Baralaba South Project EIS

Aquatic Ecology Assessment Report

Prepared for: Baralaba South Pty Ltd

Prepared by: Ecological Service Professionals Pty Ltd

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Acknowledgement of Country: In the spirit of reconciliation, Ecological Service Professionals acknowledges the Traditional Custodians of country where we have worked, and we recognise their connection to land, sea and community. We pay our respect to their Elders past and present and extend that respect to all Aboriginal and Torres Strait Islander peoples through our scientific work on country.

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Executive Summary

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) and forms part of the Environmental Impact Statement (EIS) for the Baralaba South Project (BSP), hereafter referred to as the Project. The Project is a proposed open-cut coal mine within an area of approximately 2,214 hectares covered by Mining Lease Application (MLA) 700057 and located approximately 8 km south of the township of Baralaba in the lower Bowen Basin region of Central Queensland.

For the purposes of this assessment, the Project area has been defined as within MLA 700057. The proposed disturbance area for the Project does not encompass the entire MLA; but does include a realignment of the Moura-Baralaba Road and an Electricity Transmission Line (ETL). The study area has been defined as the regional waterways and wetlands surrounding the Project area (adjacent to, upstream and downstream) that were surveyed as part of this assessment (Dawson River and Anabranch, Banana Creek and Shirley's Gully).

This report provides a baseline assessment of the current condition of the aquatic ecosystems in the vicinity of the Project, and an assessment of the impacts of the Project on these aquatic ecosystems. Specifically, it provides:

- a summary of aquatic flora and fauna known from or likely to occur in the region, as informed by a desktop review and results from comprehensive seasonal surveys and a supplementary site inspection;
- a detailed assessment of aquatic ecological condition and value of waterways and potential surface expression groundwater-dependent ecosystems (GDEs);
- an assessment of the potential likelihood of occurrence of any aquatic Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES); and
- an assessment of the potential impacts of the Project on aquatic ecology and the appropriate mitigation measures.

Methods

A comprehensive desktop review was completed to summarise the known aquatic ecological conditions of the waterways and wetlands (including mapped potential surface expression GDEs) in the study area, and to provide context for the field survey results.

To verify and supplement the results of the desktop review, as well as identify any potential important dry season refuges, two seasonal field surveys were completed: one in the dry season (June 2017) and one in the wet season (March 2018). Aquatic ecological indicators assessed included aquatic habitat, water quality, sediment quality, aquatic plants, macroinvertebrates (including macrocrustaceans), fish, turtles, and platypus.

A supplementary site inspection was completed from 1 to 4 August 2023, to verify that there had been no major changes in aquatic habitat condition and availability since the comprehensive surveys were completed, and to ground truth the location and characteristics of waterways providing for fish passage (a MSES) to be disturbed by the Project.

Results

Aquatic habitats of waterways and wetlands within the Project area were typical of ephemeral areas and were highly disturbed by activities associated with the adjacent agricultural land-use. The waterways within the Project area had poor habitat conditions as they were ephemeral drainage lines that had minimal in-stream habitat features (or were dry during both surveys). In some cases, there was no defined waterway present where a waterway was mapped e.g. there was a lack of defined bed or banks.

Based on the August 2023 assessment, there are no waterways providing for fish passage within the proposed mine disturbance area, except for one minor green (low risk) tributary (Tributary 7) and some reaches of the mapped red (high risk) tributary (Tributary 8). However, the WWBW spatial layer does not accurately represent the on-ground location of Tributary 8. Mapping updates to the WWBW spatial layer have been proposed to reflect on-ground conditions.

Wetlands within the Project area provided some lasting refuges (when wet) but were poorly connected, with poor to fair habitat conditions based on diversity of instream features and disturbance levels. Dry wetlands provided minimal aquatic habitat, except for aquatic flora.

Within the broader study area in the larger waterways adjacent to and downstream of the disturbance area, aquatic habitat conditions were considered fair. These waterways had a good variety and availability of in-stream habitat; a variety of flow regimes; good bank stability; and, although the adjacent lands were disturbed, a reduced but mainly intact riparian zone remained along the waterways.

Water and sediment quality were typical of moderately disturbed ecosystems that are influenced by surrounding land-uses. Sites had variable water quality, often with high electrical conductivity and poor percent saturation of dissolved oxygen. Laboratory results indicated moderate to high concentrations of nutrients and some metals (particularly aluminium, copper and iron), which were outside of the relevant water/sediment quality objectives at several sites.

Biological communities (including aquatic plants, macroinvertebrates, macrocrustaceans, fish and turtles) recorded within the study area were typical of the broader region and no listed threatened species known from the catchment (Fitzroy River turtle and white-throated snapping turtle) were recorded.

Aquatic flora communities were dominated by emergent plants growing on the banks and fringing the edges of the water. Most waterways had low coverage of in-stream aquatic plants and low diversity and coverage of floating and submerged species recorded. The wetlands within the Project had higher coverage of aquatic plants and the wetted palustrine wetland had a good diversity of species. Two declared restricted invasive plant species (water lettuce and olive hymenachne) were recorded outside of the Project area.

Macroinvertebrate communities were in poor to moderate condition and were typical of a community influenced by a range of external factors that degraded water quality conditions (including a range of anthropogenic, industrial and / or agricultural pollution sources).

Fish communities within the Project area were limited to the wetted wetlands and an overall low diversity of species was recorded; no fish were recorded in the waterways within the Project area. Within the broader study area, waterways supported a higher diversity of species, including the three fish species endemic to the basin (southern saratoga, leathery

grunter and golden perch), which were recorded in the Dawson River and Anabranch and Shirley's Gully. Banana Creek and Shirley's Gully provide good fish breeding habitat and refuge area during high-flow periods in the Dawson River.

Turtles were not recorded within the Project area, however the Dawson River and Anabranch, Banana Creek and Shirley's Gully support turtle populations comprised of species common in the region. There is no suitable habitat for the listed turtle species within the Project area, however potential suitable habitat for them was identified in the Dawson River and Anabranch, Shirley's Gully and the lower reaches of Banana Creek. There is a low likelihood for the listed turtle species to occur in these reaches; and if they do occur, it is considered likely that they would be present on a transient rather than permanent basis, due to a lack of preferred habitat.

No platypus were recorded. No potential habitat was identified within the Project area, and there is a low likelihood that they may occur the Dawson River and Anabranch, Banana Creek and Shirley's Gully.

Aquatic Ecosystem Values

Aquatic ecosystem values of waterways and wetlands in the Project area are considered low to moderate, and the aquatic ecosystem values of the waterways adjacent to the Project (Banana Creek, the Dawson River and Anabranch and the lower reaches of Shirley's Gully) are considered moderate to high. One High Ecological Significance (HES) wetland lies partially within the Project area, but the disturbance area is separated from the mapped wetland vegetation by at least 1 km. The field assessments concluded that aquatic ecosystem value of this wetland was moderate rather than high, and that this wetland would provide similar value habitat as the other wetlands in the region, and it would not support listed threatened aquatic species.

Conclusions

The Project has the potential to directly and indirectly impact aquatic ecosystems; however, impacts to aquatic ecosystems will be minimised by:

- Limiting the area of direct impact to aquatic ecosystems to the proposed disturbance area;
- Implementing effective erosion and sediment control strategies that are: designed in accordance with best practice guidelines; designed to contain sediment affected runoff from disturbed areas; and protect against erosion from increased velocities during flood flows (i.e. localised erosion protection works);
- An effective water management system that: minimises the capture of natural flows by diverting clean water around the Project area; effectively manages the storage of mine affected water (MAW); maximises and prioritises use of onsite water retention and recycling to reduce external raw water supply requirements; effectively manages seepage in the water management system and achieves water quality objectives;
- Adopting a controlled release strategy that ensures release events will coincide with medium-high streamflow conditions in the Dawson River and are in accordance with Environmental Authority conditions; and
- Implementing high quality and appropriate management plans developed for the management of waste, hydrocarbons and contaminants and weed and pest animals.

Despite these mitigation measures, there are likely to be residual impacts associated with:

- Direct loss of aquatic habitat and associated aquatic flora and fauna within the Project area as a result of the removal of aquatic habitat, although the aquatic habitats, flora and fauna of the Project area are common in the region and the impact is unlikely to extend beyond the disturbance footprint. Nevertheless, there will be a permanent impact to 2.33 ha of ground-truthed waterways providing for fish passage. This constitutes an SRI to MSES waterways, which will be partly mitigated by either redesigning the spoil dump to avoid impacts to the waterway, or construction of a diversion drain that provides for fish passage in the north-western part of the footprint (0.12 ha); while the remainder (2.21 ha) can be offset with a financial offset payment, subject to further investigation / studies challenging or validating the determination of the area to be disturbed as a waterway providing for fish passage.
- Reductions in catchment area resulting in a reduction in flows, although any medium risk impacts are restricted to the upper reaches of Shirly's Gully (upstream of the weir pool).

Considering the existing impacts in the catchment and provided the appropriate mitigation measures are in place, it is considered unlikely that the Project will result in significant impacts to aquatic ecosystems of the Dawson River Sub-basin, including to aquatic MNES and MSES species. Based on the results of modelling of the impacts to flows and water quality, the Project is not expected to make any significant contribution to cumulative impacts to aquatic ecosystems in the Dawson River Sub-basin or wider Fitzroy Basin.

1 Introduction

This aquatic ecology assessment report has been prepared by Ecological Service Professionals (ESP) and forms part of the Environmental Impact Statement (EIS) for the Baralaba South Project (BSP) (the Project).

1.1 Project Description

Approval is being sought by Baralaba Coal Company Pty Ltd (Baralaba Coal Company) to develop an open-cut metallurgical coal mine using traditional truck and excavator methods. Mining will peak at up to 2.5 million tonnes per annum (Mtpa) of run-of-mine coal. Up to a two year construction period followed by an operational mine life of approximately 23 years (under optimal mining conditions) is proposed within a disturbance area of approximately 1,208 hectares (ha) within MLA 700057 (the MLA covers a total area of 2,214 ha). The construction of water extraction and release infrastructure, the realignment of Moura-Baralaba Road and the electricity transmission line (ETL) will result in a further 27 ha of disturbance. The Project will provide a continuation of mining operations within the local area (i.e. the Baralaba North Mine).

The Project would consist of:

- a greenfield open-cut coal mine to be developed within MLA 700057, including:
    - in-pit and out-of-pit overburden emplacements from coal processing;
    - open-cut mining operations using conventional truck and excavator methods;
    - Coal Handling Preparation Plant (CHPP);
    - dewatering of CHPP coal rejects and disposal on-site within mine voids behind the advancing open-cut mining operation;
    - recovery and recycling of processed wastewater through the CHPP;
    - Run-of-Mine (ROM) coal and product coal stockpiles;
    - topsoil stockpiles, laydown areas and borrow areas;
    - haul roads and internal roads;
    - water management infrastructure;
    - final embankment bund;
    - a mining infrastructure area, including workshops, administration buildings, fuel and chemical storage facilities, warehouse and hardstand areas;
    - other associated minor infrastructure, plant, equipment and activities;
    - exploration activities;
- water release/extraction pipeline and water pump station (referred to as the water release/extraction infrastructure); and
- realignment of approximately 4.5 km section of Moura-Baralaba Road to the east of MLA 700057 (subject to separate approvals).

The Project also includes development of a proposed electricity transmission line (ETL) of approximately 8 km in length and 20 m in width. The ETL will link the Project with the Baralaba Substation, located approximately 6 km east of the Baralaba township (Figure 1.1). Two ETL alignment options are being considered for the Project and the final ETL alignment will be determined at a later date in consideration of the outcomes of the assessments conducted for the EIS. The ETL will be subject to separate approvals, for which the necessary permitting will be undertaken by Ergon.

Product coal would be hauled approximately 40 km south along the existing Baralaba North Mine haul route (a public road) using covered road trains to the existing Train Load-out (TLO) facility east of Moura.

1.2 Scope of Works

The Project has been declared a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). As such, completion of a detailed EIS is required, that includes consideration of controlling provisions relating to listed threatened species and communities (Sections 18 and 18A), listed migratory species (Sections 20 and 20A), and water resources (Sections 24D and 24E). In addition, a Voluntary EIS for the Project is being prepared under Queensland's *Environmental Protection Act 1994* (EP Act), to be assessed under the EPBC Act in accordance with the Bilateral Agreement between the Commonwealth of Australia and the State of Queensland. The EIS therefore addresses both State EP Act and Commonwealth EPBC Act matters, in accordance with the Terms of Reference (TOR) for the EIS, which was issued in July 2017 (DEHP 2017).

The purpose of the aquatic ecology assessment is to describe the aquatic values associated with the Project as relevant to current Commonwealth and State legislation, assess the impacts of the proposed actions on these values and present strategies to avoid, minimise or mitigate impacts to significant aquatic values.

This document is a supporting document to the EIS and addresses the following items of the TOR (DEHP 2017):

- Section 8.1: Flora and Fauna (critical matter), specifically items:
    - 8.1.6 – recommendations for design and rehabilitation of creek crossings;
    - 8.1.7 – describes the likely impacts on the biodiversity and natural environmental values of aquatic ecosystems arising from the construction, operation and eventual decommissioning of the project (where known). Specifically in regard to:
        - Matters of State Environmental Significance (MSES) and Matters of National Environmental Significance (MNES);
        - Aquatic ecosystems (including groundwater-dependent ecosystems);
        - Biological diversity including listed flora and fauna species;
        - The integrity of ecological processes, including habitats of threatened, near-threatened or special least-concern species;
        - Connectivity of habitats and ecosystems, including impact of waterway barriers (e.g. diversions) on fish passage in all relevant waterways

mapped on the Queensland Waterways for Waterway Barrier Works spatial data layer;

- Chronic, low-level exposure to contaminants or the bio-accumulation of contaminants;
- Impacts on aquatic ecosystems and associated native fauna due to wastes at the site, particularly those related to any form of toxicants in supernatant water of any tailings storage facility; and
- Impacts of dust from coal and overburden stockpiles and any additional coal haulage above already approved volumes on the growth and productivity of threatened aquatic species habitat.

  - 8.1.8 – provides an overview of the legislation and guidelines relevant to aquatic ecology, and will describe actions that will be assessable under the relevant legislation;
  - 8.1.9 – includes mitigation and management measures relevant to aquatic ecology;
  - 8.1.10 – addresses any obligations under State or Commonwealth legislation or policy, as relevant to aquatic ecosystems;
  - 8.1.11 – discusses buffer zones to waterways and wetlands, and waterway barriers;
  - 8.1.12 – discusses how impacts to aquatic ecosystems will be monitored and audited;
  - 8.1.13 – describes the adequacy of buffer zones for protecting the riparian zone as it relates to protecting or enhancing aquatic ecological function;
  - 8.1.14 – assesses the requirement for environmental offsets related to aquatic ecology, in accordance with the relevant State guidelines; and
  - 8.1.15 – assesses the requirement for environmental offsets related to aquatic ecology, in accordance with the relevant Commonwealth guidelines.

- Section 8.2: Water quality (critical matter), specifically item:
  - 8.2.3 (part) – includes the results of water and sediment quality sampling completed in conjunction with aquatic ecology baseline surveys.
- Section 8.9: Biosecurity (part) – includes a description of aquatic pests and weeds present in the Project area and mitigation measures to prevent their spread.

Comprehensive wet season and a dry season baseline field surveys were completed in June 2017 and March 2018 to inform the above assessment. A supplementary site inspection was completed in August 2023, to verify that the baseline survey results are likely to be valid (i.e. that there had been no major changes in aquatic habitat condition and availability since the comprehensive surveys were completed), and to ground truth the location and characteristics of waterways to be disturbed by the Project.

1.3 Description of the Study Area

The Project is located approximately 8 km south of the township of Baralaba in the lower Bowen Basin region of Central Queensland. It is within the Dawson River Sub-basin, which is part of the wider Fitzroy Basin. For the purposes of this assessment, the Project area has been defined as MLA 700057, although the disturbance area does not include the entire MLA. The Project also includes the proposed realignment of Moura-Baralaba Road, water release/extraction infrastructure and electricity supply infrastructure (Figure 1.1). The study area includes the regional waterways and wetlands surrounding the Project (adjacent to, upstream and downstream) that were surveyed as part of this assessment (Figure 1.1).

The Project is located partly within the floodplain of the Dawson River near the confluence of Banana Creek and the Dawson River. Within the Project area, a number of wetlands are mapped, including one lacustrine wetland and three palustrine wetlands; one of which is mapped as a wetland of High Ecological Significance (HES) and Wetland Protection Area (WPA) with an associated WPA trigger area; the other two are mapped as wetlands of general ecological significance (GES) (refer Section 4.1.2). A number of minor (stream order 1 and 2) waterways and drainage lines also occur within the Project area and road realignment. These waterways are tributaries of an unnamed (stream order 3) waterway that flows through the Project area, exiting at the north-east boundary of the Project's mining lease and meeting an Anabranch of the Dawson River (referred to as the Dawson River Anabranch) approximately 2.5 km downstream of the Project area. The reach of this waterway closest to the confluence with the Dawson River Anabranch is informally referred to as Shirley's Gully (Figure 1.1).

Within the broader study area, Banana Creek flows from upstream of the Project area in a north-west direction and to the west of the MLA boundary. It flows within 250 m of MLA 700057 at its closest point and meets the Dawson River approximately 750 m west of the north-western portion of the Project area (Figure 1.1). The Dawson River is located approximately 500 m west of MLA 700057 at the closest point. The Dawson River flows in a northerly direction downstream of the Project and joins the Mackenzie River just north of Duaringa. At its confluence with the Mackenzie River it forms the Fitzroy River, which eventually discharges into the Coral Sea east of Rockhampton (approximately 380 km downstream of the Project area).

The ETL study area traverses several stream order 1 drainage lines, and a stream order 3 waterway (Benleith Creek) in the far north of the study area. Benleith Creek ultimately flows into the Dawson River approximately 4.5 km downstream. The ETL and associated infrastructure will have minimal ground disturbance and the transmission line poles will be located outside of waterways to not impact overland flows or flooding. The ETL is expected to have negligible surface water impacts (Engeny Water Management, 2023a).

The waterways and wetlands of the study area are classified as Lower Dawson River Sub-basin freshwaters under the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP Water and Wetland Biodiversity).

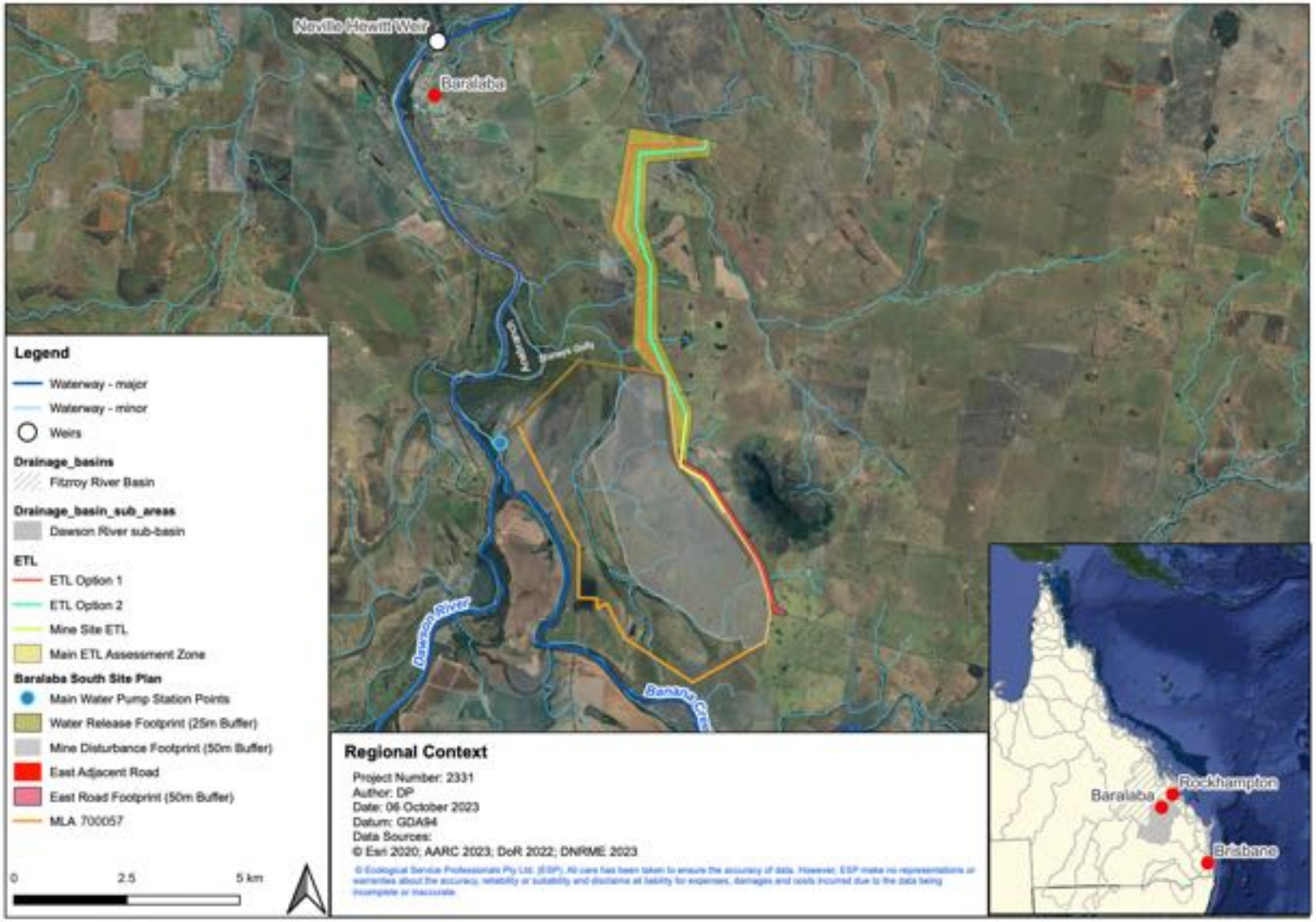


Figure 1.1 Map of the Project area and surrounds.

2 Methods

2.1 Literature Review

A detailed desktop review of available information on the aquatic ecology of the study area was completed, including a review of:

- The Commonwealth Department of Climate Change Energy, the Environment and Water (DCCEEW) EPBC Act Protected Matters Search Tool (DCCEEW 2023);
- The Queensland Department of Environment and Science (DES) WetlandInfo Facts and Maps wildlife statistics for the Fitzroy Basin and the Lower Dawson River (DES 2023a,b);
- The Queensland Department of Environment and Science (DES) Wildlife Online database (DES 2023c);
- The Atlas of Living Australia (ALA) species occurrence records database (ALA 2023);
- Government mapping layers:
    - DES (2023d) Matters of state environmental significance – Queensland series;
    - DES (2023i) Wetland data version 4 and the Wetlands Planning and Legislation Toolbox;
    - DES (2023f) Land use mapping series;
    - DES (2023g) Queensland Groundwater Dependent Ecosystems (GDE) and Potential GDE Aquifer Mapping and BOM (2023b) Groundwater Dependent Ecosystem Atlas;
    - The Queensland Department of Regional Development, Manufacturing and Water (DRDMW[1]) Watercourse identification map – Queensland series (DRDMW 2023a)
    - DRDMW (2023b) Ordered drainage 100K mapping, and
    - The Queensland Department of Agriculture and Fisheries (DAF) Queensland waterways for waterway barrier works (WWBW) mapping (DAF 2019);
- The environmental values, water quality objectives and designated high ecological value areas scheduled for the Dawson River Sub-basin under the EPP (Water and Wetland Biodiversity) (DEHP 2013);
- Published government studies, such as the State of the Rivers assessments and Aquatic Conservation Assessments (using AquaBAMM methods) (Inglis & Howell 2009);
- Aquatic ecology studies completed to contribute to the existing Baralaba Coal Mine sites' environmental management plan (BMT WBM 2011a);

[1] Formerly the Department of Natural Resources, Mines and Energy (DNRME)

- Aquatic ecology monitoring completed for the Baralaba Coal Mine Receiving Environment Monitoring Program (REMP) and Transitional Environmental Program (TEP) (AARC 2021; AARC 2022; BMT WBM 2011b; c);
- The Aquatic Ecology Assessment for the Baralaba North Continued Operations Project EIS (frc environmental 2014);
- Fish Passage Assessment for Banana Creek Bridge Upgrade (Archer Ecology 2015);
- Middle Road EPBC Act Referral Listed Species Assessments (Archer Ecology 2014);
- The Baralaba South Project Initial Advice Statement (Baralaba Coal Company Limited 2017);
- The terms of reference for the Baralaba South Project environmental impact statement (EIS) dated July 2017; and
- Other published reports and peer-reviewed literature (e.g. Pusey et al. 2004, Limpus et al. 2011, Venz et al. 2002, IESC 2018).

2.2 Field Surveys

2.2.1 Timing

Two comprehensive aquatic ecology baseline surveys of the study area have been completed, one in the dry season and one in the wet season.

The dry season aquatic ecology survey was completed from the 5th to 9th June 2017. The weather was dry and sunny with temperatures ranging from 23 – 25°C. Rainfall in the months prior to the survey was high (above the long-term monthly average) in January and March but low (below the long-term monthly average) in February and April. Some rainfall was recorded in early May (40 mm was recorded between the 10th and 15th May); however, no rainfall occurred in the three weeks leading up to the survey (Bureau of Meteorology Belvedere station 039201; BOM 2018) (Figure 2.1a).

The wet season aquatic ecology survey was completed from the 13th to 19th March 2018. The weather was dry and sunny with temperatures ranging from 30 – 34°C. Rainfall in the months prior to the survey was high (above the long-term average) in October, December and February and close to average in November. Rainfall was also recorded in the week prior to the survey (66 mm was recorded between the 6th and 7th March) (Bureau of Meteorology Belvedere station 039201; BOM 2018) (Figure 2.1b).

A supplementary site inspection was completed from the 1st to 4th of August 2023, to verify that there had been no major changes in aquatic habitat condition and availability since the comprehensive surveys were completed, and to ground truth the location and characteristics of waterways providing for fish passage to be disturbed by the Project. Weather conditions were variable throughout the site inspection with temperatures ranging from 24 – 29°C. A localised storm passed over the survey area on Wednesday the 2nd August, and 7 mm of rain was recorded on Thursday the 3rd August (Bureau of Meteorology Belvedere station 039201; BOM 2023).

2.2.2 Site Details

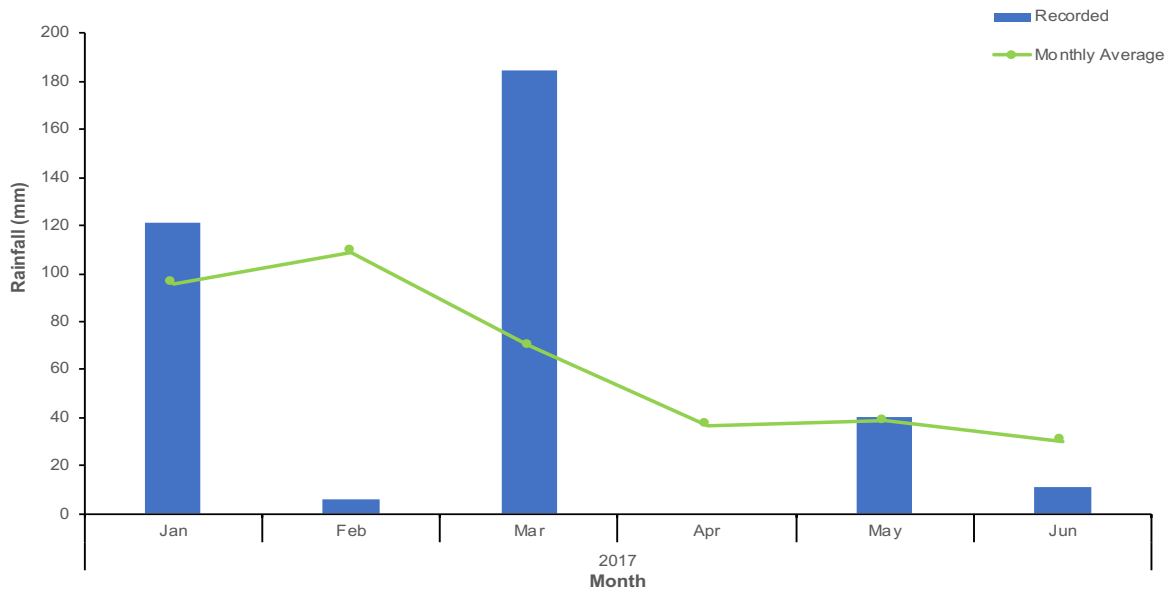
Aquatic habitat, surface water quality, sediment quality, aquatic plants, fish, macroinvertebrates and turtles were surveyed at 10 sites during the comprehensive baseline surveys, including:

- Two sites on the Dawson River downstream of the Project area; one on the Dawson River Anabranch (site DA1) and one on the Dawson River proper (site DR1);
- One site on Shirley's Gully downstream of the Project area (site SG1);
- Two sites on minor unnamed waterways/drainage lines within the Project area; both tributaries of the main unnamed waterway that flows through the Project area (sites UWT1 and UW2);
- Three sites on mapped wetlands within the Project area; two palustrine wetlands (including one HES wetland (sites PW1 and PW2)) and one lacustrine wetland (site LW1); and
- Two sites on Banana Creek; one upstream of (site BC1), and one adjacent to the Project area (site BC2).

The location of the sites is shown on Figure 2.2 and parameters surveyed at each site during each survey is shown in Table 2.1.

Aquatic habitat was re-surveyed at the above 10 sites during the supplementary site inspection. In addition, the mapped waterways providing for fish passage (as per the WWBW spatial layer) within the proposed disturbance footprint were ground-truthed at additional waterway determination sites (Table 2.2; Figure 2.3).

a)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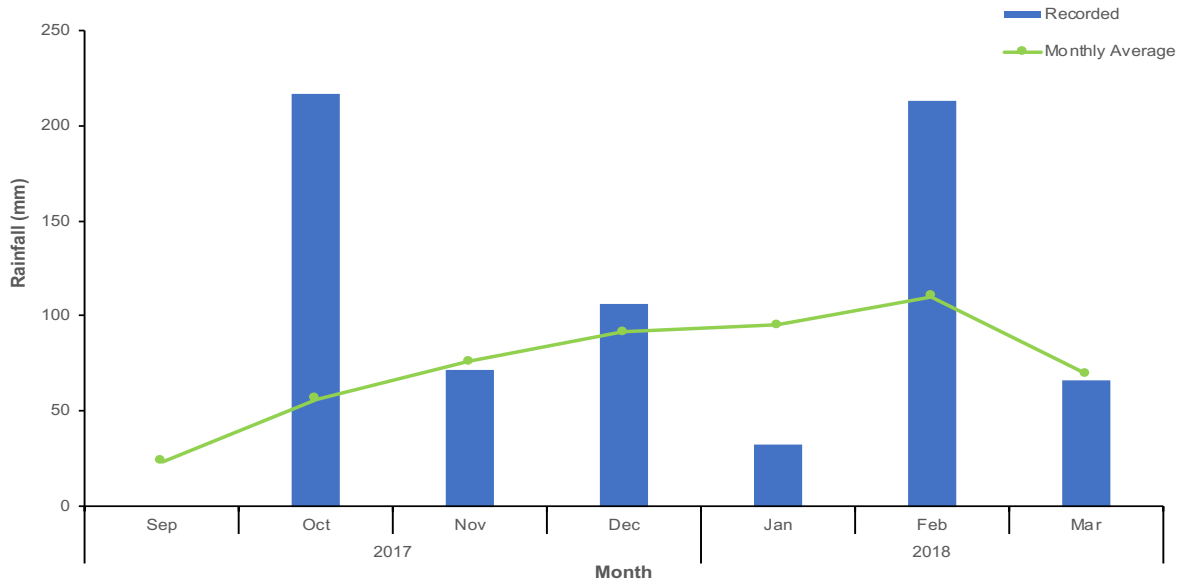
Recorded
Monthly Average
Rainfall (mm)
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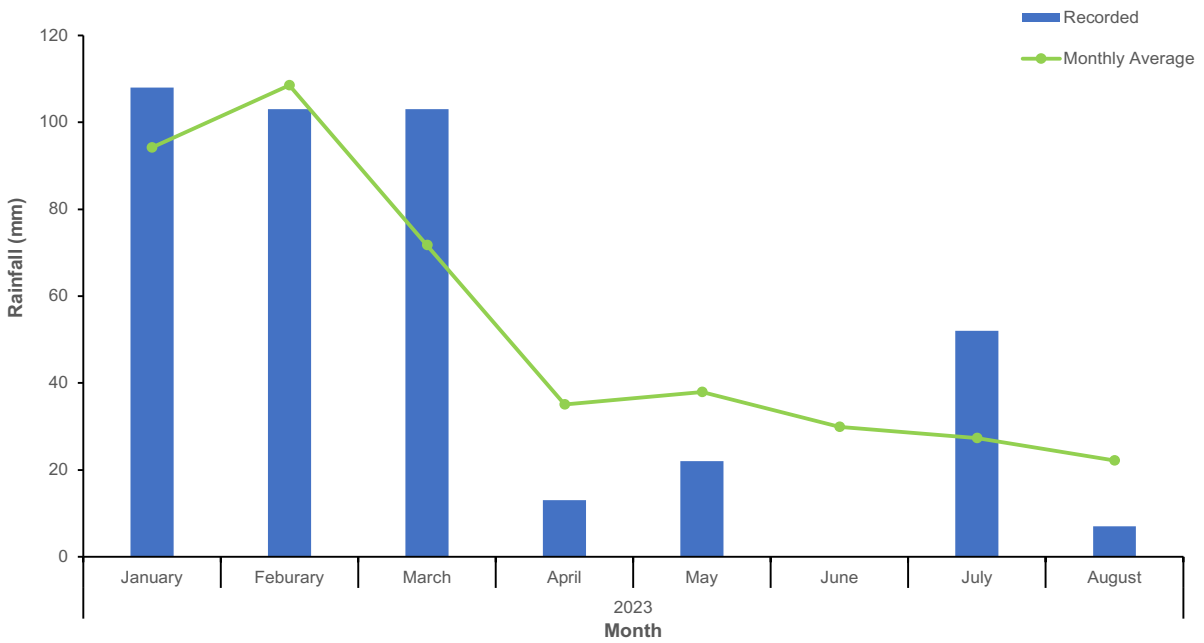

Figure 2.1 Monthly average and recorded rainfall data leading up to a) the June 2017 survey b) the March 2018 survey and c) the August 2023 site inspection.

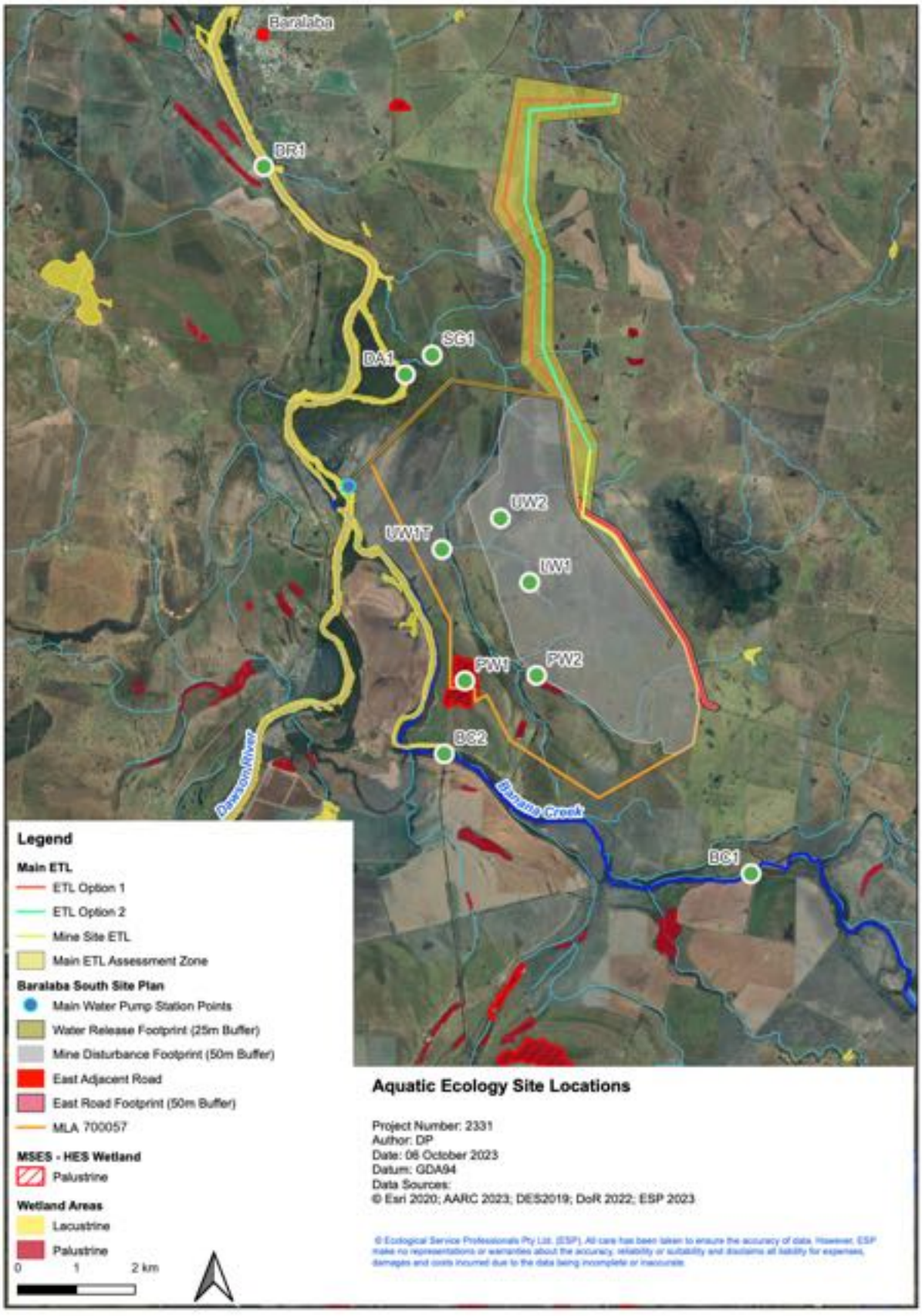

Figure 2.2 Location of aquatic ecology survey sites.

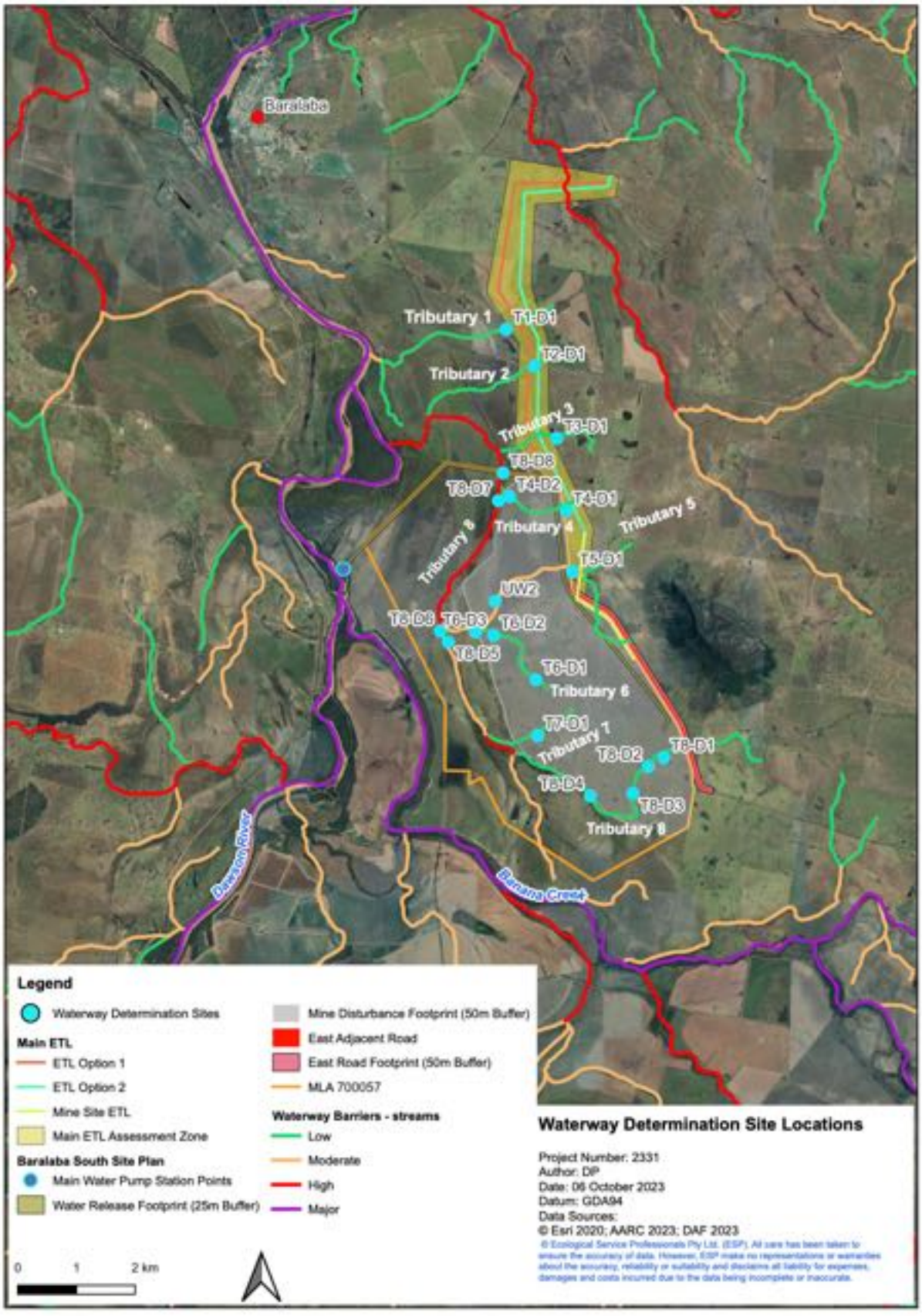

Figure 2.3 Location of waterway determination sites and tributary names.

Table 2.1 Aquatic ecology survey site locations, names, coordinates, and ecological indicators assessed at each site during the comprehensive baseline surveys in June 2017 and March 2018.

Location	Site	Latitude	Longitude	June 2017						March 2018						
				Aquatic Habitat	Water Quality	Sediment Quality	Aquatic Plants	Fish & Turtles	Macroinvertebrates	Aquatic Habitat	Water Quality	Sediment Quality	Aquatic Plants	Fish & Turtles	Macroinvertebrates	Listed Species
Downstream of the Project area																
Dawson River	DR1	-24.2022°	149.8139°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Dawson River anabranch	DA1	-24.2337°	149.8383°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Shirley's Gully	SG1	-24.2306°	149.8428°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Within the Project area																
Unnamed waterway tributary	UW1T	-24.2604°	149.8451°	yes	yes	yes	yes	yes	yes	yes	–	yes	yes	–	–	NA
Unnamed waterway	UW2	-24.2555°	149.8548°	yes	–	yes	yes	–	–	yes	–	yes	yes	–	–	NA
Lacustrine wetland	LW1	-24.2652°	149.8599°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NA
Palustrine wetland	PW1	-24.2806°	149.8494°	yes	–	yes	yes	–	–	yes	–	yes	yes	–	–	NA
	PW2	-24.2795°	149.8614°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NA
Upstream / adjacent to the Project area																
Banana Creek	BC1	-24.3093°	149.8981°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	BC2	-24.2919°	149.8462°	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

– Not surveyed as site was dry

NA ecological indicator not assessed at site because suitable habitat was not present

Table 2.2 Waterway determination site locations surveyed during the August 2023 supplementary site inspection.

Tributary Name and Description	Site	Latitude	Longitude
Within the Electricity Transmission Line Assessment Zone			
Tributary 1 to the Dawson River	T1-D1	-24.2137°	149.8557°
Tributary 2 to the Dawson River	T2-D1	-24.2192°	149.8606°
Tributary 3 to the Dawson River	T3-D1	-24.2303°	149.8646°
Tributary 4 to the Dawson River	T4-D1	-24.2414°	149.8664°
Tributary 5 to the Dawson River	T5-D1	-24.2507°	149.8677°
Within the Disturbance Footprint			
Tributary 4 to the Dawson River	T4-D2	-24.2394 °	149.8568 °
Tributary 5 to the Dawson River	UW2*	-24.2555°	149.8548°
Tributary 6 to the Dawson River	T6-D1	-24.2674 °	149.8619 °
	T6-D2	-24.2608 °	149.8547 °
	T6-D3	-24.2603°	149.8516°
Tributary 7 to the Dawson River	T7-D1	-24.2760°	149.8624°
Tributary 8 to the Dawson River	T8-D1	-24.2790°	149.8836°
	T8-D2	-24.2804°	149.8811°
	T8-D3	-24.2846°	149.8785°
	T8-D4	-24.2852°	149.8714°
	T8-D5	-24.2619°	149.8470°
	T8-D6	-24.2603°	149.8457°
	T8-D7	-24.2401°	149.8550°
	T8-D8	-24.2358°	149.8557°

* Also an aquatic ecology assessment site

2.2.3 Aquatic Habitat

Aquatic habitat was assessed at each site in both the dry and wet season baseline surveys, and in the supplementary site inspection, based on the Australian River Assessment System (AUSRIVAS) habitat assessment protocol, modified where required to suit the purposes of this study. Observations for aquatic habitat value included:

- Features of the water body, including bank height, estimate of flow, estimated width and depth of any standing water present;
- Aquatic plants (cover, growth form and species);

- Details of the riparian zone (e.g. width, canopy height, species present) and adjacent land use;
- Details of surrounding land use and disturbance, and how it may be impacting on aquatic habitat and communities;
- Aquatic habitat types present and their relative percent cover within the reach;
- Channel characteristics (e.g. description of beds and banks, channel width and gradient); and
- Details of the sediment types present (e.g. relative percent cover of different grain sizes, presence of anoxic sediments).

The overall habitat condition of each waterway site (except for dry sites and excluding palustrine and lacustrine wetlands) was described based on the River Bio-assessment Scoring system described in the Queensland AUSRIVAS Sampling and Processing Manual (DNRM 2001). Sites were assessed on a number of criteria and given a numeric score for each criterion. The sum of the numerical rating from each criterion produced an overall habitat condition score that allocated each site to one of four categories. Sites with scores of:

- >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.

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 these descriptions contributed to interpretation of the biological survey results and the impact assessment.

2.2.4 Waterways Providing for Fish Passage

A ‘waterway providing for fish passage’ is defined under the *Fisheries Act 1994* (Fisheries Act) as a waterway such as a river, creek, stream, watercourse, drainage feature or inlet of the sea. A waterway as defined by Queensland Department of Agriculture and Fisheries (DAF) (2023) must have at least one of the following:

- Defined bed and banks:
    - The bed and banks need to be continuous upstream and downstream of the site rather than isolated and broken sections of a depression. However, the most upstream extent of a waterway may not have defined bed and banks further upstream.
- Flow adequacy:
    - The flow needs to be sufficient to sustain basic ecological processes and habitats, and to maintain biodiversity within or across the feature. The adequacy of the flow depends on the ecological function of the channel e.g. some waterways that connect to fish habitat like a wetland or waterhole may only need infrequent and short-duration flows to provide connectivity for fish.

- Fish habitat at, or upstream of, the site:
    - Most instream features provide habitat for fish under adequate flow conditions or, in the case of pools, during dry periods. Therefore, it is important to have some knowledge of the fish species for the site and their habitat use, particularly in headwater streams. The ability to provide constant or periodic connectivity to upstream and off-stream fish habitat is also considered a feature of a waterway.

The Environmental Offsets Regulation 2014 (EO Regulation) states that any part of a waterway providing for passage of fish is a Matters of State Environmental Significance (MSES) if the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway.

Data collected at each waterway determination site during the August 2023 supplementary site inspection included:

- GPS locations (waypoints) for each site;
- An assessment against the criteria for a waterway providing for fish passage, as outlined above;
- Photographs of upstream, downstream, and left and right banks;
- A measurement of bankfull width, main channel width (refer below) and low flow channel width where a waterway was present; and
- A brief description of the observed habitat features, where a waterway was present.

Representative photographs and the detailed results of the waterway determination assessments are provided in Appendix D. Publicly available aerial photographs and digital elevation models (DEM) (ELVIS 2023), the 'hillshade' layer on Queensland Globe, the outcomes of the geomorphology assessment (WRM 2023) and LiDAR data provided by AARC (as shown in Figure 4.3 of the Flood Impact Assessment Report (Engeny Water Management 2023b) were reviewed to supplement the waterway determination assessment. Localised rainfall restricted access to the disturbance footprint throughout the second half of the survey. Due to the presence of black soil in the area, the field team was instructed by property owners to drive tracks in good condition only. However, mapped waterways were walked between waterway determination sites where access was possible and deemed safe.

Appendix 3 of the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (ADRs) (DAF 2018) provides guidance on what constitutes the main channel.

The following definitions are provided in the ADRs (as illustrated in Figure 3):

- Bankfull width is the width of the waterway at the bankfull level.
- Main channel is the active component of the flow channel characterised by a distinct change in appearance or structure at the upper limit of the channel such as undercutting, changes in vegetation density, sudden changes in bank slope, boundary levels for water marks, mosses or lichens, changes in sediment particle size.

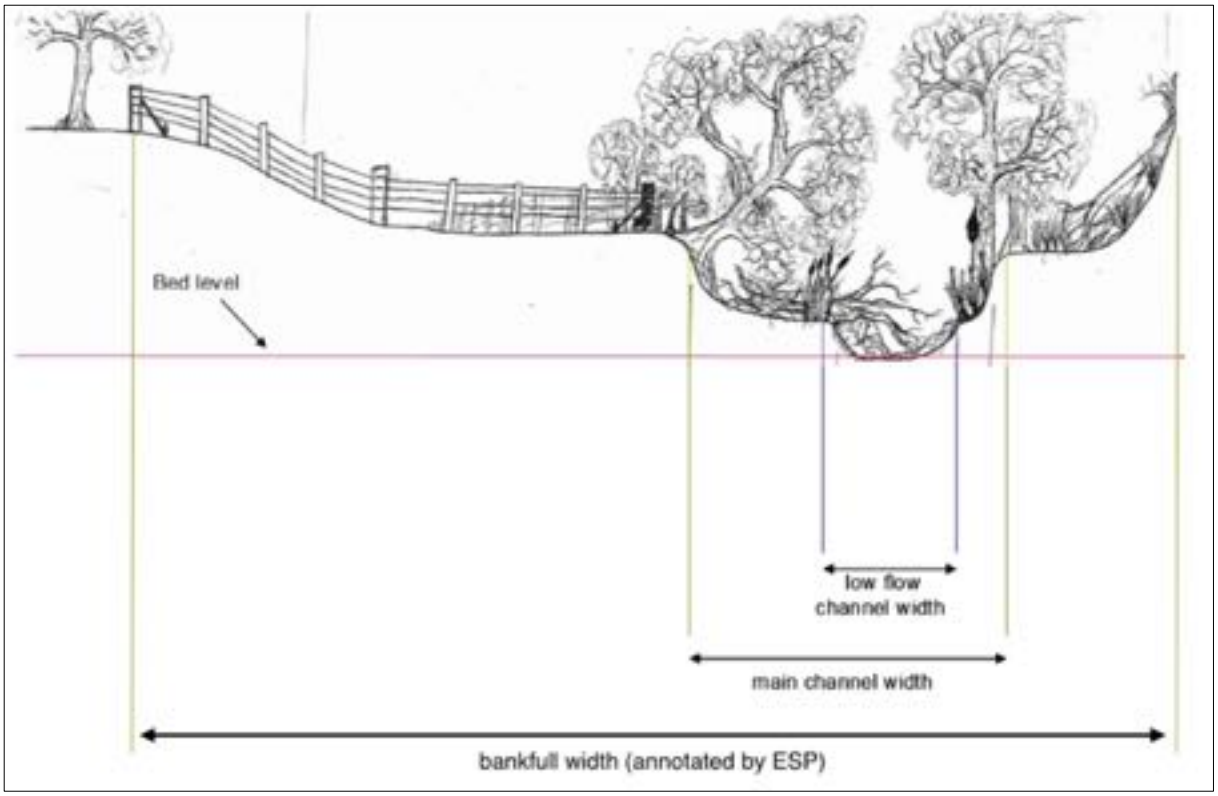

Figure 2.4 Example of waterway cross section showing main channel, low flow channel and bankfull width (adapted from DAF 2018).

2.2.5 Surface Water Quality

Surface water quality data was collected to provide an indication of the condition of water quality at the time of the surveys to inform the interpretation of biological survey results. At each site that held sufficient water in both the dry and wet season baseline surveys, and in the supplementary site inspection, 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 20 cm below the water surface. The water quality meter was calibrated according to the manufacturers' recommendations prior to field sampling.

Grab samples were also collected from 30 cm below the water surface during the dry and wet season baseline surveys. All water quality sampling was undertaken in accordance with the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a). All samples were held under the appropriate conditions (e.g. in eskies in the field and during transport) and delivered to ALS Environmental (a National Association of Testing Authorities [NATA] accredited laboratory) within the required holding times for analysis of the parameters included in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (ESR/2015/1561, formerly EM288, DES 2018b). The parameters analysed were:

- Total suspended solids (TSS);
- Nutrients (total nitrogen, nitrate, nitrite, oxides of nitrogen (NOx), ammonia, Total Kjeldahl Nitrogen (TKN), reactive and total phosphorous);
- Total hardness;
- Major cations (calcium, magnesium and sodium);

- Major anions (fluoride and sulfate);
- 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); and
- Total petroleum hydrocarbons (TPHs) and total recoverable hydrocarbons (TRHs).

The results were reviewed, and all parameters that were 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) (Table 2.3) adopted from the following sources:

- WQOs for Lower Dawson River Sub-basin waters (used for comparison to waterway and palustrine wetland sites DA1, DR1, BC1, BC2, UW1T, SG1 and PW2) published for the Dawson River Sub-basin (DEHP 2013);
- WQOs for freshwater lakes/reservoirs (used for comparison to lacustrine wetland (dam) site LW1) published for the Dawson River Sub-basin (DEHP 2013);
- Default guideline values (DGVs) for slightly to moderately disturbed ecosystems for 95% level of protection (unless otherwise recommended) published in the National water quality guidelines (ANZG 2018); and
- Trigger levels (TLs) for aquatic ecosystem protection specified in the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2018b).

Increasing hardness results in decreased toxicity of some metals. The DGVs for some metals (e.g. cadmium, chromium, lead, nickel and zinc) outlined in National guidelines apply to waters with a standard hardness value of 30 mg/L calcium carbonate ($CaCO_3$). Where water hardness was above this value at a site, and where concentrations of these metals were above the DGV site-specific hardness modified guideline values (HMGVs) were calculated in accordance with recommendations in Batley et al. (2018) and Warne et al. (2018) (Table 2.4).

Table 2.3 Water Quality Objectives for the analysed parameters.

Parameter	Units	WQO
Physical		
Temperature	ºC	
EC	µS/cm	340[a],250[b]
pH	pH units	6.5 – 8.5[a],6.5 – 8.0[b]
DO	% sat.	85 – 110[a],90 – 110[b]
Turbidity	NTU	50[a], 1 – 20[b]
Total Suspended Solids	mg/L	<10[a]
Ions		
Total Hardness	mg/L	–
Sulfate	mg/L	<25[a]
Fluoride	mg/L	–
Calcium	mg/L	–

Parameter	Units	WQO
Magnesium	mg/L	–
Sodium	mg/L	–
Nutrients		
Ammonia	µg/L	<20[a],<10[b]
Nitrite	µg/L	–
Nitrate	µg/L	–
Nitrite + Nitrate	µg/L	<60[a],<10[b]
Total Kjeldahl Nitrogen	µg/L	–
Total Nitrogen	µg/L	<500[a],<350[b]
Reactive Phosphorus	µg/L	<20[a],<5[b]
Total Phosphorus	µg/L	<50[a],<10[b]
Dissolved Metals and Metalloids		
Aluminium	µg/L	55[c]
Arsenic	µg/L	13[g]
Boron	µg/L	940[c]
Cadmium	µg/L	0.2 x (H/30)$^{0.89}$[d]
Chromium	µg/L	0.1[h]
Cobalt	µg/L	90[e]
Copper	µg/L	1.4
Iron	µg/L	300[f]
Lead	µg/L	3.4 x (H/30)$^{1.27}$, [d]
Manganese	µg/L	1700[e]
Mercury	µg/L	0.06[j]
Molybdenum	µg/L	0.2[i]
Nickel	µg/L	11 x (H/30)$^{0.85}$[d]
Selenium	µg/L	5[j]
Silver	µg/L	0.05[c]
Uranium	µg/L	1.0[j]
Vanadium	µg/L	10[j]
Zinc	µg/L	8.0 x (H/30)$^{0.85}$[d]
Total Petroleum Hydrocarbons (TPHs)		
C6 - C9 Fraction	µg/L	20[j]
C10 - C14 Fraction	µg/L	–
C15 - C28 Fraction	µg/L	–
C29 - C36 Fraction	µg/L	–
C10 - C36 Fraction (sum)	µg/L	100[j]

[a] WQOs from Lower Dawson River Sub-basin waters (WQ1309) (DEHP 2013) used for comparison to waterway and palustrine wetland sites DA1, DR1, BC1, BC2, UW1T, SG1 & PW2.

[b] WQOs for freshwater lakes/reservoirs (DEHP 2013) used for comparison to lacustrine wetland (dam) site LW1.

[c] DGV for 95% of species protection for slightly to moderately disturbed waters (ANZG 2018).

[d] DGV modified based on water hardness-dependent algorithm, where TV = trigger value; H = water hardness.
[e] Moderate reliability DGV (ANZG 2018).
[f] Interim WQO based on Canadian guideline value, as per recommendations in ANZG (2018).
[g] DGV for arsenic V (ANZG 2018), adopted as a conservative approach, because analyses did not speciate arsenic.
[h] DGV for chromium VI (ANZG 2018), adopted as a conservative approach because analyses did not speciate chromium.
[i] DGV for 99% of species protection for slightly to moderately disturbed waters as per recommendations in (ANZG 2018).
[j] TL for aquatic ecosystem protection outlined in the model mining conditions (DES 2018b).

Table 2.4 Hardness modified guideline values (HMGVs) calculated for each site for relevant contaminants in June 2017 and March 2018 based on hardness-dependent algorithms.

Metal[a]	Survey	DR1	DA1	SG1	UW1T	LW1	PW2	BC1	BC2
Lead µg/L	Jun-17	5.1	4.1	5.1	7.2	13.0	11.8	43.7	13.5
	Mar-18	4.1	4.1	5.1	–	11.6	9.8	7.0	5.5
Zinc µg/L	Jun-17	10.4	9.1	10.4	13.2	19.6	18.4	44.2	20.2
	Mar-18	9.1	9.1	10.4	–	18.2	16.2	13.0	11.1

[a] HMGVs not calculated for cadmium and nickel, as concentrations of these metals were below the LOR or the DGV at all sites.

2.2.5.1 Quality Assurance / Quality Control

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.

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 percent difference (RPD) of <20% between field replicates was deemed acceptable (where the values were more than five to ten times the laboratory limit of reporting) (DES 2018a). The laboratory also completed quality control measures including analysis of blanks, spikes, and duplicates. A Certificate of Analysis for water quality samples is provided in Appendix B.

2.2.6 Sediment Quality

Sediment quality in the stream channel was assessed at each site during the comprehensive baseline surveys to inform the interpretation of biological survey results. A single sample was collected from a low-flow stream bank using a stainless-steel trowel. Samples were transferred into suitable glass jars provided by and sent to ALS Environmental (a NATA accredited laboratory) for analysis within the required holding times. Samples were held under the appropriate conditions in eskies on ice and during transport and refrigerated at other times. The samples were analysed for concentrations (mg/kg) of:

- Total metals and metalloids (aluminium, arsenic, boron, cadmium, chromium, cobalt copper, lead, iron, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium, and zinc); and
- TPHs and TRHs.

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 for sediments and to the GV-High as outlined in ANZG (2018) and Simpson et al. (2013) (Table 2.5).

Table 2.5 Default guideline values for sediment quality (ANZG 2018).

Parameter	Units	DGV	GV-High[a]
Metals			
Aluminium	mg/kg	–	–
Arsenic	mg/kg	20	70
Beryllium	mg/kg	–	–
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	1.0
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 (TPHs)			
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

[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.

2.2.6.1 Quality Assurance / Quality Control

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.

In both baseline 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 percent difference (RPD) of <50% 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 Appendix B.

2.2.7 Aquatic Plants

Aquatic plant communities were quantitatively assessed at each site during the comprehensive baseline surveys 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 aquatic plants;
- Aquatic plant growth form (i.e. submerged, emergent, floating); and
- Percent cover of each species (both native and exotic).

The total taxonomic richness and percent cover were calculated for each site.

2.2.8 Aquatic Macroinvertebrates

Macroinvertebrate communities (including macrocrustaceans) were sampled in both the dry and wet season baseline surveys at each site that held sufficient water (Table 2.1). A standard, triangular framed dip net (250 µm mesh) was used and one AUSRIVAS sample was collected from a 10 m section of each available habitat type (e.g. bed / pool, edge, riffle, run) at each site using the standard kick sweep method. Any macrocrustaceans (e.g. prawns, shrimp and yabbies) caught during fish surveys were also recorded. Macroinvertebrates were preserved in the field using a 70% ethanol solution and transported back to ESP's laboratory to be sorted, counted, and identified to the lowest practical taxonomic level (in most instances family) to comply with standard AUSRIVAS methodology.

Once transported to the laboratory, individual samples were logged into a register for tracking, as per ESP's laboratory quality procedure. Each sample was picked for 30 minutes in which time at least 20 individuals (where abundance allowed) of each macroinvertebrate taxa were picked. After this time, an additional 10 minutes was spent searching specifically for new taxa; if any new taxa were found in the 10 minutes, the picking time was extended by another 10 minutes.

Macroinvertebrates were then identified to the lowest practical taxonomic level (i.e. family level for most taxonomic groups, sub-family for Chironomids and higher level for worms, mites and microcrustaceans), and counted, to comply with standard AUSRIVAS methodology (DNRM 2001).

2.2.8.1 Quality Assurance/Quality Control

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

2.2.8.2 Macroinvertebrate Indices

Macroinvertebrate indices were calculated for each sample, including:

- Abundance: total number of animals at each site;
- 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 are 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). Taxa that do not have a sensitivity grade number, for example Copepoda, Cladocera and Ostracoda, were not used in the calculation of the SIGNAL Index as recommended in the *Monitoring and Sampling Manual: Environmental Protection (Water) Policy* (DES 2018a). 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.

Indices at each site sampled were compared against the relevant biological objectives outlined for the Dawson River Sub-basin (DEHP 2013) (Table 2.6). The values are derived for streams (i.e. flowing waters) and as such comparisons of results from wetland with the biological objectives should be interpreted with caution.

Table 2.6 Freshwater macroinvertebrate guideline values for moderately disturbed waters in the lower Dawson River Sub-basin (DEHP 2013).

Index	Habitat [a]	Guideline Values
Taxa richness	Composite	12 – 21
	Edge	23 – 33
PET taxa richness	Composite	2 – 5
	Edge	2 – 5
SIGNAL Score	Composite	3.33 – 3.85
	Edge	3.31 – 4.20

[a] Composite is a mixture of all bed habitats within the site (e.g. sandy pool, rocky pool, riffle, run, cascade); the guideline value for composite is applicable to bed and riffle samples.

A SIGNAL 2 / family bi-plot was also produced by plotting the SIGNAL 2 scores against the number of families found in the sample (Chessman 2003). SIGNAL 2 / family bi-plots are a means of interpreting waterway health conditions and impacts at sites; the bi-plot is divided into four quadrants, with each quadrant indicative of environmental conditions that may influence a community (Figure 2.5). Quadrant boundaries for the SIGNAL 2 / Family Bi-plot used for this assessment are based on the lower (20th percentile) WQO values for taxonomic richness and SIGNAL scores.

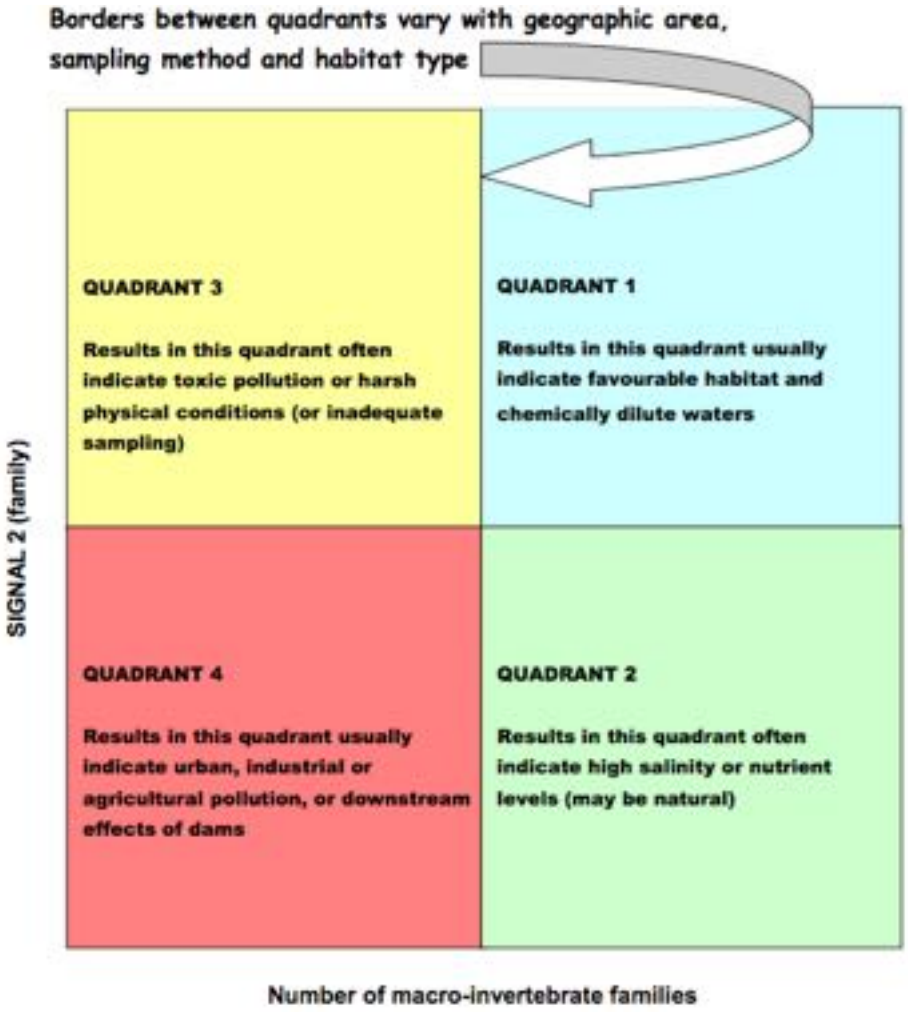

Figure 2.5 Quadrant diagram for SIGNAL2 / Family Bi-plot (Chessman 2003).

2.2.9 Fish

Fish assemblages were surveyed in both the dry and wet season baseline surveys at each site holding sufficient water (Table 2.1), using a combination of methods depending on the habitat characteristics of the site. The methods included boat electrofishing (BEF), fyke nets, seine netting and baited box traps. Survey methods and effort used at each site during each survey are displayed in Table 2.8. 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 173341 (June 2017) / 193593 (March 2018), Animal Ethics Approval CA2014/07/794 (June 2017) / CA 2017/06/1072 (March 2018) and Scientific Purposes Permit WISP14986614.

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 of native fish caught at each site was measured. Pest fish were identified, counted, and euthanized 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.

2.2.10 Turtles

The Terrestrial Vertebrate Survey Guidelines for Queensland (Eyre et al. 2018) recommends that turtle surveys in freshwater areas of Queensland employ one or more of the following capture techniques: visual survey, snorkelling, spotlighting, trapping and/or seine netting. Additionally, the partly carnivorous diet of the Fitzroy River turtle (*Rheodytes leukops*) indicates it might be attracted to meat baits in traps and nets.

General surveys for turtles were completed during the dry season survey at sites that held sufficient water, and included (Table 2.8):

- Electrofishing from boat – while this sampling was specifically targeting fish, turtles are usually observed and sometimes incidentally caught and released during this activity;
- Baited fyke nets (117.5 hrs over 3 days) – this sampling specifically targeted both fish and turtles; and
- Seine netting (1 sweep at site BC2) – this sampling specifically targeted both fish and turtles.

During the dry season survey, a habitat assessment was completed to determine the presence of suitable or preferred habitat for the threatened Fitzroy River turtle (*Rheodytes leukops*) and white-throated snapping turtle (*Elseya albagula*). Suitable turtle and nesting habitat that is preferred by these species includes:

- General habitat features such as:
    - 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).

The habitat provided within the Dawson River and Banana Creek adjacent to and downstream of the Project is characterised by a large, deep weir pool created by the Neville Hewitt Weir downstream of the Project. These reaches are mapped as lacustrine wetland by DES under the Queensland Wetlands Mapping Program (Figure 2.2). The waterways do not provide the preferred / key riverine habitat characteristics for these species (such as pool and riffle sequences, diversity of substrate and habitat types; refer to Sections 4.10.2 & 4.10.3) in the vicinity of the site, although it is acknowledged that the Fitzroy river turtle and white-throated snapping turtle can and do occur in the upper reaches of weir pools in the Dawson River (Limpus et al. 2011; Limpus, C. [DES] pers. comm. 2020). Both waterways are highly turbid. It was considered that the Dawson River and anabranch, and lower reaches of Shirley's Gully and Banana Creek provided potential, albeit not preferable, habitat for the Fitzroy river turtle and white-throated snapping turtle. As such, along with repeating the general surveys described above, additional survey effort for the Fitzroy river turtle and white-throated snapping turtle was completed in the wet season survey within these waterways.

The methods used for the turtle surveys in the wet season survey included (Table 2.8):

- Spotlighting from boat in the Dawson River and Shirley's Gully (over a 1 km distance) and from the bank in Banana Creek (over a 100 m distance) (19.25 hrs over 4 days);
- Electrofishing from boat – as above this method did not target turtles but turtles were incidentally recorded;
- Baited fyke nets (125 hrs over 4 days); and
- Daytime searching for nests and assessment of potential habitat.

All sampling was completed in accordance with the *Survey Guidelines for Australia's Threatened Reptiles* (Commonwealth of Australia 2011), the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (Eyre et al. 2018) as well as relevant permits issued to ESP, including Animal Ethics Approval CA2014/07/794 (June 2017) / CA 2017/06/1072 (March 2018) and Scientific Purposes Permit WISP14986614.

Once caught, turtles were identified and returned to the environment from which they were caught.

2.2.10.1 Limitations

The Fitzroy River turtle is difficult to survey as this species rarely enters traps. The *Survey Guidelines for Australia's Threatened Reptiles* (Commonwealth of Australia 2011) suggests the Fitzroy River turtle is readily observed in the riffle zones by diving with a face mask and snorkel, or collected by seine netting. The Commonwealth survey guidelines indicate that snorkelling, where possible, is considered to be the preferred and generally most successful means of surveying the majority of threatened turtle species occurring in rivers. However, as noted in the *Terrestrial Vertebrate Fauna Survey Guidelines for Queensland* (Eyre et al. 2018), the success of the snorkelling technique is limited by water clarity.

For the current survey, the methods that are considered the most effective (hand capture via snorkelling and muddling, and seine-netting) were not possible within the study area due to high turbidity levels, and the high abundance of in-stream woody debris (with the exception of site BC2 in Banana Creek where seine netting was completed; Table 2.8). This is a common constraint for surveys of Fitzroy River turtle in the Dawson River (Limpus, C. [DES] pers. comm. 2020; Venz, M. [Queensland Herbarium] pers. comm. 2020). Evening spot-lighting was the most suitable method for the targeted Fitzroy River turtle surveys based on the conditions in the survey area; however, the effectiveness was still limited due to the high turbidity (higher than average) at the time of the survey. The effectiveness of evening spotlighting is limited when visibility through the water is <60 cm (Limpus, C. [DES] pers. comm. 2020). To compensate, additional effort was employed to assess the suitability of habitat at each site to support the Fitzroy River turtle and white-throated snapping turtle, and reviewing available data on the occurrences of listed turtle species in the region to inform the likelihood of their occurrence in the study area.

2.2.11 Platypus

Habitat features preferred by platypus (*Ornithorhynchus anatinus*) were noted if present such as:

- Permanent pools (not deeper than 5 m) with runs and riffles;
- A diversity of instream features to refuge amongst (e.g. submerged aquatic vegetation, submerged rock crevices, undercut banks and/or submerged logs and fallen trees); and
- Relatively steep earth banks well-consolidated by riparian vegetation and with growth overhanging the bank (Scott and Grant 1997).

In March 2018, targeted surveys for platypus were completed at sites identified as having potentially suitable habitat during the June 2017 survey (i.e. at sites on the Dawson River, Shirley's Gully and Banana Creek). Visual surveys were completed at dusk at each site for a period of one hour from a boat or from the bank over a distance of 100 m – 1 km.

Survey methods and effort used at each site during each survey are displayed in Table 2.8.

2.2.12 Aquatic Ecosystem Values

The overall aquatic ecosystem values of the waterways and wetlands were identified based on the criteria outlined in Table 2.7. 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.

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 2.7 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

Table 2.8 Survey effort for each fish and turtle survey method used at each site in June 2017 and in March 2018.

Location	Site	Method	#	Date	Time In	Date	Time Out	Total Effort
June 2017								
Dawson River	DA1	Boat e-fisher	1	6/06/17	9:45	6/06/17	11:00	1212s
	DR1	Boat e-fisher	1	6/06/17	11:45	6/06/17	13:45	1244s
Shirley's Gully	SG1	Fyke net	2	8/06/17	13:00	9/06/17	8:15	38.5hr
Un-named Waterway	UW1T	Fyke net	1	7/06/17	13:00	8/06/17	9:45	20.75hr
		Box traps	5	7/06/17	13:00	8/06/17	9:45	103.75hr
Lacustrine Wetland	LW1	Boat e-fisher	1	6/06/17	15:00	6/06/17	15:50	434s
Palustrine Wetland	PW2	Fyke net	1 [d]	6/06/17	16:45	7/06/17	9:00	16.25hr
Banana Creek	BC1	Fyke net	1	8/06/17	9:15	9/06/17	10:00	24.75hr
		Box traps	5	8/06/17	9:15	9/06/17	10:00	123.75hr
	BC2	Fyke net	1 [d]	7/06/17	15:15	8/06/17	8:00	17.25hr
		Box traps	5	7/06/17	15:15	8/06/17	8:00	86.25hr
		Seine net	1	7/06/17	10:40	7/06/17	10:50	1 sweep
March 2018								
Dawson River	DA1	Boat e-fisher	1	15/03/18	14:00	15/03/18	14:45	1200s
			1	15/03/18	19:30	15/03/18	20:30	
		Spotlighting [a]	3	15/03/18	18:45	15/03/18	20:30	5.25hr
	DR1	Boat e-fisher	1	14/03/18	18:30	14/03/18	20:30	1450s
			1	15/03/18	15:00	15/03/18	16:30	
		Spotlighting [a]	3	14/03/18	18:30	14/03/18	20:30	6hr
Shirley's Gully	SG1	Boat e-fisher	1	15/03/18	12:00	15/03/18	13:15:00	800s
		Spotlighting [a]	3	14/03/18	18:30	14/03/18	20:30	6hr
		Fyke	1 [c]	17/03/18	14:00	18/03/18	9:30	20.5h

Location	Site	Method	#	Date	Time In	Date	Time Out	Total Effort
Lacustrine Wetland	LW1	Boat e-fisher	1	16/03/18	8:00	16/03/18	9:00	714s
		Fyke	1 [c]	16/03/18	16:00	17/03/18	9:00	17h
Palustrine Wetland	PW2	Fyke	1 [d]	16/03/18	14:45	17/03/18	9:15	19.5hr
		Box traps	5	16/03/18	14:45	17/03/18	9:15	97.5hr
Banana Creek	BC1	Fyke	2	17/03/18	17:30	18/03/18	11:00	35h
		Box traps	5	17/03/18	18:30	18/03/18	11:00	82.5hr
		Spotlighting [b]	2	17/03/18	18:45	17/03/18	19:15	1 hr
	BC2	Fyke	2	18/03/18	15:00	19/03/18	7:30	33hr
		Box traps	5	18/03/18	15:00	19/03/18	8:00	85hr
		Spotlighting [b]	2	18/03/18	18:45	18/03/18	19:15	1 hr

s seconds, hr hours

[a] spotlighting completed from boat over a 1 km distance; silent spotlighting for platypus was conducted for 30 minutes before commencing night electrofishing and spotlighting for threatened turtles was completed continuously in conjunction with night electrofishing effort

[b] spotlighting completed from bank over a 100 m distance

[c] one large mesh fyke net set as additional survey effort to target turtles

[d] one small mesh fyke net set due to site conditions (not enough water or depth in the pools to allow an additional large mesh net to be set)

3 Relevant Legislation, Policy, 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 3.1. In summary, the key items relating to aquatic ecology are:

- The potential presence of listed threatened aquatic species, specifically:
    - Fitzroy River turtle - vulnerable (EPBC Act, NC Act);
    - white-throated snapping turtle - critically endangered (EPBC Act, NC Act)[2];
    - silver perch (*Bidyanus bidyanus*) - critically endangered (EPBC Act)[3];
    - Murray cod (*Maccullochella peelii*) - vulnerable (EPBC Act);
- The presence of water resources (waterways and potential surface-expression GDEs) and mapped HES wetlands (also a matter of state environmental significance, MSES);
- Mapped waterways providing for fish passage (under the *Queensland Waterways for Waterway Barrier Works* spatial layer) which are a MSES as defined under the *Environmental Offsets Regulation 2014* (EO Regulation), only if the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway (though it is noted that that approvals for waterway barrier works are not required within the Mining Lease); and
- The presence of listed pest species of aquatic plants and animals.

The estuarine crocodile (*Crocodylus porosus*) was listed in the EPBC Protected Matters Search Tool Report as potentially occurring within 1 km of the Project area. However, this species is considered highly unlikely to occur due to lack of suitable habitat, the existence of multiple weirs and barrages downstream of the study area, and no known records in the study area, and it is not considered further.

[2] At the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547) the white-throated snapping turtle was not listed as threatened under the EPBC Act and therefore is not considered a MNES for the Project.

[3] At the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547) the silver perch was not listed as threatened under the EPBC Act and therefore is not considered a MNES for the Project.

Table 3.1 Summary of relevant legislation, policies, and guidelines relating to aquatic ecology that are relevant to the Project area.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides for the protection and management of nine matters of national environmental significance (MNES).	The project has been determined to be a controlled action, i.e. it requires assessment against the EPBC Act. The relevant controlling provisions are: • listed threatened species and communities • listed migratory species, and • water resources.	The potential for aquatic MNES species to be present in the study area is discussed in Sections 4.9 and 4.10.
Queensland			
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 Dawson River Sub-basin.	The potential for aquatic pest species in the study area is discussed in Sections 4.7 and 4.9.
Environmental Offsets Act 2014 (Offsets Act) and the subordinate *Environmental Offsets Regulation 2014*	Seeks to counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets.	Offsets may be required if there is a significant residual impact to a Matter of State Environmental Significance (MSES) as prescribed in Schedule 2 of the Offsets Regulations 2014.	The aquatic MSES in the Project area and broader study area are discussed in Section 4. The requirement for environmental offsets (relating to aquatic ecology) are discussed in Section 6.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Environmental Protection Act 1994 (EP Act) and the subordinate *Environmental Protection Regulation 2019*	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 Section 4.
EP Act and the subordinate *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity))	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 Dawson River Sub-basin under Schedule 1 of the EPP (Water and Wetland Biodiversity). A HES wetland (designated as a wetland protection area (WPA) in Great Barrier Reef catchments) is mapped within the Project area. There are no high ecological value waterways within the Project area or the broader study area.	The aquatic ecological values of wetlands, waterways, and surface-expression GDEs protected under the EPP (Water and Wetland Biodiversity) are described in Section 4.2.2. The results of water quality and sediment quality sampling are provided in Sections 4.5 and 4.6. The aquatic ecological values of habitats comprising the HES wetland are described in Section 4.2.2. Terrestrial values of the HES wetland are described in the terrestrial ecology impact assessment report (Ecological Survey & Management 2023).
Fisheries Act 1994 (Fisheries Act) and the subordinate *Fisheries Regulation 2008*	Seeks to achieve economically viable, socially acceptable and ecologically sustainable development of Queensland's fisheries resources. Measures are designed to protect fisheries resources, and	Waterway barrier works approval may be required if new waterway crossings are constructed or existing crossings are modified outside of the mining lease but as part of the Project. The proposed Moura-Baralaba Road realignment crosses two mapped ('low risk')	The fish habitat value of the waterways in the study area, including the condition of those crossed by the proposed ETL and Moura-Baralaba Road realignment, are summarised in Section 4.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
	include regulation of waterway barrier works, declaration of fish habitat areas and protection of marine plants.	waterways under the *Queensland Waterways for Waterway Barrier Works* spatial layer. Construction of these crossings will not require a development approval if the culverts are designed and constructed in accordance with the Accepted Development Requirements. The two ETL alignment options cross first order waterways mapped as "low" risk and Benleith Creek mapped as "high" risk. However, no new waterway crossings will be required for the proposed ETL or associated power supply infrastructure outside of MLA 700057. While the power supply infrastructure will be subject to separate approvals it is anticipated that no waterway barrier works approval would be required under the Fisheries Act. Waterway barrier works approval under the Fisheries Act is not required within the mining lease, however waterways within and adjacent to the Project area are mapped on the *Queensland Waterways for Waterway Barrier Works* spatial layer and so consideration is required to be given to the impact to fish passage from the Project, including the potential for a significant residual impact to MSES.	The outcomes of the waterway determination assessments completed in August 2023 are summarised in Section 4.3.

Legislation / Policy / Guideline	Synopsis	Relevance	Relevant Report Section
Nature Conservation Act 1992 (NC Act) and subordinate *Nature Conservation (Animal) Regulation 2020* and the *Nature Conservation (Plants) Regulation 2020*	Provides for the protection of endangered, vulnerable and near threatened species of flora and fauna as listed under the Regulations.	Listed threatened aquatic species are present in the Dawson River Sub-basin.	The potential for listed threatened aquatic species to be present within the study area is discussed in Sections 4.9 and 4.10.
Planning Act 2016 and subordinate State Planning Policy (SPP)	The SPP is a key component of Queensland's land use planning system, which enables development, protects our natural environment and allows communities to grow and prosper. Development outside of the mining lease will be subject to approvals under the Planning Act.	MSES identified in the Project area: HES wetlands (refer EP Act and EPP (Water and Wetland Biodiversity), potential listed species (refer NC Act) and regulated vegetation (refer VM Act).	Ecological values of MSES are described in Section 4.
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).	A riverine protection permit is required to excavate, or place fill in a watercourse, lake or spring. Waterways in the Project area are classed as drainage features, while Shirley's Gully, the Dawson River and Anabranch, and Banana Creek are classed as watercourses on the DRDMW's *Watercourse Identification Map* (WIM).	The aquatic ecological values of watercourses and drainage features are described in Section 4.

4 Description of Existing Environment

4.1 Water Types

4.1.1 Water Types of the Region

Waterways and wetlands mapping (DES 2019) identifies the main water types in the Dawson River Sub-basin as:

- Major watercourses;
- Minor waterways and drainage lines;
- Riverine wetlands;
- Lacustrine wetlands;
- Palustrine wetlands; and
- Wetlands of high ecological significance.

4.1.1.1 Riverine Wetlands

Riverine wetlands are defined as 'wetlands and deep water habitats contained within a channel' (DEHP 2013). The channel can be either natural or artificially created. Waterflow can be limited to the wet season, leading to ephemeral streams. Riverine habitat can also be connecting two bodies of standing water.

Much of the Dawson River and its major tributaries are characterised as permanent to semi-permanent riverine wetlands while the smaller tributaries are mostly temporary or ephemeral watercourses and waterways (Telfer 1995).

4.1.1.2 Lacustrine Wetlands

Lacustrine systems (e.g. lakes) are wetlands and deep water habitats in topographic depressions, dammed river channels or artificial waterbodies, that:

- Are dominated by open water;
- Have less than 30% coverage of emergent perennial vegetation (including trees, shrubs and emergent macrophytes, mosses or lichens); and
- Are more than 8 ha in total area (DEHP 2013).

4.1.1.3 Palustrine Wetlands

Palustrine wetlands are defined as wetlands that are (DES 2019d):

- Dominated (more than 30% coverage) by persistent emergent vegetation (including trees, shrubs and emergent macrophytes, mosses or lichens); and
- Less than 8 hectares in size and include billabongs, swamps, bogs, springs, and soaks.

4.1.1.4 High Ecological Significance Wetlands

Wetlands that have been assigned a “very high” conservation value according to the AquaBAMM desktop assessments are considered high ecological significance (HES) wetlands based on the following (Inglis & Howell 2009):

- A high score for the ‘naturalness’ criteria;
- A very high score for the ‘diversity and richness’ criteria;
- A very high score for the ‘threatened species and ecosystems’ criteria;
- A very high score for the ‘priority species and ecosystems’ criteria; and
- A very high score for the ‘representativeness’ criteria.

4.1.2 Water Types of the Study Area

Waterways and wetlands mapping (DES 2021) identifies the major water types in the study area to include watercourses, waterways, drainage lines and wetlands, namely:

- Within the Project area and immediate surrounds (Figure 4.1; Figure 4.2):
    - A lacustrine wetland and three palustrine wetlands. One of the palustrine wetlands is mapped as a HES wetland while the other two are mapped as general ecological significance (GES) wetlands; and
    - A number of minor (mapped as stream order 1 and 2) waterways and drainage lines that are tributaries of one main unnamed (stream order 3) waterway that flows through the Project area. These are all mapped as drainage features under the Water Act.
- Adjacent to and downstream of the Project area (Figure 4.1):
    - Shirley’s Gully: the reach of the main unnamed waterway closest to the confluence with the Dawson River Anabranch, which is mapped as a stream order 3 and is classified as a watercourse under the Water Act;
    - The Dawson River and the Dawson River Anabranch: mapped as a stream order 8 waterway and lacustrine wetland upstream of the Neville Hewitt Weir and are classified as watercourses under the Water Act; and
    - Banana Creek: mapped as a stream order 5 waterway and partially mapped as a lacustrine wetland (near the confluence with the Dawson River) and is classified as a watercourse under the Water Act.
- Benleith Creek in the north of the ETL study area: mapped as a stream order 3 waterway but is not currently mapped under the Water Act.

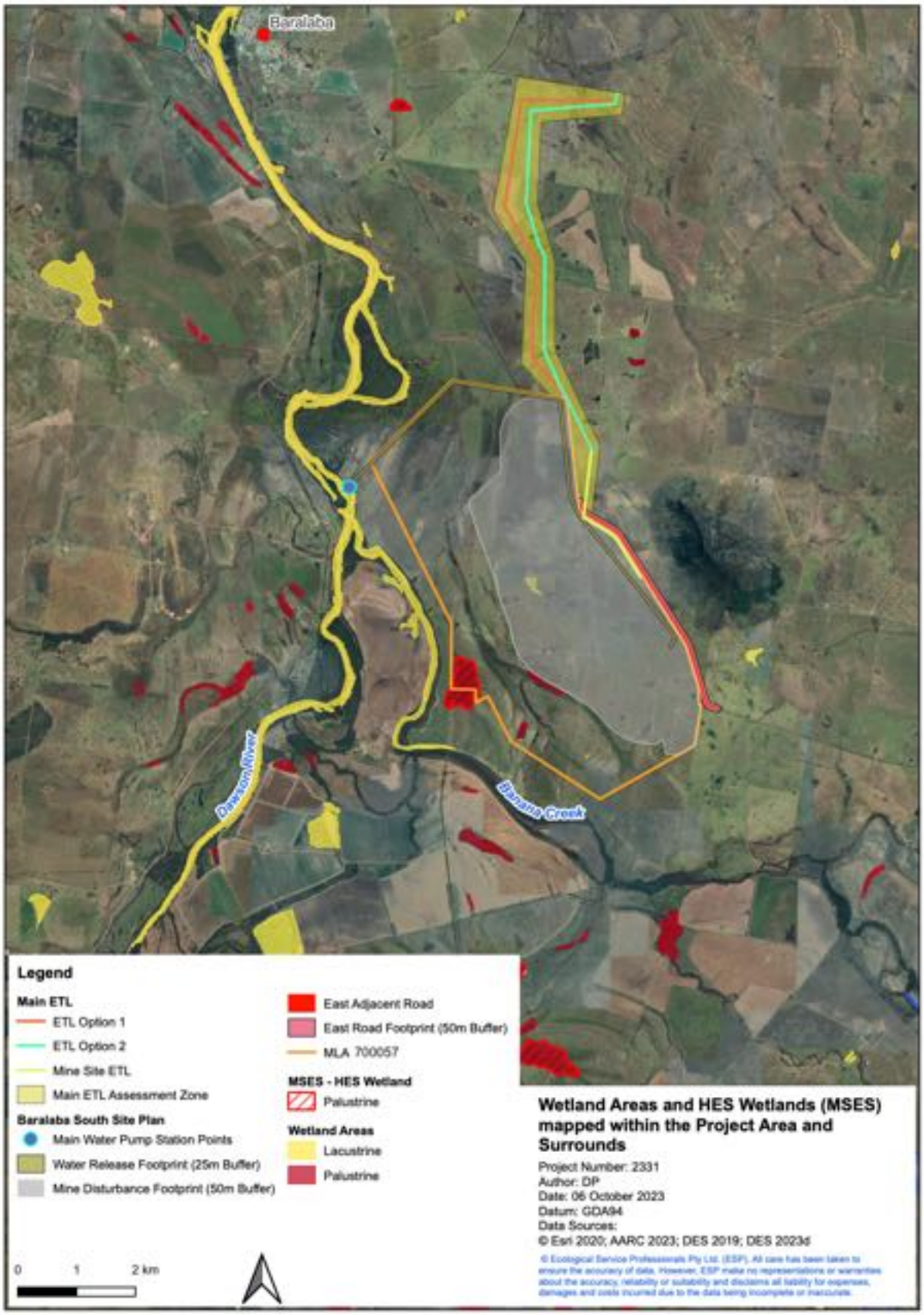

Figure 4.1 Non-riverine wetland areas, including HES wetlands mapped within the Project area and surrounds.

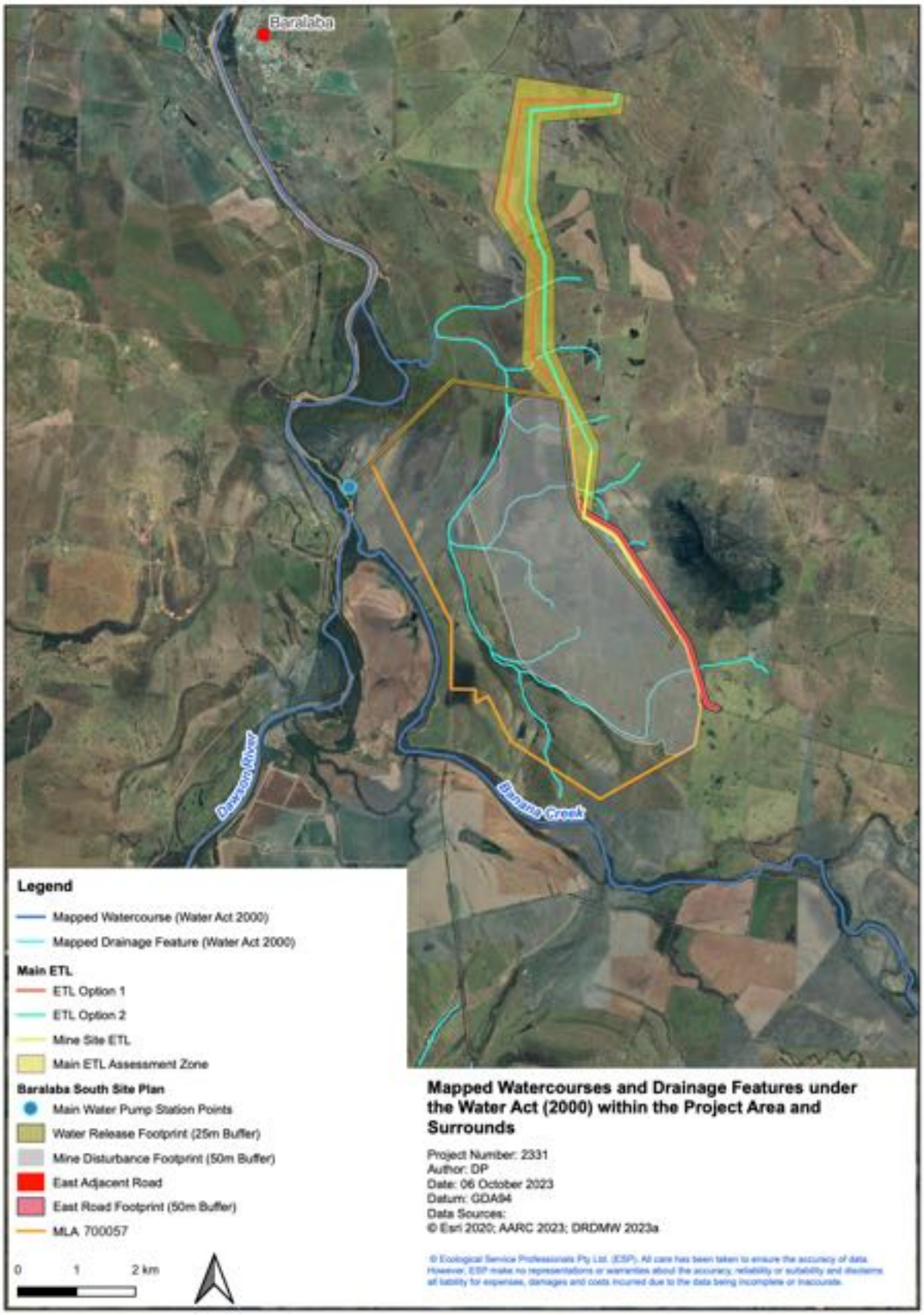

Figure 4.2 Mapped watercourses and drainage features under the Water Act within the Project area and surrounds.

4.2 Aquatic Habitat

4.2.1 Aquatic Habitat of the Region

The aquatic habitat condition of waterways and wetlands in the Dawson River Sub-basin are variable. Previous surveys completed at sites on the Dawson River and surrounding waterways and wetlands in the region have found the anabranches of the Dawson River and the Dawson River proper to be in good condition and of high ecological value (BMT WBM 2001; frc environmental 2014). The minor waterways and wetlands of the region tend to have low to moderate habitat condition and value (BMT WBM 2001; frc environmental 2014).

Dominant land uses within the region include grazing (mostly beef cattle) with some irrigated and rainfed cropping (DES 2023f). There are also a significant number of operational mines in the region, several of which are adjacent to the Dawson River upstream and downstream of the Project area, including Dawson South Mine, Dawson North and Central Mines, and Baralaba North Mine (DES 2023f). Land adjacent to waterways in the sub-basin is typically moderately to highly disturbed with extensive vegetation clearing (Telfer 1995).

Riparian vegetation in the region typically comprises a variety of native trees providing an overstory, namely *Eucalyptus* spp., *Melaleuca* spp., *Callistemon* spp., and *Casuarina* spp. with an understory of shrubs, commonly including *Acacia* spp. and *Ficus* spp., as well as vines and creepers and a groundcover dominated by perennial grasses often with sedges and herbs. Riparian vegetation has been reduced or disturbed across most of the Dawson River Sub-basin, generally a result of land clearing associated with surrounding land uses. The introduction of exotic weed species as a consequence of clearing and disturbance to riparian vegetation communities is also evident within most of the riparian vegetation communities in the region (Telfer 1995). The riparian vegetation of the Dawson River near Baralaba is considered to be in moderate to very good condition (Telfer 1995), while smaller waterways and wetlands tend to have less intact and significantly reduced riparian zones (frc environmental 2014).

Bank stability in the region has been assessed as mostly stable but is mostly impacted by areas of erosion, with the presence of stock and vegetation clearing identified as the main contributing factors (Telfer 1995).

The in-stream habitat of riverine wetlands and major watercourses in the region are dominated by pool habitat (i.e. riffle, run and glide habitats are not common except during periods of high rainfall). The Dawson River holds water permanently (but can be reduced to individual waterholes during the dry season) although the flow regime is considered intermittent and is largely dependent on rainfall. The majority of the rainfall for the region occurs during the wet season (typically between November and March) (BOM 2018). During the dry season large permanent waterholes in the Dawson River and some of the major tributaries provide refuge for aquatic flora and fauna, while small tributaries commonly dry up completely or become disconnected and isolated. Natural flows have been significantly disrupted in the catchment by the construction of weirs, including the Neville Hewitt Weir on the Dawson River and numerous farm dams on the adjoining tributaries. In-stream habitat typically comprises:

- Shallow and deep pools;
- Woody debris (large and small logs and branches);

- Detritus;
- In-stream aquatic plants (although coverage is considered low); and
- Overhanging and trailing bank vegetation fringing the edges and providing additional stream cover (frc environmental 2014; BMT WBM 2001; Telfer 1995).

Wetlands in the region are characterised as naturally formed wetlands with flat banks, constructed farm dams or highly modified waterbodies used for farm water supply, and gilgai wetlands. Many are considered ephemeral in nature and do not hold water for long periods, while others remain wet and provide refuge for aquatic fauna in dry periods. In-stream habitat features are typically limited and comprise primarily aquatic plants, which tend to be more abundant in natural wetlands compared to modified (dammed) wetlands. Bed substrate is homogenous and dominated by fine sediments (frc environmental 2014).

4.2.2 Aquatic Habitat of the Study Area

A detailed description of aquatic habitat condition at each site is presented in Appendix A.

4.2.2.1 Within the Project Area

Aquatic habitat condition at sites within the Project area was poor to fair (Figure 4.5). The minor waterways within the Project area were generally considered to be in poor condition. They were characterised as ephemeral drainage lines or overland flow paths (i.e. no defined bed or banks) that had minimal in-stream habitat features (or were dry and largely disconnected) and were highly disturbed by activities associated with the adjacent land-use (e.g. riparian zone clearing and access by cattle) (Figure 4.3).

The wetlands within the Project area varied in their condition; habitat condition in the lacustrine wetland was considered poor with minimal in-stream habitat features and a high level of disturbance (it was a modified (dammed) wetland), while the habitat condition of the palustrine wetlands was considered fair, with more diverse available in-stream habitat features and lower disturbance from surrounding land-uses. The wetted wetlands (LW1 and PW2) provide dry season refuge for aquatic fauna and could sustain aquatic communities, however connectivity to other waterways would be rare (only during significant rainfall events) and they did not provide unique habitat features or suitable habitat for listed species.

There were no notable changes in aquatic habitat within the Project area between the baseline surveys in 2017 and 2018 and the supplementary site inspection in August 2023.

4.2.2.2 High Ecological Significance Wetland

The HES wetland (PW1) was dry during all three surveys, however extensive beds of dry aquatic plants were evident during the June 2017 and March 2018 surveys, indicating that inundation occurs under certain conditions (i.e. during significant wet seasons), but the wetland is considered ephemeral in nature. No aquatic plants were recorded during the August 2023 site inspection, which suggests that inundation of this wetland had not occurred for an extended period of time.

The wetland provides suitable potential habitat for aquatic fauna and would likely host a variety of aquatic flora for a short period of time when wetted. The proximity of the wetland to the Dawson River Anabranch provides the possibility for aquatic fauna to find refuge in the wetland after periods of high flow and flood events. However connectivity to other waterways would be rare and the wetland would not provide long-lasting habitat (Figure 4.3e;f). The

terrestrial values of the HES wetland are described in the terrestrial ecology impact assessment report (Ecological Survey & Management 2023).

a)

b)

c)

d)

e)

f)

g) h)

Figure 4.3 Photographs taken at sites on the minor waterways and wetlands within the Project area, including (a) upstream at site UW1T in June 2017; (b) upstream at site UW1T in March 2018; (c) site UW2 in June 2017; (d) site UW2 in March 2018; (e) facing upstream and showing bare riparian zone and cattle access at site LW1I; (f) dry ephemeral HES wetland at site PW1 in June 2017; (g) upstream at site UW1T in August 2023; (h) north orientation at site PW1 in August 2023.

4.2.3 Waterways Upstream, Adjacent to and Downstream of the Project Area

Aquatic habitat condition of Banana Creek, Shirley's Gully and the Dawson River and Anabranch was considered fair, but overall was better than the waterways and wetlands within the Project area (Figure 4.4). These waterways had a good variety and availability of in-stream habitat, a variety of flow regimes (during wet periods) and good bank stability. Although the adjacent lands were disturbed, a reduced but mainly intact riparian zone remained along the waterways. These sites were considered suitable to support a variety of aquatic fauna and where permanent, would provide dry season refuges. The waterways would also provide connectivity and passage to upstream and downstream habitats during periods of flow.

The Dawson River and Anabranch and the lower reaches of Shirley's Gully and Banana Creek provided some habitat features for listed species, including in-stream structure for resting and refuge (particularly for turtles) and some sections of the banks were considered to potentially be suitable for turtle nesting and/or platypus burrows (Figure 4.4a;b). Further discussion regarding the potential suitability of the habitats for threatened or special least concern species is provided in Sections 4.9.2.2 (fish), 4.10 (turtles) and 4.11 (platypus).

Water levels of Banana Creek, Shirley's Gully and the Dawson River Anabranch were lower during the August 2023 site inspection than during the comprehensive baseline surveys in 2017 and 2018. Otherwise, there were no notable differences in aquatic habitat between the baseline surveys and the supplementary site inspection (Figure 4.5).

a)

b)

c)

d)

Figure 4.4 Photographs taken of habitat features present at sites on the Dawson River and Anabranch, including (a) In-stream inundated trees and fringing riparian vegetation at site DA1 on the Dawson River Anabranch in June 2017 (b) deep pool habitat at BC2 on Banana Creek in March 2018; c) overhanging branches and fringing riparian vegetation at site DA1 on the Dawson River Anabranch in August 2023; and d) shallow pool refugia habitat at BC1 on Banana Creek in August 2023.

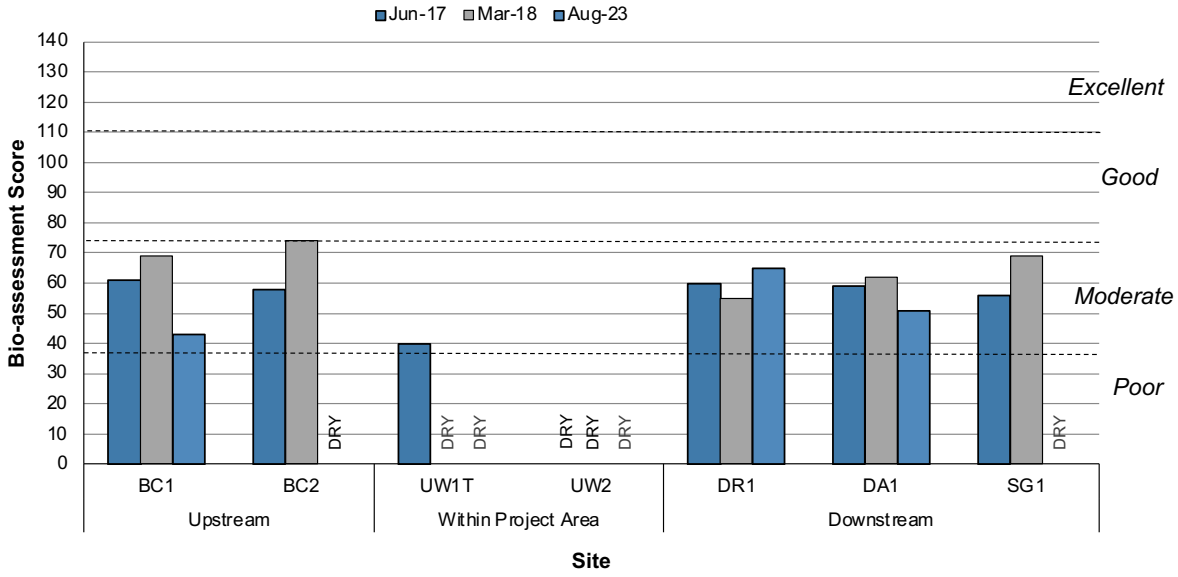

Figure 4.5 Bio-assessment scores for each waterway site that held water in June 2017, March 2018, and August 2023.

4.3 Waterways for Fish Passage

Waterways, as defined by the Fisheries Act, include rivers, creeks, streams, watercourses or inlets of the sea. The DAF Queensland Waterways for Waterway Barrier Works (WWBW) spatial layer indicates the level of 'risk' associated with undertaking waterway barrier works within Queensland waterways.

Project activities will be undertaken within the mining lease under the conditions of an EA (and not a development approval), and as such a waterway barrier works approval under the Planning Act is not required. However, waterways providing for fish passage are MSES under the EO Regulation, where the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway. This would include impacts to (removal of) waterways within the proposed mine disturbance footprint.

Within the study area (Figure 2.3):

- The Dawson River and Anabranch and Banana Creek are classified as major risk (purple) of adverse impacts to fish movement;
- The minor waterways and drainage lines that are tributaries of the main unnamed waterway (Tributary 8) are classified as low (green) to moderate (orange) risk of adverse impacts to fish movement; however, the majority of these mapped waterways do not exhibit any discernible waterway features (refer Section 4.3.1 below);
- The main unnamed waterway (Tributary 8, known as Shirley's Gully at its downstream extent) is variously classified as low (green), moderate (amber) and high (red) risk of adverse impacts to fish movement; and
- Benleith Creek is classified as high (red) risk of adverse impacts to fish movement.

The proposed Moura-Baralaba Road realignment, proposed electricity supply infrastructure and water extraction/release infrastructure will be constructed off-lease. The proposed ETL and road realignment cross over a number of low stream order waterways that are mostly mapped as low risk (green) of adverse impacts to fish movement (Figure 2.3).

4.3.1 Supplementary Waterway Surveys

During the August 2023 site inspection, supplementary surveys were conducted to ground truth the WWBW spatial layer within the Project area. Based on the August 2023 assessment, there are two waterways providing for fish passage within the proposed mine disturbance area – Tributary 7 and Tributary 8 (refer sub-sections below and Figure 4.14).

A summary of each feature is discussed in this section, and a more detailed assessment for each waterway determination site is presented in Appendix D.

4.3.1.1 Tributary 1

Tributary 1 is crossed by the ETL and is mapped as green (low risk of impact) on the WWBW spatial mapping (Figure 2.3). Tributary 1 did not have defined bed and banks, there were no aquatic plants and there was no potential fish habitat present (Figure 4.6). The feature was flat and overgrown with terrestrial plants, indicating that it does not receive flows very often. Tributary 1 was immediately downstream from a constructed farm dam and would likely only receive overflow from the dam during periods of high rainfall. Even so, this feature is unlikely to sustain flows for extended periods that would be sufficient to sustain basic ecological processes and habitats, or to provide connectivity to other fish habitats.

Tributary 1 at and upstream of site T1-D1 does not have the characteristics of a waterway providing for fish passage. However, it is unlikely that the construction of the ETL would directly impact this feature.

a) b)

Figure 4.6 Green mapped waterway Tributary 1 showing a) upstream towards the dam wall and b) downstream from site T1-D1.

4.3.1.2 Tributary 2

Tributary 2 is crossed by the proposed ETL and is mapped as green (low risk of impact) on the WWBW spatial layer (Figure 2.3). Tributary 2 did not have continuous defined bed and banks and there were no aquatic plants or fish habitat features present. Tributary 2 at site T2-D1 was located on Moura-Baralaba Road with two pipe culverts, approximately 30 cm in diameter each, running underneath the road (Appendix D). Upstream of site T2-D1, the feature represents a small depression that had been stabilised with rocks, which likely channels localised flow into the culverts during high rainfall events. However, downstream of the road, the feature was non-existent and there was no obvious distinction between the mapped feature and surrounding paddocks (Figure 4.7). There was no waterway feature present that would provide connectivity to other fish habitats.

Tributary 2 at and upstream of site T2-D1 does not have the characteristics of a waterway for fish passage. It is unlikely that the construction of the ETL would have direct impacts on this feature.

a) b)

Figure 4.7 Green mapped waterway Tributary 2 showing a) upstream and b) downstream from site T2-D1.

4.3.1.3 Tributary 3

Tributary 3 is crossed by the proposed ETL and is mapped as green (low risk of impact) on the WWBW spatial layer (Figure 2.3). Tributary 3 did not have defined bed and banks and there were no aquatic plants or fish habitat features present. Tributary 3 at site T3-D1 was located on Moura-Baralaba Road with two large pipe culverts, approximately 50 cm in diameter each, running underneath the road (Appendix D). Upstream of site T3-D1, the feature was a wide, flat overland flow path with terrestrial grasses and vegetation, and a lack of riparian vegetation. Downstream, the feature was small, narrow, and overgrown by terrestrial grasses suggesting that flow, if any, is limited to channelling runoff during rainfall events and is not sufficient to maintain basic ecological processes and habitats (Figure 4.8). There was no waterway feature that would provide connectivity to other fish habitats.

Tributary 3 at and upstream of site T3-D1 does not have the characteristics of a waterway for fish passage. It is unlikely that the construction of the ETL would have direct impacts on this feature.

a) b)

Figure 4.8 Green mapped waterway Tributary 3 showing a) upstream and b) downstream from site T3-D1.

4.3.1.4 Tributary 4

Tributary 4 is crossed by the proposed ETL and is within the proposed mine disturbance footprint. It is mapped as green (low risk of impact) on the WWBW spatial layer (Figure 2.3). Tributary 4 at sites T4-D1 and T4-D2 did not have defined bed and banks, there were no aquatic plants and there was no fish habitat present (Figure 4.9).

The feature at both sites was flat and overgrown with terrestrial plants, indicating that it does not have sufficient flow to sustain basic aquatic ecological processes. Site T4-D1 was immediately downstream from a constructed farm dam and would likely only receive overflow from this dam during periods of high rainfall. As such, this feature is unlikely to sustain flows for extended periods.

Downstream of Moura-Baralaba Road towards T4-D2 (i.e. within the proposed disturbance footprint), the tributary is indistinct within the paddock. Likewise, there was flat pasture at site T4-D2 and there was no indication of a waterway within the immediate area. There was no waterway feature present that would provide connectivity to other fish habitats. Upon review of topographical data and aerial photos, the area surrounding Tributary 4 appears to have been heavily modified from historical and current agricultural land uses. While there are sections of the mapped feature that resemble a relict channel, these sections are erosional features that lack riparian vegetation and are disconnected (isolated) from downstream waterways by flat floodplain and gilgai habitat (that lacks a distinct channel). That is, there are no continuous bed and banks along the mapped feature. Due to this, and the lack of flow adequacy to sustain basic ecological processes as described above, Tributary 4 does not have the characteristics of a waterway for fish passage (Figure 4.14).

a)

b)

c)

d)

Figure 4.9 Green mapped waterway Tributary 4 showing a) upstream from site T4-D1; b) downstream from site T4-D1; c) upstream from site T4-D2 and; d) downstream from site T4-D2.

4.3.1.5 Tributary 5

Tributary 5 is crossed by the proposed ETL and is within the mine disturbance footprint, and is mapped as amber (moderate risk of impact) on the WWBW spatial mapping (Figure 2.3). Tributary 5 at the assessment points did not have defined continuous bed and banks, and there was no potential fish habitat present (Figure 4.10). The feature was flat and overgrown with terrestrial plants, however some aquatic plants were present (*Cyperus sp.* and *Persicaria sp.*) indicating that water intermittently pools within the general location of the mapped feature. These locations were typical of gilgai habitat rather than waterway habitat.

Tributary 5 at site T5-D1 was immediately downstream from a constructed farm dam and would likely only receive overflow during periods of high rainfall. This feature is unlikely to sustain flows for extended periods. Tributary 5 at site T5-D1 was located on Moura-Baralaba

Road, however no culverts were present under the road. The presence of a dam upstream and the absence of culverts downstream suggests that flow is not adequate at this location to maintain basic ecological processes or to support fish passage.

Tributary 5 at site UW2 was indistinct, and it was determined that there was no waterway feature present at this location. The field team walked the immediate surrounds of the mapped feature and did not find any evidence of a waterway. The area was primarily flat pasture, with no aquatic plants, fish habitat or signs of defined bed and banks.

Waterway determination site T6-D3 (discussed below in Section 4.3.1.6) was downstream of site UW2 and the confluence of Tributary 5 and 6, and there was no evidence of a waterway at this location.

Based on the lack of a waterway channel, historical land disturbance and review of aerial photographs and topographical data, it is likely that this area represents disturbed floodplain and gilgai habitat with some broken sections of disconnected relict channel. Tributary 5 within the Project area does not have the characteristics of a waterway for fish passage.

a)

b)

c)

d)

Figure 4.10 Amber mapped waterway Tributary 5 showing a) upstream from site T5-D1; b) downstream from site T5-D1; c) upstream from site UW2 and; d) downstream from site UW2.

4.3.1.6 Tributary 6

Tributary 6 is within the proposed mine disturbance footprint, and is mapped as green (low risk of impact) at its headwaters and mapped as amber (moderate risk of impact) downstream of the confluence with Tributary 5 on the WWBW spatial layer (Figure 2.3). The headwaters of Tributary 6 at site T6-D1 are immediately upstream of a constructed farm dam, and the channel is ill-defined without bed and banks, and overgrown with terrestrial grasses (Figure 4.11). Further downstream towards sites T6-D2 and T6-D3, there is no feature present and there is no distinction between the mapped feature and the surrounding paddocks (Figure 4.11).

Tributary 6, along its entirety, does not have the characteristics of a waterway for fish passage.

a)

b)

c)

d)

Figure 4.11 Tributary 6 showing a) green mapped section, upstream from site T6-D1; b) green mapped section downstream from site T6-D1; c) amber mapped section, upstream of T6-D3 and; d) amber mapped section, downstream of T6-D3.

4.3.1.7 Tributary 7

Tributary 7 is within the proposed mine disturbance footprint and is mapped as green (low risk of impact) on the WWBW spatial mapping (Figure 2.3). Tributary 7 did not show obvious defined bed and banks during the site inspection (Figure 4.12). The feature was flat, wide, and overgrown with terrestrial plants. Site T7-D1 was immediately downstream from a constructed farm dam and would likely only receive overflow during periods of high rainfall. However, upon review of aerial photographs and topographical data, there appears to be a distinct channel present upstream of the dam, and the vegetation downstream of site T7-D1 is indicative of riparian vegetation (Figure 4.12b). Therefore, during periods of high rainfall and flood events, Tributary 7 likely provides fish passage to its upper reaches.

Tributary 7 has some characteristics of a waterway for fish passage (Figure 4.14).

a) b)

Figure 4.12 Green mapped waterway Tributary 7 showing a) upstream towards the farm dam wall and b) downstream from site T7-D1.

4.3.1.8 Tributary 8

The headwaters of Tributary 8 are within the proposed mine disturbance area and are a mapped green (low risk of impact) waterway. Downstream reaches mapped as red (high risk of impacts) and amber (moderate risk of impacts) are mostly outside of the proposed disturbance area (Figure 2.3). The headwaters of Tributary 8 at site T8-D1 has well defined, continuous bed and banks; an obvious channel; various aquatic plant species and complex structure providing potential fish habitat (Figure 4.11). Additionally, the field team observed the claw from a yabby (*Cherax sp.*) in the bed of the tributary, suggesting that at times, the section of Tributary 8 between T8-D1 and T8-D3 provides passage for fish and aquatic fauna from the small farm dam downstream of T8-D3.

The upstream reaches of Tributary 8, between sites T8-D1 and T8-D3, have the characteristics of a waterway for fish passage. However, it should be noted that fish communities are likely to persist in this area solely due to the presence of the farm dam downstream of site T8-D3.

Downstream of this dam, it is difficult to determine the alignment of Tributary 8, which has degraded significantly due to localised land uses and lack of flow due to the damming of upstream reaches. During the June 2017 and March 2018 surveys, fish were caught at wetland site PW2, which is located along the green mapped section of Tributary 8 (Figure 2.2). This would indicate that at least periodically, fish passage occurs along this section of Tributary 8. There was no waterway channel evident at site T8-D7, which is within the proposed mine disturbance footprint. Upon review of aerial photographs, topographical data, and flood modelling (Engeny Water Management 2023b), it was identified that the waterway channel is further to the west than indicated on the WWBW mapping. Aerial photographs indicate that Tributary 8 meanders in and out of the far north-western extent of the project disturbance footprint, and this has been mapped accordingly in Figure 4.14.

a)

b)

c)

d)

Figure 4.13 Tributary 8 showing a) green mapped section, upstream from site T8-D1; b) green mapped section downstream from site T8-D1; c) red mapped section, upstream of T8-D7 and d) red mapped section, downstream of T8-D7.

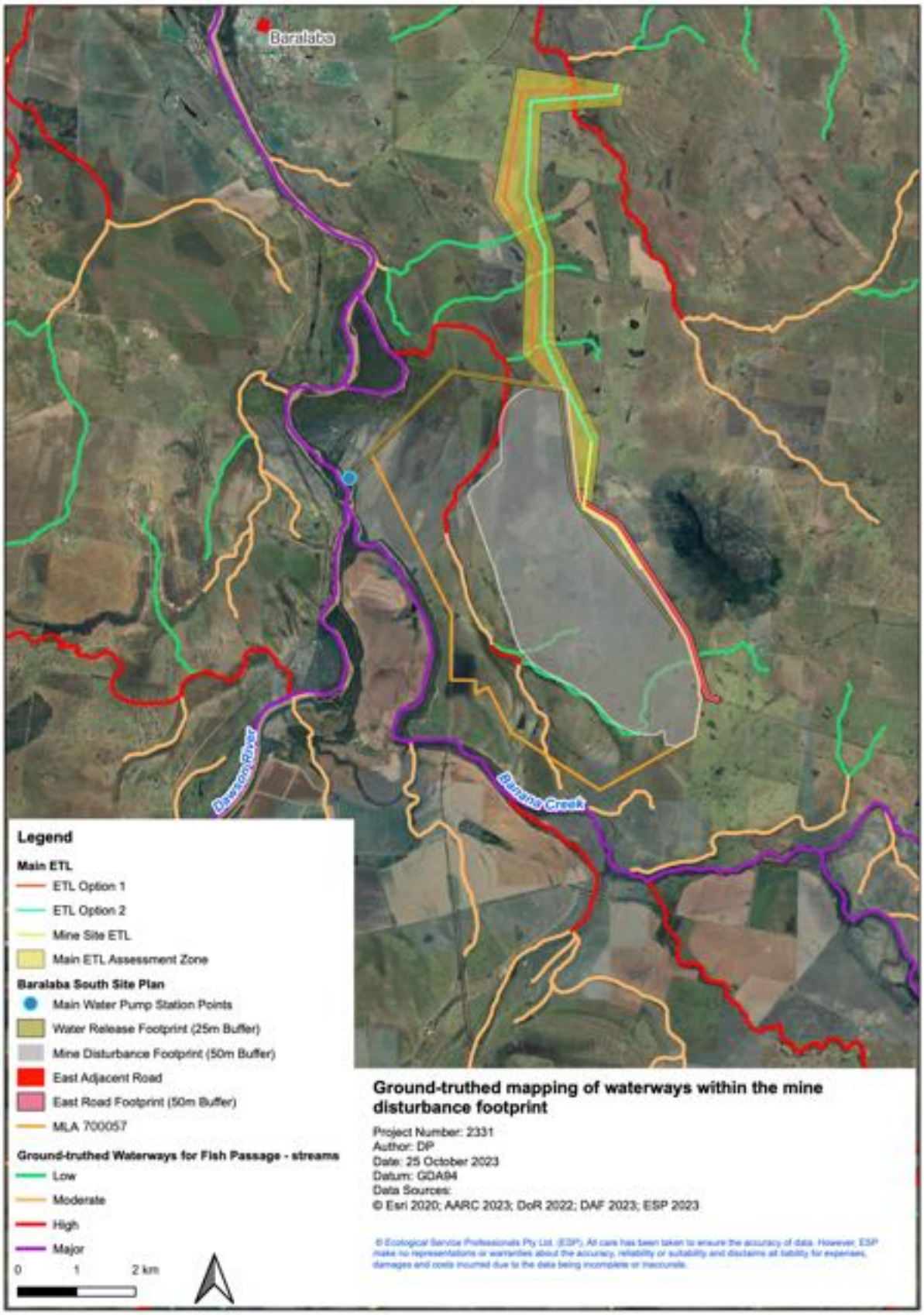

Figure 4.14 Ground-truthed mapping of waterways within the mine disturbance footprint.

4.4 Groundwater Dependent Ecosystems

Groundwater-Dependent Ecosystems (or GDEs) are ecosystems that rely upon groundwater for their continued existence. Aquatic GDEs are surface water ecosystems which may have a groundwater component (i.e. a surface expression of groundwater) and can include rivers, wetlands and springs (BOM 2023b).

Desktop review of potential aquatic (surface-expression) GDEs mapped on the BOM GDE Atlas (BOM 2023a) and relevant State mapping (DES 2023c) found that no potential aquatic GDEs are located within the study area. The terrestrial vegetation associated with the Dawson River and anabranch and Banana Creek adjacent to the Project area is mapped as having low potential (at a regional-scale) to be dependent on subsurface expressions of groundwater (BOM 2023b), i.e. a terrestrial GDE (Figure 4.15). This is consistent with the results of our assessment, which indicated that the wetted habitats in the study area varied with season (based on rainfall), and that aquatic flora and fauna communities of the waterways and wetlands of the study area were consistent with those of the wider region (i.e. not indicative of a reliance on groundwater inflows) (see Sections 4.7 to 4.12 below).

Further to the consideration of groundwater dependent ecosystems by the groundwater assessment (Watershed HydroGeo, 2023), terrestrial ecology assessment (Ecological Survey & Management, 2023) and aquatic ecology assessment (this report); ground truthing and survey of potential GDEs within the Project area was completed by 3d Environmental (2023). Key findings of these assessments were:

- There are no springs or seeps within the Project area;
- The HES wetland near the western boundary of MLA 700057 is considered to be reliant on surface water inflow (i.e. direct rainfall, runoff and floodwaters), which are held near the surface by the underlying shallow clay substrate and the wetland is not dependent on groundwater (i.e. it is not a GDE); and
- Development of mining infrastructure is predicted to result in direct clearing of less than 7.2 ha of groundwater dependent vegetation. However, drawdown associated with mining void development is not predicted to impact the ecological function of any GDEs which utilise and rely upon the perched seasonal groundwater resources.

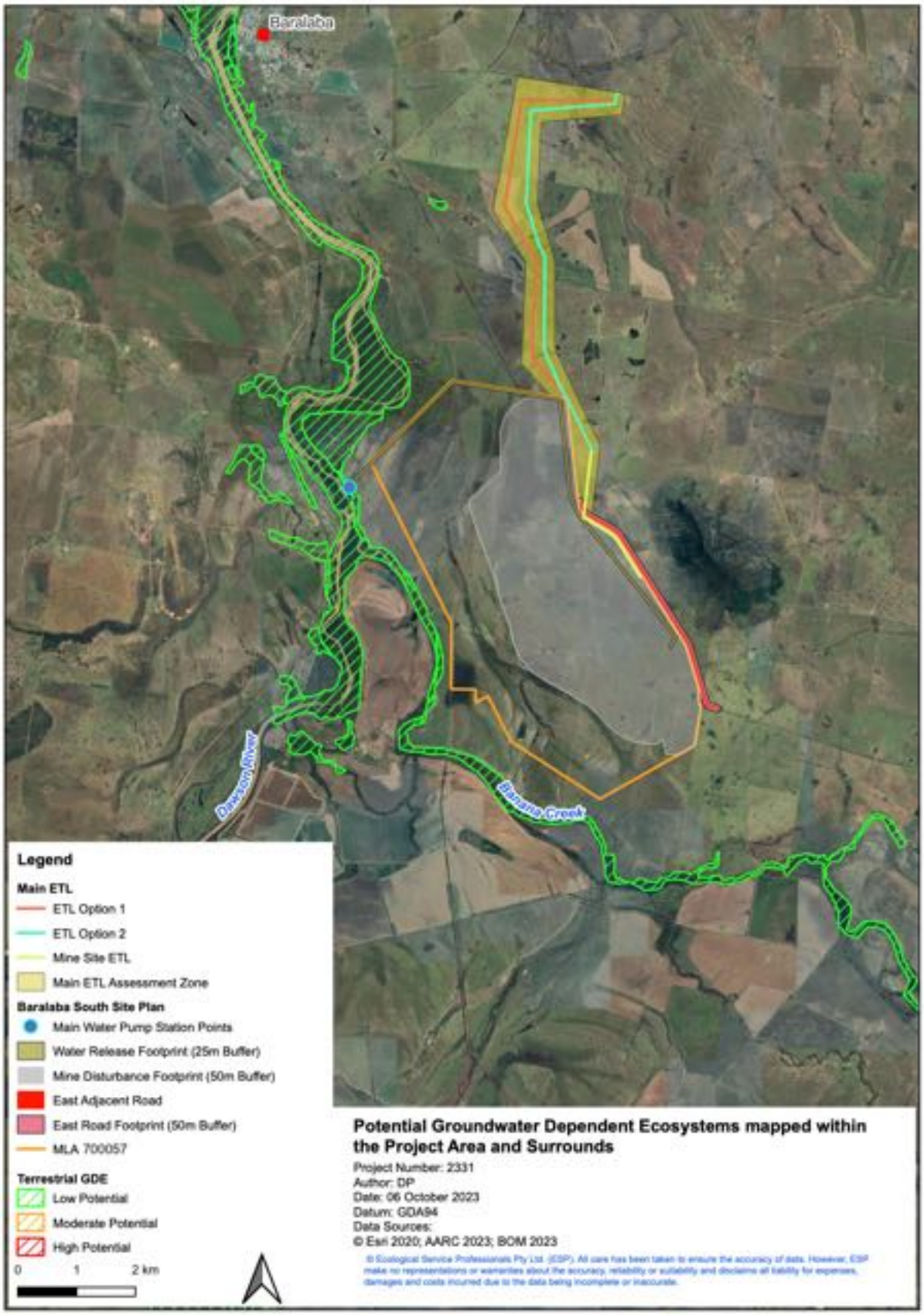

Figure 4.15 Mapped potential Groundwater Dependent Ecosystems within the study area (based on the BOM GDE Atlas). Note: there are no mapped Aquatic GDEs within the Project Area or surrounds.

4.5 Surface Water Quality

4.5.1 Water Quality in the Region

4.5.1.1 Environmental Values

The waterways of the Dawson River Sub-basin have been scheduled under the EPP (Water and Wetland Biodiversity), which identifies and specifies the environmental values (EVs) for waters of the Upper and Lower Dawson River as:

- Aquatic ecosystems;
- Irrigation, farm supply and stock watering;
- Aquaculture;
- Human consumption;
- Recreational use (primary, secondary and visual);
- Drinking water;
- Industrial use; and
- Cultural and spiritual values.

4.5.1.2 Water Quality

Previous surveys completed at sites on the Dawson River and surrounding waterways and wetlands in the region indicate water quality is slightly to moderately disturbed (i.e. influenced by surrounding land-uses) and characterized by (frc environmental 2014; BMT WBM 2011a;b;c):

- Average pH, which was typically slightly alkaline, however lower, more acidic pH values have also been recorded in one survey completed in the region (frc environmental 2014);
- Variable electrical conductivity which was typically higher on the Dawson River compared to surrounding waterways and wetlands;
- Low dissolved oxygen;
- High turbidity and total suspended solids;
- High concentrations of nutrients; and
- High concentrations of aluminium, chromium, copper, iron, selenium and zinc.

4.5.2 Water Quality of the Study Area

Water quality results sampled during the aquatic ecology baseline field surveys are presented in Table 4.1 (June 2017) and Table 4.2 (March 2018). Water quality results were relatively typical of the region and indicated the waterways and wetlands of the study area are moderately disturbed and influenced by surrounding land-uses but are considered suitable for supporting the relevant EVs of the region. Further reporting and assessment of surface water quality is provided in the Surface Water Impact Assessment (Engeny Water Management, 2023a).

Across the study area water quality was generally characterised by:

- Neutral to alkaline pH
- Low electrical conductivity;
- Low dissolved oxygen typically below the WQO range;
- High turbidity and concentrations of suspended solids typically above the WQOs;
- Low concentrations of ions;
- High concentrations of nutrients (nitrogen and phosphorous) with the bioavailable fractions of nutrients also generally higher than relevant WQOs;
- Concentrations of various metals and metalloids that exceeded the laboratory LORs; but dissolved concentrations of most metals and metalloids were low at most sites, except for aluminium, copper and iron;
- Concentrations of hydrocarbons that were generally (but not always) below the laboratory LORs.

In situ water quality was measured during the supplementary site inspection in August 2023. The results were generally consistent with the baseline surveys, with water quality characterised by neutral to alkaline pH; low electrical conductivity in the Dawson River and Anabranch and moderate electrical conductivity in Banana Creek and the lacustrine wetland (farm dam) within the Project area; variable dissolved oxygen; and low to moderate turbidity (Table 4.3).

Table 4.1 Water quality results for each site sampled in June 2017.

			Upstream / Adjacent to Project Area		Within Project Area			Downstream of Project Area		
Parameter	Units	WQO	BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1
Physical										
Temperature	ºC	–	10.9	12.6	14	15.9	9.6	13.3	17.3	19
EC	µS/cm	340[a],250[b]	506	144	88.1	158.9	136.8	98.7	93	93.4
pH	pH units	6.5 – 8.5[a],6.5 – 8.0[b]	7.52	7.45	7.15	8.49	7.01	7.26	6.67	6.92
DO	% sat.	85 – 110[a],90 – 110[b]	63.7	91.1	69.7	104	55.4	85.4	42	35.3
Turbidity	NTU	50[a], 1 – 20[b]	6	14	123	22	62	40	83	91
Total Suspended Solids	mg/L	<10[a],–[b]	8	32	54	26	280	14	16	14
Ions										
Total Hardness	mg/L	–	224	89	54	86	80	41	35	41
Sulfate	mg/L	<25[a],–[b]	35	3	<LOR	<LOR	<LOR	5	4	4
Fluoride	mg/L	–	0.3	0.2	<LOR	0.1	0.1	0.1	0.1	0.1
Calcium	mg/L	–	55	21	15	23	24	10	9	10
Magnesium	mg/L	–	21	9	4	7	5	4	3	4
Sodium	mg/L	–	101	18	8	10	19	20	20	17
Nutrients										
Ammonia	µg/L	<20[a],<10[b]	20	60	70	160	60	20	20	20
Nitrite	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nitrate	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	160	170
Nitrite + Nitrate	µg/L	<60[a],<10[b]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	160	170
Total Organic Nitrogen	µg/L	<420[a],<330[b]	980	1140	1880	2040	2540	780	480	480
Total Nitrogen	µg/L	<500[a],<350[b]	1000	1200	1950	2200	2600	800	700	700
Reactive Phosphorus	µg/L	<20[a],<5[b]	<LOR	20	125	70	260	30	70	50
Total Phosphorus	µg/L	<50[a],<10[b]	50	130	390	200	620	180	150	150
Total Metals										
Aluminium	µg/L	–	250	620	3060	660	7500	2350	3510	3560

			Upstream / Adjacent to Project Area		Within Project Area			Downstream of Project Area		
Parameter	Units	WQO	BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1
Arsenic	µg/L	–	3	2	2	5	4	2	2	1[g]
Boron	µg/L	–	60	<LOR	60	80	60	<LOR	<LOR	60
Cadmium	µg/L	–	0.1	<LOR	0.1	0.1	0.1	0.1	<LOR	0.1
Chromium	µg/L	–	<LOR	<LOR	2	<LOR	5	6	4	<LOR
Cobalt	µg/L	–	<LOR	<LOR	1	2	8	<LOR	1	<LOR
Copper	µg/L	–	2	2	4	1	11	3	4	2
Iron	µg/L	–	270	1320	3080	820	6520	2810	3970	2350
Lead	µg/L	–	<LOR	<LOR	2	<LOR	5	<LOR	1	<LOR
Manganese	µg/L	–	92	47	44.5	222	665	52	70	17[g]
Mercury	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	–	4	<LOR	<LOR	1	1	<LOR	<LOR	<LOR
Nickel	µg/L	–	3	3	4	2	8	4	4	2
Selenium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc	µg/L	–	<LOR	<LOR	9	<LOR	18	<LOR	6	<LOR
Dissolved Metals										
Aluminium	µg/L	55[c]	<LOR	<LOR	80	<LOR	<LOR	80	60	80
Arsenic	µg/L	13[g]	2	1	2	4	2	1	1	2
Boron	µg/L	370[c]	70	80	80	90	80	60	80	<LOR
Cadmium	µg/L	0.2 x (H/30)$^{0.89}$[d]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	0.1[h]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	3
Cobalt	µg/L	90[e]	<LOR	<LOR	<LOR	1	<LOR	<LOR	<LOR	<LOR
Copper	µg/L	1.4	<LOR	<LOR	1	<LOR	2	<LOR	<LOR	2
Iron	µg/L	300[f]	<LOR	110	115	<LOR	<LOR	150	180	150
Lead	µg/L	3.4 x (H/30)$^{1.27}$[d]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1[g]

			Upstream / Adjacent to Project Area		Within Project Area			Downstream of Project Area		
Parameter	Units	WQO	BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1
Manganese	µg/L	1700[e]	9	38	23	62	28	13	16	72[g]
Mercury	µg/L	0.06[i]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	0.2[i]	3	<LOR	<LOR	1	1	<LOR	<LOR	<LOR
Nickel	µg/L	11 x (H/30)$^{0.85}$[d]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Selenium	µg/L	5[i]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	0.05[c]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	1.0[j]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	10[j]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	10
Zinc	µg/L	8.0 x (H/30)$^{0.85}$[d]	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Petroleum Hydrocarbons										
C6 – C9 Fraction	µg/L	20[j]	<20	<20	<20	<20	<20	<20	<20	<20
C10 –C14 Fraction	µg/L	–	<50	<50	<50	<50	<50	<50	<50	<50
C15 –C28 Fraction	µg/L	–	<100	160	155	<100	120	<100	<100	<100
C29 – C36 Fraction	µg/L	–	<50	60	70	<50	60	<50	<50	<50
C10 – C36 Fraction (sum)	µg/L	100[j]	<50	220	225	<50	180	<50	<50	<50
Total Recoverable Hydrocarbons										
C6 – C10 Fraction	µg/L	–	<20	<20	<20	<20	<20	<20	<20	<20
C6 – C10 Fraction minus BTEX	µg/L	–	<20	<20	<20	<20	<20	<20	<20	<20
>C10 – C16 Fraction	µg/L	–	<100	<100	<100	<100	<100	<100	<100	<100
>C16 – C34 Fraction	µg/L	–	<100	<100	220	<100	160	<100	<100	<100
>C34 – C40 Fraction	µg/L	–	<100	<100	<100	<100	<100	<100	<100	<100
>C10 –C40 Fraction (sum)	µg/L	–	<100	<100	220	<100	160	<100	<100	<100
C10 – C16 Fraction minus Naphthalene	µg/L	–	<100	<100	<100	<100	<100	<100	<100	<100
BTEXN										
Benzene	µg/L	–	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	–	<2	<2	<2	<2	<2	<2	<2	<2

			Upstream / Adjacent to Project Area		Within Project Area			Downstream of Project Area		
Parameter	Units	WQO	BC1	BC2	UW1T	LW1	PW2	SG1	DA1	DR1
Ethylbenzene	µg/L	–	<2	<2	<2	<2	<2	<2	<2	<2
meta & para-Xylene	µg/L	–	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	–	<2	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	–	<2	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	–	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	–	<5	<5	<5	<5	<5	<5	<5	<5

Grey shading denotes values that are above the relevant WQO / WQO range; blue shading denotes values that are below the relevant WQO / WQO range.
<LOR = below the laboratory limit of reporting.

[a] WQOs for Lower Dawson River Sub-basin freshwaters (DEHP 2013a) used for comparison to waterway and palustrine wetland sites: DA1, DR1, BC1, BC2, UW1T, SG1 & PW2.
[b] WQOs for Lower Dawson River Sub-basin freshwater lakes/reservoirs (DEHP 2013a) used for comparison to lacustrine wetland (dam) site LW1.
[c] DGV for 95% of species protection for slightly to moderately disturbed waters (ANZG 2018).
[d] DGV modified based on water hardness-dependent algorithm, where TV = trigger value; H = water hardness.
[e] Moderate reliability DGV (ANZG 2018).
[f] Interim WQO based on Canadian guideline value, as per recommendations in ANZG (2018).
[g] DGV for arsenic V (ANZECC & ARMCANZ 2000), adopted as a conservative approach as per recommendations in ESP (2018) because analyses did not speciate arsenic
[h] DGV for chromium VI (ANZECC & ARMCANZ 2000), adopted as a conservative approach because analyses did not speciate chromium
[i] DGV for 99% of species protection for slightly to moderately disturbed waters as per recommendations in (ANZG 2018)
[j] TL for aquatic ecosystem protection outlined in DES 2018b

Table 4.2 Water quality results for each site sampled in March 2018.

Parameter	Units	WQO	Upstream / Adjacent to Project Area		Within Project Area		Downstream of Project Area		
			BC1	BC2	LW1	PW2	SG1	DA1	DR1
Physical									
Temperature	°C	–	25.7	23.8	27.6	25.4	27.3	27.6	26.4
Electrical conductivity	µS/cm	340[a],250[b]	193.3	156.2	294.4	236.3	157.1	143.5	145.7
pH	–	6.5 – 8.5[a],6.5 – 8.0[b]	7.34	6.85	8.47	7.01	7.26	7.42	7.41
Dissolved oxygen	% sat	85 – 110[a],90 – 110[b]	64	6	100	46	46	74	67
Turbidity		50[a], 1 – 20[b]	95.9	71.3	20.3	110	417.8	165.7	172.8
Total dissolved solids	mg/L	–	154	137	232	216	249	275	360
Total suspended solids	mg/L	<10[a],–[b]	56	42	16	20	84	48	44
Ions		–							
Total Hardness	mg/L	–	53	44	79	69	41	35	35
Sulfate	mg/L	<25[a],–[b]	<LOR	<LOR	<LOR	<LOR	2	2	2
Fluoride	mg/L	–	0.1	0.1	0.1	<LOR	0.1	0.1	0.1
Calcium	mg/L	–	13	11	20	21	10	9	9
Magnesium	mg/L	–	5	4	7	4	4	3	3
Sodium	mg/L	–	11	10	10	14	12	12	12
Potassium	mg/L	–	5	6	34	12	7	6	6
Nutrients									
Ammonia	µg/L	<20[a],<10[b]	40	60	80	40	30	40	30
Nitrite	µg/L	–	<LOR	<LOR	20	<LOR	<LOR	<LOR	<LOR
Nitrate	µg/L	–	<LOR	<LOR	<LOR	<LOR	90	250	250
Nitrite + Nitrate	µg/L	<60[a],<10[b]	<LOR	<LOR	20	<LOR	90	250	250
Total Organic Nitrogen	µg/L	<420[a],<330[b]	1960	1740	2120	1260	1230	860	770
Total Nitrogen	µg/L	<500[a],<350[b]	2000	1800	2200	1300	1400	1200	1000

Parameter	Units	WQO	Upstream / Adjacent to Project Area		Within Project Area		Downstream of Project Area		
			BC1	BC2	LW1	PW2	SG1	DA1	DR1
Reactive Phosphorus	µg/L	<20[a],<5[b]	140	180	100	420	170	200	200
Total Phosphorus	µg/L	<50[a],<10[b]	570	530	270	510	450	350	370
Total Metals									
Aluminium	µg/L	–	8120	2080	140	1160	4340	4410	5130
Arsenic	µg/L	–	10	8	6	4	4	2	3
Boron	µg/L	–	<LOR	<LOR	80	70	<LOR	<LOR	<LOR
Cadmium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	–	7	2	<LOR	<LOR	3	3	3
Cobalt	µg/L	–	4	3	1	<LOR	2	1	2
Copper	µg/L	–	8	4	<LOR	3	6	6	8
Iron	µg/L	–	9100	3580	330	1030	5060	4240	5140
Lead	µg/L	–	3	1	<LOR	<LOR	3	2	2
Manganese	µg/L	–	562	521	177	72	220	68	88
Mercury	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	–	<LOR	<LOR	<LOR	2	<LOR	<LOR	1
Nickel	µg/L	–	8	5	2	4	5	4	4
Selenium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	–	0.02	0.01	<LOR	<LOR	0.02	0.01	0.01
Uranium	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	–	20	<LOR	<LOR	<LOR	10	10	20
Zinc	µg/L	–	14	7	<LOR	<LOR	11	11	15
Dissolved Metals									
Aluminium	µg/L	55[c]	560	510	<LOR	80	420	280	290
Arsenic	µg/L	13[g]	6	5	5	4	2	2	2
Boron	µg/L	370[c]	<LOR	<LOR	70	70	<LOR	<LOR	<LOR

Parameter	Units	WQO	Upstream / Adjacent to Project Area		Within Project Area		Downstream of Project Area		
			BC1	BC2	LW1	PW2	SG1	DA1	DR1
Cadmium	µg/L	0.2 x (H/30)$^{0.89,d}$	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium	µg/L	0.1^{h}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cobalt	µg/L	90^{e}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper	µg/L	1.4	2	2	<LOR	2	2	2	3
Iron	µg/L	300^{f}	570	660	<LOR	70	350	240	240
Lead	µg/L	3.4 x (H/30)$^{1.27,d}$	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese	µg/L	1700^{e}	6	5	<LOR	7	2	1	1
Mercury	µg/L	0.06^{i}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Molybdenum	µg/L	0.2^{i}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel	µg/L	11 x (H/30)$^{0.85,d}$	3	3	2	3	3	2	2
Selenium	µg/L	5^{i}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver	µg/L	0.05^{c}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Uranium	µg/L	1.0^{j}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Vanadium	µg/L	10^{j}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc	µg/L	8.0 x (H/30)$^{0.85,d}$	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Petroleum Hydrocarbons									
C6 - C9 Fraction	µg/L	20^{j}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C14 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C15 - C28 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C29 - C36 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 - C36 Fraction (sum)	µg/L	100^{j}	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Recoverable Hydrocarbons									
C6 – C10 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C6 – C10 Fraction minus BTEX	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Parameter	Units	WQO	Upstream / Adjacent to Project Area		Within Project Area		Downstream of Project Area		
			BC1	BC2	LW1	PW2	SG1	DA1	DR1
>C10 – C16 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
>C16 – C34 Fraction	µg/L	–	110	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
>C34 – C40 Fraction	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
>C10 –C40 Fraction (sum)	µg/L	–	110	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
C10 – C16 Fraction minus Naphthalene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
BTEXN									
Benzene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Toluene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ethylbenzene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
meta & para-Xylene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
ortho-Xylene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Xylenes	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Sum of BTEX	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Naphthalene	µg/L	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Grey shading denotes values that are above the relevant WQO / WQO range; blue shading denotes values that are below the relevant WQO / WQO range.
<LOR = below the laboratory limit of reporting.

[a] WQOs for Lower Dawson River Sub-basin freshwaters (DEHP 2013a) used for comparison to waterway and palustrine wetland sites: DA1, DR1, BC1, BC2, UW1T, SG1 & PW2.
[b] WQOs for Lower Dawson River Sub-basin freshwater lakes/reservoirs (DEHP 2013a) used for comparison to lacustrine wetland (dam) site LW1.
[c] DGV for 95% of species protection for slightly to moderately disturbed waters (ANZG 2018).
[d] DGV modified based on water hardness-dependent algorithm, where TV = trigger value; H = water hardness.
[e] Moderate reliability DGV (ANZG 2018).
[f] Interim WQO based on Canadian guideline value, as per recommendations in ANZG (2018).
[g] DGV for arsenic V (ANZECC & ARMCANZ 2000), adopted as a conservative approach as per recommendations in ESP (2018) because analyses did not speciate arsenic
[h] DGV for chromium VI (ANZECC & ARMCANZ 2000), adopted as a conservative approach because analyses did not speciate chromium
[i] DGV for 99% of species protection for slightly to moderately disturbed waters as per recommendations in (ANZG 2018)
[j] TL for aquatic ecosystem protection outlined in DES 2018b

Table 4.3 In-situ water quality results for each site sampled in August 2023.

			Upstream / Adjacent to Project Area		Within Project Area					Downstream of Project Area		
Parameter	Units	WQO	BC1	BC2	UW1T	UW2	LW1	PW1	PW2	SG1	DA1	DR1
Physical												
Temperature	ºC	–	16.8	–	–		20.5		–	–	16.7	19.4
EC	µS/cm	340[a],250[b]	466.9	–	–		437.7		–	–	275.7	272.7
pH	pH units	6.5 – 8.5[a],6.5 – 8.0[b]	7.59	–	–		8.61		–	–	7.43	7.9
DO	% sat.	85 – 110[a],90 – 110[b]	85.9	–	–		121.1		–	–	71.1	94.3
Turbidity	NTU	50[a], 1 – 20[b]	15.8	–	–		15.5		–	–	63.5	20.8

Grey shading denotes values that are above the relevant WQO / WQO range; blue shading denotes values that are below the relevant WQO / WQO range.

<LOR = below the laboratory limit of reporting.

[a] WQOs for Lower Dawson River Sub-basin freshwaters (DEHP 2013a) used for comparison to waterway and palustrine wetland sites: DA1, DR1, BC1, BC2, UW1T, UW2, SG1, PW1 & PW2.

[b] WQOs for Lower Dawson River Sub-basin freshwater lakes/reservoirs (DEHP 2013a) used for comparison to lacustrine wetland (dam) site LW1.

– Indicates that the site was dry during the August 2023 site inspection.

4.6 Sediment Quality

4.6.1 Sediment Quality in the Region

There is minimal regional data available for sediment quality, however a previous survey completed at sites on the anabranch of the Dawson River downstream of the study area indicate sediment in the region was in moderate condition. Concentrations of most metals detected in sediment were in low concentrations (below the DGVs), although concentrations of nickel and selenium were close to the DGV (BMT WBM 2011b).

4.6.2 Sediment Quality of the Study Area

Sediment quality results for samples collected during the aquatic ecology baseline surveys are presented in Table 4.4 (June 2017) and Table 4.5 (March 2018).

Sediment quality in the study area was moderate to good. In both June 2017 and March 2018, concentrations of the following metals and metalloids were detected in sediment at all sites within the study area:

- Aluminium;
- Chromium;
- Cobalt;
- Copper;
- Iron;
- Lead;
- Manganese;
- Nickel;
- Vanadium; and
- Zinc.

The concentrations of most parameters were below the DGVs (where available) except for:

- Nickel, concentrations of which were:
    - Above the DGV (but below the GV-high) at sites on Shirley's Gully (SG1) and Banana Creek (sites BC1 and BC2) in June 2017; and
    - Above the DGV (but below the SQG-high) at the Dawson River Anabranch (downstream of the Project area, site DA1) in March 2018.
- Total Petroleum Hydrocarbons (referring to both naturally occurring sources of hydrocarbons (e.g. organic matter) and petroleum-based contaminants that may be present), concentrations of which were:
    - Above the DGV (but below the GV-high) at site BC2 (Banana Creek adjacent to the Project area) in both surveys; and
    - Above the GV-high at site PW1 (HES wetland, within the Project area) in both surveys.

Table 4.4 Laboratory analysed sediment quality results for June 2017 and the low and high default guideline values (ANZG 2018).

Parameter		Units	DGV	**GV-High**	DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2
Metals and Metalloids	Aluminium	mg/kg	–	–	15300	16900	26400	26100	25300	4280	19900	17100	21600	27100
	Arsenic	mg/kg	20	70	6	<5	8	5	<5	<5	<5	<5	14	8
	Boron	mg/kg	–	–	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	Cadmium	mg/kg	1.5	10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Chromium	mg/kg	80	370	18	23	24	20	17	8	16	13	25	30
	Cobalt	mg/kg	–	–	12	8	32	14	17	6	11	15	20	15
	Copper	mg/kg	65	270	18	23	28	27	23	8	22	20	32	35
	Iron	mg/kg	–	–	20100	17400	31800	25500	21500	5550	21600	16300	35300	30700
	Lead	mg/kg	50	220	12	13	26	16	20	6	14	15	16	18
	Manganese	mg/kg	–	–	591	203	2250	569.5	1000	285	579	685	524	651
	Molybdenum	mg/kg	–	–	<2	<2	<2	<3	<2	<2	<2	<2	<2	<2
	Nickel	mg/kg	21	52	16	15	28	19.5	16	6	16	14	26	29
	Selenium	mg/kg	–	–	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Silver	mg/kg	1	3.7	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Vanadium	mg/kg	–	–	44	49	66	53.5	41	18	43	38	66	80
	Zinc	mg/kg	200	410	41	45	70	71	56	15	54	43	64	64
	Mercury	mg/kg	0.15	1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Uranium	mg/kg	–	–	0.6	0.8	0.8	0.55	0.2	0.1	0.4	0.3	0.4	0.7
Total Petroleum Hydrocarbons	C6 – C9 Fraction	mg/kg	–	–	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	C10 – C14 Fraction	mg/kg	–	–	<50	<50	<50	<50	<50	<50	80	<50	<50	<50
	C15 – C28 Fraction	mg/kg	–	–	130	<100	<100	<100	<100	<100	330	<100	100	240
	C29 – C36 Fraction	mg/kg	–	–	110	<100	<100	120	<100	<100	250	<100	<100	210
	C10 – C36 Fraction (sum)	mg/kg	280	550	240	<50	<50	120	<50	<50	660	<50	100	450

Parameter		Units	DGV	GV-High	DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2
Total Recoverable Hydrocarbons	C6 – C10 Fraction	mg/kg	–	–	<10	<10	<10	<10	<10	<10	<10	<10	<20	<20
	C6 – C10 Fraction minus BTEX	mg/kg	–	–	<10	<10	<10	<10	<10	<10	<10	<10	<20	<20
	>C10 – C16 Fraction	mg/kg	–	–	50	<50	<50	<50	<50	<50	100	<50	<100	80
	>C16 – C34 Fraction	mg/kg	–	–	160	<100	<100	150	<100	<100	440	<100	130	330
	>C34 – C40 Fraction	mg/kg	–	–	<100	<100	<100	<100	<100	<100	140	<100	<100	130
	>C10 –C40 Fraction (sum)	mg/kg	–	–	210	<50	<50	150	<50	<50	680	<50	130	540
	C10 – C16 Fraction minus Naphthalene	mg/kg	–	–	50	<50	<50	<50	<50	<50	100	<50	<100	80
BTEXN	Benzene	mg/kg	–	–	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Toluene	mg/kg	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Ethylbenzene	mg/kg	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	meta & para-Xylene	mg/kg	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	ortho-Xylene	mg/kg	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Total Xylenes	mg/kg	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Sum of BTEX	mg/kg	–	–	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Naphthalene	mg/kg	–	–	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Shading indicates a value that exceeds a DGVs; grey=above DGV-low and dark grey = above GV high.

Table 4.5 Laboratory analysed sediment quality results for March 2018 and the low and high default guideline values (ANZG 2018).

Parameter		Units	DGV	GV-High	DR1	DA1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2
Metals and Metalloids	Aluminium	mg/kg	–	–	17000	19200	13400	16400	16400	2120	14000	11300	15300	20400
	Arsenic	mg/kg	20	70	6	5	<LOR	<LOR	5	<LOR	<LOR	<LOR	8	6
	Beryllium	mg/kg	–	–	1	1	1	1	1	<LOR	1	1	<LOR	1
	Boron	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Cadmium	mg/kg	1.5	10	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Chromium	mg/kg	80	370	22	30	13	14	12	6	13	8	22	24
	Cobalt	mg/kg	–	–	16	20	12	10	14	4	8	8	14	12
	Copper	mg/kg	65	270	22	25	18	22	17	5	20	19	26	30
	Iron	mg/kg	–	–	24800	29100	19400	17800	15800	4080	14100	10700	24000	23200
	Lead	mg/kg	50	220	13	13	13	14	15	<LOR	15	11	11	15
	Manganese	mg/kg	–	–	932	963	761	408	873	217	318	346	683	527
	Mercury	mg/kg	0.15	1.0	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Molybdenum	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Nickel	mg/kg	21	52	17	26	13	13	13	3	12	10	20	18
	Selenium	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Silver	mg/kg	1	4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Uranium	mg/kg	–	–	0.7	0.8	0.5	0.5	0.3	<LOR	0.7	0.2	0.4	0.6
	Vanadium	mg/kg	–	–	54	60	41	41	46	17	40	26	58	68
	Zinc	mg/kg	200	410	46	52	40	51	37	6	35	34	42	53
Total Petroleum Hydrocarbons	C6 – C9 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	C10 – C14 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	270	<LOR	<LOR	70
	C15 – C28 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	920	<LOR	<LOR	190
	C29 – C36 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	580	<LOR	<LOR	160
	C10 – C36 Fraction (sum)	mg/kg	280	550	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1770	<LOR	<LOR	420
	C6 – C10 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Parameter		Units	DGV	GV-High	DR1	DA1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2
Total Recoverable Hydrocarbons	C6 – C10 Fraction minus BTEX	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	>C10 – C16 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	280	<LOR	<LOR	100
	>C16 – C34 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	120	<LOR	<LOR	1200	<LOR	<LOR	260
	>C34 – C40 Fraction	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	330	<LOR	<LOR	<LOR
	>C10 –C40 Fraction (sum)	mg/kg	–	–	<LOR	<LOR	<LOR	120	<LOR	<LOR	1810	<LOR	<LOR	360
	C10 – C16 Fraction minus Naphthalene	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	280	<LOR	<LOR	100
BTEXN	Benzene	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Toluene	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Ethylbenzene	mg/kg	–	–	<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
	ortho-Xylene	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
	Total Xylenes	mg/kg	–	–	<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
	Naphthalene	mg/kg	–	–	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Shading indicates a value that exceeds a SQGV; grey=above SQGV and dark grey = above SQG-high.

4.7 Aquatic Plants

4.7.1 Aquatic Plant Communities in the Region

Aquatic flora of the Fitzroy River basin is generally sparse with a low diversity of species, which has been attributed to the naturally harsh environmental conditions of ephemeral waterways (Negus 2007). Throughout the Dawson River Sub-basin, a total of 194 native aquatic plant species are known to occur (DES 2019b).

Aquatic plant surveys have been conducted on the Dawson River and surrounding waterways and wetlands in the region for Baralaba Mine and Baralaba North Mine (BMT WBM 2011a; frc environmental 2014). These studies have identified up to 68 species of aquatic plants including submerged, floating and emergent species (frc environmental 2014; BMT WBM 2011a).

Aquatic plant diversity was low to moderate at sites surveyed around Baralaba North Mine. Taxonomic richness ranged from five to twelve species per site with lower diversity typically recorded at sites on the Dawson River compared to the smaller tributaries and surrounding wetlands, which generally supported a higher diversity of aquatic plants (BMT WBM 2011a, frc environmental 2014). Lower aquatic plant diversity at sites in the main channel of the Dawson River was attributed to habitat degradation and flooding events (BMT WBM 2011a).

Aquatic plant coverage varied depending on survey timing and waterway type. Aquatic plant coverage was higher in surveys completed in dry periods compared to surveys completed after rain and flow events (BMT WBM 2011a;c & frc environmental 2014). Overall, sites on the Dawson River had lower aquatic plant coverage, compared to surrounding waterways and wetlands, which had moderate to high coverage.

Overall, species coverage and diversity varied with seasons based on rainfall, flow and disturbance. Emergent species (namely sedges and rushes) were the most common growth form and dominated plant communities on the Dawson River where they grew on the banks and fringing the water's edge. Floating or submerged aquatic plants were recorded more on surrounding waterways and wetlands where they grew in often high densities in-stream (BMT WBM 2011a; frc environmental 2014).

4.7.1.1 Threatened Aquatic Plant Species in the Region

Four species of vulnerable or endangered aquatic plants are known to occur in the Dawson River Sub-basin (DES 2023b):

- *Thelypteris confluens:* listed as vulnerable under the NC Act;
- Two subspecies of salt pipewort; *Eriocaulon carsonii* subsp. *carsonii* and *E. carsonii* subsp. *orientale:* listed as endangered under the NC Act and the EPBC Act; and
- Swamp-orchid (*Phaius australis*): listed as endangered under the NC Act and the EPBC Act.

There are no published records of any of these species occurring within 10 km of the study area (DES 2019c) and none of these species have been recorded during previous surveys completed at sites on the Dawson River and surrounding waterways and wetlands in the region (BMT WBM 2011a; frc environment 2014).

4.7.1.2 Pest Aquatic Plant Species in the Region

The *Biosecurity Act 2014* provides a modern and risk-based framework for measures to manage biosecurity and the management of pests (including weeds), diseases and contaminants. Under the Act, invasive plants can be classed as either prohibited (plants that are not established in Queensland and must be reported immediately) or restricted. Restricted invasive plants are established in Queensland, and have the capacity to seriously threaten Queensland's agriculture, environment and health of livestock and people. Restricted invasive plants can be categorised as one or more of the following:

- Category 2: the invasive plant must be reported within 24 hours;
- Category 3: the invasive plant must not be distributed in any way or released into the environment;
- Category 4: the invasive plant must not be moved:
- Category 5: the invasive plant must not be kept.

Fifteen introduced species of aquatic plants are known to occur in the Dawson River Sub-basin (DES 2019b). Of these, three species are declared Category 3 restricted invasive plants under the Biosecurity Act:

- Olive hymenachne (*Hymenachne amplexicaulis*), which is also listed as a weed of national significance (WONS);
- Water lettuce (*Pistia stratiotes*); and
- Salvinia (*Salvinia molesta),* which is also listed as a weed of national significance (WONS).

In addition, one species that is a declared Category 3 restricted invasive plant under the Biosecurity Act is known to occur in the wider Fitzroy Basin but is not listed as occurring in the Dawson River Sub-basin: Water hyacinth (*Eichhornia crassipes*), which is also listed as a WONS.

Database searches indicate olive hymenachne and Salvinia are likely to occur within 5 km of the study area (DES 2019c). Previous surveys completed at sites on the Dawson River and surrounding waterways and wetlands in the region (Baralaba North) have recorded olive hymenachne, water lettuce and water hyacinth (BMT WBM 2011a; frc environment 2014).

4.7.2 Aquatic Plants of the Study Area

The aquatic plant species recorded in the study area are typical of the region and indicate a low to moderate diversity and abundance of aquatic flora in the study area. A total of 32 species of plants, from 20 families, were recorded at sites within the study area across both baseline surveys (Table 4.6).

Most native species recorded are recognised as wetland indicator species. Emergent species, including sedges (*Cyperus* spp. and *Eleocharis* spp.) and smartweeds (*Persicaria* spp.) were the most widespread aquatic plants and were growing on the banks or in the shallow margins of the waterways at most sites. Lesser joyweed (*Alternanthera denticulata*) was also a widespread species, recorded at eight sites in both surveys. This species is not recognised as a wetland indicator species, however it is commonly found around waterbodies and wetlands and was providing aquatic habitat at sites where recorded.

Species richness was highest in the palustrine wetland at site PW2 during both surveys, with a variety of aquatic plants of different growth forms (submerged, floating and emergent) recorded (Table 4.6). Site UW2 (which was dry) had the lowest species richness in June 2017 and sites UW1T, UW2 and PW1 (all of which were dry) had the lowest species richness in March 2018 (Table 4.6).

Aquatic plant coverage varied; most sites had low to moderate percent cover of aquatic plants (between 10 – 57% coverage). In both surveys a high percent cover of aquatic plants was recorded at palustrine wetland PW1 which was dry, however extensive beds of dried aquatic plants dominated by spikerush (*E. pallens*) were present. Aquatic plant coverage was lowest at site UW1T in both surveys, which was located on a minor waterway and was dry in March 2018. Aquatic plant coverage at sites on the Dawson River and Anabranch were dominated by emergent species that were growing on the banks and fringing the water's edge, while aquatic plant coverage at sites on minor waterways and wetlands comprised of a higher diversity of growth forms (i.e. submerged and floating plants as well as emergent).

4.7.2.1 Invasive Plant Species

Two declared restricted invasive plant species (water lettuce and olive hymenachne) were recorded in all three surveys on the Dawson River and Shirley's Gully. They were not present at sites within the Project area.

4.7.2.2 Listed Aquatic Plant Species in the Region

No listed threatened species of aquatic plants were recorded during the surveys or are expected to occur based on other records and their preferred habitat (e.g. artesian springs).

Table 4.6 Percent cover of aquatic plants recorded at each site in June 2017 and March 2018.

Family *Species Name*	Common Name	Average Percent Cover – July 2017											Average Percent Cover – March 2018										
		DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total	DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total
Alistmataceae																							
Damasonium minus	Starfruit	–	–	–	0.1	–	–	–	2.4	–	–	**2.5**	–	–	–	–	–	–	–	–	–	–	**–**
Amaranthaceae																							
Alternanthera denticulata	Lesser joyweed	0.6	–	1.9	0.8	10.4	–	1.0	0.5	1.6	3.2	**19.9**	–	–	–	1.7	23.3	–	2.2	4.2	1.8	–	**33.2**
Araceae																							
Lemna aequinoctialis	Common duckweed	3.7	1.3	0.6	–	–	–	–	–	0.4	0.25	**6.3**	1	8.3	1	–	–	–	–	0.4	1.1	0.3	**12.1**
Pistia stratiotes	Water lettuce*	4.6	3.2	2.0	–	–	–	–	–	–	–	**9.8**	2.9	9.7	0.5	–	–	–	–	–	–	–	**13.1**
Azollaceae																							
Azolla pinnata	Ferny azolla	–	–	–	–	–	–	–	0.2	–	0.15	**0.3**	–	–	–	–	–	–	–	0.4	1.6	–	**2**
Ceratophyllaceae																							
Ceratophyllum demersum	Hornwort	–	–	–	–	–	0.5	–	0.7	–	–	**1.2**	–	–	–	–	–	–	–	–	–	–	**–**
Cyperaceae																							
Cyperus betchei	Sedge	–	–	–	–	–	–	–	–	1.8	–	**1.8**	–	5.2	–	–	32.5	0.3	–	28	4.2	–	**70.2**
Cyperus difformis	Rice sedge	–	–	0.6	–	–	–	–	2.8	–	1.8	**5.2**	–	–	–	–	–	0.1	–	1.7	–	–	**1.8**
Cyperus exaltatus	Giant sedge	–	0.3	5.1	0.4	7.0	–	0.7	14.7	–	4.3	**32.5**	–	–	–	–	–	–	–	–	–	17	**17**
Cyperus gymnocaulos	Spiny flatsedge	–	–	–	–	–	–	–	2.8	–	–	**2.8**	–	–	–	–	–	–	–	–	–	–	**–**
Cyperus haspan	Flat sedge	–	–	–	–	–	–	–	–	–	–	**–**	2.6	–	31.7	–	–	–	–	–	–	–	**34.3**
Eleocharis plana	Ribbed spikerush	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–	–	–	–	–	6.1	–	–	**6.1**
Eleocharis pallens	Spikerush	–	–	–	–	–	–	68.5	–	–	2.2	**70.7**	–	–	–	–	–	–	63.8	–	–	–	**63.8**
Elatinaceae																							
Elatine gratioloides	Waterwort	–	–	–	–	–	–	–	0.8	–	–	**0.8**	–	–	–	–	–	–	–	3.1	–	–	**3.1**

Family *Species Name*	Common Name	Average Percent Cover – July 2017											Average Percent Cover – March 2018										
		DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total	DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total
Haloragaceae																							
Myriophyllum gracile	Milfoil	–	–	–	–	–	–	–	1.5	–	–	**1.5**	–	–	–	–	–	–	–	–	–	–	**–**
Juncaceae																							
Juncus usitatus	Rush	0.7	1.1	0.2	–	–	–	–	0.9	–	–	**2.9**	0.8	3.3	0.2	–	–	–	–	–	–	–	**4.3**
Juncaginaceae																							
Cycnogeton procerus	Water ribbons	–	–	–	–	–	–	–	–	0.1	0.3	**0.4**	–	–	–	–	–	–	–	–	–	–	**–**
Marsileaceae																							
Marsilea drummondii	Nardoo	–	–	–	0.1	1.0	–	0.7	2.5	–	2	**6.2**	–	–	–	1.3	0.9	–	2.5	2.7	–	–	**7.4**
Menyanthaceae																							
Nymphoides indica	Water snowflake	–	–	–	–	–	–	–	–	0.3	–	**0.3**	–	–	–	–	–	–	–	–	1.4	–	**1.4**
Najadaceae																							
Najas tenuifolia	Waternymph	–	–	–	–	–	–	–	0.2	–	–	**0.2**	–	–	–	–	–	–	–	–	–	–	**–**
Nymphaeaceae																							
Nymphaea gigantea	Giant waterlily	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.4	–	**1.4**
Onagraceae																							
Ludwigia octovalvis	Willow primrose	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3	–	–	**1.3**
Ludwigia peploides	Water primrose	–	–	–	–	–	2.0	–	0.9	–	–	**2.9**	–	–	0.2	–	–	12.3	–	–	–	–	**12.5**
Poaceae																							
Echinochloa colona	Awnless barnyard grass	–	–	–	–	–	1.2	–	–	–	–	**1.2**	–	–	–	–	–	–	–	–	–	–	**–**
Hymenachne amplexicaulis	Olive hymenachne*	–	16.0	–	–	–	–	–	–	–	–	**16.0**	1.4	12.4	–	–	–	–	–	–	–	–	**13.8**
Paspalum distichum	Water couch	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.1	–	–	–	1.4	**2.5**
Phragmites australis	Common reed	0.6	–	–	–	–	–	–	–	–	–	**0.6**	–	–	–	–	–	–	–	–	–	–	**–**
Polygonaceae																							
Persicaria attenuata	Smartweed	0.2	21.0	1.7	–	–	–	–	–	20.6	1.6	**45.1**	5.2	1.7	2.1	0.7	–	0.8	–	–	11.9	6.7	**29.1**

Family *Species Name*	Common Name	Average Percent Cover – July 2017											Average Percent Cover – March 2018										
		DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total	DA1	DR1	SG1	UW1T	UW2	LW1	PW1	PW2	BC1	BC2	Total
Persicaria hydropiper	Water pepper	–	–	–	–	–	–	–	–	–	4.8	**4.8**	–	–	–	–	–	–	–	–	–	–	**–**
Pontederiaceae																							
Monochoria cyanea	Monochoria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.6	–	–	**3.6**
Ricciaceae																							
Ricciocarpos natans	Liverwort	–	–	–	–	–	–	–	0.2	–	–	**0.2**	–	–	–	–	–	–	–	0.8	–	–	**0.8**
Streptophyceae																							
Nitella sp.	Musk grass	–	–	–	0.2	–	0.1	–	–	–	–	**0.3**	–	–	–	–	–	–	–	–	–	–	**–**
Total coverage (%)*		**10**	**43**	**12**	**1**	**18**	**4**	**71[a]**	**31**	**25**	**21**	**–**	**14**	**41**	**36**	**4**	**57**	**15**	**69**	**52**	**23**	**25**	**–**
Species richness		**6**	**6**	**7**	**5**	**3**	**4**	**4**	**14**	**6**	**10**	**26**	**6**	**6**	**6**	**3**	**3**	**5**	**3**	**11**	**7**	**4**	**22**

* Rounded to the nearest whole number.

[a] Represents percent coverage of dried remnant beds of aquatic plants

4.8 Aquatic Macroinvertebrates

4.8.1 Macroinvertebrate communities in the region

4.8.1.1 Macroinvertebrates

Previous surveys indicate that macroinvertebrate communities in the region vary due to seasonal changes and are in moderate condition but influenced by a range of factors including the local land use and existing water quality (BMT WBM 2011a; BMT WBM 2011b; frc environmental 2014; AARC 2021; AARC 2022).

The communities were dominated by pollution tolerant taxa, including:

- Non-biting midge larvae (subfamilies Chironominae and Tanypodinae);
- Water mites (Acarina);
- Water boatmen (family Corixidae);
- Beetles (family Dytiscidae, Hydrophilidae and Ptilodactilyidae);
- Segmented worms (Oligochaeta); and
- Freshwater snails (families Physidae and Planorbidae).

Index calculations indicated macroinvertebrate communities were variable between sites and habitats (i.e. riverine and waterway sites and wetland sites):

- Taxonomic richness ranged from 6 – 24 (bed habitat) and 5 – 28 taxa (edge habitat) at riverine and waterway sites and ranged from 7 – 16 (bed habitat) and 13 – 30 (edge habitat) at wetland sites;
- PET richness ranged from 0 – 5 (bed habitat) and 0 – 6 (edge habitat) at riverine and waterway sites and ranged from 0 – 1 (bed habitat) and 0 – 4 (edge habitat) at wetland sites;
- SIGNAL-2 scores ranged from 3.06 – 4.48 (bed habitat) and 2.90 – 4.60 (edge habitat) at riverine and waterway sites and ranged from 2.40 – 3.62 (bed habitat) and 2.55 – 3.25 (edge habitat) at wetland sites;
- SIGNAL-2 / family bi-plots: sites tended to fall within quadrants 1, 2 and 3 and were clustered close to the borders.

Macroinvertebrate communities at sites on the Dawson River or associated with the Dawson River (i.e. sites on the Anabranch located near the Dawson River main channel) were more abundant and diverse, while sites on smaller waterways and wetlands surrounding the Dawson River tended to have low diversity and lacked the presence of sensitive taxa.

4.8.1.2 Macrocrustaceans

Four taxa of Macrocrustaceans have been recorded in previous surveys completed on the Dawson River and surrounding waterways and wetlands in the region (BMT WBM 2011b, c; frc environmental 2014):

- Freshwater shrimp (family Atyidae);
- Freshwater prawns (family Palaemonidae);

- Freshwater crayfish ("yabbies", family Parastacidae); and
- Freshwater crab (family Potamonidae).

Previous surveys indicate that macrocrustaceans are relatively abundant in riverine and waterway habitats (i.e. at sites on the Dawson River and surrounding waterways such as Saline Creek). The abundance of these taxa was found to be higher during wet season surveys compared to dry season surveys (frc environmental 2014).

4.8.1.3 Listed Macroinvertebrates in the Region

No exotic, rare or threatened macroinvertebrate or macrocrustacean species are known to occur in the Dawson River Sub-basin (DES 2019b) and none have been recorded in previous surveys completed on the Dawson River and surrounding waterways and wetlands in the region (BMT WBM 2011a, b, c; frc environmental 2014; AARC 2021; AARC 2022).

4.8.2 Macroinvertebrate Communities of the Study Area

4.8.2.1 Taxonomic Richness

A total of 52 and 56 taxa were identified in the June 2017 and March 2018, respectively, across all sites surveyed for macroinvertebrates.

In June 2017:

- 48 different taxa were identified in edge samples; and
- 32 different taxa were identified in bed samples.

In March 2018:

- 47 different taxa were identified in edge samples; and
- 41 different taxa were identified in bed samples.

Taxonomic richness in **edge** habitat was generally low (Figure 4.16). At:

- Sites on the Dawson River and Anabranch: taxonomic richness ranged from 14 – 27 and was below the WQO range except at site DA1 (anabranch) in March 2018;
- Sites on Banana Creek: taxonomic richness ranged from 19 – 24 and was below the WQO range except at site at BC2 in June 2017;
- Sites on the minor waterways: taxonomic richness ranged from 13 – 18 and was below the WQO range at both sites in both surveys;
- Sites on wetlands: taxonomic richness ranged from 17 – 18 and was below the WQO range at all sites in both surveys.

The most common and widespread major groups and taxa in edge habitat included:

- True flies (order Diptera) with non-biting midges and bloodworms from families Chironominae and/or Tanypodinae present in edge samples collected all sites in both surveys;
- True bugs (order Hemiptera) present in all edge samples collected at all sites in both surveys; and

- Damselflies and dragonflies (order Odonata) present in edge samples collected at all sites in both surveys.

In addition, segmented worms (class Oligochaeta), beetles (order Coleoptera) and snails (order Hygrophila) were also relatively common and present across most sites in both surveys. These taxa are all typical of the region and are classified as tolerant to very tolerant (where sensitivity ratings are available). However, three sensitive taxa of mayflies (order Ephemeroptera), namely the families Baetidae, Caenidae and Leptophlebiidae, were also widespread; at least one of these mayfly families was present in edge samples collected at all sites in both surveys except at site PW2 in June 2017. Three additional sensitive taxa of caddisflies (order Trichoptera, namely families Ecnomidae, Hydroptilidae and Leptoceridae), were moderately widespread and were present at all sites except DA1, SG1 and LW1 in June 2017 but were only present at two sites (DR1 and DA1) in March 2018.

The least widespread major groups and taxa, included two very tolerant taxa of:

- Spring tails (class Collembola): Collembola were only present at site DR1 in March 2018; and
- Caterpillars (order Lepidoptera): Crambidae were only present at site LW1 in June 2017 and DR1 in March 2018.

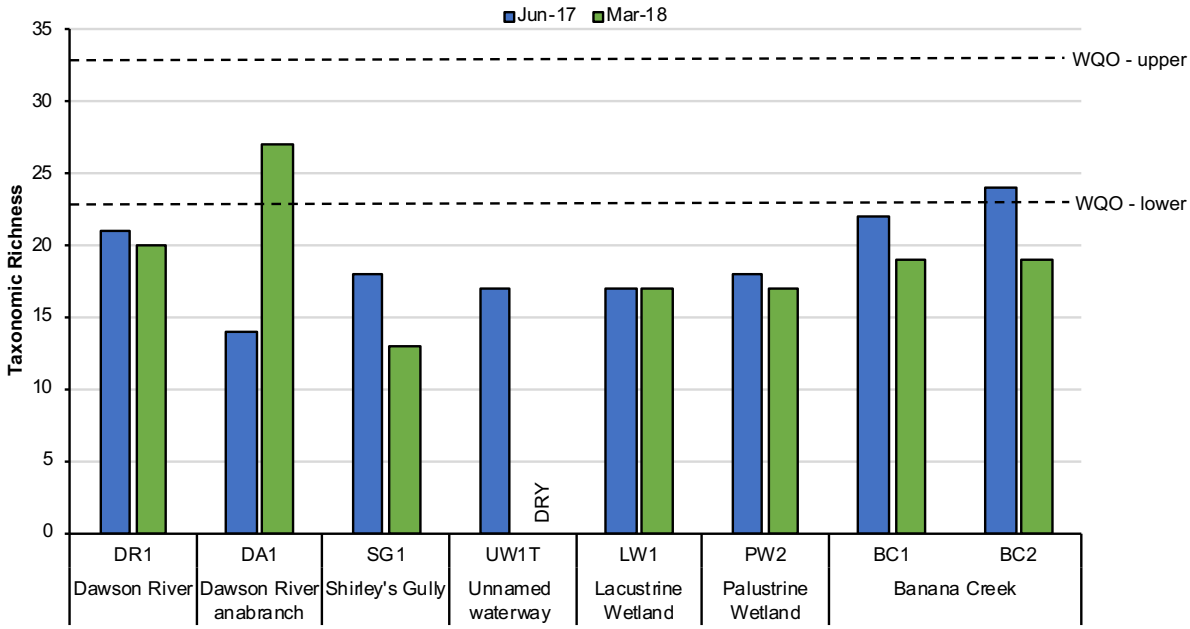

Figure 4.16 Taxonomic richness for edge habitat at each site.

Taxonomic richness in **bed** habitat was low to moderate (Figure 4.17), at:

- Sites on the Dawson River and Anabranch: taxonomic richness was moderate, ranging from 13 – 17 and was within the WQO range at both sites in both surveys;
- Sites on Banana Creek: taxonomic richness was low to moderate, ranging from 11 – 13 and only within the WQO range during one survey at each site;
- Sites on the minor waterways: taxonomic richness was low to moderate, ranging from 10 – 14 and was generally below the WQO range except at site UWT1 in June 2017;

- Sites on the wetlands: taxonomic richness was low, ranging from 8 – 11 and was below the WQO range in both surveys at both sites.

The most common and widespread major groups and taxa in bed habitat were true flies (order Diptera) with non-biting midges and bloodworms from families Chironominae and/or Tanypodinae present in bed samples collected at all sites in both surveys. In addition, several other major groups and taxa were widespread and present across most sites in both surveys, including:

- True bugs (order Hemiptera): family Corixidae were present at all sites in June 2017 and most sites in March 2018;
- Damselflies and dragonflies (order Odonata): with families Coenagrionidae and/or Libellulidae present at most sites in each survey; and
- Beetles (Order Coleoptera): with either Dytiscidae or Hydrophilidae present at most in June 2017, but less widespread in March 2018.

These taxa are all considered to be typical of waterways within the region and are classified tolerant to very tolerant (where sensitivity ratings are available). However, sensitive taxa of mayflies (order Ephemeroptera, namely families Baetidae, Caenidae and Leptophlebiidae) were also moderately common and widespread present at most sites in each survey. Another sensitive taxa of caddis flies (order Trichoptera, namely families Ecnomidae and Leptoceridae) were also present at four sites (DA1, SG1, UW1T and PW2) in June 2017, but only two sites (DR1 and DA1) in March 2018.

The least widespread major groups and taxa included:

- Caterpillars (order Lepidoptera): Crambidae were only present at site SG1 in March 2018 and are considered very tolerant taxa; and
- Mussels (class Bivalvia): Cyrenidae and Hyriidae were only present in the Dawson River (site DR1) in March 2017 and are both considered to be tolerant taxa.

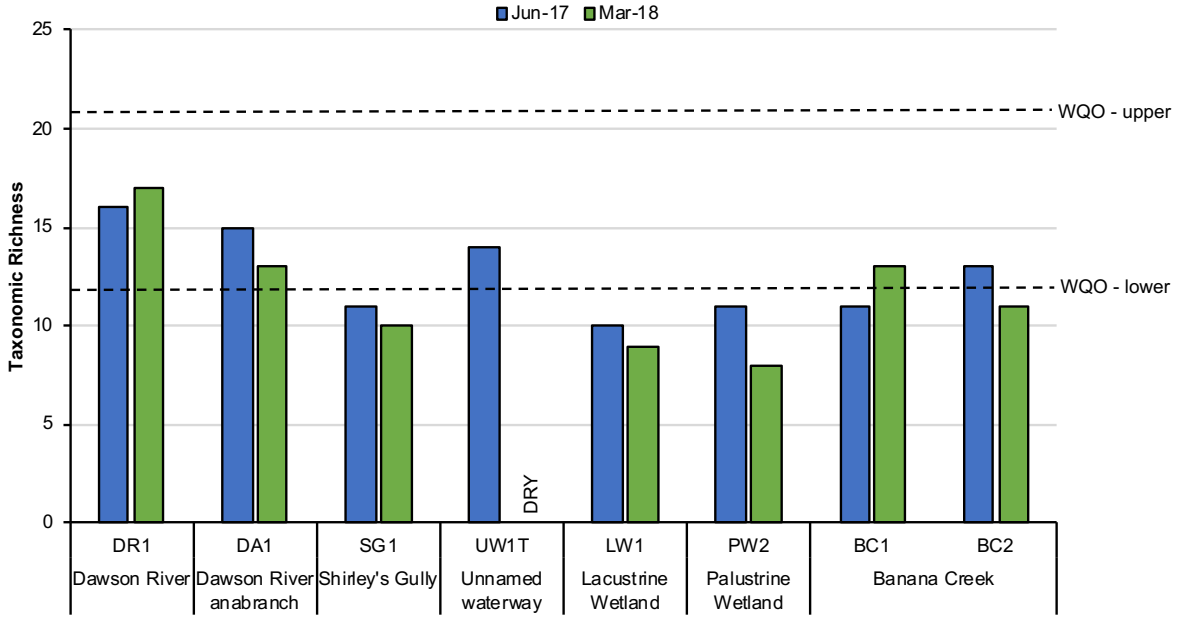

Figure 4.17 Taxonomic richness for bed habitat at each site.

4.8.2.2 PET Richness

A total of six PET taxa were identified across all sites, habitats and surveys, including three taxa of mayflies and three taxa of caddis flies.

PET richness in **edge** habitat was low to moderate (Figure 4.18). At:

- Sites on the Dawson River and Anabranch: PET richness ranged from 2 – 4 and was equal to the lower WQO or within the WQO range during both surveys;
- Sites on Banana Creek: PET Richness ranged from 1 – 2 and was equal to or below the WQO range;
- Sites on the minor waterways: PET richness ranged from 1 – 2 and was equal to or below the WQO range;
- Wetlands: PET richness was 1 and below the WQO range at both sites in both surveys.

PET richness in **bed** habitat was low to moderate (Figure 4.19). At:

- Sites on the Dawson River and Anabranch: PET richness ranged from 2 – 3 and was equal to the lower WQO or within the WQO range during both surveys;
- Sites on Banana Creek: PET Richness was 1 and was below the WQO at both sites in both surveys;
- Sites on the minor waterways and wetlands: PET richness ranged from 0 – 2 and was below the WQO range at both wetland sites (LW1 and PW2) in both surveys; and was equal to or below the lower WQO at minor waterway sites.

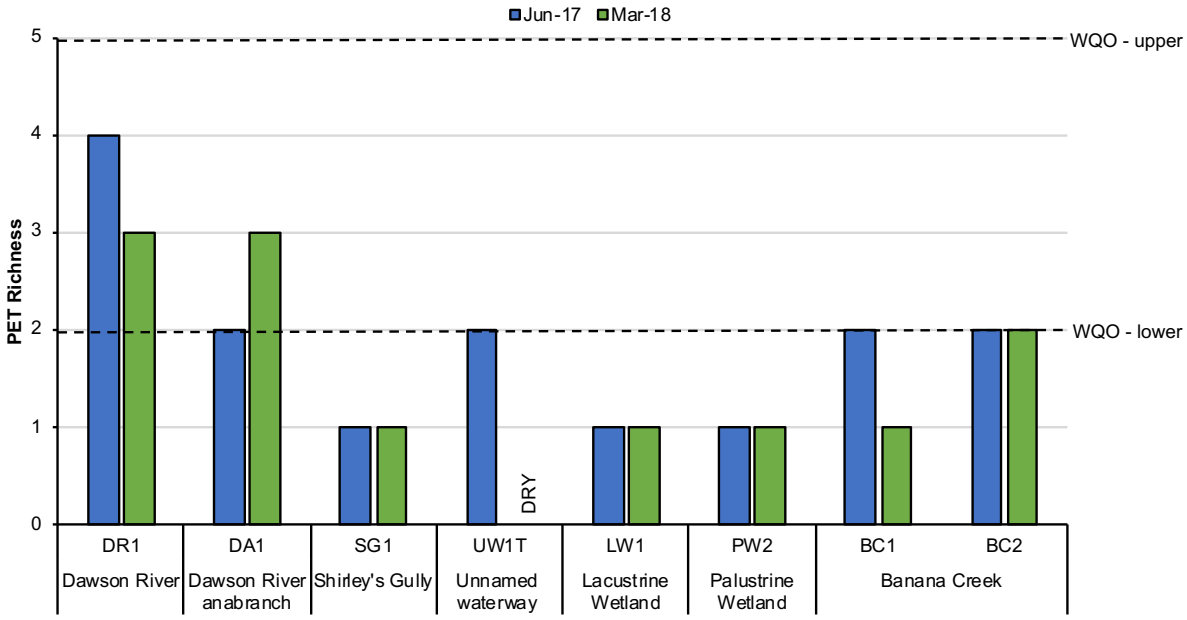

Figure 4.18 PET richness for edge habitat at each site.

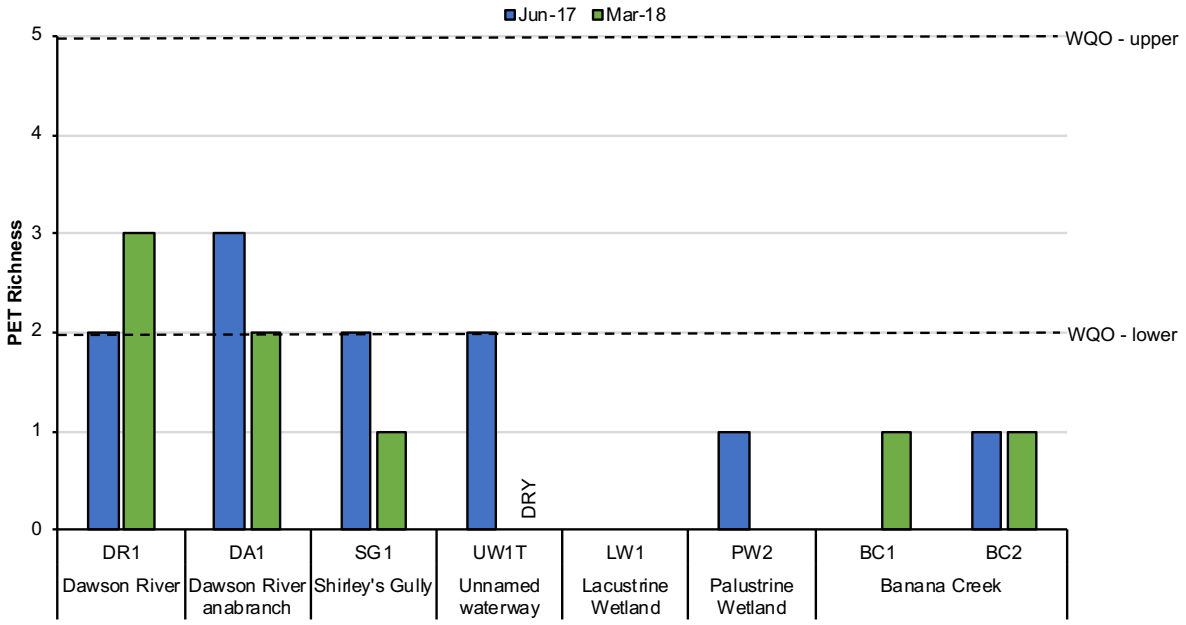

Figure 4.19 PET richness for bed habitat at each site.

4.8.2.3 Signal 2 Score

SIGNAL 2 scores in **edge** habitat were low (Figure 4.20). At:

- Sites on the Dawson River and Anabranch: SIGNAL 2 scores ranged from 2.81 – 3.04 and were below the WQO range during both surveys;
- Sites on Banana Creek: SIGNAL 2 scores ranged from 2.92 – 3.34 and were below the WQO range except in March 2018 at site BC2;
- Sites on the minor waterways: SIGNAL 2 scores ranged from 2.73 – 3.19 and were below the WQO range at both sites in both surveys;
- Sites on the wetlands: SIGNAL 2 scores ranged from 2.51 – 2.91 and were below the WQO range at both sites in both surveys.

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in edge habitat, most sites fell within Quadrant 4 in both surveys (site conditions are likely influenced by urban industrial or agricultural pollution) except for site BC2 in June 2017 and DA1 in March 2018, which were placed in Quadrant 2 (indicative of high concentrations of nutrients and/or high turbidity and salinity) (Figure 4.11 and 4.12). Water quality data supports this, with high concentrations of nutrients recorded at all sites, which is typical of waterways surrounded by agricultural land, and although electrical conductivity was low across all sites, turbidity was high and particularly high at site BC2 in June 2017 and site DA1 in March 2018.

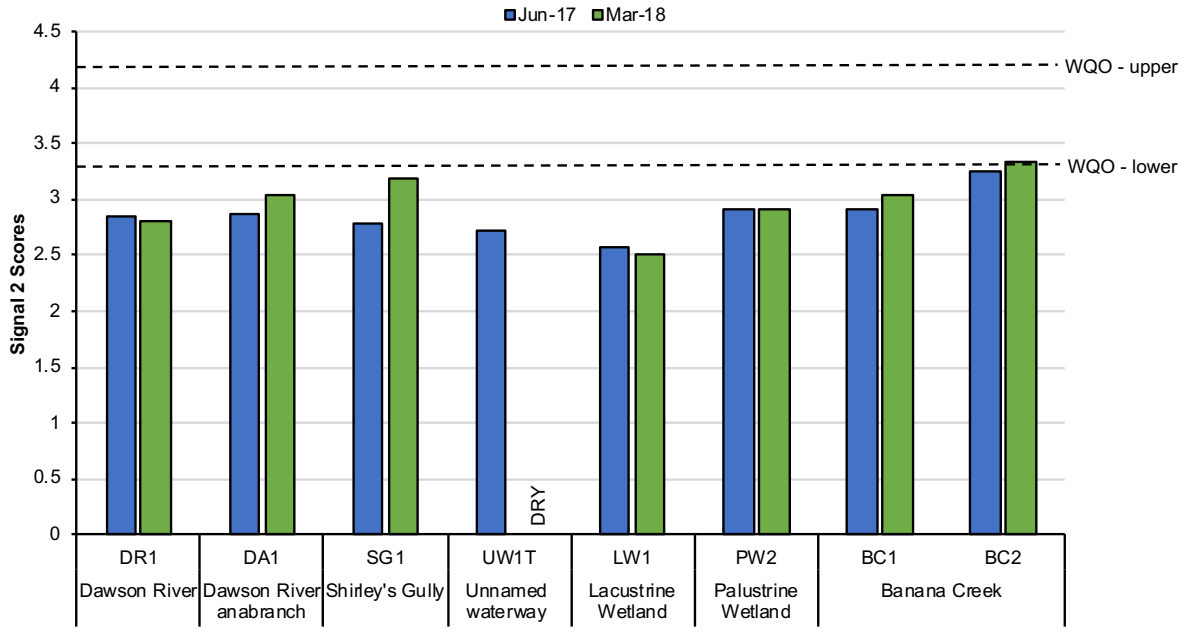

Figure 4.20 Signal 2 Scores for edge habitat at each site.

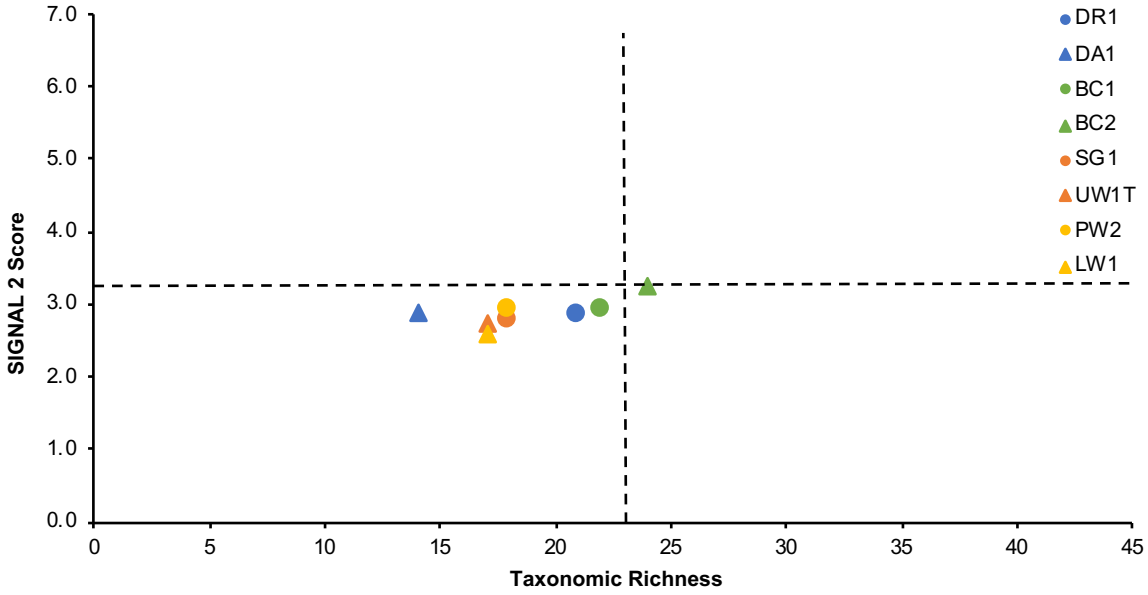

Figure 4.21 Signal 2 Bi-plot for edge habitat for each site in June 2017.

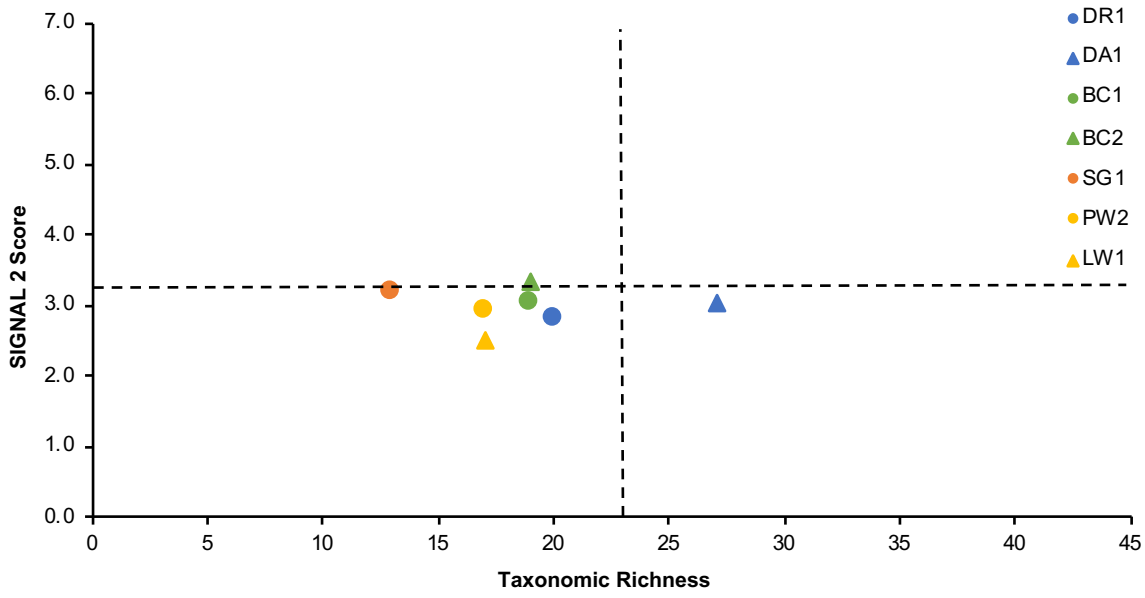

Figure 4.22 Signal 2 Bi-plot for edge habitat for each site in March 2018.

SIGNAL 2 scores in **bed** habitat varied (Figure 4.23). At:

- Sites on the Dawson River and Anabranch: SIGNAL 2 scores ranged from 3.00 – 3.50 and were below the WQO range in June 2017 but within the WQO range in March 2018;
- Sites on Banana Creek: SIGNAL 2 scores ranged from 2.37 – 3.91 and were below the WQO range except for site BC2 in March 2018;
- Sites on the minor waterways: ranged from 3.33 – 3.47 and were within the WQO range at both sites in both surveys;
- Sites on the wetlands: SIGNAL 2 scores ranged from 2.50 – 3.50 and were below the WQO range except at site PW2 in March 2018.

On SIGNAL 2 / family bi-plots for macroinvertebrate communities in bed habitat sites fell within all quadrants (Figure 4.24 & Figure 4.25). This indicates pollutants from surrounding land run-off or potentially natural sources of contaminants may be affecting conditions at sites, and as a result, impacting macroinvertebrate communities, specifically in terms of:

- High turbidity, salinity and concentrations of nutrients (characteristic of sites that fall within Quadrant 2); and
- Low pH and high concentrations of trace metals (characteristic of sites that fall within Quadrants 3 and 4).

Water quality data supports this, with high concentrations of nutrients recorded at all sites, which is typical of waterways surrounded by agricultural land (as is the study area) and high concentrations of metals (particularly dissolved metals) at sites that fell within quadrants 3 and 4. The exception to this was site LW1, where concentrations of trace metals were low. However, poor physical conditions such as bare muddy beds can also result in sites falling within quadrants 3 and 4, and this was characteristic of the bed habitat at site LW1. Quadrant 1 is indicative of favourable conditions and while some sites fell within this quadrant, their

position was borderline with quadrant 2 indicating that external factors were still influencing the conditions at these sites to some degree, which is again further supported by the water quality results.

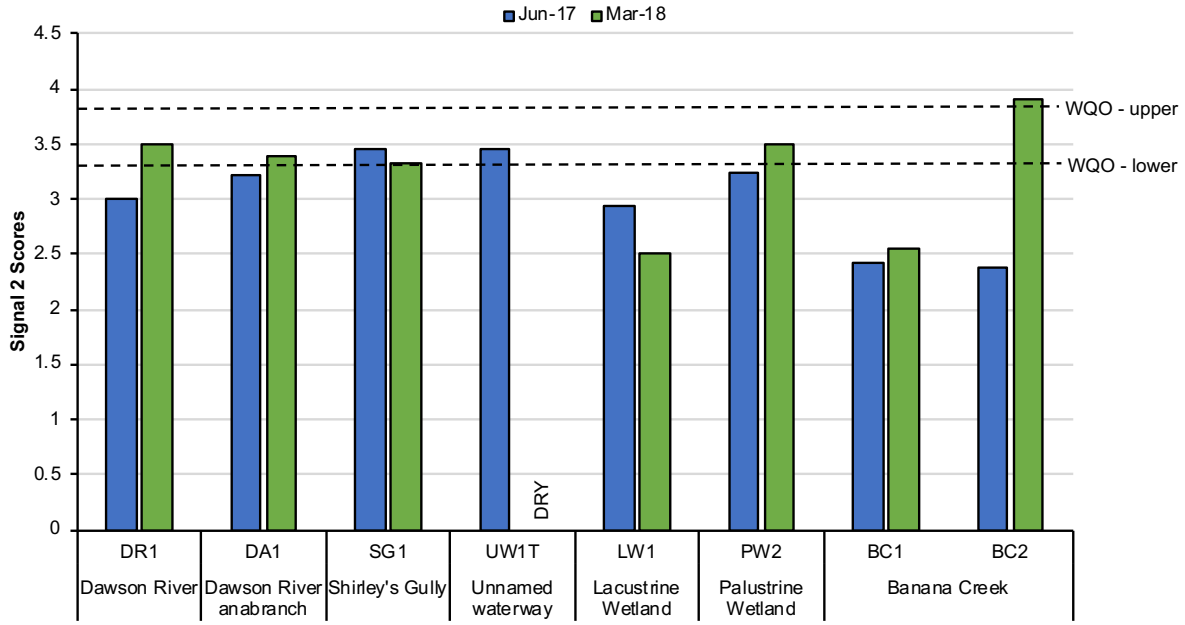

Figure 4.23 Signal 2 Scores for bed habitat at each site.

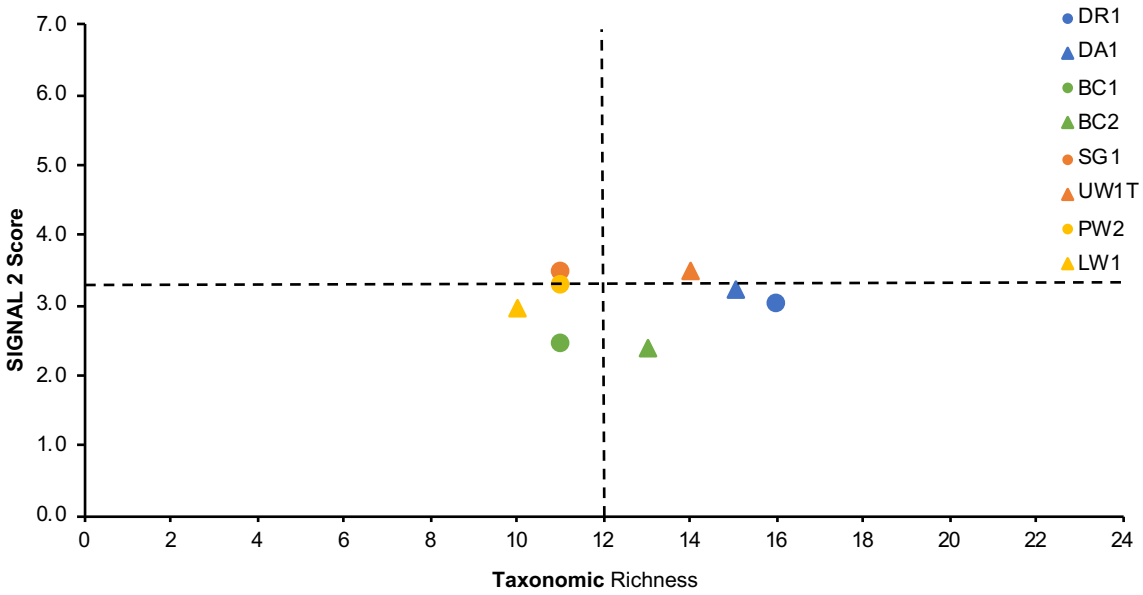

Figure 4.24 Signal 2 Bi-plot for bed habitat for each site in June 2017.

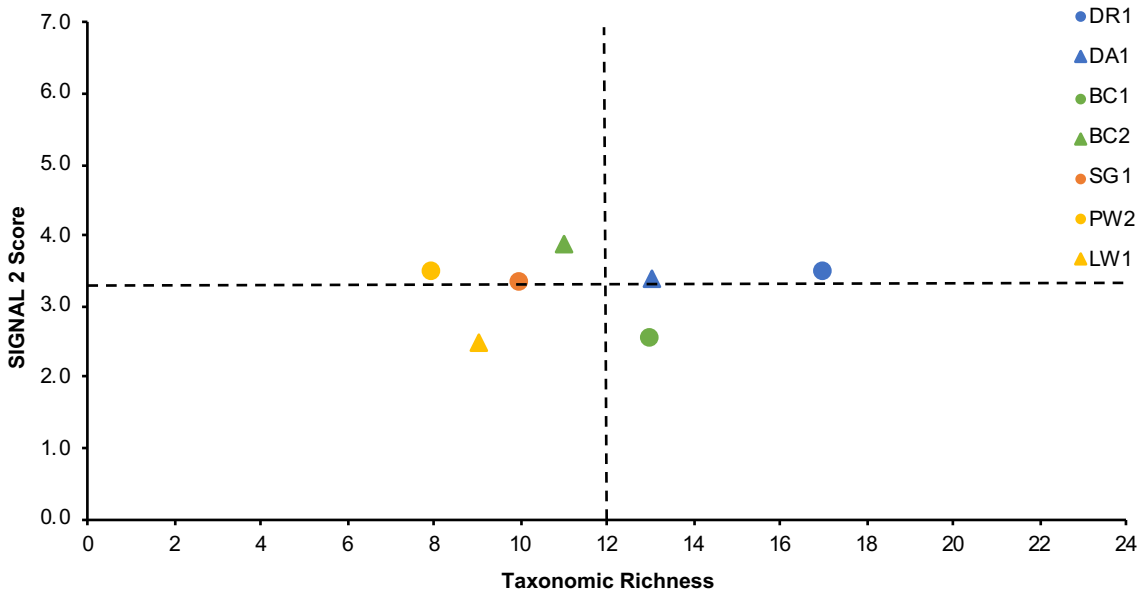

Figure 4.25 Signal 2 Bi-plot for bed habitat for each site in March 2018.

4.9 Fish

4.9.1 Fish Communities of the Region

There are 49 naturally occurring native species of fish in the freshwaters of the Fitzroy River basin and 35 species within the Dawson River Sub-basin (DES 2019a, b; DERM 2011) (Table 4.1). Three species, the southern saratoga, leathery grunter and golden perch are considered endemic to the Fitzroy Basin (DES 2019a, DERM 2011). Three species, silver perch (*Bidyanus bidyanus*), sooty grunter (*Hephaestus fuliginosus*) and Murray cod (*Maccullochella peelii peelii)* do not naturally occur in the basin but have been translocated (DERM 2011; Ye at al. 2014). The silver perch and Murray cod are listed threatened species under the EPBC Act. Their preferred habitat, distribution and ecology is discussed below in Section 4.9.1.1.

Five pest species of fish are known to occur in the Fitzroy Basin, four of which are also known to occur in the Dawson River Sub-basin (DES 2019a, b; DERM 2011; FBA 2017) (Table 4.7):

- Carp *(Cyrprinus carpio;* known from the Fitzroy Basin and Dawson River Sub-basin);
- Mosquitofish (*Gambusia holbrooki;* known from the Fitzroy Basin and Dawson River Sub-basin);
- Tilapia (*Oreochromis mossambicus;* known from the Fitzroy Basin and Dawson River Sub-basin);
- Goldfish (*Carassius auratus;* known from the Fitzroy Basin and Dawson River Sub-basin); and
- Guppy (*Poecilia reticulata*)*;* known from the wider Fitzroy Basin only).

Carp, mosquitofish and tilapia are listed as restricted biosecurity matters and noxious fish under the Biosecurity Act. Guppies and goldfish are non-indigenous to Australia. There is a

general biological obligation (GBO) under the Biosecurity Act to take reasonable and practical steps to minimise the risks associated with the spread of all pest fish (DAF 2018).

Previous surveys completed on the Dawson River and surrounding waterways and wetlands for the Baralaba Mine and Baralaba North Project recorded a total of 31 species of native fish and two species of pest fish (BMT WBM 2011a, b; frc environmental 2014) (Table 4.7). One listed threatened species (silver perch) was recorded during surveys completed in 2010. The other recorded native fish species are considered widespread throughout eastern Australia and native to the Fitzroy and Dawson River basins (Pusey et al. 2004). Most species 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 (e.g. high range in pH and salinity), which are typical adaptations for fish inhabiting ephemeral streams and rivers (Pusey et al. 2004). Many species also migrate upstream and downstream for reproduction and between different stages of their life cycle.

4.9.1.1 Listed Threatened Fish Species

Murray Cod

The Murray cod is listed as vulnerable under the EPBC Act. The natural distribution of this species is within the Murray-Darling basin, which extends from southern Queensland, through New South Wales (NSW), the Australian Capital Territory (ACT) and Victoria to South Australia. This species was translocated into the Fitzroy River basin and stocked into several dams across Queensland, although the translocation is thought to have failed to establish a permanent population in the Fitzroy Basin (Pusey et al. 2004, Ye at al. 2014). Murray cod are frequently found in the main channels of rivers and larger tributaries and is considered a main-channel specialist (DoEE 2019b). The Murray cod is listed as potentially occurring within 10 km of the study area (DoEE 2019a). However, there are no published records of the Murray cod in the vicinity of the study area or within the Dawson River Sub-basin (DES 2023c; ALA 2023). The closest published records of this species are in the Condamine-Balonne Sub-basin, approximately 290 km south-east of the study area, and Lake Baraboon in the Nogoa River Sub-basin, approximately 210 km to the north-west of the study area. Furthermore, no Murray cod were recorded during previous surveys completed on the Dawson River and surrounding waterways and wetlands in the region (BMT WBM 2011a, b; frc environment 2014). This species is considered unlikely to occur in the study area.

Silver Perch

The silver perch is currently listed as critically endangered under the EPBC Act. At the time of the EPBC Act Controlled Action Decision (EPBC Referral 2012/6547), this species was not listed as threatened and is therefore not a MNES requiring consideration for this Project. The silver perch is the largest terapontid grunter in Australia, with a natural distribution limited to the Murray-Darling Basin, but is widely translocated throughout Queensland (Pusey et al. 2004). This species inhabits freshwater rivers, lakes and reservoirs, particularly in areas of high water flow (Bray and Thompson 2019). The distribution and abundance of silver perch in its natural range of Victoria and New South Wales has experienced a significant decline (Bray and Thompson 2019). Silver perch are a popular angling species and are also raised in aquaculture and in farm dams (Bray and Thompson 2019). Silver perch migrate over large distances, moving between rivers and their tributaries (Bray and Thompson 2019). Silver perch are omnivorous and their diet includes insect larvae, molluscs,

annelids and algae (Bray and Thompson 2019). This species has rarely been recorded in waterways of the lower Dawson River (DERM 2011); however, during surveys previously completed within the region for Baralaba Mine, a silver perch was recorded at a site on an Anabranch of the Dawson River (BMT WBM 2011a), located approximately 17 km downstream of the current Project area.

Table 4.7 Fish of the Fitzroy Basin and Dawson River Sub-basin recorded in databases, previous studies in the vicinity of Baralaba, and the current survey.

Family *Species Name*	Common Name	Distribution			
		Fitzroy Basin[a]	Dawson Sub-Basin[b]	Previous studies[c]	Current survey
Ambassidae					
Ambassis agassizii	Agassiz's glassfish	Yes	Yes	Yes	Yes
Ambassis sp.	–	Yes	Yes	–	
Anguillidae					
Anguilla reinhardtii	longfin eel	Yes	Yes	Yes	–
Apogonidae					
Glossamia aprion	mouth almighty	Yes	Yes	Yes	Yes
Ariidae					
Neoarius graeffei	blue catfish	Yes	Yes	Yes	Yes
Atherinidae					
Craterocephalus marjoriae	silverstreak hardyhead	Yes	–	Yes	–
Craterocephalus stercusmuscarum	flyspecked hardyhead	Yes	Yes	Yes	Yes
Belonidae					
Strongylura krefftii	freshwater longtom	Yes	Yes	Yes	Yes
Centropomidae					
Lates calcarifer	barramundi	Yes	Yes	Yes	–
Ceratodontidae					
Neoceratodus forsteri	Australian lungfish	Yes	–	–	–
Clupeidae					
Nematalosa erebi	bony bream	Yes	Yes	Yes	Yes
Cyprinidae					
*Carassius auratus**	goldfish	Yes	Yes	Yes	Yes
*Cyprinus carpio***	European carp	Yes	Yes	–	–

Family *Species Name*	Common Name	Distribution			
		Fitzroy Basin[a]	Dawson Sub-Basin[b]	Previous studies[c]	Current survey
Eleotridae					
Gobiomorphus australis	striped gudgeon	Yes	–	–	–
Hypseleotris compressa	empire gudgeon	Yes	Yes	Yes	–
Hypseleotris galii	firetail gudgeon	Yes	Yes	–	Yes
Hypseleotris klunzingeri	western carp gudgeon	Yes	Yes	Yes	Yes
Hypseleotris sp.	Midgley's carp gudgeon	Yes	Yes	Yes	Yes
Hypseleotris species 1	Murray-Darling carp gudgeon	Yes	Yes	–	–
Hypseleotris species 3	carp gudgeon	Yes	–	–	–
Mogurnda adspersa	southern purplespotted gudgeon	Yes	Yes	Yes	Yes
Oxyeleotris aruensis	Aru gudgeon	Yes	Yes	–	–
Oxyeleotris lineolata	sleepy cod	Yes	Yes	Yes	Yes
Philypnodon grandiceps	flathead gudgeon	Yes	Yes	Yes	Yes
Gobiidae					
Redigobius bikolanus	speckled goby	Yes	–	–	–
Hemiramphidae					
Arrhamphus sclerolepis	snubnose garfish	Yes	Yes	–	–
Lutjanidae					
Lutjanus argentimaculatus	mangrove jack	Yes	–	–	–
Megalopidae					
Megalops cyprinoides	oxeye herring	Yes	Yes	–	–
Melanotaeniidae					
Melanotaenia splendida splendida	eastern rainbowfish	Yes	Yes	Yes	Yes
Rhadinocentrus ornatus	ornate rainbowfish	Yes	–	–	–

Family *Species Name*	Common Name	Distribution			
		Fitzroy Basin[a]	Dawson Sub-Basin[b]	Previous studies[c]	Current survey
Monodactylidae					
Monodactylus argenteus	diamondfish	Yes	–	–	–
Mugilidae					
Mugil cephalus	sea mullet	Yes	Yes	–	–
Trachystoma petardi	pinkeye mullet	Yes	–	–	–
Osteoglossidae					
Scleropages leichardti	southern saratoga	Yes	Yes	Yes	Yes
Percichthyidae					
Maccullochella peelii	Murray cod	Yes	–	–	–
Macquaria ambigua	golden perch	Yes	Yes	Yes	–
Plotosidae					
Neosilurus ater	black catfish	Yes	–	Yes	–
Neosilurus hyrtlii	Hyrtl's catfish	Yes	Yes	Yes	Yes
Porochilus rendahli	Rendahl's catfish	Yes	Yes	Yes	–
Tandanus tandanus	freshwater catfish	Yes	Yes	Yes	Yes
Poeciliidae					
*Gambusia holbrooki***	mosquitofish	Yes	Yes	Yes	Yes
*Poecilia reticulata**	guppy	Yes	Yes	–	–
Pseudomugilidae					
Pseudomugil signifer	Pacific blue eye	Yes	Yes	Yes	–
Retropinnidae					
Retropinna semoni	Australian smelt	Yes	Yes	–	Yes
Scatophagidae					
Scatophagus argus	spotted scat	Yes	–	–	–
Selenotoca multifasciata	striped scat	Yes	–	–	–

Family *Species Name*	Common Name	Distribution			
		Fitzroy Basin[a]	Dawson Sub-Basin[b]	Previous studies[c]	Current survey
Scorpaenidae					
Notesthes robusta	bullrout	Yes	Yes	–	–
Synbranchidae					
Ophisternon gutturale	swamp eel	Yes	–	Yes	–
Terapontidae					
Amniataba percoides	barred grunter	Yes	Yes	Yes	Yes
Bidyanus bidyanus	silver perch	Yes	Yes	Yes	–
Hephaestus fuliginosus	sooty grunter	Yes	Yes	–	–
Leiopotherapon unicolor	spangled perch	Yes	Yes	Yes	Yes
Scortum hillii	leathery grunter	Yes	Yes	Yes	Yes
Terapon jarbua	crescent grunter	Yes	–	–	–
Grand Total	**Grand Total**	**54**	**38**	**31**	**23**

* indicates pest species under the Biosecurity Act
** indicates restricted noxious pest species under the Biosecurity Act
[a] DES 2023a; DERM 2011
[b] DES 2023b; DERM 2011
[c] surveys completed for Baralaba North Mine within 15 km of the Project area (DERM 2011; BMT WBM 2011a,b; frc environmental 2014)

4.9.2 Fish Communities of the Study Area

The fish species caught in the study area during the baseline surveys are typical of the region and a low to moderate diversity and abundance of fish species occur within the study area. A total of 1577 native fish, representing 21 species from 13 families, were recorded at sites within and adjacent to the Project area across both surveys. In June 2017, a total of 18 native species from 13 families were recorded, and in March 2018 a total of 19 native species from 12 families were recorded (Table 4.8). 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). Many also migrate upstream and downstream for reproduction and between different stages of their life cycle.

Carp gudgeons (*Hypseleotris* spp.), fly-specked hardyhead (*Craterocephalus stercusmuscarum*), bony bream (*Nematalosa erebi*) and Agassiz's glassfish (*Ambassis agassizii*) were the most abundant and widespread native species recorded across both the dry season and wet season surveys. Australian smelt (*Retropinna semoni*) and eel-tailed catfish (*Tandanus tandanus*) were the least abundant and widespread. All three species that are considered endemic to the Fitzroy Basin (southern saratoga, leathery grunter and golden perch) were caught in the Dawson River and Anabranch in both surveys (Table 4.8).

Fish diversity (taxonomic richness) was highest at sites on the Dawson River and Anabranch and Shirley's Gully and was lowest at sites located on the minor waterways and wetland within the Project area (Table 4.8). At:

- Sites on the Dawson River and Anabranch: species richness was highest in June 2017 (13 species recorded) and lower in March 2018 (9 species recorded);
- Sites on Banana Creek: species richness was similar between seasons upstream of the weir pool (site BC1) but higher in the wet season within the weir pool (site BC2);
- Sites on the minor waterways: species richness was highest in Shirley's Gully, with 11 species recorded in June 2017 and 15 in March 2018 (the highest out of all sites in the study area). No species of fish were recorded at UW1T in June 2017 and the site was subsequently dry in March 2018; and
- Sites on wetlands: species richness ranged from 1 – 4 and in both surveys was lower than the species richness in other waterways (except for at site UW1T).

Fish from all life history stages (adult, intermediate and juvenile) were caught at all sites where fish were captured in June 2017 (Figure 4.26). No juvenile fish were caught at site DA1 on the Dawson River Anabranch (but were present at site DR1 on the Dawson River), and no intermediate fish were caught at wetland site PW2 in March 2018 (Figure 4.26). Higher proportions of juvenile fish (>40% of total catch) were recorded and observed at sites on the Dawson River and Anabranch and at wetland site LW1 in June 2017, while adult fish typically made up a higher proportion of the catch (>50% of the total catch) at all sites except SG1 in March 2018.

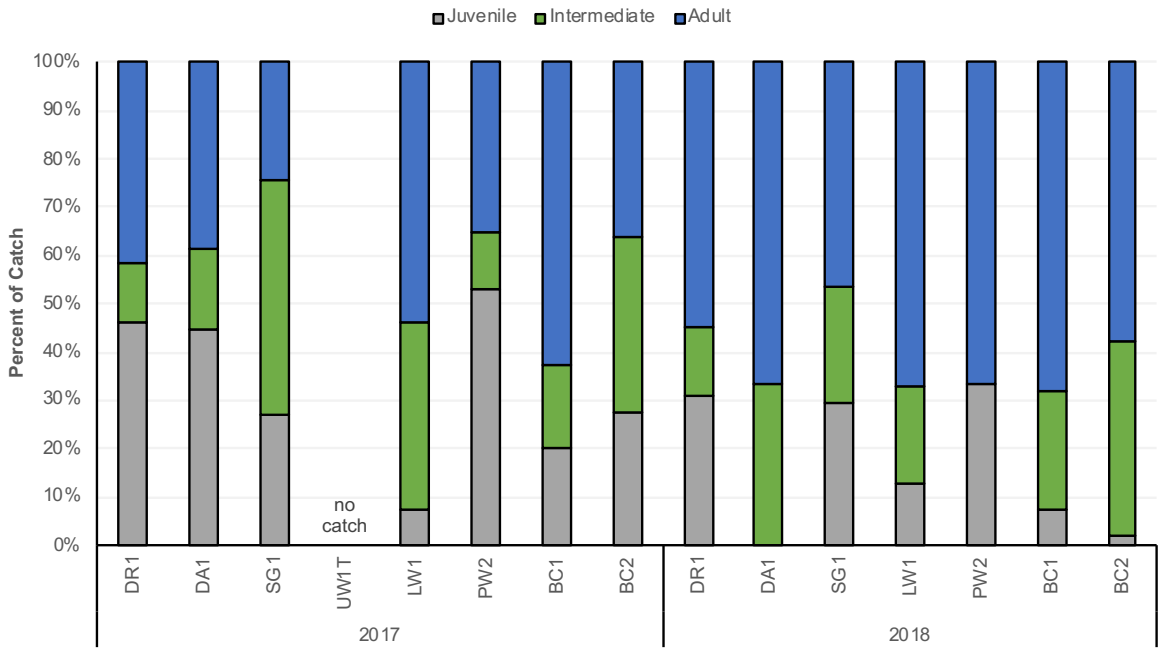

Figure 4.26 Proportion of native fish from juvenile, intermediate and adult life stages caught at locations in both surveys.

4.9.2.1 Pest Fish Species in the Region

Two pest species of fish from two families were recorded in both surveys: mosquitofish and goldfish (Table 4.8). Across both surveys, goldfish were recorded at three sites, including DR1, SG1 and LW1 (i.e. on the Dawson River, a minor waterway and a wetland). Mosquitofish were more widespread and abundant across the study area; across both surveys they were recorded at all sites where fish were captured and attributed 26% of the total catch in June 2017 and 12% of the total catch in March 2018.

4.9.2.2 Listed Fish Species in the Region

No listed rare or threatened species of fish were recorded. Given the distribution range and lack of confirmed records within the Dawson River Sub-basin it is considered unlikely that Murry cod would occur within the waterways of the study area. Although there is one record of a silver perch in the Dawson River in close proximity to the study area, this is considered an isolated occurrence; it is widely accepted that populations of this translocated species have not become established in the Fitzroy Basin. Considering the habitat preferences for the silver perch there is a low likelihood that the species would occur within the waterways of the study area due to lack of habitat and connectivity; any occurrences would be limited to the waters of the Dawson River and Anabranch.

Table 4.8 Fish species abundance and richness recorded at each site in the baseline surveys.

Family *Species Name*	Common Name	June 2017									March 2018							
		DR1	DA1	SG1	UW1T	LW1	PW2	BC1	BC2	Total	DR1	DA1	SG1	LW1	PW2	BC1	BC2	Total
Ambassidae																		
Ambassis agassizi	Agassiz's glassfish	2	1	7	–	–	12	18	4	**44**	–	–	–	–	11	6	48	**65**
Apogonidae																		
Glossamia aprion	mouth almighty	2	3	1	–	–	–	1	–	**7**	–	–	1	–	–	–	–	**1**
Ariidae																		
Neoarius graeffei	blue catfish	5	2	1	–	–	–	–	–	**8**	3	1	13	–	–	–	–	**17**
Atherinidae																		
Craterocephalus stercusmuscarum	fly-specked hardyhead	2	1	60	–	119	–	2	–	**184**	2	–	3	343	–	–	–	**348**
Belonidae																		
Strongylura krefftii	freshwater longtom	2	–	–	–	–	–	–	–	**2**	3	2	2	–	–	–	–	**7**
Clupeidae																		
Nematalosa erebi	bony bream	64	46	6	–	–	–	3	1	**120**	37	41	196	–	–	3	16	**293**
Cyprinidae																		
Carassius auratus *	goldfish	1	–	2	–	–	–	–	–	**3**	1	–	3	2	–	–	–	**6**
Eleotridae																		
Hypseleotris galii	firetail gudgeon	–	1	–	–	–	–	8	–	**9**	–	–	–	–	–	–	–	**0**
Hypseleotris spp.	carp gudgeon	1	–	102	–	81	–	–	1	**185**	–	–	1	74	–	3	–	**78**
Mogurnda adspersa	purple-spotted gudgeon	–	–	1	–	–	–	–	1	**2**	–	–	–	–	–	8	3	**11**
Oxyeleotris lineolatus	sleepy cod	14	12	–	–	–	–	–	–	**26**	11	–	7	–	–	–	1	**19**
Hypseleotris klunzingeri	western carp gudgeon	–	–	–	–	–	–	–	–	**–**	–	–	–	22	–	–	1	**23**
Philypnodon grandiceps	flathead gudgeon	–	–	–	–	–	–	–	–	**–**	–	–	–	–	–	3	–	**3**

Family *Species Name*	Common Name	June 2017									March 2018							
		DR1	DA1	SG1	UW1T	LW1	PW2	BC1	BC2	Total	DR1	DA1	SG1	LW1	PW2	BC1	BC2	Total
Melanotaeniidae																		
Melanotaenia splendida splendida	eastern rainbowfish	5	5	–	–	–	1	1	4	**16**	2	–	2	–	–	–	3	**7**
Osteoglossidae																		
Scleropages leichardti	southern saratoga	4	3	–	–	–	–	–	–	**7**	6	3	1	–	–	–	–	**10**
Percichthyidae																		
Macquaria ambigua	golden perch	1	1	13	–	–	–	–	–	**15**	–	–	2	–	–	–	–	**2**
Plotosidae																		
Neosilurus hyrtlii	Hyrtl's tandan	–	–	4	–	–	–	–	–	**4**	–	–	–	–	–	2	1	**3**
Tandanus tandanus	eel-tailed catfish										–	–	1	–	–	–	–	**1**
Poeciliidae																		
Gambusia holbrooki *	mosquitofish	–	–	3	–	36	106	56	27	**228**	2	1	2	16	3	69	34	**127**
Retropinnidae																		
Retropinna semoni	Australian smelt	–	2	–	–	–	–	–	–	**2**	–	–	–	–	–	–	–	**0**
Terapontidae																		
Amniataba percoides	barred grunter	2	–	–	–	–	4	–	–	**6**	2	–	1	–	–	–	–	**3**
Leiopotherapon unicolor	spangled perch	–	–	4	–	1	–	2	–	**7**	–	1	1	21	–	4	–	**27**
Scortum hillii	leathery grunter	6	2	1	–	–	–	–	–	**9**	1	3	2	–	–	–	–	**6**
Native Species Abundance		**110**	**79**	**200**	**0**	**201**	**17**	**35**	**11**	**653**	**67**	**51**	**233**	**460**	**11**	**29**	**73**	**924**
Exotic Species Abundance		**1**	**0**	**5**	**0**	**36**	**106**	**56**	**27**	**231**	**3**	**1**	**5**	**18**	**3**	**69**	**34**	**133**
Native Species Richness		**13**	**12**	**11**	**0**	**3**	**3**	**7**	**5**	**18**	**9**	**6**	**14**	**4**	**1**	**7**	**7**	**19**
Exotic Species Richness		**1**	**0**	**2**	**0**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**2**

* Pest species.
– Species not recorded.

4.10 Turtles

4.10.1 Turtles Communities of the Region

There are seven species of freshwater turtle known to occur in the Fitzroy Basin and in the Dawson River Sub-basin (DES 2023a, b):

- White-throated snapping turtle (*Elseya albagula*);
- Murray turtle (*Emydura macquarii macquarii*);
- Krefft's river turtle (*Emydura macquarii krefftii*);
- Broad-shelled river turtle (*Chelodina expansa*);
- Eastern snake-necked turtle (*Chelodina longicollis*);
- Fitzroy River turtle (*Rheodytes leukops*); and
- Saw-shelled turtle (*Wollumbinia latisternum*).

Murray turtle, Krefft's river turtle, broad-shelled river turtle, eastern snake-necked turtle and saw-shelled turtle are widely distributed on the east coast of Australia in rivers and wetlands. They are not listed under the EPBC Act and are listed as least concern under the NC Act (ALA 2023; DES 2023a, b).

The white throated snapping turtle is listed as critically endangered under the EPBC Act, although it was not listed under the EPBC Act at the time of the controlled action decision for this Project, and is therefore not a MNES requiring consideration for this Project; it is listed as endangered under the Queensland NC Act. The Fitzroy River turtle is listed as vulnerable under both the EPBC Act and the NC Act, and was listed under the EPBC Act at the time of the controlled action decision for this Project so is a MNES requiring consideration for this Project. Both species are a high priority species under the Back on Track program for the Fitzroy Natural Resource Management Region (DERM 2010). Their preferred habitat, distribution and ecology is discussed below.

4.10.2 Fitzroy River Turtle

4.10.2.1 Description

The Fitzroy River turtle is a medium to dark brown freshwater turtle with an oval shell, growing up to 25 cm in length with scattered darker spots on the upper shell surface (DoE 2020). It has a pale yellow or cream underside, dull olive-grey exposed fleshy parts and a distinct narrow white ring around the eye in adults, or a silvery-blue iris in hatchlings (Cogger 2000; Hamann et al. 2007; DoE 2020). The Fitzroy River turtle has relatively long forelimbs with five long claws and large cloacal bursae (Cogger 2000; Wilson & Swan 2003).

4.10.2.2 Bimodal Respiration

The Fitzroy River turtle belongs to a unique group of bimodally-respiring Australian freshwater turtles that have the ability to extract oxygen from both the air and the water using highly modified cloacal bursae that extract up to 70% of its total oxygen requirements from cloacal ventilation (Priest 1997). As such, they are well adapted for foraging in flowing riffle

zones, as the elevated dissolved oxygen enables the turtles to undertake prolonged dives, utilizing the cloaca to flush water in and out to obtain dissolved oxygen (Limpus et al. 2011).

The advantage of bimodal respiration is that the turtle can reduce the surfacing frequency, thus reducing surface predation and increase the amount of time available for foraging or resting (Stone et al. 1992). Additionally, as this species is negatively buoyant, considerable energy is required to swim to the surface for air (Priest 1997). Both the turtles' physiological and environmental conditions are responsible for the amount of time a turtle may be submerged. Lower water temperatures contain a higher level of dissolved oxygen, as well as reducing the metabolic rate of the turtle, thereby, prolonging the period of time the turtle may remain submerged (Priest and Franklin 2002).

4.10.2.3 Diet

This species is a benthic omnivore, with a diet consisting of insects, macroinvertebrates (principally larvae and pupae of Trichoptera and Lepidoptera), crustaceans, gastropods, worms, freshwater sponges, algae, and aquatic plants including ribbonweed (*Vallisneria* sp.) (DEWHA 2008).

4.10.2.4 Habitat and Ecology

The Fitzroy River turtle is largely sedentary with a relatively small home and movements typically restricted between riffle zones and adjacent pools. The average home range for nine individuals in 2001 was between 417 to 679 m, and typically remaining between 258 to 359 m to a riffle zone (Tucker et al. 2001). However large-scale movement may potentially occur for the purpose of dispersal, courtship and nesting migrations and repositioning following flood displacement (Tucker et al. 2001). This species does follow movement patterns relating to flow rate (Tucker et al. 2001), in that it:

- moves slightly upstream of riffle zones under moderate flow;
- moves downstream of riffle zones under base flows; and
- No obvious directional movement patterns under flood conditions.

The Fitzroy River turtle's preferred habitat is clear flowing watercourses that have (Cogger et al 1993; Tucker et al 2001; Limpus et al. 2011):

- Rocky, gravelly or sandy substrates;
- Large deep pools (between 1 and 5 m deep) that provide refuge areas and are associated with shallow riffles zones that provide favourable foraging habitat for macroinvertebrates;
- In-stream features such as undercut banks, submerged boulders, tree roots and logs, which provide rest and refuge spots;
- In-stream vegetation (in particular ribbonweed (*Vallisneria* sp.) which is a preferred food source and provides favourable foraging habitat for macroinvertebrates; and
- Healthy riparian vegetation fringing the waterway including blue gums (*Eucalyptus tereticornis*), river oaks (*Casuarina cunninghamiana*), weeping bottlebrushes (*Callistemon viminalis*) and paperbarks (*Melaleuca linariifolia*) (DEWHA 2008).

During wet periods, the turtles prefer habitats with moderate flow and 1 – 2.5 m visibility to assist while foraging in riffles. During dry periods, when the riffle zones dry, the turtles inhabit deeper pools with standing or slow-flowing water.

While flowing waters are thought to be preferred by the species, the Fitzroy River turtle is also known to inhabit the shallow upstream margins of impoundments and have been recorded within impounded waters, including breeding populations (Limpus, C. [DES] pers. comm. 2020). However, deep water areas (> 5 m) typical of impoundments are considered largely unsuitable to the species due to low oxygen levels, little or no light penetration, cold temperatures and low available of favourable foraging habitats (Limpus et al. 2011).

4.10.2.5 Nesting

Nesting habitat is typically restricted to areas with alluvial sand / loam banks 1–4 m above water level, deposited after flooding events. Some nesting sites have been found 15 m from the water on flat sandbanks (DEWHA 2008). Banks that have a relatively steep slope, low density of ground/understorey vegetation and partial shade cover are considered to be preferred based on limited data. Females have an annual reproductive potential of 46 to 59 eggs (29 mm long and 21 mm wide) laid within three clutches which are deposited in nesting chambers 170 mm deep (DEWHA 2008; Hamann et al. 2007). Nesting occurs in spring (September to November), with hatching occurring between November and March (Limpus et al. 2011). Sexual maturity is reached between 15 and 20 years (Hamann et al. 2007).

4.10.2.6 Distribution

The Fitzroy River turtle is endemic to the Fitzroy River basin in Queensland and occurs in an estimated total area of less than 10 000km^2, within the permanent water habitats of the middle and lower reaches of the Fitzroy–Dawson–Mackenzie–Comet rivers and associated tributaries (DEWHA 2008; Limpus et al. 2011). Their distribution extends from the Fitzroy Barrage to the upper areas of the Dawson (to at least Theodore Weir), Nogoa and Connors rivers (Figure 4.27).

Areas where the species is known to occur include waterways around Boolburra, Gainsford, Glenroy Crossing, Theodore, Baralaba, the Mackenzie River, the Connors River, Duaringa, Marlborough Creek and Gogango (Cogger et al. 1993). Known key breeding spots 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).

4.10.2.7 Records

The closest published records of this species in the Atlas of Living Australia are in the Dawson River approximately 70 km downstream near the town of Boolburra, and 45 km upstream to the south near Moura (ALA 2023) (Figure 4.27). However, the record from Moura is from a skeleton lodged with the museum (Amey, A. [Queensland Museum] pers. comm. 2020), as such it is difficult to ascertain whether there are individuals or a population of this species at Moura Weir, or whether this specimen was washed downstream and simply recovered from this location.

However, during surveys previously completed within the region for the Baralaba Mine, a Fitzroy River turtle was recorded at a site on the Dawson River downstream of Neville Hewitt Weir, 20 km downstream of the study area; the exact location of this record is unpublished (BMT WBM 2011a). There are also unpublished records that indicate two Fitzroy River

turtles have been recorded within the waters of the Neville Hewitt weir; the exact location of the records is unknown, but the Neville Hewitt Weir impoundment is within the study area (Venz et al. 2002; Limpus et al. 2011). Because freshwater turtles are relatively long-lived (approximately 20 years to maturity), it is difficult to determine if the presence of this species in these locations represents a relictual population persisting in unfavourable conditions, or whether those individuals are part of a healthy breeding population (Venz et al. 2002).

The species has only been recorded in waters of the Dawson River main channel, and not in any of the smaller waterways in the region likely due to lack of suitable habitat. This species occurs within the permanent freshwater riverine reaches, with no known records of occurrences in spring-fed waterholes and streams or small farm dams created outside of the permanent riverine habitats, nor has it been detected in permanent billabongs that parallel the main stream on the flood plains of the lower Fitzroy (Limpus et al. 2011; Limpus, C. [DES] pers. comm. 2020).

4.10.2.8 Threats and Environmental Impacts

The most significant threat to the Fitzroy River turtle is the predation and trampling of eggs by agricultural stock. Breeding is being undermined because communal nesting sites along river banks are now heavily exploited by foxes (*Vulpes vulpes*), pigs (*Sus scrofa*), dingos (*Canis lupus*), cats (*Felus catus*), goannas (*Varanus gouldii*) and water rats (*Hydromys chrysogaster*), with over 90% of nests being lost to predation – the turtle population now consists almost entirely of adults, with no juveniles recruiting into the population (Limpus et al. 2011). Artificial barriers increase this threat as turtles have to move further over land to find suitable habitat which may increase the risk of interactions with feral animals (DoEE 2017). Fishing and recreational boats may also cause injury or mortality (Limpus et al. 2011).

Other dominant threats identified include (DEWHA 2008):

- loss and disturbance of habitat from mining and agriculture (particularly cotton and cattle farming);
- invasive weeds, which may increase the difficulty of access to the preferred nesting sites;
- water salinity, pollution and siltation in rivers and creek habitat, which affects food resources and cloacal respiration;
- damming of rivers, which restricts water flow and may threaten this species by impacts on dietary ecology or cloacal respiration; dams and weirs may also act as a physical barrier which restricts access to feeding and nesting sites; and
- water quality changes such as increased sediment and nutrient load from dam and weir construction works, and increased runoff of pesticides and herbicides from irrigation, which are likely to have detrimental effects on the dietary ecology of this species (Venz et al. 2002).

4.10.3 White-throated Snapping Turtle

4.10.3.1 Description

The white-throated snapping turtle (WTST) is the largest species of snapping turtle with a carapace length reaching 42 cm (DES 2017). Adults are heavily built and display sexual dimorphism, with females being significantly larger than males (DoE 2014). This species is

distinguished by the irregular white or cream markings present on the throat and lower sides of the face.

4.10.3.2 Bimodal Respiration

Similar to the Fitzroy River turtle, the white-throated snapping turtle is also one of Australia's cloacal ventilating freshwater turtles. As such, the white-throated snapping turtle requires high oxygenated water environments (i.e. flowing water habitats) as it as it obtains up to 74% of its total oxygen supply from the water (Limpus et al. 2011).

4.10.3.3 Habitat and Ecology

The white-throated snapping turtle, being a habitat specialist, has a small home range; however, it is thought to migrate kilometres up or downstream rivers to traditional nesting sites (Limpus et al. 2011). This species is rarely present in water bodies that are isolated from flowing streams, such as farm dams or sewage treatment plants, suggesting that they do not move extended distances over dry land (Hamann et al. 2007).

During the day, these turtles are affiliated with habitats of high shade (i.e. submerged logs, overhanging riparian vegetation), and at night they inhabit shallow riffles. The species' preferred habitat is clear, flowing and well oxygenated watercourses that have (Limpus et al. 2011):

- Sandy-gravel substrates;
- Large deep pools (between 1 and 10m deep) that provide refuge areas and are associated with glides;
- Runs or riffle zones that provide favourable foraging habitat;
- In-stream features such as undercut banks, submerged boulders, tree roots and logs, which provide rest and refuge spots;
- In-stream vegetation which provides a food source and favourable foraging habitat; and
- Healthy riparian vegetation fringing the waterway.

They do occur in non-flowing waters, but typically at much reduced densities (DoE 2014). Similar to the Fitzroy River turtle, during dry periods, when the riffle and run zones dry up the turtles inhabit deeper pools with standing or slow-flowing water, however deep-water areas (> 5 m) typical of impoundments are considered largely unsuitable. Despite this they have been recorded in impounded waters within the Fitzroy Barrage, Eden Bann Weir, Theodore Weir and Glebe Weir (both on the Dawson River upstream of Baralaba) and Callide Dam (Hamann et al. 2007).

4.10.3.4 Nesting

Nesting habitat does not appear to be specific, with substrates ranging from sandy to loam/dark clay; however, nesting occurs primarily in sand and loam alluvial deposits from flooding events. The highest proportion of nesting occurs from May to June (Limpus 2008); although the timing of nesting and laying of eggs appears to be site-specific and variable within the Fitzroy Basin (Limpus et al. 2011). Hatchlings then emerge from nests between spring and summer (November to January) (Limpus 2008; Limpus et al. 2011). Sexually mature females (15 to 20 years) will breed in each successive year, unless the turtle has

been debilitated or unless the riverine habitat is severely depleted through severe drought or excessive water extraction. This species has low fecundity, laying only a single clutch of 14 eggs (on average) per annual breeding season (Hamann et al. 2007; Limpus et al. 2011).

4.10.3.5 Distribution

The white-throated snapping turtle is endemic to New Guinea and south eastern Queensland, where it occurs in approximately 3,300 km of riverine habitat in the Fitzroy, Mary and Burnett Basins and associated waterways in south eastern Queensland (Limpus et al. 2011) (Figure 4.27). The white-throated snapping turtle has recently been recorded in the Baffle creek sub-basin for the first time (BMRG 2023). Within the Fitzroy catchment, this species occurs throughout the permanent freshwater reaches from the Fitzroy Barrage to the uppermost spring fed pool in the McKenzie and Dawson sub catchments. It may also occur in impoundments, with known records in the Eden Bann Weir, Glebe Weir and Emerald Town Weir (Limpus et al. 2011).

4.10.3.6 Threats

The Fitzroy, Mary and Burnett catchments are heavily fragmented into three basins, which is further fragmented by dam and weir structures that creates a body of unsuitable deep water as they are largely anoxic and detrimental to cloacal ventilating (DoE 2014). Additionally, the dam and weir structures obstruct the migration to traditional nesting and feeding sites (Limpus et al 2011).

Abundant evidence of nesting can be found in the three catchments but approaching 100% of eggs are predated or lost to trampling by stock (DoE 2014). Sampling of turtles at multiple study sites throughout each catchment has demonstrated that there is a severe depletion of immature turtles in the populations (Hamann et al. 2007; Limpus 2008; Limpus et al. 2011; DoE 2014). This egg loss is continuing and has been occurring for at least a generation. The majority of the population is aging adults with very low recruitment to the adult breeding population (DoE 2014). Similar to the Fitzroy River turtle, the most significant threat to the population is egg loss and trampling of nesting sites by agricultural stock. The dominant predators throughout the three catchments include feral (foxes, pigs, dogs and cats) and native animals (water rats and varanids) (DoE 2014).

In addition to habitat fragmentation and egg loss, other dominant threats to this species include:

- mortality through water releases and drowning in filter screens (Hamann et al 2007);
- inappropriate water allocation leading to low flow rate or cessation of flow, impeding cloacal respiration (DoE 2014);
- flooding of traditional nesting areas (Limpus et al. 2011);
- loss of riparian vegetation overhanging riverine habitat, leading to reduction in fruit as a food resource (Limpus et al. 2011);
- stocking of predatory fish into dam impoundments, increasing predation on juvenile turtles (Limpus et al. 2011);
- recreational fishing through hook injury if caught, which may also result in mortality if turtles are released with ingested hooks (Limpus et al 2011);

- dense aquatic weeds in the river or along the riverbank which degrade nesting habitat (Limpus et al 2011); and
- extended drought periods exacerbated by water extraction. This can result in a reduction of water quality and reductions in breeding rates (Limpus et al 2011).

4.10.3.7 Records

The closest published record of this species is in the Dawson River approximately 25 km downstream of the Project area (with the record occurring downstream of the Neville Hewitt Weir), and 80 km upstream (to the south of Moura) (ALA 2023). During surveys previously completed for the Baralaba North Mine, white-throated snapping turtles were recorded at a site on the Dawson River downstream of the Neville Hewitt Weir (frc environmental 2014) (Figure 4.27). The species has only been recorded in waters of the Dawson River main channel and not in any of the smaller waterways in the region likely due to lack of suitable habitat.

Life history factors of this species including physiology, diet and late maturation (20+ years) result in this species being one of the most susceptible to disturbances associated with water management practices, as impoundments detrimentally affect the riffle habitats and reduce food items (Tucker 1999).

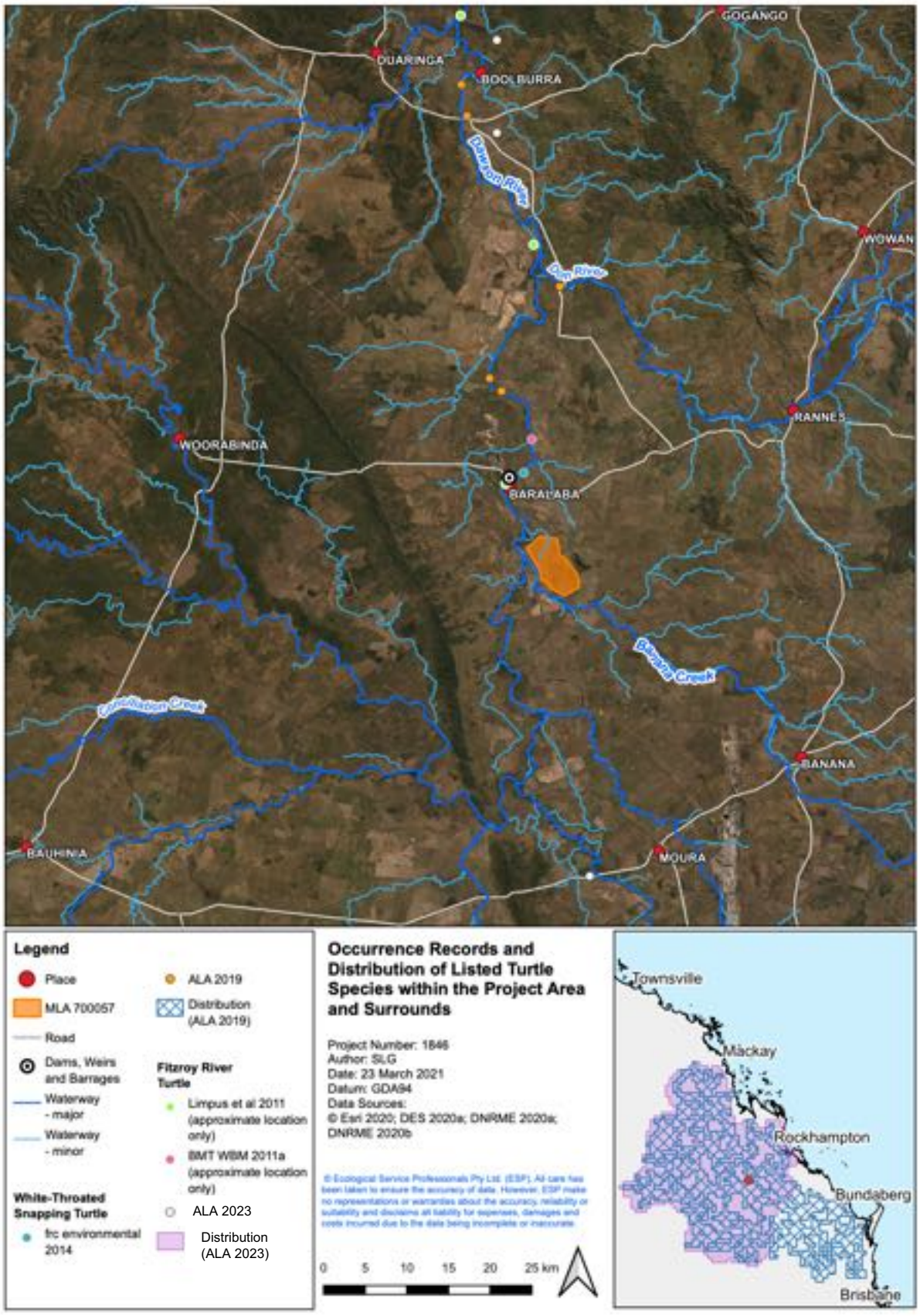

Figure 4.27 Distribution and occurrence records of listed turtle species (FRT = Fitzroy River turtle; WTST = White throated snapping turtle).

4.10.4 Turtles of the Project Area

Two species of turtles were recorded in the study area, including the Krefft's river turtle and the saw-shelled turtle (Table 4.9). All individuals captured were mature adults. The species caught are known to occur in the region and have been recorded in previous surveys completed on the Dawson River and surrounding waterways and wetlands in the region. Both species are considered widespread and common throughout waterways in Queensland.

No turtle nests were observed at any site.

4.10.4.1 Listed Threatened Turtles Species

No listed species of turtles were recorded in the study area during the field surveys. The waterways and wetlands within the Project area are not considered suitable to support the inhabitation or breeding requirements of the listed turtle species. Within the broader study area, the Dawson River and Anabranch, and the lower reaches of Banana Creek and Shirley's Gully provide potential habitat for these species, including permanent pool habitat and available in-stream structure for resting / refuge. However, no ideal banks for nesting were noted at sites on Banana Creek or Shirley's Gully (i.e. sandy alluvial banks), however potential nesting banks were noted around the Dawson River and Anabranch; both species have been known to nest in well-vegetated earthen banks, which characterised the banks of these waterways.

Overall, the Dawson River and Anabranch and Shirley's Gully adjacent to the Project area are considered to have some of the suitable habitat characteristics needed to support these species, however they are not considered ideal as they lack several of the preferred habitat features i.e. clear, flowing and well-oxygenated water with coarse bed substrates (e.g. cobble and gravel), riffle zones and in-stream aquatic vegetation. The listed turtle species may therefore transiently occur in the area as they have both been known to inhabit impoundments, backwaters and reaches of rivers with similar conditions (Limpus et. al. 2011), and both species have been recorded in the Dawson River within 15 km downstream of the study area, including one record from the Neville Hewitt Weir approximately 9 km downstream of the Project area. However, the habitat of the Dawson River downstream of the weir is considered to be more suitable for these species.

There is a low likelihood that the species would occur in Banana Creek, except possibly in the downstream reaches of the waterway closest to the confluence with the Dawson River; the disconnected nature of the waterway during dry periods reduced the potential for these species to occur further upstream.

Table 4.9 Turtles recorded during both surveys.

Species Name	Common Name	DR1	DA1	SG1	UW1T	LW1	PW2	BC1	BC2	Total
June 2017										
Emydura krefftii	Krefft's river turtle	2	–	–	–	–	–	–	–	2
March 2018										
Emydura krefftii	Krefft's river turtle	4	1	2	–	–	–	–	2	9
Wollumbinia latisternum	saw-shelled turtle	–	1	–	–	–	–	–	–	1
	Grand Total	**6**	**2**	**2**	**–**	**–**	**–**	**–**	**2**	**12**

4.11 Platypus

4.11.1 Platypus of the Region

Platypus occur in eastern Australia from Cooktown in north Queensland to Victoria and Tasmania. This species is not listed as threatened under the EPBC Act, but it is an iconic species and is protected more generally as 'Special Least Concern' under the Queensland NC Act.

Platypus inhabit freshwater streams, rivers, lakes and dams. They 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 riverbank 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.

The distribution of platypus is very sparse in the central Queensland region (BAAM 2009). The closest published records are approximately 60 km downstream near Boolburra, and approximately 85 km upstream and to the south of Moura (ALA 2023) (Figure 4.28). No platypus have been recorded during previous surveys completed within the region (BMT WBM 2011; frc environment 2014).

4.11.2 Platypus of the Study Area

No platypus were sighted at any of the sites in the current surveys and no evidence of platypus, such as burrows were observed. The Dawson River and Anabranch, and lower reaches of Banana Creek and Shirley's Gully have potentially suitable habitat available to support this species, including permanent pool habitat and available in-stream structure for resting / refuge. However, they are not considered ideal as they lack several of the preferred habitat features associated with this species (clear, flowing water with coarse bed substrates (e.g. cobble and gravel), riffle zones and dense coverage of submerged aquatic vegetation). The banks at these sites are considered suitable for burrows, however no burrows were observed. Overall, given the habitat requirements and distribution range of platypus it is considered a low likelihood that platypus would occur in these waterways within the study area.

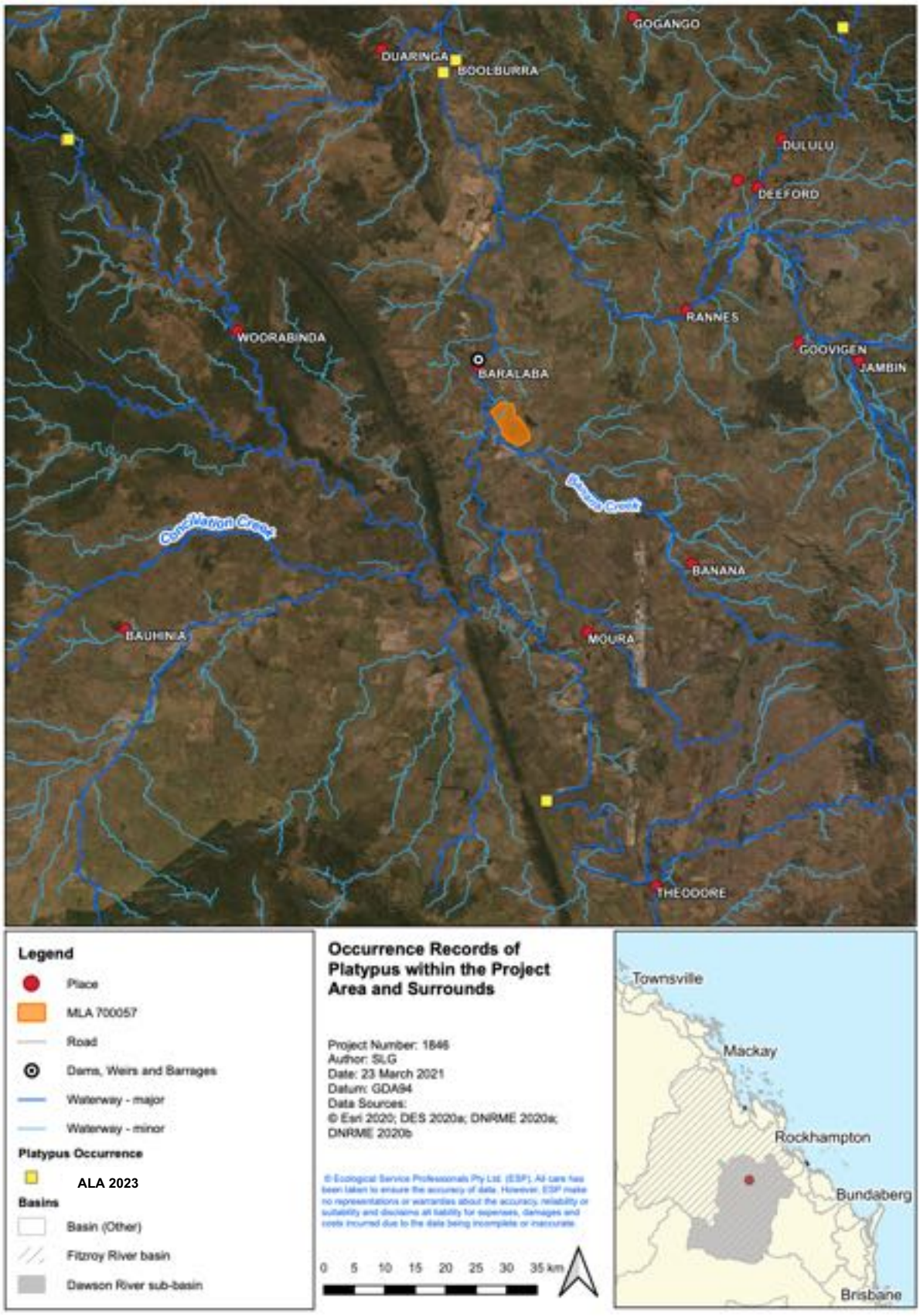

Figure 4.28 Map showing the occurrence records of platypus in relation to the Project.

4.12 Summary of Aquatic Ecological Values of the Project Area

Aquatic habitat conditions of the waterways within the Project area were poor as they were ephemeral drainage lines that had minimal in-stream habitat features (or were dry) and were highly disturbed by activities associated with the adjacent land-use. Aquatic habitat conditions of wetlands within the Project area varied; the lacustrine wetland was considered poor with minimal in-stream habitat features and a high level of disturbance (it was a modified (dammed) wetland), while the palustrine wetlands were considered fair with more diverse available in-stream habitat features and lower disturbance from surrounding land-uses. Aquatic habitat conditions of the Dawson River and Anabranch, Banana Creek and Shirley's Gully were considered fair. These waterways had a variety of in-stream habitat features and flow regimes, good bank stability and although the adjacent lands were disturbed, a reduced but mainly intact riparian zone remained along the waterways.

The waterways within the Project area include stream order 1, 2 and 3 waterways that are mapped as low, moderate and high risk of adverse impacts to fish movements on the WWBW spatial layer. However, based on the results of the August 2023 site inspection, most of the mapped waterways within the disturbance area were not present, with no continuous bed or banks evident and a lack of sufficient flow to maintain ecological processes. In these cases, the mapped waterways were indistinguishable from the surrounding paddocks. Rather, these areas sometimes contained depressions or isolated erosional features which may temporarily hold water in the wet season, i.e. they are better characterized as gilgai habitat within the Dawson River floodplain. This is consistent with the findings of the Flood Impact Assessment (Engeny Water Management 2023b).

No water was present within any of the tributaries surveyed within the disturbance area during the August 2023 sampling event. Additionally, no fish were recorded during the field surveys in any of the waterways within the disturbance area. The exception was at site PW2 (which is on Tributary 8) in the baseline surveys, and at waterway determination site T8-D1 in the upper reaches of Tributary 8, where fish passage was confirmed by the presence of yabby claws in the dry bed of the channel (Appendix D). As such, Tributary 8 is a waterway providing for fish passage (though the channel location differs from that mapped in the spatial layer and has been re-mapped in Figure 4.14). Additionally, after review of aerial photographs and topographical data, Tributary 7 is also (conservatively) considered to be a waterway providing for fish passage, whilst all other waterways within the disturbance footprint and mining lease should be removed from the waterways for waterway barrier works mapping layer (Figure 4.14).

Aquatic flora of the study area was typical of the region with low diversity and relatively low coverage. The majority of species recorded were emergent plants growing on the banks and fringing the edges of the water. Most waterways had low coverage of in-stream aquatic plants with low diversity and coverage of floating and submerged species recorded, except at the wetted palustrine wetland. No listed rare or threatened species were recorded, however two declared restricted invasive plant species (water lettuce and olive hymenachne) were recorded.

Aquatic macroinvertebrate communities were typical of the region with tolerant taxa dominating the community composition indicating communities are influenced by slightly degraded water quality conditions as a result of surrounding land uses.

Fish communities were typical of the region with common and widespread species characterising the community composition. Within the Project area, fish communities were limited to the farm dams that held water, which had a low diversity of species; no fish were recorded in the waterways within the Project area. Within the broader study area, waterways supported a higher diversity of species, including the three fish species endemic to the basin, which were recorded in the Dawson River and Anabranch and Shirley's Gully. Banana Creek and Shirley's Gully provide good fish breeding habitat and refuge area during high-flow periods in the Dawson River.

Turtle communities were typical of the region with common and widespread species recorded. No turtles were recorded within the Project area; only the Dawson River and Anabranch, Banana Creek and Shirley's Gully support turtle populations.

No platypus were recorded in the study area. No potential habitat was identified within the Project area, and there is considered to be a low likelihood that they would occur the Dawson River and Anabranch, Banana Creek or Shirley's Gully.

No listed rare or threatened species were recorded within the study area during this assessment. No potential habitat for rare and threatened species was identified within the Project area. The Dawson River and Anabranch, Banana Creek and Shirley's Gully may provide suitable habitat for listed species to occur, although their occurrence is considered to be likely transient rather than permanent due to a lack of preferred habitat.

Waterways and wetlands within the Project area are considered to have low to moderate aquatic ecological values; none are considered to be of high aquatic ecological value as they are not considered to provide any vital or unique habitat for aquatic communities (particularly for listed species) and the surrounding landscape within the Project area is highly disturbed. All the minor unnamed waterways have low aquatic ecological value due to their ephemeral nature and poor connectivity. The lacustrine and palustrine wetlands within the Project area are considered moderate value, as they are providing long-term refuge and support aquatic flora and fauna communities.

The HES wetland is also considered to be of moderate aquatic ecological value. While it supported aquatic flora, its ephemeral nature means it does not support diverse aquatic communities (i.e. fish and macroinvertebrate communities) and did not support any aquatic communities beyond the other wetlands within the study area. Furthermore, it has been historically cleared and is moderately disturbed by surrounding land uses. As such, it is not considered to fulfil to criteria of a wetland of high ecological value from an aquatic ecological perspective. The terrestrial values of this wetland are discussed in Ecological Survey & Management (2023).

In the broader study area, the aquatic ecological values of the waterways adjacent to and downstream of and adjacent to the Project area (i.e. Dawson River and Anabranch and Banana Creek and Shirley's Gully) are considered moderate to high. The habitat of these waterways has been permanently affected by the Neville Hewitt Weir, which has reduced habitat diversity, i.e. changed from riverine habitat and its associated pool and riffle / run sequences to lacustrine habitat. Nevertheless, these waterways have good in-stream habitat conditions (such as large woody debris), provide long-lasting refuges and good connectivity, and support an abundance and diversity of aquatic communities.

5 Potential Impacts to Aquatic Ecology

5.1 Direct Impacts

The Project would remove or modify aquatic habitat within the disturbance area, but due to the low to moderate aquatic ecological value of waterways within the disturbance area, these changes are considered insignificant and unlikely to have a measurable aquatic ecological impact beyond the disturbance area. Specifically:

- The unnamed waterways and the mapped lacustrine (farm dams) and palustrine wetlands (ephemeral wetlands) of GES within the disturbance area will be partially or completely lost;
- There will be a small area of disturbance on the banks of the Dawson River to construct the proposed water release and extraction infrastructure;
- The mapped waterways crossed by the proposed Moura-Baralaba Road realignment will be modified, but ground-truthing indicates a lack of waterway features in some instances, and the scale of this disturbance is minor in nature and can be mitigated; and
- No direct impacts to waterways are likely as a result of the ETL due to a lack of waterway characteristics in the ETL assessment zone (though in any case, the ETL can be constructed to avoid direct impacts to mapped features).

Each of these impacts is described in further detail below.

5.1.1 Loss of Waterways and Wetlands within the Disturbance Area

Within the disturbance area, waterways provide only low aquatic ecosystem value and wetlands (farm dams) provide moderate aquatic ecosystem value. Most of the mapped waterways do not meet the definition of a waterway providing for fish passage (as defined under the Fisheries Act), with no bed and banks present i.e. the waterway channel was indistinguishable from the surrounding paddocks. Nevertheless, ground-truthing confirmed that 0.88 ha of waterways providing for fish passage will be permanently lost within the disturbance area. Additionally, a further 1.45 ha of waterways providing for fish passage will be impacted upstream of the disturbance area, due to a loss of connectivity to downstream waterways impacted by the Project. This equates to a total impact to waterways providing for fish passage of 2.33 ha (8,357 m of waterway length x an average main channel width of 2.8 m, Appendix D).

The estimated total area of wetlands to be lost is 2.69 ha. While the lacustrine wetlands provide some habitat when wet and support aquatic communities, they are constructed farm dams that are poorly connected (i.e. provide limited available habitat to aquatic flora and fauna outside established and likely self-sustaining communities).

Overall, the aquatic habitats of these waterways and wetlands are common and typical of the region, and while their removal will mean a loss of available aquatic habitat for aquatic communities, this is not expected to impact aquatic ecology on a regional scale.

5.1.2 Direct Disturbance of the Mapped HES Wetland

The Project has been designed to avoid impacts to the HES wetland and the associated wetland protection area (WPA) trigger area. At its closest point, the northern spoil dump is set-back from the mapped HES wetland vegetation by over 1 km, and no mapped wetland vegetation or WPA trigger area is within the extent of potential disturbance.

The potential indirect impacts to the HES wetland are discussed in Section 5.2.

5.1.3 Water Release and Extraction Infrastructure

The Project would source its water demands from surface water runoff within the mining lease and groundwater ingress; however when required, water would be sourced from the Dawson River using existing water allocations (Engeny Water Management, 2023a). Controlled releases of mine affected water will also be made via release point in the Dawson River, that is co-located with the water extraction infrastructure. Construction of this infrastructure will result in the disturbance of a small area of riparian vegetation and streambank habitat (<1,000 m^2 total); however, no canopy trees are proposed to be removed.

5.1.4 Road Realignment

The proposed Moura-Baralaba Road realignment will cross over two mapped ephemeral waterways (the headwaters of Tributary 5 and Tributary 8). However, there is no evidence of a waterway e.g. defined bed and banks at Tributary 5. The upper reaches of Tributary 8 do have waterway features. The crossing will result in the removal of aquatic habitat and riparian vegetation from the banks of Tributary 8 around the footprint of the road crossing, and has the potential to be a barrier to fish passage. However, the development footprint of the realignment is expected to be small, and the design of waterway crossings (culverts) will be undertaken in consideration of fish passage and water flow, and will be designed in accordance with the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) (Section 6.1). As such, no significant impacts to these waterways are expected from the road realignment.

5.1.5 ETL

The ETL study area traverses several stream order 1 drainage lines, and a stream order 3 waterway (Benleith Creek) in the far north of the study area. Benleith Creek ultimately flows into the Dawson River approximately 4.5 km downstream. The ETL and associated infrastructure will have minimal ground disturbance and the transmission line poles will be located outside of waterways to not impact overland flows or flooding. It is not envisaged that there will be a need for any waterway crossings (e.g. for access tracks). As such, no direct impacts to waterways are expected as a result of the ETL.

5.2 Indirect Impacts

The Project has the potential to impact on aquatic flora and fauna communities through changes to water quality and hydrology, with the general nature of these potential impacts described below. The specific indirect impacts predicted as a result of the Project are outlined in Sections 5.2.1 – 5.2.7.

The Project has the potential to influence the surface water quality of adjacent and downstream waterways through a number of mechanisms. Potential impacts to water quality include increased sedimentation and turbidity, increased concentrations of nutrients and contaminants (namely metals and hydrocarbons) and saline and acid drainage, depending on the source.

Increases in sediment can potentially impact the health, composition and resilience of aquatic fauna and flora by affecting respiration, breeding and feeding (e.g. clogging fish gills) or by burying benthic communities. High levels of turbidity as a result of sedimentation can impact growth and diversity of aquatic plants and algae as light required for photosynthesis is reduced (although there are few aquatic plants in the receiving environment). In addition, the deposition of fine sediments can decrease in-stream bed roughness and habitat diversity and may result in the filling of existing pools. The resulting decrease in habitat available for aquatic fauna could lead to a decline in the abundance and diversity of both macroinvertebrate and fish communities in the creeks and a reduction in the number of pools available as refuge habitat in the dry season.

Increased nutrients from nutrient laden run-off can 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 as during respiration). In extreme cases, this can lead to eutrophication and fish kills.

Hydrocarbons and other contaminants (such as heavy metals) can impact growth, morphology, reproduction and development of aquatic flora and fauna. Acute and chronic toxic effects can also occur. The type, volume and concentration of hydrocarbons and other contaminants, along with environmental factors (e.g. dilution, mixing, existing exposure levels), determines the severity of impact.

Lastly, where saline or acid drainage reaches surface water, 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: AMD may cause waterways to become red coloured or unnaturally clear, or introduce precipitates on the surface or water or bank edges; and / or
- Loss of EVs associated with the waterways.

The Project has the potential to influence the hydrology of adjacent and downstream waterways through changes to the flood regime, and the timing and magnitude of flows in watercourses. These have the potential to impact on aquatic ecosystems by (Bunn & Arthington 2002; Poff & 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 influencing habitat conditions and further affecting 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.

5.2.1 Loss of Catchment Area

The Project will reduce surface water flows in the waterways downstream and adjacent to the Project area through a loss of catchment area, due to capture of runoff within the disturbance area within on-site storages and the open cut pit. No watercourse (as defined under the Water Act) diversions are proposed for the Project. The majority of the catchment affected by the Project flows in a north westerly direction to the Dawson River. As such there will not be a significant reduction to the catchment area of Banana Creek as a result of the Project.

The loss of catchment area is expected to result in a moderate reduction in flows for the minor waterways that will remain within and immediately downstream of the Project area (Engeny Water Management 2023a). The downstream reach of the north-western waterway (Shirley's Gully) is of moderate aquatic ecological value and will experience a reduction in flow from the loss of upstream catchment. This will result in an overall minor (localised) impact to the aquatic ecosystem, noting that conditions in the reaches upstream of the Neville Hewitt Weir pool are not expected to be significantly different than those that occur in many of the ephemeral waterways of the region, with this habitat still available to aquatic flora and fauna during times of flow. The lower reaches of the gully are within the Neville Hewitt Weir pool and provide refuge habitat for aquatic flora and fauna; this will not change as a result of the loss of catchment area as water here backs up from the Dawson River.

The HES wetland will not lose any of its catchment area as a result of the Project (Engeny Water Management, 2023a).

The Project is expected to result in a 0.024% reduction in the catchment area of the Dawson River at the Beckers gauging station (located approximately 22 km downstream of the Project area, i.e. downstream of the Neville Hewitt Weir), which will not result in a substantial reduction in flow in the river, and will not impact on compliance with the Environmental Flow Objectives (EFOs) for the river (Engeny Water Management, 2023a). The timing of flows will not change as a result of the loss of catchment area. The predicted negligible reduction in mean annual flow (0.045% reduction adjacent to the Project area, with a decreasing impact with distance downstream) is not expected to result in impacts to the existing Dawson River channel morphology or riparian vegetation (Engeny Water Management, 2023a). As such, there will be no discernible impact to the aquatic ecosystem of the Dawson River.

5.2.2 Changes to Flood Regimes

Currently, flood flows begin to break the banks of the Dawson River and Banana Creek in events greater than the 10% Annual Exceedance Probability (AEP) flood event (Engeny Water Management, 2023b). The Project is located outside of the 1% AEP flood event, and

will result in only minor changes to flooding elsewhere on the floodplain (Engeny Water Management, 2023b).

Overall, the changes in flow velocity up to and including the 1% AEP flood event are predicted to be within 0.1 m/s to 0.3 m/s in areas immediately adjacent to the northern out-of-pit dump, and impacts are contained within the MLA boundary. Although peak flood velocities are increased for the Mine Developed Case, they remain similar to peak flood velocities reported within the Dawson River floodplain for the Existing Case (Engeny Water Management, 2023b). These increases in flow have the potential to increase scouring and erosion of the Dawson River anabranch and Shirley's Gully. However, impacts to aquatic flora and fauna are not predicted to be significant in the context of impacts (erosion and scouring) that already occur during significant flood events. Further, localised erosion protection works such as rock armouring and establishment of floodplain vegetation (trees) may be implemented to prevent scouring and degradation of this area (Engeny Water Management, 2023b).

There are no modelled impacts to peak flood flow rates and travel time in the Dawson River (Engeny Water Management, 2023b). To the north of the MLA, there is predicted to generally be a small decrease in peak flood levels (less than 10 mm in water depth) for major flood events (2% and 1% AEP), however when compared to the existing peak flood levels, this is considered to be insignificant. As such, there will be no ecological changes in the Dawson River that arise from the Project during a major flood event.

The HES wetland is not inundated by the 20% and 10% AEP floods. In the mine developed case 2% AEP flood, there is no predicted change to the peak flood depth or the peak flood velocity (Engeny Water Management, 2023b). In the 1% AEP flood, the HES wetland will experience a very slight increase in peak flood water depth of 2 cm, no increase in peak flood velocity, and no change to the time of inundation (Engeny Water Management, 2023b). The periods of inundation experienced by the wetland would still be considered infrequent, so the nature of the habitat provided by the wetland (i.e. ephemeral aquatic habitat) will remain unchanged. For this reason, the wetland does not currently provide habitat for the listed turtle species, and this will continue to be the case.

5.2.3 Water Releases

5.2.3.1 Controlled Water Releases

Controlled releases of both mine affected water and clean water from the Project may be required during peak weather events. These releases are not expected to significantly influence streamflow volume or duration or water quality (beyond the mixing zone) in the Dawson River.

The proposed mine affected water release strategy is to release mine affected water directly into the Dawson River via a high capacity pipe and pump system. The pipe outlet will be located beyond the bank of the river, to minimise the risk of erosion of the river bank. All controlled releases will be made in accordance with mine affected water release conditions as per the *Model Water Conditions for Coal Mines in the Fitzroy Basin* (DES 2018b). This means that all release events will coincide with medium-high streamflow conditions in the Dawson River and will occur for a length of time that is consistent with natural flows (Engeny Water Management, 2023a).

End of pipe release limits (10,000 µS/cm EC and 6.5–9.0 pH) and receiving waterway water quality limits (500 µS/cm EC and 6.5–9.0 pH) have been proposed based on consideration of the Baralaba North Mine Environmental Authority, the water quality objectives for the receiving waters, and historical Dawson River water quality (Engeny Water Management, 2023a). The maximum release rate (0.5% of the Dawson River streamflow) and end of pipe limits provide a minimum 1:200 dilution ratio, which ensures the water quality characteristics at the downstream monitoring point do not exceed the receiving waterway release limits (Engeny Water Management, 2023a). Further, the modelled water quality changes at the Beckers gauging station (approximately 22 km downstream of the Project) are negligible (e.g. a maximum predicted EC increase of 48 µS/cm as a result of the controlled releases; Engeny Water Management, 2023a) and not ecologically significant.

When releases are occurring, elevated electrical conductivity is expected in the localised vicinity of the controlled release discharge location (i.e. within the mixing zone); however the average electrical conductivity in the river immediately downstream of the discharge location will remain below the receiving waterway water quality limit of 500 µS/cm, which is well within the electrical conductivity range that is tolerated by most native aquatic species. This is due to the high dilution rate from the proposed release conditions and mixing of the release waters with the water of the Dawson River (Engeny Water Management, 2023a).

There may be localised impacts to aquatic flora and fauna within the mixing zone during controlled water releases as a result of the high electrical conductivity (and potentially high concentrations of other elements). However, any such impacts would be intermittent (i.e. occur only when releases are made), short-term (i.e. for the duration of the release) and reversible, as aquatic flora and fauna would recolonise the area once releases cease. Where the expected dilution is achieved and the receiving waterway water quality limit is met, no impacts to aquatic flora and fauna beyond the mixing zone are expected.

5.2.3.2 Uncontrolled Water Releases

All mine water storages and site infrastructure proposed for the Project are located outside of the 1% AEP flood level (Engeny Water Management, 2023b).

The sediment dams have been designed to provide sufficient storage for settlement of suspended solids so that water quality during overtopping events has negligible impact on the water quality in the receiving waterway. Settlement dams will also include overflow control structures with scour protection (rock chutes, rock aprons or level spreaders) to ensure non-erosive discharges (Engeny Water Management, 2023a). Overflow from sediment dams would be directed to receiving waterways of Banana Creek and the Dawson River. Uncontrolled release events from the sediment dams will only occur during significant rainfall events, and the timing and duration of these discharges is in alignment with natural flow events for the region and would allow for dilution within receiving waterways, reducing contaminant concentrations to levels consistent with background conditions (Engeny Water Management, 2023a).

5.2.3.3 Clean Water Releases

Clean water captured on site in clean water storages is expected to have the same water quality as the receiving environment waterways. Water will be released from clean water storages to the Dawson River via the release infrastructure, to maximise separation of clean and mine affected water (Engeny Water Management, 2023a). This is not expected to have

any impacts to the water quality, and therefore aquatic ecological values, of the Dawson River.

5.2.4 Seepage

Seepage generated in the out-of-pit and in-pit dumps is expected to be of low salinity and neutral to alkaline pH (Terrenus Earth Sciences 2023, cited in Engeny Water Management, 2023a), so is not expected to influence water quality in the receiving environment or impact the aquatic ecosystem. The geochemical assessment of potential spoil and coal reject materials completed found spoil to be low risk and Non-Acid Forming (NAF). Potential coal reject material was also found to be low risk and mostly classified as NAF, although it was partially classified as Potentially Acid Forming (PAF) with a 'low' to 'moderate' capacity to generate significant acidity (Terrenus Earth Sciences 2023, cited in Engeny Water Management, 2023a).

5.2.5 Litter, Waste and Spills

Litter and waste associated with vehicle maintenance and mining operations has the potential to entangle larger fauna and contribute to the degradation of water and sediment quality if it was to enter the aquatic ecosystems. Where appropriate controls are in place, such as a waste management system, the risk of litter and waste entering aquatic ecosystems and subsequent impact on aquatic ecology values is very low.

Provided the appropriate management of chemicals is maintained, the Project is unlikely to result in leaks / spills that would eventuate in serious environmental harm to aquatic species or their habitat. Appropriate storage of chemicals and hydrocarbons will be required as part of ongoing operations as well as a dedicated fuel and lube facility, which will be constructed to provide adequate containment and spill response (Engeny Water Management, 2023a,b).

5.2.6 Groundwater Drawdown

While the predicted groundwater drawdown due to the Project would be limited in the shallow groundwater systems, it would incidentally result in some groundwater leakage from the Dawson River (upstream of Neville Hewitt Weir) by up to approximately 0.17 ML/day, which when compared to the average surface water flows in the Dawson River for the past 5 years (and recently prescribed passing flow conditions for the Dawson River) is less than a 0.01% reduction in flow (Watershed HydroGeo, 2023). This was considered in the modelling of the streamflow impacts of the Project on the Dawson River completed by Engeny Water Management (2023a). The predicted reduction in mean annual flow (0.045% reduction adjacent to the Project area, with a decreasing impact with distance downstream, Engeny Water Management 2023a) is negligible and is not expected to result in impacts to the existing Dawson River channel morphology or riparian vegetation; the environmental flow objectives for the Dawson River at the closest downstream node (Becker's gauging station) will be met.

5.2.7 Water Demand and Supply

The Project will source water from surface water runoff and groundwater ingress into the pit as far as practical. However, water will also need to be sourced from the Dawson River under existing water licenses, via the water extraction infrastructure (Engeny Water

Management, 2023a). This is particularly the case during Years 2 to 6, when dust suppression demands are the highest and groundwater inflows are at their lowest. The assumed water allocation of 500 ML is exhausted in 75% of times during this period, and in 25% of years for the majority of the Project duration (Engeny Water Management, 2023a).

This has the potential to impact on the aquatic ecology at and downstream of the offtake point, however the severity and extent of impact would be influenced by the river water levels and flows at the time of extraction. As the water offtake is from the impounded reaches of the river, water extraction will result in reduction in water levels within the river (rather than a change in habitat diversity). The main impact of this water level reduction would be a loss of aquatic plants and associated macroinvertebrates from edge habitat as it dries out, as currently occurs as water levels in the impoundment drop. Mobile species (fish and turtles) would still have refuge habitat to move into in the centre of the river channel, and as such, impacts to these species as a result of water extraction are not expected.

5.3 Cumulative Impacts

The cumulative impacts to water resources have been assessed based on the predicted impacts of the Project along with the existing or approved impacts of other activities in the region, specifically the nearby Baralaba North Mine and Dawson Mine. In summary, these assessments concluded that there would be negligible cumulative impacts to the Dawson River streamflow (Engeny Water Management, 2023a). Based on the worst-case scenario (when all three sites are releasing and a 90th percentile background streamflow EC), the Dawson River at Beckers gauging station EC is estimated to be 485 µS/cm (Engeny Water Management, 2023a), which is below the proposed receiving waters EC limit in (500 µS/cm) and within the known tolerance range for most freshwater aquatic species in the Dawson River system.

The flood Impact assessment (as summarised in Section 5.2.2) reflects a cumulative impact assessment, as it takes into account existing and proposed regional infrastructure and landforms (Engeny Water Management, 2023b).

The groundwater drawdown associated with the Project would not overlap with the drawdown associated with the Baralaba North Mine and impacts to the Great Artesian Basin would be negligible (Watershed HydroGeo, 2023).

5.4 Summary of Potential Impacts to Aquatic Flora

The Project will impact aquatic flora within the disturbance area, but the impact is considered insignificant and unlikely to have a measurable aquatic ecological impact beyond the Project area.

The impact to aquatic flora is due to: a reduction in habitat available to aquatic flora (as discussed in Section 5.1) and direct loss of aquatic plants present within the disturbance footprint. Aquatic plant coverage at waterway sites within the Project area was very low; most aquatic plant species were recorded at the wetlands (particularly at palustrine wetlands, which are largely outside of the proposed disturbance footprint). All aquatic flora species detected during the surveys are Least Concern under the NC Act and are not protected under the EPBC Act. No conservation significant aquatic flora species were detected within the Project area or the broader study area. As such, all species are considered common and

have a broad distribution in the region, and so the removal of aquatic plants within the disturbance footprint will not have a significant impact outside the disturbance footprint.

The suitability of conditions for aquatic plant growth within the HES wetland is not predicted to be affected by the Project.

5.4.1 Proliferation of Aquatic Weeds

Increases in invasive species can lead to significant changes to the community structure and health of aquatic ecosystems through (DES 2019h):

- Out-competing native species for resources and space;
- Degrading habitat conditions as a result of feeding behaviours (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.

The Project is unlikely to result in the addition of new invasive species of aquatic flora, however it is possible that the Project may promote the growth and spread of aquatic weeds, which could have a significant and measurable aquatic ecological impact if not appropriately managed and mitigated.

Two species of invasive aquatic plants (water lettuce and olive hymenachne) were recorded as part of the field surveys in the Dawson River and Anabranch, and are also known from the wider Dawson River Sub-basin. Given additional “make-up” water is being sourced from within the catchment, it is unlikely that new species will be introduced as a result of water supply to the Project.

Changes to water quality may promote conditions that encourage the proliferation of invasive aquatic plants, which can thrive in poor water quality (e.g. high nutrient waters). However, concentrations of nutrients in the Dawson River are already high, and where impacts to water quality are appropriately managed (as is proposed), this outcome is not predicted.

There is potential that aquatic weeds may enter and establish in the HES wetland when it is inundated by flood waters from the Dawson River, however the risk of this occurring is not increased compared with the current scenario, as the frequency of flooding in the wetland will not change. In addition, works in and around wetlands and waterways outside of the Project area where invasive plant species occur have the potential to spread aquatic weeds if vehicle and other plant and equipment are not appropriately washed down.

5.5 Summary of Potential Impacts to Aquatic Fauna

The Project will impact aquatic fauna within the disturbance area, but the impact is considered minor and unlikely to have a measurable aquatic ecological impact beyond the Project area.

5.5.1 Loss of Aquatic Fauna

There will be a reduction in habitat available to aquatic fauna as a result of the removal of habitat within the disturbance area (as discussed Section 5.1) and aquatic fauna within the disturbance area will likely become stranded/will be lost as a result of this. All aquatic fauna species (including fish, turtles, and macroinvertebrates) detected within the disturbance area during the field surveys are Least Concern under the NC Act and are not protected under the EPBC Act. No aquatic fauna species listed under the NC Act, or Priority fauna species, were detected. As such, the Project will result in the loss of individuals of species that are considered common and have a broad distribution in the region, but will not result in the loss of any individuals of listed species.

5.5.2 Potential Impacts to Species of Conservation Significance

The Project will not directly impact any listed species of aquatic fauna (fish, turtles, or platypus) that are known to occur in the region. No listed species of fauna were recorded in the study area during the field surveys and the waterways and wetlands within the Project area are not considered suitable to support the inhabitation or breeding requirements of any listed species.

The Dawson River and Anabranch and Banana Creek may support transient occurrences of listed species. As described in Section 5.2 above, no ecologically-significant impacts to the water quality, hydrology or flood behaviour of these waterways is predicted. Where appropriate mitigation measures are implemented to protect downstream water quality and flows (as is proposed), there is not expected to be any indirect impacts to species of conservation significance, if they do occur in these waterways (Sections 5.7 & 5.8).

5.5.3 Restriction of Fish Passage

The Project will result in the removal of waterways and wetlands (as discussed in Section 5.1); however, the impact to fish passage will be localized, and due to the poor-quality fish habitat and fish passage values of the waterways, there is unlikely to be a measurable impact to fisheries resources beyond the Project area. Nevertheless, the disturbance footprint would result in the permanent loss of 0.88 ha of waterways within the disturbance area, and restriction of fish passage to a further 1.45 ha of waterway upstream of the disturbance area. This equates to an impact to 2.33 ha of ground-truthed waterways providing for fish passage (Section 5.8.2).

Dams located upstream of the Project area will also become disconnected as a result of the removal of downstream reaches of waterways that are within the Project area. However, it is considered unlikely that the farm dams located on reaches upstream of the Project area connect to downstream reaches frequently or adequately enough to provide valuable fish passage, and the upstream dams are not considered important habitats that require fish passage.

The proposed Moura-Baralaba Road realignment that will be completed off-lease crosses two mapped low-risk waterways. However, based on the August 2023 ground-truthing of the these mapped waterways, there are no waterway characteristics present at any of the mapped features crossed by the road realignment, with the exception of Tributary 8 (Figure 4.14). Impacts to fish passage on this waterway, if present, can be minimised and mitigated

through appropriate culvert design and installation. Waterway barrier works are not likely to be required for construction of the ETL.

Overall, connectivity through the waterways and wetlands within and upstream of the Project area is currently very limited due to the ephemeral nature of the area, the lack of defined waterway channels within the flat floodplain habitat (which has been extensively modified for agricultural purposes) and existing waterway barriers including farm dams. Based on the field survey results, there are no important aquatic breeding, feeding or refuge areas to consider. Species that are found within the disturbance area (and any species that may potentially occur in the farm dams upstream of the Project area) are common within the region and resilient and have likely established self-sustaining communities that are not reliant on connections through the Project area to other waterways.

5.5.4 Proliferation of Pest Species

The Project is unlikely to result in the addition of new invasive species of aquatic fauna. Two species of invasive fish (eastern mosquitofish and goldfish) were recorded as part of the field surveys and are known from the wider Dawson River Sub-basin. Given additional "make-up" water is being sourced from the Dawson River adjacent to the Project, it is unlikely that new species will be introduced as a result of any water supply pipelines associated with the Project.

Changes to water quality may promote conditions that encourage the proliferation of invasive fish, which can thrive in poor water quality (e.g. high nutrient waters). However, where impacts to water quality are appropriately managed (as is proposed), this outcome is not predicted.

5.6 Summary of Impacts to Groundwater Dependent Ecosystems (GDEs)

As described in Section 4.4 the aquatic habitat associated with the waterways and wetlands downstream of and adjacent to the disturbance area are unlikely to be dependent on groundwater, and the groundwater leakage from the Dawson River is predicted to be negligible in the context of stream flows in the Dawson River. As such, any potential impacts to groundwater are not expected to impact surface water aquatic ecology (Watershed HydroGeo, 2023).

Impacts to terrestrial vegetation reliant on surface expression of groundwater, including riparian vegetation, is discussed in the Groundwater Dependent Ecosystem Report (3d Environmental, 2023) and Terrestrial Ecology Impact Assessment Report (Ecological Survey & Management, 2023). In summary, the riparian vegetation of the Dawson River, Banana Creek and the lower reaches of Shirley's Gully utilise groundwater located in discontinuous sandy lenses that are separate from the regional groundwater system. The groundwater within these lenses is not predicted to be impacted by groundwater drawdown associated with the Project (3d Environmental, 2021). As such, groundwater dependent riparian vegetation is not expected to be impacted, and there will therefore be no secondary impacts to aquatic habitat.

5.7 Impacts to Matters of National Environmental Significance (MNES)

There were no MNES aquatic flora or fauna species recorded within, or considered likely to occur, within the Project area.

The Fitzroy River turtle and white-throated snapping turtle have been recorded within 20 km of the study area, and it is considered possible that these species may transiently occur in the study area in waters of the Dawson River and Anabranch, downstream reaches of Banana Creek and the lower reaches of Shirley's Gully that are part of the Neville Hewitt Weir inundation area.

The white-throated snapping turtle was not listed under the EPBC Act at the time of the controlled action decision (18 October 2012); as such, an assessment of this species in accordance with the EPBC Act *Significant Impact Guidelines* (DoE 2013) is not required.

An assessment of the potential impacts to the Fitzroy River turtle, in accordance with the required impact assessment hierarchy for MNES, is provided below.

5.7.1 Fitzroy River Turtle

5.7.1.1 Description

A detailed description of the ecology of the Fitzroy River turtle, including its preferred habitat and distribution, is provided in Section 4.10.2. In summary, the Fitzroy River turtle occurs in the Dawson River, upstream of the confluence with the Mackenzie River to Taroom and beyond (i.e. upstream of the study area). It has been recorded in weir pools within the Dawson River, including a reliable record from within the Neville Hewitt Weir pool at Baralaba (Venz et al. 2002; Limpus et al. 2011; Venz, M. [Queensland Herbarium] pers. comm. 2020). A breeding population is known from the Theodore Weir pool, upstream of the study area; the deeper waters within impoundments are not suitable habitat for this species, but they can be abundant in the shallow upper reaches of impoundments (Limpus, C. [DES] pers. comm. 2020). Fitzroy River turtles have not been recorded in off-stream wetlands or dams (Limpus, C. [DES] pers. comm. 2020).

5.7.1.2 Survey Effort

The survey effort for the Fitzroy River turtle is described in Section 2.2.10. In summary, the Fitzroy River turtle can be difficult to survey as they rarely enter traps. The highly turbid waters of the Dawson River and tributaries within the study area restricted the use of preferred survey techniques for this species, including snorkeling. The presence of snags precluded the use of seine nets, except for in Banana Creek. The main survey techniques relied upon were:

- Spotlighting from boat in the Dawson River and Shirley's Gully (over a 1 km distance) and from the bank in Banana Creek (over a 100 m distance) (19.25 hrs over 4 days);
- Electrofishing from boat – as above this method did not target turtles but turtles were incidentally recorded;
- Baited fyke nets (117.5 hrs over 3 days in the dry season survey and 125 hrs over 4 days in the post-wet season survey);
- Seine netting (1 sweep at site BC2 in Banana Creek during the dry season survey); and

- Daytime searching for nests and assessment of potential habitat.

The effectiveness of evening spotlighting was also impacted by the highly turbid water, which is a known limitation of surveying in turbid environments for this species (Limpus, C. [DES] pers. comm. 2020). To compensate, additional effort was employed to assess the suitability of habitat at each site to support the Fitzroy River turtle, and reviewing available data on the occurrences of listed turtle species in the region to inform the likelihood of their occurrence in the study area.

5.7.1.3 Habitat Assessment

There is no suitable habitat for the Fitzroy River turtle within the Project area.

The habitat provided within the Dawson River, Dawson River Anabranch, Shirley's Gully and Banana Creek adjacent to and downstream of the Project is characterised by a large, deep weir pool created by the Neville Hewitt Weir downstream of the Project. These reaches are mapped as lacustrine wetland by DES under the Queensland Wetlands Mapping Program (Figure 1.1). The waterways do not provide the preferred / key riverine habitat characteristics for the Fitzroy River turtle (such as pool and riffle sequences, diversity of substrate and habitat types; refer to Sections 4.10.2 & 4.10.3) in the vicinity of the site, although it is acknowledged that the Fitzroy River turtle can and does occur in the upper reaches of weir pools in the Dawson River (Limpus et al. 2011; Limpus, C. [DES] pers. comm. 2020). It was therefore considered that the Dawson River and anabranch, Shirley's Gully and Banana Creek provided potentially suitable habitat for the Fitzroy River turtle. As the Fitzroy River turtle was not detected during the field surveys and as there is no key or preferred habitat present (due relatively deep water as a result of the Neville Hewitt Weir downstream), the occurrence of the Fitzroy River turtle in the areas adjacent to the Project is considered likely to be transient rather than permanent.

No ideal banks for nesting (i.e. sandy alluvial banks) were noted at sites on Dawson River, Dawson River Anabranch, Shirley's Gully and Banana Creek, however potential nesting banks were noted around the Dawson River and Anabranch; Fitzroy River turtles have been known to nest in well-vegetated earthen banks, which characterised the banks of the Dawson River and Anabranch.

5.7.1.4 Assessment of Direct Impacts

There is no suitable habitat for the Fitzroy River turtle within the disturbance footprint. As such, there will be no direct impacts to this species or its habitat within the Project.

It is possible that the minor works on the banks of the Dawson River that are required to construct water extraction or water release infrastructure could affect a very localized area of potential habitat for the Fitzroy River turtle (overhanging vegetation, large woody debris, rocks or sandy banks). The proposed water infrastructure site is within the Neville Hewitt Weir inundation area, which does not provide preferred habitat for this species. The worst-case estimate of the area of potential stream bank to be affected is <500 m^2.

5.7.1.5 Assessment of Indirect Impacts

The Project has the potential to indirectly impact the suitability of the Dawson River, Dawson River Anabranch and Shirley's Gully adjacent to and downstream of the Project, as a result of:

- impacts to water quality, which if they occur could create unfavorable water quality conditions for the Fitzroy River turtle;
- impacts to water levels within the Neville Hewitt Weir impoundment: were a decrease in water levels to occur, it could mean that suitable habitat for this species (such as overhanging vegetation, large woody debris and rocks) is no longer inundated; or conversely an increase in water levels would result in a greater proportion of deep areas that are not suitable habitat for this species; and
- impacts to flows: changes in the flow regime of the Neville Hewitt Weir impoundment are likely to be negligible due to the nature of this habitat; but any changes to the flow regime downstream of the weir have the potential to affect the quality of the preferred habitat that occurs in the reaches downstream of the weir.

These indirect impacts could occur as a result of:

- a loss of catchment area and therefore inflows to the Neville Hewitt Weir impoundment; and
- surface water management on the site, including the controlled release of mine affected water and clean water, and unplanned releases from on-site sediment dams.

Each of these potential impacts has been considered, and is discussed below.

As described in detail in Section 5.2 above, the potential impacts to water quality in the receiving environment of the Dawson River as a result of planned releases are predicted to be minor and not significant in an ecological context, with the exception of localised impacts in the mixing zone. As the proposed release point is not located in an area containing preferred habitat for the Fitzroy River turtle, it is considered highly unlikely that the controlled releases will impact on this species or its habitat; particularly as it is a mobile species.

The modelled impacts to the hydrology and flooding of the Dawson River as a result of the Project are minor in an ecological context, and they are unlikely to change the nature of the habitat available upstream and downstream of the Neville Hewitt Weir (i.e. weir pool habitat and regulated riverine habitat respectively). Most notably, there will be no significant reductions in flow downstream of the weir; and as such, no impacts to the existing Dawson River channel morphology (including the presence of run and riffle habitat) or riparian vegetation are expected. As such, the changes are not likely to result in noticeable impacts to the extent or quality of Fitzroy River turtle habitat present in the river.

It is not expected that the Project will result in the introduction of any new aquatic pest species to the Dawson River, and as such no indirect impacts to the habitat of the Fitzroy River turtle are expected as a result of this. Likewise, as there will be no major changes to the habitat present within the Neville Hewitt Weir pool (i.e. no changes to water depths, velocity or water quality), there is no predicted change to the current extent of aquatic weed species within the study area.

No indirect impacts to Fitzroy River turtle habitat are expected as a result of impacts to groundwater, as the waterways providing Fitzroy River turtle habitat are not considered to be aquatic (surface-expression) GDEs, no impacts to the riparian vegetation (which is a terrestrial GDE) are expected, and negligible impacts to flows in the river are predicted as a result of groundwater leakage from the Dawson River (Watershed HydroGeo, 2023).

5.7.1.6 Facilitated Impacts

The Project will not result in any other actions that have the potential to impact on Fitzroy river turtles or their habitats. As such, no facilitated impacts to the Fitzroy River turtle are predicted.

5.7.1.7 Cumulative Impacts

Potential cumulative impacts to the Fitzroy River turtle could arise as the result of indirect impacts, e.g. changes to the water quality and hydrology of the Dawson River (including the anabranch) and its tributaries, as a result of the cumulative impacts of the Baralaba South Project along with other Projects in the area.

The cumulative impacts of the Baralaba South Project and the Baralaba North Mine and Dawson Mine on the hydrology of the Dawson River and tributaries have been modelled. In summary, these assessments concluded that there would be negligible cumulative impacts to the Dawson River streamflow (Engeny Water Management, 2023a). This minor reduction is not predicted to result in changes to the extent or availability of preferred Fitzroy River turtle habitat, such as riffles and runs, downstream of the Neville Hewitt Weir.

5.7.1.8 Avoidance, Mitigation and Management Measures

There is no potential Fitzroy River turtle habitat within the disturbance footprint; as such, direct impacts have been avoided. The exception is the potential for a very small area (<500 m^2) of bank habitat to be affected by construction of water extraction or discharge infrastructure; above-ground infrastructure is proposed to reduce disturbance of the bank, and no canopy trees will be removed. Reducing the construction footprint of the water extraction infrastructure as far as practical, and limiting disturbance of the bank on which it will be positioned will further minimise the potential for direct impacts.

The potential indirect impacts to Fitzroy River turtle habitat as a result of impacts to water quality and hydrology will be minimised and mitigated by developing and implementing the following management and monitoring plans for the site:

- Water Management Plan;
- Erosion and Sediment Control Plan;
- Progressive Rehabilitation and Closure Plan;
- Water Quality Monitoring Program;
- Receiving Environment Monitoring Program (REMP). The REMP is to monitor the impacts of the Project on the environmental values of the receiving environment (including water quality, flows and biological health indicators such as macroinvertebrates), and to provide feedback for continuous improvement of environmental management if required.

5.7.1.9 Significant Impact Assessment

The residual impacts of the Project, after the avoidance, mitigation and management measures described above have been implemented, have been assessed against the significant impact criteria for vulnerable species (DoE 2013) in Table 5.1.

Table 5.1 Significant impact assessment for the MNES Fitzroy River turtle.

Significant Impact Criteria (DOE 2013)	Residual Significant Impact Assessment for the Project
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species	An important population of the Fitzroy River turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, with the appropriate mitigation measures in place, mortality of individual Fitzroy River turtles is not expected, nor are impacts to breeding (noting that it has not been established that breeding of this species occurs within the study area). Likewise, no significant impacts to water quality or hydrology are predicted downstream of the Neville Hewitt Weir, and as such no impacts to individuals or breeding populations in the reaches downstream of the weir are predicted.
reduce the area of occupancy of an important population	An important population of the Fitzroy River turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, the Project is not expected to have any direct or indirect impacts to the habitat of Fitzroy River turtle (either upstream or downstream of the weir); and as such the area of occupancy for this species will not be reduced.
fragment an existing important population into two or more populations	An important population of the Fitzroy River turtle has not been identified within the waters of the Neville Hewitt Weir pool. Regardless, the Project will not result in the fragmentation of Fitzroy River turtle habitat or populations.
adversely affect habitat critical to the survival of the species	It has not been established that the waters of the Neville Hewitt Weir pool provide habitat critical to the survival of the species; rather, it is highly likely that they do not. Regardless, the Project will not result in any adverse impacts to Fitzroy River turtle habitat.
disrupt the breeding cycle of an important population	It has not been established that there is a breeding population of Fitzroy River turtle in the Neville Hewitt Weir pool. Regardless, the Project will not result in any adverse impacts to Fitzroy River turtle breeding habitat, or any

Significant Impact Criteria (DOE 2013)	Residual Significant Impact Assessment for the Project
	reductions in water or habitat quality (that could lead to decreased fitness or breeding success).
modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not result in any adverse impacts to potential Fitzroy River turtle habitat, either as a result of direct impacts or indirect impacts (e.g. to water quality or flows).
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The Project will not result in the establishment of an invasive species within the Fitzroy River turtle's habitat.
introduce disease that may cause the species to decline	The Project does not have the potential to introduce a disease that may cause the Fitzroy River turtle population to decline.
interfere substantially with the recovery of the species	The Project will not interfere with the recovery of the Fitzroy River turtle, as it will not directly or indirectly impact this species or its habitat.

5.7.2 Water Resources

Water resources in relation to coal seam gas development and large coal mining development was listed as a controlling provision for the Project in the Commonwealth's determination for the Project. As described in Sections 5.1–5.6 above, no significant impacts to aquatic ecosystem function as a result of impacts to hydrology or water quality are predicted.

5.8 Impacts to Matters of State Environmental Significance (MSES)

The Fitzroy River turtle and white-throated snapping turtle, both listed as threatened species (MSES), may transiently occur in the waters of the Dawson River and Anabranch, downstream reaches of Banana Creek and Shirley's Gully.

As described above, fish passage to 2.33 ha of ground-truthed MSES waterways providing for fish passage will be disrupted due to the loss of waterways within the proposed disturbance footprint. While these ground-truthed waterways are of low aquatic ecosystem and fish passage value and no significant impacts to fisheries resources beyond the Project footprint are expected, loss of these MSES waterways constitutes a significant residual impact (SRI) in accordance with the SRI guidelines (Section 5.8.2).

No watercourses listed as HES are located within or surrounding the Project area. Regulated vegetation intersecting a watercourse is a MSES, and is addressed in the terrestrial ecology assessment (Ecological Survey & Management 2023).

5.8.1 Threatened Turtles

No significant impact to the Fitzroy River turtle or the white-throated snapping turtle are predicted as a result of the Project, as described in Table 5.2.

Table 5.2 Significant impact assessment for the MSES Fitzroy River turtle and white-throated snapping turtle.

Significant Impact Criteria (DEHP 2014)	Residual Significant Impact Assessment for the Project
An action is likely to have a significant impact on endangered and vulnerable if the impact on the habitat is likely to:	
lead to a long-term decrease in the size of a local population	The Fitzroy River turtle and white-throated snapping turtle may occur within the waters of the Neville Hewitt Weir pool. With the appropriate mitigation measures in place, mortality of individual Fitzroy River turtles and white-throated snapping turtles is not expected, nor are impacts to breeding (noting that it has not been established that breeding of this species occurs within the study area). Likewise, no significant impacts to water quality or hydrology are predicted downstream of the Neville Hewitt Weir, and as such no impacts to individuals or breeding populations in the reaches downstream of the weir are predicted.
reduce the extent of occurrence of the species	Important population of the Fitzroy River turtle and white-throated snapping turtle have not been identified within the waters of the Neville Hewitt Weir pool. Regardless, the Project is not expected to have any direct or indirect impacts to the habitat of Fitzroy River turtle or white-throated snapping turtle (either upstream or downstream of the weir); and as such the extent of occurrence for these species will not be reduced.
fragment an existing population	It has not been established that there are populations of the Fitzroy River turtle and white-throated snapping turtle within the waters of the Neville Hewitt Weir pool; rather, individuals may be transient. Regardless, the Project will not result in the fragmentation of Fitzroy River turtle and white-throated snapping turtle habitat or populations.
result in genetically distinct populations forming as a result of habitat isolation	As above, there will be no fragmentation of habitat for the Fitzroy River turtle and white-throated snapping turtle. As such, the Project will not result in genetically distinct populations forming.

Significant Impact Criteria (DEHP 2014)	Residual Significant Impact Assessment for the Project
result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	The Project will not result in the establishment of an invasive species within the Fitzroy River turtle and white-throated snapping turtle habitat.
introduce disease that may cause the species to decline	The Project does not have the potential to introduce a disease that may cause the Fitzroy River and white-throated snapping turtle to decline.
interfere substantially with the recovery of the species	The Project will not interfere with the recovery of the Fitzroy River turtle and white-throated snapping turtle, as it will not directly or indirectly impact these species or their habitat.
Cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species	The Project will not result in any adverse impacts to potential Fitzroy River turtle and white-throated snapping turtle habitat, either as a result of direct impacts or indirect impacts (e.g. to water quality or flows).

5.8.2 Waterways Providing for Fish Passage

Ground-truthing confirmed that approximately 2.33 ha of waterways providing for fish passage will be permanently impacted within and upstream of the disturbance area, and this constitutes a SRI in accordance with the SRI Guidelines (Table 5.3).

Table 5.3 Significant impact assessment for MSES waterways providing for fish passage.

Significant Impact Criteria (DEHP 2014)	Residual Significant Impact Assessment for the Project
An action is likely to have a significant impact on a waterway providing for fish passage if there is a real possibility that it will:	
result in the mortality or injury of fish; or	Removal of waterways within the disturbance footprint may result in the mortality of fish, though it is noted that the waterways are dry for most of the year and therefore do not support fish for most of the year, nor significant fish populations when they hold water.
result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish; or	Removal of waterways within the disturbance footprint will prevent the passage of fish upstream. Where possible, the spoil dump in the north west of the disturbance footprint will be redesigned to avoid an impact to the waterway in this location. However, where this cannot be achieved, the impact from the spoil dump will be mitigated by a diversion drain, designed to facilitate fish passage.

Significant Impact Criteria (DEHP 2014)	Residual Significant Impact Assessment for the Project
	Waterways will be permanently lost within the southern portion of the disturbance footprint.
reduce the extent, frequency or duration of fish passage previously found at a site; or	Removal of waterways within the disturbance footprint will reduce the extent, frequency or duration of fish passage previously found within the Project area (noting that the extent, frequency, and duration of fish passage that currently occurs is minimal due to the ill-defined and highly ephemeral nature of the waterways within the disturbance footprint).
substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish; or	Removal of waterways within the disturbance footprint will destroy and fragment areas of fish habitat within the Project area. It is noted that the quality of fish habitat provided by the waterways on the site is poor. There are no substantial areas of in-stream vegetation, snags and woody debris, substrate, bank, or riffle formations within the proposed disturbance area.
result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows; or	The loss of catchment area is expected to result in a moderate reduction in flows for the minor waterways that will remain within and immediately downstream of the Project area (Engeny Water Management 2023a). The downstream reach of the north-western waterway (Shirley's Gully) is of moderate aquatic ecological value and will experience a reduction in flow from the loss of upstream catchment. This will result in an overall minor (localised) impact to the aquatic ecosystem, noting that conditions in the reaches upstream of the Neville Hewitt Weir pool are not expected to be significantly different than those that occur in many of the ephemeral waterways of the region, with this habitat still available to aquatic flora and fauna during times of flow. The lower reaches of the gully are within the Neville Hewitt Weir pool and provide refuge habitat for aquatic flora and fauna; this will not change as a result of the loss of catchment area as water here backs up from the Dawson River. No measurable change in the hydrological regime of Banana Creek or the Dawson River is predicted.
lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species.	No significant changes in the water quality of minor waterways are predicted. No significant impacts to the water quality of the Dawson River are predicted as a result of planned releases of MAW.

5.8.3 HES Wetland

While approximately 60% of the HES wetland (20.2 hectares) is within the boundary of the MLA, the Project has been designed to avoid the HES wetland and associated WPA trigger area. The northern spoil dump is located over 1 km away from the edge of the wetland vegetation (as mapped by the State under the VMA). Modelling has demonstrated that there will not be any significant impacts to the hydrology or flooding of this wetland as a result of the Project, and the water management system for the Project will protect the water quality of this wetland (Engeny Water Management 2023a, b). The periods of inundation experienced by the wetland would still be considered infrequent, so the nature of the habitat provided by the wetland (i.e. ephemeral aquatic habitat) will remain unchanged.

On this basis, the Project is not expected to result in a SRI to the HES wetland (Table 5.4).

Table 5.4 HES Wetland Significant Residual Impact Assessment.

Criteria	Assessment / consideration
An action is likely to have a significant residual impact on prescribed wetlands or watercourses if it is likely that the action will result in environmental values being affected in any of the following ways:	
Areas of the wetland or watercourse being destroyed or artificially modified;	The Project has been designed to avoid direct impacts to the mapped extent of wetland vegetation (in accordance with the VMA mapping) and the WPA trigger area. The northern spoil dump will be located at least 1 km from the edge of the wetland vegetation.
A measurable change in water quality of the wetland or watercourse – for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or	The water quality management system has been designed so that there are no changes to water quality or sedimentation in the wetland (Engeny Water Management 2023a). Specifically, in the infrequent event of an uncontrolled water release, water will not flow towards or into the HES wetland.
The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or	No direct impacts to the mapped extent of wetland habitat (vegetation) are proposed, and there is no predicted change to the water quality or frequency of flood inundation within the HES wetland. The wetland is ephemeral and provides only moderate aquatic ecological value and minimal aquatic habitat to fauna except during wet periods.
A substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or	The groundwater assessment concluded the wetland is reliant on direct rainfall, runoff and floodwaters and not on surface expressions of groundwater. As such, no significant change associated with groundwater interaction is expected. The overall hydrological regime (including flooding) of the wetland will remain unchanged (Engeny Water Management 2021a, b).

Criteria	Assessment / consideration
An invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland.	Invasive aquatic plant species are already present within the broader catchment. Two species (namely, water lettuce and olive hymenachne) were identified as part of the field surveys at sites on the Dawson River downstream of the Project area but were not recorded in waterways of wetlands within the Project area (including the HES wetland) or Banana Creek (adjacent to the HES wetland). Given these species are known to occur in the Dawson River, and the wetland is sometimes inundated by flood waters from the Dawson River, there is potential that these invasive aquatic plant species may enter and establish within the wetland. However, as the wetland will remain ephemeral (and the invasive aquatic species typically occur in permanently inundated areas), the risk of these species becoming established in the wetland is considered low and no different from the current case. Invasive fish species (eastern mosquitofish and goldfish) were recorded at sites within and adjacent to / downstream of the Project area. No fish species were recorded in the HES wetland as it was dry during both surveys. Given invasive fish species already occur in the Project area, it is likely that they would already occur in the wetland under wet conditions. The risk of invasive fish species occurring in the wetland is unlikely to change significantly due to the Project.

6 Risk Assessment, Mitigation Measures and Offsets

6.1 Risk Assessment and Mitigation Measures

Risks of potential impacts were assessed according to the criteria outlined in Table 6.1, Table 6.2 and Table 6.3. The unmitigated risks were assessed as well as the mitigated risks. The outcomes of the assessment, including a summary of the appropriate mitigation measures, is presented in Table 6.4.

Table 6.1 Risk matrix, including likelihood of an impact occurring, and the severity of subsequent consequences.

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

Table 6.2 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 5 years).
Unlikely	The event is not expected to occur (the event is likely to occur approximately once every 5 – 10 years).
Rare	The event may occur only in exceptional circumstances (the event is likely to occur with less frequency than once every 10 years).

Table 6.3 Definitions of consequence for the risk assessment.

Severity of Consequence	Definitions
Severe	Extensive long-term environment harm and / or harm that is extremely widespread. Impacts considered to be permanent.
Major	Major or widespread, moderate to long-term effect. Significant resources required to respond and rehabilitate, and damage caused may take more than 10 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.

6.2 Offsets

Where possible, the spoil dump in the north-western part of the development footprint will be redesigned to avoid impacts to the waterway in that location. However, where this is not possible, the impacts to fish passage in this location will be mitigated by the construction of a diversion channel (drainage feature) providing for fish passage in the north-western part of the disturbance area.

This diversion channel will be 390 m long and 10 m wide. Assuming a low-flow channel width of 3 m in general accordance with the characteristics of the existing feature, this equates to 0.12 ha of waterway to be re-instated. To provide fish habitat and for fish passage, the diversion will include the following design features:

- Ensuring functionality and longevity of the riparian corridor, including revegetation to a pre mining condition and management of the riparian vegetation;
- Ensuring that the diversion is constructed at a gradient of no more than 5%;
- Ensuring that conditions within the diversion (depth and velocities) would be similar to the existing feature and suitable to provide adequate fish passage;
- Reinstating pre mining habitat and geomorphic features by salvaging and using material such as woody debris consistent with pre-mining condition to create habitat diversity within the diverted waterway; and
- Including natural features that are consistent with conditions immediately up and downstream of the diversion.

The remaining SRI to waterways providing for fish passage of 2.21 ha can be settled with a financial offset payment[4].

[4] Financial offset value to be confirmed; current value based on DES online calculator is $55,250.00.

Table 6.4 Risk assessment and proposed mitigation measures.

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Proposed Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Direct loss of aquatic habitat	Direct and permanent loss of available aquatic habitat of waterways and wetlands considered to be habitat types common to the region with low to moderate aquatic ecological value.	Limit area of direct impact to the disturbance area. Use disturbance area for any temporary construction and storage.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Minor **Risk: Medium**
Changes in flow (reductions due to reduction in catchment)	Highly localised changes to habitat and biotic communities of the unnamed waterway downstream of the disturbance area (Tributary 8 / Shirley's Gully). No significant impacts to Banana Creek or the Dawson River (including the anabranch and lower reaches of Shirley's Gully within the Neville Hewitt impoundment are predicted as a result of the reduction in catchment area.	Disturbance footprint has been minimised as far as practical. Implementation of a water management plan for the site.	Likelihood: Likely Consequence: Minor **Risk: Medium**	Likelihood: Likely Consequence: Minor **Risk: Medium**
Changes in flow (increases due to controlled water releases)	Localised impacts, including changes to habitat structure and diversity as well as biotic communities and their behavioural patterns (life cycles) at and downstream of the discharge point.	All release events will coincide with medium-high streamflow conditions in the Dawson River and are predicted to occur for a duration consistent with the existing duration of natural flows, which will minimise changes to flow outside natural flow conditions. Similarly, design of water storages (sediment dams and Mine Water Dams) ensure uncontrolled release events from all storages are very infrequent and would potentially occur only during significant rainfall events when the existing waterways are already experiencing natural high flow, indicating the timing and duration of these discharges is in alignment with flow events for the region.	Likelihood: Almost certain Consequence: Moderate **Risk: High**	Likelihood: Rare Consequence: Moderate **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Proposed Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Changes in flow (flood regimes)	Localised impacts, as a result of loss of available aquatic habitat due to areas no longer inundated (already lost due to development of the mine) and a gain of aquatic habitat in areas west of the northern spoil dump that will be more frequently inundated.	The northern spoil dump is designed such that there is minimal capture of natural flows by the Project and prevents harvesting of flood flows on the floodplain.	Likelihood: Almost certain Consequence: Moderate **Risk: High**	Likelihood: Rare Consequence: Moderate **Risk: Low**
Aquatic flora	Localised loss of aquatic flora within the Project area. Aquatic plants to be lost are all considered common with a broad distribution in the region. The impacts are expected to be minor on a regional scale.	None	Likelihood: Almost certain Consequence: Insignificant **Risk: Low**	NA
Aquatic fauna (loss)	Localised loss of habitat for aquatic fauna and loss of aquatic fauna within the disturbance footprint. Aquatic fauna to be lost are individuals of species common with a broad distribution in the region. The impacts are expected to be minor on a regional scale.	None	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Almost certain Consequence: Minor **Risk: Medium**
Loss of fish passage	Permanent loss of ground-truthed waterways within the disturbance area (Tributaries 7 and 8) and restriction of fish passage to upstream reaches of Tributary 8. The waterways do not connect to any important breeding, feeding or refuge areas and fish passage is currently very limited based on the results of the field surveys. The disturbance footprint (including a 50 m buffer) comes close to, but does not overlap, the mapped green reaches of Tributary 8 along the south western extent of the disturbance area.	Ensure that ground disturbance along the south western boundary of the development footprint is managed to avoid disturbance of the main channel of Tributary 8 (mapped as green on the WWBW spatial layer). Re-design the spoil dump in the north western part of the development footprint to avoid impacts to Tributary 8; OR Provide a diversion around the north west of the disturbance area, to maintain connectivity along Tributary 8 in this location that is consistent with pre-mining conditions. To provide fish habitat and for	Likelihood: Almost certain Consequence: Moderate **Risk: High**	Likelihood: Almost certain Consequence: Minor **Risk: Medium**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Proposed Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
	However, the disturbance footprint overlaps with the main channel of the mapped red reaches of Tributary 8 in the north western portion of the development footprint. Impacts here have the potential to impede fish passage to reaches further upstream.	fish passage, the diversion will include the following design features: • Ensuring functionality and longevity of the riparian corridor, including revegetation to a pre-mining condition and management of the riparian vegetation; • Ensuring that the diversion is constructed at a gradient of no more than 5%; • Ensuring that conditions within the diversion (depth and velocities) would be consistent with the existing feature and suitable to provide adequate fish passage; • Reinstating habitat and geomorphic features by salvaging and using material such as woody debris consistent with pre-mining condition, to create habitat diversity within the diverted waterway; and • Including natural features that are consistent with conditions immediately up and downstream of the diversion.		
	Impacts to fish passage as a result of the Moura-Baralaba Road realignment.	Design the road crossings in accordance with the ADRs for green waterways for waterway barrier works.		
Impacts to water quality from surface run-off	Reduced water quality, including high suspended sediments, sedimentation, turbidity, and nutrients concentrations and potentially contaminants if run-off is from disturbed areas. Potential impacts to health, composition and resilience of flora and fauna; respiration and feeding of fauna;	Localised erosion protection works such as rock armouring and establishment of floodplain vegetation (trees), if required, to prevent scouring and degradation of the area identified with increases in peak flood velocity.	Likelihood: Almost certain Consequence: Severe **Risk: Very High**	Likelihood: Rare Consequence: Severe **Risk: Medium**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Proposed Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
	reduce growth and diversity in aquatic plants and algae; and/or bury benthic communities.	Sediment basins designed to contain sediment affected runoff from disturbed areas including rehabilitated areas until they are suitably established. Sediment and erosion control structures designed in accordance with the IECA guidelines to minimise water quality impacts from disturbed land on the receiving waterways.		
Impacts to water quality from controlled releases of mine affected water	Direct impacts to water quality and sediment quality and indirect impacts to aquatic habitat, flora and fauna in the receiving environment.	Controlled release strategy that ensures mine affected water is only released when conditions in the receiving waterway allow water quality (outside of the mixing zone) to be maintained at levels which achieve the determined water quality objectives (as is proposed).	Likelihood: Almost certain Consequence: Severe **Risk: Very High**	Likelihood: Possible Consequence: Minor **Risk: Medium**
Impacts to water quality from uncontrolled releases of mine affected water	Direct impacts to water quality and sediment quality, and indirect impacts to aquatic habitat, flora and fauna in the receiving environment.	Controlled releases of mine affected water to be made under appropriate conditions and rates to prevent the accumulation of mine water on site and reduce the risk of uncontrolled releases to natural waterways. Sediment dams designed to contain an 85th percentile 5-day rainfall event. Mine Water Dams designed to contain greater than 95th percentile wet years. Water storage measures ensure uncontrolled release events from all storages potentially occur only during significant rainfall events when dilution within receiving waterways is expected to reduce contaminant concentrations to levels consistent with background conditions.	Likelihood: Almost certain Consequence: Severe **Risk: Very High**	Likelihood: Rare Consequence: Moderate **Risk: Low**

Potential Impact	Potential Impacts to the Aquatic Ecosystem	Proposed Mitigation Measures	Risk (Unmitigated)	Risk (Mitigated)
Leaks and spills of hydrocarbons and other contaminants	Direct impact to water quality and indirect impacts to aquatic ecology in the receiving environment (e.g. toxicity to flora and fauna).	Appropriate procedures, containment and spill control measures to be implemented at appropriate locations where the transportation and loading, as well as storage of materials occurs onsite. The design and management of all required fuels and hydrocarbons to ensure there are effective means of secondary containment to prevent or minimise releases to the environment from any fuel and oil storage onsite.	Likelihood: Almost certain Consequence: Major **Risk: Very High**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Saline and acid mine drainage	Seepage is expected to be of low salinity and neutral to alkaline pH. It is not expected that seepage from waste rock dumps will cause any additional impacts to water quality in the receiving waterway.	Seepage to be managed in the mine water system.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Rare Consequence: Minor **Risk: Low**
Litter and Waste	Potentially be ingested by fauna; entangle or entrap aquatic flora and fauna and / or negatively impact water quality.	Ensure appropriate Waste Management Plan is in place to minimize production of litter and waste.	Likelihood: Almost certain Consequence: Minor **Risk: Medium**	Likelihood: Unlikely Consequence: Minor **Risk: Low**
Water extraction from the Dawson River	Impact on the aquatic ecology at and downstream of the offtake point by changing water levels and habitat conditions.	Water management system that will maximise and prioritise use of onsite water retention and recycling and minimize the requirement for external raw water supply from the Dawson River.	Likelihood: Almost certain Consequence: Moderate **Risk: High**	Likelihood: Likely Consequence: Insignificant **Risk: Low**
Introduction of invasive aquatic species	Changes in community structure and general health of aquatic fauna and flora.	A Weed and Pest Animal Management Plan will be developed and implemented, which will incorporate standard and industry recognized controls for weed and pest animal management (e.g. use of wash-down facilities by all vehicles and plant prior to entering existing the site, if they have been operating off graded roads).	Likelihood: Possible Consequence: Major **Risk: High**	Likelihood: Unlikely Consequence: Minor **Risk: Low**

7 Summary

The Project is located within the Dawson River Sub-basin of the wider Fitzroy River basin, with the Dawson River and Banana Creek are the main waterways adjacent to and downstream of the Project. Agricultural activities that dominate surrounding land-uses impact the catchment through consumption of the catchment's water for stock and crop watering, contributing to contaminated run-off and erosion associated with land clearing (Telfer 1995; DES 2019f). The catchment is also affected by water resource development (e.g. weirs and dams), including the Neville Hewitt Weir the impoundment area of which encompasses the waters adjacent to and immediately downstream of the Project area. Weirs and dams typically restrict flow though waterways and limit the passage of aquatic fauna, enhance the aggradation of sediments, reduce the habitat diversity within the impoundment area and potentially decrease the diversity of aquatic fauna (Marsden & Power 2007).

Aquatic habitat conditions of the waterways within the Project area are poor as they consist of discontinuous ephemeral drainage lines that had minimal in-stream habitat features (or were dry) and were highly disturbed by activities associated with the adjacent land-use. In many cases, there was no defined waterway present where a waterway was mapped, i.e. there was a lack of defined bed or banks or evidence of sufficient flows to maintain aquatic ecological processes.

Aquatic habitat conditions of wetlands within the Project area varied; the lacustrine wetland was considered poor with minimal in-stream habitat features and a high level of disturbance (it was a modified (dammed) wetland), while the palustrine wetlands were considered fair with more diverse available in-stream habitat features and lower disturbance from surrounding land-uses. Aquatic habitat conditions of the Dawson River and Anabranch, Banana Creek and Shirley's Gully were considered fair. These waterways had a variety of in-stream habitat features and flow regimes, good bank stability and although the adjacent lands were disturbed, a reduced but mainly intact riparian zone remained along the waterways.

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

- Loss of aquatic habitat, flora and fauna within the Project area;
- Modification of aquatic habitat adjacent to and downstream of the Project area;
- Changes to flow and flood regimes or waterways and wetlands adjacent to and downstream of the Project area;
- Changes in water and sediment quality associated with surface water run-off, controlled and uncontrolled releases, and seepage of saline or acid drainage;
- Litter and waste; and
- Proliferation of aquatic pests.

Impacts to aquatic ecosystems will be minimised by:

- Limiting the area of direct impact to aquatic ecosystems to the proposed disturbance area;
- Implementing effective erosion and sediment control strategies that are: designed in accordance with best practice guidelines; designed to contain sediment affected

runoff from disturbed areas; and protect against erosion from increased velocities during flood flows (i.e. localised erosion protection works);

- An effective water management system that: minimises the capture of natural flows by diverting clean water around the Project area; effectively manages the storage of mine affected water; maximises and prioritises use of onsite water retention and recycling to reduce external raw water supply requirements; effectively manages seepage in the water management system and achieves water quality objectives;
- Adopting a controlled release strategy that ensures release events will coincide with medium-high streamflow conditions in the Dawson River and are in accordance with Environmental Authority conditions; and
- Implementing high quality and appropriate management plans developed for the management of waste, hydrocarbons and contaminants and weed and pest animals.

Despite these mitigation measures, there are likely to be residual impacts associated with:

- Direct loss of aquatic habitat and associated aquatic flora and fauna within the Project area as a result of the removal of aquatic habitat, although the aquatic habitats, flora and fauna of the Project area are common in the region and the impact is unlikely to extend beyond the disturbance footprint. Nevertheless, there will be a permanent impact to 2.33 ha of ground-truthed waterways providing for fish passage. This constitutes an SRI to MSES waterways, which will be partly mitigated by either redesigning the spoil dump to avoid impacts to the waterway, or construction of a diversion drain that provides for fish passage in the north-western part of the footprint (0.12 ha); while the remainder (2.21 ha) can be offset with a financial offset payment[5], subject to further investigation / studies challenging or validating the determination of the area as a waterway providing for fish passage; and
- Reductions in catchment area resulting in a reduction in flows, although any medium risk impacts are restricted to the upper reaches of Shirly's Gully (upstream of the weir pool).

The site water management system has been designed such that the risk of off-site uncontrolled release of mine affected water during operations is very low, and sediment inputs can be controlled through drainage, and erosion and sediment control measures. Furthermore, the outcomes from the water balance modelling indicate that the proposed controlled release strategy would achieve the required WQOs in the Dawson River receiving environment (beyond the mixing zone) and therefore not impact on its environmental values (Engeny Water Management 2023a).

Considering the existing impacts in the catchment and provided the appropriate mitigation measures are in place, it is considered unlikely that the Project will result in significant impacts to aquatic ecosystems of the Dawson River Sub-basin, including to aquatic MNES and MSES species. Based on the results of modelling of the impacts to flows and water quality, the Project is not expected to make any significant contribution to cumulative impacts to aquatic ecosystems in the Dawson River Sub-basin or wider Fitzroy Basin.

[5] Financial offset value to be confirmed; current value based on DES online calculator is $55,250.00.

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Appendix A Site Habitat Descriptions

Site Photographs	Site Description
DR1  **Downstream March 2018**  **Upstream March 2018**  **Fringing and trailing vegetation on the right bank: March 2018**	This site was located on the Dawson River downstream of the Project area. The Dawson River is identified as a watercourse under the Water Act and is classified as a stream order 8 waterway. This reach of the Dawson River is within the Neville Hewitt Weir impoundment area. The site was characterised as a wide and deep permanent waterway (wetted width 90-100m, depth >10m). The Dawson River experiences consistent flows throughout the year as it obtains inflow from groundwater sources throughout its length. In-stream habitat comprised of: • deep pools • substrate dominated by fine sediments (silt and clay, some sand) • inundated trees and submerged and emerging logs and branches • sparse coverage of floating aquatic plants, and • overhanging and trailing bank vegetation fringing the edges. Surrounding land-uses included cropping and grazing. Banks were steep and high (3-6m) with infrequent areas of erosion (from stock access and land clearing). They were well-vegetated and composed of consolidated earth substrate. The riparian zone was in moderate conditions. Riparian vegetation was mostly continuous, although reduced in width (10-20m) due to land clearing associated with the adjacent land uses. Vegetation comprised an overstory of native trees (Eucalyptus and Acacia) and a grass understory. Emergent macrophyte species of herbs, rushes and sedges lined the lower banks fringing the waterway. Habitat condition was considered fair. It lacked diversity in the absence of a variety of flow regimes and substrate types, however more complex habitat features were present around the edges, which were considered suitable to support a variety of aquatic fauna. The site provided some favourable habitat features for listed species, including abundant in-stream structure for resting and refuge (particularly for turtles) and some sections of the banks were considered potentially suitable for nesting and burrows. But the deep pool habitat that dominated the site is considered largely unsuitable for the listed species and would limit habitation to transient (short-term) occurrences. Overall the aquatic ecological value of the site was considered high. The permanent nature of the site allows it to provide consistent available habitat for refuge and breeding as well as connectivity to other areas for a variety of aquatic fauna. In addition, it has the potential to support the transient occurrence of listed species that are known to occur in the region.

Site Photographs	Site Description
 **Downstream August 2023**  **Upstream August 2023**  **Fringing and trailing vegetation on the right bank: August 2023** **Note: Photographs were taken from the western bank during the August 2023 surveys, as the eastern bank was inaccessible by foot.**	In comparison to the March 2018 survey, little change was observed at the site. During the August 2023 site inspection, the field team observed that the water clarity had improved, which is likely to be related to lower rainfall prior to the site inspection and a reduction of sedimentation from upstream in the catchment. Overall, the aquatic ecological value of this site did not change.

DA1

Downstream June 2017

Upstream June 2017

Left bank showing riparian vegetation: June 2017

This site was located on an anabranch of the Dawson River downstream of the Project area. The anabranch is identified as a watercourse under the Water Act and is classified as a stream order 8 waterway. It is located within the Neville Hewitt Weir impoundment area and is mapped as a lacustrine wetland. The Anabranch was characterised as a wide and deep permanent waterway (wetted width 20-30m, depth 5-7m). The anabranch comprises run habitat during flow periods and pool habitat during low to no flow periods.

The site was surveyed in both the dry and wet season surveys. In-stream habitat comprised of:

- deep and shallow pools
- substrate dominated by fine sediments (silt and clay, some sand)
- sparse coverage of floating aquatic plants
- overhanging and trailing bank vegetation fringing the edges, and
- Inundated trees with high density of submerged and emerging logs and branches

Surrounding land-uses included cropping and grazing. Banks were steep and high (3-6m) with infrequent areas of erosion (from stock access and land clearing). They were well-vegetated and composed of consolidated earth substrate.

The riparian zone was in moderate to good condition. Riparian vegetation was continuous along both banks. Vegetation was reduced in width (10-20m) along the right bank due to land clearing associated with the adjacent land uses, while the left bank was undisturbed and intact. Vegetation comprised of native canopy trees (Eucalyptus and Acacia) and a grass dominated understory. Emergent macrophyte species of herbs, rushes and sedges lined the lower banks fringing the waterway.

Habitat condition was considered fair. The site lacked diversity in the absence of a variety of flow regimes and substrate types, however more complex habitat features were present around the edges and were considered suitable to support a variety of aquatic fauna.

The site provided some favourable habitat features for listed species, including abundant in-stream structure for resting and refuge (particularly for turtles) and some sections of the banks were considered potentially suitable for nesting and burrows. However, the deep pool habitat that dominated the site is considered largely unsuitable for the listed species and would limit habitation to transient (short-term) occurrences.

Overall the aquatic ecological value of the site was considered high. The permanent nature of the site allows it to provide consistent available habitat for refuge and breeding for a variety of fauna as well as connectivity to other areas. In addition, it has potential to support the transient occurrence of listed species that are known to occur in the region.

In comparison to the baseline wet and dry season surveys, the field team observed that the water level in August 2023 appeared to be significantly lower.

Site Photographs	Site Description
 **Downstream August 2023**  **Upstream August 2023**  **Left bank showing riparian vegetation: August 2023**	The site was characterised as a narrowed and shallow waterway (wetted width 10-15m, depth 1-2m) when compared to previous surveys. Despite the lowered water levels, complex habitat features were still present within the site and around the edges and were considered suitable to support a variety of aquatic fauna. Overall, the aquatic ecological value of this site did not change.

SG1

Downstream June 2017

Upstream June 2017

Reduced riparian vegetation on the right bank: June 2017

This site was located at the downstream extent of the unknown waterway that flows through the Project area, which is locally referred to as Shirley's Gully and is downstream of the Project area and approximately 700 m upstream of the waterway's confluence with the Dawson River Anabranch. Shirley's Gully is classified as a stream order 3 waterway and the lower reaches are identified as a watercourse on the WIM. The site was characterised as a wide permanent waterway (wetted width approximately 15m, depth 1.5m-2m). This reach of the unnamed waterway commonly receives backflow from the Anabranch during periods of high flow and high water levels within the Neville Hewitt Weir Pool.

Habitat features were diverse and comprised of:

- deep and shallow pools
- substrate dominated by silt
- low coverage of in-stream submerged and emergent aquatic plants
- low cover of overhanging and trailing bank vegetation fringing the edges, and
- variety of in-stream structure (submerged woody debris, backwaters and pools).

Surrounding land-use included grazing. Banks were high (4-5m) but gently sloping, with low stability as a result of stock access (evident at the site) and impacts from high flows.

Riparian vegetation was continuous and in fair condition. The riparian zone was significantly reduced in width (5m) due to land clearing associated with the adjacent land-uses. Vegetation was dominated by *Eucalyptus* spp., providing a light overstory and good overhanging fringing vegetation. The understory was dominated by grasses, and some shrubs. Emergent macrophytes (*Persicaria* spp.) were growing on the bank and in-stream, and free-floating water lettuce (*Pistia stratiotes*) was also recorded.

Habitat condition was considered fair. The site lacked diversity in the absence of a variety of flow regimes, substrate types and coverage of aquatic plants. However, the habitat features present were considered suitable to support a variety of aquatic fauna, although not considered suitable for listed species.

Overall the aquatic ecological value of the site was considered moderate. The reach would likely become disconnected during dry periods, however remaining long-lasting pools would provide refuge for aquatic flora and fauna during dry periods and its vicinity to the Dawson River would allow it to provide refuge to aquatic fauna during high flows and breeding habitat for aquatic species.

In comparison to the seasonal baseline surveys, the site was dry in August 2023. The site was previously characterised as a permanent waterway, however, in the August 2023 survey, the field team observed no water and reduced riparian vegetation due to land clearing and livestock access (evident at the site). Despite the dry conditions, the site's vicinity to the Dawson River would allow it to provide refuge to

Site Photographs	Site Description
 **Downstream August 2023**  **Upstream August 2023**  **Reduced riparian vegetation on the right bank: August 2023**	aquatic fauna during significant rain events and high flows or at times when water levels in the Neville Hewitt Weir impoundment are higher (and water backs up into Shirley's Gully). Overall despite no water, the aquatic ecological value of the site did not appear to change.

UW1T

Downstream June 2017

Upstream June 2017

Upstream March 2018

This site was located on a western tributary of Tributary 8 that flows through the Project area. The tributary is unmapped and is stream order 1 ephemeral drainage channel characterised as a shallow isolated pool in June 2017 but was dry in March 2018.

Habitat features were limited and comprised of:

- shallow pools
- substrate dominated by silt
- low cover of overhanging vegetation
- low coverage of in-stream aquatic plants, and
- woody debris.

Surrounding land use included grazing. Banks were low (1.5 m high) and gently sloping but bank stability was reduced due to poor vegetation coverage and disturbance from cattle access.

The riparian zone was in poor condition. Riparian vegetation was scattered and significantly reduced in width (2-3 m) due to land clearing associated with the adjacent land uses. Vegetation comprised *Eucalyptus* sp. and *Acacia* sp. with a groundcover of grasses.

Habitat condition was considered poor due to an overall lack of habitat diversity, specifically the absence of a variety of regimes, a lack of variable substrate types, low bank stability and minimal streamside vegetation cover. The site was not considered appropriate for listed species.

Overall the aquatic habitat value of the site was considered low. The tributary is poorly defined and poorly connected with a low potential to hold water after periods of rain. Any aquatic habitat the site is potentially able to provide would be limited to short periods after seasonal rainfall and would not support a diversity of aquatic flora and fauna or provide distinct or vital habitat for refuge and/or breeding. No fish were recorded in the fish survey completed in June 2017.

Similar to the March 2018 survey, the site was dry in August 2023. Therefore, the overall aquatic ecological value of the site did not change.

Site Photographs	Site Description
 **Downstream August 2023**  **Upstream August 2023**	
UW2  **Downstream June 2017**	This site was located on Tributary 5 that flows through the Project area. The tributary is classified as a stream order 2 waterway and is a drainage feature on the WIM. The site was characterised as a an overland flow area within the Dawson river flood plain that was dry in June 2017, March 2018 and August 2023. There were no defined bed or banks and no riparian vegetation. i.e. there was no channel discernible from the surrounding paddock. No in-stream aquatic habitat features were present; remnant and sparse patches of emergent wetland indicator plants (e.g. sedges and rushes) were present indicating the area has depressions that are periodically inundated to support the growth of aquatic plants. The area was a modified rural landscape that has been cleared for grazing and is vegetated by grasses only. Aquatic habitat condition was considered poor due to an overall lack of a waterway and aquatic habitat features. The site was not considered appropriate for listed aquatic species. The site and surrounds may be best characterised as gilgai habitat. The aquatic habitat value of the site was considered very low. There was a lack of a defined channel with

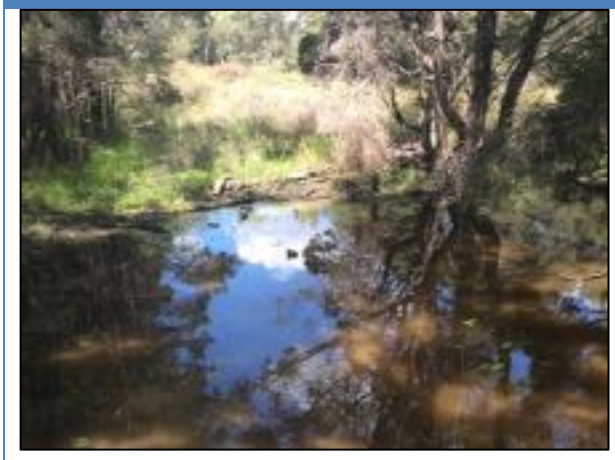
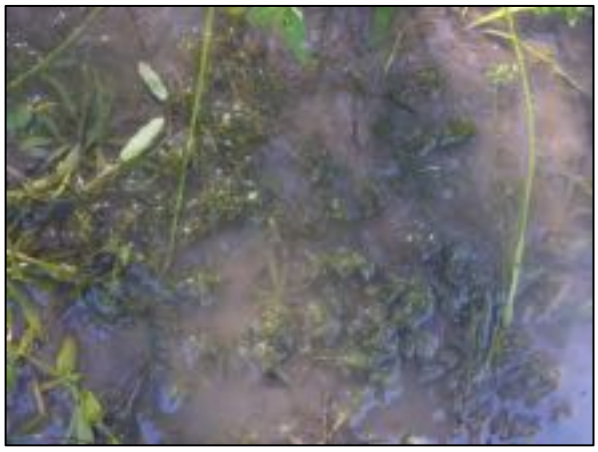
Site Photographs	Site Description
 **Upstream June 2017**  **Upstream March 2018**  **Downstream August 2023**	bed and banks. The site does not have any distinct habitat features to support a diversity of aquatic flora or provide any vital habitat for refuge or breeding.

Site Photographs	Site Description
 **Upstream August 2023**	
LW1  **Downstream June 2017**  **Upstream June 2017**	This site was located on a mapped lacustrine wetland situated on Tributary 6 (stream order 1, drainage feature on the WIM) that flows through the Project area. The site was characterised as a farm dam (approximately 100 m long, 30 – 50 m wide, >1 m deep) with a surface area of approximately 0.4ha. The tributary the wetland is located on was poorly defined (i.e. an overland flow path within the Dawson River flood plain) with no distinct channels connecting the wetland to surrounding waterways (refer also to Appendix D). Habitat features comprised of: • deep and shallow pools • substrate dominated by sand and silt, with some gravel and pebble around the edges • minimal woody debris, and • aquatic plants fringing the edges of the wetland and growing in the shallow margins of the wetland. Surrounding land-use was grazing. Banks were low to moderate (0.5-3 m high) and gently sloping. Limited erosion was evident, but bank stability was reduced due to poor vegetation coverage and disturbance from cattle access. The riparian zone was in poor condition. The wetland is located in a modified rural landscape. Riparian vegetation has been significantly disturbed due to land clearing associated with the surrounding land use and modification of the waterway to create the dam; no distinct riparian vegetation remained and only grasses vegetated the banks. Habitat condition was considered poor due to an overall lack of habitat diversity, specifically the absence of a variety of flow regimes, low diversity of substrate types and instream habitat features, and minimal streamside cover. The site was not considered appropriate for listed species. Overall the aquatic habitat value of the site was considered low. The wetland has poor habitat condition and is poorly connected and highly disturbed. The aquatic habitat the site does not support a large variety of aquatic fauna or flora and due to its disconnected nature, it is not able to

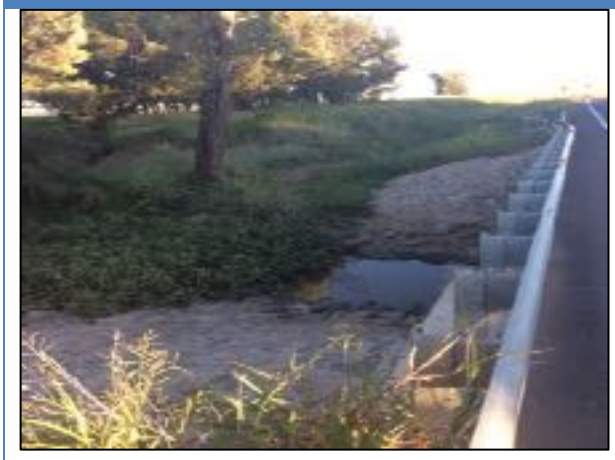
Site Photographs	Site Description
 **In-stream aquatic plants: March 2018**  **Downstream August 2023**  **Upstream August 2023**	provide distinct or vital habitat for refuge and/or breeding. Little change was observed in the nature and condition of the habitat at this site between the baseline surveys and the site inspection in August 2023.
PW1	This site was located on a wetland situated approximately 500 m east of Banana Creek partially within the Project area (i.e. the wetland borders the south-west boundary of the ML). The wetland is mapped as a palustrine system and a HES wetland. The site was characterised as an expansive ephemeral wetland (approximately 370 m long and 380 m wide) with a surface area of approximately 38ha. The wetland is not located on a defined or mapped waterway but is within the Dawson River

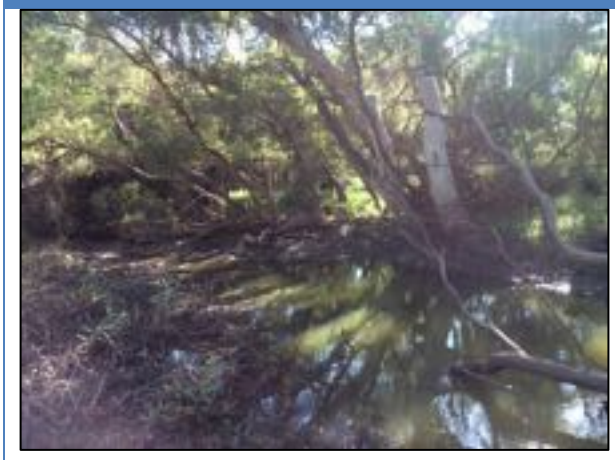
Site Photographs	Site Description
 **North orientation June 2017**  **South orientation June 2017**  **South orientation March 2018**	flood plain. The site was dry in both June 2017 and March 2018. Features that would provide habitat in periods of inundation comprised: • small and large woody debris and tree roots • substrate dominated by silt and clay • overhanging and trailing bank vegetation, and • macrophyte beds. The riparian zone was in poor condition. The wetland is located in a modified rural landscape and vegetation has been cleared to the parameter of the wetland leaving no obvious riparian zone buffering the wetland. The wetland vegetation comprises an overstory of *Eucalyptus* sp. and *Acacia* sp. (Brigalow) and extensive beds of dry aquatic plants comprised the groundcover. Habitat condition of the site was considered fair. Although dry, the wetland provided habitat for aquatic flora, and during periods of inundation it would support some aquatic fauna (i.e. macroinvertebrates; it is unlikely to support fish or turtles due to poor connectivity). The site was not considered appropriate for listed species. Overall the aquatic habitat value of the site was considered low. The wetland does not support a large variety of aquatic flora and would rarely be able to support aquatic fauna due to its ephemeral nature and poor connectivity. In comparison to the June 2017 and March 2018 surveys, conditions were drier in August 2023. The overall aquatic ecological value of the site did not appear to change.

Site Photographs	Site Description
 **North orientation August 2023**  **South orientation August 2023**	
PW2  **Wetted pool June 2017**	This site was located on a wetland situated on Tributary 8 that flows through the Project area. The wetland is mapped as a palustrine system and the tributary is classified as a stream order 1 waterway that is a drainage feature on the WIM. The site was characterised as an elongated wetland (approximately 150 m wide and 700 m long) with a surface area of 7 ha. The wetland comprised dry giglai depressions and a series of disconnected pools along the waterway that were holding water in both June 2017 and March 2018. The pools were typically 2 – 7 m wide and approximately 0.5 – 1 m deep. Habitat features comprised of: • shallow pools • sediment dominated by silt and clay • large and small woody debris • overhanging and trailing bank vegetation, and • emergent, floating or submerged macrophytes. Surrounding land-use was grazing. Banks were low (0.5 m) and gently sloping. Bank and bed substrate indicated moderate disturbance from cattle access.

Site Photographs	Site Description
 **Wetted pool March 2018**  **Variety of aquatic plants growing in wetted pool: June 2017**  **Recently dry bed in August 2023**	The wetland is located in a modified rural landscape and vegetation has been cleared to the parameter of the wetland leaving no obvious riparian zone buffering the wetland. The wetland vegetation has been historically cleared but is comprised of native regrowth in good condition, including *Melaleuca* sp. with some *Eucalyptus* sp. (Coolibah) and *Acacia* sp. and stands of *Duma* sp.. The habitat conditions was considered fair. The wetland supported a variety of aquatic flora and long lasting pools but lacked overall habitat diversity and connectivity. The site was not considered appropriate for listed species. Overall the aquatic habitat value was considered low. The wetland does support a variety of aquatic flora, however it does not support a diversity of fauna. Its disconnected nature and high level of disturbance makes it unsuitable for listed species and it is not considered to provide distinct or vital habitat for aquatic flora or fauna in the region. The wetland was dry (though the pool had only recently dried up) in August 2023, confirming that while pools in the wetland are long-lasting, they are not perennial. The aquatic ecological value of the site did not change.

Site Photographs	Site Description
 **Recently dried substrate August 2023**	
BC1  **Downstream: June 2017**  **Upstream: June 2017**	This site was located on Banana Creek upstream of the Project area and approximately 12 km upstream of its confluence with the Dawson River. This reach of Banana Creek is identified as a watercourse under the Water Act and is classified as a stream order 5 waterway. The site was characterised as a semi-permanent pool (wetted width 5-7 m, depth 0.5-2 m). A culvert-style road crossing passed through the waterway at the site, which has affected the connectivity of the waterway and modified flow regimes in the immediate reach of the site. In-stream habitat comprised of: • deep and shallow pools • variable substrate (dominated by fine sediments but larger rocks were present around the footprint of the road crossing • large and small woody debris, logs and branches • undercut banks • abundance of in-stream aquatic plants, and • overhanging and trailing bank vegetation fringing the edges. Surrounding land-use included grazing and cropping. Banks were high (3-4 m) with moderate to steep gradients and infrequent areas of erosion present. They were well-vegetated and composed of consolidated earth. The riparian zone was in moderate condition. Riparian vegetation was mostly continuous except around the road crossing and the width of riparian vegetation was reduced (5-15m) due to land clearing associated with the adjacent land uses. Vegetation comprised an overstory of native trees (Eucalyptus and Melaleuca) and a groundcover dominated by perennial grasses. Emergent macrophyte species of herbs, rushes and sedges lined the lower banks fringing the waterway. Habitat condition was considered fair. The site lacked diversity in the absence of a variety of flow regimes and there was significant modification to the channel morphology due to deposition of fine sediments downstream of the road crossing.

Site Photographs	Site Description
 **Road crossing through site: Mach 2018**  **Downstream August 2023**  **Upstream August 2023**	However, the habitat features present were considered suitable to support a variety of aquatic flora and fauna, although not considered suitable for listed species. Overall, the aquatic ecological value of the site was considered moderate. The reach may become disconnected during dry periods, however remaining long lasting pools would provide refuge during those periods. Furthermore, its proximity to the Dawson River would allow it to provide passage and refuge to aquatic fauna during high flow and the habitat features present would provide suitable breeding areas for many species (but unlikely for listed species). In comparison to the June 2017 and March 2018 surveys, the water level was significantly lower in August 2023. The site was characterised as a semi-permanent, narrowed and shallow pool downstream (wetted width 3m, depth 0.5-1m) and dry upstream. Despite the lowered water levels, complex habitat features were still present within the site and around the edges of the pool, and were considered suitable to support a variety of aquatic fauna. The aquatic ecological value of the site did not change.
BC2	This site was located on Banana Creek adjacent to the Project area and approximately 5.6 km upstream of its confluence with the Dawson River. This reach of Banana Creek is identified as a watercourse under the Water Act and is classified as a stream order 5 waterway. The site was characterised as a permanent pool (wetted width 5-10 m, depth 1-3 m). A bed-level track crossing passed through the waterway at the site, which has affected the

Site Photographs	Site Description
 **Downstream: June 2017**  **Upstream March 2018**  **Backwater pool with large woody debris and overhanging vegetation: March 2018**	connectivity of the waterway and modified flow regimes in the immediate reach of the site. In-stream habitat comprised of: • deep and shallow pools • substrate dominated by fine sediment (silt with some sand • large and small woody debris, logs and branches • undercut banks • in-stream aquatic plants, and • overhanging and trailing bank vegetation fringing the edges Surrounding land-use included grazing and cropping. Banks were high (3-4 m) with moderate to steep gradients and infrequent areas of erosion present. They were well-vegetated and composed of consolidated earth. The riparian zone was in good conditions. Riparian vegetation was continuous except around the track crossing and the width of riparian vegetation was reduced (10-20m) due to land clearing associated with the adjacent land uses. Vegetation comprised an overstory of native trees (Eucalyptus and Melaleuca) and a groundcover dominated by perennial grasses. Emergent macrophyte species of herbs, rushes and sedges lined the lower banks fringing the waterway. Habitat condition was considered fair. The site lacked diversity in the absence of a variety of flow regimes and substrate types, and the channel morphology was modified due to the deposition of fine sediments in-stream and around bends. However, the habitat features present were considered suitable to support a variety of aquatic flora and fauna and potentially suitable to support certain listed species (i.e. listed turtles and platypus). Overall the aquatic ecological value of the site was considered high. The reach would provide consistent available habitat for refuge and breeding as well as connectivity to other areas for a variety of aquatic fauna, including listed species. In comparison to the June 2017 and March 2018 surveys, the site was dry in August 2023. This is likely to be related to rainfall prior to the survey and lower water levels in the Neville Hewitt weir pool. Despite the dry conditions, complex habitat features were still present within the site and around the edges and were considered suitable to support a variety of aquatic fauna. The aquatic ecological value of the site was downgraded to moderate, due to the lack of permanent pools that were considered likely to occur during the baseline assessments.

Site Photographs	Site Description
 **Downstream August 2023**  **Upstream August 2023**  **Dry pool with woody debris and overhanging vegetation: August 2023**	

Appendix B Laboratory Certificates of Analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1711948**	Page	: 1 of 15
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: AARON DUNLOP	Contact	: Customer Services EB
Address	: PO BOX 5935 MANLY 4179	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: 1707 BARALABA STH EIS	Date Samples Received	: 12-Jun-2017 12:15
Order number	: ----	Date Analysis Commenced	: 12-Jun-2017
C-O-C number	: ----	Issue Date	: 20-Jun-2017 07:32
Sampler	: AD/RK		
Site	: ----		
Quote number	: BNBQ/099/16		
No. of samples received	: 21		
No. of samples analysed	: 21		

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*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Greg Vogel	Laboratory Manager	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, 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 no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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.

- EG005T (Total Metals by ICP-AES): Sample EB1711948-021 (UW2) shows poor duplicate result due to sample heterogeneity. Confirmed by visual inspection.
- 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.
- EG020F (Dissolved Metals) were found to be higher than EG020T (Total Metals) for EB1711948-003 (DR1). This was confirmed by re-digestion and re-analysis.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	DA1	DR1	LW1	PW2	PW1
			Client sampling date / time	06-Jun-2017 00:00	06-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00
Compound	CAS Number	LOR	Unit	EB1711948-002	EB1711948-004	EB1711948-006	EB1711948-008	EB1711948-009
				Result	Result	Result	Result	Result
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	38.2	35.8	35.9	33.8	11.4
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	15300	16900	4280	17100	19900
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	12	8	6	15	11
Iron	7439-89-6	50	mg/kg	20100	17400	5550	16300	21600
Manganese	7439-96-5	5	mg/kg	591	203	285	685	579
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	44	49	18	38	43
Arsenic	7440-38-2	5	mg/kg	6	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	18	23	8	13	16
Copper	7440-50-8	5	mg/kg	18	23	8	20	22
Lead	7439-92-1	5	mg/kg	12	13	6	15	14
Nickel	7440-02-0	2	mg/kg	16	15	6	14	16
Zinc	7440-66-6	5	mg/kg	41	45	15	43	54
EG020T: Total Metals by ICP-MS								
Uranium	7440-61-1	0.1	mg/kg	0.6	0.8	0.1	0.3	0.4
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
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	80
C15 - C28 Fraction	----	100	mg/kg	130	<100	<100	<100	330
C29 - C36 Fraction	----	100	mg/kg	110	<100	<100	<100	250
^ C10 - C36 Fraction (sum)	----	50	mg/kg	240	<50	<50	<50	660
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	100
>C16 - C34 Fraction	----	100	mg/kg	160	<100	<100	<100	440

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	DA1	DR1	LW1	PW2	PW1
				Client sampling date / time	06-Jun-2017 00:00	06-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-002	EB1711948-004	EB1711948-006	EB1711948-008	EB1711948-009
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	**140**
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		**210**	<50	<50	<50	**680**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		**50**	<50	<50	<50	**100**
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**	1330-20-7	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	%		**94.4**	**93.5**	**98.2**	**97.9**	**109**
Toluene-D8	2037-26-5	0.2	%		**85.9**	**86.0**	**87.1**	**88.2**	**100**
4-Bromofluorobenzene	460-00-4	0.2	%		**87.2**	**85.2**	**86.4**	**88.8**	**103**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)			Client sample ID	UWIT	UWIT_R2	BC2	BC1	UW3F
			Client sampling date / time	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	08-Jun-2017 00:00	08-Jun-2017 00:00
Compound	CAS Number	LOR	Unit	EB1711948-011	EB1711948-013	EB1711948-015	EB1711948-018	EB1711948-020
				Result	Result	Result	Result	Result
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	40.5	37.9	55.5	42.4	43.6
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	30000	22200	27100	21600	26400
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cobalt	7440-48-4	2	mg/kg	15	13	15	20	32
Iron	7439-89-6	50	mg/kg	28800	22200	30700	35300	31800
Manganese	7439-96-5	5	mg/kg	591	548	651	524	2250
Molybdenum	7439-98-7	2	mg/kg	<2	<2	<2	<2	<2
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	56	51	80	66	66
Arsenic	7440-38-2	5	mg/kg	5	<5	8	14	8
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	22	18	30	25	24
Copper	7440-50-8	5	mg/kg	28	26	35	32	28
Lead	7439-92-1	5	mg/kg	17	15	18	16	26
Nickel	7440-02-0	2	mg/kg	20	19	29	26	28
Zinc	7440-66-6	5	mg/kg	78	64	64	64	70
EG020T: Total Metals by ICP-MS								
Uranium	7440-61-1	0.1	mg/kg	0.5	0.6	0.7	0.4	0.8
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
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	240	100	<100
C29 - C36 Fraction	----	100	mg/kg	120	<100	210	<100	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg	120	<50	450	100	<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	80	<50	<50
>C16 - C34 Fraction	----	100	mg/kg	150	<100	330	130	<100

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	UWIT	UWIT_R2	BC2	BC1	UW3F
				Client sampling date / time	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	08-Jun-2017 00:00	08-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-011	EB1711948-013	EB1711948-015	EB1711948-018	EB1711948-020
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	**130**	<100	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		**150**	<50	**540**	**130**	<50
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	**80**	<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	1330-20-7	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	%		**92.1**	**86.0**	**92.8**	**88.6**	**91.6**
Toluene-D8	2037-26-5	0.2	%		**83.9**	**74.3**	**82.9**	**80.4**	**82.2**
4-Bromofluorobenzene	460-00-4	0.2	%		**82.8**	**75.1**	**83.3**	**78.4**	**82.8**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	UW2	----	----	----	----
				Client sampling date / time	08-Jun-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1711948-021	--------	--------	--------	--------
					Result	----	----	----	----
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%		**13.9**	----	----	----	----
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		**25300**	----	----	----	----
Boron	7440-42-8	50	mg/kg		<50	----	----	----	----
Cobalt	7440-48-4	2	mg/kg		**17**	----	----	----	----
Iron	7439-89-6	50	mg/kg		**21500**	----	----	----	----
Manganese	7439-96-5	5	mg/kg		**1000**	----	----	----	----
Molybdenum	7439-98-7	2	mg/kg		<2	----	----	----	----
Selenium	7782-49-2	5	mg/kg		<5	----	----	----	----
Silver	7440-22-4	2	mg/kg		<2	----	----	----	----
Vanadium	7440-62-2	5	mg/kg		**41**	----	----	----	----
Arsenic	7440-38-2	5	mg/kg		<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg		<1	----	----	----	----
Chromium	7440-47-3	2	mg/kg		**17**	----	----	----	----
Copper	7440-50-8	5	mg/kg		**23**	----	----	----	----
Lead	7439-92-1	5	mg/kg		**20**	----	----	----	----
Nickel	7440-02-0	2	mg/kg		**16**	----	----	----	----
Zinc	7440-66-6	5	mg/kg		**56**	----	----	----	----
EG020T: Total Metals by ICP-MS									
Uranium	7440-61-1	0.1	mg/kg		**0.2**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	----	----	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	----	----	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	----	----	----	----
C29 - C36 Fraction	----	100	mg/kg		<100	----	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	----	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg		<10	----	----	----	----
>C10 - C16 Fraction	----	50	mg/kg		<50	----	----	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	----	----	----	----

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	UW2	----	----	----	----
				Client sampling date / time	08-Jun-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1711948-021	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	mg/kg		<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	----	----	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	----	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	----	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	----	----	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	----	----	----	----
^ **Total Xylenes**	1330-20-7	0.5	mg/kg		<0.5	----	----	----	----
Naphthalene	91-20-3	1	mg/kg		<1	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**107**	----	----	----	----
Toluene-D8	2037-26-5	0.2	%		**95.6**	----	----	----	----
4-Bromofluorobenzene	460-00-4	0.2	%		**98.6**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DA1	DR1	LW1	PW2	UWIT
				Client sampling date / time	06-Jun-2017 00:00	06-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-001	EB1711948-003	EB1711948-005	EB1711948-007	EB1711948-010
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**16**	**14**	**26**	**280**	**60**
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		**35**	**41**	**86**	**80**	**54**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**4**	**4**	<1	<1	<1
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**9**	**10**	**23**	**24**	**15**
Magnesium	7439-95-4	1	mg/L		**3**	**4**	**7**	**5**	**4**
Sodium	7440-23-5	1	mg/L		**20**	**17**	**10**	**19**	**8**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.06**	**3.56**	<0.01	<0.01	**0.07**
Arsenic	7440-38-2	0.001	mg/L		**0.001**	**0.002**	**0.004**	**0.002**	**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	**0.003**	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	**0.002**	<0.001	**0.002**	**0.001**
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		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	**0.001**	<0.001	<0.001	<0.001
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		**0.016**	**0.072**	**0.062**	**0.028**	**0.023**
Molybdenum	7439-98-7	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
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<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		**0.08**	<0.05	**0.09**	**0.08**	**0.08**
Iron	7439-89-6	0.05	mg/L		**0.18**	**2.35**	<0.05	<0.05	**0.11**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**3.51**	**0.08**	**0.66**	**7.50**	**2.96**
Arsenic	7440-38-2	0.001	mg/L		**0.002**	**0.001**	**0.005**	**0.004**	**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		**0.004**	<0.001	<0.001	**0.005**	**0.002**
Copper	7440-50-8	0.001	mg/L		**0.004**	**0.002**	**0.001**	**0.011**	**0.004**
Cobalt	7440-48-4	0.001	mg/L		**0.001**	<0.001	**0.002**	**0.008**	**0.001**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DA1	DR1	LW1	PW2	UWIT
				Client sampling date / time	06-Jun-2017 00:00	06-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-001	EB1711948-003	EB1711948-005	EB1711948-007	EB1711948-010
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.002**	**0.002**	**0.008**	**0.004**
Lead	7439-92-1	0.001	mg/L		**0.001**	<0.001	<0.001	**0.005**	**0.002**
Zinc	7440-66-6	0.005	mg/L		**0.006**	<0.005	<0.005	**0.018**	**0.009**
Manganese	7439-96-5	0.001	mg/L		**0.070**	**0.017**	**0.222**	**0.665**	**0.044**
Molybdenum	7439-98-7	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
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<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	**0.02**	<0.01
Boron	7440-42-8	0.05	mg/L		<0.05	**0.06**	**0.08**	**0.06**	**0.06**
Iron	7439-89-6	0.05	mg/L		**3.97**	**0.15**	**0.82**	**6.52**	**3.00**
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
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	**0.1**	**0.1**	<0.1
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	**0.16**	**0.06**	**0.08**
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		**0.16**	**0.17**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.16**	**0.17**	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.5**	**0.5**	**2.2**	**2.6**	**2.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.7**	**0.7**	**2.2**	**2.6**	**2.0**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.15**	**0.15**	**0.20**	**0.62**	**0.42**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.07**	**0.05**	**0.07**	**0.26**	**0.13**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DA1	DR1	LW1	PW2	UWIT
				Client sampling date / time	06-Jun-2017 00:00	06-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-001	EB1711948-003	EB1711948-005	EB1711948-007	EB1711948-010
					Result	Result	Result	Result	Result
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	**120**	**150**
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	**60**	**70**
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	**180**	**220**
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	**160**	**200**
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	**160**	**200**
^ >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	1330-20-7	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	%		**99.2**	**95.7**	**99.3**	**96.8**	**97.6**
Toluene-D8	2037-26-5	2	%		**98.9**	**98.4**	**96.7**	**99.8**	**100.0**
4-Bromofluorobenzene	460-00-4	2	%		**97.2**	**95.8**	**94.9**	**97.1**	**96.1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	UWIT_R2	BC2	BC2_R2	BC1	UW3F
				Client sampling date / time	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	08-Jun-2017 00:00	08-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-012	EB1711948-014	EB1711948-016	EB1711948-017	EB1711948-019
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		48	32	<5	8	14
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		54	89	<1	224	41
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	3	18	35	5
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		15	21	<1	55	10
Magnesium	7439-95-4	1	mg/L		4	9	<1	21	4
Sodium	7440-23-5	1	mg/L		8	18	<1	101	20
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.09	<0.01	<0.01	<0.01	0.08
Arsenic	7440-38-2	0.001	mg/L		0.002	0.001	<0.001	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		0.001	<0.001	<0.001	<0.001	<0.001
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		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
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		0.023	0.038	<0.001	0.009	0.013
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	0.003	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<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		0.08	0.08	<0.05	0.07	0.06
Iron	7439-89-6	0.05	mg/L		0.12	0.11	<0.05	<0.05	0.15
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		3.16	0.62	<0.01	0.25	2.35
Arsenic	7440-38-2	0.001	mg/L		0.002	0.002	<0.001	0.003	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		0.002	<0.001	<0.001	<0.001	0.006
Copper	7440-50-8	0.001	mg/L		0.004	0.002	<0.001	0.002	0.003
Cobalt	7440-48-4	0.001	mg/L		0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	UWIT_R2	BC2	BC2_R2	BC1	UW3F
				Client sampling date / time	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	08-Jun-2017 00:00	08-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-012	EB1711948-014	EB1711948-016	EB1711948-017	EB1711948-019
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.003**	<0.001	**0.003**	**0.004**
Lead	7439-92-1	0.001	mg/L		**0.002**	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		**0.009**	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L		**0.045**	**0.047**	<0.001	**0.092**	**0.052**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	**0.004**	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<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		**0.06**	<0.05	<0.05	**0.06**	<0.05
Iron	7439-89-6	0.05	mg/L		**3.16**	**1.32**	<0.05	**0.27**	**2.81**
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
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		<0.1	**0.2**	<0.1	**0.3**	**0.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.06**	**0.06**	**0.02**	**0.02**	**0.02**
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		**1.9**	**1.2**	<0.1	**1.0**	**0.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.9**	**1.2**	<0.1	**1.0**	**0.8**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.36**	**0.13**	<0.01	**0.05**	**0.18**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.12**	**0.02**	<0.01	<0.01	**0.03**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	UWIT_R2	BC2	BC2_R2	BC1	UW3F
				Client sampling date / time	07-Jun-2017 00:00	07-Jun-2017 00:00	07-Jun-2017 00:00	08-Jun-2017 00:00	08-Jun-2017 00:00
Compound	CAS Number	LOR	Unit		EB1711948-012	EB1711948-014	EB1711948-016	EB1711948-017	EB1711948-019
					Result	Result	Result	Result	Result
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		**160**	**160**	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		**70**	**60**	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		**230**	**220**	<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		**220**	**190**	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		**220**	**190**	<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**	1330-20-7	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	%		**97.6**	**99.8**	**100**	**99.0**	**97.5**
Toluene-D8	2037-26-5	2	%		**97.0**	**98.1**	**99.2**	**97.8**	**97.4**
4-Bromofluorobenzene	460-00-4	2	%		**93.9**	**95.9**	**96.4**	**94.9**	**95.6**

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	: **EB1807123**	Page	: 1 of 15
Client	: **ECOLOGICAL SERVICE PROFESSIONALS**	Laboratory	: Environmental Division Brisbane
Contact	: REBECCA KING	Contact	: Customer Services EB
Address	: PO BOX 5935 MANLY NSW, AUSTRALIA 4179	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: 1707 Baralaba EIS	Date Samples Received	: 19-Mar-2018 16:55
Order number	:	Date Analysis Commenced	: 20-Mar-2018
C-O-C number	: ----	Issue Date	: 27-Mar-2018 14:54
Sampler	: RK / CB		
Site	: ----		
Quote number	: BN/445/17		
No. of samples received	: 20		
No. of samples analysed	: 20		

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Inorganics, Stafford, QLD
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, 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) for sample EB1807123-007 (SGI R3). However, the difference is within experimental variation of the methods.
- EG005T (Total Metals by ICP-AES): Sample EB1807123-010 (DR1) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- 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.
- 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.

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	DR1	DA1	LW1	PW1	PW2
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-010	EB1807123-011	EB1807123-012	EB1807123-013	EB1807123-014
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		45.5	45.6	27.0	16.4	40.7
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		17000	19200	2120	14000	11300
Arsenic	7440-38-2	5	mg/kg		6	5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		200	210	60	170	110
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		22	30	6	13	8
Cobalt	7440-48-4	2	mg/kg		16	20	4	8	8
Copper	7440-50-8	5	mg/kg		22	25	5	20	19
Iron	7439-89-6	50	mg/kg		24800	29100	4080	14100	10700
Lead	7439-92-1	5	mg/kg		13	13	<5	15	11
Manganese	7439-96-5	5	mg/kg		932	963	217	318	346
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		17	26	3	12	10
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		54	60	17	40	26
Zinc	7440-66-6	5	mg/kg		46	52	6	35	34
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		0.7	0.8	<0.1	0.7	0.2
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
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	270	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	920	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	580	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	<50	1770	<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

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	DR1	DA1	LW1	PW1	PW2
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-010	EB1807123-011	EB1807123-012	EB1807123-013	EB1807123-014
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	<50	<50	**280**	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	**1200**	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	**330**	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	<50	<50	**1810**	<50
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg		<50	<50	<50	**280**	<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	%		**113**	**99.4**	**115**	**127**	**106**
Toluene-D8	2037-26-5	0.2	%		**93.6**	**72.1**	**94.9**	**106**	**85.6**
4-Bromofluorobenzene	460-00-4	0.2	%		**100.0**	**84.5**	**98.3**	**111**	**89.1**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	SGI R1	SGI R2	BC1	BC2	UWIT
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-015	EB1807123-016	EB1807123-017	EB1807123-018	EB1807123-019
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%		35.5	35.0	40.4	48.9	13.2
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg		13400	17900	15300	20400	16400
Arsenic	7440-38-2	5	mg/kg		<5	<5	8	6	<5
Barium	7440-39-3	10	mg/kg		140	240	170	220	210
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		13	16	22	24	14
Cobalt	7440-48-4	2	mg/kg		12	21	14	12	10
Copper	7440-50-8	5	mg/kg		18	22	26	30	22
Iron	7439-89-6	50	mg/kg		19400	21700	24000	23200	17800
Lead	7439-92-1	5	mg/kg		13	18	11	15	14
Manganese	7439-96-5	5	mg/kg		761	1070	683	527	408
Molybdenum	7439-98-7	2	mg/kg		<2	<2	<2	<2	<2
Nickel	7440-02-0	2	mg/kg		13	19	20	18	13
Selenium	7782-49-2	5	mg/kg		<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg		41	54	58	68	41
Zinc	7440-66-6	5	mg/kg		40	49	42	53	51
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		0.5	0.6	0.4	0.6	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
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		<50	70	<50	70	<50
C15 - C28 Fraction	----	100	mg/kg		<100	<100	<100	190	<100
C29 - C36 Fraction	----	100	mg/kg		<100	<100	<100	160	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	70	<50	420	<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

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	SGI R1	SGI R2	BC1	BC2	UWIT
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-015	EB1807123-016	EB1807123-017	EB1807123-018	EB1807123-019
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	**80**	<50	**100**	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	**260**	**120**
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	**80**	<50	**360**	**120**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	**80**	<50	**100**	<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	%		**107**	**114**	**108**	**104**	**114**
Toluene-D8	2037-26-5	0.2	%		**82.5**	**92.8**	**85.6**	**94.0**	**103**
4-Bromofluorobenzene	460-00-4	0.2	%		**89.9**	**99.3**	**89.8**	**91.7**	**102**

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	UW2	----	----	----	----
				Client sampling date / time	17-Mar-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1807123-020	--------	--------	--------	--------	
				Result	----	----	----	----	
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	1.0	%	**10.2**	----	----	----	----	
EG005T: Total Metals by ICP-AES									
Aluminium	7429-90-5	50	mg/kg	**16400**	----	----	----	----	
Arsenic	7440-38-2	5	mg/kg	**5**	----	----	----	----	
Barium	7440-39-3	10	mg/kg	**270**	----	----	----	----	
Beryllium	7440-41-7	1	mg/kg	**1**	----	----	----	----	
Boron	7440-42-8	50	mg/kg	<50	----	----	----	----	
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----	
Chromium	7440-47-3	2	mg/kg	**12**	----	----	----	----	
Cobalt	7440-48-4	2	mg/kg	**14**	----	----	----	----	
Copper	7440-50-8	5	mg/kg	**17**	----	----	----	----	
Iron	7439-89-6	50	mg/kg	**15800**	----	----	----	----	
Lead	7439-92-1	5	mg/kg	**15**	----	----	----	----	
Manganese	7439-96-5	5	mg/kg	**873**	----	----	----	----	
Molybdenum	7439-98-7	2	mg/kg	<2	----	----	----	----	
Nickel	7440-02-0	2	mg/kg	**13**	----	----	----	----	
Selenium	7782-49-2	5	mg/kg	<5	----	----	----	----	
Vanadium	7440-62-2	5	mg/kg	**46**	----	----	----	----	
Zinc	7440-66-6	5	mg/kg	**37**	----	----	----	----	
EG020T: Total Metals by ICP-MS									
Silver	7440-22-4	0.1	mg/kg	<0.1	----	----	----	----	
Uranium	7440-61-1	0.1	mg/kg	**0.3**	----	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg	<0.1	----	----	----	----	
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg	<10	----	----	----	----	
C10 - C14 Fraction	----	50	mg/kg	<50	----	----	----	----	
C15 - C28 Fraction	----	100	mg/kg	<100	----	----	----	----	
C29 - C36 Fraction	----	100	mg/kg	<100	----	----	----	----	
^ **C10 - C36 Fraction (sum)**	----	50	mg/kg	<50	----	----	----	----	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	----	----	----	----	
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	10	mg/kg	<10	----	----	----	----	

Analytical Results

Sub-Matrix: SEDIMENT (Matrix: SOIL)				Client sample ID	UW2	----	----	----	----
				Client sampling date / time	17-Mar-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EB1807123-020	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	50	mg/kg		<50	----	----	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	----	----	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg		<0.2	----	----	----	----
Toluene	108-88-3	0.5	mg/kg		<0.5	----	----	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	----	----	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	----	----	----	----
^ **Sum of BTEX**	----	0.2	mg/kg		<0.2	----	----	----	----
^ **Total Xylenes**	----	0.5	mg/kg		<0.5	----	----	----	----
Naphthalene	91-20-3	1	mg/kg		<1	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		**107**	----	----	----	----
Toluene-D8	2037-26-5	0.2	%		**99.8**	----	----	----	----
4-Bromofluorobenzene	460-00-4	0.2	%		**100**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DR1	DA1	LW1	PW2	SGI R1
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-001	EB1807123-002	EB1807123-003	EB1807123-004	EB1807123-005
					Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		360	275	232	216	249
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		44	48	16	20	84
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		35	35	79	69	41
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		2	2	<1	<1	2
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		9	9	20	21	10
Magnesium	7439-95-4	1	mg/L		3	3	7	4	4
Sodium	7440-23-5	1	mg/L		12	12	10	14	12
Potassium	7440-09-7	1	mg/L		6	6	34	12	7
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.29	0.28	<0.01	0.08	0.42
Arsenic	7440-38-2	0.001	mg/L		0.002	0.002	0.005	0.004	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		0.003	0.002	<0.001	0.002	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		0.002	0.002	0.002	0.003	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	0.001	<0.001	0.007	0.002
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<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	0.07	0.07	<0.05
Iron	7439-89-6	0.05	mg/L		0.24	0.24	<0.05	0.07	0.35
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		5.13	4.41	0.14	1.16	4.34
Arsenic	7440-38-2	0.001	mg/L		0.003	0.002	0.006	0.004	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		0.003	0.003	<0.001	<0.001	0.003

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DR1	DA1	LW1	PW2	SGI R1
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-001	EB1807123-002	EB1807123-003	EB1807123-004	EB1807123-005
					Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.008**	**0.006**	<0.001	**0.003**	**0.006**
Cobalt	7440-48-4	0.001	mg/L		**0.002**	**0.001**	**0.001**	<0.001	**0.002**
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.004**	**0.002**	**0.004**	**0.005**
Lead	7439-92-1	0.001	mg/L		**0.002**	**0.002**	<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		**0.015**	**0.011**	<0.005	<0.005	**0.011**
Manganese	7439-96-5	0.001	mg/L		**0.088**	**0.068**	**0.177**	**0.072**	**0.220**
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		**0.02**	**0.01**	<0.01	<0.01	**0.01**
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	**0.08**	**0.07**	<0.05
Iron	7439-89-6	0.05	mg/L		**5.14**	**4.24**	**0.33**	**1.03**	**5.06**
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	**0.02**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	**0.1**	<0.1	**0.1**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	**0.04**	**0.08**	**0.04**	**0.03**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.02**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.25**	**0.25**	<0.01	<0.01	**0.09**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.25**	**0.25**	**0.02**	<0.01	**0.09**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.8**	**0.9**	**2.2**	**1.3**	**1.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DR1	DA1	LW1	PW2	SGI R1
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EB1807123-001	EB1807123-002	EB1807123-003	EB1807123-004	EB1807123-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ Total Nitrogen as N	----	0.1	mg/L		1.0	1.2	2.2	1.3	1.4
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		0.37	0.35	0.27	0.51	0.45
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		0.20	0.20	0.10	0.42	0.17
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	%		90.8	95.4	96.2	94.5	97.0
Toluene-D8	2037-26-5	2	%		94.6	96.1	95.6	95.3	97.8
4-Bromofluorobenzene	460-00-4	2	%		94.4	94.0	93.6	97.5	98.2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SGI R2	SGI R3	BC1	BC2	----
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit		EB1807123-006	EB1807123-007	EB1807123-008	EB1807123-009	--------
					Result	Result	Result	Result	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**232**	<10	**154**	**137**	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		**110**	<5	**56**	**42**	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		**41**	<1	**53**	**44**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	<1	<1	<1	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**10**	<1	**13**	**11**	----
Magnesium	7439-95-4	1	mg/L		**4**	<1	**5**	**4**	----
Sodium	7440-23-5	1	mg/L		**12**	**1**	**11**	**10**	----
Potassium	7440-09-7	1	mg/L		**7**	<1	**5**	**6**	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.31**	**0.05**	**0.56**	**0.51**	----
Arsenic	7440-38-2	0.001	mg/L		**0.002**	<0.001	**0.006**	**0.005**	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L		**0.002**	<0.001	**0.002**	**0.002**	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L		**0.002**	<0.001	**0.003**	**0.003**	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	----
Manganese	7439-96-5	0.001	mg/L		**0.002**	<0.001	**0.006**	**0.005**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L		**0.26**	<0.05	**0.57**	**0.66**	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**5.89**	<0.01	**8.12**	**2.08**	----
Arsenic	7440-38-2	0.001	mg/L		**0.004**	<0.001	**0.010**	**0.008**	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
Chromium	7440-47-3	0.001	mg/L		**0.005**	<0.001	**0.007**	**0.002**	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SGI R2	SGI R3	BC1	BC2	----
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit		EB1807123-006	EB1807123-007	EB1807123-008	EB1807123-009	--------
					Result	Result	Result	Result	----
EG020T: Total Metals by ICP-MS - Continued									
Copper	7440-50-8	0.001	mg/L		**0.007**	<0.001	**0.008**	**0.004**	----
Cobalt	7440-48-4	0.001	mg/L		**0.004**	<0.001	**0.004**	**0.003**	----
Nickel	7440-02-0	0.001	mg/L		**0.006**	<0.001	**0.008**	**0.005**	----
Lead	7439-92-1	0.001	mg/L		**0.003**	<0.001	**0.003**	**0.001**	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		**0.017**	<0.005	**0.014**	**0.007**	----
Manganese	7439-96-5	0.001	mg/L		**0.407**	<0.001	**0.562**	**0.521**	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L		**0.02**	<0.01	**0.02**	<0.01	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L		**6.84**	<0.05	**9.10**	**3.58**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<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	----
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	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Silver	7440-22-4	0.01	µg/L		**0.01**	<0.01	**0.02**	**0.01**	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	<0.1	**0.1**	**0.1**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	**0.04**	**0.06**	----
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	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.08**	**0.01**	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.08**	**0.01**	<0.01	<0.01	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.4**	<0.1	**2.0**	**1.8**	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SGI R2	SGI R3	BC1	BC2	----
				Client sampling date / time	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	17-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit		EB1807123-006	EB1807123-007	EB1807123-008	EB1807123-009	--------
					Result	Result	Result	Result	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser - Continued									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.5**	<0.1	**2.0**	**1.8**	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.45**	**0.01**	**0.57**	**0.53**	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.17**	<0.01	**0.14**	**0.18**	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	**110**	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	**110**	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**96.5**	**93.0**	**90.0**	**95.3**	----
Toluene-D8	2037-26-5	2	%		**96.4**	**97.0**	**97.1**	**96.3**	----
4-Bromofluorobenzene	460-00-4	2	%		**93.8**	**97.7**	**97.3**	**96.8**	----

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

Appendix C Fish Species of the Study Area

Agassiz's glassfish

Mouth almighty

Blue catfish

Fly-specked hardyhead

Freshwater longtom

Bony bream

Goldfish (pest species)

Carp gudgeon

Firetail gudgeon

Western carp gudgeon

Purple-spotted gudgeon

Flathead gudgeon

Sleepy cod

Eastern rainbowfish

Southern saratoga

Golden perch

Hyrtl's tandan

Mosquitofish (pest species)

Australian smelt

Barred grunter

Leathery grunter

Spangled perch

Appendix D Detailed Waterway Assessments (August 2023)

8.1 Tributary 1

8.1.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	The feature was flat and overgrown with terrestrial plants, indicating that it does not receive flows very often. Tributary 1 was immediately downstream from a constructed farm dam and would likely only receive overflow during periods of high rainfall. This feature is unlikely to sustain flows for extended periods.	
Adequate flow:	The Feature is likely to only flow during and immediately after rainfall events. Feature is immediately downstream of a constructed farm dam. Dam wall is approximately 2m high, and would only spill over in high rainfall events.	
Habitat features:	No aquatic plants present and little potential fish habitat present The feature was flat and overgrown with terrestrial plants, indicating that it does not receive flows very often. There is evidence of a pre-dam watercourse downstream of the dam and road.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.1 Determination 1 at Tributary 1 showing a) upstream, and b) downstream

8.2 Tributary 2

8.2.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Indication that the feature likely flows for at least short periods during extended rainfall, due to the presence of two pipe culverts (approximately 30 cm each), running underneath the road.	
Adequate flow:	Upstream of T2D1, the feature represents a small depression that likely channels localised flow during high rainfall events. Downstream of T2D1, the feature was non-existent. Downstream and upstream is severely limited for fish passage.	
Habitat features:	No aquatic plants or fish habitat features present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.2 Determination 1 at Tributary 2 at showing a) upstream, and b) downstream

8.3 Tributary 3

8.3.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Significant pipe culverts under road suggests feature flows hard and fast after rain but likely would not hold any water for extended periods.	
Adequate flow:	Upstream of site T3-D1, the feature represents a wide flat channel that likely pools overland flow during rainfall events. However, downstream the feature was small, narrow and overgrown by terrestrial grasses suggesting that flow, if any, is limited and highly intermittent.	
Habitat features:	No aquatic plants or fish habitat present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.3 Determination 1 at Tributary 3 showing a) upstream, and b) downstream

8.4 Tributary 4

8.4.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Located immediately downstream from a constructed farm dam and would likely only receive overflow during periods of high rainfall. This feature is unlikely to sustain flows for extended periods.	
Adequate flow:	Wide, flat drainage channel downstream from a constructed farm dam. Dam walls are about 3m high and would likely only spill over in high rainfall events.	
Habitat features:	Aquatic plants present in a flattened area directly upstream from road, which likely pools water for short periods. No fish habitat present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.4 Determination 1 at Tributary 4 showing a) upstream, and b) downstream

8.4.2 Determination 2

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Unlikely to provide extended periods of flow.	
Adequate flow:	Unlikely to provide adequate flow to sustain basic ecological processes.	
Habitat features:	No aquatic plants or fish habitat features were present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.5 Determination 2 at Tributary 4 showing a) upstream, and b) downstream

8.5 Tributary 5

8.5.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Tributary 5 located immediately downstream from a constructed farm dam and would likely only receive overflow during periods of high rainfall. This feature is unlikely to sustain flows for extended periods.	
Adequate flow:	The presence of a dam upstream and the absence of culverts and a passage under the road downstream, suggests that adequate flow and fish passage is severely limited on this feature.	
Habitat features:	Aquatic plant species *Persicaria* and *Cyperus* present, indicating water intermittently pools within areas of the channel. No fish habitat present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.6 Determination 1 at Tributary 5 showing a) upstream, and b) downstream

8.5.2 Determination 2 (UW2)

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	No evidence of an extended period of flow.	
Adequate flow:	No evidence of adequate flow.	
Habitat features:	No aquatic plants, or fish habitat present. The area surrounding the mapped feature was primarily flat pasture dominated by terrestrial grasses and weeds. The field team walked the surrounding area to find the feature, but could not find any evidence of a waterway.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.7 Determination 2 (UW2) at Tributary 5 showing a) upstream, and b) downstream

8.6 Tributary 6

8.6.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Would not flow for an extended period as there is no visible channel / feature and there is no distinction between the mapped feature and the surrounding paddocks.	
Adequate flow:	Flow not adequate to maintain aquatic ecological processes. No defined channel, riparian vegetation or aquatic plants.	
Habitat features:	Overgrown by terrestrial grass, likely channels overland flow into dam. No aquatic plants or fish habitat features, however there is likely to be fish in the dam downstream.	
Is the feature a waterway providing for fish passage?	No.	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.8 Determination 1 at Tributary 6 showing a) upstream, and b) downstream

8.6.2 Determination 2

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Does not flow for an extended period. The drainage corridor is full of terrestrial grasses and weeds, indicating a lack of extended flow.	
Adequate flow:	Small drainage feature likely channels overland flow from local catchment after heavy rainfall.	
Habitat features:	No aquatic plants or fish habitat features. Small drainage feature overgrown with terrestrial grasses and weeds.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a)

b)

Figure 8.9 Determination 2 at Tributary 6 showing a) upstream, and b) downstream

8.6.3 Determination 3

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	No feature present, and does not flow for an extended period.	
Adequate flow:	No feature present adequate to sustain basic aquatic ecological processes.	
Habitat features:	No aquatic plants or fish habitat features.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.10 Determination 3 at Tributary 6 showing a) upstream, and b) downstream

8.7 Tributary 7

8.7.1 Determination 1

Defined bed and banks:	No defined or continuous bed and banks present downstream of dam, but present upstream of dam based on desktop review.	
Extended period of flow:	Would not sustain flows for extended periods. Drainage feature likely channels localised flows and the occasional spill-over from the dam.	
Adequate flow:	Flow connectivity severely limited by an indistinct channel. Area is overgrown with terrestrial grasses and weeds.	
Habitat features:	No fish habitat present downstream but trees are characteristic of riparian vegetation. Aquatic plants present immediately upstream of road/track (*Eleocharis*).	
Is the feature a waterway providing for fish passage?	Yes – upon review of LiDAR data and DEMs, Tributary 7 is likely a waterway for fish passage.	
Low flow channel width	1 m	
Main channel width	2.8 m	
Fullbank width	5 m	
Main channel bank height	L: <1 m	R: <1 m
Fullbank bank height	L: 1 m	R: 1 m

a)

b)

Figure 8.11 Determination 1 at Tributary 7 showing a) upstream towards dam wall, and b) downstream

8.8 Tributary 8

8.8.1 Determination 1

Defined bed and banks:	Well defined, continuous bed and banks and a clear channel.	
Extended period of flow:	Evidence of sediment sorting and the presence of a yabby claw in the bed of the tributary suggests that at times, the section of Tributary 8 between T8-D1 and T8-D3 provides passage for fish and aquatic fauna from the small farm dam downstream of T8-D3.	
Adequate flow:	Obvious sections of stream where water pools, and where some sediment sorting is present during high flows.	
Habitat features:	Various aquatic plant species present, and a complex structure providing potential fish habitat present.	
Is the feature a waterway providing for fish passage?	Yes	
Low flow channel width	1 m	
Main channel width	2.5 m	
Fullbank width	30 m	
Main channel bank height	L: 1.5 m	R: 1.5 m
Fullbank bank height	L: 2.5 m	R: 3 m

b)

a)

Figure 8.12 Determination 1 at Tributary 8 showing a) upstream, b) downstream, c) sediment sorting, and d) a Yabby claw

8.8.2 Determination 2

Defined bed and banks:	Minor channel evident as per photos below.	
Extended period of flow:	The presence of a yabby claw in the bed of the tributary further upstream suggests that at times, the section of Tributary 8 between T8-D1 and T8-D3 provides passage for fish and aquatic fauna from the small farm dam downstream of T8-D3.	
Adequate flow:	Localised flow only (highly ephemeral). Road present acts as a barrier downstream.	
Habitat features:	*Eleocharis* present. Provides for fish habitat.	
Is the feature a waterway providing for fish passage?	Yes	
Low flow channel width	1.5 m	
Main channel width	3 m	
Fullbank width	20 m	
Main channel bank height	L: <1 m	R: <1 m
Fullbank bank height	L: 2 m	R: 2 m

a)

b)

Figure 8.13 Determination 2 at Tributary 8 showing a) upstream, and b) downstream

8.8.3 Determination 3

Defined bed and banks:	No defined or continuous bed and banks present but a low flow path is evident through the paddock.	
Extended period of flow:	The presence of a yabby claw in the bed of the tributary further upstream suggests that at times, the section of Tributary 8 between T8-D1 and T8-D3 provides passage for fish and aquatic fauna from the small farm dam downstream of T8-D3.	
Adequate flow:	No features present.	
Habitat features:	Potential to provide for fish passage to dam downstream of T3.	
Is the feature a waterway providing for fish passage?	Yes	
Low flow channel width	1.5 m	
Main channel width	1 m	
Fullbank width	25 m	
Main channel bank height	L: <1 m	R: <1 m
Fullbank bank height	L: 2 m	R: 2 m

a)

b)

Figure 8.14 Determination 3 at Tributary 8 showing a) upstream, and b) downstream

8.8.4 Determination 4

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Does not flow or hold water for an extended period of time. Likely acts as drainage lines for overland flow from the local catchment.	
Adequate flow:	Feature overgrown by terrestrial weeds and grasses, indicating that flow, if any, is highly intermittent.	
Habitat features:	No waterway habitat features present despite a small depression in the landscape. Does not provide for fish habitat.	
Is the feature a waterway providing for fish passage?	No. Review of aerial photography indicates that connectivity to upstream habitat is likely to occur during flood periods,	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.15 Determination 4 at Tributary 8 showing a) upstream, and b) downstream

8.8.5 Determination 5

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Does not flow or hold water for an extended period of time. Likely acts as drainage lines for overland flow from the local catchment.	
Adequate flow:	Feature overgrown by terrestrial grasses, trees and weeds indicating that flow, if any, is highly intermittent.	
Habitat features:	No waterway habitat features present despite a small depression in the landscape. Does not provide for fish habitat. Heavy disturbance from cattle present.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.16 Determination 5 at Tributary 8 showing a) upstream, and b) downstream

8.8.6 Determination 6

Defined bed and banks:	Bed and banks completely absent.	
Extended period of flow:	Does not flow for an extended period. No water present, and when present water pools and settles for short periods downstream at the baseline aquatic ecology site UW1T. Likely acts as drainage lines for overland flow from the local catchment.	
Adequate flow:	Feature overgrown by terrestrial grasses, trees and weeds indicating that flow, if any, is highly intermittent.	
Habitat features:	No aquatic plants or fish habitat features present. Does not provide for fish habitat. However, snags are present downstream at site UW1T.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.17 Determination 6 at Tributary 8 showing a) upstream, and b) downstream

8.8.7 Determination 7

Defined bed and banks:	No defined or continuous bed and banks present.	
Extended period of flow:	Does not flow for an extended period. A wide feature which likely channels shallow, localised flows after heavy rain.	
Adequate flow:	Feature overgrown by terrestrial grasses and weeds indicating that flow, if any, is highly intermittent.	
Habitat features:	No aquatic plant or fish habitat features present. Located upstream of the dam.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	N/A	
Main channel width	N/A	
Fullbank width	N/A	
Main channel bank height	L: N/A	R: N/A
Fullbank bank height	L: N/A	R: N/A

a) b)

Figure 8.18 Determination 7 at Tributary 8 showing a) upstream, and b) downstream

8.8.8 Determination 8

Defined bed and banks:	Discontinuous bed and banks present.	
Extended period of flow:	Does not flow for an extended period. Likely acts as drainage lines for overland flow from the local catchment.	
Adequate flow:	Feature overgrown by terrestrial grasses, trees and weeds indicating that flow, if any, is highly intermittent.	
Habitat features:	Minimal fish habitat features and substrate diversity. Aquatic plants present and centred around the Dam, which is located immediately upstream.	
Is the feature a waterway providing for fish passage?	No	
Low flow channel width	1.5m	
Main channel width	5m	
Fullbank width	25m	
Main channel bank height	L: <1m	R: <1m
Fullbank height	L: 1.5m	R: 1.5m

a) b)

Figure 8.19 Determination 8 at Tributary 8 showing a) upstream, and b) downstream