	Waterway: Horse Creek
Upstream: December 2019 	Downstream: December 2019 	Upstream: April 2020 	Downstream: April 2020 
Aquatic Ecosystem Value: Low	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** No	**Connectivity:** Limited, during periods of flow
In-stream condition: Fair Key potential habitat features included: • ephemeral waterway • predominately sandy sediments with some gravel and pebbles, and • moderate snags and woody debris. The site was dry during both the December and April surveys.	**Riparian condition:** Fair The riparian zone was semi-continuous around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, trees and weeds. Banks were low (approximately 1.8 m high) and gently sloping with moderate bank and extensive bed erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** High External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** N/A

Survey:	Dec-19	Apr-20
Condition:	Dry	Dry
Temp (ºC):	—	—
EC (µS/cm):	—	—
DO (% sat):	—	—
pH (pH units):	—	—
Turbidity (NTU):	—	—

<table>
<tr><th>Site: ChT1</th><th>Location: Downstream</th><th>Stream Order: 2</th><th>Waterway: Unnamed Tributary of Cherwell Creek</th></tr>
<tr><td>Upstream: December 2019
N/A</td><td>Downstream: December 2019
N/A</td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td>Connectivity: Limited, during periods of flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features in April included:
• ephemeral waterway
• rocky narrow channel
• predominately cobbled sediments with some sand
• little snags and woody debris, and
• little trailing & overhanging vegetation.
The site was not sampled during the December survey and was dry during the April survey.</td><td>Riparian condition: Fair
The riparian zone was semi-continuous around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, trees and weeds. Banks were low (approximately 1 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td>Water Quality: N/A
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>N/A</td><td>Dry</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: LW1</th><th>Location: Downstream</th><th>Stream Order: 3</th><th>Waterway: Mapped lacustrine wetland on Horse Creek</th></tr>
<tr><td>Upstream: December 2019
  </td><td>Downstream: December 2019
  </td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: Yes</td><td>Connectivity: Limited due to high dam walls</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features included:
• shallow & deep pools
• aquatic plants
• predominately fine sediments (sand & silt/clay)
• little trailing & overhanging vegetation, and
• some snags, woody debris & detritus.</td><td>Riparian condition: Fair
The riparian zone was a scattered continuous mix with isolated trees around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, shrubs, trees and weeds. Banks were low (approximately 3 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock
• feral animals, and
• presence of an artificial dam.</td><td>Water Quality: Poor
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>Wet</td><td>Wet</td></tr><tr><td>Temp (ºC):</td><td>28.7</td><td>26</td></tr><tr><td>EC (µS/cm):</td><td>561</td><td>320.</td></tr><tr><td>DO (% sat):</td><td>111.5</td><td>113.1</td></tr><tr><td>pH (pH units):</td><td>9.4</td><td>8.47</td></tr><tr><td>Turbidity (NTU):</td><td>12</td><td>54.9</td></tr></table></td></tr>
</table>

<table>
<tr><th>Site: G1</th><th>Location: Downstream</th><th>Stream Order: 5</th><th>Waterway: Grosvenor Creek</th></tr>
<tr><td>Upstream: December 2019
  </td><td>Downstream: December 2019
  </td><td>Upstream: April 2020
  </td><td>Downstream: April 2020
  </td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Good, during periods of flow</td></tr>
<tr><td>In-stream condition: Good
Key habitat features in April included:
• ephemeral channel
• predominately sandy sediments with some pebbles, gavel and clay/silt
• moderate overhanging vegetation
• some shallow pools, and
• some snags, woody debris & branches.
The site was dry during the December survey.</td><td>Riparian condition: Good
The riparian zone was a scattered semi-continuous/continuous mix around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, shrubs, trees, ferns and weeds. Banks were low (approximately 4 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: High
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="3">Water Quality: Fair
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>Dry</td><td>Wet</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>28.9</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>184.1</td></tr><tr><td>DO (% sat):</td><td>—</td><td>111.9</td></tr><tr><td>pH (pH units):</td><td>—</td><td>8.05</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>66.9</td></tr></table></td></tr>
</table>

Site: Ch3	Location: Downstream	Stream Order: 5	Waterway: Cherwell Creek
Upstream: December 2019	Downstream: December 2019	Upstream: April 2020	Downstream: April 2020
			
Aquatic Ecosystem Value: Moderate	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** No	**Connectivity:** Good, during periods of flow
In-stream condition: Good Key habitat features in April included: • ephemeral channel • shallow pools • predominately sandy sediments with some pebbles, gavel and clay/silt • little overhanging & trailing vegetation, and • little snags, woody debris & branches. The site was dry during the December survey.	**Riparian condition:** Good The riparian zone was a continuous width around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, shrubs, trees, ferns and weeds. Banks were low (approximately 4 m high) and gently sloping with moderate erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** Moderate External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** Good

Survey:	Dec-19	Apr-20
Condition:	Dry	Wet
Temp (ºC):	—	27.2
EC (µS/cm):	—	476.2
DO (% sat):	—	91.3
pH (pH units):	—	7.98
Turbidity (NTU):	—	6.1

Site: Ch4	Location: Downstream	Stream Order: 5	Waterway: Cherwell Creek
Upstream: December 2019 	Downstream: December 2019 	Upstream: April 2020 	Downstream: April 2020 
Aquatic Ecosystem Value: Moderate	**MNES/MSES:** None present or likely to occur	**Dry season refuge:** No	**Connectivity:** Good, during periods of flow
In-stream condition: Good Key habitat features in April included: • ephemeral channel • predominately sandy sediments with some clay/silt • some overhanging vegetation • little snags, woody debris & branches • shallow pool at eroded bend. The site was dry during the December survey.	**Riparian condition:** Fair The riparian zone was a semi-continuous/ continuous mix around the perimeter of the waterway, and the extent of the vegetation had been reduced. Vegetation consisted grasses, shrubs, trees, ferns and weeds. Banks were low (2.5 m – 3.5 m high) and gently sloping with extensive erosion. There were some exotic terrestrial riparian species at the site.	**External Impacts:** Moderate External impacts at the site were mostly associated with the surrounding land-use and included: • reduced riparian vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** Fair

Survey:	Dec-19	Apr-20
Condition:	Dry	Wet
Temp (ºC):	—	24.8
EC (µS/cm):	—	456.6
DO (% sat):	—	63.8
pH (pH units):	—	8.12
Turbidity (NTU):	—	32.4

<table>
<tr><th>Site: PW1</th><th>Location: Downstream</th><th>Stream Order: N/A</th><th>Waterway: Mapped WPA / HES palustrine wetland</th></tr>
<tr><td>December 2019
  </td><td>December 2019
  </td><td>April 2020
N/A</td><td>April 2020
N/A</td></tr>
<tr><td>Aquatic Ecosystem Value: Low</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: No</td><td colspan="3">Connectivity: Limited, would only hold water during periods of high flow</td></tr>
<tr><td>In-stream condition: Poor
Key potential habitat features in December included:
• predominately clay/silt sediments
• little overhanging & trailing vegetation
• emergent aquatic plants, and
• little snags, woody debris & branches.
The site was dry during the December survey and was not sampled during the April survey due to property access issues.</td><td>Riparian condition: Fair
The riparian zone was reduced but continuous around the perimeter of the wetland, and the extent of the vegetation had been reduced. Vegetation consisted trees predominantly eucalyptus, grasses and shrubs. There was some erosion in the dry bed. There were some exotic terrestrial riparian species at the site.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced riparian vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="3">Water Quality: N/A
<table><tr><th>Survey:</th><th>Dec-19</th><th>Apr-20</th></tr><tr><td>Condition:</td><td>Dry</td><td>N/A</td></tr><tr><td>Temp (ºC):</td><td>—</td><td>—</td></tr><tr><td>EC (µS/cm):</td><td>—</td><td>—</td></tr><tr><td>DO (% sat):</td><td>—</td><td>—</td></tr><tr><td>pH (pH units):</td><td>—</td><td>—</td></tr><tr><td>Turbidity (NTU):</td><td>—</td><td>—</td></tr></table></td></tr>
</table>

Site: PW2	Location: Downstream	Stream Order: N/A	Waterway: Mapped palustrine wetland
December 2019 	December 2019 	April 2020 	April 2020 
Aquatic Ecosystem Value: N/A	**MNES/MSES:** N/A	**Dry season refuge:** N/A	**Connectivity:** N/A
In-stream condition: N/A No aquatic habitat features recorded at this site. Site is likely incorrectly mapped as a palustrine wetland, with terrestrial ecological values only.	**Riparian condition:** Fair This site did not feature a riparian zone as no aquatic ecological features were evident, however, terrestrial vegetation in the broader region consisted grasses, shrubs, trees, and weeds. There some exotic terrestrial species at the site.	**External Impacts:** Moderate External impacts at the site were mostly associated with the surrounding land-use and included: • reduced terrestrial vegetation as a result of land clearing • grazing by livestock, and • feral animals.	**Water Quality:** N/A

Survey:	Dec-19	Apr-20
Condition:	Dry	Dry
Temp (ºC):	—	—
EC (µS/cm):	—	—
DO (% sat):	—	—
pH (pH units):	—	—
Turbidity (NTU):	—	—

<table>
<tr><th>Site: GC03</th><th>Location: Downstream</th><th>Stream Order: 5</th><th colspan="2">Waterway: Grosvenor Creek</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td colspan="2"></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in November 2020 included:
• substrate predominately sand, rocks and pebbles
• moderate shading of reach
• extensive snags, woody debris & branches, and
• some terrestrial detritus.
The site was dry during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was a scattered semi-continuous/continuous mix of grasses, large trees, and weeds. Both banks were approximately 4 m high, with some eroded bank areas around tree roots, providing good habitat for fish and macroinvertebrates. Channel was approximately 10 m wide. Large trees in the riparian zone provided moderate-extensive shading throughout the reach.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): –
EC (µS/cm): –
DO (% sat): –
pH (pH units): –
Turbidity (NTU): –</td></tr>
</table>

<table>
<tr><th>Site: GC04</th><th>Location: Downstream</th><th>Stream Order: 5</th><th>Waterway: Grosvenor Creek</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Fair
Key habitat features in November 2020 included:
• substrate predominately unconsolidated sand
• moderate-extensive shading of reach
• extensive snags, woody debris & branches
• some large snags, and
• extensive terrestrial detritus.
The site was dry during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was a scattered continuous mix of grasses, large trees, and weeds. Both banks were approximately 3 m high, with some eroded bank areas around tree roots, providing good habitat for fish and macroinvertebrates. Channel was approximately 10 m wide. Large trees in the riparian zone provided moderate-extensive shading throughout the reach.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): –
EC (µS/cm): –
DO (% sat): –
pH (pH units): –
Turbidity (NTU): –</td></tr>
</table>

<table>
<tr><th>Site: IRO2</th><th>Location: Downstream</th><th>Stream Order: 6</th><th>Waterway: Isaac River</th></tr>
<tr><td>Upstream: November 2020
  </td><td>Downstream: November 2020
  </td><td></td><td></td></tr>
<tr><td>Aquatic Ecosystem Value: Moderate</td><td>MNES/MSES: None present or likely to occur</td><td>Dry season refuge: N/A</td><td colspan="2">Connectivity: N/A</td></tr>
<tr><td>In-stream condition: Poor
Key habitat features in November 2020 included:
• ephemeral channel
• unconsolidated sand sediments
• established terrestrial weeds in the channel
• moderate shading of reach
• some snags, woody debris & branches, and
• little detritus.
The site was dry during the November 2020 survey.</td><td>Riparian condition: Good
The riparian zone was a scattered semi-continuous/continuous mix of grasses, large trees, and weeds. Left bank downstream was gently sloping while right bank was a higher reaching steep bank. The confluence of Grosvenor Creek and Isaac River was approximately 100 m upstream of the bridge. Channel was approximately 40 m wide.</td><td>External Impacts: Moderate
External impacts at the site were mostly associated with the surrounding land-use and included:
• reduced terrestrial vegetation as a result of land clearing
• grazing by livestock, and
• feral animals.</td><td colspan="2">Water Quality: N/A
Survey: Nov-20
Condition: Dry
Temp (ºC): –
EC (µS/cm): –
DO (% sat): –
pH (pH units): –
Turbidity (NTU): –</td></tr>
</table>

Attachment D Photographs of Fish Species Caught During the Field Surveys

Table D2 Representative photographs of each fish species captured during field surveys in December 2019 and April 2020

Agassiz's glassfish

Carp gudgeon

Purple-spotted gudgeon

Eastern rainbowfish

Bony bream

Hyrtl's tandan

Spangled perch

Tilapia

Platy