

EA APPLICATION SUPPORTING REPORT

SAVANNAH GOLDFIELDS LTD

Appendix 11 Receiving Environment Monitoring Program 2022-2024 (WTS, 2024)



RECEIVING ENVIRONMENT MONITORING PROGRAM 2022-2023

AGATE CREEK GOLD MINE

SAVANNAH GOLD LIMITED



AUGUST 2024



**WULGURU TECHNICAL
SERVICES**

Contact Details		
Company	Wulguru Technical Services Pty Ltd	
Project Manager	Scott Hayes-Stanley, CEnvP, MSSSI	
Email	scott@wulgurutechservices.com.au	
Mail	PO Box 2553 IDALIA QLD 4810	
ABN	79 644 301 655	

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Definitions

Term	Definition
ANZECC & ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
AUSRIVAS	Australian River Assessment System
EA	Environmental Authority
EPP	Environmental Protection Policy
LOR	Limit of Reporting
ML	Mining Lease
NATA	National Association of Testing Authorities
NRC	Northern Resource Consultants
PET	Plecoptera (stoneflies) Ephemeroptera (mayflies) Trichoptera (caddisflies); sum of taxa from these insect orders
PSD	Particle Size Distribution
QA/QC	Quality Assurance / Quality Control
QWQG	Queensland Water Quality Guidelines (DERM 2009)
REMP	Receiving Environment Monitoring Program
SIGNAL	Stream Invertebrate Grade Number Average Level
SMD	Slightly to Moderately Disturbed
SQO	Sediment Quality Objective
SSGV	Site-Specific Guideline Value
SVG	Savannah Goldfields Ltd (formerly Laneway Resources Ltd)
WQO	Water Quality Objective

1. Introduction

Wulguru Technical Services (WTS) was engaged by Savannah Goldfields Ltd (SVG) to implement the Receiving Environment Monitoring Program (REMP) for Agate Creek Gold Mine (the Site) for the 2022-2023 period. The Site operates on mining lease (ML) ML 100030 and is owned and operated by SVG (formerly Laneway Resources Ltd). The ML is located approximately 45 km south-west of Forsayth, in North Queensland and covers approximately 689 ha.

The Site currently operates under Environmental Authority (EA) EPSL03068015. Although the current EA does not stipulate the requirement for a REMP, the EA holder must comply with the 'general environmental duty'. Additionally, an EA amendment is currently in place, and it is expected that a REMP will be required for future approvals. As such, the Site has implemented a REMP. This report presents the findings of this REMP that was carried out over the 2022 late-dry season and the 2023 post-wet season.

1.1. Purpose

The purpose of this REMP report is to facilitate the 'environmental duty' of the EA holder. The report includes:

- An overview of the methodologies used during the implementation of the reporting years REMP campaign;
- A summary of the results for water quality, sediment quality, macroinvertebrate community composition, and habitat assessments;
- A detailed interpretation of the data to evaluate whether current management practices at the Agate Creek Gold Mine and the regulatory conditions likely to be imposed by an EA are effectively protecting and maintaining the environmental values of the receiving waters and associated ecosystems; and
- Provide recommendations for future REMP campaigns to ensure the program can effectively detect and mitigate against potential harm to the receiving environment.

1.2. Site Location

The Site is located 45 km south of Forsayth, on the boundary of the Einasleigh Uplands and Gulf Plains Bioregions and is north-east of Rungulla National Park (NP), and Rungulla Resource Reserve (RR) (**Figure 1**). The west of the ML is bordered by the Gregory Range and features steep sandstone escarpments and formations. The remainder of the ML is predominately undulating open woodland, with some steep undulating hills and sheltered gullies. Agate Creek flows from the south-east to the north-west of the site, dissecting the central northern section of the ML. Agate Creek is a fourth order ephemeral watercourse that flows into the Gilbert River.

Table 1. Site details

Company Name - ABN	Savannah Goldfields Ltd – 75 003 049 714
Lot on Plan	Lot 7 on SP275179 (partial) and Lot 2 on SP242983 (partial)
Mining Lease	ML 100030
Property Size	691 ha
Local Government Area	Etheridge Shire Council
Zoning Information	Rural

1.3. Background

1.3.1. Current Mining Operations

SVG commenced mining operations at Agate Creek in February 2019. Mining activities currently include the extraction of gold ore and disposal of waste rock from the Sherwood Open Cut Pit. SVG currently extracts up to 45,000 t of ore per annum. The ore is transported to the Run of Mine (ROM) where it is temporarily stockpiled before being transported to Georgetown for processing. Waste rock is transported to the Sherwood Waste Rock Dump. Other activities undertaken on site include exploration, camp facilities and a small workshop for light vehicle maintenance.

1.3.2. Existing REMP Design

The current REMP design, updated in May 2023, has been designed to assess the ecological condition of an aquatic receiving environment and determine whether current site management systems and operations are adequate to protect the environmental values of that system. As such, the REMP monitors the physical and chemical quality of water and sediments, and the biological condition of the receiving environment. This method integrates the net ecological effects of all stressors on the system. The design of the program has been undertaken to capture impacts from release locations proposed under the current environmental authority application.



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Date: 24 May 2024

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Figure 1. Project location

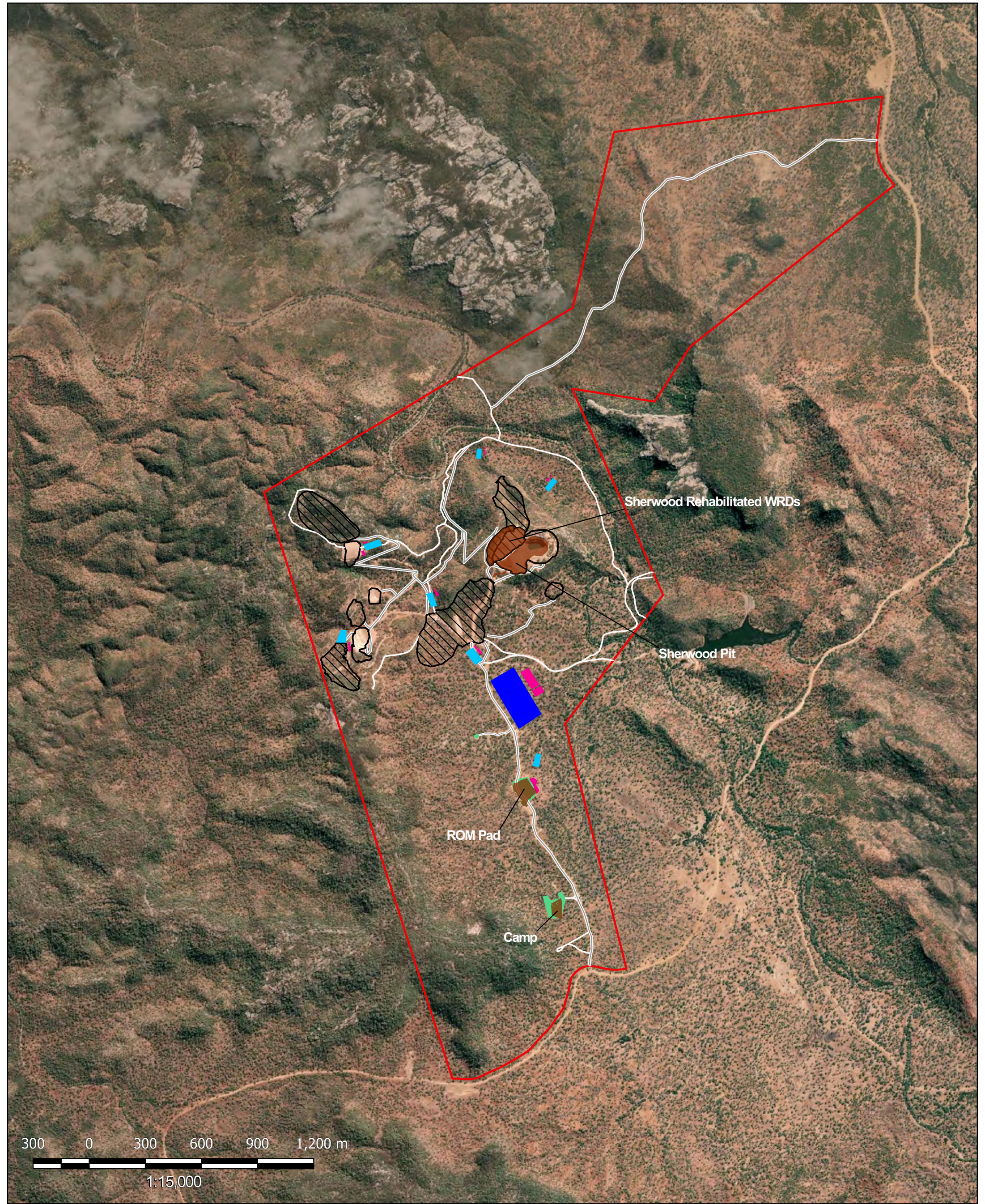
Legend

- Mining lease
- Major rivers
- Gilbert River Basin
- ESRI Satellite

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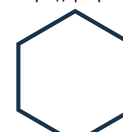
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Figure 2. Agate Creek Gold Mine layout

Legend

- | | | |
|------------------------|------------------------|-----------------|
| Mining lease | Proposed mine features | Water storage |
| Existing mine features | Infra | WRD |
| ESRI Satellite | Pit | Sediment pond |
| | Roads | Soil stockpiles |

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1.4. Legislative Context

1.4.1. Environmental Values

The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP Water) details the scheduled water quality basins and their specific management intent. The Site is in the Gilbert River Basin (Basin no. 917). Environmental values and water quality objectives have not been formally documented for the Gilbert River Basin and this region is not included in the *Queensland Water Quality Guidelines* (QWQG) (DEHP 2009), therefore national guidelines (i.e. ANZECC & ARMCANZ (2000)) are applicable.

Based on the location and surrounding land use, environmental values associated with the Gilbert River Basin are likely to be:

- aquatic ecosystems – slightly to moderately disturbed
- farm use
- stock watering (cattle)
- primary recreation
- secondary recreation
- visual recreation
- raw drinking water
- industrial
- cultural and spiritual values.

1.4.2. Water and Sediment Quality Objectives

In accordance with the updated REMP Design (WTS 2023), the WQO adopted for this reporting period are the interim Site-Specific Guideline Values (SSGV), based on all available data for surface water quality from reference sites (80th percentiles for trigger levels and 95th percentiles for contamination limits). Where there was insufficient data, the ANZECC (2000) Default Guideline Value (DGV) for the protection of 95 % species (slightly to moderately disturbed ecosystems) and/or the ANZECC (2000) WQO for livestock (cattle) drinking water were adopted.

Similarly for Sediment Quality Objectives (SQO), interim SSGV have been calculated and where there was insufficient data, the ANZECC (2000) Toxicant Default Guideline Values for Sediment Quality were adopted.

1.4.3. Macroinvertebrate Guidelines

As REMP monitoring commenced in 2021, there is insufficient data to calculate SSGV for macroinvertebrates. Therefore, the Central Coast Queensland Region, slightly to moderately disturbed waters (SMD), (DEHP 2009) freshwater macroinvertebrate guidelines have been considered for taxon richness, PET richness, SIGNAL scores and % tolerant taxa (i.e. 20th and 80th percentiles for

corresponding indices, for bed and edge habitats), for SMD waters in the Central Region (DEHP 2009) (Table 2).

Table 2. Freshwater macroinvertebrate guideline values for SMD waters in the Central Region

Index	Habitat	20 th percentile	80 th percentile
Taxa richness	Bed	12	21
	Edge	23	33
PET taxa richness	Bed	2	5
	Edge	2	5
SIGNAL2	Bed	3.33	3.85
	Edge	3.31	4.20
% tolerant taxa	Bed	25	50
	Edge	44	56

2. Methodology

All monitoring was conducted in accordance with the original Agate Creek REMP Design (WTS, 2021).

2.1. Monitoring Sites

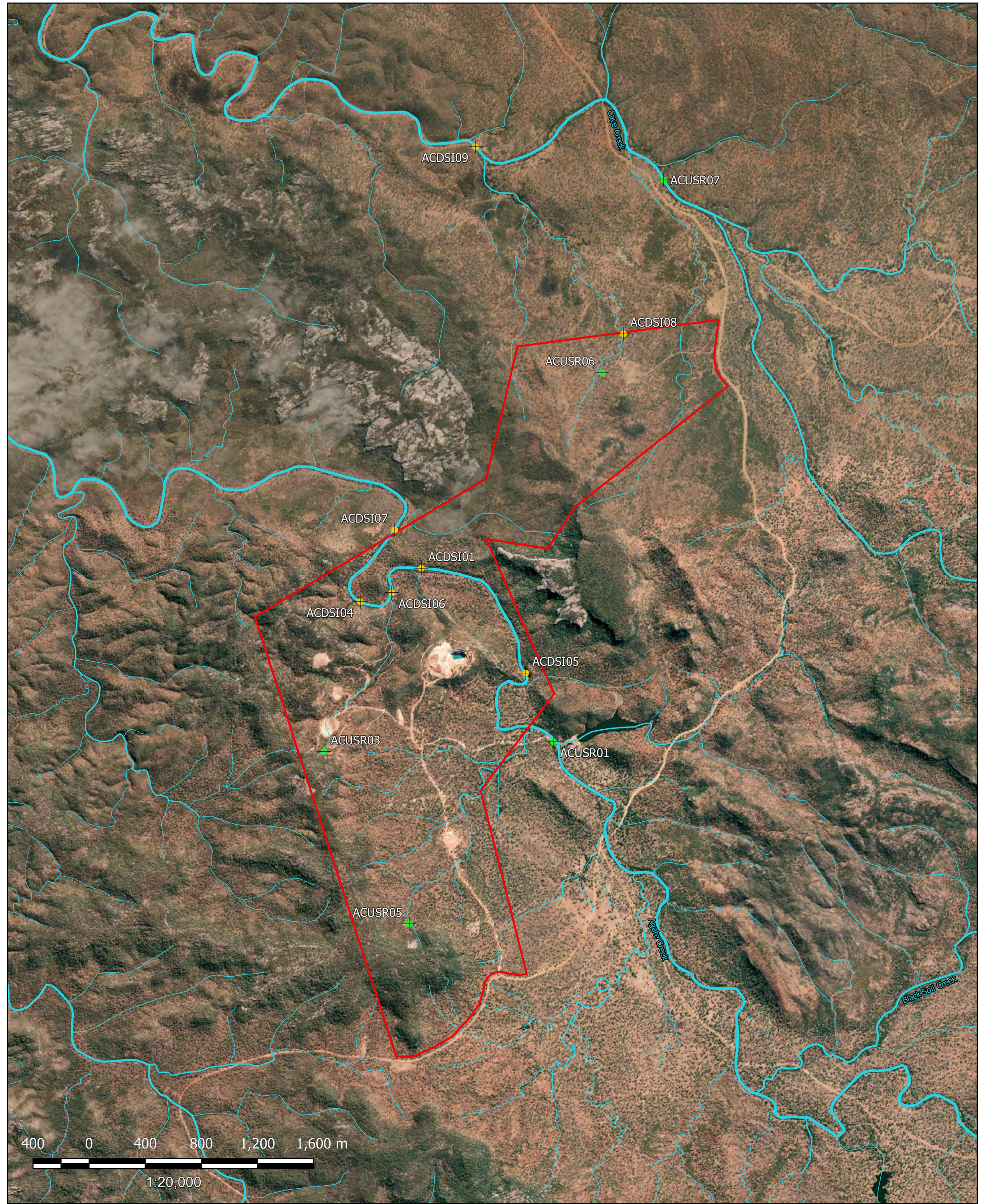
Monitoring sites upstream of mining influences were selected as reference sites and the receiving waters downstream from mining disturbance have been classified as impact sites. These sites have been established to provide a comparison with selected reference sites, which are located upstream from mining disturbance. Following the WTS recommendations from the 2022 REMP report (WTS, 2022), four monitoring sites have been removed for 2022/2023 due to poor accessibility and being dry during previous sampling periods. Sites removed include two reference sites (ACUSR02 and ACUSR04) and two impact sites (ACDSI02 and ACDSI03). Additionally, both a reference site (ACUSR07) and impact site (ACDSI09) were added for the April late wet season sampling period. The REMP Design was updated in early 2023 (i.e. after the first round of sampling) to formally document these changes (see WTS, 2023b).

The revised REMP for Agate Creek Gold Mine has a total of 12 sites (5 reference and 7 impact sites). Reference and impact sites were compared to assess the severity and extent of any contamination that may be a result of mining disturbance. REMP sites sampled in November 2022 and April 2023 are listed in **Table 2** and shown in **Figure 3**.

Sampling at reference site ACUSR01 was performed at a location downstream from the confluence of a small creek that discharges from a stock dam to the east of the ML and Agate Creek. The nominated location for this reference site was upstream of the confluence, however, to ensure the sample collected was representative of water prior to mining impact, additional impacts were to be considered.

Table 3. Description of REMP sites sampled in November 2022 and April 2023

Site Code	Latitude	Longitude	Description	Nov 2022	Apr 2023
ACUSR01	-19.00014	143.55558	Reference site. Agate Creek, (4th order), approximately 200 m upstream (outside) of ML boundary, downstream of a stock dam.	Water, Sediment, Macroinvertebrates	Water, Sediment, Macroinvertebrates
ACUSR03	-19.00081	143.540047	Reference site. Unnamed first order tributary of Agate Creek (flowing north-east), approx. 1.2 km upstream of the confluence with Agate Creek.	Sediment	Sediment
ACUSR05	-19.009669	143.547165	Reference site. Unnamed first order tributary of Agate Creek (flowing NNE), approx. 300 m upstream of the crossing along the haul road, just south of the mine camp.	Sediment	Sediment
ACUSR06	-18.975161	143.558856	Reference site. Unnamed first order tributary of Cave Creek (flowing NNE), 25m upstream (south) of the crossing along the haul road.	Sediment	Sediment
ACUSR07	-18.9621426	143.5631692	Reference site. Cave Creek (4th order), just east of Cobb Rd. (new site commencing April 2023).	NA – site added in 2023	Sediment
ACDSI01	-18.988406	143.546636	Impact site. Agate Creek (4th order), approximately 1.2 km downstream of ACUSR01.	Water, Sediment, Macroinvertebrates	Water, Sediment, Macroinvertebrates
ACDSI04	-18.990672	143.542492	Impact site. Agate Creek (4th order), approximately 3km downstream of ACUSR01, downstream of all mine operations and tributaries flowing into Agate Creek.	Sediment	Water, Sediment, Macroinvertebrates
ACDSI05	-18.995508	143.553694	Impact site. Agate Creek (4th order), approximately 1.1 km downstream of ACUSR01, downstream of Sherwood West Open Cut pit and mine camp; upstream of Sherwood Open Cut pit.	Water, Sediment, Macroinvertebrates	Water, Sediment, Macroinvertebrates
ACDSI06	-18.990053	143.544628	Impact site. Agate Creek (4th order), approximately 300 m upstream of ACDSI04, downstream of Sherwood Open Cut pit; upstream of tributaries flowing from Sherwood West Open Cut pit.	Sediment	Water, Sediment, Macroinvertebrates
ACDSI07	-18.985814	143.544825	Impact site. Agate Creek (4th order), approximately 700 m downstream of ACDSI04 (just outside ML boundary), downstream of all mine operations and tributaries flowing into Agate Creek.	Sediment	Water, Sediment, Macroinvertebrates
ACDSI08	-18.972536	143.560317	Impact site. Unnamed first order tributary of Cave Creek (flowing north-north-east), approx. 450m downstream of ACUSR06.	Sediment	Sediment
ACDSI09	-18.959996	143.55039	Impact site. Cave Creek (4th order), 1.7km downstream of ACUSR07, downstream of confluence with creeks draining north of the ML. (new site in April 2023)	NA – site added in 2023	Water, Sediment, Macroinvertebrates



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Figure 3. Agate Creek Gold Mine REMP sites 2022/2023

Legend

Mining lease

REMP sites (2022/2023)

+ Reference

+ Impact

ESRI Satellite

Watercourse - stream order

— 0

— 1

— 2

— 3

— 4

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2.2. Water Quality

2.2.1. Sampling

Water quality monitoring was undertaken in accordance with *Qld Monitoring and Sampling Manual 2009* (Department of Environment and Science, 2018). Water was sampled at all sites where sufficient surface water was present. In November 2022, three sites had surface water, including one reference (ACUSR01) and two impact (ACDSI01 and ACDSI05) sites. For April, seven surface water samples were collected including one reference (ACUSR01) and six impact (ACDSI01, ACDSI04, ACDSI05, ACDSI06, ACDSI07, ACDSI09).

All samples were collected directly from the waterbody into sample containers provided by a National Association of Testing Authorities (NATA) accredited laboratory. All sample bottles not containing preservatives were triple rinsed with water from the sample source, and samplers wore nitrile gloves when sampling to reduce the risk of contamination. Gloves were changed between sites to reduce the risk of cross-contamination.

Physico-chemical parameters and field observations were also recorded where possible, as described in **Table 4**. The water quality meter was triple rinsed with water from the sample source prior to collecting readings and calibrated before each field trip. Samples were preserved and stored according to laboratory instructions and delivered to the laboratory within the specified holding times whenever possible.

Table 4. Field readings and observations

Parameter	Units	Comment
pH		Hand-held water quality meter
Dissolved oxygen	mg/L and or % saturation	
Temperature	°C	
Electrical Conductivity (EC)	µS/cm	
Turbidity and/or Total Dissolved Solids (TDS)	FNU or ppm	
Water level	m	Maximum at deepest point
Current velocity	cm/sec	At deepest point – measured with flow meter or assigned to four-point scale (nil, <1cm/sec, 1 to 10 cm/sec or >10cm/sec)
Visible flow upstream of site	NA	Yes or No
Visible flow downstream of site	NA	Yes or No
Water surface	NA	Glassy, smooth/minor ripples, turbulent
Water colour	NA	Hue and intensity
Water clarity	NA	Record maximum depth at which bottom can be seen
Visual and olfactory anomalies	NA	Record and photograph any films, foam, slicks, unusual debris or algal blooms and any unusual odours
Weather (current and past 24 hrs)	NA	e.g. current conditions, average cloud cover over past 2 hours; rainfall in last 24 hrs

2.2.2.Laboratory Analysis

Water samples were analysed by a NATA accredited laboratory for the parameters listed in Table 5 and analysed to limits of reporting (LOR).

Table 5. Laboratory parameters for water samples

Parameter	Units
Electrical Conductivity	µS/cm
Total Dissolved Solids	mg/L
Alkalinity (Hydroxide, Carbonate, Bicarbonate and Total as CaCO ₃)	mg/L
Sulfate as SO ₄	mg/L
Chloride	mg/L
Fluoride	mg/L
Major Cations (Ca, Mg, Na, K)	mg/L
Total Anions and Cations	meq/L
Total Hardness as CaCO ₃	mg/L
Metals (Total and Dissolved; Aluminium, Arsenic, Boron, Cadmium, Chromium, Copper, Cobalt, Iron, Manganese, Mercury, Molybdenum, Nickel, Lead, Selenium, Zinc)	mg/L

2.2.3.Water Quality Objectives

Water quality was assessed against the water quality objectives provided in the *Agate Creek Gold Mine REMP Design* (WTS, 2023) (Table 6).

Table 6. Proposed interim water quality objectives (trigger and contaminant levels) for receiving waters at Agate Creek Gold Mine

Quality Characteristic	Trigger Levels (µg/L unless otherwise specified)	Contaminant Level (mg/L unless otherwise specified)
pH (pH Unit)	6.0 ⁴ (minimum) 7.5 ⁴ (maximum)	4.0 ³ (minimum) 9.0 ³ (maximum)
Dissolved Oxygen (%)	90-120 ⁴	-
Electrical Conductivity (µS/cm)	500 ¹	1000 ²
Turbidity (NTU)	80 th percentile of reference value ⁶	Reference value ⁶
Suspended Solids	80 th percentile of reference value ⁶	50 or reference value ⁶ , whichever is higher
Hardness (mg/L)	For interpretation purposes	
Sulphate (SO ₄ ²⁻)	80 th percentile of reference value ⁶	1000 ³
Chloride	80 th percentile of reference value ⁶	Reference value ⁶
Fluoride	80 th percentile of reference value ⁶	Reference value ⁶
Aluminium	55 ⁴	5 ³
Arsenic	13 ⁴	0.5 ³
Cadmium	0.2 ⁴	0.01 ³
Chromium	1	1

Quality Characteristic	Trigger Levels (µg/L unless otherwise specified)	Contaminant Level (mg/L unless otherwise specified)
Cobalt	2.8 ⁴	1 ³
Copper	1.4 ⁴	1 ³
Iron	80 th percentile of reference value ⁶	Reference value ⁶
Lead	3.4 ⁴	0.1 ³
Mercury	0.6 ⁴	0.002 ³
Molybdenum	34 ⁴	0.15 ³
Nickel	11 ⁴	1 ³
Selenium	11 ⁴	0.02 ³
Silver	0.05 ⁴	Reference value ⁶
Tin	3 ⁴	Reference value ⁶
Zinc	8 ⁴	20 ³

1 Table G4 of the Queensland Water Quality Guidelines.

2 Hart, 2008 Review of the Fitzroy River Water Quality Issues. Water Science Pty Ltd, November 2008

3 ANZECC 2000 Livestock Drinking Water Guidelines.

4 ANZECC 2000 Ecosystems (95%) moderately to slightly disturbed or DVG.

5 All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered). Trigger levels for metal/metalloids apply for dissolved results only.

6 Reference sites are defined in Table 3.

2.3. Sediment Quality

2.3.1. Sampling

Stream sediment sampling was conducted in accordance with the *Qld Monitoring and Sampling Manual 2009* (Department of Environment and Science, 2018). Sediment samples were collected from the waterbody (if water was present) or from within the main channel, for dry creek beds, and placed in containers provided by the laboratory. Samples were preserved and stored according to laboratory instructions and delivered to the laboratory within the specified holding times.

2.3.2. Laboratory Analysis

Sediment analyses were undertaken for the parameters listed in **Table 7**. Particle size distribution (PSD) analysis was also undertaken to describe the proportions of stream sediments that occurred across the sediment size classes.

Table 7. Laboratory parameters for sediment samples

Parameter	Units
Metals (Total; Antimony, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc)	mg/kg
Particle size distribution for cobble (>60mm), gravel (2-60mm), fine gravel (600-2000 µm), coarse sand (300-600 µm), fine sand (63 to 300 µm) and clay/silt (< 63 µm)*	%

* Particle size classes varied slightly between November 2022 and April 2023

2.3.2 Sediment Quality Objectives

Sediment Quality was assessed against the sediment quality objectives provided in the Agate Creek Gold Mine REMP Design (WTS, 2023) (**Table 8**).

Table 8. Proposed interim sediment quality trigger and contamination levels for receiving waters at Agate Creek Gold Mine

Parameter	Trigger Limit (mg/kg unless otherwise specified)	Contaminant Limit (mg/kg unless otherwise specified)
Arsenic	Reference value ¹ or 20 ² , whichever is higher.	70 ³ or three times the reference value ¹ , whichever is higher
Cadmium	Reference value ¹ or 1.5 ² , whichever is higher.	10 ³ or three times the reference value ¹ , whichever is higher
Cobalt	Reference value ¹	Three times the reference value ¹
Copper	Reference value ¹ or 65 ² , whichever is higher.	270 ³ or three times the reference value ¹ , whichever is higher
Lead	Reference value ¹ or 50 ² whichever is higher.	220 ³ or three times the reference value ¹ , whichever is higher
Mercury	Reference value ¹ or 0.15 ² whichever is higher.	1 ³ or three times the reference value ¹ , whichever is higher
Nickel	Reference value ¹ or 21 ² , whichever is higher.	52 ³ or three times the reference value ¹ , whichever is higher
Selenium	Reference value ¹	Three times the reference value ¹
Tin	Reference value ¹	Three times the reference value ¹
Zinc	Reference value ¹ or 200 ² , whichever is higher.	410 ³ or three times the reference value ¹ , whichever is higher

¹ Reference sites are defined in Table 3.

² ANZECC (2000) Interim Sediment Quality Guidelines – low values based on total sediments.

³ ANZECC (2000) Interim Sediment Quality Guidelines – high values based on total sediments.

2.4. Macroinvertebrates

Macroinvertebrate sampling and monitoring was conducted in accordance with *Australia-Wide Assessment of River Health: Queensland Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual* (Department of Natural Resources DNR, 2001), and following the detailed methods provided in the *REMP Design Document* (WTS 2021).

Macroinvertebrate samples were collected at all sites where surface water and appropriate habitat was present. All samples were collected with a 250 µm mesh net. A total of 10 m of habitat was sampled from a bed and an edge habitat (two samples per site). In November 2022, three sites had sufficient surface water to provide macroinvertebrate habitat. This included one reference (ACUSR01) and two impact (ACDSI01 and ACDSI05) sites. In April 2023, macroinvertebrates were sampled from seven sites, including one reference (ACUSR01) and six impact (ACDSI01, ACDSI04, ACDSI05, ACDSI06, ACDSI07, ACDSI09).

Habitat assessments, including observations regarding the stream flow, substrate, riparian zone and surrounding land use, were completed at each site. Photos were taken upstream, across channel, and downstream. Macroinvertebrate samples were preserved in the field using 70% ethanol, then

processed in the laboratory following AUSRIVAS protocols. Macroinvertebrates were identified to family level (or a lower/higher taxonomic level, as recommended by AUSRIVAS and other literature), by an AUSRIVAS accredited aquatic ecologist using a stereo microscope. The abundance of each taxon was recorded.

2.5. Data Analysis

Water and sediment quality parameters were compared against the SSGV (if available) or WQO and presented graphically for comparison between reference and impact sites, and in relation to regional macroinvertebrate guideline values (i.e. see Section 1.2.4).

The following indices were calculated from macroinvertebrate samples:

- Taxon richness;
- PET richness (i.e. richness of families from the orders Plecoptera [stoneflies], Ephemeroptera [mayflies] and Trichoptera [caddisflies]);
- Total abundance;
- SIGNAL (Stream Invertebrate Grade Number Average Level version 2, Chessman 2003); and
- % tolerant taxa (sensitive taxa are sensitivity grade 8-10; tolerant taxa are grade 1-3; % calculated is number of tolerant taxa out of the total taxa)

Comparisons of macroinvertebrate indices between reference and impact sites were analysed using permutational ANOVA (PERMANOVA). Community composition was assessed using non-metric multidimensional scaling (nMDS) to ordinate macroinvertebrate groups from biotic similarity matrices using the Bray-Curtis index for square-root transformed abundance data (Clarke and Gorley, 2015). nMDS is particularly suited for use with ecological data because it has minimal assumption regarding data distribution and normality. Differences in macroinvertebrate assemblages among a priori site types (e.g. reference versus impact) can also be tested using PERMANOVA (Clarke and Gorley, 2015). Seasonal differences were also investigated, but samples from different habitats (i.e. bed and edge) were pooled as replicates for each site, to improve the statistical power of analyses. Where differences were found in community composition, the 'Similarity Percentage' (SIMPER) analysis was run, to identify taxa contributing to the distinction between groups. Primer 7 (Version 7.0.21) was used to perform the analyses.

2.6. Quality Assurance and Quality Control

Quality Assurance and Quality Control (QA/QC) water quality samples were collected during the REMP campaign. One duplicate, laboratory blank, and field blank were collected as per recommendations specified in the *Qld Water Monitoring and Sampling Manual* (DES, 2018). One sediment duplicate sample was collected during the REMP campaign.

2.6.1. Duplicates

A duplicate sample is collected from the field at the same time as the original sample to provide an estimate of the error associated with the sampling process, environmental variability, and the laboratory

analysis processes (DES, 2018). The Relative Percent Difference (RPD) was calculated for the duplicate collected using the formula shown in **Figure 4**.

$$RPD = \frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2}\right)} \times 100$$

Where: RPD is relative percentage difference

C1 is the concentration of analyte from sample 1

C2 is the concentration of analyte from sample 2.

Figure 4. Relative Percent Difference (RPD) formula (DES, 2018)

The RPD then uses the limit of reporting (LOR) to identify thresholds for valid reproducibility. These include:

- If the mean of sample and replicate is <10x LOR: There is no RPD limit
- If the mean of sample and replicate is >10x LOR but <20x LOR: The RPD range limit is 0–50%
- If the mean of sample and replicate >20x LOR: The RPD range limit is 0-20%

2.6.2. Blanks

Rinsate blanks were collected to detect contamination from the sampling process, sample transport, or laboratory processing (DES, 2018). One laboratory blank and one field blank were collected during the sampling event.

2.6.3. Macroinvertebrates

Macroinvertebrate samples were collected and processed in the laboratory in accordance with AUSRIVAS guidelines to ensure quality control and ensure integrity of sampling procedures. Macroinvertebrates were identified by an appropriately qualified person (AUSRIVAS accredited). For every 20 samples picked and identified in the laboratory, one sample (5%) was re-identified and counted, with the percentage error recorded.

3. Results

3.1. Monitoring Restrictions

REMP assessments were undertaken twice per year in the late dry season (November 2022) and late wet season (April 2023). Ideally, macroinvertebrates should not be sampled within 4-6 weeks of a high flow event, to allow time for populations to recover and re-establish. However, the ephemeral nature of creek systems in North Queensland results in highly variable flows and hence the timing of post-wet season sampling is often restricted to a narrow period between the high-flow 'flush' and when flow ceases completely and there is insufficient water to sample. Consequently, the ideal waiting period of 4-6 weeks cannot always be achieved. In the current reporting period, mid/late-wet season sampling was undertaken on 20 and 22 of April 2023, which was ten weeks after a high-flow event following rainfall on 9 February 2023. The timing of late wet season sampling was not ideal (i.e. too long after the high-flow), but damage to the access road(s) to Agate Creek prevented staff and field crews travelling to the site in March and early April 2023. Late dry season sampling occurred between 22 -23 November 2022. As is typical for that time or year, flows were low or absent and there were no access issues.

3.2. Climate Conditions in 2022 to 2023

The closest Bureau of Meteorology Station with historical data is located at Georgetown Airport (Station ID 030124). Minimum and maximum daily temperatures in the region during the reporting period were generally close to average. Monthly rainfall was above average in the three months prior to sampling in November 2022, but there had been no significant rainfall events. Prior to sampling in April 2023, rainfall was well above average for November to February, but below average in March 2023 (**Figure 5**). The most significant rainfall event prior to wet season sampling was on the 9th of February with 92.2mm of rainfall.

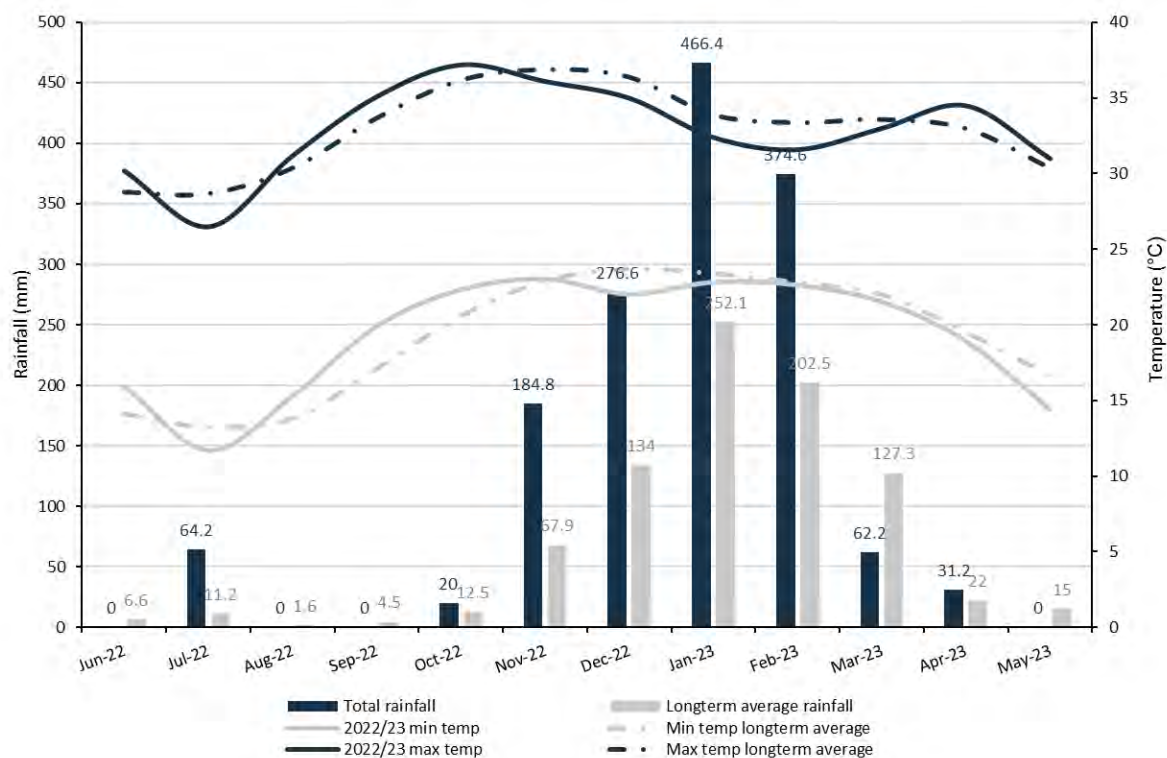


Figure 5. Minimum and maximum temperatures and monthly rainfall during the reporting period 2022 to 2023, in comparison to average conditions, at Georgetown Airport

3.3. Flow and Discharges

Flow data were not available for Agate Creek, therefore discharge information for the closest public gauging station (Gilbert River at Rockfields, approx. 115 km to the north-west) was reviewed (**Figure 6**). Based on discharge at Gilbert River, low flow levels were observed in late November 2022 and high flow events coincided with the above average rainfall in January and February 2023. Agate Creek Mine was inaccessible for several weeks due to the high flow of the Robertson River, intersecting Cobb Road Haul Road approximately 1.2km north of the ML (i.e. the main access route). There were no further high flow events in the region in the weeks immediately prior to sampling (i.e. March – early April 2023).

There were no known discharges or contaminant releases from the Agate Creek Gold Mine for the reporting period (i.e. May 2022 to April 2023).

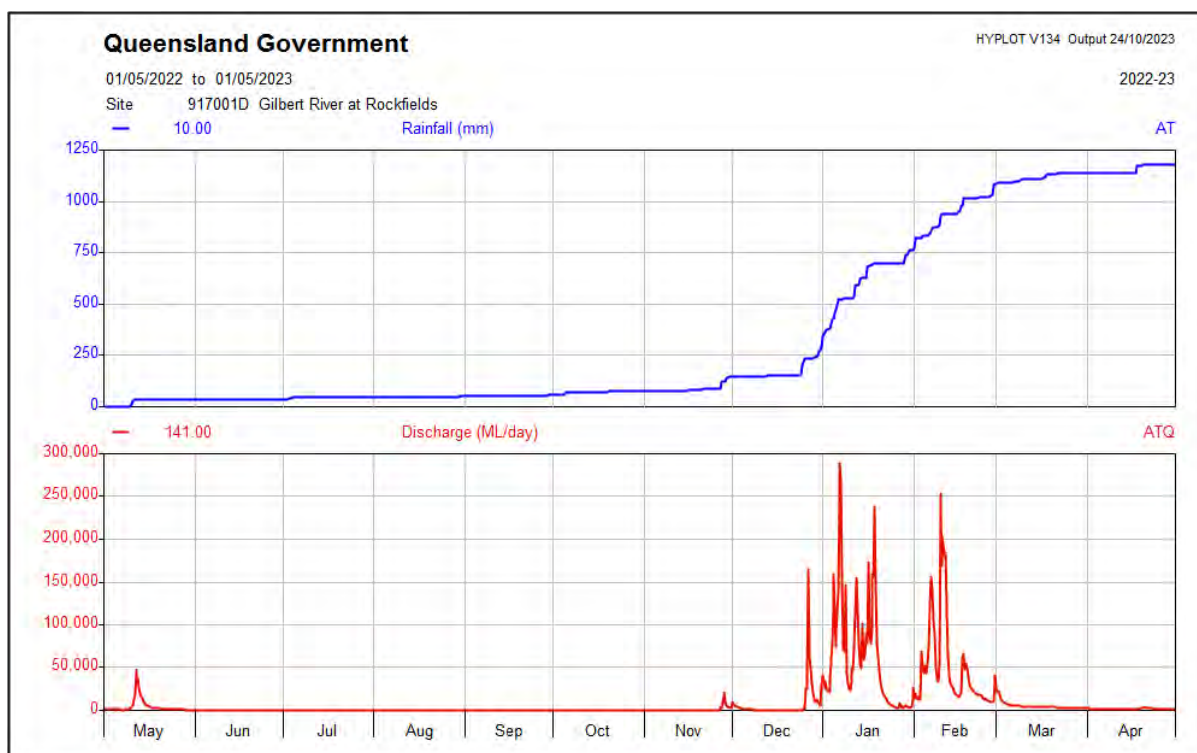


Figure 6. Stream discharge data for Gilbert River at Rockfields, for 1 May 2022 to 30 April 2023

3.4. Water Quality

3.4.1. November 2022 and April 2023

The first round of REMP sampling occurred at the end of the dry season, however there had been rainfall in the days prior. Therefore, three sites (one reference and two impact) had surface water present for water quality sampling. In the wet season, seven sites (one reference and six impact) had surface water present and were sampled. Results are presented in **Table 9** and **Table 10**.

Table 9. Results for water quality analysis - April 2023 - November 2022.

Analyte	Unit	LOR	WQO^		Reference Site		Impact Sites
			Trigger Level	Contaminant Limit	ACUSR01	ACDSI01	ACDSI05
Physico-chemical							
pH (field)	pH Unit		6.0 – 7.5	4.0 – 9.0	7.27	7.89	7.69
Temperature (Field)	°C		-	-	27.79	33.85	34.73
DO % saturation (Field)	%	0.1	90 – 120	-	18.9	25.4	17.7
Electrical Conductivity (field)	µS/cm	1	140	1000	216	243	209
Total Dissolved Solids @180°C (lab)	mg/L		4000	-	125	141	133
Total Hardness as CaCO ₃	mg/L	1	-	-	79	84	60
Sulfate	mg/L	1	ID	1000	125	141	133
Chloride	mg/L	1	ID	6	6	5	10

Analyte	Unit	LOR	WQO [^]		Reference Site		Impact Sites
			Trigger Level	Contaminant Limit	ACUSR01	ACDSI01	ACDSI05
Fluoride	mg/L	0.1	ID	0.6	0.6	0.6	2.1
Dissolved Metals/Metalloids							
Aluminium	mg/L	0.01	0.055		<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.013		0.002	<0.001	0.002
Cadmium	mg/L	0.0001	0.0002		<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.001		<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	0.0028		<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014		<0.001	<0.001	<0.001
Iron	mg/L	0.05	ID		<0.05	<0.05	<0.05
Lead	mg/L	0.001	0.0034		<0.001	<0.001	<0.001
Mercury	mg/L	0.0001	0.0006		<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	0.034		0.002	0.002	0.004
Nickel	mg/L	0.001	0.011		0.001	<0.001	0.001
Selenium	mg/L	0.01	0.011		<0.01	<0.01	<0.01
Zinc	mg/L	0.005	0.008		<0.005	<0.005	<0.005
Total Metals/Metalloids							
Aluminium	mg/L	0.01		5	0.66	0.13	0.90
Arsenic	mg/L	0.001		0.5	0.002	<0.001	0.004
Cadmium	mg/L	0.0001		0.01	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001		1	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001		1	<0.001	<0.001	0.002
Copper	mg/L	0.001		1	0.002	0.009	<0.001
Iron	mg/L	0.05		0.59	0.59	0.10	1.36
Lead	mg/L	0.001		0.1	<0.001	<0.001	0.001
Mercury	mg/L	0.0001		0.002	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001		0.15	0.001	<0.001	0.004
Nickel	mg/L	0.001		1	0.002	<0.001	0.002
Selenium	mg/L	0.01		0.02	<0.01	<0.01	<0.01
Zinc	mg/L	0.005		20	<0.005	0.006	<0.005

[^] WQO details are provided in REMP Design. Trigger level exceedance are denoted by yellow shading; contaminant limit exceedances are denoted by orange shading.

Table 10. Results for water quality analysis - April 2023

Analyte		Unit	LOR	WQO^		Reference Site ACUSR01	Impact Sites					
				Trigger Level	Contaminant Limit		ACDSI01	ACDSI04	ACDSI05	ACDSI06	ACDSI07	ACDSI09
Physico-chemical												
pH (field)		pH Unit	0.01	6.0 – 7.5	4.0 – 9.0	7.48	8.14	8.86	7.53	9.11	9.54	7.36
Temperature		°C	0.01	-	-	27.42	24.72	28.6	23.67	28.61	30.58	21.8
Electrical Conductivity (field)		µS/cm	1	140	1000	153	359	329	919	325		292
Total Dissolved Solids @180°C (lab)		mg/	10	4000	-	109	213	192	228	201	169	218
DO % saturation (field)		%	0.1	90 – 120		20.8	30.9	34.6	16.5	37.8	50.4	18.7
Total Hardness as CaCO₃		mg/L	1	-		49	129	116	125	120	92	139
Sulfate		mg/L	1	2.0	ID	<1	6	5	8	5	4	<1
Chloride		mg/L	1	9.0	ID	6	24	25	24	24	25	4
Fluoride		mg/L	0.1	1.8	ID	0.6	0.7	0.6	0.8	0.6	0.6	0.2
Dissolved Metals												
Aluminium		mg/L	0.01	0.055		0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic		mg/L	0.001	0.013		0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium		mg/L	0.0001	0.0002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium		mg/L	0.001	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt		mg/L	0.001	0.0028		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper		mg/L	0.001	0.0014		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron		mg/L	0.05	ID		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead		mg/L	0.001	0.0034		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury		mg/L	0.0001	0.0006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum		mg/L	0.001	0.034		0.004	0.001	<0.001	0.002	0.001	<0.001	<0.001
Nickel		mg/L	0.001	0.011		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Analyte		Unit	LOR	WQO [^]		Reference Site ACUSR01	Impact Sites					
				Trigger Level	Contaminant Limit		ACDSI01	ACDSI04	ACDSI05	ACDSI06	ACDSI07	ACDSI09
Selenium		mg/L	0.01	0.011		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc		mg/L	0.005	0.008		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Metals												
Aluminium		mg/L	0.01		5	0.55	0.06	0.03	0.41	0.05	0.08	0.02
Arsenic		mg/L	0.001		0.5	0.006	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Cadmium		mg/L	0.0001		0.01	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium		mg/L	0.001		1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt		mg/L	0.001		1	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper		mg/L	0.001		1	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron		mg/L	0.05		2.39	2.39	0.06	<0.05	0.47	<0.05	<0.05	0.15
Lead		mg/L	0.001		0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury		mg/L	0.0001		0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum		mg/L	0.001		0.15	0.005	0.001	0.001	0.002	0.001	0.001	<0.001
Nickel		mg/L	0.001		1	0.002	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Selenium		mg/L	0.01		0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc		mg/L	0.005		20	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

[^] WQO details are provided in REMP Design. Trigger exceedance are denoted by yellow shading; contaminant limit exceedances are denoted by orange shading.

3.5. Sediment Quality

3.5.1. November 2022 and April 2023

3.5.1.1. Particle Size Distribution

All sites were sampled for stream sediments and particle size distribution (**Figure 7** and **Figure 8**). For both seasons, finer sediment was distributed in generally the same proportions across sites between November 2022 dry season and April 2023 wet season, with fine sediments (silt-fine sand) typically comprising <30 % of stream beds. Notably, ACUSR03 had higher proportions of clay/silt across both sampling periods.

Sites were comprised of mainly coarser material (>50 % coarse sand and/or gravel) in both years (excluding ACUS03), with higher proportions of gravel in April 2023 wet season. Note that due to differences in particle sizing in lab results produced between 2022 and 2023, particle size distribution graphs are split slightly differently between years to avoid lumping together finer fractions with courser fractions. However, these graphs still allow for a general breakdown and visualization of stream bed composition at reference and impact sites between Dry and Wet season.

3.5.1.2. Sediment Chemistry

Arsenic, copper, lead, nickel and zinc were commonly detected across both the 2 mm and 63 µm fractions. Despite this, exceedances were only recorded at the reference site ACUSR03 for copper (wet season only), and nickel (**Table 11** and **Table 12**).

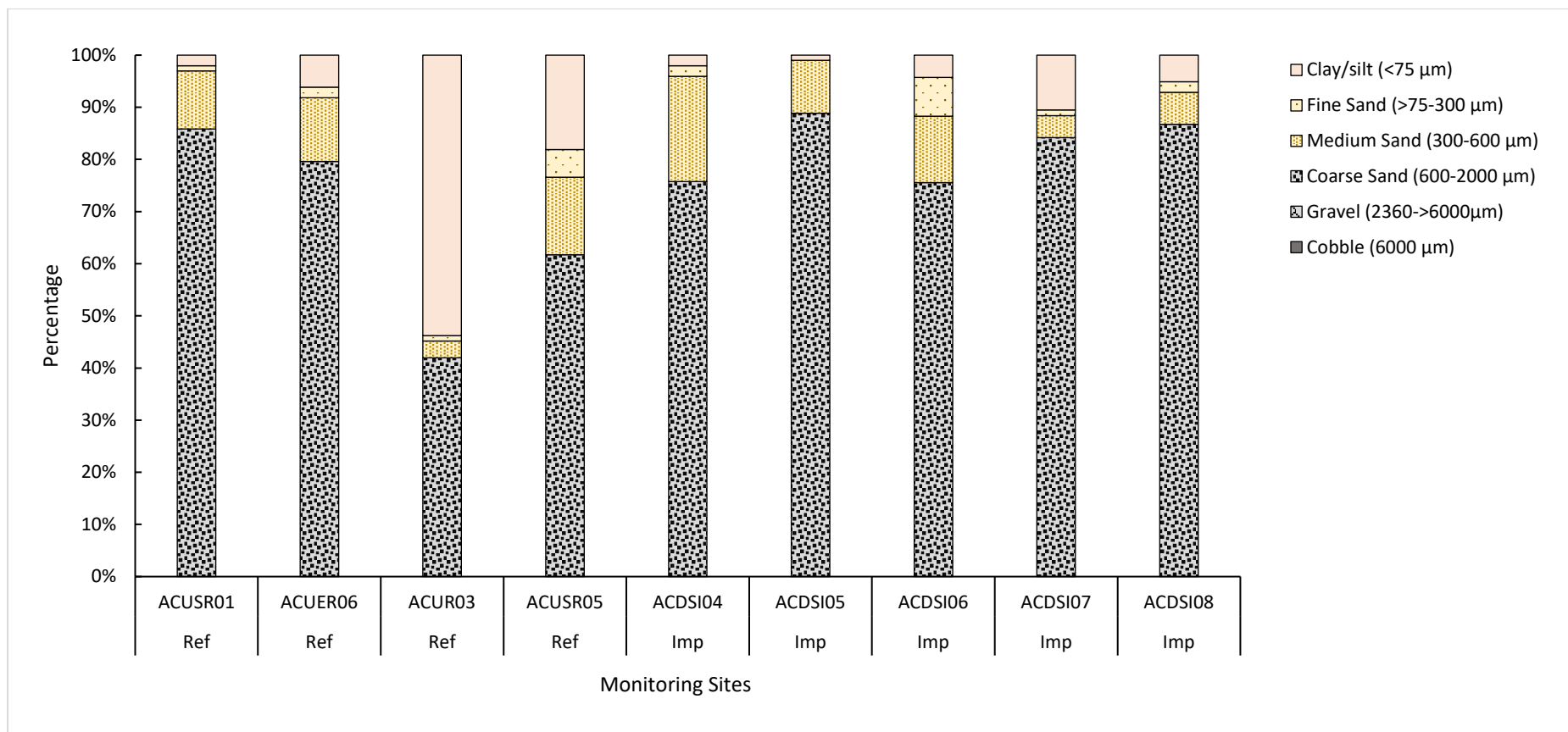


Figure 7: Particle Size Distribution for sediment samples from November 2022

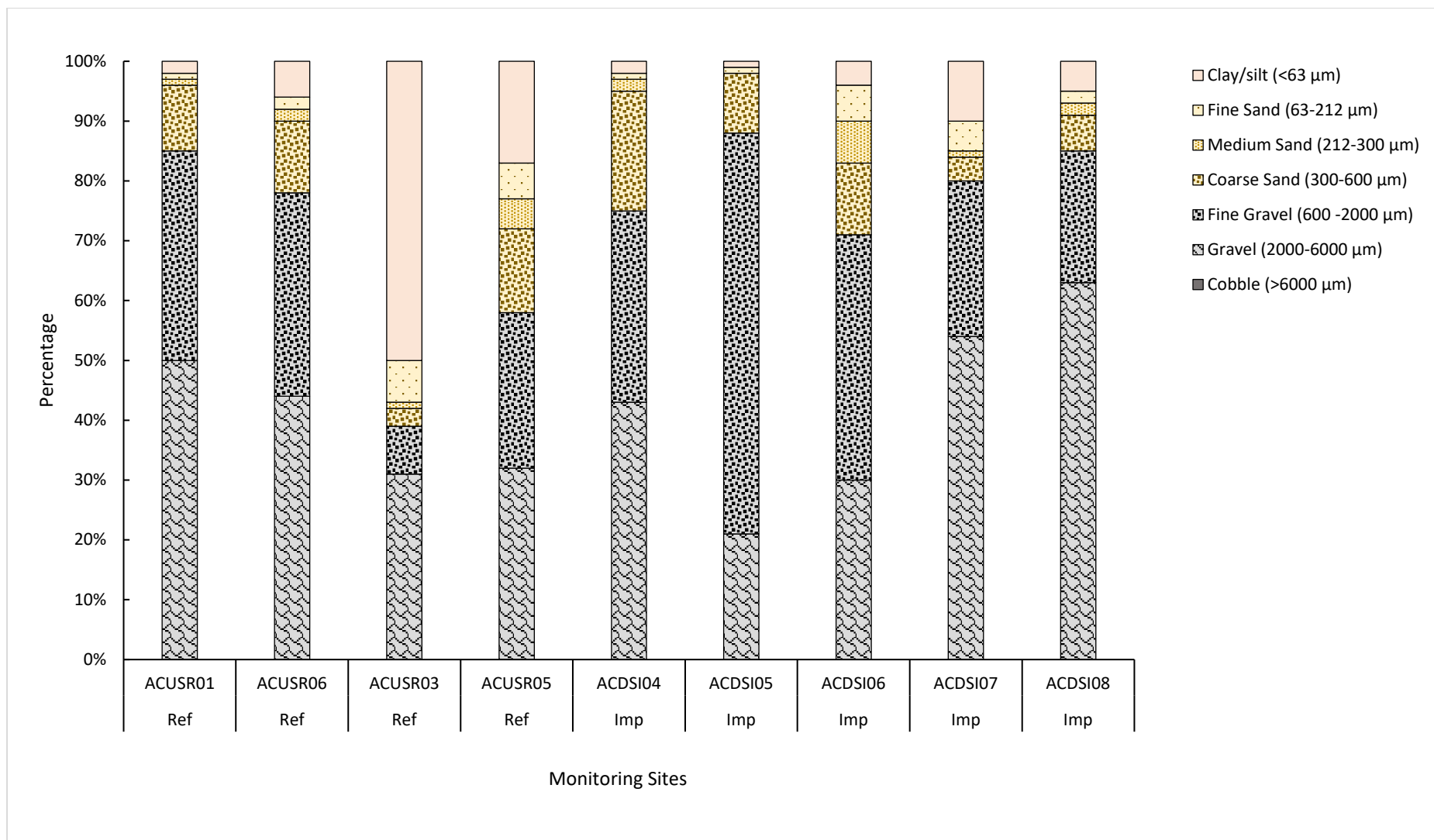


Figure 8: Particle Size Distribution for sediment samples from April 2023

Table 11: Results of sediment analysis for total metals– November 2022

Analyte		Antimony	Arsenic	Cadmium	Copper	Lead	Mercury	Nickel	Zinc
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
LOR		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5
SQO (<2mm only)		2	20	1.5	65	50	0.15	21	200
SITE	Size								
ACDSI01	<2mm	<0.1	1.5	<0.1	2.8	3.8	<0.1	4.5	12.6
	<63µm	0.3	4.1	<0.2	68.6	17.4	<0.1	28.4	147
ACDSI04	<2mm	<0.1	0.9	<0.1	2.4	2.6	<0.1	4.7	12.4
	<63µm	<0.1	2.8	<0.1	30.4	10.9	<0.1	23.3	64.6
ACDSI05	<2mm	<0.1	1.3	<0.1	2.7	4.4	<0.1	5.9	12.8
	<63µm	0.1	4	0.1	36.3	13.6	<0.1	24.1	72.8
ACDSI06	<2mm	<0.1	1.2	<0.1	3.1	4.4	<0.1	7.6	17
	<63µm	<0.1	4.4	<0.1	23.2	11.1	<0.1	24.3	57.5
ACDSI07	<2mm	<0.1	1.5	<0.1	5	5.7	<0.1	7.2	16.1
	<63µm	<0.1	2.2	<0.1	10.2	9.6	<0.1	11.3	22.6
ACDSI08	<2mm	<0.1	1.1	<0.1	3.8	3.8	<0.1	4.5	16.3
	<63µm	<0.1	3.6	<0.1	19.7	15	<0.1	13.5	43.2
ACUSR01	<2mm	<0.1	1	<0.1	2.7	4.7	<0.1	7.6	12.8
	<63µm	<0.1	2.9	0.1	32.7	14.5	<0.1	27.1	69.4
ACUSR03	<2mm	0.1	0.8	<0.1	55.6	4.4	<0.1	59.5	37.5
	<63µm	0.1	1.4	<0.1	49.8	3.7	<0.1	42.5	28.1
ACUSR05	<2mm	<0.1	0.5	<0.1	7.1	9.4	<0.1	7.5	37.5
	<63µm	<0.1	1.2	<0.1	12.8	7.6	<0.1	7.6	38.2
ACUSR06	<2mm	0.1	1.9	<0.1	5.4	4.9	<0.1	7.1	31.7
	<63µm	0.1	8.4	<0.1	21.7	25.7	<0.1	15.8	95.9

Exceedances of SQO (ANZECC 2000 Sediment Default Guideline Values) are denoted by yellow highlighting.

Table 12. Results of sediment analysis for total metals – April 2022

Analyte		Antimony	Arsenic	Cadmium	Copper	Lead	Mercury	Nickel	Zinc
Unit		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
LOR		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5
SQO (<2mm only)		2	20	1.5	65	50	0.15	21	200
SITE	Size								
ACDSI01	<2mm	<5	<5	<1	<5	<5	<0.1	7	17
	<63µm	<5	5	<1	15	10	<0.1	22	51
ACDSI04	<2mm	<5	<5	<1	5	<5	<0.1	10	23
	<63µm	<5	7	<1	18	9	<0.1	22	45
ACDSI05	<2mm	<5	<5	<1	<5	<5	<0.1	8	18
	<63µm	<5	7	<1	17	10	<0.1	21	62
ACDSI06	<2mm	<5	<5	<1	<5	5	<0.1	8	20
	<63µm	<5	7	<1	28	10	<0.1	27	28
ACDSI07	<2mm	<5	<5	<1	<5	<5	<0.1	8	20
	<63µm	<5	6	<1	24	9	<0.1	26	60
ACDSI08	<2mm	<5	<5	<1	6	8	<0.1	7	21
	<63µm	<5	12	<1	28	13	<0.1	16	60
ACDSI09	<2mm	<5	<5	<1	<5	5	<0.1	5	13
	<63µm	<5	7	<1	32	15	<0.1	17	61
ACUSR01	<2mm	<5	<5	<1	<5	<5	<0.1	7	19
	<63µm	<5	16	<1	16	12	<0.1	24	55
ACUSR03	<2mm	<5	<5	<1	76	6	<0.1	57	56
	<63µm	<5	12	<1	71	<5	<0.1	50	46
ACUSR05	<2mm	<5	9	<1	9	8	<0.1	9	39
	<63µm	<5	<5	<1	22	10	<0.1	11	52
ACUSR06	<2mm	<5	5	<1	7	7	<0.1	9	35
	<63µm	<5	15	<1	43	19	<0.1	19	91
ACUSR07	<2mm	<5	<5	<1	<5	<5	<0.1	3	10
	<63µm	<5	7	<1	29	11	<0.1	17	69

Exceedances of SQO (ANZECC 2000 Sediment Default Guideline Values) are denoted by yellow highlighting.

3.6. Macroinvertebrates

3.6.1. Overview

For November 2022, three sites contained suitable habitat for macroinvertebrate sampling: ACUSR01, ACDSI01, and ACDSI05. In April 2023, seven sites were sampled (ACUSR01, ACDSI01, ACDSI04, ACDSI05, ACDSI06, ACDSI07 and ACDSI09). As per AUSRIVAS guidelines, a bed and an edge sample were collected at each site, where possible. At one site in April 2023 (ACDSI09), there was insufficient distinct bed and edge habitat, therefore two replication 'combined' samples were collected.

3.6.1.1. November 2022

A total of 1671 individual macroinvertebrates from 32 taxa were recorded at from samples collected in November 2022 (see Table 17 in Appendix B). The most diverse group was insects with 25 taxa (dipterans – 9 taxa; hemipterans – 6 families; coleopterans– 4 families; ephemeropterans and odonatans – 2 families each; and 1 trichopteran and lepidopteran). There were also oligochaete worms, snails from families Lymnaeidae and Planorbidae, three crustacean taxa (ostracods, copepods and a parathelphusid crab), and water mites (Hydracarina) recorded.

More taxa and total individuals were recorded in the edge than the bed samples. The most abundant taxa in bed samples were planorbid snails, which represented 40 % of all individuals. Chironomids (from 2 subfamilies) were also relatively abundant (23 %), along with ephemeropterans (2 families) (22 %). The next most abundant group were hemipteran (6 families, 6 %) and all other groups were less abundant, and each represented less than 5 % of the total abundance in the bed samples. The relative abundance of taxa was different in edge samples, with chironomids (2 subfamilies) the dominant group (46 %), followed by planorbid snails (19 %), coleopterans (4 families, 13 %) and ephemeropterans (2 families, 11 %) and other dipterans (4 families, 5 %). All other groups each represented less than 5 % of the total abundance in edge samples (**Figure 9**, **Figure 10** below and **Table 15** in Appendix B).

3.6.1.2. April 2023

A total of 4070 individual macroinvertebrates from 46 taxa were recorded from samples collected in November 2022 (**Table 16** in Appendix B). The most diverse group was insects with 39 taxa (coleopterans – 9 taxa; dipterans – 8 taxa, hemipterans – 7 families; trichopterans – 6 families, odonatans – 5 families; ephemeropterans – 3 families; and 1 lepidopteran). There were also oligochaete worms, snails from families Lymnaeidae and Planorbidae, three crustacean taxa (ostracods, copepods and a palmonid prawn), and water mites (Hydracarina) recorded.

More taxa and total individuals were recorded in the edge/combined samples than the bed samples. The most abundant taxa in bed samples were caenid ephemeropterans, which represented 35 % of all individuals. Trichopterans (from 6 families) were also relatively abundant (10%). All other groups were less abundant, and each represented less than 5 % of the total abundance in the bed samples. The relative abundance of taxa was different in edge samples, with coleopterans (9 families) the dominant

group (26 %), followed by ephemeropteran (2 families, 18 %), chironomids (3 subfamilies, 17%) and odonatans (5 families, 8 %). All other groups each represented less than 5 % of the total abundance in edge/combined samples (**Figure 11**, **Figure 12** below and **Table 16** in Appendix B).

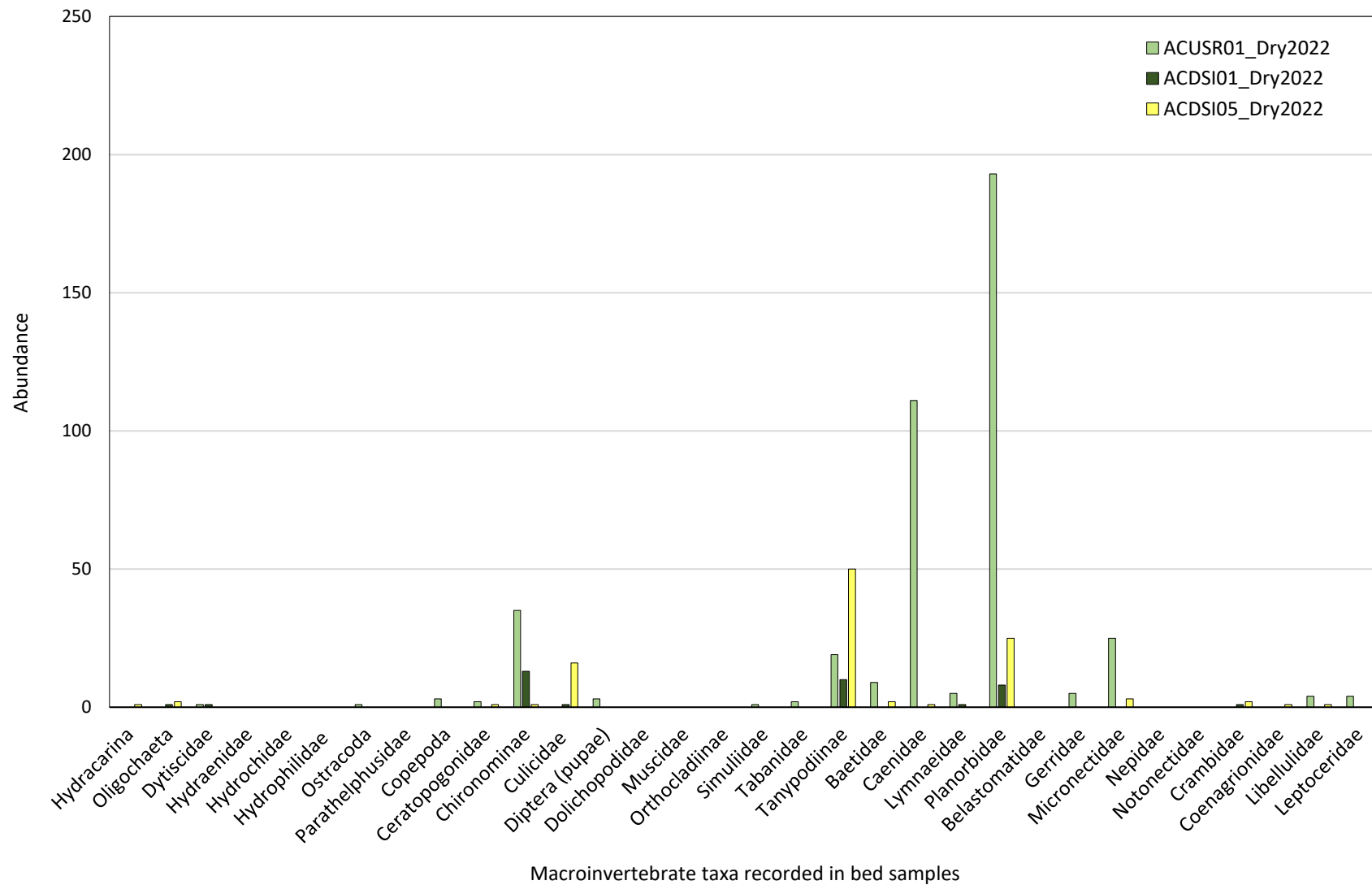


Figure 9. Abundance of macroinvertebrate taxa in bed samples in November 2022

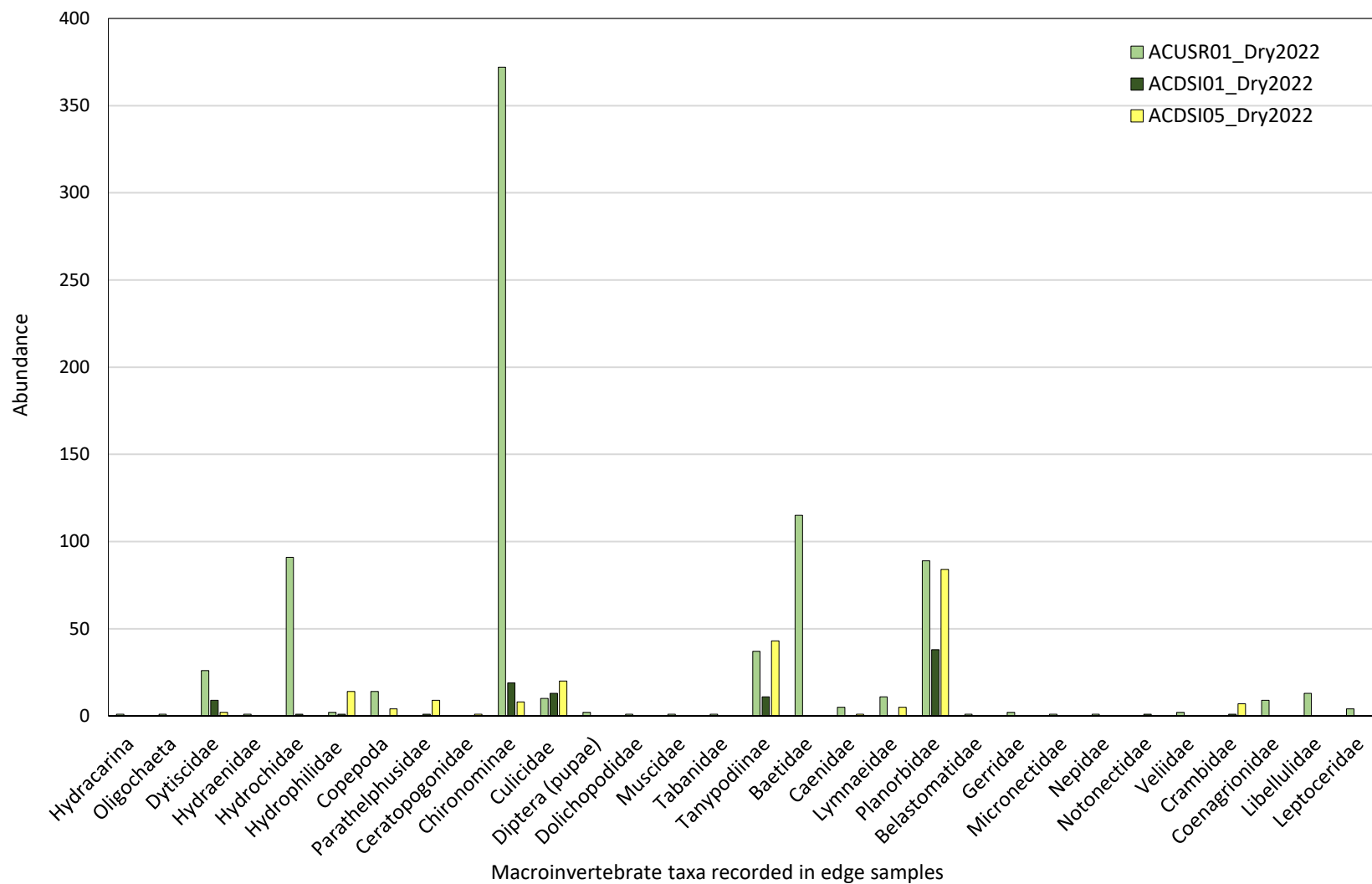


Figure 10. Abundance of macroinvertebrate taxa in edge samples in November 2022

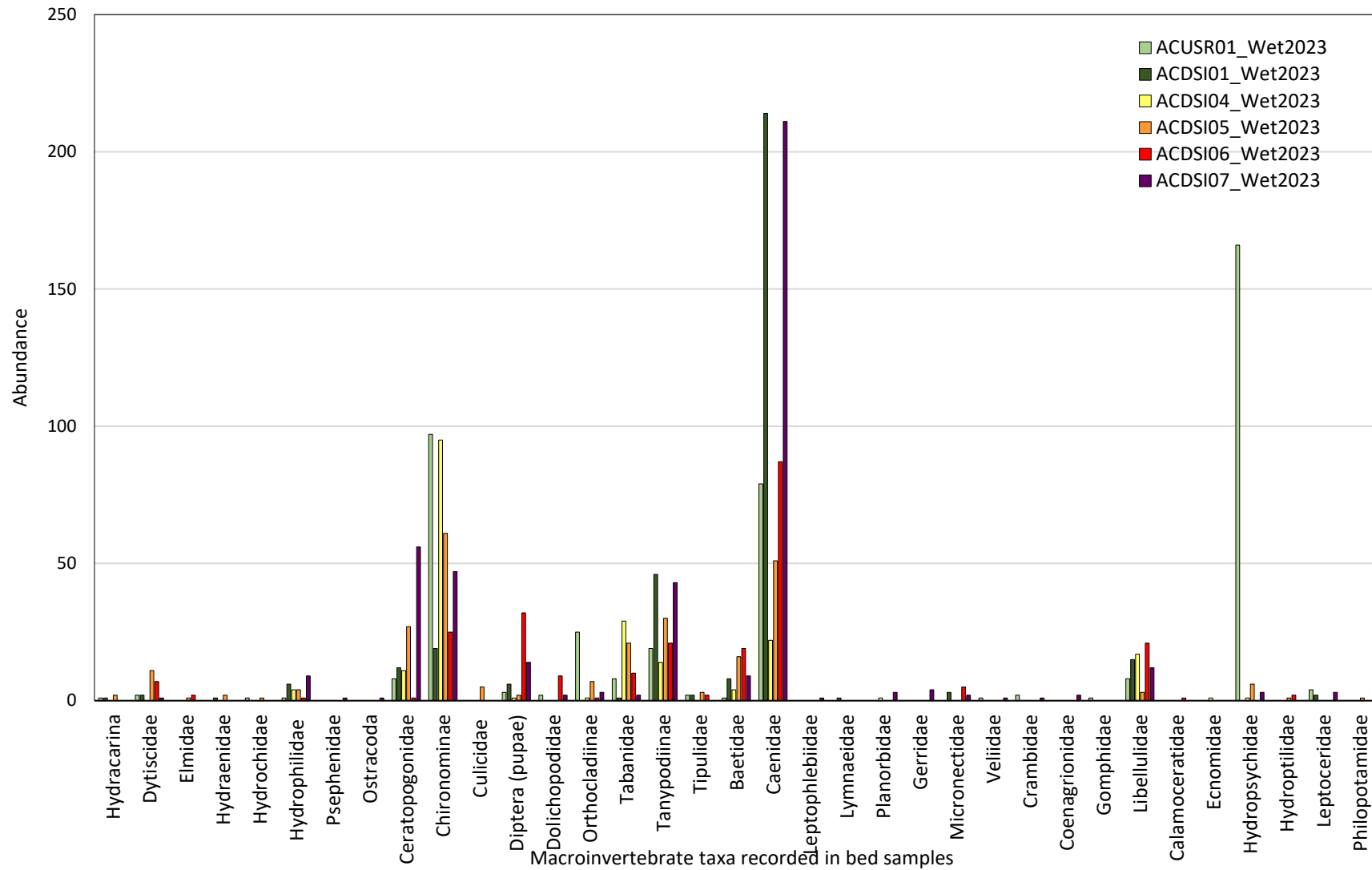


Figure 11. Abundance of macroinvertebrate taxa in bed samples in April 2023

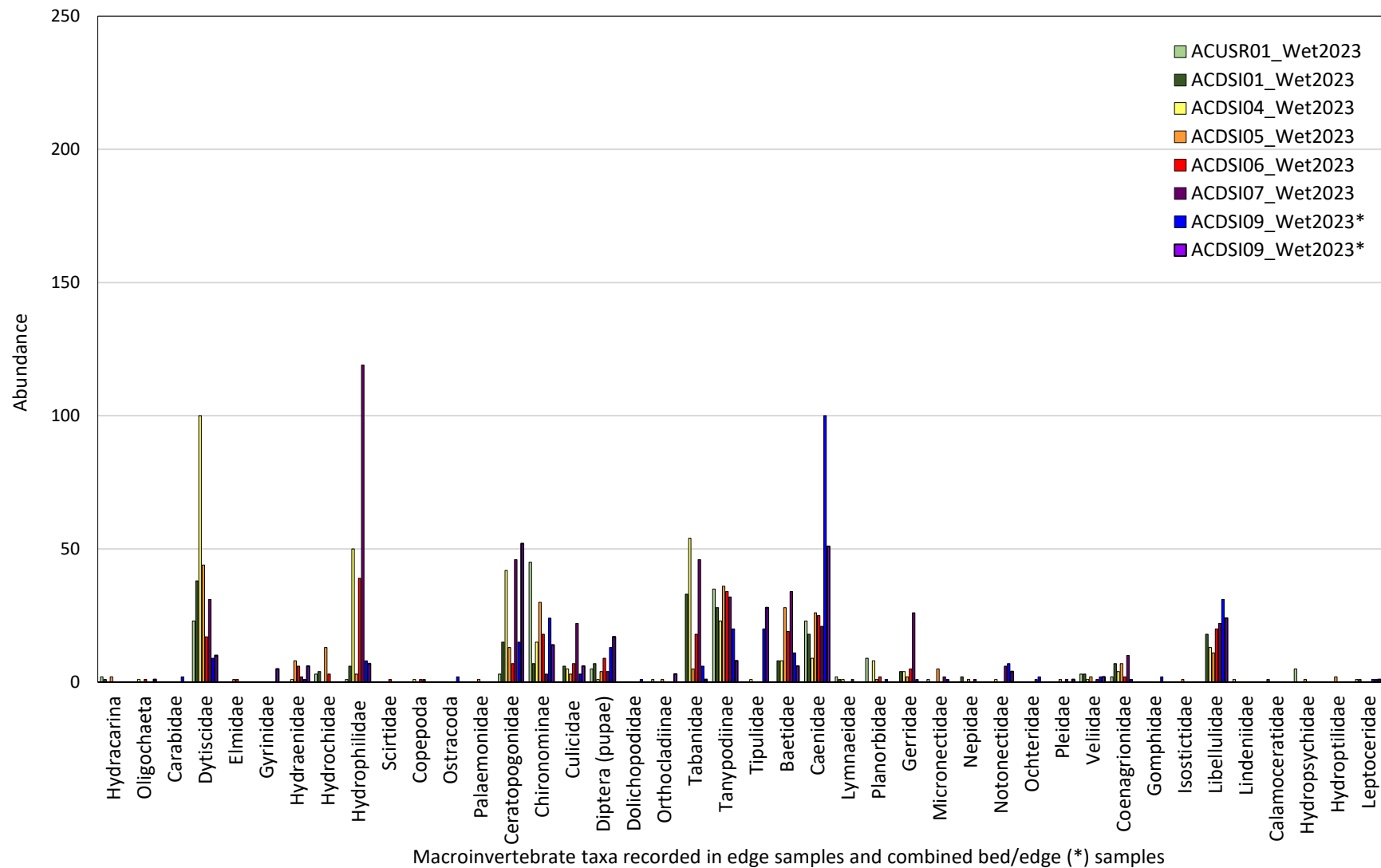


Figure 12. Abundance of macroinvertebrate taxa in edge and combined samples in April 2023

3.6.2. Habitat Assessment Scores

Habitat assessment scores were recorded at sites where macroinvertebrates were sampled in November 2022 and April 2023. In November 2022, scores ranged between 41 at impact site ACDSI05 to 50 at impact site ACUSR01. All sites were attributed a rating of 'Fair' (**Table 13** and detailed results are provided in Appendix B). In April 2023, scores were higher across all sites and ranged from 47 at impact site ACDSI09 to 84 at impact site ACDSI05. The single reference site scored 74 (Good). Ratings at impact sites were 'Good' for 2 sites and 'Fair' for 3 sites. These ratings were related to the ephemeral nature of the creeks in the local environment, and notably the low variety of flow habitats and substrate types in the dry season (observed at reference and impact sites). Flow was nil or very low at all sites in November 2022, with areas of stagnant water. Conditions were more varied in April 2023, with most sites with water still flowing (slowly). Minor grazing impact was also noted at most sites in both seasons, and some damage to riparian trees in April 2023, likely from flood/ high flow conditions that occurred in February 2023.

Table 13. Macroinvertebrate habitat assessment scores at sites sampled in November 2022 and April 2023

Site	November 2022		April 2023	
	Habitat Assessment Score	Rating	Habitat Assessment Score	Rating
Reference Sites				
ACUSR01	50	Fair	74	Good
Impact Sites				
ACDSI01	43	Fair	72	Good
ACDSI04	-	-	63	Good
ACDSI05	41	Fair	84	Good
ACDSI06	-	-	54	Fair
ACDSI07	-	-	51	Fair
ACDSI09	-	-	47	Fair

3.6.3. Macroinvertebrate Indices

The macroinvertebrate indices calculated (taxon richness, total abundance, PET richness, SIGNAL scores and % tolerant taxa) are presented graphically in **Figure 13** to **Figure 17**. The assessment of indices was undertaken with bed and edge samples pooled as site replicates, to improve statistical power. For macroinvertebrate guideline values (GV) (i.e. 20th and 80th percentiles for various diversity indices, for SMD waters in the Central Region; EHP 2009), where the values of percentiles differed between bed and edge habitats, the lower value was adopted for 20th percentiles and higher value was adopted for 80th percentiles. GV have been included in **Figure 13** to **Figure 17**. Results of statistical

analyses testing differences between reference and impact sites (pooled for habitat) and season are provided in Appendix D and trends for each index are reported below.

3.6.3.1. Taxon Richness

The highest mean taxon richness (205) was recorded in reference site samples in the dry season and the lowest mean taxon richness was in impact site samples in the dry season (10.8) (**Figure 13**). Statistical analysis did not find any significant difference in taxon richness between season ($p > 0.05$), however, there was a significant interaction between type and season ($p < 0.05$). This result is reflected in **Figure 13**, which shows that taxon richness was higher for reference site samples than impact site samples in the dry season, but not the wet season (**Table 17**, Appendix D). Taxon richness was above the 20th percentile GV in samples from all types/surveys except for impact sites in the dry season.

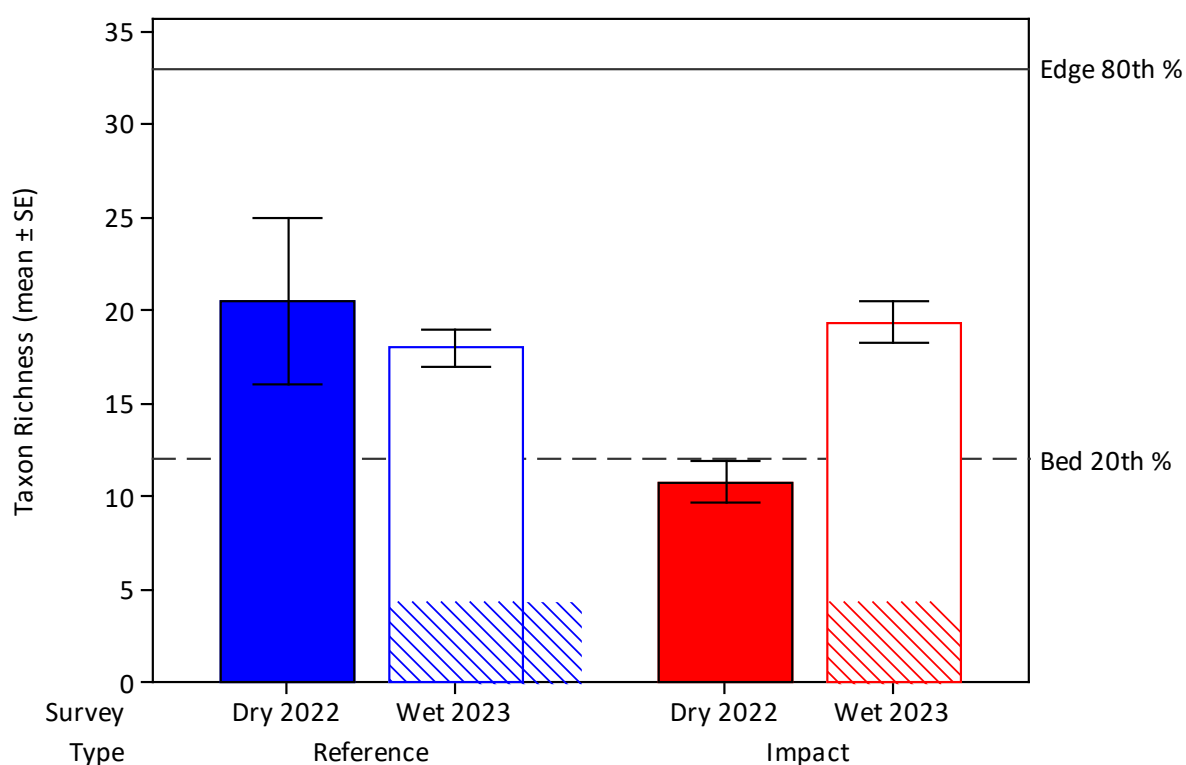


Figure 13. Taxon richness of macroinvertebrates (mean $\pm$ SE) at reference and impact sites, for both seasons 2022-23

3.6.3.2. PET Richness

The highest mean PET richness (3.5) was recorded in the wet season at reference and impact site samples, and the lowest was in dry season impact site samples (0.75) (**Figure 14**). Statistical analysis did not find any significant difference in PET richness between reference and impact sites ($p > 0.05$); however, PET richness was lower in the dry season than the wet season ($p < 0.05$). The interaction between type and season was not significant ($p > 0.05$) (**Table 17**, Appendix D). Mean PET richness

was above the 20th percentile GV in samples from all types/surveys except for impact sites in the dry season.

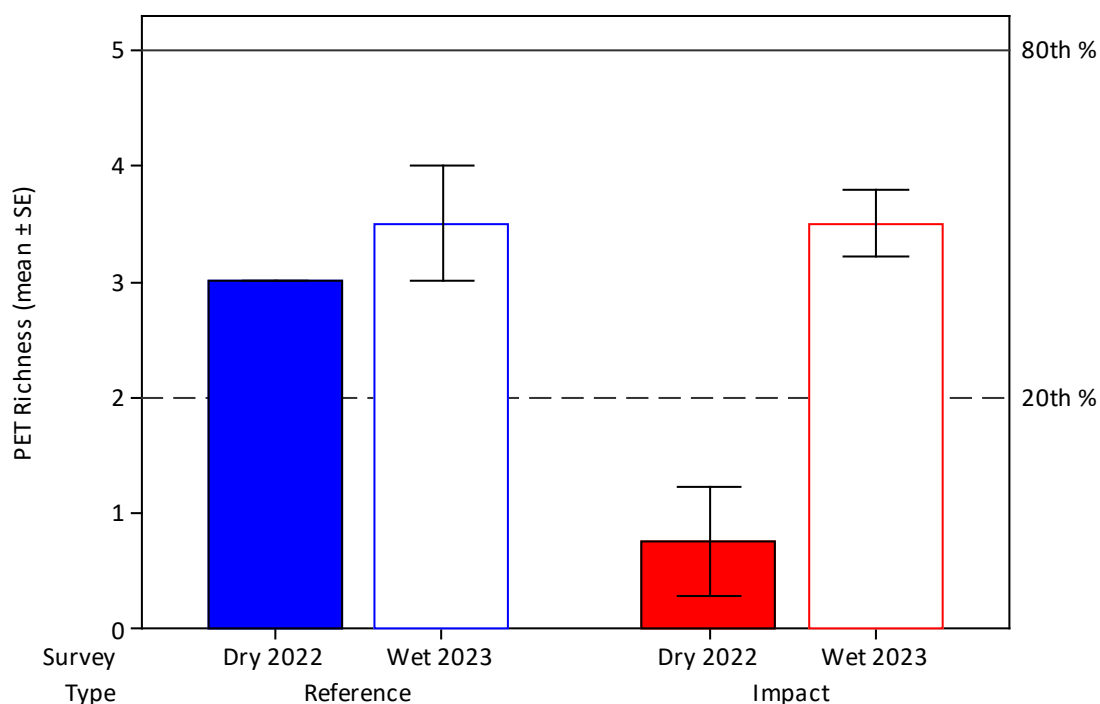


Figure 14. PET richness of macroinvertebrates (mean ± SE) at reference and impact sites, for both seasons 2022-23

3.6.3.3. Total Abundance

The highest mean total abundance (618) was recorded in the dry season in reference site samples, and the lowest was in dry season impact site samples (109) (**Figure 15**). Statistical analysis did not find any significant difference in total abundance between season ($p > 0.05$), however there was a significant interaction between type and season ($p < 0.05$) (**Table 17**, Appendix D). This result is reflected in **Figure 15**, which shows that total abundance was higher for reference site samples than impact site samples in the dry season, but not the wet season.

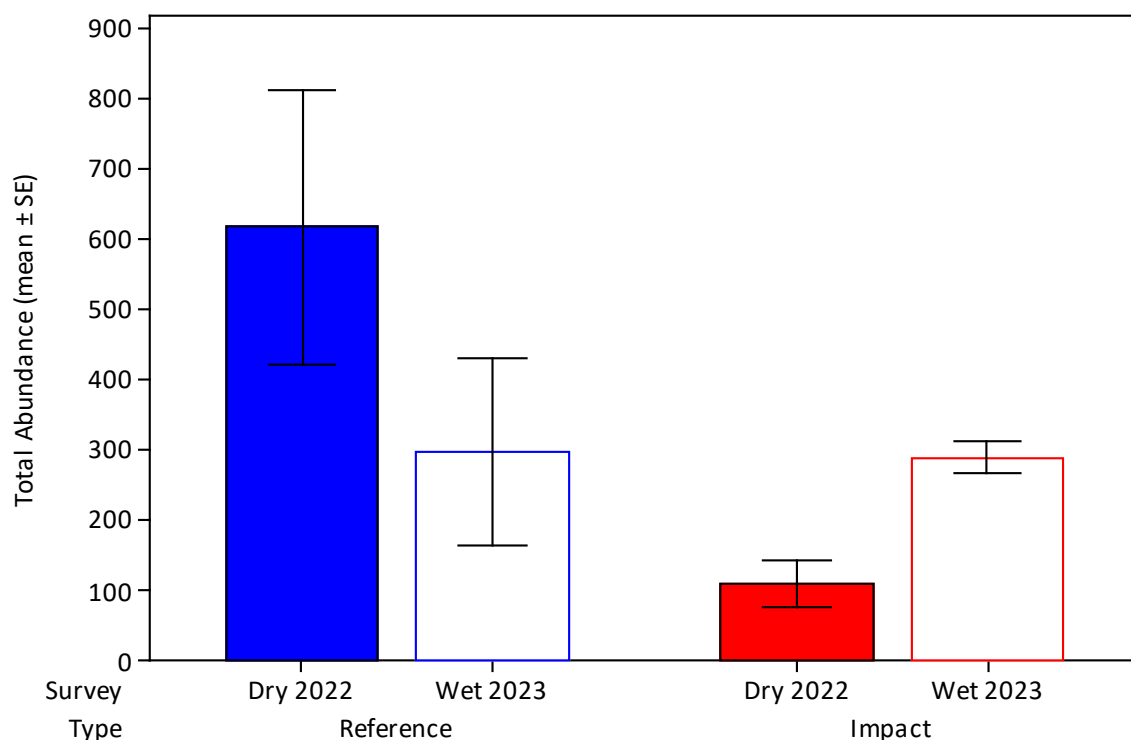


Figure 15. Total abundance of macroinvertebrates (mean $\pm$ SE) at reference and impact sites, for both seasons 2022-23

3.6.3.4. SIGNAL Scores

The highest mean SIGNAL score (3.7) was recorded in the dry season in reference site samples, and the lowest was in dry season impact site samples (2.6) (**Figure 16**). Statistical analysis found significant differences in SIGNAL scores between site types and season ($p < 0.05$); the interaction between type and season was not significant ($p > 0.05$) (**Table 17**, Appendix D). This result is reflected in **Figure 16**, which shows that SIGNAL scores were higher for reference site samples than impact site samples, and higher in the wet season than the dry season. Mean SIGNAL scores were above the 20th percentile GV in samples from all types/surveys except for impact sites in the dry season.

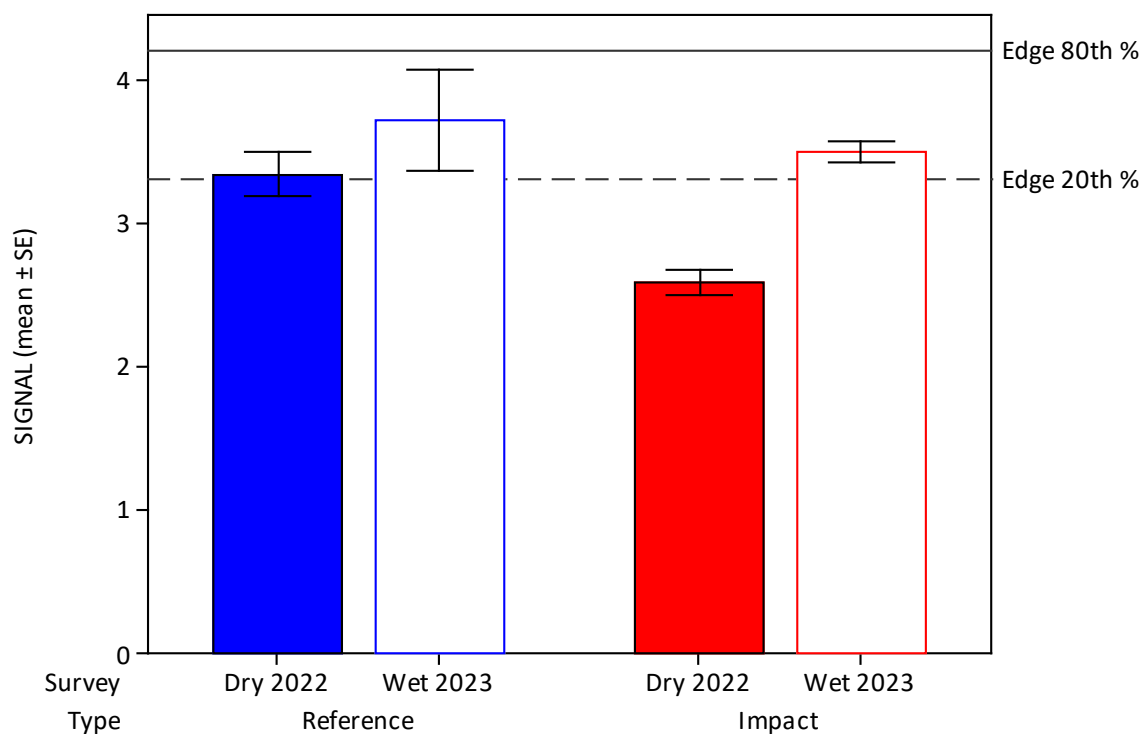


Figure 16. SIGNAL scores (mean ± SE) at reference and impact sites, for both seasons 2022-23

3.6.3.5. Percentage Tolerant Taxa

The highest mean percentage of tolerant taxa (72) was recorded in the dry season in impact site samples, and the lowest was in wet season reference site samples (45) (**Figure 17**). Statistical analysis found no significant differences in percentage of tolerant taxa between site types nor season ($p > 0.05$); the interaction between type and season was also not significant ($p > 0.05$) (**Table 17**, Appendix D). This result is reflected in **Figure 17**, which show that SIGNAL scores were higher for reference site samples than impact site samples, and higher in the wet season than the dry season. Mean percentage of tolerant taxa was below the 80th percentile GV in samples from all types/surveys except for impact sites in the dry season.

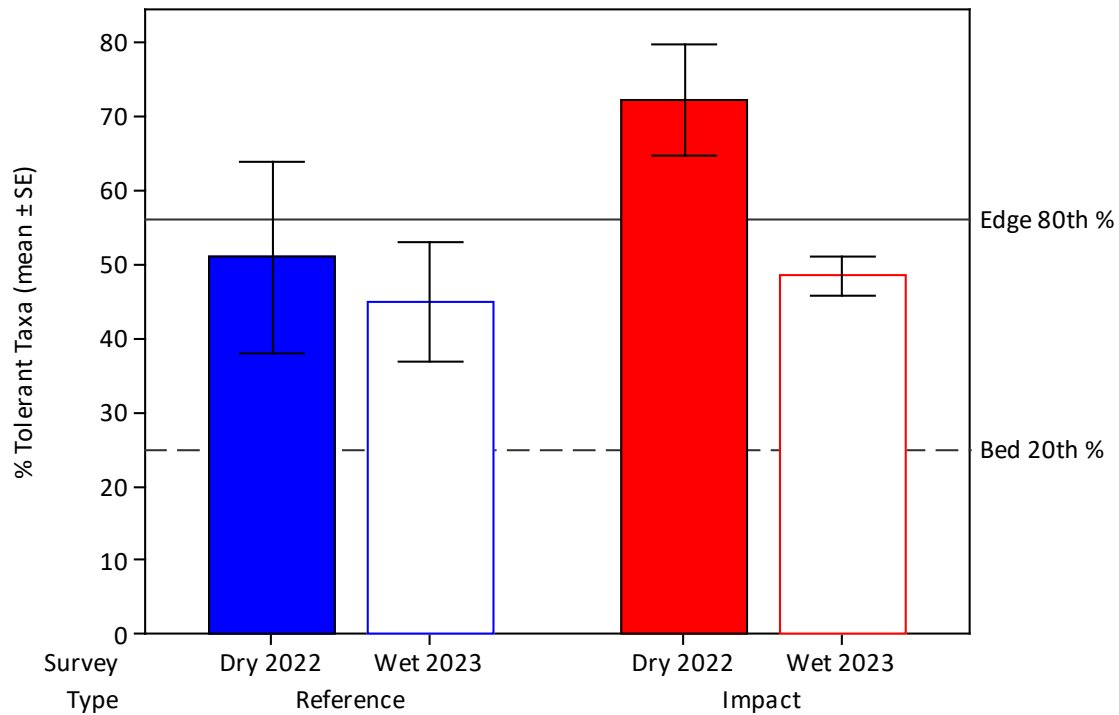


Figure 17. Percentage of tolerant taxa (mean $\pm$ SE) at reference and impact sites, for both seasons 2022-23

3.6.4. Community Composition

Graphical analysis of macroinvertebrate community composition is presented in Figure 18, in the form of an ordination plot. There was some clustering evident in relation to site type but there also appeared to be a strong seasonal influence (i.e. for the dry season samples, reference and impact samples were clearly separated in two-dimensional space, whereas in the wet season, samples were closer together). Statistical analysis using PERMANOVA statistically significant differences in composition between reference and impact sites, seasons and for the interaction term ($p < 0.05$) (**Table 17**, Appendix D). Pair-wise follow-up test results in are shown in **Table 18** (Appendix D). These tests found that community composition was significantly different between reference and impact sites in the 2023 wet season, but not for the 2022 dry season.

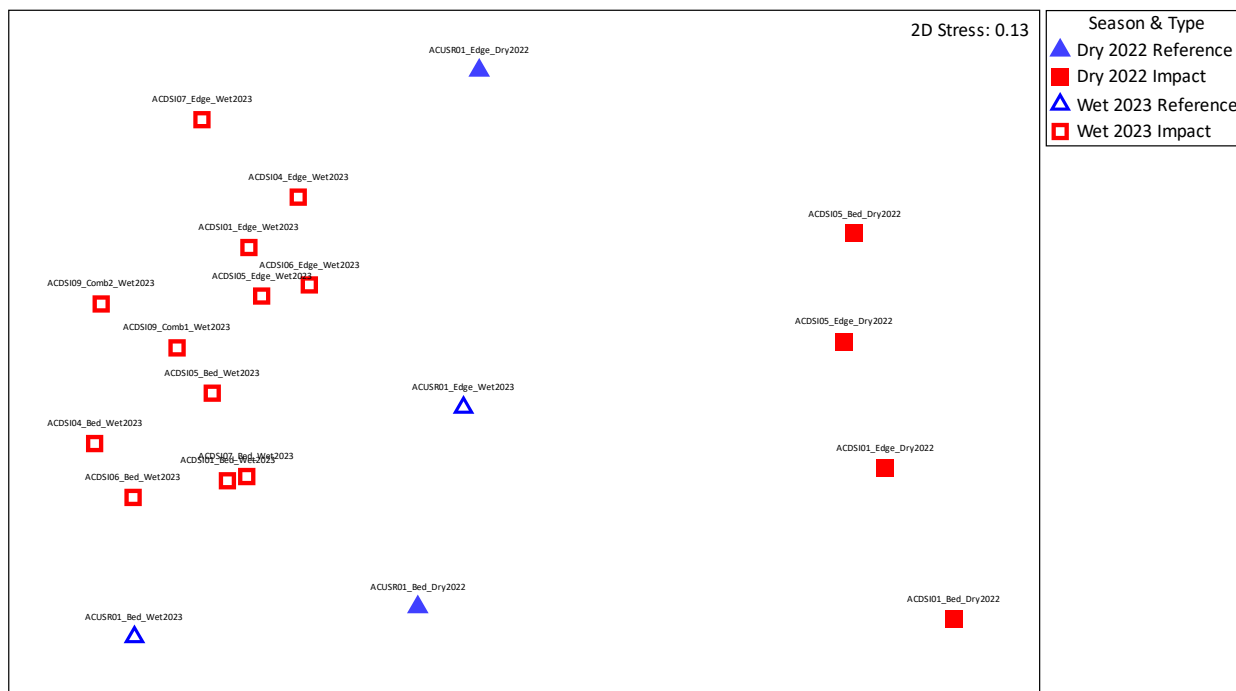


Figure 18. Ordination plot of macroinvertebrate community composition in bed and edge samples from November 2022 and April 2023.

3.7. Quality Assurance and Quality Control

3.7.1. Duplicate RPD

Relative percentage differences (RPD) were calculated for a range of water quality analytes (Appendix E). The RPD is used to verify the reproducibility of results and indicates the reliability of a value being truly representative of the water chemistry. Failed RPD results can be indicative of environmental variability, sampling methods, or analytical methods. In November 2022, 6 out of 46 parameters failed (total aluminium, total manganese, total iron, fluoride, sodium, and total hardness). In April 2023, 3 out of 46 parameters failed (total aluminium, total manganese, total iron). The duplicate samples were collected from the reference site ACUSR01 during both sampling events. Variability in total metals appears to be a consistent occurrence between both sampling events indicating that there is likely naturally high variability in metals within the sediments suspended in the water samples. Additional RPD failures for anions were recorded during November that is likely associated with natural variability from the first flush carrying salts that have settled on the landscape during the dry season.

For sediment, in November 2022, 6 out of 34 parameters failed (% +2000 µm particles, total copper in <63 µm fraction, and total cobalt/copper/nickel/lead in <2 mm fraction).

3.7.2. Blanks

The field blanks collected during each sampling event both contained 3 mg/L of bicarbonate alkalinity as CaCO₃. All other analytes were below detection limits.

3.7.3. Laboratory QA/QC

Complete laboratory reports are provided in Appendix F. A review of the laboratory quality control (QC) conducted internally by ALS of the following batches ET2206259 (water in November 2022) - EB2235588 (sediment in November 2022), ET2302171 (water in April 2023) and EB2312262 (sediment in April 2023) found that QA/QC results were within the specified requirements. The validity and sufficiency of the data is assumed to meet the objectives of the assessment. In summary, the following compliance outcomes were observed:

- No Method Blank value outliers
- No Duplicate outliers for all water samples
- Duplicate outliers for sediment in November 2022
- No Laboratory Control outliers
- No Matrix Spike outliers
- No surrogate recovery outliers
- No Quality Control Sample Frequency outliers
- Holding time outliers for water samples for TDS (2 days overdue in November 2022, 7 days overdue in April 2023), Dissolved Major Cations (1 day overdue in November 2022), and SAR and Hardness (1 day overdue in November 2022)

- Holding Time Outliers for sediment samples Total Cyanide (2 days overdue for extraction in November 2022)

The holding time outliers for TDS were considered minor, particularly as a field TDS reading was also obtained from surface water. Hence, the QA/QC results indicate that analytical data is acceptable for use and is considered sufficient for the purpose of this investigation.

Two macroinvertebrate samples were re-identified for QA/QC; no errors were recorded.

4. Discussion

4.1. Water

Exceedances of nominated WQOs in surface water quality were recorded during both sampling periods. Physico-chemical characteristic exceedances during November include upper trigger level exceedances for pH (ACDSIO1; pH 7.89, and ACDSIO5; pH 7.69), and trigger level exceedances for DO and EC (all sites). Contaminant limit exceedances were detected for sulfate (all sites), chloride (ACDSIO5), and fluoride (ACDSIO5). In addition to the physico-chemical exceedances, some metals/metalloids had trigger level exceedances for dissolve arsenic (ACUSR01 and ACDSIO5), and molybdenum (all sites), and contaminant level exceedances for iron (ACUSR01 and ACDSIO5).

Physico-chemical characteristic exceedances during April include upper pH trigger level (ACDSIO1, ACDSIO4, ACDSIO5, ACDSIO6, and ACDSIO7), EC (ACUSR01, ACDSIO1, ACDSIO4, ACDSIO5, ACDSIO6, and ACDSIO9), DO (all sites), sulfate (ACUSR01, ACDSIO1, ACDSIO4, ACDSIO5, ACDSIO6, and ACDSIO7), and chloride (ACDSIO1, ACDSIO4, ACDSIO5, ACDSIO6, and ACDSIO7).

Most waters that were sampled were done so from remnant and disconnected pools within the stream bed. As such, the most common exceedances were recorded against water quality parameters that are most impacted by residence time and temperature. For example, the low dissolved oxygen levels were not unexpected, given the seasonal factors of very high temperatures and rates of evaporation. The QWQG (DEHP, 2009) note that dissolved oxygen is naturally low in ephemeral systems and that WQO for dissolved oxygen should be applied to flowing waters only. As such, trigger level exceedances for these parameters are not necessarily indicative of mining impact but rather the natural response of waters to biotic and abiotic processes as the pools become disconnected and dry up.

The detection of dissolved and total metals/metalloids in the November samples only may be a result of the first flush whereby water quality is typically expected to be low due to the carrying of deposited contaminants (natural and non-natural) on the landscape throughout the dry period. Additionally, where these contaminants were detected at impacted sites, they were often detected at similar concentrations at the reference site.

4.2. Sediment

Sediment sampling was undertaken at all sites in both seasons. Particle size distribution analysis found that sediments were typically coarse, with high proportions of coarse sand and gravel. On average, reference sites had a slightly higher proportion of fine sediments (18.75 % in November 2022; and 6.2 % in April 2023) than impact sites (4 % for November 2022, and 2.86 % in April 2023.)

Trigger level exceedances were detected in the <2 mm fraction at ACUSR03 for nickel (November 59.5 mg/kg and April 57 mg/kg) and copper (April 76 mg/kg). Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2019) recommend that chemical analysis of sediment fraction <2 mm should be compared for default guideline values. Arsenic, lead, and zinc were also commonly

detected but were below SQOs. Given that the exceedances occurred at the reference site, it is likely that the results are reflective of the natural weathering of mineralised geologies. At present, there is no evidence that mining activities have impacted sediment quality in the receiving environment and on-going monitoring will allow more comprehensive characterisation of sediment chemistry across the site.

4.3. Macroinvertebrates

When the site data were pooled for both habitats and seasons, analyses found there was no significant difference between reference and impact sites during the wet season, however, the dry season showed significant differences for taxon richness, pet richness and total abundance. In contrast, statistical analyses found that community composition was significantly different between reference and impact sites in the 2023 Wet Season, but not for the 2022 Dry Season.

Macroinvertebrate habitat was rated as 'Fair' at all sites during the wet season (reference and impact). This was largely because of the ephemeral nature of creeks in this region, which resulted in a low variety of flow conditions and habitat features. During the wet season, these sites had been rated 'Good', with others that were not sampled in the dry being rated as 'Fair'.

Macroinvertebrates in these ephemeral environments are likely to be adapted to local conditions. On-going macroinvertebrate monitoring with careful consideration of the timing of sampling (i.e. to maximise the chance of surface water and macroinvertebrate habitat being present) will provide greater insights into the aquatic ecology of the Agate Creek Gold Mine receiving environment.

5. Conclusions and Recommendations

5.1. Conclusions

Exceedances of nominated WQOs were likely attributable to natural wet-dry cycles, as were the results of the macroinvertebrate and macroinvertebrate habitat analyses. In addition, the only exceedances for were detected at a reference site. Based on the results of the November 2022 and April 2023 REMP campaign, there is no evidence of disturbance to the receiving environment around the Agate Creek Gold Mine.

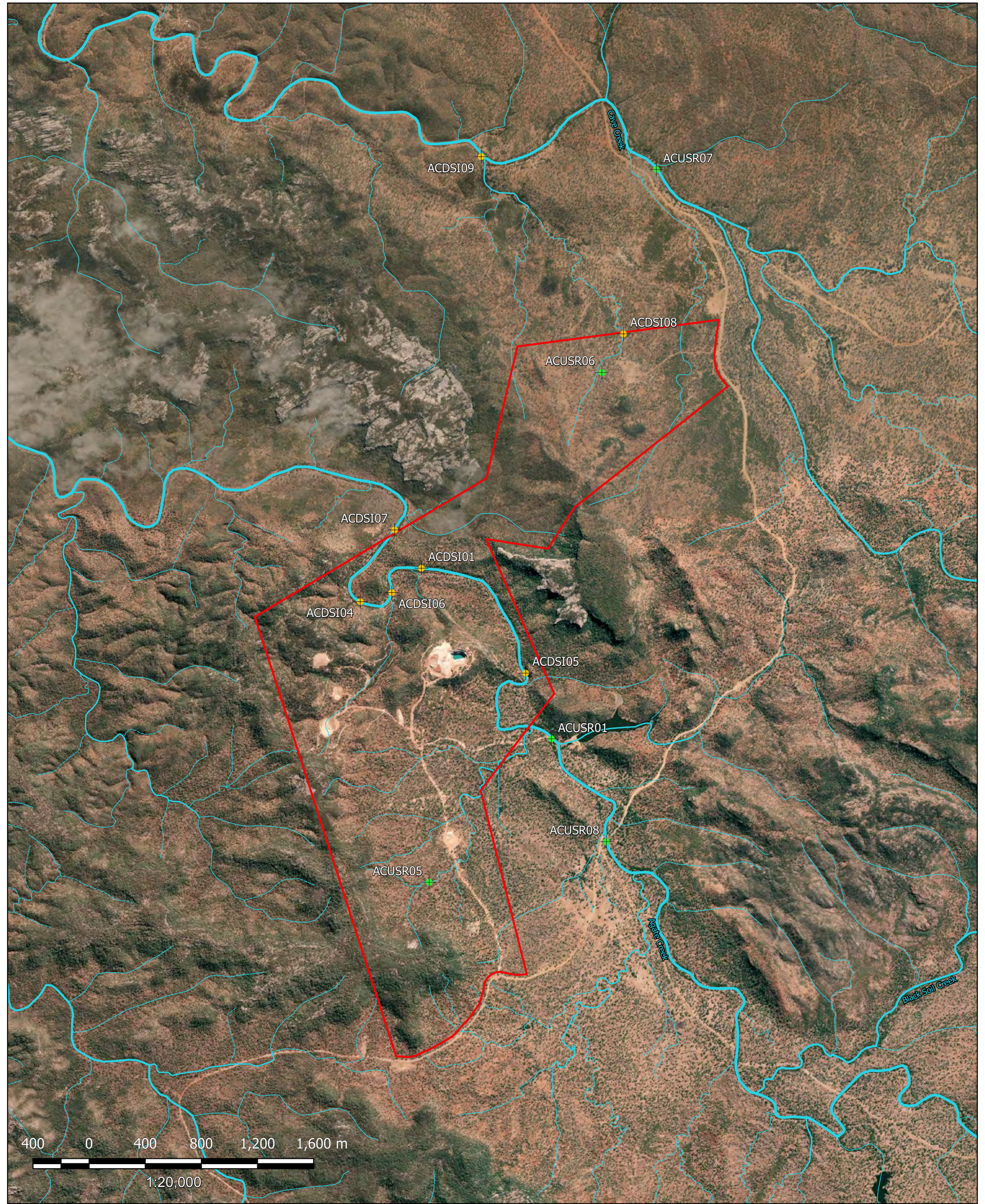
5.2. Recommendations

The REMP is recommended to continue at Agate Creek Gold Mine, with the following modifications:

1. Update the location for ACUSR05 to improve safety and accessibility.
2. Remove ACUSR03, as this location within the proposed expansion footprint will no longer be appropriate as a reference site;
3. Retain the new, trial sites added in April 2023 (ACUSR07 and ACDSI09) for inclusion in the program for future monitoring;
4. Sediment quality assessment should continue to analyse for the nominated contaminants in the fine fraction (<63 µm) as well as coarse fraction (<2 mm);
5. Continue monitoring biannually (dry season and mid-late wet season), using the methodology as specified in the updated REMP design (WTS 2023). SSVG should be calculated when there are >18 data points per analyte at each site for both water quality and sediment quality.

Table 14. Summary of recommended future REMP monitoring sites.

Site	Northing	Easting	Description
ACUSR01	-19.00014	143.55558	Reference site. Agate Creek, (4th order), approximately 200m upstream (outside) of ML boundary, downstream of a stock dam.
ACUSR05	-19.012478	143.545814	Reference site. Unnamed first order tributary of Agate Creek (flowing NNE), approx. 300m upstream of the crossing along the haul road.
ACUSR06	-18.975161	143.558856	Reference site. Unnamed first order tributary of Cave Creek (flowing north-north-east), approx. 450m upstream of ACDSI08; 25m upstream (south) of the crossing along the haul road, west of historical council disturbance.
ACUSR07	-18.962142	143.5631692	Reference Site: Cave Creek (4th order), just east of Cobb Rd.
ACUSR08	-19.006919	143.559158	Reference Site: Agate Creek (4th order), approximately 1 km upstream of ACUSR01, 50m upstream of Cobb Rd crossing
ACDSI01	-18.988406	143.546636	Impact site. Agate Creek (4th order), approximately 1.2km downstream of ACUSR01
ACDSI04	-18.990672	143.542492	Impact site. Agate Creek, approximately 3km downstream of ACUSR01, downstream of all mine operations and tributaries flowing into Agate Creek.
ACDSI05	-18.995508	143.553694	Impact site. Agate Creek, approximately 1.1km downstream of ACUSR01, downstream of Sherwood West Open Cut pit and mine camp; upstream of Sherwood Open Cut pit.
ACDSI06	-18.990053	143.544628	Impact site. Agate Creek, approximately 300m upstream of ACDSI04, downstream of Sherwood Open Cut pit; upstream of tributaries flowing from Sherwood West Open Cut pit.
ACDSI07	-18.985814	143.544825	Impact site. Agate Creek, approximately 700m downstream of ACDSI04 (just outside ML boundary), downstream of all mine operations and tributaries flowing into Agate Creek.
ACDSI08	-18.972536	143.560317	Impact site. Unnamed first order tributary of Cave Creek (flowing north-north-east), approx. 450m downstream of ACUSR06.
ACDSI09	-18.959996	143.55039	Impact site Cave Creek (4th order), 1.7km downstream of ACUSR07, downstream of confluence with creeks draining north of the ML



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Project number: 2022.07006
CRS: GDA2020 EPSG: 7844
Date: 24 May 2024

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Figure 19. Recommended future REMP sites

Legend

Mining lease

Revised future REMP sites

+ Reference

+ Impact

ESRI Satellite

Watercourse - Stream Order

— 0

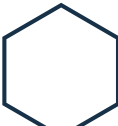
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Digital data for this report is available on the Queensland Government Spatial Portal at <https://qldspatial.information.qld.gov.au>.

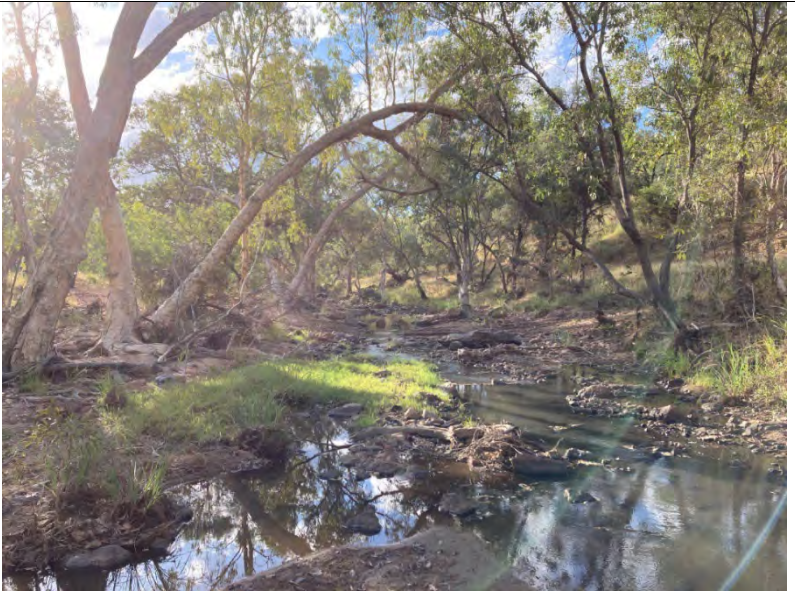


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APPENDIX A – SITE PHOTOS

Site and Description	Upstream	Across Channel	Downstream
Reference Sites			
ACUSR01 Agate Creek, approx. 250m upstream of the ML boundary (outside boundary) and immediately downstream of a tributary entering Agate Creek from below a dam. Dry Season (Nov 2022): Small amount of surface water (not flowing). Water, sediment, and macroinvertebrate samples collected.			
Wet Season (April 2023): Water present water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACUSR03 Unnamed first order tributary of Agate Creek (flowing north-east), approx. 1.2km upstream of the confluence with Agate Creek. Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): No surface water (highly ephemeral), sediment sample only. Erosion evident.			

Site and Description	Upstream	Across Channel	Downstream
ACUSR05 Unnamed first order tributary of Agate Creek (flowing north-north-east), approx. 700m upstream of the crossing along the haul road, just south of the mine camp. Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): No surface water (highly ephemeral), sediment sample only. Erosion evident.			

Site and Description	Upstream	Across Channel	Downstream
ACUSR06 Unnamed first order tributary of Cave Creek (flowing north-north-east), approx. 450m upstream of ACDSI08; 25m upstream (south) of the crossing along the haul road, west of the proposed ROM. Dry Season (Nov 2022): Sediment sample taken but unable to be analysed in lab.			
Wet Season (April 2023): No surface water (highly ephemeral), sediment sample only. Erosion (scouring) noted on creek bends.			

Site and Description	Upstream	Across Channel	Downstream
ACUSR07 Cave Creek (flowing north-northwest) approximately 930m north of the ML and 80m east of Cobb Road Haul Road Dry Season (Nov 2022): No sample collected as a new site for 2023	Intentionally blank due to no sample in dry season	Intentionally blank due to no sample in dry season	Intentionally blank due to no sample in dry season
Wet Season (April 2023): No surface water (highly ephemeral), sediment sample only. Creek is divided by an island of vegetation.			

Site and Description	Upstream	Across Channel	Downstream
Impact Sites			
ACDSI01 Agate Creek. approx. 1.2 km downstream of ACUSR01. Dry Season (Nov 2022) Water sample and sediment sample collected. Insufficient macroinvertebrate habitat.			
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI04 Agate Creek, approximately 3km downstream of ACUSR01, downstream of all mine operations and tributaries flowing into Agate Creek. Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI05 Agate Creek, approximately 1.1km downstream of ACUSR01, downstream of Sherwood West Open Cut pit and mine camp; upstream of Sherwood Open Cut pit. Dry Season (Nov 2022): Small amount of surface water (not flowing). Water, sediment and macroinvertebrate samples collected.			
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI06 Agate Creek, approximately 300m upstream of ACDSI04, downstream of Sherwood Open Cut pit; upstream of tributaries flowing from Sherwood West Open Cut pit. Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI07 Agate Creek, approximately 700m downstream of ACDSI04 (just outside ML boundary), downstream of all mine operations and tributaries flowing into Agate Creek. Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI08 Unnamed first order tributary of Cave Creek (flowing north-north-east), approx. 450m downstream of ACUSR06; downstream of ROM (just outside ML boundary). Dry Season (Nov 2022): No surface water, sediment sample only.			
Wet Season (April 2023): No surface water (highly ephemeral), sediment sample only. Some erosion (scouring) on creek bends.			

Site and Description	Upstream	Across Channel	Downstream
ACDSI09 Cave Creek 4th order stream. Approximately 1.7km downstream of ACDSI08 and 2.1km downstream of ACUSR06 Dry Season (Nov 2022): New site for 2023 – no sample collected in 2022.	Intentionally blank due to no sample in dry season	Intentionally blank due to no sample in dry season	Intentionally blank due to no sample in dry season
Wet Season (April 2023): Water present - water, sediment and macroinvertebrate samples collected.			

APPENDIX B – MACROINVERTEBRATE DATA

Table 15. Macroinvertebrate taxa recorded in November 2022.

Phylum/Class	Class/Order	Family/Subfamily	SIGNAL grade	Sensitivity ¹	ACUSR01_Bed	ACUSR01_Edge	ACDSI01_Bed	ACDSI01_Edge	ACDSI05_Bed	ACDSI05_Edge
Annelida	Oligochaeta	Oligochaeta	2	tolerant		1	1		2	
Mollusca	Gastropoda	Lymnaeidae	1	tolerant	5	11	1			5
		Planorbidae	2	tolerant	193	89	8	38	25	84
Crustacea	Copepoda	Copepoda	5.5		3	14				4
	Ostracoda	Ostracoda	5.5		1					
	Decapoda	Parathelphusidae	3	tolerant				1		9
Acarina	Hydracarina	Hydracarina	6			1			1	
Insecta	Coleoptera	Dytiscidae	2	tolerant	1	26	1	9		2
		Hydraenidae	3	tolerant		1				
		Hydrochidae	4			91		1		
		Hydrophilidae	2	tolerant		2		1		14
		Unident. (terrestrial) ²						1		4
	Diptera	Ceratopogonidae	4		2				1	1
	Chironomidae	Chironominae	3	tolerant	35	372	13	19	1	8
	Chironomidae	Orthocladiinae	4							
	Chironomidae	Tanytoidiinae	4		19	37	10	11	50	43
		Culicidae	1	tolerant		10	1	13	16	20
		Dolichopodidae	3	tolerant		1				
		Muscidae	1	tolerant		1				
		Simuliidae	5		1					
		Tabanidae	3	tolerant	2	1				
	Diptera	Diptera (pupae) ³			3	2				
	Diptera	Unident. (adult) ²					2			
	Ephemeroptera	Baetidae	5		9	115			2	
		Caenidae	4		111	5			1	1
	Hemiptera	Belastomatidae	1	tolerant		1				
		Gerridae	4		5	2				
		Micronectidae	2	tolerant	25	1			3	
		Nepidae	3	tolerant		1				
		Notonectidae	1	tolerant				1		
		Veliidae	3	tolerant		2				
		Unident. (terrestrial) ²								
	Lepidoptera	Crambidae	2	tolerant			1	1	2	7
	Odonata (Eiprocta)	Libellulidae	4		4	13			1	
	Odonata (Zygoptera)	Coenagrionidae	2	tolerant		9			1	
	Trichoptera	Leptoceridae	6		4	4				
Other										
	Actinopterygii	juvenile fish ²					2	2		
	Amphibia	Bufo marinus tadpole ³					34	138	5	2
	Arachnida	Unident. (spider) ²				3		1		
	Hymenoptera	Unident. (ant) ²			3	1	3	2		6
Total abundance					423	813	36	95	106	198
Total Taxa Richness					16	25	8	10	13	12
Total PET Richness					3	3	0	0	2	1
SIGNAL					3.49	3.19	2.53	2.40	2.80	2.62
%tolerant					38	64	88	80	54	67

1. Sensitivity ratings are sensitive = SIGNAL Grade 8-10; tolerant = SIGNAL Grade 1-3
2. Excluded from richness and abundance total
3. Excluded from richness total only

Table 16. Macroinvertebrate taxa recorded in April 2023.

Phylum/Class	Class/Order	Family/Subfamily	SIGNAL Grade	Sensitivity	ACUSR01_Bed	ACUSR01_Edge	ACDSI01_Bed	ACDSI01_Edge	ACDSI04_Bed	ACDSI04_Edge	ACDSI05_Bed	ACDSI05_Edge	ACDSI06_Bed	ACDSI06_Edge	ACDSI07_Bed	ACDSI07_Edge	ACDSI09_Co mb1	ACDSI09_Co mb2
Annelida	Oligochaeta	Oligochaeta	2	tolerant						1				1				1
Mollusca	Gastropoda	Lymnaeidae	1	tolerant		2	1	1		1						1		
		Planorbidae	2	tolerant		9			1	8		1		2	3		1	
Crustacea	Copepoda	Copepoda	5.5							1				1		1		
	Ostracoda	Ostracoda	5.5												1		2	
	Decapoda	Palaemonidae	4									1						
Acarina	Hydracarina	Hydracarina	6		1	2	1	1			2	2						
Insecta	Coleoptera	Carabidae	3	tolerant													2	
		Dytiscidae	2	tolerant	2	23	2	38		100	11	44	7	17	1	31	9	10
		Elmidae	7								1	1	2	1				
		Gyrinidae	4															5
		Hydraenidae	3	tolerant			1			1	2	8		6		2	1	6
		Hydrochidae	4		1	3		4			1	13		3				
		Hydrophilidae	2	tolerant	1	1	6	6	4	50	4	3	1	39	9	119	8	7
		Psephenidae	6												1			
		Scirtidae	6											1				
	Coleoptera	Unident. (terrestrial) ²															1	
	Diptera	Ceratopogonidae	4		8	3	12	15	11	42	27	13	1	7	56	46	15	52
	Chironomidae	Chironominae	3	tolerant	97	45	19	7	95	15	61	30	25	18	47	3	24	14
	Chironomidae	Orthoclaadiinae	4		25	1			1		7	1	1		3			3
	Chironomidae	Tanytopodiinae	4		19	35	46	28	14	23	30	36	21	34	43	32	20	8
		Culicidae	1	tolerant				6		5	5	3		7		22	3	6
		Dolichopodidae	3	tolerant	2								9		2		1	
		Tabanidae	3	tolerant	8		1	33	29	54	21	5	10	18	2	46	6	1
		Tipulidae	5		2		2			1	3		2				20	28
	Diptera	Diptera (pupae) ³			3	5	6	7	1	1	2	4	32	9	14	4	13	17
	Diptera	Unident. (adult) ²			1												3	
	Ephemeroptera	Baetidae	5		1		8	8	4	8	16	28	19	19	9	34	11	6
		Caenidae	4		79	23	214	18	22	9	51	26	87	25	211	21	100	51
		Leptophlebiidae	8	sensitive											1			
	Hemiptera	Gerridae	4					4		4		2		5	4	26	1	
		Micronectidae	2	tolerant		1	3					5	5		2	2	1	
		Nepidae	3	tolerant				2				1				1		
		Notonectidae	1	tolerant						1						6	7	4
		Ochteridae	2	tolerant												1	2	
		Pleidae	2	tolerant								1				1		1
		Veliidae	3	tolerant	1	3		3		1		2			1	1	2	2
	Lepidoptera	Crambidae	2	tolerant	2										1			
	Odonata (Epiprocta)	Gomphidae	5		1												2	
		Libellulidae	4		8		15	18	17	13	3	11	21	20	12	22	31	24
		Lindeniidae	3	tolerant		1												
	Odonata (Zygoptera)	Coenagrionidae	2	tolerant		2		7		4		7		2	2	10	1	
		Isostictidae	3	tolerant								1						
	Trichoptera	Calamoceratidae	7					1					1					
		Ecnomidae	4						1									
		Hydropsychidae	6		166	5			1		6	1			3			
		Hydroptilidae	4								1	2	2					

Phylum/Class	Class/Order	Family/Subfamily	SIGNAL Grade	Sensitivity	ACUSR01_Bed	ACUSR01_Edge	ACDSI01_Bed	ACDSI01_Edge	ACDSI04_Bed	ACDSI04_Edge	ACDSI05_Bed	ACDSI05_Edge	ACDSI06_Bed	ACDSI06_Edge	ACDSI07_Bed	ACDSI07_Edge	ACDSI09_Comb1	ACDSI09_Comb2
		Leptoceridae	6		4	1	2	1							3	1	1	1
		Philopotamidae	8	sensitive							1							
Other																		
	Actinopterygii	juvenile fish ²			1						1			1				
	Amphibia	Bufo marinus tadpole ²									1		1					
	Arachnida	Unident. (spider) ²			1			5			1			1		1	16	
	Hymenoptera	Unident. (ant) ²												3	1	2		1
	Orthoptera	Unident. (grasshopper) ²														1		
Total abundance					431	165	339	208	201	343	255	252	246	235	431	433	284	247
Total Taxa Richness					19	17	15	19	12	20	18	26	16	19	22	22	24	19
Total PET Richness					4	3	3	4	4	2	5	4	4	2	5	3	3	3
SIGNAL					4.07	3.36	3.65	3.34	3.66	3.10	3.85	3.44	3.71	3.38	3.85	3.10	3.39	3.43
%tolerant					37	53	47	47	33	60	39	50	38	47	45	64	58	53

1. Sensitivity ratings are sensitive = SIGNAL Grade 8-10; tolerant = SIGNAL Grade 1-3
2. Terrestrial taxa excluded from richness, abundance and other indices
3. Excluded from richness total only

APPENDIX C – MACROINVERTEBRATE HABITAT ASSESSMENTS

November 2022

Project Name:Agate Ck REMP

Project Number:2022.07006

Site Number:ACUSR01

Collected by:JC JS

Date:2022-11-22

Time:09:08

Rain in past week:yes

Current Weather:cloudy,fine

Weather comments:Warm and humid

SITE HABITAT ASSESSMENT

Habitat Variable	Score	Rating
Bottom substrate / available cover (0-20)	7	Fair
Embeddedness (0-20)	6	Fair
Velocity / depth category (0-20)	2	Poor
Channel alteration (0-15)	6	Fair
Bottom scouring and deposition (0-15)	5	Fair
Pool / Riffle, Run / Bend ratio (0-15)	4	Fair
Bank stability (0-10)	6	Good
Bank vegetative stability (0-10)	7	Good
Streamside cover (0-10)	7	Good
Total Score: (max 135)	50	Fair

CHANNEL, FLOW and REACH OBSERVATIONS

Velocity (m/sec) - min:	0	Reach Orientation:	NW
Velocity (m/sec) - max:	0.01	Variety of habitats:	macrophytes,pool,riffle,run,shallow,snags/woody debris,undercut bank
Mean depth (m):	0.2	Percentage of each habitat in 100m reach	
Mean channel width (m):	7	Riffle	5%
Flow Level	Low, Nil	Run	5%
Percentage bars above normal water level	50%	Pool (rocky)	0%
		Pool (sandy)	20%
		Dry	70%
		Edge	25%
		Macrophyte	5%
		Other.....	0%

RIPARIAN ZONE

Canopy Cover %	30%
Width: Left Bank (m)	3
Width: Right Bank (m)	7
Native %	80%
Exotic %	20%
Bare %	60%
Grass %	22%
Herbs %	3%
Shrubs %	0%
Trees <10m %	5%
Trees >10m %	10%
Evidence of poor tree condition	no
Details....	NA
Disturbance in riparian zone	grazing

LAND USE and IMPACTS

Human impact:	Low (1-10%)
Pastoral animal impact:	Extensive (>75%)
Non-pastoral animal impact:	Low (1-10%)
Upstream landuse:	Dam, grazing
Adjacent landuse:	Grazing
Local catchment erosion:	Moderate (51-75%)

WATER and SEDIMENT

Water colour:	Opaque	Sediment deposits:	Sand
Water surface condition:	Normal	Sediment odour:	no
Water odour:	no	Sediment oils:	no
Plume:	Low, Moderate	Algae on substrate:	None
Algae in water column:	None		

Macroinvertebrate Sample 1:

Sample Habitat:	Edge	Bed Habitat Type:	Edge,Macrophytes, Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	Low (1-10%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Low (1-10%)
Pebble (16-64mm):	1%	Macrophytes	Low (1-10%)
Gravel (4-16mm):	0%	Detritus (leaves/twigs)	Moderate (51-75%)
Sand (1-4mm):	97%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	2%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	Low (1-10%)
		Trailing bank vegetation	Low (1-10%)

Macroinvertebrate Sample 2:

Sample Habitat:	Bed	Bed Habitat Type:	Pool (sandy/silty), Riffle
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	None
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	2%	Filamentous algae	Low (1-10%)
Pebble (16-64mm):	18%	Macrophytes	None
Gravel (4-16mm):	0%	Detritus (leaves/twigs)	Low (1-10%)
Sand (1-4mm):	60%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	20%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	None
		Trailing bank vegetation	None

MACROPHYTES

Native		Exotic	
Water Primrose (<i>Ludwigia</i>)	None	Water Hyacinth	None
Sedge (<i>Cyperus</i>)	None	Salvinia	None
Common Rush (<i>Juncus</i>)	None	Para Grass	None
Cumbungi (<i>Typha</i>)	None	Hymenachne	None
Slender Knotweed (<i>Persicaria</i>)	None	Other Exotic sp.	None
Other Native sp.	None		

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MACROINVERTEBRATE HABITAT ASSESSMENT									
Project Name: Agate Ck REMP		Collected by: JC JS		Date: 2022-11-23		Rain in past week: yes		Weather comments: Warm and humid	
Project Number: 2022.07006				Time: 08:55		Current Weather: fine			
Site Number: ACDSI01									
SITE HABITAT ASSESSMENT				CHANNEL, FLOW and REACH OBSERVATIONS				RIPARIAN ZONE	
Habitat Variable		Score		Rating		Velocity (m/sec) - min: 0		Reach Orientation: W	
Bottom substrate / available cover (0-20)		6		Fair		Velocity (m/sec) - max: 0.6		pool,riffle,shallow,snags/woody debris,undercut bank	
Embeddedness (0-20)		6		Fair		Mean depth (m): 0.1		Percentage of each habitat in 100m reach	
Velocity / depth category (0-20)		1		Poor		Mean channel width (m): 10		Riffle 1%	
Channel alteration (0-15)		5		Fair		Flow Level Low		Run 0%	
Bottom scouring and deposition (0-15)		5		Fair		Percentage bars above normal water level 70%		Pool (rocky) 1%	
Pool / Riffle, Run / Bend ratio (0-15)		3		Poor				Pool (sandy) 8%	
Bank stability (0-10)		5		Fair				Dry 90%	
Bank vegetative stability (0-10)		6		Good				Edge 30%	
Streamside cover (0-10)		6		Good				Macrophyte 0%	
Total Score: (max 135)		43		Fair				Other..... 0%	
LAND USE and IMPACTS				WATER and SEDIMENT					
Human impact: Low (1-10%)				Water colour: Clear		Sediment deposits: Sand			
Pastoral animal impact: Moderate (51-75%)				Water surface condition: Foaming, Normal		Sediment odour: no			
Non-pastoral animal impact: Low (1-10%)				Water odour: no		Sediment oils: no			
Upstream landuse: Grazing, mining				Plume: Low		Algae on substrate: Low (1-10%)			
Adjacent landuse: Mine, grazing				Algae in water column: Low (1-10%)					
Local catchment erosion: Some (11-50%)									
Macroinvertebrate Sample 1:				Macroinvertebrate Sample 2:					
Sample Habitat: Bed		Bed Habitat Type: Pool (rocky/gravelly), Pool (sandy/silty),Riffle		Sample Habitat: Edge		Bed Habitat Type: Edge,Pool (rocky/gravelly), Pool (sandy/silty)			
Method: Multiple kick or edge (sum 10m)		Comments: Nil		Method: Multiple kick or edge (sum 10m)		Comments: Nil			
Substrate Description (%)		Substrate and Habitat Attributes:		Substrate Description (%)		Substrate and Habitat Attributes:			
Bedrock: 0%		Periphyton Low (1-10%)		Bedrock: 0%		Periphyton None			
Boulder (>256mm): 0%		Moss None		Boulder (>256mm): 5%		Moss None			
Cobble (64-256mm): 2%		Filamentous algae None		Cobble (64-256mm): 2%		Filamentous algae None			
Pebble (16-64mm): 5%		Macrophytes None		Pebble (16-64mm): 5%		Macrophytes None			
Gravel (4-16mm): 5%		Detritus (leaves/twigs) Low (1-10%)		Gravel (4-16mm): 0%		Detritus (leaves/twigs) Some (11-50%)			
Sand (1-4mm): 85%		Sticks (<2cm diam) Low (1-10%)		Sand (1-4mm): 85%		Sticks (<2cm diam) Low (1-10%)			
Silt/clay (<1mm): 3%		Branches (<15cm diam) None		Silt/clay (<1mm): 3%		Branches (<15cm diam) None			
Total 100%		Logs (>15cm diam) None		Total 100%		Logs (>15cm diam) Low (1-10%)			
		Bank overhang vegetation None				Bank overhang vegetation None			
		Trailing bank vegetation None				Trailing bank vegetation Low (1-10%)			
				MACROPHYTES					
Native		Exotic							
Water Primrose (Ludwigia)		None		Water Hyacinth		None			
Sedge (Cyperus)		None		Salvinia		None			
Common Rush (Juncus)		None		Para Grass		None			
Cumbungi (Typha)		None		Hymenachne		None			
Slender Knotweed (Persicaria)		None		Other Exotic sp.		None			
Other Native sp.		None							

Project Name:Agate REMP

Project Number:2022.07006

Site Number:ACDSI05

Collected by:JaS

Date:2022-11-22

Time:16:16

Rain in past week:yes

Current Weather:cloudy

Weather comments:Warm and humid

SITE HABITAT ASSESSMENT

Habitat Variable	Score	Rating
Bottom substrate / available cover (0-20)	6	Fair
Embeddedness (0-20)	4	Poor
Velocity / depth category (0-20)	2	Poor
Channel alteration (0-15)	5	Fair
Bottom scouring and deposition (0-15)	4	Fair
Pool / Riffle, Run / Bend ratio (0-15)	2	Poor
Bank stability (0-10)	5	Fair
Bank vegetative stability (0-10)	6	Good
Streamside cover (0-10)	7	Good
Total Score: (max 135)	41	Fair

LAND USE and IMPACTS

Human impact:	Low (1-10%)
Pastoral animal impact:	Some (11-50%)
Non-pastoral animal impact:	Low (1-10%)
Upstream landuse:	Track/crossing, mining, grazing
Adjacent landuse:	Mining, grazing
Local catchment erosion:	Some (11-50%)

CHANNEL, FLOW and REACH OBSERVATIONS

Velocity (m/sec) - min:	0	Reach Orientation:	NNW
Velocity (m/sec) - max:	0.01	Variety of habitats:	pool,shallow,snags/ woody debris
Mean depth (m):	15	Percentage of each habitat in 100m reach	
Mean channel width (m):	15	Riffle	0%
Flow Level	Nil	Run	0%
Percentage bars above normal water level	70%	Pool (rocky)	0%
		Pool (sandy)	25%
		Dry	45%
		Edge	30%
		Macrophyte	0%
		Other.....	0%

RIPARIAN ZONE

Canopy Cover %	40%
Width: Left Bank (m)	3
Width: Right Bank (m)	4
Native %	80%
Exotic %	20%
Bare %	34%
Grass %	50%
Herbs %	1%
Shrubs %	0%
Trees <10m %	10%
Trees >10m %	5%
Evidence of poor tree condition	no
Details....	NA
Disturbance in riparian zone	grazing, high flow

Macroinvertebrate Sample 1:

Sample Habitat:	Bed	Bed Habitat Type:	Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	None
Boulder (>256mm):	5%	Moss	None
Cobble (64-256mm):	3%	Filamentous algae	None
Pebble (16-64mm):	0%	Macrophytes	None
Gravel (4-16mm):	0%	Detritus (leaves/twigs)	Low (1-10%)
Sand (1-4mm):	79%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	3%	Branches (<15cm diam)	None
Total	90%	Logs (>15cm diam)	None
		Bank overhang vegetation	None
		Trailing bank vegetation	None

Macroinvertebrate Sample 2:

Sample Habitat:	Edge	Bed Habitat Type:	Edge, Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	None
Boulder (>256mm):	5%	Moss	None
Cobble (64-256mm):	3%	Filamentous algae	None
Pebble (16-64mm):	0%	Macrophytes	None
Gravel (4-16mm):	0%	Detritus (leaves/twigs)	Moderate (51-75%)
Sand (1-4mm):	89%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	3%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	Low (1-10%)
		Bank overhang vegetation	Low (1-10%)
		Trailing bank vegetation	Some (11-50%)

MACROPHYTES

Native		Exotic	
Water Primrose (<i>Ludwigia</i>)	None	Water Hyacinth	None
Sedge (<i>Cyperus</i>)	None	Salvinia	None
Common Rush (Juncus)	None	Para Grass	None
Cumbungi (<i>Typha</i>)	None	Hymenachne	None
Slender Knotweed (<i>Persicaria</i>)	None	Other Exotic sp.	None
Other Native sp.	None		

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MACROINVERTEBRATE HABITAT ASSESSMENT									
Project Name: Agate Remp		Collected by: JC		Date: 2023-04-20		Rain in past week: yes		Weather comments: Nil	
Project Number: 2022.07006				Time: 17:00		Current Weather: fine			
Site Number: ACUSR01									
SITE HABITAT ASSESSMENT				CHANNEL, FLOW and REACH OBSERVATIONS				RIPARIAN ZONE	
Habitat Variable		Score		Rating		Velocity (m/sec) - min: 0		Reach Orientation: NW	
Bottom substrate / available cover (0-20)		8		Fair		Velocity (m/sec) - max: 0.3		Variety of habitats: riffle,shallow	
Embeddedness (0-20)		6		Fair		Mean depth (m): 0.2		Percentage of each habitat in 100m reach	
Velocity / depth category (0-20)		15		Good		Mean channel width (m): 15		Riffle 8%	
Channel alteration (0-15)		8		Good		Flow Level Moderate		Run 4%	
Bottom scouring and deposition (0-15)		8		Good		Percentage bars above normal water level 70%		Pool (rocky) 8%	
Pool / Riffle, Run / Bend ratio (0-15)		8		Good				Pool (sandy) 20%	
Bank stability (0-10)		5		Fair				Dry 50%	
Bank vegetative stability (0-10)		8		Good				Edge 10%	
Streamside cover (0-10)		8		Good				Macrophyte 0%	
Total Score: (max 135)		74		Good				Other..... 0%	
LAND USE and IMPACTS				WATER and SEDIMENT				Disturbance in riparian zone	
Human impact: Moderate (51-75%), Some (11-50%)				Water colour: Clear				Sediment deposits: Sand	
Pastoral animal impact: Moderate (51-75%), Some (11-50%)				Water surface condition: Normal				Sediment odour: no	
Non-pastoral animal impact: Low (1-10%)				Water odour: no				Sediment oils: no	
Upstream landuse: Grazing, dam				Plume: High				Algae on substrate: Some (11-50%)	
Adjacent landuse: Grazing, dam				Algae in water column: Low (1-10%)					
Local catchment erosion: Moderate (51-75%), Some (11-50%)									
Macroinvertebrate Sample 1:				Macroinvertebrate Sample 2:				MACROPHYTES	
Sample Habitat: Bed		Bed Habitat Type: Pool (sandy/silty),Riffle		Sample Habitat: Edge		Bed Habitat Type: Pool (sandy/silty)		Native Exotic	
Method: 1x10m kick or edge		Comments: Nil		Multiple kick or edge (sum 10m)		Comments: Nil		Water Primrose (Ludwigia) None	
Substrate Description (%)		Substrate and Habitat Attributes:		Substrate Description (%)		Substrate and Habitat Attributes:		Sedge (Cyperus) None	
Bedrock: 0%		Periphyton Some (11-50%)		Bedrock: 0%		Periphyton Some (11-50%)		Common Rush (Juncus) None	
Boulder (>256mm): 10%		Moss None		Boulder (>256mm): 0%		Moss None		Cumbungi (Typha) None	
Cobble (64-256mm): 20%		Filamentous algae None		Cobble (64-256mm): 10%		Filamentous algae None		Slender Knotweed (Persicaria) None	
Pebble (16-64mm): 10%		Macrophytes None		Pebble (16-64mm): 10%		Macrophytes None		Other Native sp. None	
Gravel (4-16mm): 6%		Detritus (leaves/twigs) Some (11-50%)		Gravel (4-16mm): 5%		Detritus (leaves/twigs) Some (11-50%)			
Sand (1-4mm): 50%		Sticks (<2cm diam) None		Sand (1-4mm): 70%		Sticks (<2cm diam) Low (1-10%)			
Silt/clay (<1mm): 4%		Branches (<15cm diam) None		Silt/clay (<1mm): 5%		Branches (<15cm diam) None			
Total 100%		Logs (>15cm diam) None		Total 100%		Logs (>15cm diam) Low (1-10%)			
		Bank overhang vegetation None				Bank overhang vegetation Some (11-50%)			
		Trailing bank vegetation None				Trailing bank vegetation Some (11-50%)			

MACROINVERTEBRATE HABITAT ASSESSMENT									
Project Name: Agate Remp		Collected by: JC		Date: 2023-04-20		Rain in past week: yes		Weather comments: Nil	
Project Number: 2022.07006				Time: 10:00		Current Weather: calm,fine			
Site Number: ACDSI01									
SITE HABITAT ASSESSMENT				CHANNEL, FLOW and REACH OBSERVATIONS				RIPARIAN ZONE	
Habitat Variable		Score		Rating		Velocity (m/sec) - min: 0		Reach Orientation: W	
Bottom substrate / available cover (0-20)		9		Fair		Velocity (m/sec) - max: 0.3		Variety of habitats: deep,pool,riffle,shallow,snags/woody debris,undercut bank	
Embeddedness (0-20)		6		Fair		Mean depth (m): 0.3		Percentage of each habitat in 100m reach	
Velocity / depth category (0-20)		12		Good		Mean channel width (m): 9		Riffle 5%	
Channel alteration (0-15)		8		Good		Flow Level Low		Run 0%	
Bottom scouring and deposition (0-15)		7		Fair		Percentage bars above normal water level 50%		Pool (rocky) 5%	
Pool / Riffle, Run / Bend ratio (0-15)		9		Good				Pool (sandy) 15%	
Bank stability (0-10)		6		Good				Dry 40%	
Bank vegetative stability (0-10)		7		Good				Edge 35%	
Streamside cover (0-10)		8		Good				Macrophyte 0%	
Total Score: (max 135)		72		Good				Other..... 0%	
LAND USE and IMPACTS				WATER and SEDIMENT					
Human impact: Some (11-50%) moderate (51-75%), Some (11-50%)				Water colour: Clear				Sediment deposits: Sand	
Pastoral animal impact: 50%				Water surface condition: Normal				Sediment odour: no	
Non-pastoral animal impact: Low (1-10%), None				Water odour: no				Sediment oils: no	
Upstream landuse: Grazing, mining				Plume: Moderate				Algae on substrate: Extensive (>75%), Moderate (51-75%)	
Adjacent landuse: Grazing, mining				Algae in water column: Moderate (51-75%)					
Local catchment erosion: Some (11-50%)									
Macroinvertebrate Sample 1:				Macroinvertebrate Sample 2:				MACROPHYTES	
Sample Habitat: Bed		Bed Habitat Type: Pool (sandy/silty),Riffle		Sample Habitat: Edge		Bed Habitat Type: Pool (sandy/silty)		Native Exotic	
Method: Multiple kick or edge (sum 10m)		Comments: Nil		Method: 1x10m kick or edge		Comments: Nil		Water Primrose (Ludwigia) None Water Hyacinth None	
Substrate Description (%)		Substrate and Habitat Attributes:		Substrate Description (%)		Substrate and Habitat Attributes:		Sedge (Cyperus) None Salvinia None	
Bedrock: 10%		Periphyton Moderate (51-75%)		Bedrock: 0%		Periphyton Moderate (51-75%)		Common Rush (Juncus) None Para Grass None	
Boulder (>256mm): 0%		Moss None		Boulder (>256mm): 0%		Moss None		Cumbungi (Typha) None Hymenachne None	
Cobble (64-256mm): 10%		Filamentous algae Low (1-10%)		Cobble (64-256mm): 10%		Filamentous algae Some (11-50%)		Slender Knotweed (Persicaria) None Other Exotic sp. None	
Pebble (16-64mm): 20%		Macrophytes None		Pebble (16-64mm): 0%		Macrophytes None		Other Native sp. None	
Gravel (4-16mm): 10%		Detritus (leaves/twigs) Some (11-50%)		Gravel (4-16mm): 10%		Detritus (leaves/twigs) Low (1-10%)			
Sand (1-4mm): 50%		Sticks (<2cm diam) None		Sand (1-4mm): 80%		Sticks (<2cm diam) Low (1-10%)			
Silt/clay (<1mm): 0%		Branches (<15cm diam) None		Silt/clay (<1mm): 0%		Branches (<15cm diam) Low (1-10%)			
Total 100%		Logs (>15cm diam) None		Total 100%		Logs (>15cm diam) None			
		Bank overhang vegetation None				Bank overhang vegetation Some (11-50%)			
		Trailing bank vegetation None				Trailing bank vegetation Some (11-50%)			

Project Name:

Agate remp

Project Number:

2022.07006

Site Number:

ACDSI04

Collected by:

JC

Date:

2023-04-20

Time:

14:30

Rain in past week:

yes

Current Weather:

fine

Weather comments:

Nil

SITE HABITAT ASSESSMENT

Habitat Variable	Score	Rating
Bottom substrate / available cover (0-20)	7	Fair
Embeddedness (0-20)	6	Fair
Velocity / depth category (0-20)	12	Good
Channel alteration (0-15)	6	Fair
Bottom scouring and deposition (0-15)	5	Fair
Pool / Riffle, Run / Bend ratio (0-15)	4	Fair
Bank stability (0-10)	8	Good
Bank vegetative stability (0-10)	8	Good
Streamside cover (0-10)	7	Good
Total Score: (max 135)	63	Fair

CHANNEL, FLOW and REACH OBSERVATIONS

Velocity (m/sec) - min:	0	Reach Orientation:	WNW
Velocity (m/sec) - max:	0.2	Variety of habitats:	deep,pool,run,shallow,snags/woody debris
Mean depth (m):	0.3	Percentage of each habitat in 100m reach	
Mean channel width (m):	10	Riffle	0%
Flow Level	Low	Run	5%
Percentage bars above normal water level	50%	Pool (rocky)	0%
		Pool (sandy)	35%
		Dry	40%
		Edge	20%
		Macrophyte	0%
		Other.....	0%

RIPARIAN ZONE

Canopy Cover %	20%
Width: Left Bank (m)	5
Width: Right Bank (m)	5
Native %	70%
Exotic %	30%
Bare %	15%
Grass %	50%
Herbs %	10%
Shrubs %	0%
Trees <10m %	23%
Trees >10m %	2%
Evidence of poor tree condition	no
Details....	0
Disturbance in riparian zone	flood,grazing

LAND USE and IMPACTS

Human impact:	Low (1-10%), None
Pastoral animal impact:	Moderate (51-75%)
Non-pastoral animal impact:	Low (1-10%)
Upstream landuse:	Grazing, mining
Adjacent landuse:	Grazing, mining
Local catchment erosion:	Some (11-50%)

WATER and SEDIMENT

Water colour:	Clear	Sediment deposits:	Sand
Water surface condition:	Normal	Sediment odour:	no
Water odour:	no	Sediment oils:	no
Plume:	Moderate	Algae on substrate:	Extensive (>75%)
Algae in water column:	Extensive (>75%)		

Macroinvertebrate Sample 1:

Sample Habitat:	Bed	Bed Habitat Type:	Pool (sandy/silty),Run
Method:	1x10m kick or edge	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	Moderate (51-75%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Moderate (51-75%)
Pebble (16-64mm):	10%	Macrophytes	None
Gravel (4-16mm):	5%	Detritus (leaves/twigs)	None
Sand (1-4mm):	80%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	5%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	None
		Trailing bank vegetation	None

Macroinvertebrate Sample 2:

Sample Habitat:	Edge	Bed Habitat Type:	Edge,Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Minimal edge habitat (extensive) algae
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	10%	Periphyton	Extensive (>75%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Moderate (51-75%)
Pebble (16-64mm):	10%	Macrophytes	None
Gravel (4-16mm):	5%	Detritus (leaves/twigs)	None
Sand (1-4mm):	70%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	5%	Branches (<15cm diam)	Low (1-10%)
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	Some (11-50%)
		Trailing bank vegetation	Low (1-10%)

MACROPHYTES

Native		Exotic	
Water Primrose (<i>Ludwigia</i>)	None	Water Hyacinth	None
Sedge (<i>Cyperus</i>)	None	Salvinia	None
Common Rush (<i>Juncus</i>)	None	Para Grass	None
Cumbungi (<i>Typha</i>)	None	Hymenachne	None
Slender Knotweed (<i>Persicaria</i>)	None	Other Exotic sp.	None
Other Native sp.	None		

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Project Name:Agate Remp

Project Number:2022.07006

Site Number:ACDSI05

Collected by:JC

Date:2023-04-20

Time:07:30

Rain in past week:yes

Current Weather:fine

Weather comments:Sunny, no clouds.

SITE HABITAT ASSESSMENT

Habitat Variable	Score	Rating
Bottom substrate / available cover (0-20)	14	Good
Embeddedness (0-20)	8	Fair
Velocity / depth category (0-20)	16	Excellent
Channel alteration (0-15)	7	Fair
Bottom scouring and deposition (0-15)	5	Fair
Pool / Riffle, Run / Bend ratio (0-15)	10	Good
Bank stability (0-10)	8	Good
Bank vegetative stability (0-10)	9	Excellent
Streamside cover (0-10)	7	Good
Total Score: (max 135)	84	Good

CHANNEL, FLOW and REACH OBSERVATIONS

Velocity (m/sec) - min:	0	Reach Orientation:	NNW
Velocity (m/sec) - max:	0.5	Variety of habitats:	deep,pool,riffle,shallow,snags/woody debris
Mean depth (m):	0.3	Percentage of each habitat in 100m reach	
Mean channel width (m):	15	Riffle	20%
Flow Level	Moderate	Run	0%
Percentage bars above normal water level	70%	Pool (rocky)	10%
		Pool (sandy)	10%
		Dry	45%
		Edge	15%
		Macrophyte	0%
		Other.....	0%

RIPARIAN ZONE

Canopy Cover %	30%
Width: Left Bank (m)	3
Width: Right Bank (m)	6
Native %	70%
Exotic %	30%
Bare %	5%
Grass %	50%
Herbs %	10%
Shrubs %	5%
Trees <10m %	20%
Trees >10m %	10%
Evidence of poor tree condition	no
Details....	0
Disturbance in riparian zone	flood,grazing

LAND USE and IMPACTS

Human impact:	Low (1-10%)
Pastoral animal impact:	Moderate (51-75%)
Non-pastoral animal impact:	Low (1-10%)
Upstream landuse:	Grazing, mining
Adjacent landuse:	Grazing, mining
Local catchment erosion:	Some (11-50%)

WATER and SEDIMENT

Water colour:	Clear	Sediment deposits:	Sand
Water surface condition:	Normal	Sediment odour:	no
Water odour:	no	Sediment oils:	no
Plume:	Moderate	Algae on substrate:	Extensive (>75%)
Algae in water column:	Extensive (>75%)		

Macroinvertebrate Sample 1:

Sample Habitat:	Bed	Bed Habitat Type:	Pool (sandy/silty),Riffle
Method:	1x10m kick or edge	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	Moderate (51-75%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	20%	Filamentous algae	Some (11-50%)
Pebble (16-64mm):	10%	Macrophytes	None
Gravel (4-16mm):	20%	Detritus (leaves/twigs)	Low (1-10%)
Sand (1-4mm):	45%	Sticks (<2cm diam)	Low (1-10%)
Silt/clay (<1mm):	5%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	None
		Trailing bank vegetation	None

Macroinvertebrate Sample 2:

Sample Habitat:	Edge	Bed Habitat Type:	Edge,Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	50%	Periphyton	Some (11-50%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Moderate (51-75%)
Pebble (16-64mm):	0%	Macrophytes	Low (1-10%)
Gravel (4-16mm):	10%	Detritus (leaves/twigs)	Some (11-50%)
Sand (1-4mm):	20%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	20%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	Some (11-50%)
		Trailing bank vegetation	None

MACROPHYTES

Native		Exotic	
Water Primrose (Ludwigia)	None	Water Hyacinth	None
Sedge (Cyperus)	None	Salvinia	None
Common Rush (Juncus)	None	Para Grass	None
Cumbungi (Typha)	None	Hymenachne	None
Slender Knotweed (Persicaria)	None	Other Exotic sp.	None
Other Native sp.	None		

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Project Name:Agate Creek

Project Number:2022.07006

Site Number:ACDSI07

Collected by:JC

Date:2023-04-20

Time:13:00

Rain in past week:yes

Current Weather:cloudy,fine

Weather comments:Nil

SITE HABITAT ASSESSMENT

Habitat Variable	Score	Rating
Bottom substrate / available cover (0-20)	7	Fair
Embeddedness (0-20)	5	Poor
Velocity / depth category (0-20)	4	Poor
Channel alteration (0-15)	6	Fair
Bottom scouring and deposition (0-15)	5	Fair
Pool / Riffle, Run / Bend ratio (0-15)	3	Poor
Bank stability (0-10)	7	Good
Bank vegetative stability (0-10)	8	Good
Streamside cover (0-10)	6	Good
Total Score: (max 135)	51	Fair

CHANNEL, FLOW and REACH OBSERVATIONS

Velocity (m/sec) - min:	0	Reach Orientation:	NW
Velocity (m/sec) - max:	0.01	Variety of habitats:	pool,shallow,snags/woody debris, undercut bank
Mean depth (m):	0.2	Percentage of each habitat in 100m reach	
Mean channel width (m):	7	Riffle	0%
Flow Level	Low, Nil	Run	0%
Percentage bars above normal water level	50%	Pool (rocky)	5%
		Pool (sandy)	20%
		Dry	45%
		Edge	40%
		Macrophyte	0%
		Other.....	0%

RIPARIAN ZONE

Canopy Cover %	25%
Width: Left Bank (m)	7
Width: Right Bank (m)	10
Native %	60%
Exotic %	40%
Bare %	25%
Grass %	45%
Herbs %	10%
Shrubs %	0%
Trees <10m %	12%
Trees >10m %	8%
Evidence of poor tree condition	no
Details....	0
Disturbance in riparian zone	flood,grazing

LAND USE and IMPACTS

Human impact:	Some (11-50%)
Pastoral animal impact:	Moderate (51-75%)
Non-pastoral animal impact:	Low (1-10%)
Upstream landuse:	Grazing, mining
Adjacent landuse:	Grazing, mining
Local catchment erosion:	Some (11-50%)

WATER and SEDIMENT

Water colour:	Clear	Sediment deposits:	Sand
Water surface condition:	Foaming,Normal	Sediment odour:	no
Water odour:	no	Sediment oils:	no
Plume:	High	Algae on substrate:	Some (11-50%)
Algae in water column:	Some (11-50%)		

Macroinvertebrate Sample 1:

Sample Habitat:	Bed	Bed Habitat Type:	Pool (sandy/silty)
Method:	1x10m kick or edge	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	0%	Periphyton	Some (11-50%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Low (1-10%)
Pebble (16-64mm):	0%	Macrophytes	None
Gravel (4-16mm):	20%	Detritus (leaves/twigs)	Low (1-10%)
Sand (1-4mm):	70%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	10%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	None
		Trailing bank vegetation	None

Macroinvertebrate Sample 2:

Sample Habitat:	Edge	Bed Habitat Type:	Edge,Pool (sandy/silty)
Method:	Multiple kick or edge (sum 10m)	Comments:	Nil
Substrate Description (%)		Substrate and Habitat Attributes:	
Bedrock:	20%	Periphyton	Some (11-50%)
Boulder (>256mm):	0%	Moss	None
Cobble (64-256mm):	0%	Filamentous algae	Moderate (51-75%)
Pebble (16-64mm):	0%	Macrophytes	None
Gravel (4-16mm):	20%	Detritus (leaves/twigs)	Low (1-10%)
Sand (1-4mm):	60%	Sticks (<2cm diam)	None
Silt/clay (<1mm):	0%	Branches (<15cm diam)	None
Total	100%	Logs (>15cm diam)	None
		Bank overhang vegetation	Some (11-50%)
		Trailing bank vegetation	Some (11-50%)

MACROPHYTES

MACROPHYTES			
Native		Exotic	
Water Primrose (<i>Ludwigia</i>)	None	Water Hyacinth	None
Sedge (<i>Cyperus</i>)	None	Salvinia	None
Common Rush (<i>Juncus</i>)	None	Para Grass	None
Cumbungi (<i>Typha</i>)	None	Hymenachne	None
Slender Knotweed (<i>Persicaria</i>)	None	Other Exotic sp.	None
Other Native sp.	None		

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MACROINVERTEBRATE HABITAT ASSESSMENT									
Project Name: Agate Remp		Collected by: JC		Date: 2023-04-22		Rain in past week: yes		Weather comments: Nil	
Project Number: 2022.07006				Time: 07:09		Current Weather: fine			
Site Number: ACDSI09									
SITE HABITAT ASSESSMENT				CHANNEL, FLOW and REACH OBSERVATIONS				RIPARIAN ZONE	
Habitat Variable		Score		Rating					
Bottom substrate / available cover (0-20)		7		Fair				Canopy Cover % 40%	
Embeddedness (0-20)		8		Fair				Width: Left Bank (m) 6	
Velocity / depth category (0-20)		3		Poor				Width: Right Bank (m) 1	
Channel alteration (0-15)		5		Fair				Native % 80%	
Bottom scouring and deposition (0-15)		4		Fair				Exotic % 20%	
Pool / Riffle, Run / Bend ratio (0-15)		3		Poor				Bare % 35%	
Bank stability (0-10)		6		Good				Grass % 45%	
Bank vegetative stability (0-10)		7		Good				Herbs % 4%	
Streamside cover (0-10)		4		Fair				Shrubs % 0%	
Total Score: (max 135)		47		Fair				Trees <10m % 6%	
								Trees >10m % 10%	
								Evidence of poor tree condition no	
								Flood damage to some trees (knocked over).	
								Details....	
								Disturbance in riparian zone flood,grazing	
LAND USE and IMPACTS				WATER and SEDIMENT					
Human impact: Low (1-10%), None				Water colour: Clear					
Pastoral animal impact: Some (11-50%)				Water surface condition: Oily					
Non-pastoral animal impact: Low (1-10%)				Water odour: no					
Upstream landuse: Grazing, mining				Sediment deposits: Sand					
Adjacent landuse: Grazing, mining				Sediment odour: no					
Local catchment erosion: Some (11-50%)				Sediment oils: no					
				Plume: Low,Moderate					
				Algae in water column: Low (1-10%)					
				Algae on substrate: Moderate (51-75%)					
Macroinvertebrate Sample 1:				Macroinvertebrate Sample 2:				MACROPHYTES	
Sample Habitat: Combined		Bed Habitat Type: Pool (rocky/gravelly),Pool (sandy/silty)		Sample Habitat: Combined		Bed Habitat Type: Pool (rocky/gravelly),Pool (sandy/silty)		Native Exotic	
Method: Multiple kick or edge (sum 10m)		Comments: Nil		Method: Multiple kick or edge (sum 10m)		Comments: Nil		Water Primrose (Ludwigia) None Water Hyacinth None	
Substrate Description (%)		Substrate and Habitat Attributes:		Substrate Description (%)		Substrate and Habitat Attributes:		Sedge (Cyperus) None Salvinia None	
Bedrock: 0%		Periphyton Moderate (51-75%)		Bedrock: 0%		Periphyton Moderate (51-75%)		Common Rush (Juncus) None Para Grass None	
Boulder (>256mm): 0%		Moss None		Boulder (>256mm): 0%		Moss None		Cumbungi (Typha) None Hymenachne None	
Cobble (64-256mm): 20%		Filamentous algae Low (1-10%)		Cobble (64-256mm): 20%		Filamentous algae Low (1-10%)		Slender Knotweed (Persicaria) None Other Exotic sp. None	
Pebble (16-64mm): 5%		Macrophytes None		Pebble (16-64mm): 5%		Macrophytes None		Other Native sp. None	
Gravel (4-16mm): 30%		Detritus (leaves/twigs) Some (11-50%)		Gravel (4-16mm): 30%		Detritus (leaves/twigs) Some (11-50%)			
Sand (1-4mm): 45%		Sticks (<2cm diam) None		Sand (1-4mm): 45%		Sticks (<2cm diam) None			
Silt/clay (<1mm): 5%		Branches (<15cm diam) None		Silt/clay (<1mm): 5%		Branches (<15cm diam) None			
Total 105%		Logs (>15cm diam) Some (11-50%)		Total 105%		Logs (>15cm diam) Some (11-50%)			
		Bank overhang vegetation Some (11-50%)				Bank overhang vegetation Some (11-50%)			
		Trailing bank vegetation Some (11-50%)				Trailing bank vegetation Some (11-50%)			

APPENDIX D – STATISTICAL ANALYSES RESULTS

Table 17. PERMANOVA results for macroinvertebrate indices in 2022-23 samples

Note. (Pooled for habitat) comparing 'type' (Reference versus Impact) and Season (Dry 2022 versus Wet 2023). Statistically significant results ($p < 0.05$) are denoted by boldface.

Source	df	SS	MS	Pseudo-F	P(perm)
Taxon Richness					
Type	1	53.13	53.13	3.80	0.067
Season	1	27.76	27.76	1.99	0.175
Type*Season	1	92.13	92.13	6.58	0.019
Residual	16	223.92	14.00		
Total	19	464.80			
PET Richness					
Type	1	3.80	3.80	4.26	0.059
Season	1	7.92	7.92	8.89	0.010
Type*Season	1	3.80	3.80	4.26	0.059
Residual	16	14.25	0.89		
Total	19	37.8			
Abundance					
Type	1	156.33	156.33	16.51	0.0003
Season	1	0.59	0.59	0.06	0.8073
Type*Season	1	159.56	159.56	16.85	0.0014
Residual	16	151.52	9.47		
Total	19	449.13			
SIGNAL Scores					
Type	1	0.71	0.71	10.30	0.0065
Season	1	1.23	1.23	17.91	0.0003
Type*Season	1	0.21	0.21	3.07	0.1023
Residual	16	1.10	0.07		
Total	19	3.91			
% Tolerant Taxa					
Type	1	461.03	461.03	3.55	0.075
Season	1	649.58	649.58	5.00	0.044
Type*Season	1	235.31	235.31	1.81	0.195
Residual	16	2078.90	129.93		
Total	19	3915.40			
Community Composition					
Type	1	2469.5	2469.5	2.88	0.004
Season	1	4375.2	4375.2	5.10	0.001
Type*Season	1	3027.2	3027.2	3.53	0.002
Residual	16	13720	857.5		
Total	19	27025			

Table 18. Pair-wise test for community composition of macroinvertebrates samples from each season.

Note. Statistically significant results ($p < 0.05$) are denoted by boldface.

Pair-wise comparisons	t	P(perm)
Dry 2022		
Reference versus Impact	1.77	0.070
Wet 2023		
Reference versus Impact	1.56	0.020

APPENDIX E – QA/QC

RPD was calculated using the methods described in Section 2.7.1. Summary tables for water and sediment quality analysis RPD are presented in Tables 22 to 24, below.

Table 19. RPD report for water quality analyses for November 2022.

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Electrical Conductivity	µS/cm	1	213	225	5.5	< 20%
Total Dissolved Solids	mg/L	10	137	125	9.2	< 50%
Arsenic Dissolved	mg/L	0.001	0.002	0.002	0.0	no limit
Zinc Dissolved	mg/L	0.005	<0.005	<0.005	NA	NA
Selenium Dissolved	mg/L	0.01	<0.01	<0.01	NA	NA
Cadmium Dissolved	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Nickel Dissolved	mg/L	0.001	0.001	0.001	0.0	no limit
Copper Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Lead Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Cobalt Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Manganese Dissolved	mg/L	0.001	0.141	<0.001	NA	NA
Boron Dissolved	mg/L	0.05	<0.05	<0.05	NA	NA
Molybdenum Dissolved	mg/L	0.001	0.005	0.002	85.7	no limit
Aluminium Dissolved	mg/L	0.01	<0.01	<0.01	NA	NA
Chromium Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Iron Dissolved	mg/L	0.05	<0.05	<0.05	NA	NA
Zinc Total	mg/L	0.005	<0.005	<0.005	NA	NA
Aluminium Total	mg/L	0.01	1.01	0.66	41.9	< 20%
Arsenic Total	mg/L	0.001	0.004	0.002	66.7	no limit
Boron Total	mg/L	0.05	<0.05	0.05	NA	NA
Cadmium Total	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Cobalt Total	mg/L	0.001	0.002	<0.001	NA	NA
Chromium Total	mg/L	0.001	<0.001	<0.001	NA	NA
Copper Total	mg/L	0.001	<0.001	0.002	NA	NA
Manganese Total	mg/L	0.001	0.8	0.19	123.2	< 20%
Molybdenum Total	mg/L	0.001	0.004	0.001	120.0	no limit
Nickel Total	mg/L	0.001	0.002	0.002	0.0	no limit
Lead Total	mg/L	0.001	0.001	<0.001	NA	NA
Selenium Total	mg/L	0.01	<0.01	<0.01	NA	NA
Iron Total	mg/L	0.05	1.42	0.59	82.6	< 20%
Mercury Dissolved	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Mercury Total	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Total Cations	meq/L	0.01	2.16	2.23	3.2	< 20%
Total Anions	meq/L	0.01	2.2	2.27	3.1	< 20%
Fluoride	mg/L	0.1	2.1	0.6	111.1	< 50%
Chloride	mg/L	1	10	6	50.0	no limit

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Sulfate as SO ₄ - Turbidimetric Dissolved	mg/L	1	1	4	120.0	no limit
Hydroxide Alkalinity as CaCO ₃	mg/L	1	<1	<1	NA	NA
Carbonate Alkalinity as CaCO ₃	mg/L	1	<1	<1	NA	NA
Bicarbonate Alkalinity as CaCO ₃	mg/L	1	95	101	6.1	< 20%
Total Alkalinity as CaCO ₃	mg/L	1	95	101	6.1	< 20%
Calcium Dissolved	mg/L	1	13	20	42.4	< 50%
Magnesium Dissolved	mg/L	1	6	7	15.4	no limit
Sodium Dissolved	mg/L	1	21	11	62.5	< 50%
Potassium Dissolved	mg/L	1	4	7	54.5	no limit
Total Hardness as CaCO ₃ Dissolved	mg/L	1	57	79	32.4	< 20%

* RPD% above the acceptable limit are shaded **orange**.

Table 20. RPD report for water quality analyses for April 2023.

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Electrical Conductivity	µS/cm	1	175	162	7.7	< 20%
Total Dissolved Solids	mg/L	10	120	109	9.6	< 50%
Arsenic Dissolved	mg/L	0.001	0.006	0.002	100.0	no limit
Zinc Dissolved	mg/L	0.005	<0.005	<0.005	NA	NA
Selenium Dissolved	mg/L	0.01	<0.01	<0.01	NA	NA
Cadmium Dissolved	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Nickel Dissolved	mg/L	0.001	0.001	<0.001	NA	no limit
Copper Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Lead Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Cobalt Dissolved	mg/L	0.001	0.002	<0.001	NA	NA
Manganese Dissolved	mg/L	0.001	0.442	0.286	NA	NA
Boron Dissolved	mg/L	0.05	<0.05	<0.05	NA	NA
Molybdenum Dissolved	mg/L	0.001	0.003	0.004	28.6	no limit
Aluminium Dissolved	mg/L	0.01	0.96	0.01	NA	NA
Chromium Dissolved	mg/L	0.001	<0.001	<0.001	NA	NA
Iron Dissolved	mg/L	0.05	2.13	<0.05	NA	NA
Zinc Total	mg/L	0.005	<0.005	<0.005	NA	NA
Aluminium Total	mg/L	0.01	0.01	0.55	192.9	< 20%
Arsenic Total	mg/L	0.001	0.002	0.006	100.0	no limit
Boron Total	mg/L	0.05	<0.05	<0.05	NA	NA
Cadmium Total	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Cobalt Total	mg/L	0.001	<0.001	0.003	NA	NA
Chromium Total	mg/L	0.001	<0.001	<0.001	NA	NA
Copper Total	mg/L	0.001	0.002	0.002	NA	NA

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Manganese Total	mg/L	0.001	0.257	0.753	98.2	< 20%
Molybdenum Total	mg/L	0.001	0.004	0.005	22.2	no limit
Nickel Total	mg/L	0.001	<0.001	0.002	NA	no limit
Lead Total	mg/L	0.001	<0.001	<0.001	NA	no limit
Selenium Total	mg/L	0.01	<0.01	<0.01	NA	NA
Iron Total	mg/L	0.05	0.06	2.39	190.2	< 20%
Mercury Dissolved	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Mercury Total	mg/L	0.0001	<0.0001	<0.0001	NA	NA
Total Cations	meq/L	0.01	1.67	1.62	3.0	< 20%
Total Anions	meq/L	0.01	1.59	1.63	2.5	< 20%
Fluoride	mg/L	0.1	1	1	0.0	< 50%
Chloride	mg/L	1	4	4	0.0	no limit
Sulfate as SO ₄ - Turbidimetric Dissolved	mg/L	1	<1	<1	NA	no limit
Hydroxide Alkalinity as CaCO ₃	mg/L	1	<1	<1	NA	NA
Carbonate Alkalinity as CaCO ₃	mg/L	1	<1	<1	NA	NA
Bicarbonate Alkalinity as CaCO ₃	mg/L	1	74	76	2.7	< 20%
Total Alkalinity as CaCO ₃	mg/L	1	74	76	2.7	< 20%
Calcium Dissolved	mg/L	1	14	13	7.4	< 50%
Magnesium Dissolved	mg/L	1	4	4	0.0	no limit
Sodium Dissolved	mg/L	1	13	13	0.0	< 50%
Potassium Dissolved	mg/L	1	3	3	0.0	no limit
Total Hardness as CaCO ₃ Dissolved	mg/L	1	51	49	4.0	< 20%

* RPD% above the acceptable limit are shaded **orange**.

Table 21. RPD report for sediment quality analyses for November 2022.

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Total Cyanide	mg/kg	1	<1	<1	NA	NA
Total Organic Carbon	%	0.02	0.05	0.05	0.0	no limit
+63µm	%	1	98	98	0.0	< 20%
+600µm	%	1	80	85	6.1	< 20%
+212µm	%	1	98	97	1.0	< 20%
+300µm	%	1	96	96	0.0	< 20%
+2000µm	%	1	38	50	27.3	< 20%
Moisture Content	%	0.1	12.9	14.4	11.0	< 20%
Mercury Total (<63µm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Arsenic Total (<63µm fraction)	mg/kg	0.1	3.1	2.9	6.7	< 20%
Cobalt Total (<63µm fraction)	mg/kg	0.1	22.1	24	8.2	< 20%
Copper Total (<63µm fraction)	mg/kg	0.1	22	32.7	39.1	< 20%

Analyte	Units	LOR	Duplicate	Original Results ACUSR01	RPD %*	Acceptable RPD %
Nickel Total (<63µm fraction)	mg/kg	0.1	24.1	27.1	11.7	< 20%
Lead Total (<63µm fraction)	mg/kg	0.1	13	14.5	10.9	< 20%
Antimony Total (<63µm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Zinc Total (<63µm fraction)	mg/kg	0.5	66.1	69.4	4.9	< 20%
Tin Total (<63µm fraction)	mg/kg	0.1	1.1	1.6	37.0	< 50 %
Selenium Total (<63µm fraction)	mg/kg	1	2	1	66.7	no limit
Cadmium Total (<63µm fraction)	mg/kg	0.1	0.2	0.1	66.7	no limit
Bismuth Total (<63µm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Silver Total (<63µm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Arsenic Total (<2mm fraction)	mg/kg	0.1	0.9	1	10.5	no limit
Cobalt Total (<2mm fraction)	mg/kg	0.1	5.2	18.6	112.6	< 20%
Copper Total (<2mm fraction)	mg/kg	0.1	2.1	2.7	25.0	< 20%
Nickel Total (<2mm fraction)	mg/kg	0.1	5.4	7.6	33.8	< 20%
Lead Total (<2mm fraction)	mg/kg	0.1	3	4.7	44.2	< 20%
Antimony Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Zinc Total (<2mm fraction)	mg/kg	0.5	13.2	12.8	3.1	< 20%
Tin Total (<2mm fraction)	mg/kg	0.1	0.2	0.1	66.7	no limit
Selenium Total (<2mm fraction)	mg/kg	1	<1	<1	NA	NA
Cadmium Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Bismuth Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Silver Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Mercury Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA

* RPD% above the acceptable limit are shaded **orange**.

Table 22. RPD report for sediment quality analyses for April 2023.

Analyte	Units	LOR	Duplicate	Original Results (ACUSR01)	RPD %*	Acceptable RPD %
Gravel (>2mm)	%	1	20	20	0.0	< 20%
Cobbles (>6cm)	%	1	<1	<1	NA	NA
Sand (>75 µm)	%	1	77	76	1.3	< 20%
Fines (<75 µm)	%	1	3	4	28.6	no limit
+150µm	%	1	95	88	7.7	< 20%
+425µm	%	1	64	57	11.6	< 20%
+600µm	%	1	49	45	8.5	< 20%
+1180µm	%	1	29	29	0.0	< 20%
+2.36mm	%	1	16	16	0.0	< 50 %
+9.5mm	%	1	<1	<1	NA	NA
+75.0mm	%	1	<1	<1	NA	NA
+4.75mm	%	1	6	4	40.0	no limit
+19.0mm	%	1	<1	<1	NA	NA

Analyte	Units	LOR	Duplicate	Original Results (ACUSR01)	RPD %*	Acceptable RPD %
+75µm	%	1	97	96	1.0	< 20%
+300µm	%	1	80	68	16.2	< 20%
+37.5mm	%	1	<1	<1	NA	NA
Mercury Total (<63µm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Arsenic Total (<63µm fraction)	mg/kg	5	26	16	47.6	no limit
Zinc Total (<63µm fraction)	mg/kg	5	71	55	25.4	< 50 %
Antimony Total (<63µm fraction)	mg/kg	5	<5	<5	NA	NA
Cadmium Total (<63µm fraction)	mg/kg	1	1	<1	NA	NA
Chromium Total (<63µm fraction)	mg/kg	2	29	26	10.9	< 50 %
Copper Total (<63µm fraction)	mg/kg	5	21	16	27.0	no limit
Lead Total (<63µm fraction)	mg/kg	5	8	12	40.0	no limit
Nickel Total (<63µm fraction)	mg/kg	2	25	24	4.1	< 50 %
Mercury Total (<2mm fraction)	mg/kg	0.1	<0.1	<0.1	NA	NA
Arsenic Total (<2mm fraction)	mg/kg	5	<5	<5	NA	NA
Zinc Total (<2mm fraction)	mg/kg	5	19	19	0.0	no limit
Antimony Total (<2mm fraction)	mg/kg	5	<5	<5	NA	NA
Cadmium Total (<2mm fraction)	mg/kg	1	<1	<1	NA	NA
Chromium Total (<2mm fraction)	mg/kg	2	10	10	0.0	no limit
Copper Total (<2mm fraction)	mg/kg	5	5	<5	NA	no limit
Lead Total (<2mm fraction)	mg/kg	5	<5	<5	NA	NA
Nickel Total (<2mm fraction)	mg/kg	2	8	7	13.3	no limit

* RPD% above the acceptable limit are shaded **orange**.

APPENDIX F – LABORATORY REPORTS

CERTIFICATE OF ANALYSIS

Work Order : **EB2235588**
Client : **WULGURU TECHNICAL SERVICES PTY LTD**
Contact : **KERRY BEGGS**
Address : **17 MUELLER ST WULGURU QLD**
 WULGURU 4811
Telephone : ----
Project : **2022.07006 Agate Crk REMP**
Order number : ----
C-O-C number : ----
Sampler : **JAMIE SMITH**
Site : ----
Quote number : **BN/517/22 V2**
No. of samples received : **33**
No. of samples analysed : **33**

Page : 1 of 9
Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053

Telephone : +61-7-3243 7222
Date Samples Received : 29-Nov-2022 09:00
Date Analysis Commenced : 29-Nov-2022
Issue Date : 23-Dec-2022 13:43



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Inorganics, Stafford, QLD



General Comments

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

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

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

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

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

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

- EG020-T (Total Metals by ICP-MS): Sample ACUSR01 (EB2235588-023) and ACDSI08 (EB2235588-032) shows poor duplicate results due to sample heterogeneity. Confirmed by visual inspection.
- EG020T (Total Metals by ICP-MS): Limit of reporting raised for sample ACDSI01 (EB2235588-022) due to low volume.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	ACUSR01	ACUER06	AGATE DUP	ACUR03	ACUSR05
Sampling date / time					22-Nov-2022 09:00	22-Nov-2022 14:30	22-Nov-2022 09:00	22-Nov-2022 17:30	23-Nov-2022 07:00
Compound	CAS Number	LOR	Unit		EB2235588-001	EB2235588-002	EB2235588-003	EB2235588-004	EB2235588-005
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		14.4	3.8	12.9	11.7	10.6
EA150: Particle Sizing									
+63µm	----	1	%		98	94	98	50	83
+212µm	----	1	%		97	92	98	43	77
+300µm	----	1	%		96	90	96	42	72
+600µm	----	1	%		85	78	80	39	58
+2000µm	----	1	%		50	44	38	31	32
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	1	mg/kg		<1	<1	<1	<1	<1
EP003: Total Organic Carbon (TOC) in Soil									
Total Organic Carbon	----	0.02	%		0.05	0.07	0.05	0.60	0.09



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI04	ACDSI05	ACDSI06	ACDSI07	ACDSI08
Sampling date / time				22-Nov-2022 11:30	22-Nov-2022 15:46	22-Nov-2022 11:00	22-Nov-2022 13:00	22-Nov-2022 15:00
Compound	CAS Number	LOR	Unit	EB2235588-006	EB2235588-007	EB2235588-008	EB2235588-009	EB2235588-010
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	3.2	17.9	13.0	16.8	19.0
EA150: Particle Sizing								
+63µm	----	1	%	98	99	96	90	95
+212µm	----	1	%	97	98	90	85	93
+300µm	----	1	%	95	98	83	84	91
+600µm	----	1	%	75	88	71	80	85
+2000µm	----	1	%	43	21	30	54	63
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	1	mg/kg	<1	<1	<1	<1	<1
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	0.03	0.03	0.13	0.62	0.02



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI01	ACUSR01 <63µm fraction	ACUSR06 <63µm fraction	AGATE DUP <63µm fraction	ACUSR03 <63µm fraction
Sampling date / time				22-Nov-2022 12:30	22-Nov-2022 09:00	22-Nov-2022 14:30	22-Nov-2022 09:00	22-Nov-2022 17:30
Compound	CAS Number	LOR	Unit	EB2235588-011	EB2235588-012	EB2235588-013	EB2235588-014	EB2235588-015
				Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	19.4	----	----	----	----
EA150: Particle Sizing								
+63µm	----	1	%	98	----	----	----	----
+212µm	----	1	%	97	----	----	----	----
+300µm	----	1	%	95	----	----	----	----
+600µm	----	1	%	78	----	----	----	----
+2000µm	----	1	%	29	----	----	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	----	2.9	8.4	3.1	1.4
Selenium	7782-49-2	1	mg/kg	----	1	<1	2	<1
Silver	7440-22-4	0.1	mg/kg	----	<0.1	<0.1	<0.1	0.1
Cadmium	7440-43-9	0.1	mg/kg	----	0.1	<0.1	0.2	<0.1
Bismuth	7440-69-9	0.1	mg/kg	----	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	----	24.0	13.5	22.1	21.2
Copper	7440-50-8	0.1	mg/kg	----	32.7	21.7	22.0	49.8
Nickel	7440-02-0	0.1	mg/kg	----	27.1	15.8	24.1	42.5
Lead	7439-92-1	0.1	mg/kg	----	14.5	25.7	13.0	3.7
Antimony	7440-36-0	0.1	mg/kg	----	<0.1	0.1	<0.1	0.1
Zinc	7440-66-6	0.5	mg/kg	----	69.4	95.9	66.1	28.1
Tin	7440-31-5	0.1	mg/kg	----	1.6	0.6	1.1	0.2
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	<0.1	<0.1	<0.1
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	1	mg/kg	<1	----	----	----	----
EP003: Total Organic Carbon (TOC) in Soil								
Total Organic Carbon	----	0.02	%	0.05	----	----	----	----
GEO26: Sieving								
-63µm	----	0.01	%	----	0.12	5.49	0.22	52.6



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR05 <63µm fraction	ACDSI04 <63µm fraction	ACDSI05 <63µm fraction	ACDSI06 <63µm fraction	ACDSI07 <63µm fraction
Sampling date / time				23-Nov-2022 07:00	22-Nov-2022 11:30	22-Nov-2022 15:46	22-Nov-2022 11:00	22-Nov-2022 13:00
Compound	CAS Number	LOR	Unit	EB2235588-016	EB2235588-017	EB2235588-018	EB2235588-019	EB2235588-020
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	1.2	2.8	4.0	4.4	2.2
Selenium	7782-49-2	1	mg/kg	<1	<1	1	1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	6.1	15.4	15.0	18.0	9.3
Copper	7440-50-8	0.1	mg/kg	12.8	30.4	36.3	23.2	10.2
Nickel	7440-02-0	0.1	mg/kg	7.6	23.3	24.1	24.3	11.3
Lead	7439-92-1	0.1	mg/kg	7.6	10.9	13.6	11.1	9.6
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	38.2	64.6	72.8	57.5	22.6
Tin	7440-31-5	0.1	mg/kg	0.6	1.7	1.6	0.8	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
GEO26: Sieving								
-63µm	----	0.01	%	12.2	0.10	0.19	1.78	7.42



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI08 <63µm fraction	ACDSI01 <63µm fraction	ACUSR01 -2mm fraction	ACUSR06 -2mm fraction	AGATE DUP -2mm fraction
Sampling date / time				22-Nov-2022 15:00	22-Nov-2022 12:30	22-Nov-2022 09:00	22-Nov-2022 14:30	22-Nov-2022 09:00
Compound	CAS Number	LOR	Unit	EB2235588-021	EB2235588-022	EB2235588-023	EB2235588-024	EB2235588-025
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	3.6	4.1	1.0	1.9	0.9
Selenium	7782-49-2	1	mg/kg	<1	<2	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.2	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.2	<0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg	<0.1	<0.2	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	10.8	15.5	18.6	4.4	5.2
Copper	7440-50-8	0.1	mg/kg	19.7	68.6	2.7	5.4	2.1
Nickel	7440-02-0	0.1	mg/kg	13.5	28.4	7.6	7.1	5.4
Lead	7439-92-1	0.1	mg/kg	15.0	17.4	4.7	4.9	3.0
Antimony	7440-36-0	0.1	mg/kg	<0.1	0.3	<0.1	0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	43.2	147	12.8	31.7	13.2
Tin	7440-31-5	0.1	mg/kg	0.5	2.9	0.1	<0.1	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
GEO26: Sieving								
-2000µm	----	0.01	%	----	----	53.4	56.8	60.5
-63µm	----	0.01	%	3.53	0.22	----	----	----



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR03 -2mm fraction	ACUSR05 -2mm fraction	ACDSI04 -2mm fraction	ACDSI05 -2mm fraction	ACDSI06 -2mm fraction
Sampling date / time				22-Nov-2022 17:30	23-Nov-2022 07:00	22-Nov-2022 11:30	22-Nov-2022 15:46	22-Nov-2022 11:00
Compound	CAS Number	LOR	Unit	EB2235588-026	EB2235588-027	EB2235588-028	EB2235588-029	EB2235588-030
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	0.8	0.5	0.9	1.3	1.2
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	<1	<1
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	7440-69-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Cobalt	7440-48-4	0.1	mg/kg	27.1	5.8	4.1	6.4	5.1
Copper	7440-50-8	0.1	mg/kg	55.6	7.1	2.4	2.7	3.1
Nickel	7440-02-0	0.1	mg/kg	59.5	7.5	4.7	5.9	7.6
Lead	7439-92-1	0.1	mg/kg	4.4	9.4	2.6	4.4	4.4
Antimony	7440-36-0	0.1	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	0.5	mg/kg	37.5	37.5	12.4	12.8	17.0
Tin	7440-31-5	0.1	mg/kg	0.1	0.2	<0.1	<0.1	0.1
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	69.6	64.6	59.4	79.8	69.3



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI07 -2mm fraction	ACDSI08 -2mm fraction	ACDSI01 -2mm fraction	----	----
Sampling date / time				22-Nov-2022 13:00	22-Nov-2022 15:00	22-Nov-2022 12:30	----	----
Compound	CAS Number	LOR	Unit	EB2235588-031	EB2235588-032	EB2235588-033	-----	-----
				Result	Result	Result	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	1.5	1.1	1.5	----	----
Selenium	7782-49-2	1	mg/kg	<1	<1	<1	----	----
Silver	7440-22-4	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Bismuth	7440-69-9	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Cobalt	7440-48-4	0.1	mg/kg	6.3	3.2	3.7	----	----
Copper	7440-50-8	0.1	mg/kg	5.0	3.8	2.8	----	----
Nickel	7440-02-0	0.1	mg/kg	7.2	4.5	4.5	----	----
Lead	7439-92-1	0.1	mg/kg	5.7	3.8	3.8	----	----
Antimony	7440-36-0	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	0.5	mg/kg	16.1	16.3	12.6	----	----
Tin	7440-31-5	0.1	mg/kg	0.2	<0.1	<0.1	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	49.8	39.3	68.6	----	----

CERTIFICATE OF ANALYSIS

Work Order : **ET2206259**
Client : **WULGURU TECHNICAL SERVICES PTY LTD**
Contact : **KERRY BEGGS**
Address : **17 MUELLER ST WULGURU QLD**
 WULGURU 4811
Telephone : ----
Project : **2022.07006 Agate Creek REMP**
Order number : ----
C-O-C number : ----
Sampler : **JAMIE SMITH, JESSICA CRABB**
Site : ----
Quote number : **TV/135/21 V3**
No. of samples received : **5**
No. of samples analysed : **5**

Page : 1 of 4
Laboratory : Environmental Division Townsville
Contact : Customer Services ET
Address : 13 Carlton Street, Kirwan Townsville QLD Australia 4815
Telephone : +61 7 4773 0000
Date Samples Received : 28-Nov-2022 13:00
Date Analysis Commenced : 28-Nov-2022
Issue Date : 06-Dec-2022 16:25



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe		Townsville Inorganics, Townsville, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Narelle Drummond	Laboratory Manager	Townsville Inorganics, Townsville, QLD



General Comments

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

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

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

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

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

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

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H⁺ to the Cations and Nitrate, SiO₂ and Fluoride to the Anions.
- EA010-P, EA015H, ED037-P, ED041G, ED045G, EK040P conducted by ALS Townsville, NATA accreditation no. 825, (Site no. 23472 for Chemical Testing and Site no. 23313 for Biological Testing)
- All remaining analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818.
- It is recognised that EG020T (Total Metals by ICP-MS) is less than EG020F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER
 (Matrix: WATER)

Sample ID

				ACDSI01	FB AGATE	AGATE DUP	ACDSI05	ACUSR01
Sampling date / time				23-Nov-2022 09:30	23-Nov-2022 09:30	22-Nov-2022 09:00	22-Nov-2022 15:46	22-Nov-2022 09:00
Compound	CAS Number	LOR	Unit	ET2206259-001	ET2206259-002	ET2206259-003	ET2206259-004	ET2206259-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	238	<1	213	219	225
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	141	<10	137	133	125
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	116	3	95	95	101
Total Alkalinity as CaCO3	----	1	mg/L	116	3	95	95	101
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	<1	1	1	4
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	5	<1	10	10	6
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	22	<1	13	14	20
Magnesium	7439-95-4	1	mg/L	7	<1	6	6	7
Sodium	7440-23-5	1	mg/L	14	<1	21	21	11
Potassium	7440-09-7	1	mg/L	4	<1	4	4	7
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	84	<1	57	60	79
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.002	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	<0.001	<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
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	0.141	0.160	<0.001
Molybdenum	7439-98-7	0.001	mg/L	0.002	<0.001	0.005	0.004	0.002
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05



Analytical Results

Sub-Matrix: **WATER**
 (Matrix: **WATER**)

Sample ID

				ACDSI01	FB AGATE	AGATE DUP	ACDSI05	ACUSR01
Sampling date / time				23-Nov-2022 09:30	23-Nov-2022 09:30	22-Nov-2022 09:00	22-Nov-2022 15:46	22-Nov-2022 09:00
Compound	CAS Number	LOR	Unit	ET2206259-001	ET2206259-002	ET2206259-003	ET2206259-004	ET2206259-005
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.13	<0.01	1.01	0.90	0.66
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.004	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	0.009	<0.001	<0.001	<0.001	0.002
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.002	0.002	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.002	0.002	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.001	0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.006	<0.005	<0.005	<0.005	<0.005
Manganese	7439-96-5	0.001	mg/L	0.095	<0.001	0.800	0.797	0.190
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.004	0.004	0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	0.05
Iron	7439-89-6	0.05	mg/L	0.10	<0.05	1.42	1.36	0.59
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	0.6	<0.1	2.1	2.1	0.6
EN055: Ionic Balance								
∅ Total Anions	----	0.01	meq/L	2.50	0.06	2.20	2.20	2.27
∅ Total Cations	----	0.01	meq/L	2.38	<0.01	2.16	2.21	2.23

Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(WATER) EG020F: Dissolved Metals by ICP-MS

(WATER) EG020T: Total Metals by ICP-MS

(WATER) EG035F: Dissolved Mercury by FIMS

(WATER) EG035T: Total Recoverable Mercury by FIMS

(WATER) EN055: Ionic Balance

(WATER) ED093F: Dissolved Major Cations

(WATER) ED093F: SAR and Hardness Calculations



CERTIFICATE OF ANALYSIS

Work Order : **EB2312262**
Client : **WULGURU TECHNICAL SERVICES PTY LTD**
Contact : KERRY BEGGS
Address : LEVEL 1, SUITE 3, 559 FLINDERS STREET
TOWNSVILLE 4810
Telephone : ----
Project : 2022.07006 Agate REMP Soil
Order number : ----
C-O-C number : ----
Sampler : Emma Garison, JESSICA CRABB
Site : ----
Quote number : TV/135/21 V3
No. of samples received : 39
No. of samples analysed : 39

Page : 1 of 10
Laboratory : Environmental Division Brisbane
Contact : Madison Forster
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : +61-7-3243 7222
Date Samples Received : 27-Apr-2023 08:20
Date Analysis Commenced : 17-May-2023
Issue Date : 25-May-2023 21:07



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	Position	Accreditation Category
Beatriz Llarinas	Senior Chemist - Inorganics	Brisbane Inorganics, Stafford, QLD
Layla Hafner	Acid Sulphate Soils - Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD



General Comments

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

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

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

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



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI05	ACDSI01	ACDSI07	ACDSI04	ACDSI06
Sampling date / time				20-Apr-2023 07:30	20-Apr-2023 10:00	20-Apr-2023 13:00	20-Apr-2023 14:30	20-Apr-2023 16:00
Compound	CAS Number	LOR	Unit	EB2312262-001	EB2312262-002	EB2312262-003	EB2312262-004	EB2312262-005
				Result	Result	Result	Result	Result
EA150: Particle Sizing								
+75µm	----	1	%	99	94	98	94	98
+150µm	----	1	%	98	89	98	90	98
+300µm	----	1	%	96	78	91	80	96
+425µm	----	1	%	91	71	82	73	93
+600µm	----	1	%	82	62	69	56	86
+1180µm	----	1	%	57	39	37	27	56
+2.36mm	----	1	%	30	19	15	15	24
+4.75mm	----	1	%	12	3	5	8	9
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	1	6	2	7	1
Sand (>75 µm)	----	1	%	61	69	76	74	66
Gravel (>2mm)	----	1	%	38	25	22	19	33
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR01	ACDSI09	ACUSR07	ACDSI08	ACUSR06
Sampling date / time				20-Apr-2023 17:00	22-Apr-2023 07:30	22-Apr-2023 10:15	22-Apr-2023 10:30	22-Apr-2023 11:00
Compound	CAS Number	LOR	Unit	EB2312262-006	EB2312262-007	EB2312262-008	EB2312262-009	EB2312262-010
				Result	Result	Result	Result	Result
EA150: Particle Sizing								
+75µm	----	1	%	96	99	100	98	96
+150µm	----	1	%	88	98	99	97	95
+300µm	----	1	%	68	96	97	96	93
+425µm	----	1	%	57	90	94	92	88
+600µm	----	1	%	45	80	88	85	77
+1180µm	----	1	%	29	52	71	62	52
+2.36mm	----	1	%	16	26	51	37	35
+4.75mm	----	1	%	4	11	25	10	19
+9.5mm	----	1	%	<1	<1	<1	<1	6
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	4	1	<1	3	4
Sand (>75 µm)	----	1	%	76	65	42	52	56
Gravel (>2mm)	----	1	%	20	34	57	45	40
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR03	ACUSR05	AC DUP	ACDSI05 <2mm Fraction	ACDSI01 <2mm Fraction
Sampling date / time				22-Apr-2023 13:00	22-Apr-2023 15:00	20-Apr-2023 17:00	20-Apr-2023 07:30	20-Apr-2023 10:00
Compound	CAS Number	LOR	Unit	EB2312262-011	EB2312262-012	EB2312262-013	EB2312262-014	EB2312262-015
				Result	Result	Result	Result	Result
EA150: Particle Sizing								
+75µm	----	1	%	86	91	97	----	----
+150µm	----	1	%	85	90	95	----	----
+300µm	----	1	%	81	82	80	----	----
+425µm	----	1	%	78	74	64	----	----
+600µm	----	1	%	75	64	49	----	----
+1180µm	----	1	%	62	42	29	----	----
+2.36mm	----	1	%	40	26	16	----	----
+4.75mm	----	1	%	17	10	6	----	----
+9.5mm	----	1	%	<1	<1	<1	----	----
+19.0mm	----	1	%	<1	<1	<1	----	----
+37.5mm	----	1	%	<1	<1	<1	----	----
+75.0mm	----	1	%	<1	<1	<1	----	----
EA150: Soil Classification based on Particle Size								
Fines (<75 µm)	----	1	%	14	9	3	----	----
Sand (>75 µm)	----	1	%	39	60	77	----	----
Gravel (>2mm)	----	1	%	47	31	20	----	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	----	----	----	<5	<5
Arsenic	7440-38-2	5	mg/kg	----	----	----	<5	<5
Cadmium	7440-43-9	1	mg/kg	----	----	----	<1	<1
Chromium	7440-47-3	2	mg/kg	----	----	----	8	10
Copper	7440-50-8	5	mg/kg	----	----	----	<5	<5
Lead	7439-92-1	5	mg/kg	----	----	----	<5	<5
Nickel	7440-02-0	2	mg/kg	----	----	----	8	7
Zinc	7440-66-6	5	mg/kg	----	----	----	18	17
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	----	----	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	----	----	----	59.7	76.3



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI07 <2mm Fraction	ACDSI04 <2mm Fraction	ACDSI06 <2mm Fraction	ACUSR01 <2mm Fraction	ACDSI09 <2mm Fraction
Sampling date / time				20-Apr-2023 13:00	20-Apr-2023 14:30	20-Apr-2023 16:00	20-Apr-2023 17:00	22-Apr-2023 07:30
Compound	CAS Number	LOR	Unit	EB2312262-016	EB2312262-017	EB2312262-018	EB2312262-019	EB2312262-020
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	<5	<5	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	9	13	9	10	8
Copper	7440-50-8	5	mg/kg	<5	5	<5	<5	<5
Lead	7439-92-1	5	mg/kg	<5	<5	5	<5	5
Nickel	7440-02-0	2	mg/kg	8	10	8	7	5
Zinc	7440-66-6	5	mg/kg	20	23	20	19	13
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	74.2	83.0	69.6	80.6	68.4



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR07 <2mm Fraction	ACDSI08 <2mm Fraction	ACUSR06 <2mm Fraction	ACUSR03 <2mm Fraction	ACUSR05 <2mm Fraction
Sampling date / time				22-Apr-2023 10:15	22-Apr-2023 10:30	22-Apr-2023 11:00	22-Apr-2023 13:00	22-Apr-2023 15:00
Compound	CAS Number	LOR	Unit	EB2312262-021	EB2312262-022	EB2312262-023	EB2312262-024	EB2312262-025
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	<5	5	9	<5
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	7	9	10	25	9
Copper	7440-50-8	5	mg/kg	<5	6	7	76	9
Lead	7439-92-1	5	mg/kg	<5	8	7	6	8
Nickel	7440-02-0	2	mg/kg	3	7	9	57	9
Zinc	7440-66-6	5	mg/kg	10	21	35	56	39
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	47.0	50.5	60.4	50.6	65.2



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				AC DUP <2mm Fraction	ACDSI05 <63µm Fraction	ACDSI01 <63µm Fraction	ACDSI07 <63µm Fraction	ACDSI04 <63µm Fraction
Sampling date / time				20-Apr-2023 17:00	20-Apr-2023 07:30	20-Apr-2023 10:00	20-Apr-2023 13:00	20-Apr-2023 14:30
Compound	CAS Number	LOR	Unit	EB2312262-026	EB2312262-027	EB2312262-028	EB2312262-029	EB2312262-030
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	<5	7	5	6	7
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	10	23	28	29	25
Copper	7440-50-8	5	mg/kg	5	17	15	24	18
Lead	7439-92-1	5	mg/kg	<5	10	10	9	9
Nickel	7440-02-0	2	mg/kg	8	21	22	26	22
Zinc	7440-66-6	5	mg/kg	19	62	51	60	45
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	83.6	----	----	----	----
-63µm	----	0.01	%	----	0.57	3.03	0.41	3.40



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACDSI06 <63µm Fraction	ACUSR01 <63µm Fraction	ACDSI09 <63µm Fraction	ACUSR07 <63µm Fraction	ACDSI08 <63µm Fraction
Sampling date / time				20-Apr-2023 16:00	20-Apr-2023 17:00	22-Apr-2023 07:30	22-Apr-2023 10:15	22-Apr-2023 10:30
Compound	CAS Number	LOR	Unit	EB2312262-031	EB2312262-032	EB2312262-033	EB2312262-034	EB2312262-035
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	7	16	7	7	12
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	32	26	21	27	20
Copper	7440-50-8	5	mg/kg	28	16	32	29	28
Lead	7439-92-1	5	mg/kg	10	12	15	11	13
Nickel	7440-02-0	2	mg/kg	27	24	17	17	16
Zinc	7440-66-6	5	mg/kg	68	55	61	69	60
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-63µm	----	0.01	%	0.40	1.49	0.22	0.26	0.27



Analytical Results

Sub-Matrix: SOIL
 (Matrix: SOIL)

Sample ID

				ACUSR06 <63µm Fraction	ACUSR03 <63µm Fraction	ACUSR05 <63µm Fraction	AC DUP <63µm Fraction	----
Sampling date / time				22-Apr-2023 11:00	22-Apr-2023 13:00	22-Apr-2023 15:00	20-Apr-2023 17:00	----
Compound	CAS Number	LOR	Unit	EB2312262-036	EB2312262-037	EB2312262-038	EB2312262-039	-----
				Result	Result	Result	Result	----
EG005(ED093)T: Total Metals by ICP-AES								
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	----
Arsenic	7440-38-2	5	mg/kg	15	12	<5	26	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	1	----
Chromium	7440-47-3	2	mg/kg	24	20	13	29	----
Copper	7440-50-8	5	mg/kg	43	71	22	21	----
Lead	7439-92-1	5	mg/kg	19	<5	10	8	----
Nickel	7440-02-0	2	mg/kg	19	50	11	25	----
Zinc	7440-66-6	5	mg/kg	91	46	52	71	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----
GEO26: Sieving								
-63µm	----	0.01	%	0.22	12.1	6.68	1.37	----



CERTIFICATE OF ANALYSIS

Work Order : ET2302171
Client : WULGURU TECHNICAL SERVICES PTY LTD
Contact : KERRY BEGGS
Address : LEVEL 1, SUITE 3, 559 FLINDERS STREET
TOWNSVILLE 4810
Telephone : ----
Project : 2022.07006 Agate REMP Water
Order number : ----
C-O-C number : ----
Sampler : Emma Garison, JESSICA CRABB
Site : ----
Quote number : TV/135/21 V3
No. of samples received : 9
No. of samples analysed : 9

Page : 1 of 7
Laboratory : Environmental Division Townsville
Contact : Madison Forster
Address : 13 Carlton Street, Kirwan Townsville QLD Australia 4815
Telephone : +61 7 4773 0000
Date Samples Received : 24-Apr-2023 10:10
Date Analysis Commenced : 28-Apr-2023
Issue Date : 05-May-2023 17:04



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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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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
Kim McCabe		Townsville Inorganics, Townsville, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Narelle Drummond	Laboratory Manager	Townsville Inorganics, Townsville, QLD



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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 Contract for details.

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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.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H⁺ to the Cations and Nitrate, SiO₂ and Fluoride to the Anions.
- 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.
- EA010-P, EA015H, ED037-P, ED041G, ED045G, EK040P conducted by ALS Townsville, NATA accreditation no. 825, (Site no. 23472 for Chemical Testing and Site no. 23313 for Biological Testing)
- Ionic Balance out of acceptable limits for some samples due to analytes not quantified in this report.
- All remaining analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818.
- It is recognised that EG020T (Total Metals by ICP-MS) is less than EG020F (Dissolved Metals by ICP-MS) for 'AC DUP' (ET2302171-008). This was confirmed by re-digestion and re-analysis.
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.



Analytical Results

Sub-Matrix: WATER
 (Matrix: WATER)

Sample ID

				ACDSI05	ACDSI01	ACDSI07	ACDSI04	ACDSI06
Sampling date / time				20-Apr-2023 07:30	20-Apr-2023 10:00	20-Apr-2023 13:00	20-Apr-2023 14:30	20-Apr-2023 16:00
Compound	CAS Number	LOR	Unit	ET2302171-001	ET2302171-002	ET2302171-003	ET2302171-004	ET2302171-005
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	391	364	276	343	333
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	228	213	169	192	201
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	3	24	9	23
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	137	136	80	125	112
Total Alkalinity as CaCO3	----	1	mg/L	137	140	104	134	134
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8	6	4	5	5
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	25	24	24	24	24
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	32	32	22	30	30
Magnesium	7439-95-4	1	mg/L	11	12	9	10	11
Sodium	7440-23-5	1	mg/L	30	29	26	27	28
Potassium	7440-09-7	1	mg/L	4	4	4	4	4
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	125	129	92	116	120
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<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
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	0.066	0.006	0.003	0.003	0.006
Molybdenum	7439-98-7	0.001	mg/L	0.002	0.001	<0.001	<0.001	0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05



Analytical Results

Sub-Matrix: WATER
 (Matrix: WATER)

Sample ID

				ACDSI05	ACDSI01	ACDSI07	ACDSI04	ACDSI06
Sampling date / time				20-Apr-2023 07:30	20-Apr-2023 10:00	20-Apr-2023 13:00	20-Apr-2023 14:30	20-Apr-2023 16:00
Compound	CAS Number	LOR	Unit	ET2302171-001	ET2302171-002	ET2302171-003	ET2302171-004	ET2302171-005
				Result	Result	Result	Result	Result

EG020F: Dissolved Metals by ICP-MS - Continued

EG020T: Total Metals by ICP-MS

Aluminium	7429-90-5	0.01	mg/L	0.41	0.06	0.08	0.03	0.05
Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<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
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	0.187	0.018	0.009	0.007	0.009
Molybdenum	7439-98-7	0.001	mg/L	0.002	0.001	0.001	0.001	0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	0.47	0.06	<0.05	<0.05	<0.05

EG035F: Dissolved Mercury by FIMS

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
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EG035T: Total Recoverable Mercury by FIMS

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
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EK040P: Fluoride by PC Titrator

Fluoride	16984-48-8	0.1	mg/L	0.8	0.7	0.6	0.6	0.6
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EN055: Ionic Balance

∅ Total Anions	----	0.01	meq/L	3.61	3.60	2.84	3.46	3.46
∅ Total Cations	----	0.01	meq/L	3.91	3.95	3.07	3.60	3.72
∅ Ionic Balance	----	0.01	%	3.99	4.62	----	1.96	3.68



Analytical Results

Sub-Matrix: WATER
 (Matrix: WATER)

Sample ID

				ACUSR01	ACDSI09	AC DUP	AC FB	----
Sampling date / time				20-Apr-2023 17:00	22-Apr-2023 07:30	20-Apr-2023 17:00	20-Apr-2023 17:30	----
Compound	CAS Number	LOR	Unit	ET2302171-006	ET2302171-007	ET2302171-008	ET2302171-009	-----
				Result	Result	Result	Result	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	162	373	175	<1	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	109	218	120	<10	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	76	155	74	3	----
Total Alkalinity as CaCO3	----	1	mg/L	76	155	74	3	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4	25	4	<1	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	13	36	14	<1	----
Magnesium	7439-95-4	1	mg/L	4	12	4	<1	----
Sodium	7440-23-5	1	mg/L	13	32	13	<1	----
Potassium	7440-09-7	1	mg/L	3	4	3	<1	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	49	139	51	<1	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.96	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	0.006	<0.001	----
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	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.002	<0.001	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.001	<0.001	----
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	0.286	0.008	0.442	<0.001	----
Molybdenum	7439-98-7	0.001	mg/L	0.004	<0.001	0.003	<0.001	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	2.13	<0.05	----



Analytical Results

Sub-Matrix: WATER
 (Matrix: WATER)

Sample ID

				ACUSR01	ACDSI09	AC DUP	AC FB	----
Sampling date / time				20-Apr-2023 17:00	22-Apr-2023 07:30	20-Apr-2023 17:00	20-Apr-2023 17:30	----
Compound	CAS Number	LOR	Unit	ET2302171-006	ET2302171-007	ET2302171-008	ET2302171-009	-----
				Result	Result	Result	Result	----

EG020F: Dissolved Metals by ICP-MS - Continued

EG020T: Total Metals by ICP-MS

Aluminium	7429-90-5	0.01	mg/L	0.55	0.02	0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	0.006	<0.001	0.002	<0.001	----
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	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	0.003	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	<0.001	----
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	0.753	0.029	0.257	<0.001	----
Molybdenum	7439-98-7	0.001	mg/L	0.005	<0.001	0.004	<0.001	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Iron	7439-89-6	0.05	mg/L	2.39	0.15	0.06	<0.05	----

EG035F: Dissolved Mercury by FIMS

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
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EG035T: Total Recoverable Mercury by FIMS

Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
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EK040P: Fluoride by PC Titrator

Fluoride	16984-48-8	0.1	mg/L	1.0	0.2	1.0	<0.1	----
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EN055: Ionic Balance

∅ Total Anions	----	0.01	meq/L	1.63	3.80	1.59	0.06	----
∅ Total Cations	----	0.01	meq/L	1.62	4.28	1.67	<0.01	----
∅ Ionic Balance	----	0.01	%	----	5.89	----	----	----



Inter-Laboratory Testing

Analysis conducted by ALS Brisbane, NATA accreditation no. 825, site no. 818 (Chemistry) 18958 (Biology).

(WATER) EG020F: Dissolved Metals by ICP-MS

(WATER) EG020T: Total Metals by ICP-MS

(WATER) EG035F: Dissolved Mercury by FIMS

(WATER) EG035T: Total Recoverable Mercury by FIMS

(WATER) EN055: Ionic Balance

(WATER) ED093F: Dissolved Major Cations

(WATER) ED093F: SAR and Hardness Calculations