Carter's Freshwater Mussel Annual Monitoring Program, 2025-26

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Executive Summary

The 2025-26 Carter's Freshwater Mussel (CFM; *Westralunio carteri*) monitoring program addressed the monitoring and reporting requirements outlined in the CFMMP (Stantec 2023a) for annual monitoring of the Vulnerable (BC Act and EPBC Act) Carter's Freshwater Mussel in Freshwater Lake, the Augustus River and at regional reference sites. Field surveys were undertaken between the 2nd and 11th November 2025 (shallow water survey) and between the 30th and 31st March 2026 (deep water dive survey). A total of 16 sites were assessed across Freshwater Lake (eight sites), the Augustus River (three sites) and at regional reference sites (five sites) during the 2025-26 Program. Surveys included water and sediment quality, aquatic fauna (fish and crayfish) sampling, habitat characterisation, and targeted deep-water mussel searches. Water level and flow data provided by Worsley Alumina were examined to address monitoring and reporting requirements outlined in the CFMMP (Stantec 2023a).

Freshwater Lake exhibited low habitat complexity, and was characterised by limited riparian vegetation, low woody debris, and reduced organic inputs, resulting in marginal suitability for CFM recruitment. Deeper areas were dominated by unconsolidated, anoxic sediments unsuitable for stable CFM populations. In contrast, the Augustus River maintained relatively higher habitat complexity and supported larger CFM populations, although recent drying has likely reduced densities.

Surface water levels at Freshwater Lake ranged from 228–238 m AHD between 2022 and 2025, with 2025 recording the lowest level since monitoring began (228 m AHD in June). In 2025, water levels fell below the 231 m AHD trigger, particularly from April to August, likely due to below-average rainfall and peak abstraction. Seasonal patterns were atypical, with lows occurring in winter rather than summer. Concurrently, environmental flow requirements to the Augustus River were not met during the monitoring period, with average discharge rates from September to December below the stipulated 2.9 m³/5 mins and flow rates frequently below the stipulated rates, resulting in extended cease-to-flow periods. In consultation with DWER, South32 were permitted to extend the program to meet the required flow. Low flows were also observed outside this period, continuing a trend similar to 2024. These conditions may have reduced available habitat for CFM and fish hosts.

Surface water quality at Freshwater Lake, Augustus River and regional reference sites during the 2025-26 Program was characterised by generally circumneutral to slightly alkaline pH across all sites, with dissolved oxygen remaining within acceptable limits for aquatic fauna. Freshwater Lake exhibited elevated electrical conductivity, turbidity, and nutrients (total nitrogen and total phosphorus) relative to the respective ANZG (2018) guideline values (GVs) for upland rivers, suggesting influences from sediment inputs and surrounding land use. In contrast, Augustus River sites generally met ANZG (2018) GVs for turbidity and nutrients. All sites remained within freshwater salinity thresholds, and acid sulfate soil risk was low despite elevated sulfate at some of the monitored sites. Most dissolved metals were within GVs; however, aluminium concentrations exceeded the ANZG (2018) 95% species protection default guidelines values (DGVs) and the trigger criteria under the CFMMP (**Table ES1**). While dissolved oxygen was within acceptable limits during sampling, the monitoring design cannot detect short-term hypoxic events. While ammonia concentrations at all sites remained within acceptable limits, elevated nutrient loads increase the risk of eutrophication and subsequent depletion of dissolved oxygen, particularly in low-flow conditions.

Sediment quality during the 2025-26 Program was characterised by moderately acidic to neutral pH at Freshwater Lake and neutral at Augustus River and reference sites, with all sites classified as non-saline. Freshwater Lake showed higher moisture content and aluminium concentrations, and the Augustus River exhibited elevated sediment nitrogen, potentially reflecting nutrient inputs from organic matter loading or catchment-driven influences such as increased fertiliser use. Most metals were below ANZG (2018) DGVs and GV-High, though aluminium was elevated in Freshwater Lake sediments (likely linked to refining processes) and at one Augustus River site (AR2). Concentrations of mercury, required to be assessed in accordance with the CFMMPMP (Stantec 2023) (**Table ES1**), were below the LoRs at all sites sampled during the 2025-26 Program. Regionally, major ion concentrations increased from 2024 (notably calcium, magnesium, potassium, and sodium), likely reflecting reduced hydroperiods. While still within freshwater ranges, these changes indicate potential declining water availability and risk to water quality. Elevated interstitial ammonia may also constrain early life stages of CFM, though this is not detectable under the current monitoring program.

A total of 230 CFM individuals were recorded across 11 sites during the 2025-26 Program, with 78% of all CFM alive at the time of detection. Freshwater Lake populations were small (39 live CFM recorded during the targeted dive survey), confined to deeper habitats around the periphery of the lake, and dominated by large, older individuals, indicating little to no recent recruitment and a high risk of long-term decline. Fish data indicates that the available CFM glochidia host populations have declined from 2023, while potential aquatic crustacean predators have remained at 2023 levels. These pressures may be restricting recruitment at Freshwater Lake. While mortality detections (six individuals) were comparatively low, the absence of recent recruitment indicates a potential risk of long-term population decline, particularly under continued environmental stress.

The Augustus River supported 82 live mussels and remains a comparatively stable population, despite a minor 15.6% decline in density since 2021. This decline is below the 20% trigger criteria defined in the CFMMP (Stantec 2023) (**Table ES1**). The minor reduction in density over time is likely attributable to the acute environmental stress likely associated with reduced hydroperiods and below-average rainfall. There have been substantial increases in CFM population density over time at Augustus River, notably when the population density peaked at 9.7 mussels/m^2 during the 2024-25 monitoring period. Despite a reduction in larger adults between 2024 and 2025–26 at Augustus River sites, the detection of smaller individuals indicates recent recruitment and an overall stable CFM population at Augustus River.

Regional reference sites showed high variability, with some sites lacking CFM and others supporting stable or declining populations. Both CESA16 (Harris River) and BRUN01 (Brunswick River), recorded live individuals. The CFM population structure at BRUN01 indicates it is a viable, stable population with active recruitment, however the population at Harris River suggests it has experienced losses in recent years with a complete absence of older individuals. In contrast, two sites recorded no CFM (RR02_99 and LR_Dam), and one site recorded a single dead CFM (RR10_99). This variability highlights increasing fragmentation and sensitivity to local conditions, reinforcing the importance of maintaining multiple reference sites.

Freshwater fish sampling during the 2025–26 Program confirmed the presence of suitable host species for CFM glochidia across all systems, including Freshwater Lake (Western Pygmy Perch and the Western Minnow), indicating host availability is unlikely to limit CFM recruitment. Fish abundance and diversity were highest in the Augustus River, where all recorded species were either potential or confirmed glochidia host species and catch rates exceeded those from the previous 2023 monitoring. In contrast, Freshwater Lake supported lower diversity and fish abundances, likely reflecting the reduced habitat complexity, elevated turbidity, and lower water levels, which may constrain CFM recruitment dynamics. Regional reference sites supported a mix of native and invasive species (e.g. Rainbow Trout), while Lunenburgh Dam was dominated by the invasive Eastern Gambusia, with no native fish recorded from the site, consequently suggesting the potential suppression of native taxa at the Dam. Smooth Marron and the native Gilgie were recorded across sites, with Smooth Marron particularly widespread and abundant. These generalist omnivores are likely to prey on juvenile CFM, representing an additional pressure on the early life stages of the species.

The recommendations provided in Section 6 of this report have been developed to improve understanding of factors influencing CFM population dynamics and survival, and to strengthen monitoring and assessment under the CFMMP. These recommendations are intended to enhance interpretation of existing datasets, address key data gaps, and improve comparability across monitoring sites.

Table ES1: CFMMP outcome-based management provisions criteria assessment based on the 2025-26 Program.

	Outcome-based Management Objectives	Trigger Criteria	Trigger Criteria Exceeded?	Threshold Criteria	Threshold Criteria Exceeded?
IW1	Minimise adverse impacts to CFM due to project-related land clearing surrounding Freshwater Lake or Augustus River.	• Clearing occurs without an authorised internal permit within the CBME, but outside the 50 m buffer zone of Freshwater Lake.	• Not applicable to this scope of work	• Unauthorised clearing or disturbance within the 50 m buffer zone of Freshwater Lake.	• Not applicable to this scope of work
		• Clearing occurs without an authorised internal permit within the CBME, but outside the 200m buffer zone of Augustus River.	• Not applicable to this scope of work	• Unauthorised clearing or disturbance within the 200m buffer zone of Augustus River.	• Not applicable to this scope of work
IW2	**Avoid adverse impacts to Carter's Freshwater Mussel from decreased water levels below minimum caused by excessive water abstraction within Freshwater Lake.**	• Water levels recorded below 231 m AHD in Freshwater Lake.	• **Trigger criteria exceeded** in Freshwater Lake April to August 2025	• Water levels recorded below 225 m AHD for a period of three months in Freshwater Lake.	• Threshold criteria not exceeded in Freshwater Lake between April to August 2025, with a minimum of 228 m AHD
IW3	Avoid adverse impacts to Carter's Freshwater Mussel from changes in suspended solids due to Project-related sedimentation.	• Isolated occurrence of overtopping of sediment trap(s) into Freshwater Lake.	• Not applicable to this scope of work	• Continued occurrence / or overtopping of multiple sediment trap(s) into Freshwater Lake.	• Not applicable to this scope of work
IW3	**Avoid adverse impacts to Carter's Freshwater Mussel from changes in suspended solids due to Project-related sedimentation.**	• Total Suspended Soilds: >8 mg/L in the surface water of Freshwater Lake and Augustus River in a single monitoring event.	• TSS not measured in 2025. • Turbidity in FWL ranged 120 – 170 NTU, while AR ranged from 4.3 – 4.7NTU.	• Total Suspended Soilds: >15 mg/L in the surface water of Freshwater Lake and Augustus River in a single monitoring event.	• Not measured in 2025.
IW4	**Avoid adverse impacts to Carter's Freshwater Mussel from elevated mercury (Hg) levels in the surface water of Freshwater Lake or Augustus River and in the sediment of Freshwater Lake.**	• Dissolved Mercury: >0.00006 mg/L in the surface water of Freshwater Lake and Augustus River, in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; NOTE: the LoR for dissolved mercury in 2025 was 0.0001 mg/L	• Dissolved mercury: >0.0006 mg/L in the surface water of Freshwater Lake and Augustus River, in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River. NOTE the LoR for dissolved mercury in 2025 was 0.0001 mg/L
		• Total Mercury: 0.15 mg/kg in the sediment of Freshwater Lake and Augustus River, in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Total Mercury: 1.0 mg/kg in the sediment of Freshwater Lake and Augustus River, in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River
IW5	**Avoid adverse impacts to Carter's Freshwater Mussel from elevated aluminium, cadmium, copper, lead, and zinc concentrations in the surface water of Freshwater Lake or Augustus River.**	• Dissolved Aluminium: >0.027 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• **Trigger criteria exceeded** for aluminium within Freshwater Lake at all five sites (0.04 mg/L – 0.05 mg/L) • Trigger criteria not exceeded within the Augustus River	• Dissolved Aluminium: >0.055 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River
		• Dissolved Cadmium: >0.00006 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved cadmium in 2025 was 0.0001 mg/L	• Dissolved Cadmium: >0.0002 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved cadmium in 2025 was 0.0001 mg/L
		• Dissolved Copper: >0.001 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Dissolved Copper: >0.0014 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River
		• Dissolved Lead: >0.001 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Dissolved Lead: >0.034 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River
		• Dissolved Zinc: >0.0024 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved zinc in 2025 was 0.005 mg/L	• Dissolved Zinc: >0.008 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved zinc in 2025 was 0.005 mg/L
IW6	**Minimise adverse impacts to Carter's Freshwater Mussel from salinisation of the surface water of Freshwater Lake and Augustus River.**	• Salinity >1.6 g/L in the surface water of Freshwater Lake and/or Augustus River in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Salinity >3 g/L in the surface water of Freshwater Lake and/or Augustus River in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River
		• Individual mortality recorded of Carter's Freshwater Mussel at Freshwater Lake.	• **Trigger criteria exceeded** within Freshwater Lake with 6 dead Carter's Freshwater Mussel individuals recorded in 2025. Noting that deaths cannot be linked directly to salinity using single annual water quality measure.	• 50% reduction in Carter's Freshwater Mussel known population size (individuals) in Freshwater Lake.	• Threshold criteria not exceeded within Freshwater Lake
		• Reduction in density (per square metre) of Carter's Freshwater Mussel by >20% recorded at Augustus River.	• **Trigger criteria not exceeded** within the Augustus River with average density declining 15.6% from 2021 baseline densities. • Total 43 dead mussels detected in AR.	• 50% reduction in Carter's Freshwater Mussel known density (per square metre) in Augustus River.	• **Threshold criteria not exceeded** within the Augustus River with average loss of 15.6% (2021 to 2025-26)

Acronyms / Abbreviations

Acronym / Abbreviation	Full Name
ASS	Acid Sulphate Soils
AHD	Australian Height Datum
BBM	Boddington Bauxite Mine
BoM	Bureau of Meteorology
BTC	Bauxite Transport Corridor
CBME	Contingency Bauxite Mining Envelope
CFM	Carter's Freshwater Mussel
CFMMP	Carter's Freshwater Mussel Management Plan
CPUE	Catch Per Unit Effort
DBCA	Department of Biodiversity Conservation and Attractions
DO	Dissolved Oxygen
DVGs	Default Guideline Values
DWER	Department of Water and Environmental Regulation
EC20	20% Effective Concentration
EC50	50% Effective Concentration
EP Act	*Environmental Protection Act 1986*
IBRA	Interim Biogeographic Regionalisation for Australia
LD_{50}	Lethal Dose for 50% of a population
LoR	Limits of Reporting
NATA	National Association of Testing Authorities
NTU	Nephelometric Turbidity Units
PCA	Principal Components Analysis
RLA	Refinery Lease Area
SD	Standard Deviation
SSGVs	Site-specific Guideline Values
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Sediments
WME	Worsley Mine Expansion
WMDE	Worsley Mine Development Envelope

1 Introduction

1.1 Background

South32 Worsley Alumina Pty Ltd (Worsley Alumina) currently operates the Boddington Bauxite Mine (BBM), Worsley Refinery (the Refinery), and port operations at the Bunbury Port. Worsley Alumina is expanding their existing operations at the BBM and the Refinery, collectively referred to as the Worsley Mine Expansion (WME). The WME comprises three development envelopes: the Worsley Mine Development Envelope (WMDE), the Bauxite Transport Corridor (BTC), and the Contingency Bauxite Mining Envelope (CBME), with the latter located at the Refinery, approximately 15 km northwest of the town of Collie and approximately 143 km south of Perth (**Figure 1**). The CBME is a key component of the WME. It is approximately 747 hectares (ha) in size and is located within the boundary of the Refinery Lease Area (RLA), situated approximately 65 km southwest of Boddington (**Figure 1**).

An artificial freshwater lake (referred to as Freshwater Lake) is situated at the Refinery and supplies raw water for operations. The Refinery and Freshwater Lake are located at the headwaters of the Augustus River, which was dammed in 1980 to create the approximately 62 ha artificial lake. The Augustus River continues downstream of Freshwater Lake, with a reach of the tributary situated within the boundary of the CBME (**Figure 1**). Freshwater Lake is recharged directly and indirectly by rainfall, with drainage from the Augustus River headwater diverted around the Refinery into the lake via a series of sediment traps.

Carter's Freshwater Mussel (CFM), *Westralunio carteri* Iredale, 1934, is one of three freshwater mussel taxa endemic to southwestern Western Australia (Klunzinger *et al.* 2022). It is a slow growing, long-lived species reaching maturity at 4–6 years and living up to 50 years (Klunzinger *et al.* 2014), with a larval stage that relies on a range of native and introduced host fish (e.g. a host generalist). The species typically occurs in permanent to semi-permanent, low salinity water bodies with substantial riparian vegetation and fine to medium grained sediments, often associated with woody debris near river banks (Klunzinger *et al.* 2015a; Ma *et al.* 2022a; Morgan *et al.* 2011; TSSC 2018). The species has experienced a >40% decline in extent of occurrence (EOO) over the past 50 years (Klunzinger *et al.* 2015a; Walker *et al.* 2014), and it is listed as Vulnerable under both the *Biodiversity Conservation Act 2016* (BC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Freshwater Lake, the Augustus River and other perennial freshwater rivers and lakes within the Collie region are known to support CFM populations (Hale *et al.* 2000; Stantec 2021b; 2024; WRM 2005). As filter feeders, freshwater mussels play a key ecological role in maintaining water quality, nutrient cycling and biodeposition, while also contributing to food webs (Klunzinger *et al.* 2014; Vaughn and Hakenkamp 2001; Vaughn *et al.* 2008).

In 2021, Worsley Alumina funded a baseline survey within Freshwater Lake and the Augustus River to document the extent of the CFM population relative to Refinery operations (Stantec 2021b), along with a regional survey of the Hotham, Williams and Murray Rivers as part of the environmental approval assessment process for the proposed WME (Stantec 2022). Worsley Alumina subsequently funded the development of the Carter's Freshwater Mussel Management Plan (CFMMP) to guide management of potential impacts to CFM populations within Freshwater Lake and the Augustus River associated with the proposed WME (Stantec 2023b). The first annual monitoring program was undertaken in 2023, incorporating water and sediment quality assessments and CFM surveys in Freshwater Lake and the Augustus River with regional reference sites selected in the Brunswick River, Ernest River and Lunenburgh River Dam (Stantec 2024). The 2025-26 monitoring program (the 2025-26 Program) represents the third consecutive year of implementation under the CFMMP, with methods consistent with previous monitoring programs.

1.2 Legislative Context

Current Worsley Alumina operations are regulated by the Department of Water and Environmental Regulation (DWER) under Part V of the Western Australian *Environmental Protection Act 1986* (EP Act). The BBM EP Act licence was approved in 1983 and last amended in 2022 (L5960/1983/11) and the Refinery's EP Act licence was approved in 1981 and last amended in 2022 (L4504/1981/17). Worsley Alumina also holds a DWER Surface Water Licence

(SWL6804(4)). Carter's Freshwater Mussel baseline surveys, the annual monitoring program, and the CFMMP were developed and implemented in alignment with the following legislation and guidance, as far as practicable:

- Western Australian *Biodiversity Conservation Act 2016*;
- Western Australian *Environmental Protection Act 1986*;
- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*;
- Environmental Factor Guideline – Inland Waters (EPA 2018);
- Environmental Factor Guideline – Terrestrial Fauna (EPA 2016);
- Instructions: How to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans (EPA 2024);
- Environmental Management Plan Guidelines (DCCEEW 2024);
- Conservation Advice – *Westralunio carteri* Carter's freshwater mussel (TSSC 2018);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 2, Aquatic Ecosystems (ANZECC & ARMCANZ 2000) ;
- Australian & New Zealand Guidelines for Fresh & Marine Water Quality (ANZG 2018); and
- Field sampling guidelines: A guideline for field sampling for surface water quality monitoring programs (DoW 2009).

1.3 Objective and Scope

The objective of the 2025-26 Program is to monitor CFM populations at Freshwater Lake, Augustus River and regional reference sites, to detect potential impacts from the WME in accordance with the CFMMP (Stantec 2023b). The following tasks were undertaken to meet the objective:

- Collection of water and sediment samples from Freshwater Lake, the Augustus River and regional reference sites for chemical analysis, comparing results to baseline data and available guidance; and for future development of site specific guideline values (SSGVs) to complement the CFM annual monitoring program.
- Assess the population size and density of CFM in Worsley Freshwater Lake, Augustus River and regional reference sites, targeting shallow waters
- Assess the population size and density of CFM in Worsley Freshwater Lake, targeting deeper waters (sampled via a dive survey);
- Document freshwater fish species at Freshwater Lake, Augustus River and Regional Rivers in accordance with criteria defined in the CFMMP.
- Report on the key findings in relation to the management objectives and environmental criteria defined in the CFMMP.

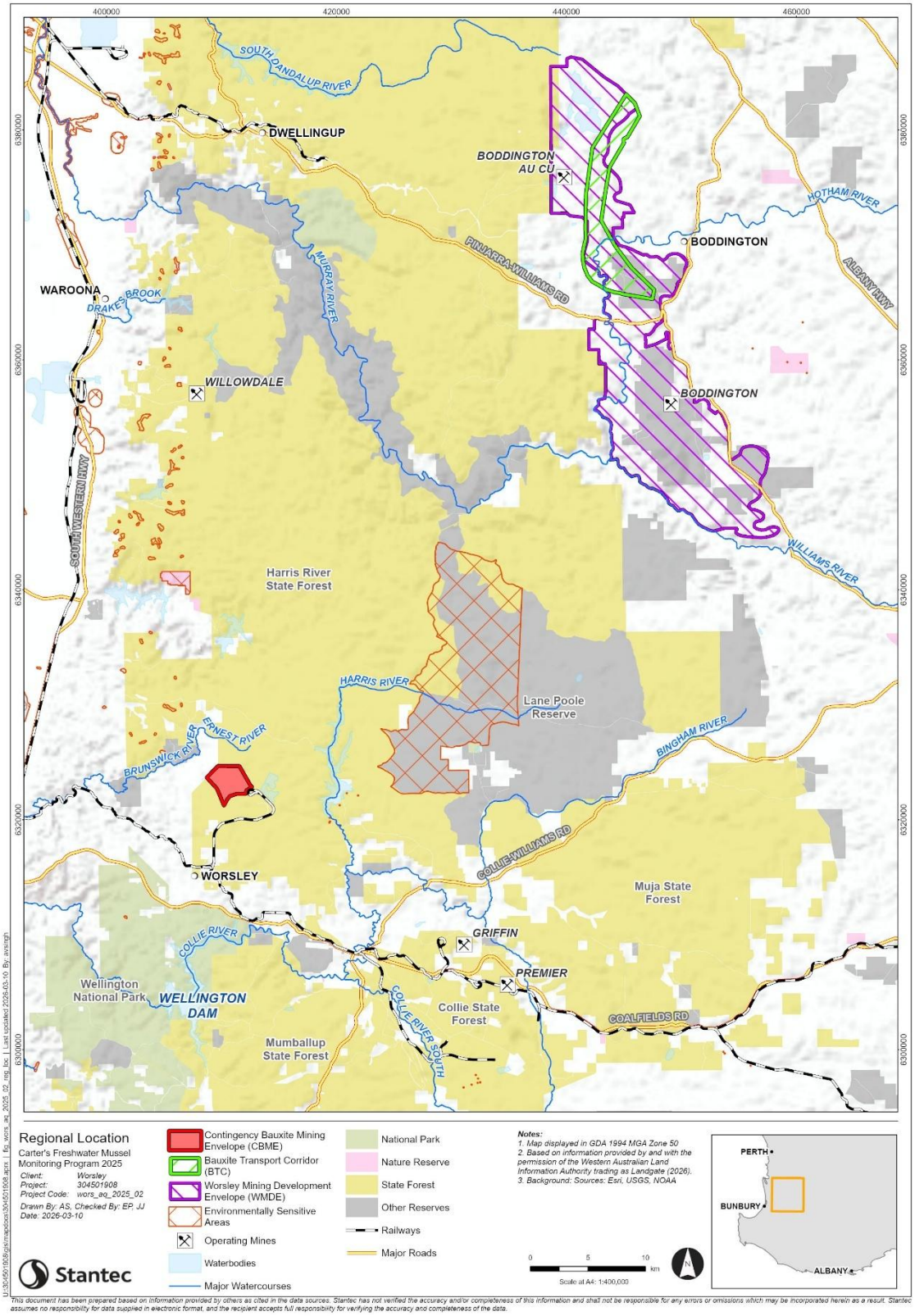


Figure 1: Regional location of the Worsley Mine Expansion development envelopes, including the Contingency Bauxite Mining Envelope.

2 Existing Environment

2.1 Biogeographic Location

The Refinery, its associated water supply reservoir (Freshwater Lake), the Augustus River, and the regional reference waterways are situated in the Northern Jarrah Forest subregion (JAF01), as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (Thackway and Cresswell 1995) (**Figure 2**). The Northern Jarrah Forest subregion is situated east of the Darling Scarp, with an average elevation of 300 m above sea level, covering a land area of 22,559.04 km^2.

The underlying geological formations of the area comprise Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust that has been dissected by later drainage and interrupted by occasional granite hills. The vegetation is dominated by overstoreys of Jarrah (*Eucalyptus marginata*) – Marri (*Corymbia calophylla*) forest in the west, with Bullich (*Eucalyptus megacarpa*) and Swan River Blackbutt (*Eucalyptus patens*) in the valleys, giving way to Wandoo (*Eucalyptus wandoo*) woodlands in the east, with Powder-bark Wandoo (*Eucalyptus accedens*) on breakaways (Williams and Mitchell 2001). Soils in the bioregion are characterised as infertile, phosphorus deprived and often salt-laden.

2.2 Hydrology and Drainage

The Refinery, CMBE and associated Freshwater Lake are surrounded by the Harris River State Forest, with the Harris River Dam located approximately 10 km to the east of the Refinery (**Figure** 1**)**. The Augustus River is a tributary of the Brunswick River, one of the major river systems within the Collie River Basin (AWRC 1976), with the confluence of the two rivers located approximately 5 km downstream of the CBME (South32 2019). The Augustus River was dammed in 1980 to create the approximately 62 ha reservoir, Freshwater Lake **(Figure 1**), with water abstracted from Freshwater Lake to supply Refinery operations.

Freshwater Lake has a maximum capacity of 6 gigalitres (GL) and dead storage of 1 GL, resulting in an available storage capacity of 5 GL (GRM 2020). In accordance with SWL6804(4), the maximum annual abstraction limit from Freshwater Lake is 5.4 GL (GRM 2020). The lake is recharged directly and indirectly by rainfall, with drainage from the Augustus River headwater diverted around the Refinery entering the lake via a series of sediment traps. In addition, Freshwater Lake is supplemented with water imported from the Harris River, as required, to meet the minimum water level requirements of 231 m AHD. Therefore, water levels within Freshwater Lake fluctuates markedly with changes in annual rainfall and abstraction rates for Refinery operations. As with the majority of rivers and creeks of southwestern Australia, the Augustus River downstream of Freshwater Lake flows seasonally, with peak flow during winter and spring coinciding with peak rainfall during June and July (South32 2019). Over summer (December-February), the Augustus River recedes to a series of stagnant pools.

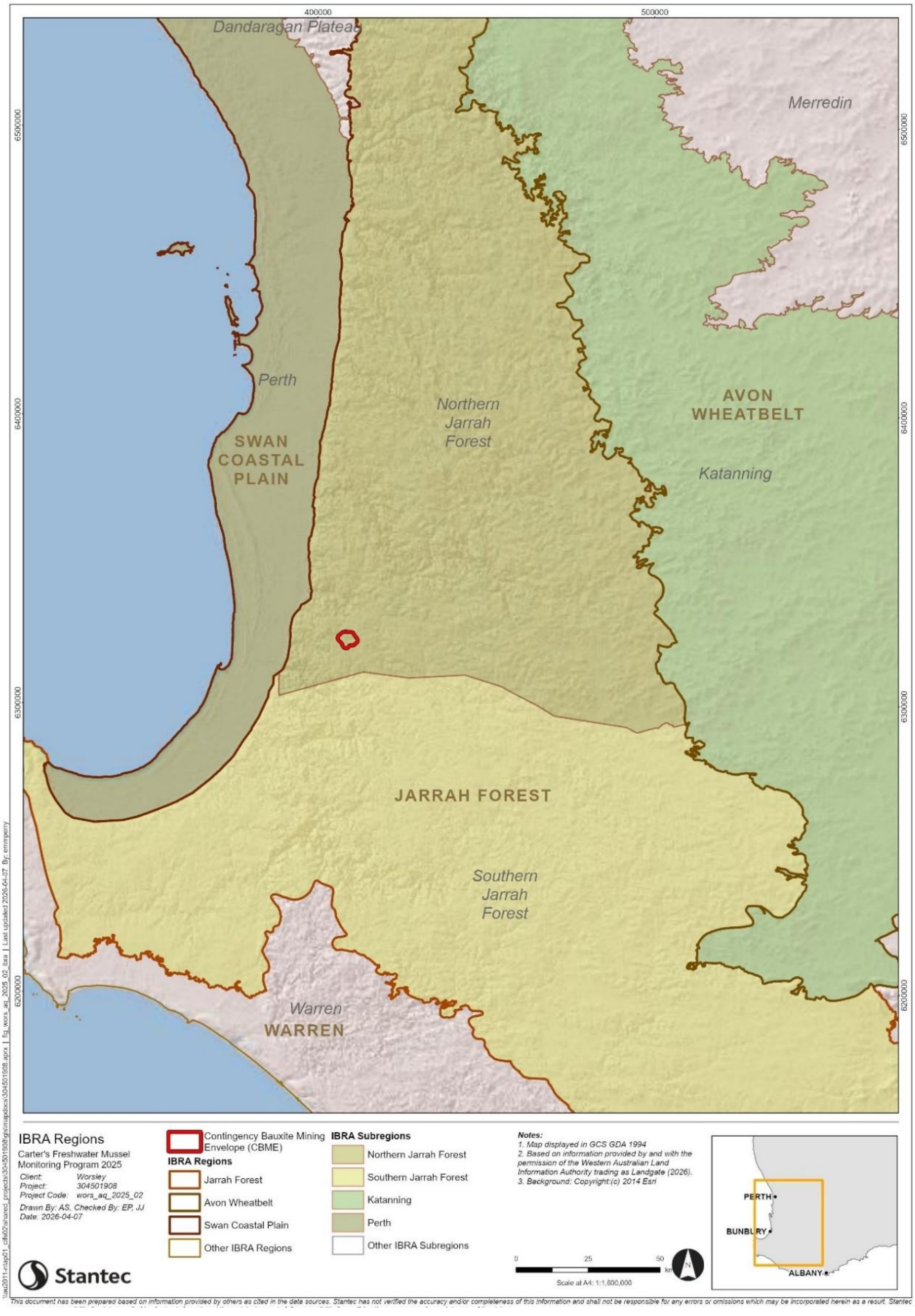


Figure 2:Location of the Contingency Bauxite Mining Envelope (CBME) within the Northern Jarrah Forrest subregion.

2.3 Climate

The climate of the Collie area is typical of Mediterranean climatic regions, with cool wet winters and hot dry summers (GRM 2020). Peak rainfall occurs primarily in July and August, coinciding with the lowest average minimum temperatures (3.8°C to 4°C) recorded from the Bureau of Meteorology (BoM) weather station nearest to the CBME and the Refinery (Collie East 009994), located approximately 3.8 km to the southeast (BoM 2023; 2026)(Figure 3). The highest maximum temperatures are typically recorded between December and February, ranging from 30.4°C to 32.8°C (BoM 2023), with the highest maximum temperature in 2025 recorded in January (32.8°C), which was similar to maximum temperatures recorded in 2024 (Figure 3) (BoM 2026).

Rainfall in most months of 2025 was below the long-term monthly average for the station, with the exception of April, July and August 2025 which were above their respective average monthly rainfall, recording 62 mm, 146.8 mm and 136.2 mm respectively (Figure 3). However, minimal rainfall was recorded in January and February 2025 (1.6 mm respectively) (Figure 3) and no rainfall was recorded in December 2025 (Figure 3).

Total annual rainfall recorded in 2025 was 571 mm, an increase from the 2024 total of 548.4 mm (BoM 2026). Notably, rainfall in 2024 and 2025 was significantly lower than the long-term annual average of 687.4 mm (2003 – 2025), however 2023 recorded just 462.3 mm, the lowest rainfall since 2019. The lowest historical annual rainfall in the period 2003 to 2025 was recorded in 2019, with just 311.2 mm. This was followed by two above-average rainfall years in 2020 and 2021, with the last four years below the long-term average for the station (**Figure 4**).

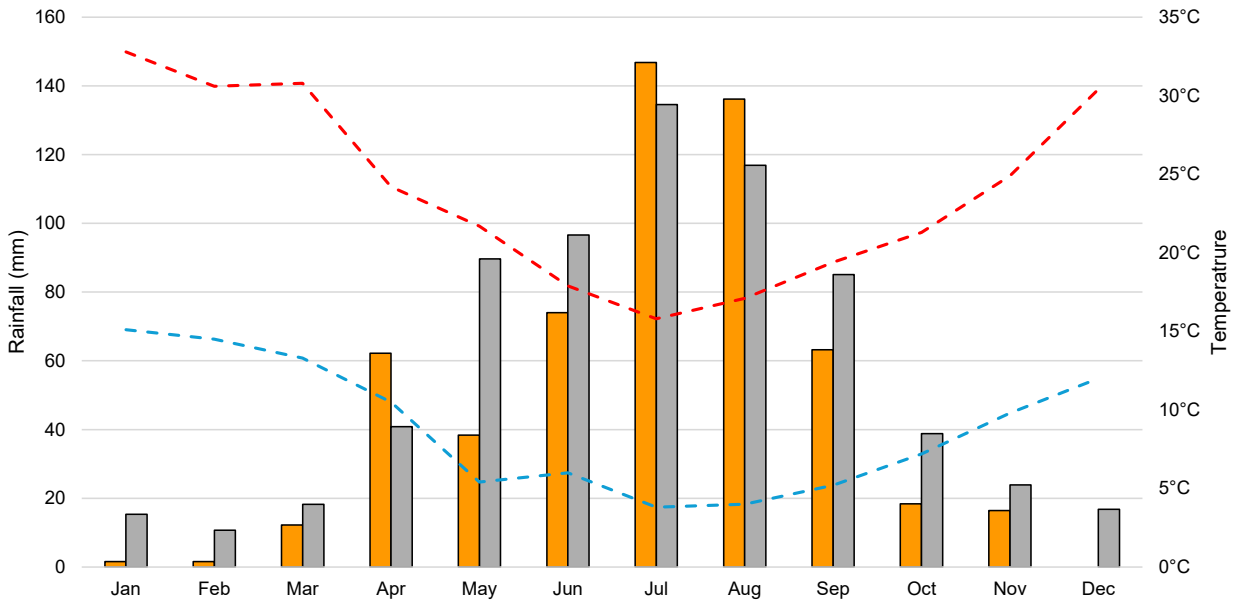


Figure 3: Total monthly rainfall (■) for 2025, long-term average monthly rainfall 2003 – 2025 (■), long-term average monthly maximum temperature (- -) and long-term average monthly minimum temperature (- -) recorded at Collie East Weather Station (BoM Site No. 009994)

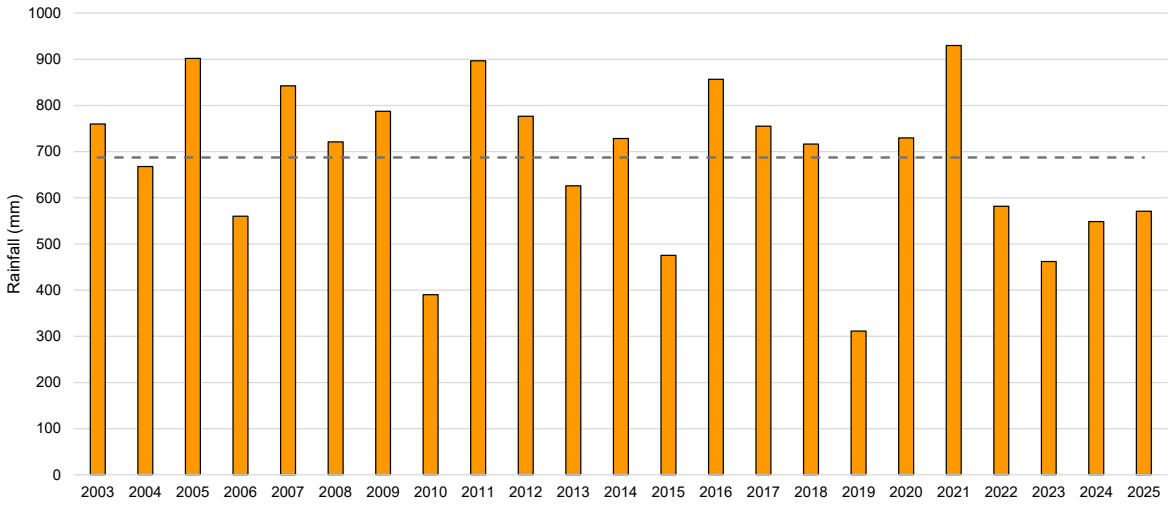


Figure 4: Annual rainfall (▬) and long-term average annual rainfall (- -) recorded at Collie East Weather Station (BoM Site No. 009994) between 2003 and 2025.

3 Methods

3.1 Monitoring Program and Site Assessment

The 2025-26 Program consisted of a shallow water survey and a deep-water SCUBA dive survey. The 2025-26 shallow water survey was conducted from the 2nd November to the 11th November 2025, and aligned with the CFMMP (Stantec 2023b). Shallow water habitat monitoring was undertaken by Aquatic Ecologist Kate Walker (3 years' experience) and Graduate Aquatic Ecologist Charles Corr (2 years' experience). A deep-water SCUBA dive survey was conducted by Stantec's Scientific Diving Team between the 30th and 31st of March 2026 by Principal Environmental Scientist Emma McQuie (13 years' experience), Environmental Scientist Madeline George (4 years' experience), and Graduate Aquatic Ecologist Charles Corr (2 years' experience). Sampling was conducted under the following licences:

- Fauna Taking (Biological Assessment) Licence No. BA27000963-c, pursuant to Regulation 27 of the Biodiversity Conservation Regulations 2018, issued by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA);
- Lawful Authority to undertake "Authorised Activities" on specified CALM Land, pursuant to Regulation 4(1) of the Conservation and Land Management Regulations 2002 issued by the DBCA; and
- Instrument of Exemption No. 251309825, pursuant to Section 7(1) of the *Fish Resources Management Act 1994*, issued by the Western Australian Department of Primary Industries and Regional Development (DPIRD).

During the 2025-26 Program, a total of 16 sites were assessed, consisting of eight sites in Freshwater Lake, three sites in the Augustus River, and five regional reference sites in the Lunenburgh River Dam, Brunswick River (two sites), Harris River and Ernest River (**Figure 5**). At the request of the client, sites FWL07_23, FWL08_23 and FWL09_23 were not surveyed.

To maintain consistency with sites established by Stantec between 2021 and 2025, sites names retain the original site code prefix. A suffix indicating the last two digits of the year in which the site was first established is appended. Where a site location remains unchanged, the original suffix is retained. However, for clarity, only the primary site code is used throughout this document. A complete list of historical sites, their location and sampling components are provided in **Appendix A**.

In addition to the sampling components outlined below, site assessments were undertaken at each site. These included recording site coordinates, capturing site photographs (**Appendix B**) and documenting habitat characteristics (e.g. sediment type, water depth, riparian vegetation and instream diversity) (**Appendix C**). Raw CFM shell measurement data is provided in **Appendix D**. Detailed methods for each sampling component are described in subsequent sections.

3.1.1 Limitations

Inconsistencies in monitoring locations between years have limited direct comparison of trends between impact and reference sites. Reference sites are important for distinguishing whether observed changes are driven by regional-scale processes or by localised pressures (e.g. changes in water quality within a water body).

Monitoring at several reference sites has been constrained due to below average rainfall in 2024 and 2025, which resulted in insufficient water availability during CFM surveys. In addition, one reference site in the Lunenburgh River (LR_DAM) that recorded CFM during the 2021 baseline assessment has not recorded any live mussels in subsequent surveys. To address this, two additional reference sites were included into the 2025-26 Program. These sites were identified during the 2026 CFM Baseline Survey (Stantec 2026) as likely to be permanent and both supported CFM populations. As these sites have only recently been included, interpretation of temporal trends

for regional reference sites should be undertaken with caution due to inconsistencies in site representation between years.

Several water and sediment quality parameters, including dissolved oxygen (DO), salinity (EC), nutrients and pH require relatively high-frequency monitoring to adequately characterise temporal variability in habitat condition. For example, spot measurements do not capture diel fluctuations or short-term hypoxic events, which are critical to CFM, while parameters such as pH and nutrients are often closely linked to DO dynamics. Similarly, salinity and nutrient concentrations can vary in response to flow conditions, rainfall and surrounding land use. As such, the snapshot of water quality captured in this Program should not be considered a comprehensive assessment of conditions relevant to CFM survival within the sampled waterbodies. Interpretation should instead be supported by higher-frequency datasets collected by South32 under their licence monitoring requirements.

Table 1:Sites and sampling components assessed during the 2025-26 Program.

Site Classification	Waterbody	Site	Coordinates (UTM)	Water Quality	Sediment Quality	Habitat Characterisation	Qualitative Mussel Sampling	Targeted Mussel Sampling	Fish and Crayfish	
									Fyke	Seine
Impact Sites	Freshwater Lake	FWL1	50 H 410040, 6322977	✓	✓	✓	✓		✓	✓
		FWL2	50 H 410399, 6322159	✓	✓	✓				
		FWL3	50 H 410392, 6323135	✓	✓	✓	✓		✓	✓
		FWL4	50 H 410838, 6323502	✓	✓	✓	✓		✓	✓
		FWL5	50H 410594 6323648	✓	✓	✓	✓		✓	✓
		FWL_Dive1	50 H 410039, 6322977			✓		✓		
		FWL_Dive2	50 H 410216, 6322781			✓		✓		
		FWL_Dive3	50 H 410362, 6323083			✓		✓		
	Augustus River	AR1	50 H 409047, 6323850	✓	✓	✓	✓		✓	
		AR2	50 H 409233, 6323778	✓	✓	✓	✓		✓	
		AR3	50 H 408538, 6324014	✓	✓	✓	✓			
Regional Reference Sites	Lunenburgh River Dam	LR_DAM	50 H 405512, 6319488	✓	✓	✓	✓		✓	✓
	Brunswick River	BRUN01	50 H 392029, 6319488	✓	✓	✓	✓			✓
		RR10_99	50 H 406012, 6324676	✓	✓	✓	✓		✓	
	Ernest River	RR02_99	50 H 408648, 6328622	✓	✓	✓	✓			
	Harris River	CESA16	50 H 420525 6319148	✓	✓	✓	✓			✓

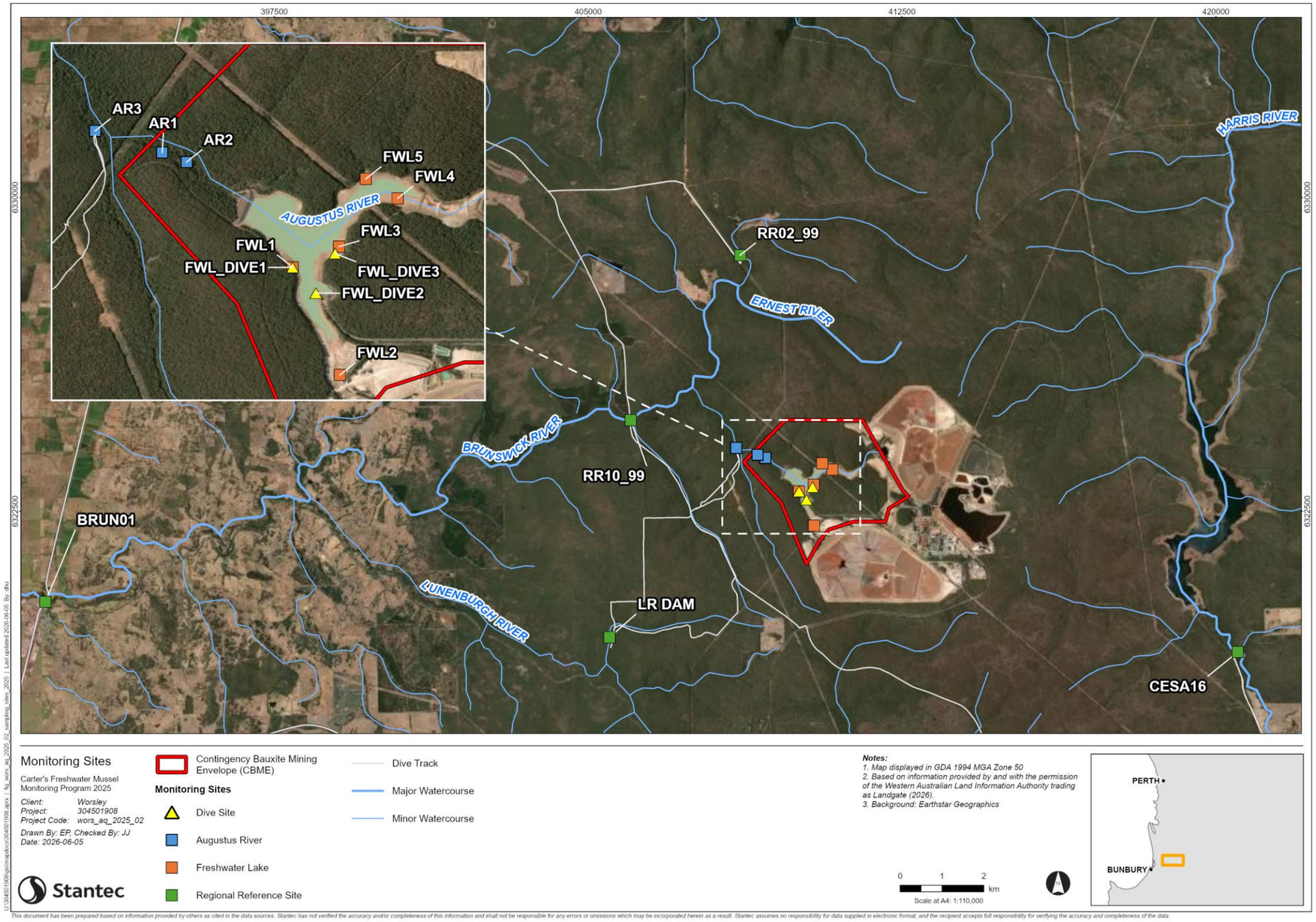


Figure 5: Sites sampled within Freshwater Lake and the Augustus River, Lunenburgh River Dam, Brunswick River and Ernest River for the 2025-26 Program.

3.2 Water Levels and Flows — Freshwater Lake

South 32 provided Stantec with hydrological data, including daily water levels, monthly abstraction rates for Freshwater Lake, and discharge rates from Freshwater Lake to the Augustus Riiver. These data were collated and assessed against the threshold criteria outlined in Worsley Alumina's Surface Water License (SWL6804(4)).

3.3 Water Quality

Basic water quality parameters were measured *in situ* using a portable, hand-held water quality field meter (Professional Plus Handheld Multiparameter Model PSE1 – 1m, YSI Inc., 1725 Brannum Lane, Yellow Springs, OH 45387, USA), including salinity (mg/L), electrical conductivity (as specific conductivity, µS/cm), dissolved oxygen (% and mg/L), temperature (°C) and pH (pH units). The water quality field meter was calibrated according to manufacturer's standards prior to the field survey. A summary of *in situ* water quality measurments are provided in **Appendix C**.

Water samples were collected for laboratory analysis from the 13 shallow water sites (**Table 1**), using protocols commensurate with NATA-accredited testing during the field survey and analysed for the parameters listed in **Table 2.** At each site, bottles were labelled with the date and time of sampling, site identification code, project identification code, and staff name. Water samples were collected from ca. 10 cm below the water's surface using a plastic bucket, taking care to avoid the collection of any floating debris. Each sterilised analytical sample bottle (containing preservative where required) was filled with water using a sterile syringe and sealed, excluding air from the samples. Nutrient samples were filtered through a 45 µm filter cartridge attached to the syringe. Following collection, the samples were stored in an esky with ice and moved into a refrigerator at a temperature setting of 4°C. Nutrient samples were stored in the freezer at a setting of -5°C, to meet the requirements of Australian Laboratory Services (ALS). At the completion of sampling, all samples were transported in an esky with ice back to Stantec, Perth, stored in a refrigerator or a freezer (nutrient suite samples) overnight and shipped to ALS via courier the next morning for analysis. Holding times were met for all parameters except for pH at all sites; pH results are therefore indicative only.

Table 2: Parameters analysed from water quality samples during the 2025-26 Program.

Basic Parameters	Major Ions	Nutrients	Dissolved Metals and Metalloids	
pH	Chloride	Total Nitrogen	Aluminium	Manganese
Total Dissolved Solids	Bicarbonate	Total Phosphorus	Arsenic	Molybdenum
Electrical Conductivity	Carbonate	Total Kjeldahl Nitrogen	Boron	Nickel
Temperature	Sulphate	Ammonia	Barium	Lead
Dissolved Oxygen	Sodium	Ammonium	Cadmium	Selenium
Turbidity	Calcium		Cobalt	Sulphur
	Potassium		Chromium	Silicon
	Magnesium		Copper	Uranium
	Alkalinity		Iron	Vanadium
			Mercury	Zinc

The pH was compared to the classification by Foged (1978), comprising acidic waters (4.5 to 6.5), circumneutral waters (6.5 to 7.5), and alkaline waters (>7.5). Salinity was compared to Hammer (1986), classifying surface waters into freshwater (<3,000 mg/L), hyposaline (3,000 to 20,000 mg/L), mesosaline (20,000 to 50,000 mg/L), and hypersaline (>50,000 mg/L).

Water quality parameters and nutrient concentrations were also compared to the lower and upper default guideline values (DGVs) for upland rivers and wetlands in the southwest of WA (ANZG 2018). Concentrations of metals and metalloids (referred to as metals) were compared against the ANZG (2018) DGVs for 80% species protection and 95% species protection. These values were used in the absence of site-specific guideline values and are considered default values only.

3.4 Sediment Quality

Sediment samples were collected from 13 sites for laboratory analysis (**Table 1**), using protocols commensurate with NATA-accredited testing during the field survey, with parameters analysed listed in **Table 3**. For each site, collection jars were labelled with the date and time of sampling, site identification code, project identification code, and the names of the samplers. The top 2 cm of sediment was scraped into a sterilised glass jar (excluding voids), provided by ALS. Following collection, the samples were stored in an esky with ice and moved into a freezer to extend the holding time for nitrate, as instructed by ALS. After all samples had been collected, they were transported in an esky with ice back to Stantec, Perth, stored in a freezer overnight and shipped to ALS via courier the next morning for analysis. Holding times were met for all parameters.

Sediment pH was compared to the classification system developed by Hazelton and Murphy (2007) comprising slightly acidic (6.1 – 6.5), neutral (6.6 – 7.4), mildly alkaline (7.4 – 7.8), and moderately alkaline (7.9 – 8.4) categories, noting that this classification system was developed for application to soil in agricultural environments. Concentrations of metals were compared to the ANZG (2018) DGVs and upper guideline values (GV-High) for sediment, with toxicity-related effects to species potentially observed at concentrations above the GV-High value.

Table 3: Parameters analysed from sediment samples during the 2025-26 Program.

Basic Parameters	Major Ions	Nutrients	Dissolved Metals and Metalloids	
pH	Chloride	Total Nitrogen	Aluminium	Manganese
Total Dissolved Solids	Bicarbonate	Total Phosphorus	Arsenic	Molybdenum
Electrical Conductivity	Carbonate	Total Kjeldahl Nitrogen	Boron	Nickel
Temperature	Sulphate	Ammonia	Barium	Lead
Dissolved Oxygen	Sodium	Ammonium	Cadmium	Selenium
Turbidity	Calcium		Cobalt	Sulphur
	Potassium		Chromium	Silicon
	Magnesium		Copper	Uranium
	Alkalinity		Iron	Vanadium
			Mercury	Zinc

3.5 Freshwater Mussel Ecology Survey

3.5.1 Quantitative Sampling: Shallow-water Sites

The 2025-26 Program aligned with the CFMMP (Stantec 2023b), which followed established methods (Klunzinger 2012; Klunzinger *et al.* 2012a; Klunzinger *et al.* 2011a; Klunzinger *et al.* 2011b; Lymbery *et al.* 2008; Sheldon *et al.* 2020). At each quantitative monitoring site, a 50 m to 100 m reach of waterway was visually inspected for the presence of CFM shells or live individuals. At each site, one person wearing waders entered the water to a maximum depth of waist-deep and conducted searches of the waterway substrate for CFM using a sieve or fine-toothed rake. Where individual CFM were found, a 50 m long transect was established, perpendicular to the water's edge, to a maximum water depth of 1 m using a graduated field measuring tape between temporary star pickets hammered into the ground.

At each site, quantitative sampling comprised:

- Deployment of 10 x 1 m^2 PVC quadrats placed randomly along the 50 m transect on substrate considered suitable for Carter's Freshwater Mussel with the start and end point of each transect. Each individual quadrat was marked using a handheld GPS unit with coordinates recorded; and
- Collection of individual CFM within each quadrat. Individuals were counted and measured for height, length and width (**Figure 6**).

Quadrat sampling was undertaken to reduce sampling bias and to estimate CFM patch density. When CFM individuals were located within the sediment, they were inspected to determine if they were alive or dead. If shells were fully intact, did not have any holes and could not be pried apart, they were determined to be alive. The presence of dead individuals or shell fragments were also recorded, and shells were retained in plastic zip lock bags labelled with survey date and site for later measurement. The length and height (**Figure 6**) of all sampled individuals (live and dead) was measured to the nearest 0.1 mm using handheld vernier callipers. Live individuals were released to their approximate point of collection.

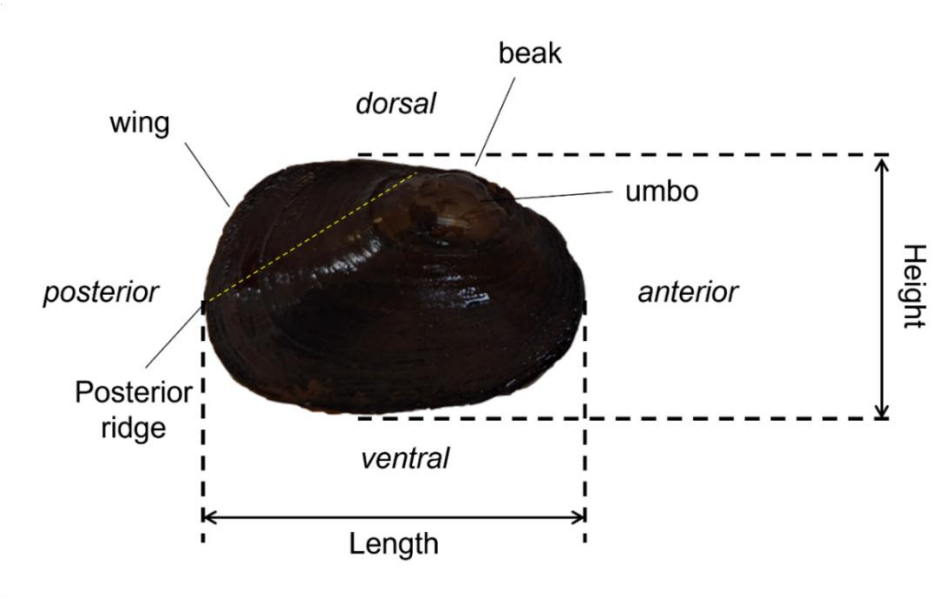


Figure 6: Carter's Freshwater Mussel shell anatomy, shell measurements (Height and Length) and orientation descriptors (provided in italics).

3.5.2 Targeted Survey: Deep Water Sites

Targeted CFM searches were undertaken via SCUBA diving at three sites within Freshwater Lake as required under the CFMMP for deep water sites, each within 50 m from the shoreline. At each site a transect was established by rolling out a weighted measuring tape perpendicular to the shore. One diver on each side of the tape conducted visual and tactile searches of the lake substate up to 1 m either side of the tape. Depth and temperature were recorded automatically with the use of Garmin Descent G1 Solar dive computers until the end of the transect was reached. Upon completion of the perpendicular transect, divers conducted a tactile search along a 50 m transect parallel to the shore at approximately 2 to 3 m depth. Carter's Freshwater Mussel individuals were collected in mesh dive bags and taken to shore to be measured as described above. At each sampling transect, CFM individuals were determined to be alive or dead, and dead shells were retained while live individuals were released by the divers to their approximate place of collection. Quadrat sampling was not conducted at Freshwater Lake deep-water sites due to visibility and sediment stability limitations associated with SCUBA diving.

3.5.3 Freshwater Fish and Crayfish Sampling

Native fish fauna was targeted using integrated fishing methods, consisting of a combination of fyke nets and beach seine netting. In most instances, at least one method was used at each site, except for Ernest River site RR02_99, and FWL2 in Freshwater Lake. Water levels at these sites during the 2025-26 Program were too low for either method to be effective. Two fyke nets were set at seven sites in shallow areas, in opposite directions (where practicable), submerged sufficiently to allow fish to swim into the net, but with sufficient air space within the net for by-catch to be able to breathe (**Plate 1, Appendix E**). Fyke nets were deployed overnight and emptied every 24 hours, with nets deployed for a minimum of 72 hours at each site. Fyke nets were not deployed at FWL2, AR3, RR02_99, BRUN01, and CESA16 as water depths were insufficient and only a single fyke net was set at FWL3, FWL4 and FWL5 to maximise sampling effort at the Freshwater Lake sites in the available timeframe.

Beach seine nets were used along the banks at suitable sites with safe access. Seine nets were employed at eight sites during the 2025-26 Program. Seine nets were used in areas free of emergent vegetation or submerged logs. The net was drawn through the water in a sweeping arc by two people, and all fish and crayfish captured were dispensed into a bucket for enumeration and identification.

All fish and crayfish were identified in the field, with fish measured for standard length (SL mm) and crayfish measured for carapace length (CL mm). All captured individuals were checked for CFM larvae (if possible), health and reproductive status and then released. Fish nomenclature followed that of Allen *et al.* (2002). Freshwater fish and crayfish abundance has been presented as catch per unit effort (CPUE) at Freshwater Lake and Augustus River for the 2025-26 Program.



Plate 1: Fyke nets deployed in and LR Dam (left) Freshwater Lake (right).

3.6 Statistical Analysis

A range of multivariate statistical analyses were employed to interrogate the data collected during the Study performed in the statistical package PRIMER, Version 7.0. Principal components analysis (PCA) was used to investigate patterns in abiotic parameters (water and sediment quality) for the 2025-26 Program. Prior to analysis, data values below the level of analytical detection were halved, while parameters with more than 50% of values below detection were removed from the dataset. Selected parameters were transformed to reduce skewness (ensuring the data was normally distributed) and collinear variables (those with a linear relationship) were removed during pre-treatment of the data. The results of the PCA are shown in the form of a biplot, on which sites that are similar are clustered closer together. Vectors radiate from the centre of the plot, the length and direction of the vector representing the influence of each parameter on each site. Higher concentrations of a parameter tend to occur near the end point of the vector. Acute angles between vectors indicates they are correlated while those at 90° to one another are not correlated. The reported percentage variance is used to explain the strength of the PCA; presented over the first two axes of the plot. A value of more than 60% is considered a useful interpretation of the results (Clarke and Warwick 2001).

Average densities of CFM/m^2 (counts of live CFM per quadrat/total number of quadrats surveyed at that site) were calculated to provide between and within year comparison of population densities between quantitatively monitored sites. Catch per unit effort (CPUE) were calculated for all fish and crayfish data to provide a suitable comparison measure between sites to determine spatial trends in freshwater fish hosts.

3.7 Temporal Comparison

The 2025-26 Program results were compared to baseline data from 2021 to assess potential changes in sediment and water quality parameters and CFM populations. For interpretability, most parameters were averaged across sites within each waterbody type (e.g. Freshwater Lake, Augustus River and Regional Reference Sites), yielding a single annual metric per parameter for each waterbody type. Figures include standard error bars to indicate variability among sites within each year; and larger values reflect greater within-group variability (e.g. among regional reference sites versus Augustus River sites). As the composition of regional reference sites has varied between years, comparisons within this group should be interpreted with caution.

4 Results and Discussion

4.1 Habitat Description

4.1.1 Freshwater Lake

Freshwater Lake sites during the 2025-26 Program were characterised by a moderately steep, unvegetated shoreline with no evidence of woody debris, organic matter or emergent macrophytes in the waterbody. Low water levels in the lake in 2025 resulted in a large separation (>15 m) between the shoreline and riparian vegetation limiting natural organic loads to the water body. There was no surface water in the southernmost section of the lake (FWL2) in November 2025 and water samples were taken from the closest surface water, a small (10 cm wide) nearby stream which was flowing into the larger water body (Stantec 2024). Freshwater Lake's substrate comprises consolidated clay interspersed with coarse sand and cobbles. At greater depths, sediment condition follows a gradient of increasing soft clay, transitioning abruptly to a deep (>2 m) layer of unconsolidated, anoxic sedimentary deposits within the deeper areas of the lakebed.

4.1.2 Augustus River

The Augustus River is a seasonally flowing natural stream, that has been modified by a v-notch weir in the section immediately downstream of Freshwater Lake. Site AR2 is situated upstream of the weir, and is a deep (ca. 1.5 m), permanent pool which was characterised by silty sediments, native riparian vegetation and instream macrophyte growth during the 2025-26 Program. Downstream from the weir, sites AR1 and AR3 are situated on the narrow stream profile. The stream has rocky substrates, dense macrophyte growth instream and dense intact riparian vegetation. The downstream sites AR1 and AR3 typically experience flooding from June to November and contained water during the November shallow-water survey. However, in February 2025 (2024-25 monitoring) AR3 was dry. These dry conditions in February 2025 likely resulted from a combination of below average rainfall in 2023 and 2024, the delayed environmental flow releases from Freshwater Lake (following consultation with DWER) and the reduced flow from the upstream v-notch weir (see **Section 4.2**).

4.1.3 Regional Reference Sites

Regional reference sites RR02_99 (Ernest River), RR10_99 and BRUN01 (Brunswick River), and CESA16 (Harris River) are typical of natural narrow riverine channels in the region. Surface water was present at all monitored regional reference sites at the time of the 2025-26 Program. These sites are narrow river channel sections fringed by dense native riparian vegetation, which contribute to shading and organic matter inputs. A notable exception is BRUN01. The riparian vegetation at this site comprises primarily exotic plant species, including exotic pasture grasses and willow trees. The proximity of this site to the Brunswick township, caravan park and its location within a largely modified landscape is likely to contribute to lower water quality when compared to other reference sites.

BRUN01 and CESA16 exhibited moderate flow conditions during the 2025-26 Program, with the substrates dominated by exposed bedrock overlain by pebbles, coarse sand, and organic detritus. Water depth was 1 m and 2 m respectively. In contrast, RR02_99 and RR10_99 displayed low-flow conditions, with substrates comprising fine silt interlaced with pebbles and overlain by substantial accumulations of leaf litter, indicating a higher contribution of organic material and reduced hydraulic energy.

Lunenburgh River Dam (LR_Dam) contained water and exhibited habitat and substrate characteristics broadly comparable to those observed at Freshwater Lake, including sand–clay substrates. In contrast to Freshwater Lake, LR_Dam had extensive stands of fringing vegetation in the riparian zone, submerged macrophytes, leaf litter, and detritus providing extensive structural habitat complexity relative to Freshwater Lake.

4.2 Water Level and Flow — Freshwater Lake

Surface water levels at the Freshwater Lake have ranged from a minimum of 228 Australian Height Datum (AHD) in 2025 to a maximum of 238 AHD in 2022 (**Figure 7**). In 2025, levels ranged from a maximum of 234 AHD on the 1st January 2025 with the lowest level recorded on the 4th June 2025 of 228 AHD. Water levels which are monitored fortnightly were recorded below the trigger criterion of 231 m AHD defined in the CFMMP (Stantec 2023b) between early April through to August 2025. The minimum level recorded during this period (228 AHD) was the lowest observed since monitoring commenced in 2017. Rainfall for 2025 was below average from January to March and May to June (**Figure 3**) and likely contributed to the low water levels in the lake, however low water levels also coincided with peak abstraction rates from Freshwater Lake (**Figure 8**). Post the August 2025 lows, maximum water levels reached 231.6 AHD in October 2025, only marginally above the trigger criterion. The timing of maximum and minimum water levels observed in 2025 are atypical in comparison to historical trends, where water levels typically peak between August and September in response to winter rainfall, and minimum levels occur during the dry summer months between October and April.

Worsley Alumina's Surface Water License (SWL6804(4)) stipulates that water must be released from Freshwater Lake at a rate of 35 L/hr. (equating to 2.9 m^3/5 mins), into the Augustus River between September and December each year, with the aim of maintaining environmental flows in the downstream receiving environment (GRM 2020). An average discharge rate of 2.5 m^3/5 mins was achieved in September 2025 with a minimum flow of 1.02 m^3/5 mins and peak flow rate of 8.79 m^3/5 mins (**Figure 9**). Low flow periods were recorded in December 2024 (average 0.68 m^3/5 mins), June 2025 (average 0.63 m^3/5 mins), November 2025 (average 2.56 m^3/5 mins), and December 2025 (1.43 m^3/5 mins). The average flow rate in October was 0.96 m^3/5 mins with monthly average flow rates in the September to December period all below the stipulated environmental release rates. Similar low flow trends were observed in 2024 with flows declining from December 2023 to June 2024.

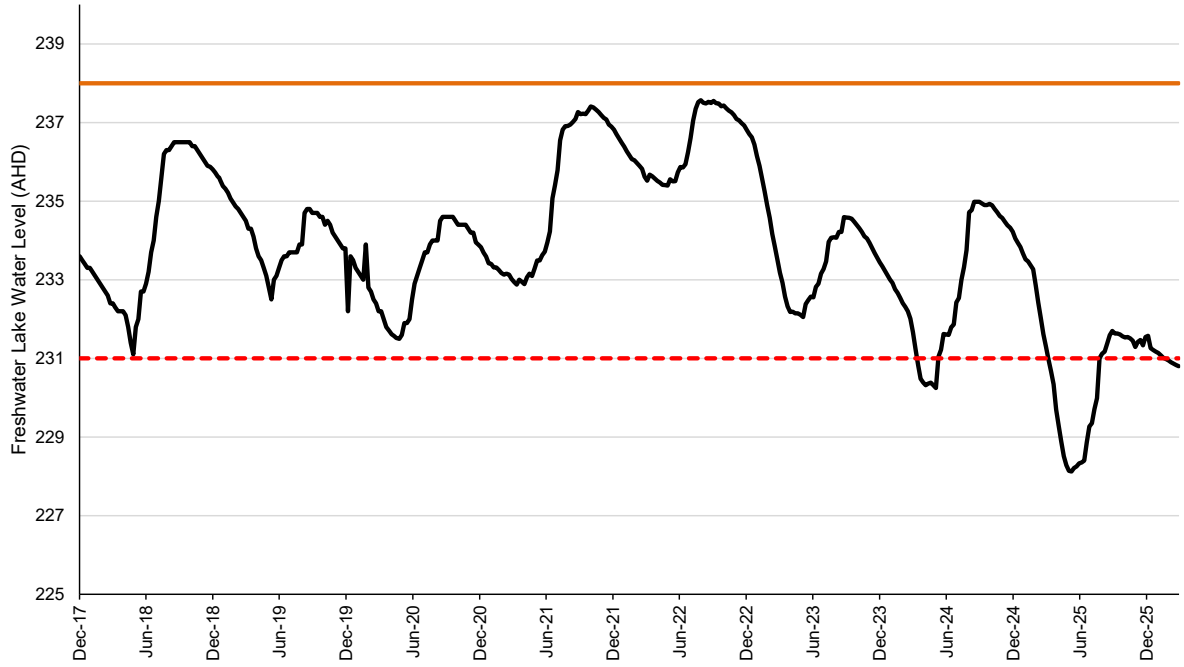


Figure 7: Water level, maximum storage capacity (—) and trigger level (—) at Freshwater Lake between December 2017 and January 2025.

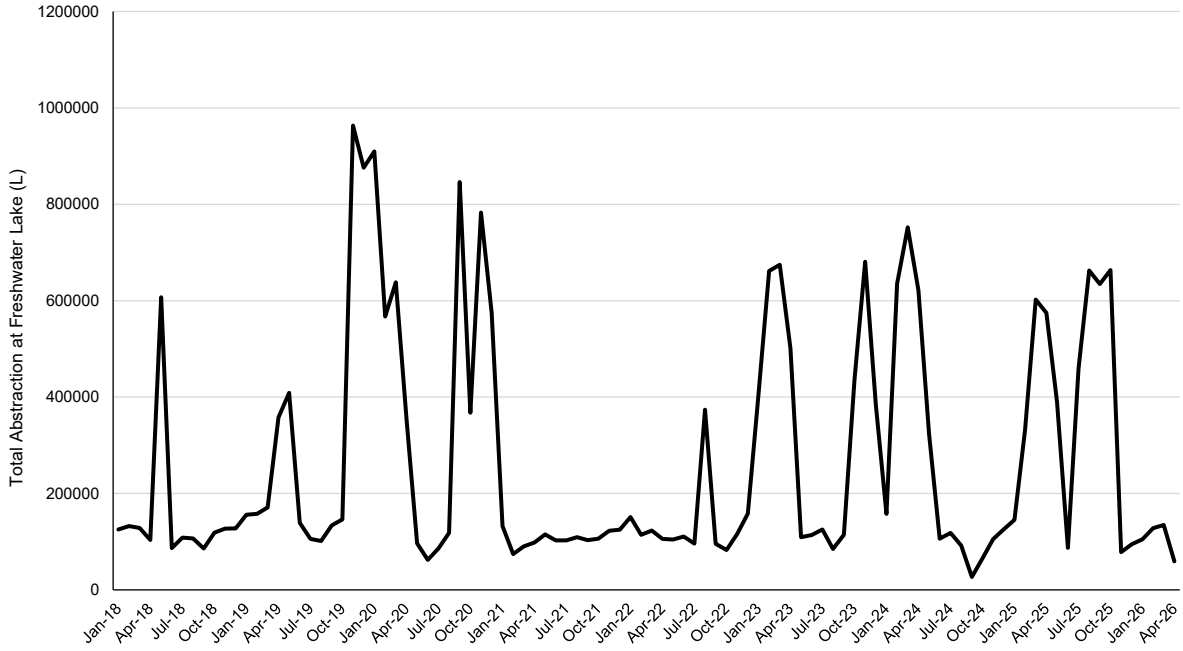


Figure 8: Total water abstraction at Freshwater Lake between January 2021 and January 2025.

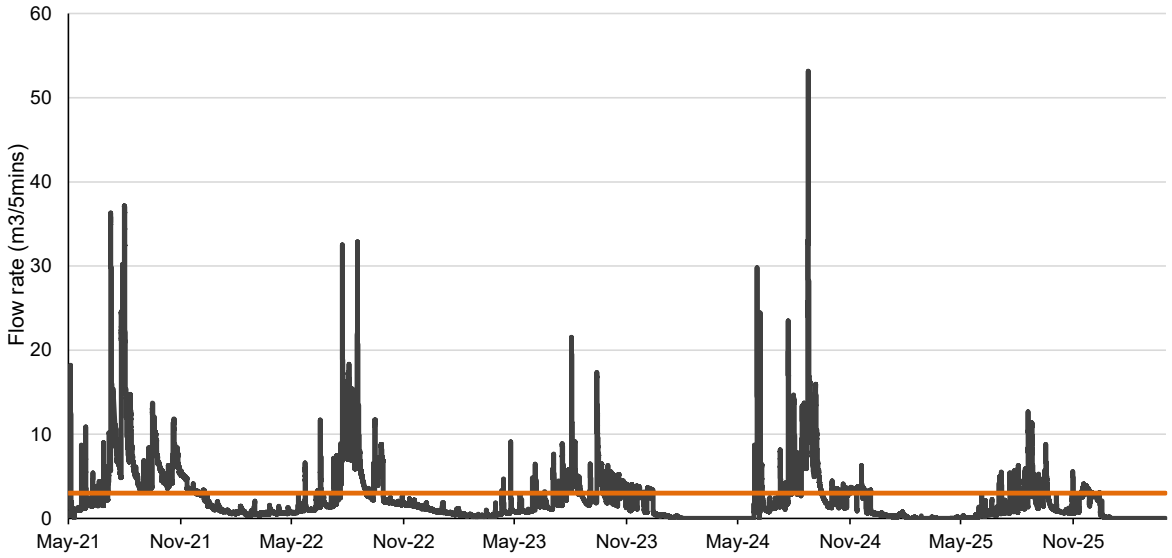


Figure 9: Discharge rate (—) measured at Augustus River v-notch weir (data supplied by Worsley South 32) and average required release rate (—) between 2021 and 2026

4.1 Water Quality

4.1.1 2025 Results

Surface water quality was analysed at thirteen sites during the 2025-26 Program, consisting of eight impact sites (five sites on Freshwater Lake and three sites on Augustus River) and five regional reference sites (**Table 4**).

Surface water pH at all impact sites was circumneutral (pH 6.5 – 7.5) to slightly alkaline (>7.5) based on Foged (1978) and within the South32 pH trigger range of 6.5 to 8. Freshwater Lake ranged from 7.48 (FWL4) to 7.53 (FWL3), while Augustus River sites ranged from 6.81 (AR3) to 7.25 (AR2) (**Table 4**, **Figure 10A**). Regional reference sites were also largely circumneutral, ranging from 6.89 to 7.54, however RR02 on the Ernest River fell below the ANZG (2018) derived upland river guideline value (GV) with a pH of 6.74 (**Table 4**, **Figure 10A**). Dissolved oxygen (DO) concentrations ranged from 7.09 to 9.12 mg/L from impact sites, and from 5.36 to 9.31 mg/L at regional reference sites, with all concentrations within tolerable limits for aquatic fauna (ANZG 2018)(**Table 4**). Dissolved oxygen levels below 5 mg/L may stress fish, and prolonged exposure to levels less than 2 mg/L can be fatal for CFM (Koehn and O'Connor 1990; Paice and Beatty 2022).

At Freshwater Lake, total dissolved solids (TDS) ranged from 138 to 146 mg/L (**Table 4, Figure 10B**), with electrical conductivity (EC) ranging from 202 to 240 µS/cm. Augustus River EC ranged from 226 – 233 µS/cm. Electrical conductivity at Freshwater Lake sites were within the prescribed range of DGVs for ANZG (2018) upland rivers (120 - 300 µS/cm) (**Table 4**; **Figure 10B**). TDS can be influenced by fine suspended particulate material (Boulton and Brock 1999) and this increase is potentially reflective of the organic fraction of TDS. The TDS at regional reference sites were generally comparable, except for BRUN01 (TDS of 645 mg/L and EC of 1160 µS/cm) reflecting its modified catchment setting (**Table 4**, **Figure 10B, C**). Despite elevated salinity, all sites remained within freshwater classification (TDS<3,000 mg/L)(Williams 1987) (**Table 4**) and below the LD_{50} for CFM defined for the Collie River (LD_{50} 3,040 mg/L, 95% CI 2,800 – 3,300 mg/L)(Klunzinger *et al.* 2015a; Klunzinger *et al.* 2015b).

Turbidity in Freshwater Lake ranged from 110 to 170 Nephelometric Turbidity Units (NTU) (**Table 2, Figure 10D**), exceeding typical guidelines values for lakes (10 – 100 NTU) (ANZG 2018). In contrast, turbidity in Augustus River sites was between 4.3 and 4.7 NTU and within guidelines (**Table 2)**. Elevated turbidity in Freshwater Lake is consistent with sediment mobilisation and catchment inputs. High suspended sediment loads have the potential to adversely affect freshwater mussels by impairing feeding, reducing habitat stability and mobilising contaminants (Beatty *et al.* 2017; Goldsmith *et al.* 2020)

Total nitrogen (TN) at Freshwater Lake sites ranged from 0.5 to 0.6 mg/L exceeding the ANZG (2018) GVs for freshwater wetlands (0.35 mg/L) and upland rivers (0.45 mg/L) (**Table 2, Figure 11A**). Total nitrogen concentrations at regional reference sites ranged from 0.1 to 0.7 mg/L, with several sites exceeding the upland river GV (**Table 2, Figure 11A**). In contrast, TN concentrations at impact sites on Augustus River ranged from 0.1 to 0.2 mg/L and all sites were below the upland river GV (**Figure 11A**). All sites remained below the estimated ideal upper limit for TN of 0.69 mg/L for CFM, noting that precise tolerance limits for CFM have not been established (Klunzinger *et al.* 2015a). Total phosphorus (TP) concentrations ranged from 0.1 to 0.4 mg/L at impact sites, with exceedances at FWL2, FWL3, and FWL5 (**Table 4**, **Figure 11B**). Regional reference sites were generally below GVs, except for BRUN01 (**Table 4, Figure 11B**). Elevated TP is likely associated with influences from surrounding land use (Sharma *et al.* 2021). Despite these minor TN and TP exceedances, South32 are not required to sample these parameters for either their SWL or WMP, however the influence of TN and TP on CFM is considered herein.

Screening levels for acid sulfate soils (ASS) were employed to evaluate ASS risk (EPHC 2011; Sullivan *et al.* 2002). Although sulphate concentrations exceeded the 10 mg/L ASS screening level at Freshwater Lake and selected reference sites (e.g. BRUN01, CESA16; **Figure 11C**), calcium carbonate ($CaCO_3$) concentrations at all sites were below the limits of reporting (LoR), indicating a low risk of ASS development (EPHC 2011)(**Table 4**).

Most dissolved metals were either below the LoR, or remained within the derived DGVs (ANZG 2018), with the exception of dissolved aluminium, which exceeded the 95% species protection DGV (0.55 mg/L) at FWL5 (0.06 mg/L). All Freshwater Lake sites also exceeded the CFMMP IW5 trigger criteria of 0.027mg/L (South32 2023; Stantec 2023b) **(Table 4**, **Figure 11D**). Elevated metal concentrations can be toxic to freshwater mussels (Jorge *et al.* 2013; Naimo 1995) with aluminium shown to impair filtration activity in some species (Kádár *et al.* 2001). Wang *et*

al. (2018) undertook laboratory-based toxicity testing on the freshwater mussel *Lampsilis siliquoidea* exposing individuals to aluminium under controlled pH conditions (pH 6). The results indicated that acute 50% effective concentrations (EC_{50}) exceeded 0.62 mg/L, while the chronic 20% effective concentration (EC_{20}) was 0.0163 mg/L, well below the current ANZG (2018) 95% species protection DGV for aluminium (Wang *et al.* 2018). Despite this, no toxicity studies have been conducted on CFM and species-specific toxicity thresholds are currently unknown.

Principal components analysis (PCA) of the water quality data showed that the first two axes explained 78.7% of the variation among sites. All Freshwater Lake sites clustered closely, indicating similar water quality characteristics, and were positively associated with PC2 (**Figure 12**). This axis distinguished sites with elevated nitrite–nitrate, ammonia–ammonium, and aluminium concentrations. In contrast, Augustus River and regional reference sites were negatively associated with PC2 and characterised by higher manganese and barium concentrations. Reference sites RR10 and RR02 were positively associated with PC1, with low levels of potassium and TDS differentiating these sites from others (**Figure 12**). The regional reference site BRUN01 was negatively associated with PC1, and was characterised by higher TDS, potassium, sulfate and barium concentrations (**Figure 12**).

Table 4: Water quality results from the 2025-26 Program.

	Water Quality Parameters	LoR	Impact Sites								Regional Reference Sites					ANZG (2018) Upland River GV		ANZG (2018) DGVs		
			Freshwater Lake					Augustus River			Lunenburgh River Dam	Ernest River	Brunswick River		Harris River					
			FWL1	FWL2	FWL3	FWL4	FWL5	AR1	AR2	AR3	LR_DAM	RR02	RR10	BRUN01	CESA16	Lower	Upper	80%	95%	99%
Basic	pH (unit)	0.01	7.49	7.52	7.53	7.48	7.49	7.24	7.25	6.81	7.16	6.74	6.89	7.54	7.16	6.8	8	-	-	
Basic	Total Dissolved Solids	10	140	146	142	144	138	142	116	144	115	116	132	645	184	-	-	-	-	
Basic	Electrical Conductivity (µS/cm)	1	203	202	204	203	204	231	226	233	188	196	218	1,160	333	120	300	-	-	
Basic	Dissolved Oxygen		9.04	9.12	8.92	8.76	9.07	7.59	7.43	7.09	9.31	5.94	5.36	8.52	8.33	2[b] - 5	5			
Basic	Turbidity (NTU)		120	110	130	170	120	4.7	4.3	4.4	1.8	12	1.1	5.5	1.4		110			
Major Ions	Sodium	1	34	33	34	35	34	37	36	38	30	31	33	166	52	-	-	-	-	
Major Ions	Magnesium	1	3	3	3	3	3	4	3	4	4	4	5	36	6	-	-	-	-	
Major Ions	Calcium	1	3	4	4	4	4	3	4	3	2	2	3	18	4	-	-	-	-	
Major Ions	Potassium	1	1	1	1	1	1	1	1	1	2	<1	1	3	2	-	-	-	-	
Major Ions	Chloride	1	39	40	41	41	41	48	1	50	45	49	53	366	72	-	-	-	-	
Major Ions	Bicarbonate	1	18	19	18	19	19	18	18	10	8	9	11	42	21	-	-	-	-	
Major Ions	Sulphate	1	12	13	13	13	13	10	11	14	9	5	6	32	15	-	-	-	-	
Major Ions	Carbonate	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	
Nutrients	Total Nitrogen	0.1	0.5	0.5	0.6	0.5	0.6	0.2	0.2	0.1	0.7	0.5	0.1	0.5	0.4	-	0.45	-	-	
Nutrients	Total Kjeldahl Nitrogen	0.1	0.2	0.2	0.27	0.2	0.3	0.1	0.1	0.1	0.7	0.4	0.1	0.4	0.4	-	-	-	-	
Nutrients	Nitrite + Nitrate (NO_x)	0.01	0.26	0.27	0.27	0.26	0.27	0.05	0.07	0.03	0.01	0.06	0.04	0.12	0.02	-	-	-	-	
Nutrients	Total Phosphorus	0.01	0.02	0.03	0.04	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.03	<0.01	-	0.02	-	-	
Nutrients	Ammonia	0.01	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.03	0.02	0.01	0.02	0.02	0.01	-	-	2.3[a]	0.72[a]	0.24[a]
Nutrients	Ammonium	0.01	0.02	0.02	0.03	0.02	0.02	<0.01	0.02	0.03	0.02	<0.01	0.02	0.02	<0.01	-	-	-	-	
Metals & Metalloids	Aluminium	0.01	0.05	0.05	0.05	0.04	**0.06**	<0.01	<0.01	0.02	<0.01	<0.01	0.03	<0.01	<0.01	-	-	0.15	0.055	0.027
Metals & Metalloids	Arsenic	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	0.14	0.013	0.0008
Metals & Metalloids	Barium	0.001	0.005	0.005	0.004	0.005	0.005	0.014	0.012	0.018	0.009	0.007	0.014	0.036	0.007	-	-	-	-	-
Metals & Metalloids	Boron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	2.5	0.94	0.34
Metals & Metalloids	Cadmium	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	0.0008	0.0002	0.0001
Metals & Metalloids	Chromium	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	0.00001
Metals & Metalloids	Cobalt	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-
Metals & Metalloids	Copper	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	0.0025	0.0014	0.0010
Metals & Metalloids	Iron	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.06	0.06	0.1	0.09	0.07	-	-	0.73	0.28	-
Metals & Metalloids	Lead	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	0.094	0.034	0.0010
Metals & Metalloids	Manganese	0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.02	0.021	0.041	<0.001	0.005	0.003	0.012	0.033	-	-	3.6	1.9	1.2
Metals & Metalloids	Mercury	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	0.0054	0.0006	0.0001
Metals & Metalloids	Molybdenum	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-
Metals & Metalloids	Nickel	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	0.017	0.011	0.008
Metals & Metalloids	Selenium	0.04	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	-	0.034	0.011	0.005
Metals & Metalloids	Uranium	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-	-
Metals & Metalloids	Vanadium	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-
Metals & Metalloids	Zinc	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	0.031	0.008	0.0024

Note: all units are mg/L unless otherwise specified; LoR = limit of reporting, Grey values show below LoR; yellow shading indicates values below the lower limit of the ANZG (2018) GV range for upland rivers and red shading indicates exceedances of the ANZG (2018) GVs for upland rivers; bolded values indicates exceedances against the ANZG (2018) DVGs for the protection of 95% of species in pristine freshwater systems. a. ANZG (2026) at pH 7.5, temp 20°C; b.(Paice and Beatty 2022)

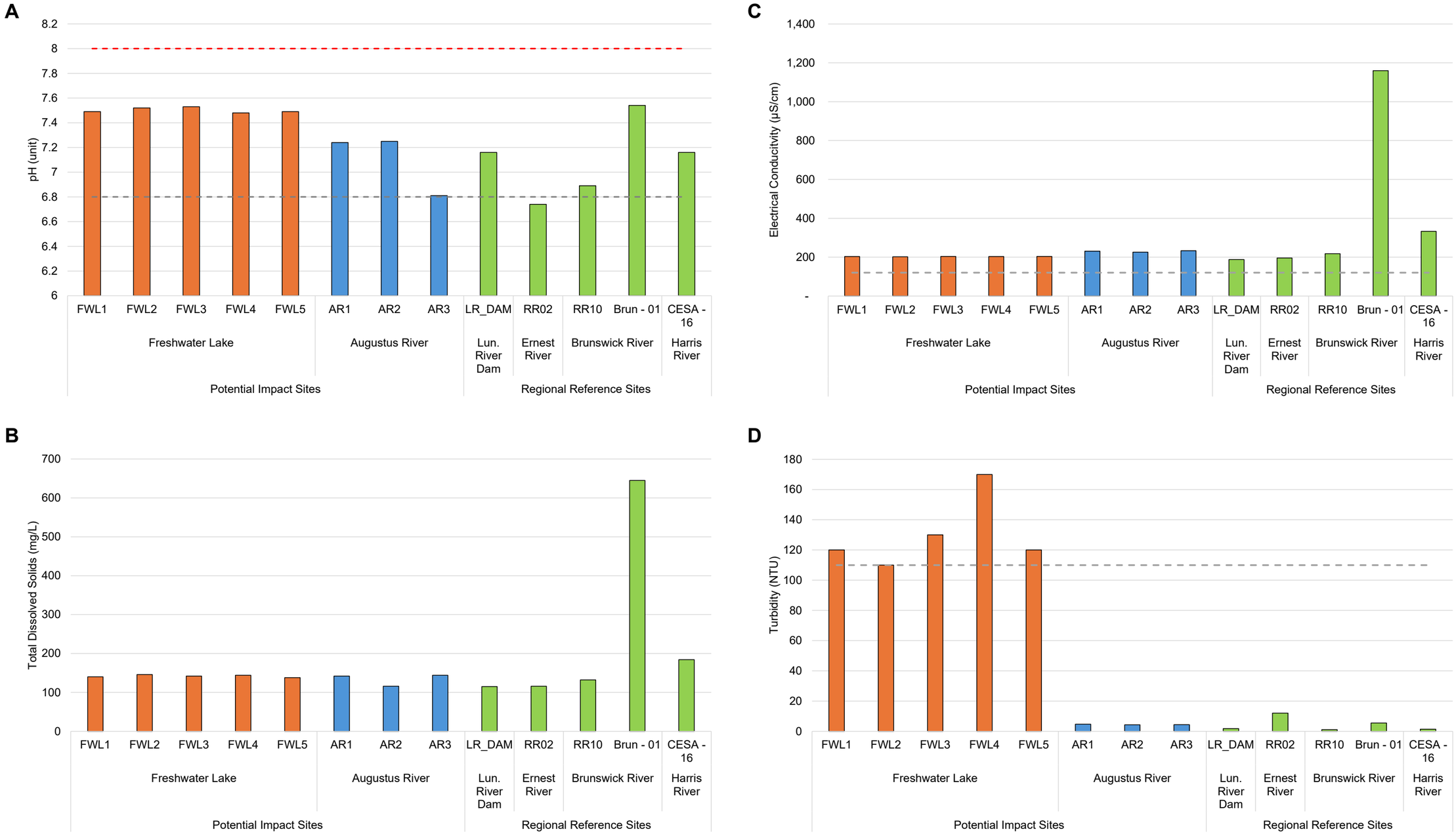
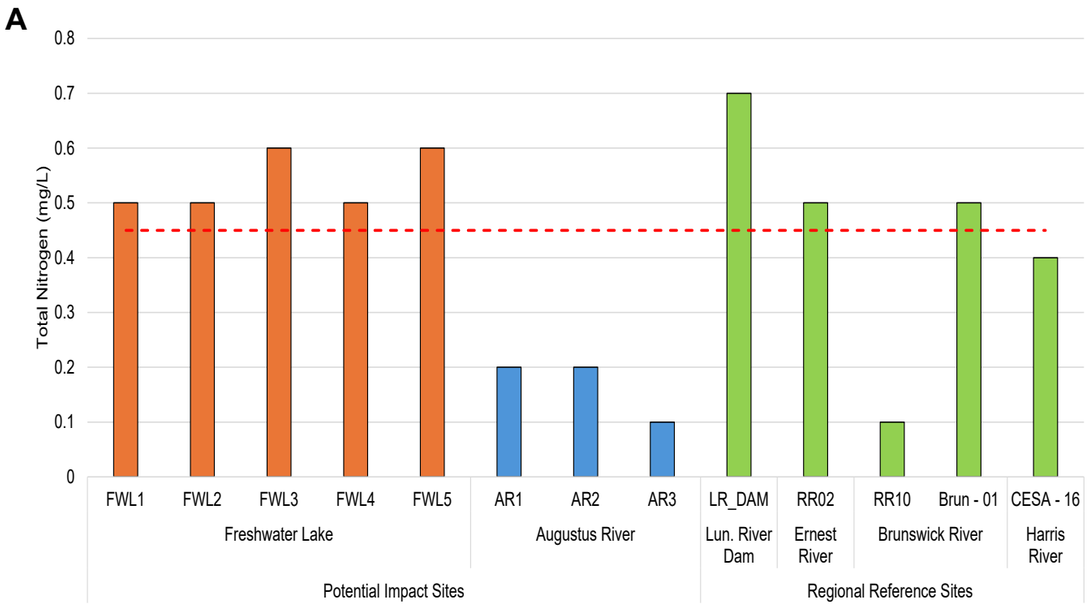
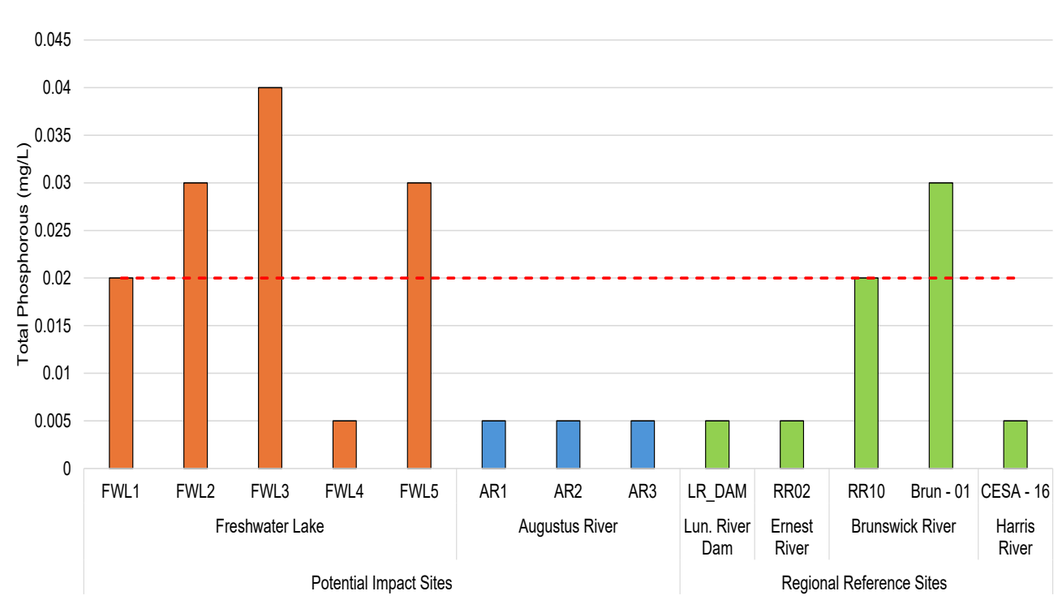
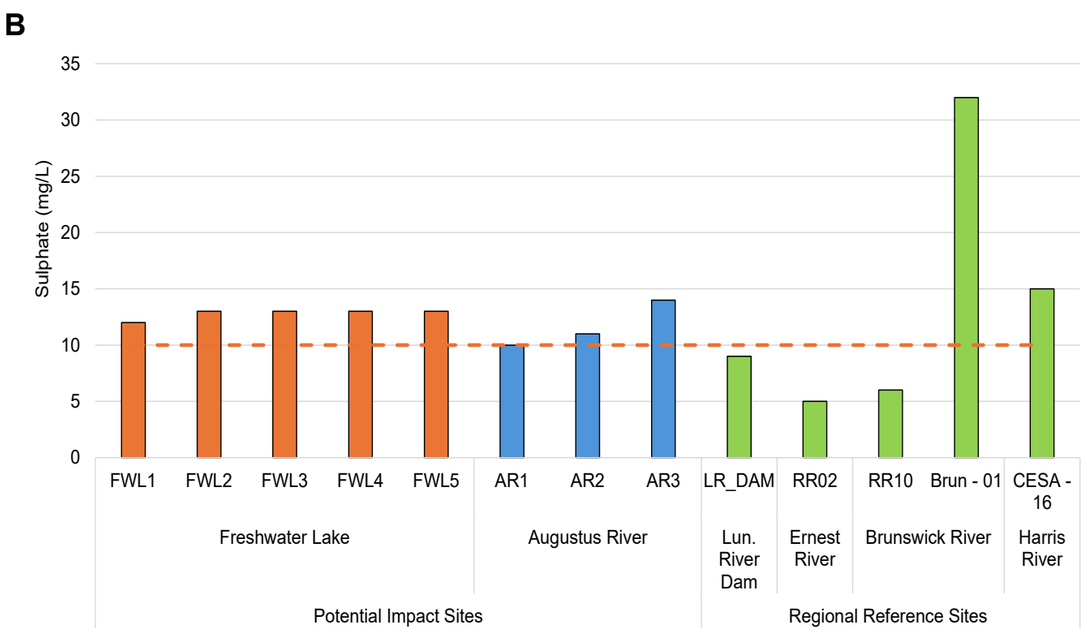


Figure 10: pH (A), electrical conductivity (B) TDS (C) and turbidity (D) recorded from the surface waters of Freshwater Lake, Augustus River and regional reference sites. Dashed grey lines (- -) represent the ANZG lower limit of the Upland River GV. Red dashed line (- -) represents upper limit of the ANZG 2018 Upland River GV.







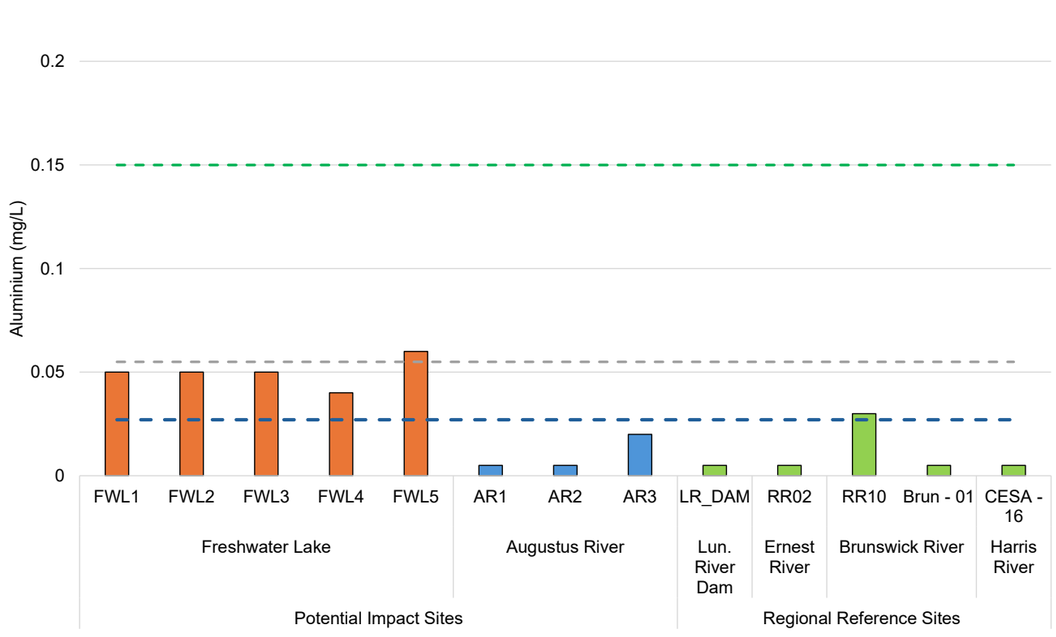


Figure 11: Total nitrogen (A), total phosphorus (B), sulphate (C) and aluminium (D) concentrations recorded from the surface waters of Freshwater Lake, Augustus River and regional reference sites. Orange dashed line (- -) represents the GV for increased risk of the presence of acid sulphate soils (Sulphate only (EPHC 2011)); red dashed lines (- -) represents upper limit of the ANZG (2018) Upland River GV; dashed green line (- -) represents the ANZG (2018) 80% DGV; dashed grey line (- -) represents the ANZG (2018) 95%; and dashed blue line (- -) represents the ANZG (2018) 99% DGV.

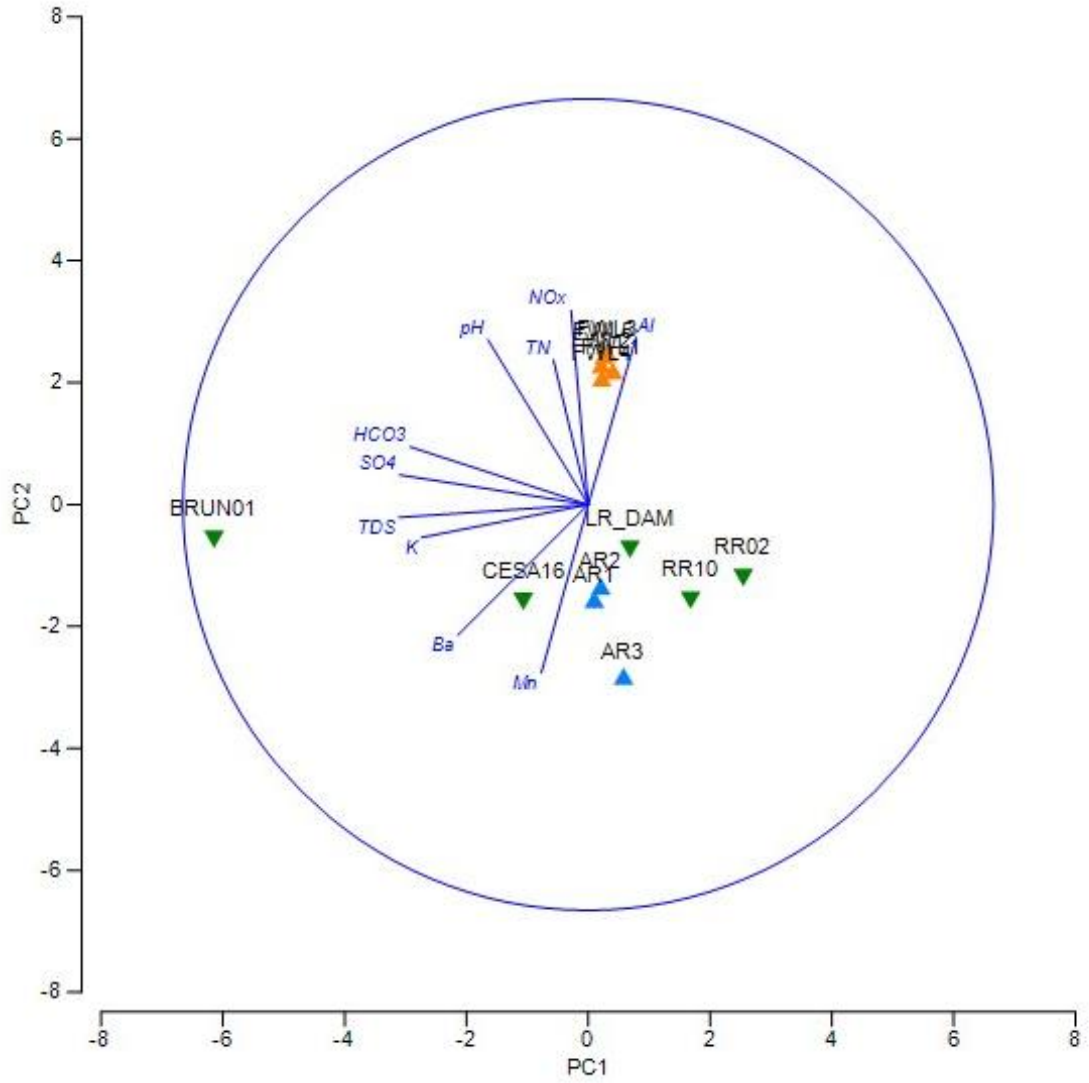


Figure 12: PCA of water quality during the 2025-26 Program (▲= Freshwater Lake, ▲= Augustus River and Freshwater Lake, ▼= regional reference sites). A total of 78.7% of variation in the data is explained by the first two axes. Note: where values were below LoR, values were represented in plots as half the LoR.

4.1.2 Temporal Comparison

No significant temporal changes in pH were observed between 2021 and 2025, with pH values across most waterbodies remaining within ANZG (2018) guidelines (**Figure 13A**). The consistently lower pH at regional reference sites associated with RR02 likely reflects persistent site-specific conditions (Stantec 2024)(**Appendix F**). The naturally acidic conditions at the site is typical of upland river systems, with pH likely driven by organic acid inputs from catchment vegetation and limited buffering capacity of soils (ANZG 2018).

Electrical conductivity declined in the 2025-26 Program compared to the 2024-25 Program at Freshwater Lake (247 µS/cm in 2025-26 compared to 262 µS/cm in 2024-25), and Augustus River (226 µS/cm in 2025-26 to 233 µS/cm in 2024-25, **Figure 13B**). In contrast, TDS at Freshwater Lake increased from the 2024-25 Program to the 2025-26 Program, increasing from an average of 134.5 µS/cm to 142 µS/cm respectively (**Figure 13B**). TDS can be influenced by fine suspended particulate material, potentially reflecting increased contributions from fine suspended particles (Boulton and Brock 1999).

Freshwater Lake has exhibited variable turbidity over time, including extreme events (>2000 NTU) recorded in 2019 and 2020 (Stantec 2021a). Turbidity in Freshwater Lake during the 2025–26 Program was on average was similar, or lower than 2021 baseline levels (130 NTU and 155.18 NTU respectively) (**Figure 13C**). In contrast, turbidity in the Augustus River has remained low and stable over time (**Figure 13C**).

Elevated TN and TP concentrations at Freshwater Lake have been persistent across monitoring years, with the 2025-26 Program TN and TP concentrations similar to or even lower those recorded during the 2021 baseline (**Figure 14A**, **B**), with no clear trends evident over time (**Figure 14A, B**). Regional reference sites showed greater variability in TN concentrations in the 2025-26 Program when compared to previous years as demonstrated by the large standard error for TN (**Figure 14A, B**). This variability was likely driven by the surrounding land use at regional reference sites (e.g. BRUN01). Augustus River TP and TN concentrations have remained consistently lower than both Freshwater Lake and regional reference sites from 2021 to 2025-26 (**Figure 14A, B**).

Elevated TN was primarily associated with a substantial increase in nitrite-nitrate (NO_x) concentrations observed across all waterbodies in 2025-26 relative to previous years (**Figure 14C**). This was particularly evident at Freshwater Lake sites, with an average of increase of 30% from 2024, and concentrations more than double the concentrations observed in Augustus River or regional reference sites. Increases in NO_x are often associated with increased anthropogenic sources such as broadscale fertiliser use in the catchment or remobilisation of wetland sediment during disturbance events (Dunn *et al.* 2017; Li *et al.* 2023).

Aluminium concentrations in Freshwater Lake have declined relative to the 2021 baseline levels, despite concentrations in the lake remaining elevated compared to both Augustus River and regional reference sites (**Figure 14D**). No clear temporal trends were observed for other metals, which have typically been below the respective LoRs or within acceptable limits between 2021 and 2025-26.

Results from the PCA show that temporal variability in Freshwater Lake water quality is driven by NOx, TN, pH, and aluminium (**Figure 15**). Variability in nitrogenous nutrients appears to align with variability in turbidity and it is likely that high rainfall events either contribute nutrients to the system and/or the disturbance of the lake sediments leads to the release of nitrogen and phosphorus into the water column (Dunn *et al.* 2017; Li *et al.* 2023). Aluminium levels have been variable over time, with the 2025-26 water quality indicating that these sites are more strongly aligned by this metal compared to previous years.

Augustus River sites have historically been characterised by higher concentrations of manganese, barium, lower pH and nitrogenous nutrients. Augustus River sites align mores consistently with regional reference sites in terms of water quality compared to Freshwater Lake and this is consistent with the comparatively natural origins of this river system (**Figure 15**).

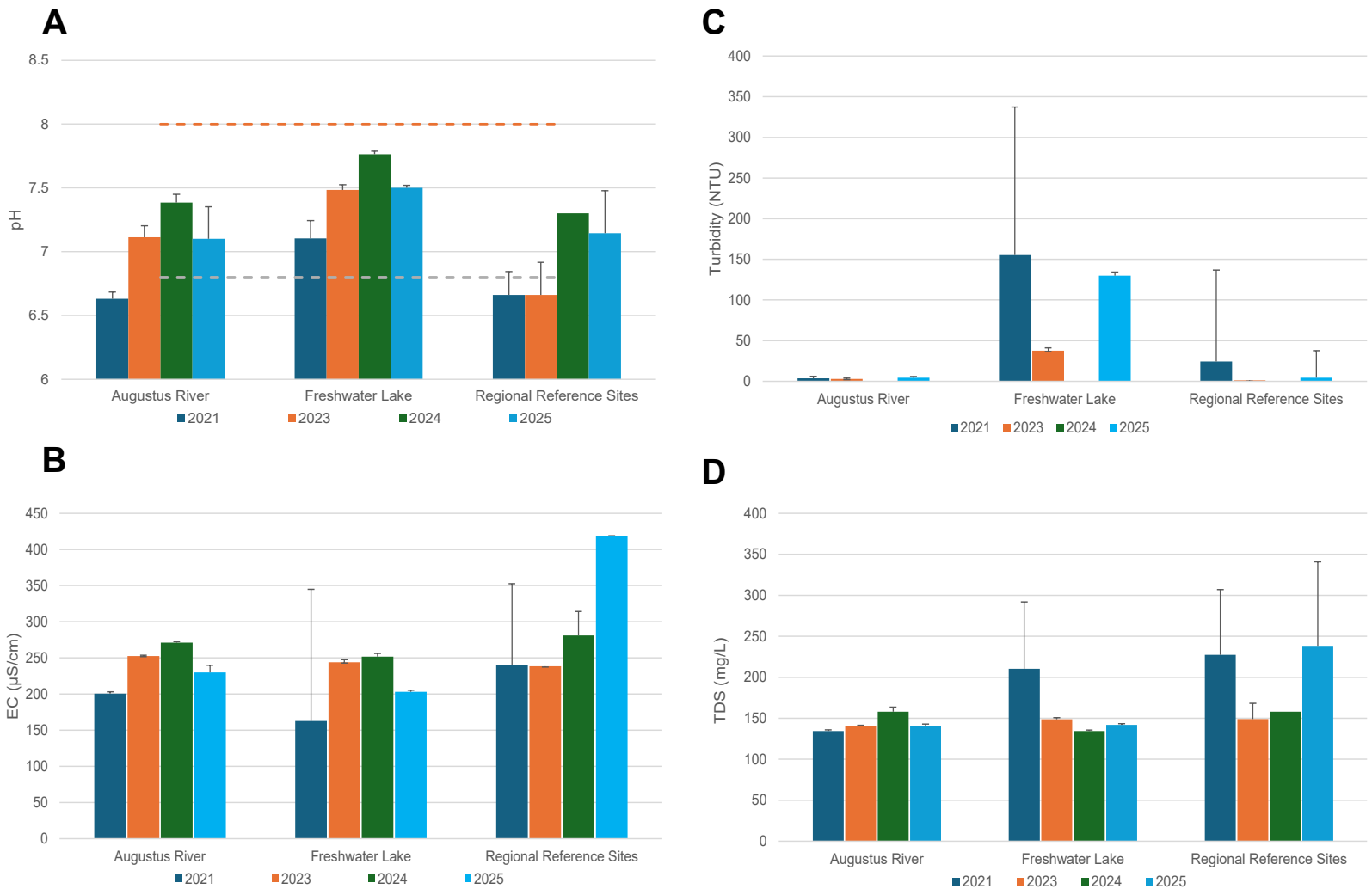


Figure 13: pH (A), EC (B), TDS (C) and turbidity (D) recorded from the surface waters of Freshwater Lake, Augustus River and regional reference sites between 2021 and 2025. Values represent annual means averaged within each waterbody type. Error bars indicate standard error.

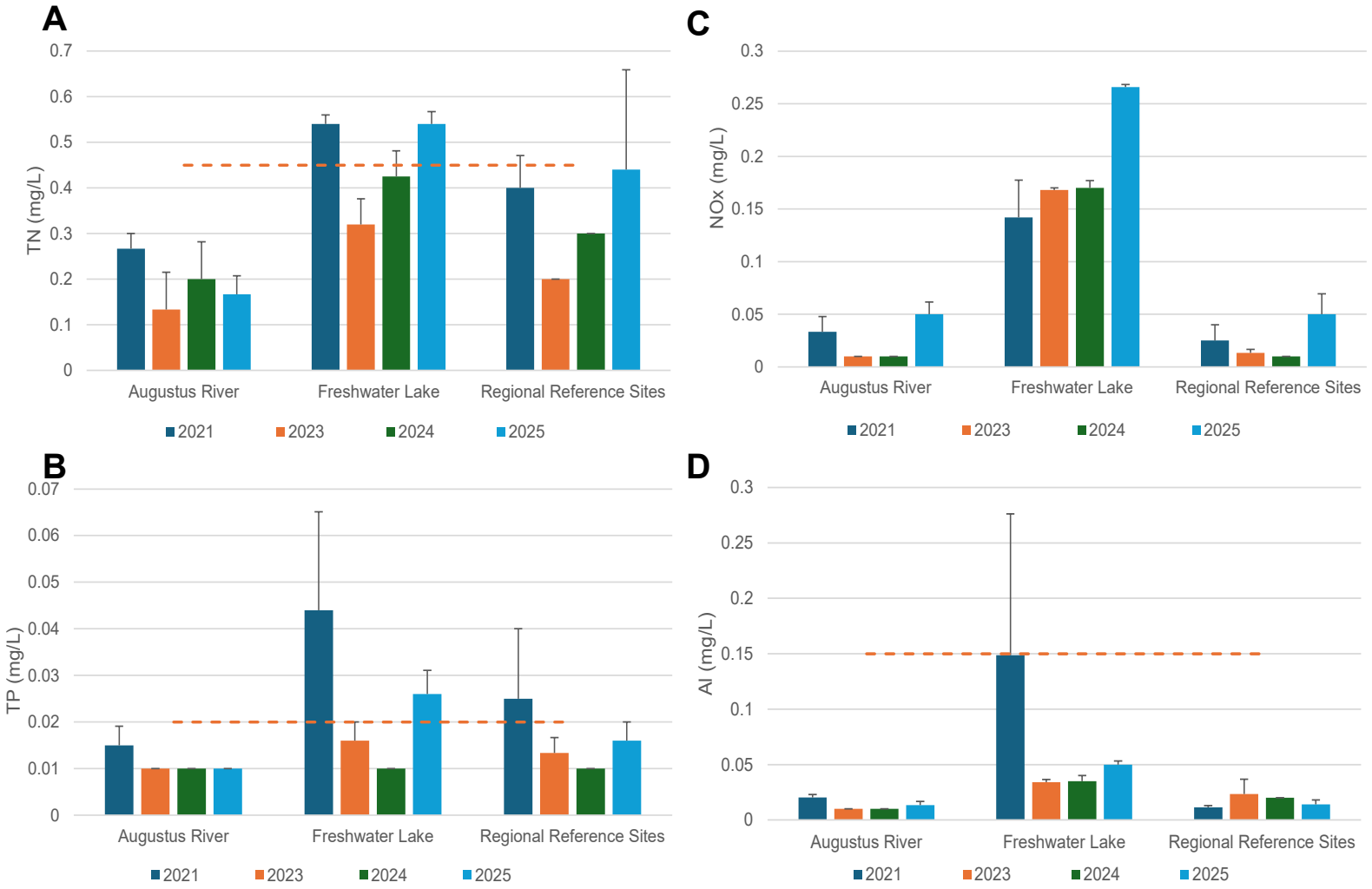


Figure 14: Total nitrogen (A), total phosphorus (B) nitrate-nitrite (NO_x) (C) and aluminium (D) in water within each waterbody type 2021 to 2025. Values averaged within a waterbody type each year. Orange dashed line (- -) represents upper limit of the ANZG (2018) Upland River GV. Error bars indicate standard error.

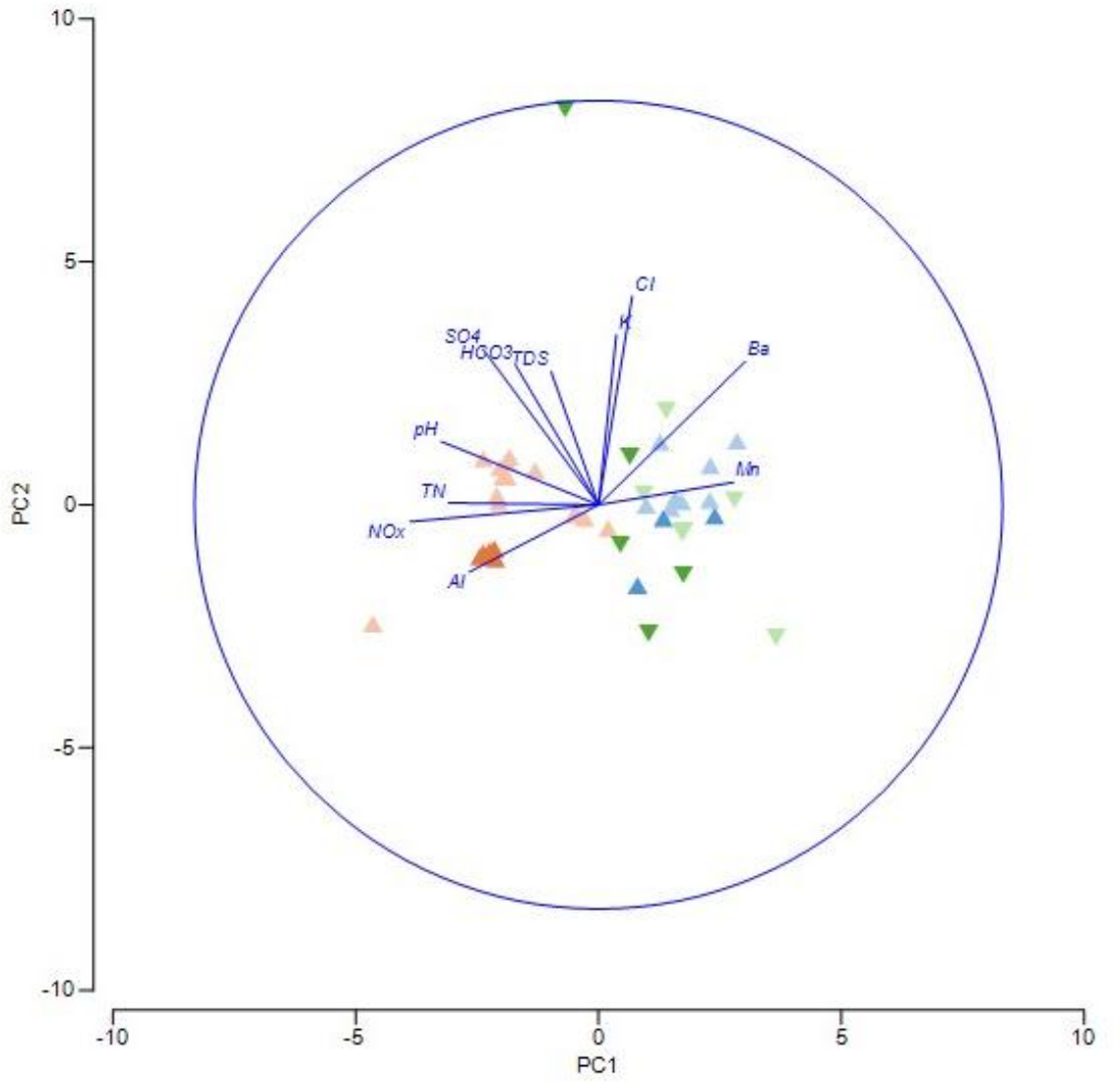


Figure 15: PCA of water quality temporal change from the 2021 baseline (▲= Freshwater Lake 2025-26, ▲= Freshwater Lake historic; ▲= Augustus River 2025-26, ▲= Augustus River historic, ▼= regional reference sites 2025-26, ▼= regional reference sites historic). A total of 60.7% of the variation was explained by the first two axes. Note: where values were below LoR, values were represented in plots as half the LoR.

4.2 Sediment Quality

4.2.1 2025 Results

Sediment quality was analysed at thirteen sites during the 2025-26 Program, consisting of eight impact sites (five sites on Freshwater Lake and three sites on Augustus River) and five regional reference sites (**Table 5**).

Sediment pH measured during the 2025-26 Program ranged from slightly acidic to neutral across sites (**Table 5**). At Freshwater Lake, the lowest pH was recorded at site FWL4 (pH 6.3), with values across the lake ranging from pH 6.3 to 6.8 (**Table 5**). In the Augustus River, sediment pH ranged from 6.78 (AR1) to 7.2 (AR3) (**Table 5**). Based on Hazelton and Murphy (2007) classification system, sediments from Freshwater Lake are moderately acidic to neutral, whereas those from the Augustus River are neutral. All regional reference sites were considered neutral (**Table 5**). Sediment salinity was fairly consistent across Freshwater Lake sites, recording between 26 to 32 µS/cm. Augustus River sites recorded higher variability with AR2 similar to Freshwater Lake at 30 µS/cm while AR1 recorded just 11 µS/cm (**Table 5, Figure 16A**). Regional reference sites were highly variable, ranging from 16 µS/cm at RR02 and 54 µS/cm at BRUN01.

Calcium was the dominant cation in the sediment for all sites in Augustus River and the majority of regional reference sites recording a cation dominance of Ca>Mg>K>Na. Calcium was particularly elevated at Augustus River site AR2 recording 3410 mg/kg, in contrast, AR1 recorded 650 mg/kg. Cation dominance in Freshwater Lake sites were typically Ca>Mg>Na>K. Calcium levels in Freshwater Lake were highly variable ranging from 120 mg/kg to 1,280 mg/kg (**Table 5**). Sodium concentrations at Freshwater Lake ranged from 90 to 200 mg/kg, while regional reference sites ranged from <50 mg/kg (below the LoR) to 110 mg/kg, with no reportable exceedances (**Table 5**). Chloride was the dominant anion across all sites, albeit only marginally higher than sulphate. Carbonate was below the limit of reporting for all sites (Table 5). Despite increases in anions and cations within the sediment all monitored sites were classified non-saline. Although sediment moisture content varied across sites, moisture conditions were comparable across systems with slightly higher variability from Freshwater Lake.

Nutrient concentrations were similar across the Freshwater Lake sites, with total nitrogen (TN) ranging from 410 mg/kg (FWL2) to 970 mg/kg (FWL5, **Table 5, Figure 16B**). In contrast, Augustus River sites recorded substantially higher TN concentrations, ranging from 1,010 mg/kg (AR3) to 4,500 mg/kg (AR2, **Figure 16B**), This indicates stronger nutrient inputs to the system, potentially reflecting greater organic matter loading from riparian vegetation or catchment-driven influences such as increased fertiliser use. Augustus River sites were also elevated when compared to regional reference sites which ranged from 470 mg/kg (RR10) to 1090 mg/kg at CESA16. Total phosphorus (TP) in Freshwater Lake, ranged from 111 mg/kg (FWL2) to 172 mg/kg (FWL1 and FWL3), with slightly higher TP concentrations recorded from AR1 and AR2 compared to both Freshwater Lake and regional reference sites (**Table 5**, **Figure 16C**). Ammonia levels were below the LoR (<0.2 mg/kg) at most Freshwater Lake sites, with the exception of FWL1 and FWL5, which were slightly above the LoR (**Table 5**). In contrast, ammonia levels were higher at most reference sites, especially BRUN01 on the Brunswick River. This may reflect broader environmental drivers (e.g. natural organic matter decomposition, sediment release under low-oxygen conditions, or catchment-scale inputs) (**Table 5, Figure 16D**. As this is a known toxin to glochidia and juvenile CFM, monitoring ammonia and nutrient concentrations are important in understanding long term CFM population dynamics (Kleinhenz *et al.* 2019; Walker *et al.* 2014).

All metal concentrations were below the ANZG (2018) DGVs and GV-High thresholds where available, with multiple metal analytes being below the respective LoRs at all sites (arsenic, boron, cadmium, mercury, molybdenum and selenium). Concentrations of mercury, required to be assessed in accordance with the CFMMPMP (Stantec 2023), were below the LoRs at all sites sampled during the 2025-26 Program (**Table 5**). Aluminium concentrations were higher in all Freshwater Lake sites when compared to all regional reference sites and most Augustus River sites. However, Augustus River site AR2, exhibited aluminium concentrations similar to those from Freshwater Lake (**Table 5**, **Figure 17A**). As with the surface water, elevated aluminium within the sediments from Freshwater Lake, particularly from site FWL4 (42,600 mg/kg), is likely attributed to the aluminium refining process, resulting in aluminium precipitating out of surface water and accumulating within the sediment over time.

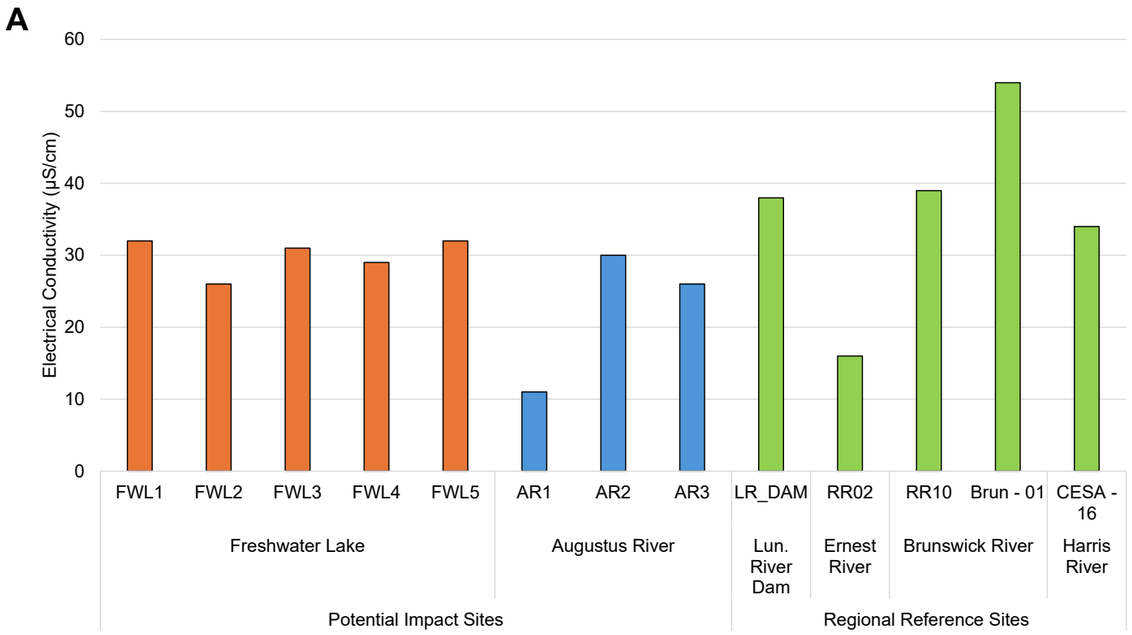
Copper, chromium, cobalt and zinc were detected in sediments at all sites; however, none exceeded the relevant ANZG (2018) DGV's (**Table 5**). Cobalt concentrations were elevated at AR1 and AR3 relative to all other sites (**Figure 17B**) and copper concentrations at FWL1 were more than double those at all other sites (**Figure 17C**). Currently no ANZG (2018) DGV's are available for vanadium and manganese in sediment, however both metals were elevated at some sites during the 2025-26 Program. Notably, manganese concentrations at AR1 (847 mg/kg) were at least double those recorded at all other sites (**Figure 17D**). Vanadium was also elevated at several Freshwater Lake sites (up to 100 mg/kg) and at AR2 (115 mg/kg) relative to concentrations at regional reference sites (9 to 88 mg/kg, **Table 5**). Vanadium is a naturally occurring metal that in low concentrations enhances biological systems. Globally, it occurs in soils at concentrations ranging from 10 to 220 mg/kg (Hanus-Fajerska *et al.* 2021), with iron rich soils in Western Australia reported at concentrations of up to 351 mg/kg (Widyastuti *et al.* 2025).

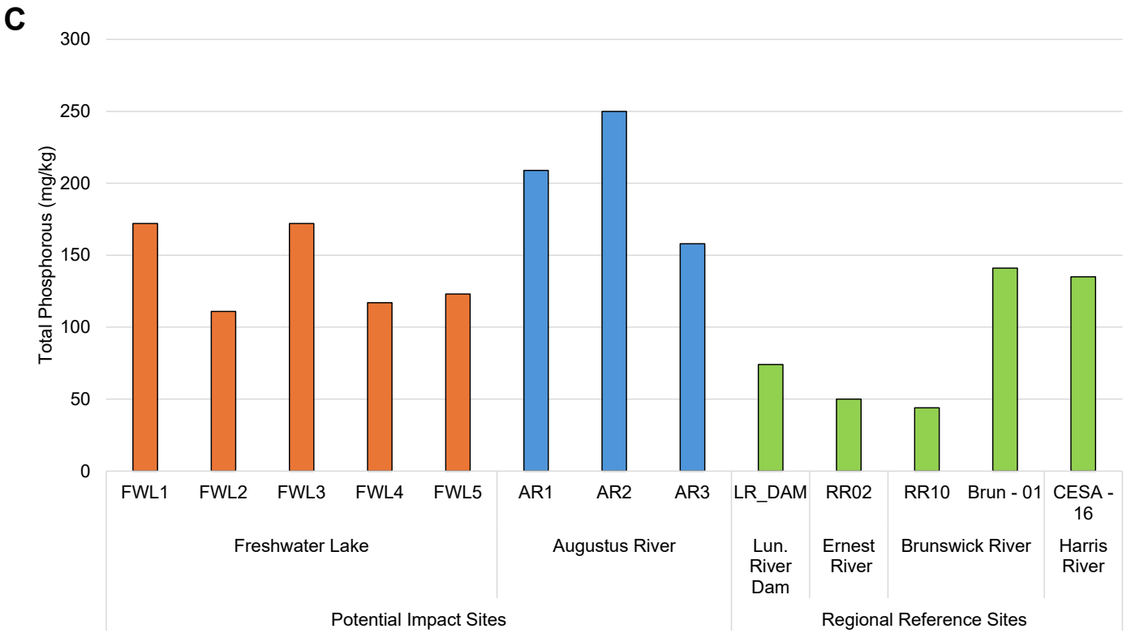
The sediment quality PCA illustrated that there was limited variation between sites, with only 55.8% of the variance between sites explained by the first two axes (**Figure 18**). Most Freshwater Lake sites were positively correlated with PC2, which was associated with high moisture content, copper, aluminium and chromium concentrations. FWL2 was the exception, with a lower soil moisture content and metal concentrations, separating in the PCA from all other Freshwater Lake sites (**Figure 18**). This reflected the relatively dry conditions at that site, clustering more closely with regional reference sites which had low water levels and comparable pH in 2025-26. CESA16 clustered to Freshwater Lake sites and this is likely associated with the permanence of the water at the site and its low sediment pH (**Figure 18**). Most Augustus River sites were positively associated with PC1 and were characterized by high concentrations of nitrogen in the sediments. The permanent nature of AR2 resulted in higher moisture content separating it from the other two Augustus River sites, while AR1 had low EC by comparison.

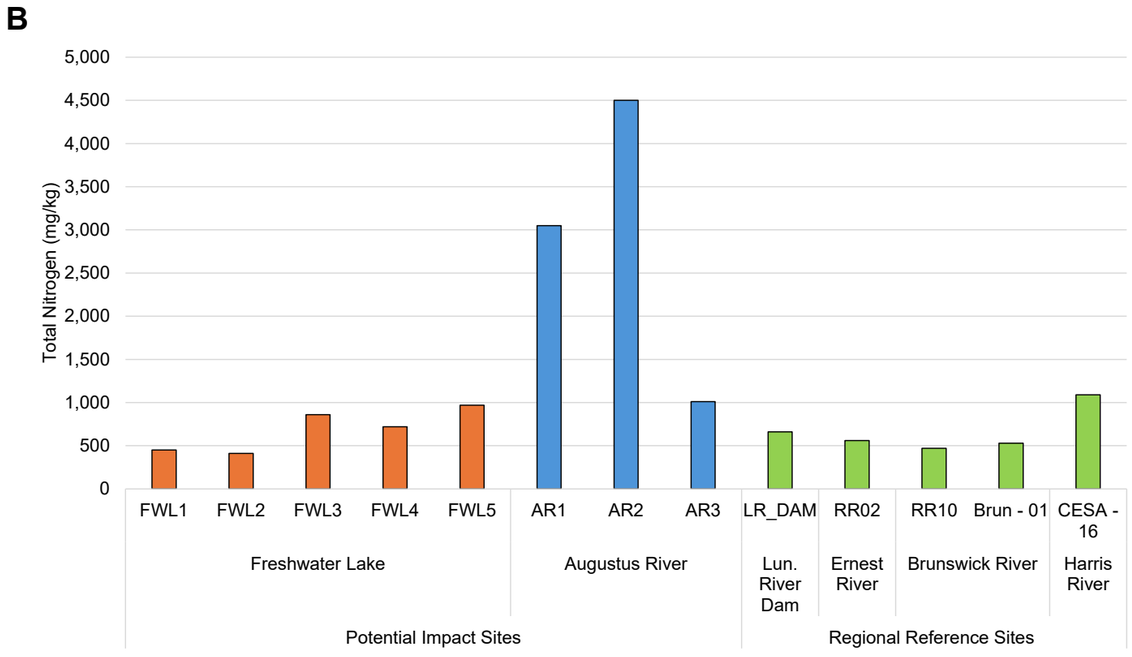
Table 5: Sediment parameters recorded from the 2025-26 sampling sites compared against ANZG (2018) DGVs.

Sediment Parameters		LoR	Impact								Regional Reference					ANZG (2018) DGVs	
			Freshwater Lake					Augustus River			Lunenburgh River Dam	Ernest River	Brunswick River		Harris River		
			FWL1	FWL2	FWL3	FWL4	FWL5	AR1	AR2	AR3	LR_DAM	RR02	RR10	BRUN01	CESA - 16	DGV	GV-High
Basic	pH (unit)	0.1	6.7	6.8	6.9	6.3	7.2	6.8	7	7.2	6.6	7.5	6.8	6.9	6.5	-	-
	Moisture content (%)	1	37.1	22.1	33.7	32.4	38.4	20.7	30	24.7	30.4	27.9	19.5	23.8	28.8	-	-
	Electrical Conductivity (µS/cm)	1	32	26	31	29	32	11	30	26	38	16	39	54	34	-	-
Cations and Anions	Sodium	50	150	90	100	130	200	<50	280	90	100	<50	60	100	110	-	-
	Magnesium	50	460	260	250	310	400	390	1,290	530	340	200	230	470	260	-	-
	Calcium	50	1,280	390	430	120	760	650	3,410	780	1,330	310	340	410	850	-	-
	Potassium	50	120	140	80	540	120	190	320	340	130	<50	70	240	80	-	-
	Chloride	10	20	20	20	30	50	<10	50	40	50	20	20	60	40	-	-
	Bicarbonate	5	51	39	33	38	55	41	43	31	26	28	74	34	11	-	-
	Sulphate	10	<10	20	30	30	30	<10	20	20	<10	<10	<10	10	20	-	-
	Carbonate	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-
Nutrients	Total Nitrogen	20	450	410	860	720	970	3,050	4,500	1,010	660	560	470	530	1,090	-	-
	Total Kjeldahl Nitrogen	20	450	410	860	720	970	3,050	4,500	1,010	660	560	470	530	1,090	-	-
	Nitrite + Nitrate	0.1	<0.1	0	1	0	1	<0.1	0	<0.1	<0.1	0	<0.1	0	<0.1	-	-
	Total Phosphorus	2	172	111	172	117	123	209	250	158	74	50	44	141	135	-	-
	Ammonia	0.2	1	<0.2	<0.2	<0.2	2	3	1	2	6	3	7	23	2	-	-
	Ammonium	0.2	1	<0.2	<0.2	<0.2	1	3	1	2	5	2	5	18	2	-	-
Metals & Metalloids	Aluminum	50	37,200	31,300	34,200	42,600	37,400	6,710	31,600	7,510	18,500	14,700	11,200	3,550	22,100	-	-
	Arsenic	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	20	70
	Boron	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50		
	Cadmium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.5	10
	Chromium	2	32	14	32	38	33	6	34	5	20	10	41	7	39	80	370
	Cobalt	2	4	3	4	6	3	11	2	10	2	6	5	3	14	-	-
	Copper	5	22	<5	9	9	7	<5	9	<5	6	<5	5	<5	8	65	270
	Lead	5	7	6	7	11	10	<5	7	<5	7	<5	6	<5	10	50	220
	Manganese	5	158	129	301	365	221	847	410	388	77	126	62	69	175	-	-
	Mercury	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.15	1
	Molybdenum	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-
	Nickel	2	6	5	3	5	3	7	5	3	3	3	5	3	8	21	52
	Selenium	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-
	Uranium	0.1	2	1	3	2	2	0	1	1	1	0	1	1	9	-	-
	Vanadium	5	87	40	98	100	87	16	115	20	69	42	9	16	88	-	-
	Zinc	5	13	8	12	20	13	12	8	7	8	<5	79	6	8	200	410

Note: all units are mg/kg unless otherwise specified; Grey text indicates analyte was below limit of reporting (LoR).







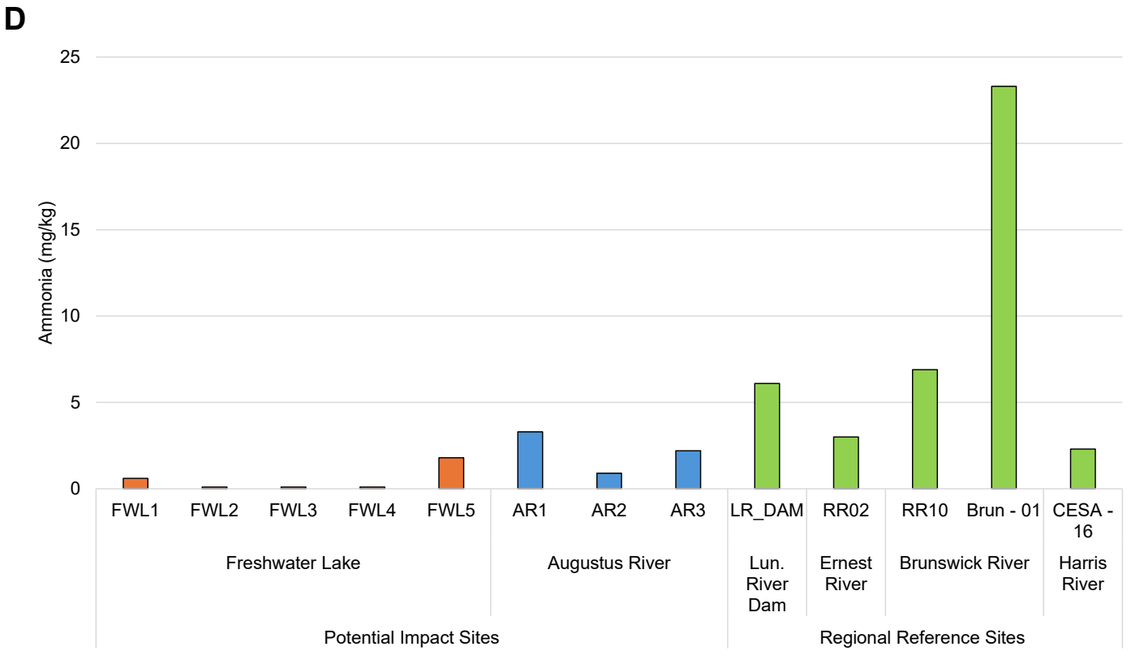


Figure 16: Electrical conductivity (A), total phophorus (B), total nitrogen (C) and ammonia (D) recorded from sediments of Freshwater Lake, Augustus River and regional reference sites in November 2025.

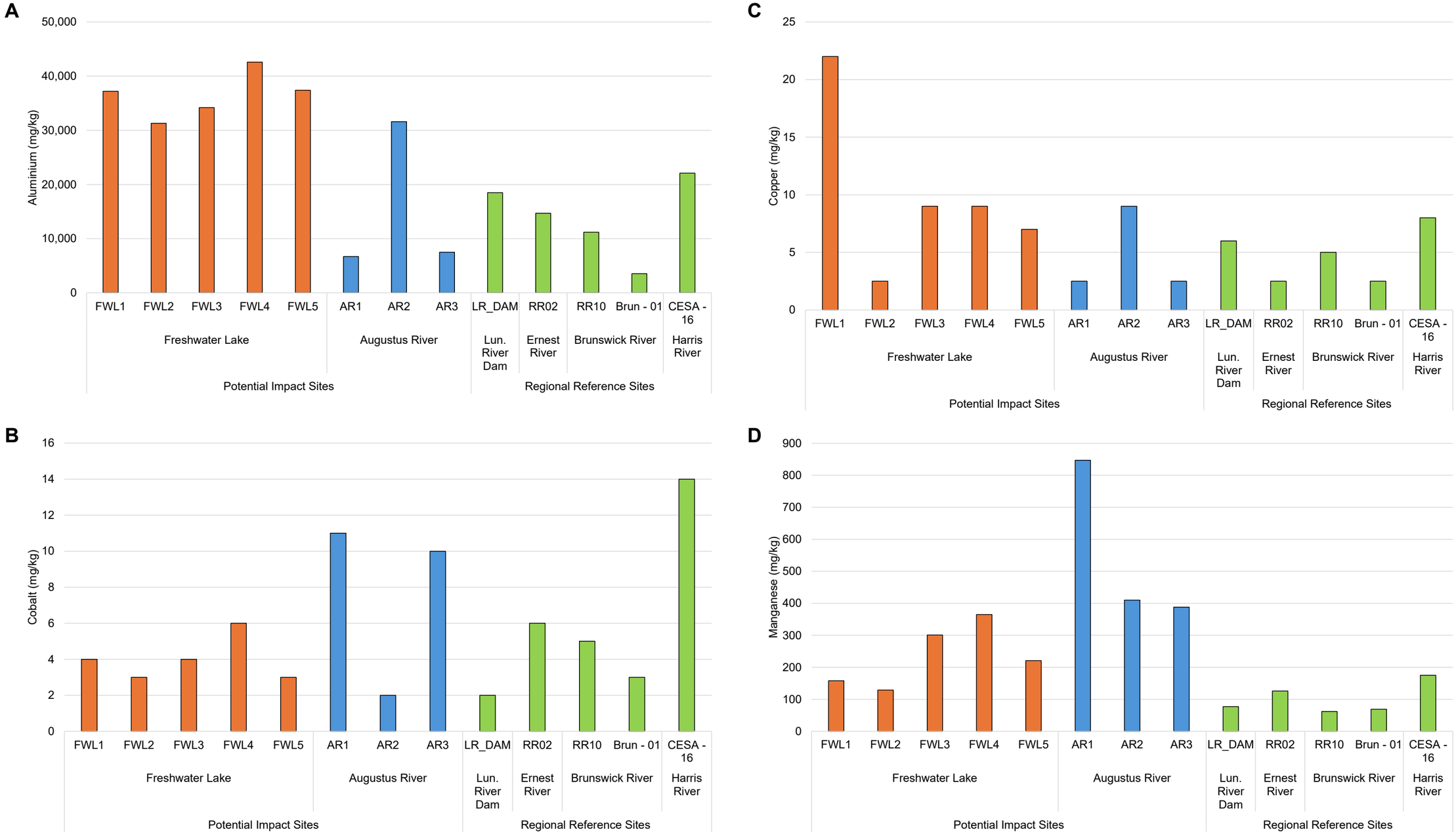


Figure 17: Concentration of aluminium (A), cobalt (B), copper (C) and manganese (D) recorded from sediments of Freshwater Lake, Augustus River and regional reference sites in November 2025.

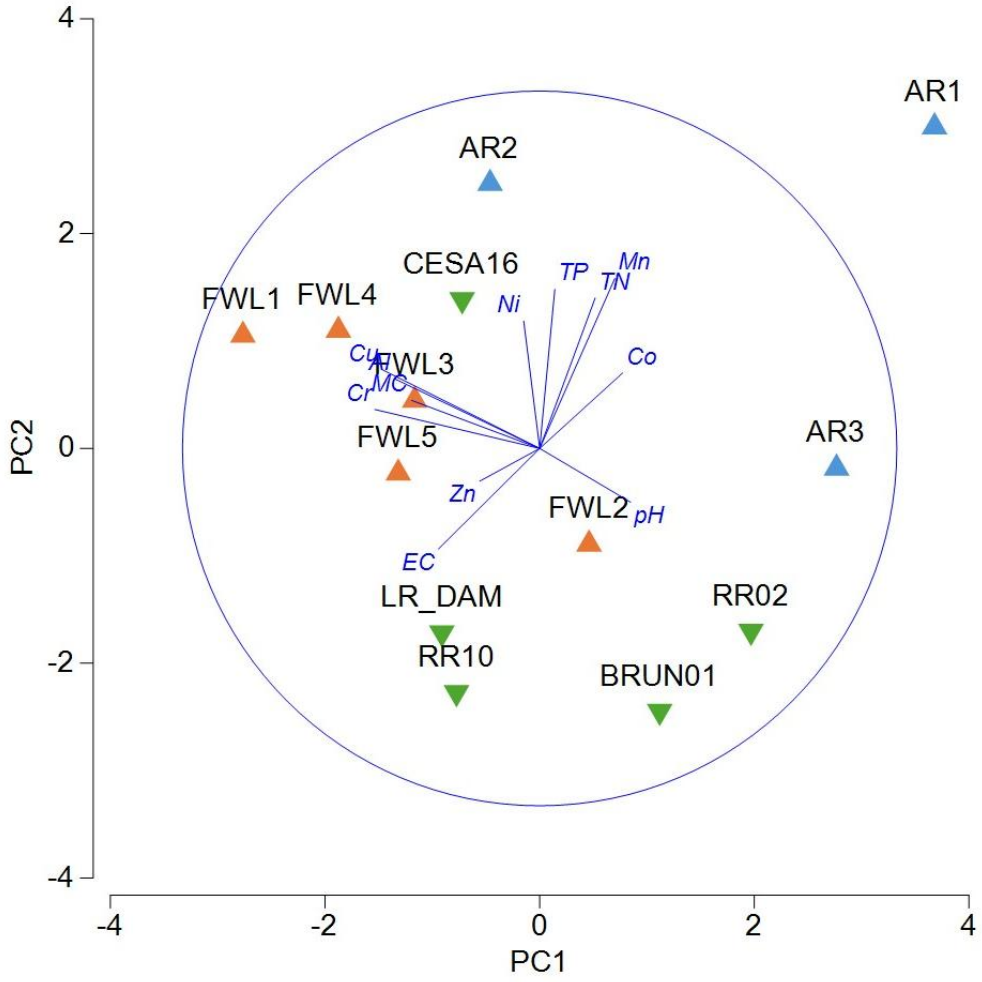


Figure 18: PCA of sediment quality during the 2025-26 Program (▲= Freshwater Lake, ▲= Augustus River and Freshwater Lake, ▼= regional reference sites). A total of 55.8% of the variation in the data is explained by the first two axes. Note: where values were below LoR, values were represented in plots as half the LoR.

4.2.2 Temporal Comparison

Sediment pH has remained relatively stable in Freshwater Lake and regional reference sites over time, with values in 2025-26 consistent with 2024-25 monitoring **(Figure 19A**) and regional expectations (van Gool *et al.* 2018). In contrast, Augustus River sites shifted from moderately acidic conditions in 2024 (pH 5.7 – 6.2, **Figure 19A**) to neutral in 2025–26 (pH 6.5 – 7.3,**Table 5**). This shift is likely associated with increased calcium concentrations in the waterbody and these neutral conditions may facilitate the reduction in ammonia toxicity within sediment interstitial spaces (ANZECC & ARMCANZ 2000).

A pronounced temporal shift in sediment chemistry was observed, with calcium, magnesium, potassium and sodium increasing from below LoR between 2021 and 2024, to measurable levels across all monitored sites in 2025–26. This trend was particularly evident for calcium, with average calcium concentrations having increased markedly relative to the 2021 baseline and the 2024-25 monitoring period (**Figure 19B, A**). Sodium exhibited a similar increasing trend, with the most substantial rises recorded at Augustus River and Freshwater Lake sites (**Figure 19C**). These changes likely reflect a combination of seasonal drying, organic matter decomposition and groundwater inputs, compounded by prolonged below average rainfall since 2022. Together, these factors promote solute concentration and salt accumulation in sediments, particularly in low-flow environments. Additional inputs from land use practices (e.g. fertiliser or gypsum application) may also be contributing to observed cation enrichment (Gondek *et al.* 2020; Huang *et al.* 2024; Ma *et al.* 2022b; Wallace 1994). Despite these increases in both cations and anions, EC and total soluble salts (TSS), all sites continue to be considered non-saline, with concentrations below critical thresholds for CFM. However, the observed upward trends suggest that salinity remains a key risk factor for the species, and restoration of environmental flows may help mitigate future impacts from accumulating salt loads.

Sulphate concentrations in Freshwater Lake sediments have remained relatively low with limited temporal variability (**Figure 19D**). In contrast, Augustus River sites exhibited substantial variability, with concentrations ranging from 14.14 mg/kg in 2021 to 127 mg/kg in 2023. Levels declined to 5.77 mg/kg in 2025-26, suggesting that the processes driving earlier fluctuations have diminished. These patterns may reflect site-specific factors, such as sediment exposure and mobilisation under low water conditions, potentially linked to acid sulfate soil (ASS) activation. However, the temporal sulphate data do not provide clear evidence to support active ASS processes

Total nitrogen (TN) concentrations at Freshwater Lake increased relative to the 2021 baseline but were lower in 2025–26 than in 2024–25, suggesting reduced nutrient inputs or changes in sedimentation processes (**Figure 20A**). In contrast, TN levels at Augustus River sites were elevated across all sites in 2025–26 compared to previous years, indicating increased nutrient loading during this period (**Figure 20A**). Total phosphorus (TP) concentrations at both Freshwater Lake and Augustus River increased from 2023 to 2025–26 and remain above the 2021 baseline, while reference sites have shown little change (**Figure 20B**). Although sediment TP guidelines are not established, elevated phosphorus can enhance primary productivity, particularly under anoxic conditions (Yu *et al.* 2022).

Aluminium concentrations have remained consistently elevated in Freshwater Lake and adjacent impact sites across monitoring years (**Figure 20C**). Aluminium levels also doubled at LR_DAM between 2023 and 2024-25, increasing from 9,730 mg/kg in 2023 to 18,900 mg/kg in 2024-25, while CESA16 recorded a concentration of 22,100 mg/kg during the 2025-26 Program, which was five times higher than 2024-25 (4,350 mg/kg, Stantec (2026)). Manganese concentrations have also increased over time at select Freshwater Lake and Augustus River sites (**Figure 20D**), most notably at AR1, where levels increased from 115.5 mg/kg in 2021 to 847 mg/kg in 2025-26. Manganese is a naturally occurring element in Western Australian soils and an essential micronutrient for most organisms. In mussels, it plays a role in mitigating oxidative stress by scavenging free radicals (Archambault *et al.* 2017; Campanella *et al.* 2005). Under oxic conditions, manganese oxidises forming insoluble mineral phases; therefore, recent drying events at AR1 may have promoted increased deposition in sediments. There are currently no DGV's for manganese in sediments.

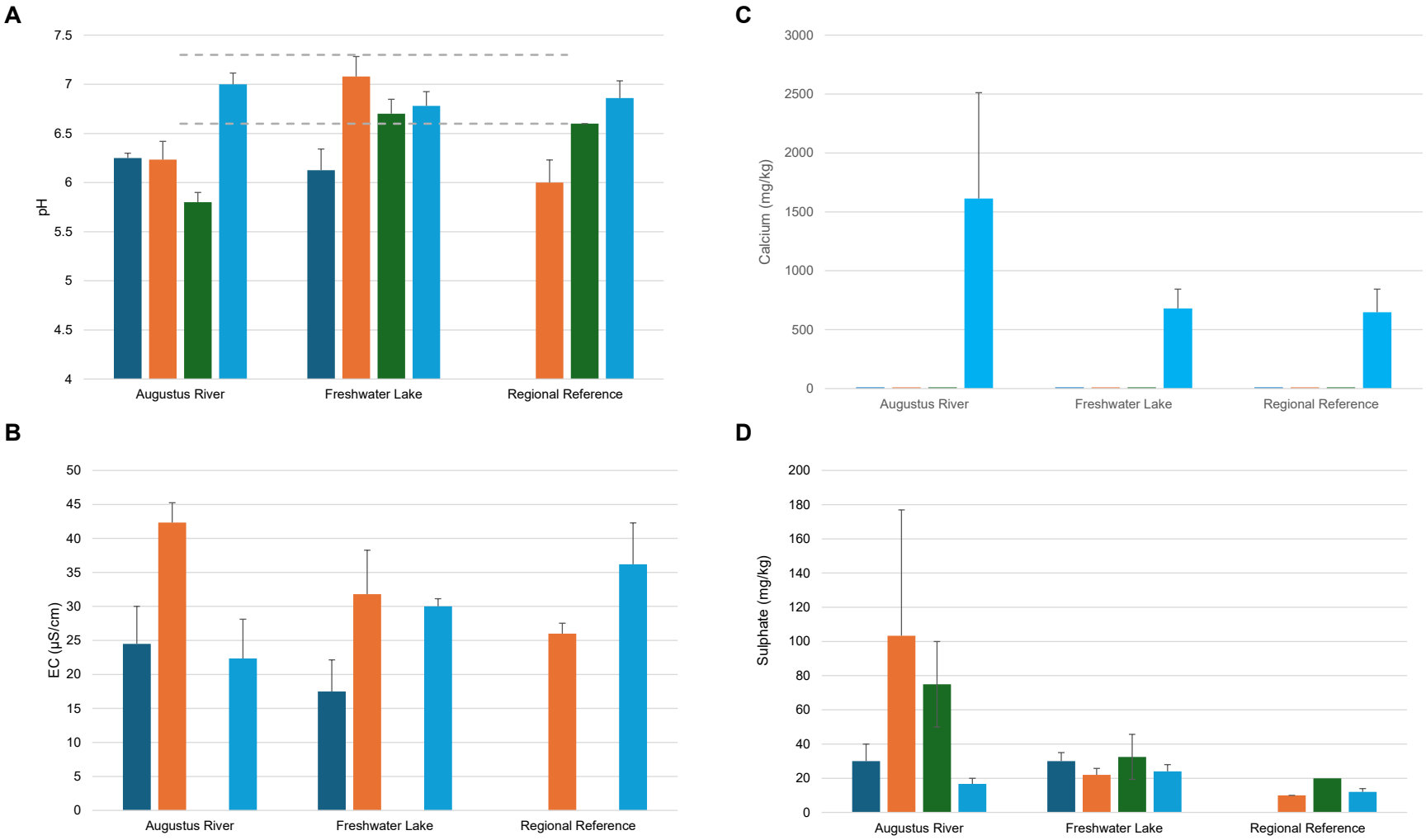


Figure 19: Changes in pH (A), EC (B), calcium (C) and sulphate (D) in sediments over time (■ = 2021, ■ = 2023, ■ = 2024 ■ = 2025). Values averaged across sites within a waterbody type. Error bars = Standard error.

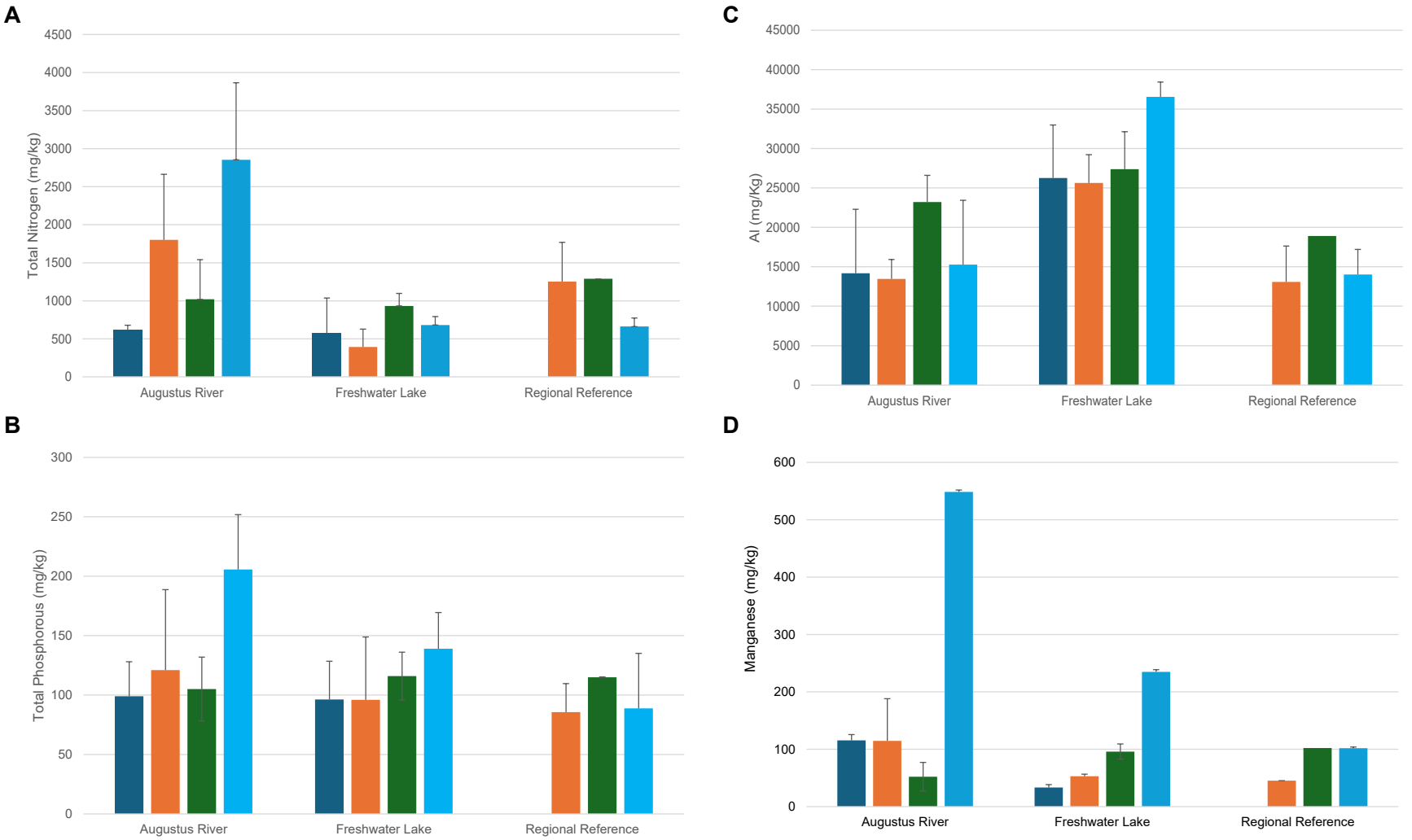


Figure 20: Changes in total nitrogen(A) total phosphorus(B), aluminium (C) and manganese (D) in sediments over time (■ = 2021, ■ = 2023, ■ = 2024 ■ = 2025). Values averaged across sites within a waterbody type. Error bars = Standard error.

4.3 Carters Freshwater Mussel

4.3.1 Abundance and Density

4.3.1.1 2025 Results

A total of 230 Carter's Freshwater Mussel individuals were recorded from 11 sites during the 2025-26 Program (**Table 6**). Of these, a total of 180 (78%) were alive at the time of collection. Although no live mussels were found at any of the Freshwater Lake quantitative monitoring sites during the 2025 shallow-water survey, live mussels were recorded during the deep water survey in March 2026 (**Table 6**). The majority of live mussels recorded during the 2025-26 Program were observed in Augustus River sites, located immediately downstream of Freshwater Lake (82 mussels, 45.5%) of which 58 were recorded from site AR1 (**Table 6**).

A total of 39 live mussels were recorded across all sites in Freshwater Lake in the 2025-26 Program (**Table 6**). Live CFM appeared to be constrained by substrate type, with most detections occurring along the lake margins where substrates comprised moderately firm clay with cobbles. In contrast, deeper areas were characterised by a substantial accumulation of highly mobile fine sediments, which did not appear to support CFM establishment. Dive site FWL_Dive 3, the shallowest of the dive sites, recorded the highest CFM abundance, with 21 individuals (54%; **Table 6**). During the 2025-26 Program, five dead mussels were recorded at FWL3 and one dead individual from FWL5 (13.3% mortality; **Table 6**), exceeding trigger criterion IW6 of the CFMMP relating to individual mortality. Empty shells were also observed along the exposed shoreline near the water monitoring sites; however, these were excluded from abundance estimates as they were located outside the defined survey area and were heavily bleached, indicating mortality was not recent.

Healthy populations of CFM were observed from all Augustus River sites, with 82 live mussels observed across all three sites (**Table 6**). Regional reference sites RR02, RR10 and LR_DAM did not record any live mussels, however BRUN01, and CESA16 recorded 31 (3.1 mussels/m^2), and 28 (2.8 mussels/m^2) individuals respectively with no detected mortality (**Table 6**).

Between Augustus River sites, CFM density (live mussels only) ranged from 1.1 mussels/m^2 from AR3 to 5.7 mussels/m^2 at AR1 (**Table 6**). Augustus River site AR1 is located near the v-notch weir downstream of Freshwater Lake. This reach of the Augustus River provides optimum habitat for CFM, with stable, fine-grained sediment soft enough for burrowing and intact riparian zone for shelter (**Appendix B**). There is also plenty of shade at these sites, to prevent drying during period of drought (e.g. low water levels), and abundant leaf litter and detritus providing a consistent food source. Mussel density within the Augustus River was broadly comparable to densities typically recorded from Swan Coastal Plain rivers and streams. For example, Beatty *et al.* (2017) recorded an average Carter's freshwater mussel density of 1.7 mussels/m^2 within the Lower Vasse River near Busselton, with other studies reflecting comparable mussel densities in southwest of WA (Klunzinger *et al.* 2011b; WRM 2020).

Table 6: Carter's Freshwater Mussel abundance during the 2025-26 Program.

Site Classification	Waterbody	Site	Live mussels	Dead mussels	Total Mussels	Mortality (%)	Mean Length (Live)	Density (no. mussels/m^2)
Impact Sites	Freshwater Lake	FWL1						
		FWL2						
		FWL3		5	5	100		
		FWL4						
		FWL5		1	1	100		
		FWL_Dive1	3		3	0	58.67	NA
		FWL_Dive2	15		15	0	58.86	NA
		FWL_Dive3	21		21	0	61.14	NA
	Freshwater Lake Total		**39**	**6**	**45**	**Av: 40%**	**Av: 59.56**	**NA**
	Augustus River	AR1	58	38	96	39.58	43.69	5.7
		AR2	13		13	0	51.61	1.3
		AR3	11	5	16	31.25	28.82	1.1
	Augustus River Total		**82**	**43**	**125**	**Av: 23.61%**	**Av: 41.37**	**Av: 2.7**
Regional Reference Sites	Lunenburgh River Dam	LR_DAM						
	Ernest River	RR02_99						
	Brunswick River	BRUN01	31		31	0	44.45	3.1
		RR10_99		1	1	100		
	Harris River	CESA16	28		28	0	45.00	2.8
	Regional Reference Total		**59**	**1**	**60**	**Av: 33.33%**	**Av: 44.72**	**Av: 2.95**
Grand Total			**180**	**50**	**230**			

4.3.1.2 Temporal Comparison

A total of 39 live CFM were detected across all sites in Freshwater Lake in the 2025-26 Program, compared to 5 live mussels in the 2021 baseline. This demonstrates a small but gradual increase in the CFM population in the lake from 2021. The relative abundance of dead CFM (e.g. number of dead CFM averaged across all sites monitored in Freshwater Lake) declined from 4 mussels in 2023 and 2024 to just 0.75 mussels in the 2025-26 Program (**Figure 21**).

There has been a decline in CFM density at Augustus River sites over time, with 2.7 mussels/m^2 recorded in 2025-26 compared to 3.2 mussels/m^2 during the baseline assessment, representing a 15.6% reduction in density since baseline (Stantec 2021b). Despite this decrease, mussel densities remain within acceptable limits (<20% decline) as defined by the IW6 trigger criterion of the CFMMP (Stantec 2023b) with healthy mussel populations persisting at Augustus River (**Figure 22**). Between 2021 and 2024-25, live mussel density increased substantially, with 3.2 mussels/m^2 during the baseline assessment to 7.1 mussels/m^2 in 2023 and 9.5 mussels/m^2 in 2024-25, suggesting conditions during this period were suitable for recruitment (**Figure 22**).

Most sites monitored in 2025-26 and 2024-25 had reduced water levels compared to 2023 (Stantec 2024). In November 2023, the Augustus, Brunswick, and Ernest Rivers were flowing, however all river flow ceased in the lead up to the 2024-25 survey, and reference sites RR02 (Ernest River) and RR10 (Brunswick River) were dry. All monitored sites in the 2025-26 Program contained surface water, but most only retained a few centimetres of water following a prolonged dry period since the 2024-25 survey.

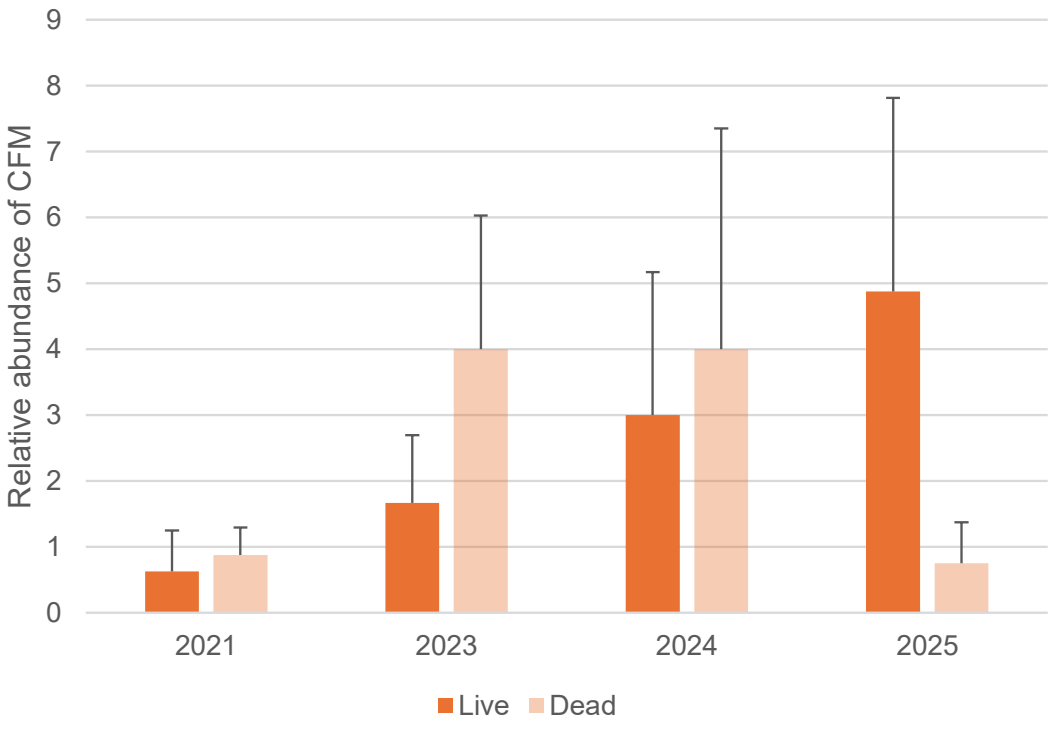


Figure 21: Relative abundance (abundance/effort averaged across sites) of live and dead CFM with Freshwater Lake 2021 to 2025-26. Error bars = standard error.

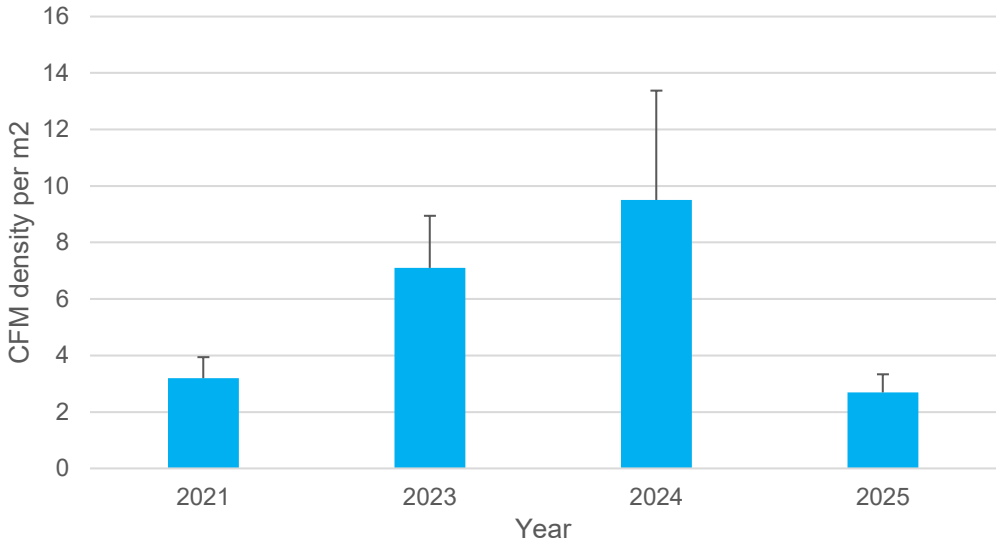


Figure 22: Average density (live CFM mussels at Augustus River 2021 to 2025-26). February 2025 data was used for 2024-25 period as all three sites within Augustus River were monitored. Error bars = standard error.

4.3.2 Population Structure and Recruitment

4.3.2.1 2025 Results

In the 2025-26 Program, the CFM population in Freshwater Lake was dominated by large individuals with an average length of 60.1 mm (**Figure 23, Figure 24**). Shell length frequency distributions can be used to infer recruitment and population age structure. Based on Klunzinger (2012), individuals measuring 31.5 mm are estimated to be approximately 5 years old, and those around 54 mm estimated to be around 10 years-old. Applying these benchmarks suggests that most individuals sampled in Freshwater Lake are older than 10 years, distinguishing this population from other monitored sites (**Figure 23**). The absence of smaller size classes indicates limited recent recruitment at the lake. However, methodological constraints (e.g. diving) and habitat characteristics (e.g. fine clay sediments) may reduce detectability of smaller individuals. Mortality was low during the 2025-26 Program, with only six dead individuals recorded.

In contrast to Freshwater Lake, Augustus River sites in 2025-26 were dominated by smaller size classes of CFM, suggesting the site has experienced recruitment in recent years (**Figure 23, Figure 24**). The interquartile range in the 2025-26 Program was 36 mm to 51 mm with a median length of 42 mm and average length of 42.9 mm (**Figure 23**). At a site level, no deaths were recorded in AR2. AR3 recorded deaths in the 35–50 mm size classes in AR3, with mortality across most size classes in AR1 (**Appendix D**). AR3 recorded fewer live CFM than AR1 and AR2; however, a greater proportion were smaller individuals, indicating that conditions at AR3 have supported recent recruitment (**Figure 25**). In contrast, the smallest individual recorded at AR2 was 40 mm. Given that AR2 maintains more permanent water than AR1, the apparent lack of recent recruitment at the site is unexpected. AR1 supported the widest size distribution, with individuals ranging from 30 mm to 61 mm, indicating a more structurally diverse population.

Regional reference sites collectively had a median length of 46 mm with an interquartile range of 40.5 to 52 mm (**Figure 23).** This included data from the newly established reference sites on the Brunswick River (BRUN01) and the Harris River (CESA16). A broad range of size classes were detected from site BRUN01 on the Brunswick River, with a mean shell length of 44.4 mm and 50% of individuals measuring between 35 mm and 54 mm (**Figure 26A**). The smallest individual was 14 mm and the largest 69 mm (**Figure 26A**). The wide size distribution at BRUN01 suggests a healthy and stable population, despite the site being located within a largely modified landscape. In contrast, the Harris River (CESA16) population displayed a narrower size distribution, with 50% of individuals

measuring between 39.5 mm and 50.5 mm (Figure 26). The absence of larger individuals may indicate a historical loss of older CFM. No dead individuals were recorded at either reference site in 2025-26, suggesting that any mortality likely occurred at least 2–3 years prior. The presence of smaller individuals at CESA16 indicates that recruitment is still occurring at the site **(Figure 26B**). Ongoing monitoring of CFM populations at reference sites will support the CFMMP by enabling temporal comparisons and helping to distinguish between regional and site-specific processes influencing mussel populations.

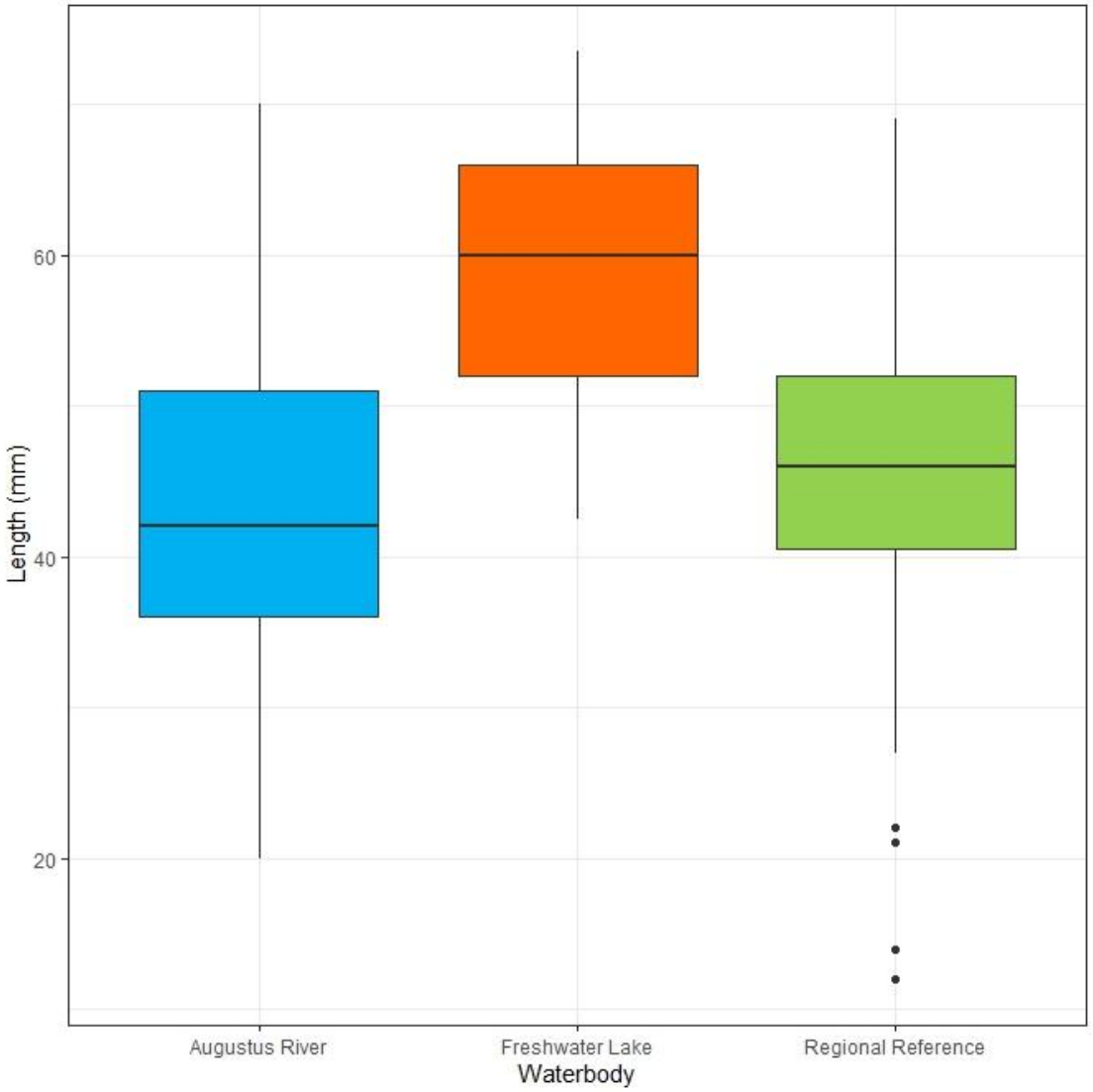


Figure 23: Box and whisker plot indicating the length frequency of CFM mussels in 2025-26 within each waterbody. Boxes represent the Interquartile range (50% of the population), the dark horizontal line is the median, whiskers the typical size range and black circles indicate outliers

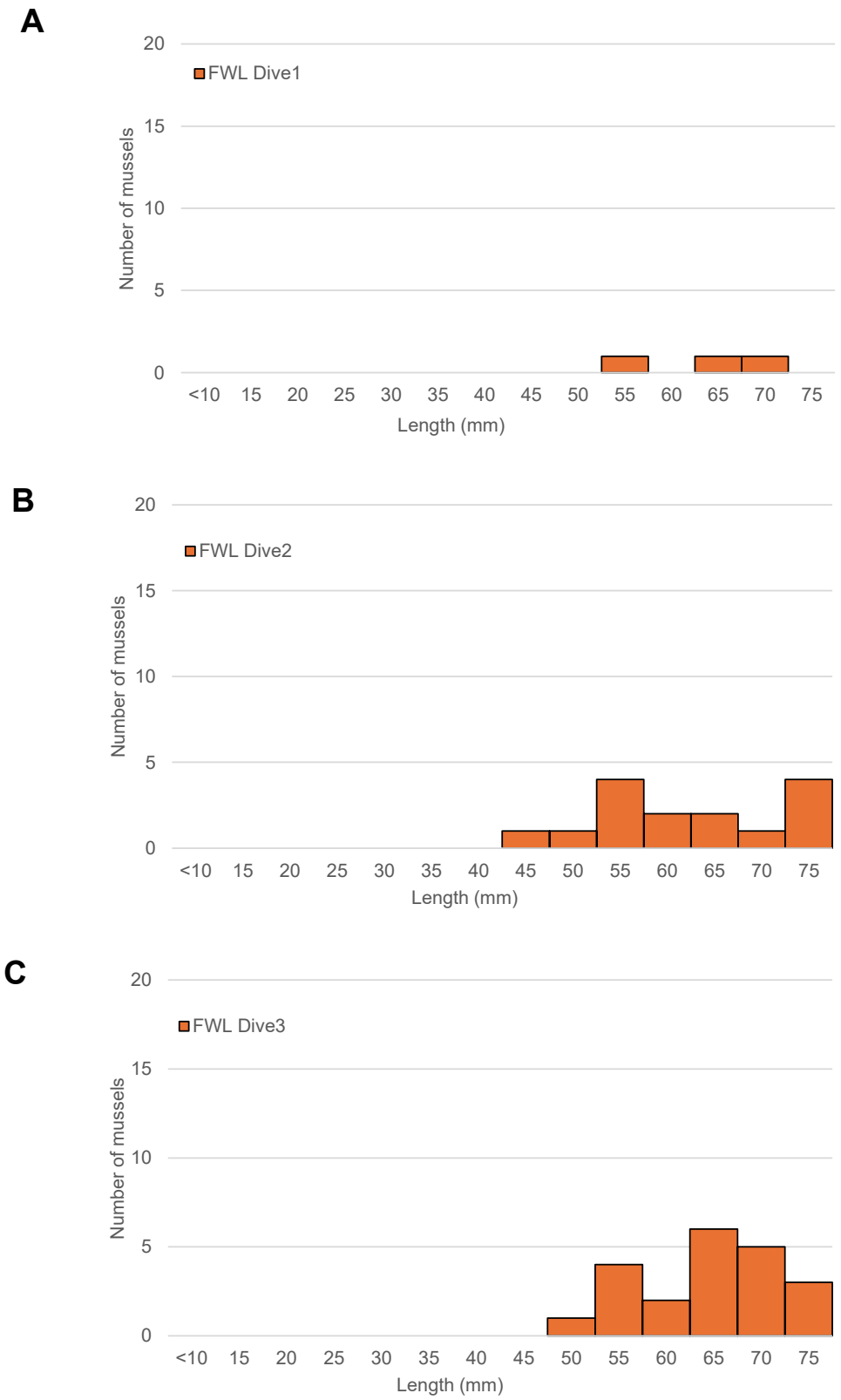


Figure 24: Frequency of live Carter's Freshwater Mussel in each size category recorded from Freshwater Lake Dive sites, FWL_Dive1 (A), FWL_Dive2 (B), and FWL_Dive3 (C) during the 2025-26 Program. X-axis = Maximum Length (mm) in each bin, Y-axis = Number of mussels in each size category.

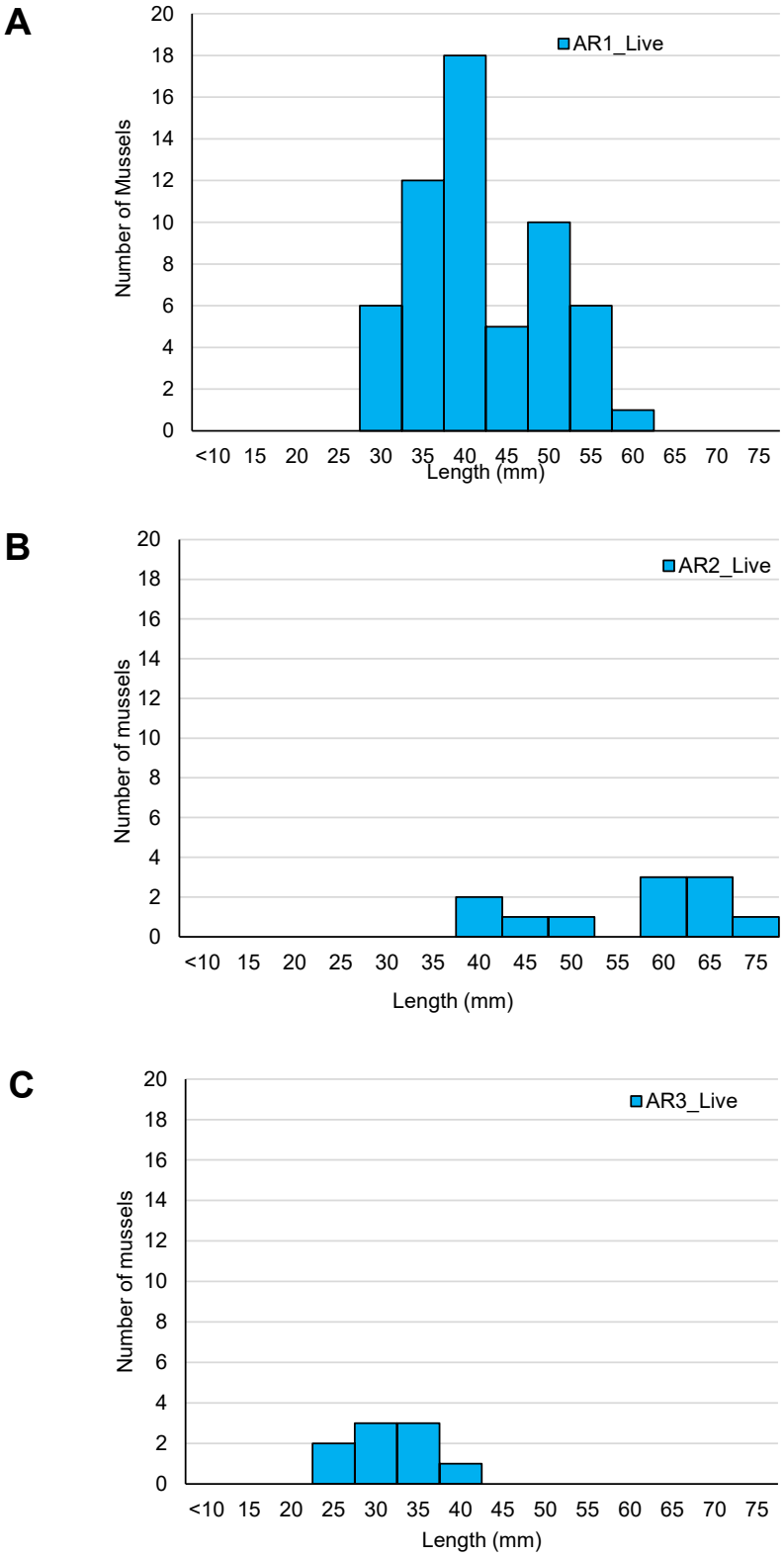


Figure 25: Frequency of live Carter's Freshwater Mussel in each size category recorded from Augustus River sites, AR1 (A), AR2 (B), and AR3 (C) during the 2025-26 Program. X-axis = Maximum Length (mm) in each bin, Y-axis = Number of mussels in each size category.

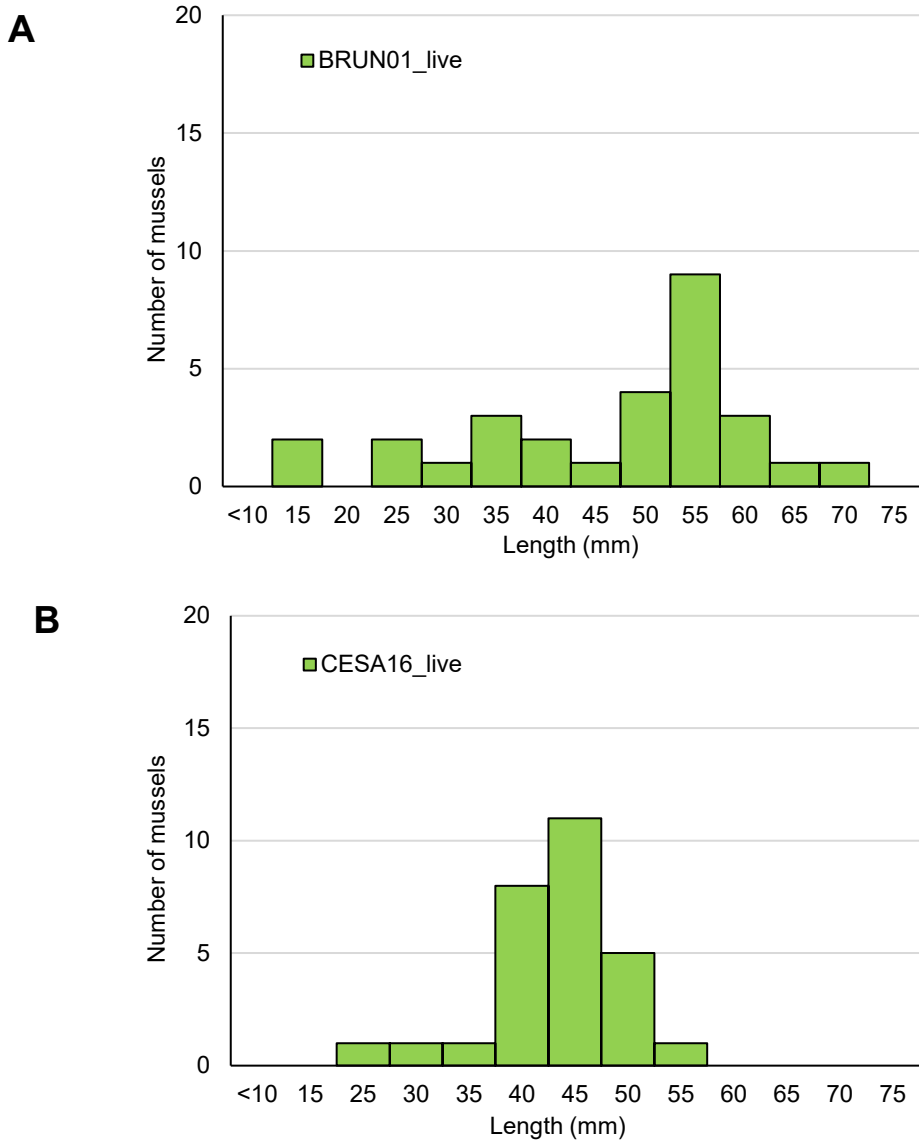


Figure 26: Frequency of live Carter's Freshwater Mussel in each size category recorded from reference sites Brunswick River (BRUN01, A) and Harris River (CESA16, B) during the 2025-26 Program. X-axis = Maximum Length (mm) in each bin, Y-axis = Number of mussels in each size category.

4.3.2.2 Temporal Comparison

Examination of temporal changes in length frequency indicates a slight shift in size classes detected in Freshwater Lake between the 2024-25 and 2025-26 Programs. The average length increased from 53 mm in 2024-25 to 60 mm in 2025-26 (**Figure 27**). Length frequency distributions also show an expansion in size range, with 50% of the sampled population (interquartile range) spanning 43–65 mm in 2024-25 compared to 46–76 mm in 2025-26 (**Figure 27**). This shift in size structure is likely attributable to growth of individuals between sampling periods and may indicate improved survival within the lake in recent years.

In contrast, Augustus River exhibited a shift towards smaller size classes in 2025-26 relative to previous years. This pattern may reflect recent recruitment and/or the loss of larger individuals (**Figure 27**). Comparison of size distributions between years indicates a notable reduction in individuals >70 mm (**Figure 27**). Error! Reference source n ot found. During the 2024–25 monitoring period, both AR1 and AR3 sites dried, and relatively high CFM mortality was recorded, with 20.1% mortality in November 2024 and 29.0% in February 2025 (Stantec 2025). Mortality was concentrated in the 50–69 mm size classes, accounting for 59% of all recorded deaths in 2024–25 (Stantec 2025), suggesting that larger mussels were disproportionally affected at Augustus River sites. A similar pattern was observed in Freshwater Lake during the 2024-25 Program, where 56% mortality was recorded, with 85% of deaths occurring in the 55–69 mm size range (Stantec 2025). Despite the mortality events, the continued presence of smaller individuals in Augustus River indicates ongoing recruitment.

These patterns are consistent with known behavioural responses of CFM to water emersion, whereby individuals track receding water levels and burrow into the substrate (Ma 2018). Smaller mussels tend to burrow early but are more susceptible to predation and scavenging, which may result in underrepresentation of smaller individuals in mortality metrics. This scavenging bias may partly explain the apparent skew towards mortality in larger size classes across both systems in the 2024–25 Program. However, mortality was also recorded at the permanently wet site AR2 in the 2024-25 Program (Stantec 2025), indicating that emersion alone does not fully explain observed losses. Reduced water levels in Freshwater Lake, together with lower than required releases to Augustus River, likely resulted in periods of degraded water quality that may have contributed to mortality. However, as the CFMMP captures only snapshot measurements of water and sediment quality, direct links between mortality and environmental conditions cannot be established with certainty. Increased temporal resolution of water quality monitoring, aligned with population assessments, would improve understanding of the drivers influencing CFM mortality in both Freshwater Lake and Augustus River.

Variation in the sites monitored as reference sites between years limits robust assessment of temporal trends in reference site CFM populations. The Lunenburgh River (LR-Dam) was monitored consistently from 2021 to 2025-26; however no live CFM have been recorded at this site since 2021 (**Figure 27)**. Similarly, the Brunswick River reference site, RR10_99 was monitored in 2023 and 2024-25, with no CFM recorded since 2023, while the Ernest River site (RR02_99) has not recorded any CFM since monitoring commenced at the site in 2023. The inclusion of two additional reference sites on the Brunswick River (BRUN01) and Harris River (CESA16) in the 2025-26 Program is expected to improve the regional context and support more robust assessment of changes in population structure in future years.

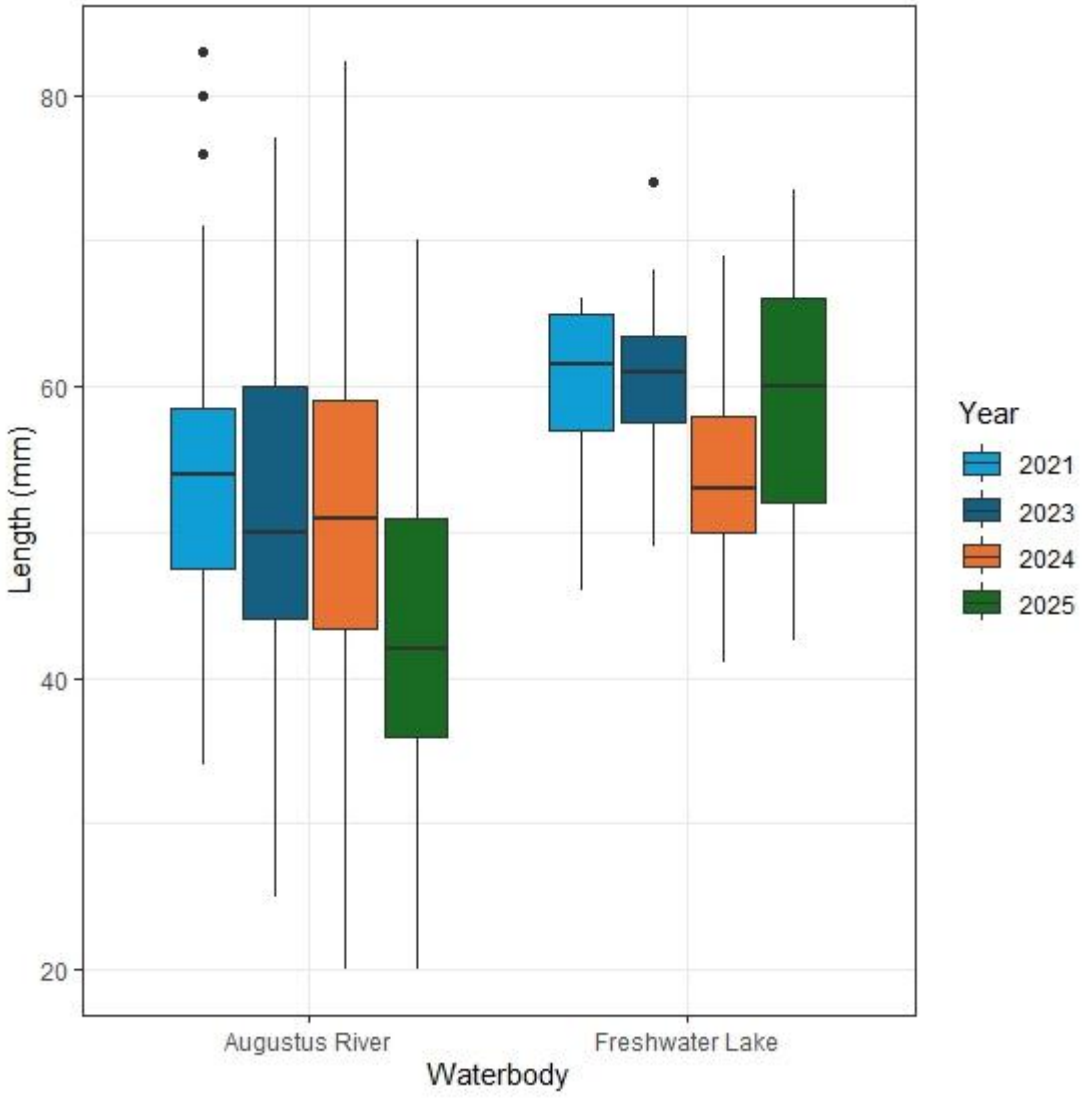


Figure 27: Box plot of mussel length frequency in Augustus River and Freshwater Lake 2021 to 2025. Boxes represent the interquartile range (50% of the population). Dark horizontal line represents the median and the whiskers = typical size range. Black dots indicate outliers.

4.3.3 Local and Regional Distribution

A total of five regional reference sites were surveyed for CFM during the 2025-26 Program, two of which contained live CFM (BRUN01 and CESA16; **Figure 28**). Mussels were not recorded at regional reference site LR_Dam, despite intensive searches, however mussels haven't been recorded from this site since 2021 (Stantec 2021b). No mussels were observed at the Ernest River site RR02_99 and only a single dead mussel was recorded from Brunswick River site RR10_99. This site had previously recorded CFM in 2021 and 2023; however mussels were absent from the site in 2024-25.

The newly established Harris River site (CESA16) recorded CFM in 2025-26. This site had previously been monitored in 2024 as part of the baseline assessment, when 21 individuals were recorded in November 2024 (Stantec 2026). Although a comprehensive regional survey was not part of this scope, these results indicate that the CFM distribution is patchy in the regional area, and vulnerable to localised stressors.

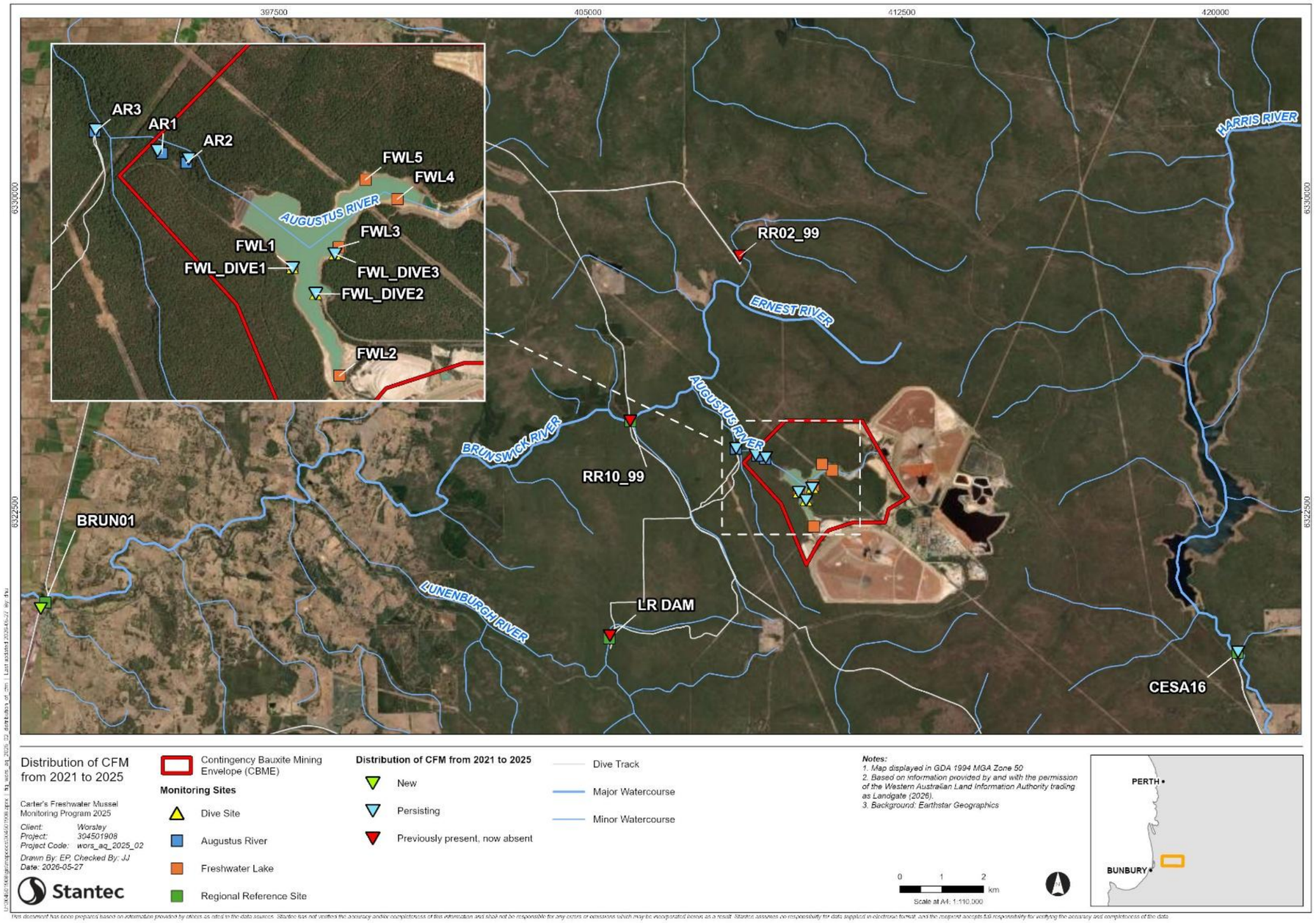


Figure 28: Location of live populations of Carter's Freshwater Mussels monitored from 2021 to 2025-26.

4.4 Freshwater Fish and Crayfish

A total of 379 finfish representing six species and 239 crustaceans representing two species were recorded during the 2025-26 Program (**Table 7**). Of the six fish species, two were invasive (Eastern Gambusia, *Gambusia holbrooki* and Rainbow Trout *Oncorhynchus mykiss*) with the remaining four representing native fish species. Five species, including the invasive Eastern Gambusia, Western Pygmy Perch (*Nannoperca vittata*), Nightfish (*Bostokia porosa*) Western Minnow (*Galaxias occidentalis*) and the Freshwater Cobbler (*Tandanus bostocki*) are presumed competent hosts of the CFM glochidia (mussel larvae) and were all recorded during the 2025-26 Program (**Table 7**).

Freshwater Lake recorded a total of 180 individuals representing two native fish species, the Western Pygmy Perch (**Plate 2A**) and the Western Minnow (**Plate 2C**) and one decapod crustacean (**Table 7**). The Western Pygmy Perch is a known CFM glochidia host and the Western Minnow is considered a potential host of CFM but has yet to be confirmed as species that can successfully host the glochidia to produce juvenile CFM (Klunzinger *et al.* 2012b). Capture rates of the Western Pygmy Perch were low at Freshwater Lake compared to the Augustus River, Brunswick River and Lunenburgh River in 2025-26 (**Figure 29A**). Nightfish (**Plate 2B**) were not recorded from Freshwater Lake during the 2025-26 Program, although the species was previously recorded in only low numbers from the Lake in 2023 (Stantec 2024). Freshwater Lake has permanent water and in theory has the potential to support high densities of fish. It is possible that water quality (e.g. elevated turbidity), limited in-lake habitat complexity (e.g. woody debris, aquatic vegetation), and reduced water levels in 2025–26 have constrained fish abundance, thereby limiting the recruitment potential of the CFM population.

Augustus River recorded the highest fish abundance and diversity, with 244 individuals representing four native fish and one decapod crustacean species (**Table 7**). Of the fish species recorded from Augustus River sites, although all four are presumed to be competent hosts of CFM glochidia, two are known hosts; Western Pygmy Perch and Freshwater Cobbler (**Plate 2D**) (Klunzinger *et al.* 2012b). Of these, the Western Pygmy Perch was the most frequently captured in fyke nets (CPUE of 12.9 fish), while only a single individual (Fyke CPUE of 0.17 fish) of both the Freshwater Cobbler and the Western Minnow were captured from the Augustus River sites (**Figure 29A**). Nightfish was the second most captured species, with a CPUE of 1.17 fish (**Figure 29A**). The Western Minnow and the Nightfish are considered potential hosts for CFM glochidia, however this requires further investigation to confirm their capacity to host glochidia to maturation (Klunzinger *et al.* 2012b). Sites AR1 and AR2 both supported taxa capable of hosting CFM glochidia (**Table 7**), and AR3 was not sampled for fish in 2025-26 due to low water levels. Adjusting for effort between years, fish captures of all species were higher in 2025-26, with CPUE ranging from 0.17 to 12.9 fish, compared to CPUE of 0.5 to 4.5 fish in 2023 (Stantec 2024).

Two regional reference sites on the Brunswick River (BRUN01 and RR10_99) collectively recorded seven fish and crustacean species, including the invasive Rainbow Trout (**Plate 2F**, Fyke CPUE = 3.33 fish), and the confirmed CFM glochidia hosts, Western Pygmy Perch (Fyke CPUE = 0.33 fish) and Freshwater Cobbler (Seine CPUE = 0.25 fish). Two other potential CFM hosts, the Nightfish (Fyke CPUE = 2 fish) and Western Minnow, (Fyke and Seine CPUE of 3.67 and 0.25 fish respectively) were also recorded in low numbers (**Figure 29A**). Higher fish abundances were recorded from RR10_99 compared to BRUN01, potentially due to the site being located within a largely modified landscape (**Table 7**). The 2025–26 Program represents the first year in which quantitative fish sampling was undertaken at these sites.

The Harris River site (CESA16) recorded a single individual of the known CFM glochidia host, the Western Pygmy Perch and five individual Western Minnows from beach seines undertaken at the site during the 2025-26 Program (**Table 7**). Beach seines were employed due to the low water levels at the site. This is the first year this site was sampled and only seine nets could be used due to the very low water levels. The 2025–26 Program represents the first year in which quantitative fish sampling was undertaken at CESA16. In contrast, the Lunenburgh River Dam (LR_Dam), recorded the highest density of the known CFM glochidia host, the invasive Eastern Gambusia, with a Fyke CPUE of 18.83 fish (**Figure 29A**). Despite being an invasive species, the Eastern Mosquitofish has been confirmed as being a competent host for CFM glochidia (Klunzinger *et al.* 2012b). No native fish species were recorded in Lunenburgh Dam; the presence of the highly aggressive, dominant Eastern Gambusia may have contributed to their suppression.

The native Smooth Maroon (*Cherax cainii,* **Plate 3A***)* was captured at all sites, with Freshwater Lake, Augustus River, and Brunswick River sites supporting the largest populations (**Table 7; Figure 29B**). The native Gilgie (*Cherax quinquecarinatus,* **Plate 3B**) was also recorded in the Brunswick River, although at much lower densities than the Smooth Marron (**Table 7**). Harris River and Lunenburgh Dam both recorded the Smooth Marron but at significantly lower densities than other sites (**Table 7**). Only Augustus River and Freshwater Lake were quantitatively monitored for crustaceans in 2023. Relative to 2023, decapod crustacean captures were reduced in the 2025–26 Program (Stantec 2024). All monitored sites recorded at least one species of decapod crustacean that may act as a predator of CFM (**Table 7**). Although direct observations of crustacean predation on CFM are limited, experimental and global literature demonstrates that freshwater crayfish readily consume juvenile unionid mussels, including individuals buried within sediments (Meira *et al.* 2024). Given the comparable life-history traits of CFM to other unionid mussels, particularly its vulnerable benthic juvenile stage, Smooth Marron and the native Gilgie are considered likely predators of early life stage CFM individuals, especially under conditions where mussels are exposed or stressed. This is further supported by the generalist, omnivorous feeding ecology of *Cherax* spp., which includes predation on benthic invertebrates (O'Hea Miller *et al.* 2024).



Plate 2: Freshwater fish recorded during the 2025-26 Program; (A) Western Pygmy Perch, (B) Nightfish, (C) Western Minnow, (D) Freshwater Cobbler, (E) Eastern Gambusia (invasive) and (F) Rainbow Trout (invasive).

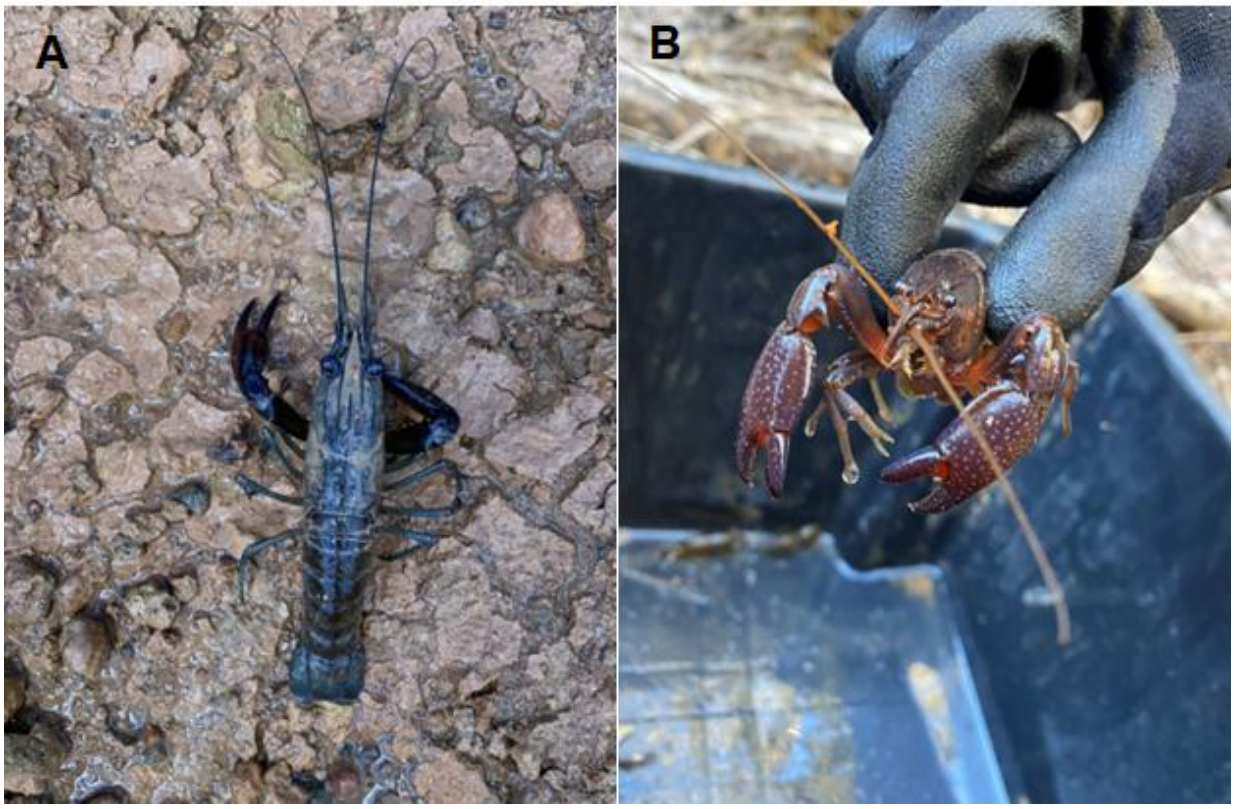


Plate 3: Freshwater crayfish recorded during the 2025-26 Program; (A) Smooth marron and (B) Gilgie.

Table 7: Freshwater fish and crayfish species recorded during the 2025-26 Survey. Values represent CPUE with numbers in parenthesis reflecting the total species abundance at the site.

Method	Scientific Name	Common Name	Impact								Regional Reference					Average Length (cm)	Length Range (cm)
			Freshwater Lake					Augustus River			Lunenburgh River Dam	Ernest River	Brunswick River		Harris River		
			FWL1	FWL2	FWL3	FWL4	FWL5	AR1	AR2	AR3	LR_DAM	RR02	RR10	BRUN01	CESA - 16		
Fyke Net	**Freshwater crayfish**																
	Cherax cainii	Smooth Marron	6.5 (52)		2 (8)	5.75 (23)	8.25 (33)	4.83 (29)	7.33 (44)		0.67 (4)		11 (33)			12.7	6 – 26
	Cherax quinquecarinatus	Gilgie											0.67 (2)			7	7
	Fish																
	Bostockia porosa	Nightfish						0.5 (3)	1.83 (11)				2 (6)			7.5	6 – 10
	Galaxias occidentalis	Western Minnow	0.12 (1)			0.25 (1)			0.17 (1)				3.67 (11)			6.85	5.5 – 8
	Gambusia holbrooki#*	Eastern Gambusia									18.83 (113)					2.35	2 – 2.6
	Nannoperca vittata#	Western Pygmy Perch	1.5 (12)		0.25 (1)	5.5 (22)	0.75 (3)	15.3 (92)	10.5 (63)							4.14	2.5 – 7
	*Oncorhynchus mykiss^*	Rainbow Trout											3.33 (10)			7.16	7 – 7.5
	Tandanus bostocki#	Freshwater Cobbler							0.17 (1)							45	45
Beach Seine	**Freshwater crayfish**																
	Cherax cainii	Smooth Marron			0.25 (1)	0.75 (3)	0.25 (1)								2 (4)	7	6 – 10
	Fish																
	Galaxias occidentalis	Western Minnow				0.25 (1)								0.25 (1)	2.5 (5)	6.8	6 – 7.5
	Nannoperca vittata#	Western Pygmy Perch	0.25 (1)		0.5 (2)	2 (8)	1.75 (7)								0.5 (1)	3.9	3 – 5
	Tandanus bostocki#	Freshwater Cobbler												0.25 (1)		25	25

** indicates invasive species and the ^ symbol indicates non-native species of concern under the Fish Resources Management Act* 1994. #indicates a confirmed host of CFM glochidia. G*rey indicates sites where a sampling method was not used due to unsuitable sampling conditions.*

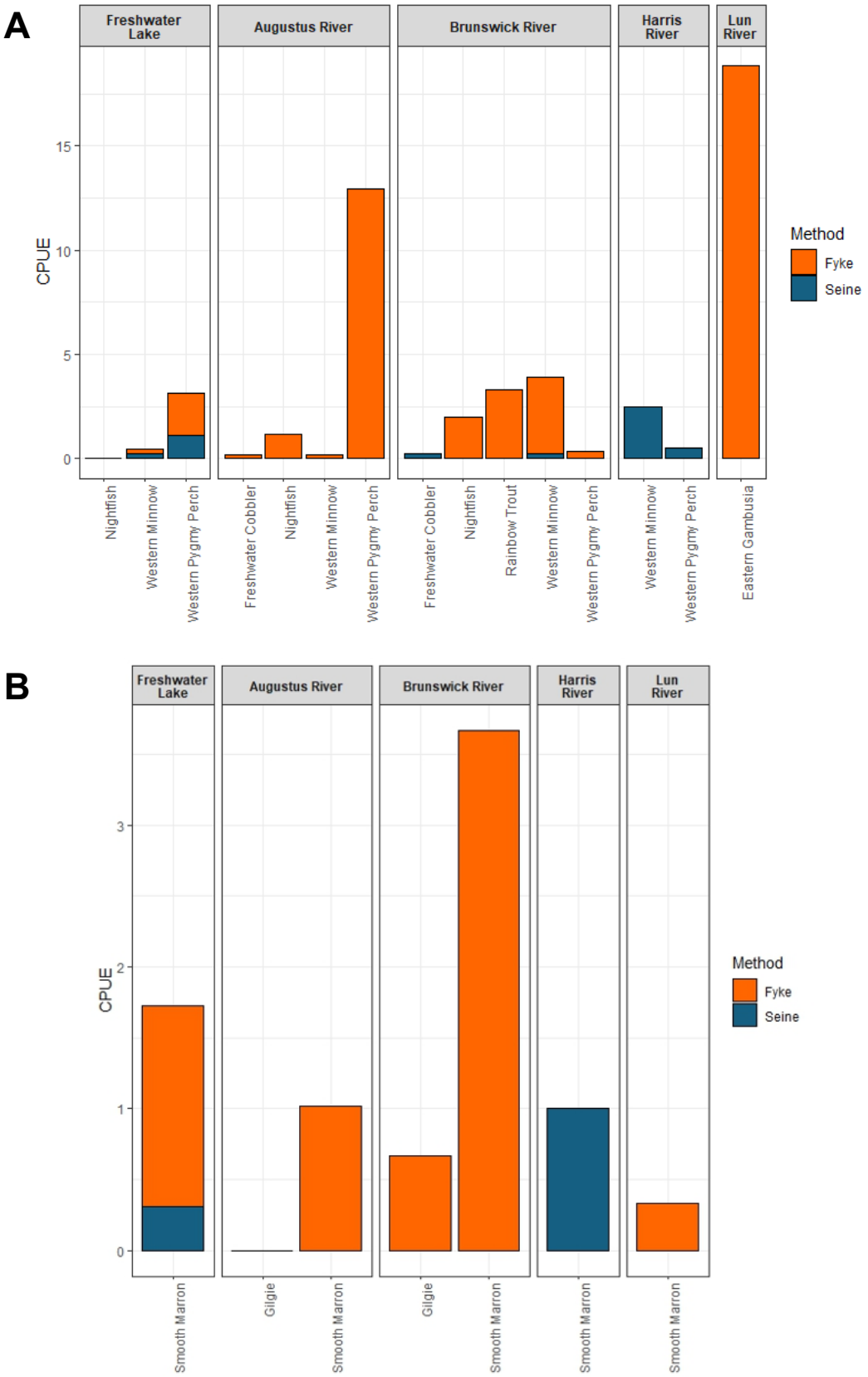


Figure 29: Relative abundance of (A) fish and (B) potential CFM predators (i.e. crayfish) captured using fyke and seine nets in each waterbody in 2025. Lun River = Lunenburgh River.

5 Summary and Conclusions

The 2025-26 Carter's Freshwater Mussel (Westralunio carteri) monitoring program addressed the monitoring and reporting requirements outlined in the CFMMP (Stantec 2023a) for annual monitoring of the Vulnerable (BC Act and EPBC Act) Carter's Freshwater Mussel in Freshwater Lake, the Augustus River and at regional reference sites. Field surveys were undertaken between the 2nd and 11th November 2025 (shallow water survey) and between the 30th and 31st March 2026 (deep water dive survey). A total of 16 sites were assessed, consisting of eight sites in Freshwater Lake, three sites in the Augustus River and five regional reference sites within the Lunenburgh River Dam, the Ernest River, the Harris River and the Brunswick River. During the November shallow water survey, water and sediment quality samples were collected, CFM, freshwater fish and crayfish were sampled, and habitat at each site was characterised and photographed. The deep-water dive survey consisted of targeted CFM searches that were conducted at three Freshwater Lake sites. Water level and flow data provided by Worsley Alumina were examined to address monitoring and reporting requirements outlined in the CFMMP (Stantec 2023a).

Habitat assessments identified major limitations in Freshwater Lake, including sparse riparian vegetation, low woody debris, and limited organic inputs, resulting in poor habitat complexity and reduced suitability for CFM recruitment. Sediments in deeper areas were dominated by unconsolidated, anoxic fines, unlikely to support stable populations. In contrast, the Augustus River showed greater habitat complexity and supported higher CFM densities, although recent drying has likely caused a modest decline.

Surface water levels at Freshwater Lake ranged from 228–238 m AHD between 2022 and 2025, with 2025 recording the lowest level since monitoring began (228 m AHD in June). In 2025, water levels fell below the 231 m AHD trigger, particularly from April to August, likely due to below-average rainfall and peak abstraction. Seasonal patterns were atypical, with lows occurring in winter rather than summer. Concurrently, environmental flow requirements to the Augustus River were not met during the monitoring period, with average discharge rates from September to December below the stipulated 2.9 m^3/5 mins and flow rates frequently below the stipulated rates, resulting in extended cease-to-flow periods. In consultation with DWER, South32 were permitted to extend the program to meet the required flow. Low flows were also observed outside this period, continuing a trend similar to 2024. These conditions may have reduced available habitat for CFM and fish hosts.

Surface water quality at Freshwater Lake, Augustus River and regional reference sites during the 2025-26 Program was characterised by generally circumneutral to slightly alkaline pH across all sites, with dissolved oxygen remaining within acceptable limits for aquatic fauna. Although dissolved oxygen concentrations during the survey were within values considered tolerable for CFM; the annual monitoring frequency prevents the assessment of short-term hypoxic events that may occur under elevated temperature and organic loading conditions. Freshwater Lake exhibited elevated electrical conductivity, turbidity, and nutrients (total nitrogen and total phosphorus) relative to the respective ANZG (2018) guideline values (GVs) for upland rivers, suggesting influences from sediment inputs and surrounding land use. In contrast, Augustus River sites generally met ANZG (2018) GVs for turbidity and nutrients. All sites remained within freshwater salinity thresholds, and acid sulfate soil risk was low despite elevated sulfate at some of the monitored sites. Most dissolved metals were within GVs; however, aluminium concentrations exceeded the ANZG (2018) 95% species protection default guidelines values (DGVs) and the trigger criteria under the CFMMP (IW5:Table 8) at Freshwater Lake sites, posing a potential risk to freshwater mussels. Elevated aluminium can present a potential chronic stressor, particularly in combination with varying pH and sediment conditions. All other metals were recorded below respective ANZG (2018) DGVs. Multivariate analysis showed distinct clustering of Freshwater Lake sites, characterised by higher nutrients and aluminium concentrations, while Augustus River and regional reference sites were associated with different metal profiles and generally lower disturbance. While ammonia concentrations at all sites remained within acceptable limits, elevated nutrient loads increase the risk of eutrophication and subsequent depletion of dissolved oxygen, particularly in low-flow conditions.

Sediment quality during the 2025-26 Program was characterised by moderately acidic to neutral pH at Freshwater Lake and neutral at Augustus River and reference sites, with all sites classified as non-saline. Nutrient concentrations were variable, with Freshwater Lake showing moderate and relatively consistent total nitrogen and total phosphorus concentrations, while Augustus River sites exhibited substantially higher total nitrogen, indicating stronger nutrient inputs potentially from organic matter loading from riparian vegetation or catchment-driven influences such as increased fertiliser use. Total phosphorus was elevated at some Freshwater Lake and Augustus River sites, although to a lesser extent than total nitrogen. Most metals were below ANZG (2018) DGVs and GV-High, although aluminium

was elevated in Freshwater Lake sediments and at one Augustus River site (AR2). While the elevated aluminium concentration at AR2 may reflect local geological or sediment characteristics, the available data are insufficient to determine whether it is attributable to refinery operations. Concentrations of mercury, required to be assessed in accordance with the CFMMPMP (Stantec 2023), were below the LoRs at all sites sampled during the 2025-26 Program. All other metals showed some site-specific variation but dominantly remained below the ANZG (2018) DGVs and GV-High thresholds. Overall, sediment characteristics were broadly similar across sites, with multivariate analysis indicating limited variation between Freshwater Lake, Augustus River and regional reference sites. Freshwater Lake sites however were associated with higher moisture content and metal concentrations, while Augustus River sites were characterised by elevated sediment nitrogen.

Regionally, major ion composition in sediments shifted across all sites. Calcium, magnesium and potassium increased from below reporting limits in 2024 to up to 3,410 mg/kg Ca at AR2. Sodium also rose at all sites, notably at AR2 (20 to 208 mg/L), though all remain within freshwater ranges. These increases likely reflect reduced hydroperiods, with ongoing surface water decline posing risks to water quality and CFM populations. While no toxicity data exist for CFM and ammonia, elevated interstitial ammonia can limit freshwater mussels, particularly early life stages. Such effects are unlikely to be detected under the current CFMMP sampling design.

A total of 230 CFM individuals were recorded across 11 sites during the 2025-26 Program, with 78% of all CFM alive at the time of detection. However, population distribution was uneven across the survey area, suggesting system-specific pressures, such as reduced hydrological cycle. Within Freshwater Lake, no live mussels were detected from the shallow quantitative monitoring sites (FWL1 – FWL5) in November 2025, with all individuals restricted to deeper habitats (≥1 m) surveyed in the targeted CFM dive survey in March 2026. A total of 39 live CFM were recorded during the targeted CFM dive survey. This is consistent with previous surveys, indicating a small and spatially constrained population of CFM at Freshwater Lake. Population structure analysis detected a dominance of large, older individuals and a lack of juvenile recruitment at Freshwater Lake, suggesting the population is ageing. In stating this however, diver-based mussel surveys are subject to imperfect detection, with the likelihood of detecting individuals influenced by factors such as water clarity, substrate type, depth, and the degree to which mussels are buried within sediments. Consequently, observed abundance and distribution patterns may underestimate true population size, particularly for small or partially buried individuals and in habitats where detectability is reduced. Fish data indicates that the available CFM glochidia host population has declined from 2023, while potential aquatic crustacean predators have remained at 2023 levels. These pressures may be restricting recruitment at Freshwater Lake. While mortality detections (six individuals) were comparatively low, the absence of recent recruitment indicates a potential risk of long-term population decline, particularly under continued environmental stress.

The Augustus River recorded a total of 82 live mussels, with 65.6% of all CFM recorded across sites alive at the time of detection, and a 34% mortality rate across sites. Compared to the 2021 baseline, density measures declined slightly by approximately 15.6% in the 2025-26 Program. This decline is below the 20% trigger criteria defined in the CFMMP (Stantec 2023). The minor reduction in density over time is likely attributable to the acute environmental stress likely associated with reduced hydroperiods and below-average rainfall. There have been substantial increases in CFM population density over time at Augustus River, notably when the population density peaked at 9.7 mussels/m2 during the 2024-25 monitoring period. Despite a reduction in larger adults between 2024 and 2025–26 at Augustus River sites, the detection of smaller individuals indicates recent recruitment and an overall stable CFM population at Augustus River.

Of the five regional reference sites surveyed, two sites recorded no CFM, and one site recorded only a single dead CFM. Both CESA16 (Harris River) and BRUN01 (Brunswick River), recorded live individuals. The CFM population structure at BRUN01 indicates it is a viable, stable population with active recruitment, however the population at Harris River suggests it has experienced losses in recent years with a complete absence of older individuals. The patchiness observed across populations indicates increasing fragmentation of CFM populations in the region and highlights their sensitivity to localised environmental conditions. The variability among reference sites also reinforces the importance of ensuring sufficient reference sites are consistently surveyed to provide context for changes that are occurring within the potential impact sites (Augustus River and Freshwater Lake).

Freshwater fish sampling during the 2025–26 Program confirmed the presence of suitable host species for CFM glochidia across all systems, including Freshwater Lake (Western Pygmy Perch and the Western Minnow), indicating host availability is unlikely to limit CFM recruitment. Fish abundance and diversity were highest in the Augustus River, where all recorded species were either potential or confirmed glochidia host species and catch rates exceeded those

from the previous 2023 monitoring. In contrast, Freshwater Lake supported lower diversity and fish abundances, likely reflecting the reduced habitat complexity, elevated turbidity, and lower water levels, which may constrain CFM recruitment dynamics. Regional reference sites supported a mix of native and invasive species (e.g. Rainbow Trout), while Lunenburgh Dam was dominated by the invasive Eastern Gambusia, with no native fish recorded from the site, consequently suggesting the potential suppression of native taxa at the Dam. Smooth Marron and the native Gilgie were recorded across sites, with Smooth Marron particularly widespread and abundant. These generalist omnivores are likely to prey on juvenile CFM, representing an additional pressure on the early life stages of the species.

6 Recommendations

Recommendations based on the current 2025-26 Program and previous are provided below.

- **Recommendation 1: Increase monitoring frequency and data interpretation:**

  Water and sediment quality parameters, including dissolved oxygen (DO), salinity (EC), nutrients, and pH, should be monitored at sufficiently high temporal resolution to capture short-term variability and ecologically relevant extremes. In particular, single point DO measurements do not capture diel fluctuations or episodic hypoxic events, which are critical for CFM survival. Similarly, pH and nutrient dynamics are closely linked to DO, while salinity and nutrient concentrations can vary with flow conditions, rainfall, and land use influences. The 2025-26 data and previous data should be interpreted as a snapshot only and not as a comprehensive representation of habitat condition. Ongoing, higher-frequency monitoring datasets (e.g., those collected by South32 under licence requirements) should be prioritised for assessing temporal trends and risks to CFM.

- **Recommendation 2: Incorporate porewater ammonia (NH_4–N) into sediment analysis:**

  Elevated nutrient concentrations, particularly interstitial ammonia, are known to adversely affect freshwater mussels, with early life stages (glochidia and juveniles) being especially sensitive (Kleinhenz *et al.* 2019; Walker *et al.* 2014). Laboratory analysis of porewater ammonia from sediment samples would provide a direct measure of exposure within the sediment–water interface and improve assessment of potential risks to CFM.

- **Recommendation 3**: **Maintain consistency in regional reference site selection:**

  Stable reference sites are essential for distinguishing between regional drivers (e.g. climatic variability) and localised impacts on CFM populations. Previous changes in reference site locations (driven by reduced water availability during below average rainfall in 2024–25) have limited temporal comparisons. Prioritising sites that retain water and support persistent CFM populations (e.g. BRUN01 and CESA16) and aligning survey methods (e.g. inclusion of LR_Dam into the dive survey), will strengthen trend interpretation and improve confidence in detecting any potential CFM population changes.

- **Recommendation 4**: **Use baseline water and sediment quality data to develop SSGVs:**

  Default ANZG (2018) guideline values have been applied historically and within this report for the assessment of water and sediment quality parameters. These guidelines are generic and were developed for broad application across a wide range of waterbodies and geographic regions. Development of site specific guideline values (SSGVs) for the CFMMP is recommended to provide guideline values that are more representative of local environmental conditions and better aligned with the protection of CFM. South32 require 24 samples from each location to determine these SSGVs, with sampling commencing in March 2025. Stantec proposes to undertake development of SSGVs collaboration with South32 in coming years.

7 CFMMP (Stantec 2023) Outcome-based Management Provisions

Trigger and threshold criteria outlined in the outcome-based management provisions within the CFMMP have been addressed in **Table 8**. Grey text indicates management objectives outside of this scope of work. Exceedances of triggers or thresholds are highlighted in red. There were three instances of trigger criteria exceedances of IW2, IW5 and IW6 and one exceedance of the threshold criteria for IW2 (**Table 8**).

Table 8: CFMMP outcome-based management provisions criteria assessment based on the 2025-26 CFM monitoring program.

Outcome-based Management Objectives		Trigger Criteria	Trigger Criteria Exceeded?	Threshold Criteria	Threshold Criteria Exceeded?
IW1	Minimise adverse impacts to CFM due to project-related land clearing surrounding Freshwater Lake or Augustus River.	• Clearing occurs without an authorised internal permit within the CBME, but outside the 50 m buffer zone of Freshwater Lake.	• Not applicable to this scope of work	• Unauthorised clearing or disturbance within the 50 m buffer zone of Freshwater Lake.	• Not applicable to this scope of work
		• Clearing occurs without an authorised internal permit within the CBME, but outside the 200m buffer zone of Augustus River.	• Not applicable to this scope of work	• Unauthorised clearing or disturbance within the 200m buffer zone of Augustus River.	• Not applicable to this scope of work
IW2	**Avoid adverse impacts to Carter's Freshwater Mussel from decreased water levels below minimum caused by excessive water abstraction within Freshwater Lake.**	• Water levels recorded below 231 m AHD in Freshwater Lake.	• **Trigger criteria exceeded** in Freshwater Lake March to August 2025	• Water levels recorded below 225 m AHD for a period of three months in Freshwater Lake.	• Threshold criteria not exceeded in Freshwater Lake between April to August 2025, with a minimum of 228 m AHD.
IW3	Avoid adverse impacts to Carter's Freshwater Mussel from changes in suspended solids due to Project-related sedimentation.	• Isolated occurrence of overtopping of sediment trap(s) into Freshwater Lake.	• Not applicable to this scope of work	• Continued occurrence / or overtopping of multiple sediment trap(s) into Freshwater Lake.	• Not applicable to this scope of work
IW3	**Avoid adverse impacts to Carter's Freshwater Mussel from changes in suspended solids due to Project-related sedimentation.**	• Total Suspended Soilds: >8 mg/L in the surface water of Freshwater Lake and Augustus River in a single monitoring event.	• TSS not measured in 2025. • Turbidity in FWL ranged 120 – 170 NTU, while AR ranged from 4.3 – 4.7NTU	• Total Suspended Soilds: >15 mg/L in the surface water of Freshwater Lake and Augustus River in a single monitoring event.	• Not measured in 2025.
IW4	**Avoid adverse impacts to Carter's Freshwater Mussel from elevated mercury (Hg) levels in the surface water of Freshwater Lake or Augustus River and in the sediment of Freshwater Lake.**	• Dissolved Mercury: >0.00006 mg/L in the surface water of Freshwater Lake and Augustus River, in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; NOTE: the LoR for dissolved mercury in 2025 was 0.0001 mg/L	• Dissolved mercury: >0.0006 mg/L in the surface water of Freshwater Lake and Augustus River, in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River. NOTE the LoR for dissolved mercury in 2025 was 0.0001 mg/L.
		• Total Mercury: 0.15 mg/kg in the sediment of Freshwater Lake and Augustus River, in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Total Mercury: 1.0 mg/kg in the sediment of Freshwater Lake and Augustus River, in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River.
IW5	**Avoid adverse impacts to Carter's Freshwater Mussel from elevated aluminium, cadmium, copper, lead, and zinc concentrations in the surface water of Freshwater Lake or Augustus River.**	• Dissolved Aluminium: >0.027 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• **Trigger criteria exceeded** for aluminium within Freshwater Lake at all five sites (0.04 mg/L – 0.05 mg/L) • Trigger criteria not exceeded within the Augustus River	• Dissolved Aluminium: >0.055 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River.
		• Dissolved Cadmium: >0.00006 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved cadmium in 2025 was 0.0001 mg/L	• Dissolved Cadmium: >0.0002 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved cadmium in 2025 was 0.0001 mg/L.
		• Dissolved Copper: >0.001 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Dissolved Copper: >0.0014 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River.
		• Dissolved Lead: >0.001 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Dissolved Lead: >0.034 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River.
		• Dissolved Zinc: >0.0024 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved zinc in 2025 was 0.005 mg/L	• Dissolved Zinc: >0.008 mg/L in the surface water of Freshwater Lake and Augustus River, recorded in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River; however, the LoR for dissolved zinc in 2025 was 0.005 mg/L.
IW6	**Minimise adverse impacts to Carter's Freshwater Mussel from salinisation of the surface water of Freshwater Lake and Augustus River.**	• Salinity >1.6 g/L in the surface water of Freshwater Lake and/or Augustus River in a single monitoring event.	• Trigger criteria not exceeded within Freshwater Lake or the Augustus River	• Salinity >3 g/L in the surface water of Freshwater Lake and/or Augustus River in a single monitoring event.	• Threshold criteria not exceeded within Freshwater Lake or the Augustus River.
		• Individual mortality recorded of Carter's Freshwater Mussel at Freshwater Lake.	• **Trigger criteria exceeded** within Freshwater Lake with 6 dead Carter's Freshwater Mussel individuals recorded in 2025. Noting that deaths cannot be linked directly to salinity using one annual water quality measure.	• 50% reduction in Carter's Freshwater Mussel known population size (individuals) in Freshwater Lake.	• Threshold criteria not exceeded within Freshwater Lake.
		• Reduction in density (per square metre) of Carter's Freshwater Mussel by >20% recorded at Augustus River.	• **Trigger criteria not exceeded** within the Augustus River with average density declining 15.6%. • Total 43 dead mussels detected in AR.	• 50% reduction in Carter's Freshwater Mussel known density (per square metre) in Augustus River.	• **Threshold criteria not exceeded** within the Augustus River with average loss of 15.6%, 2021 to 2025.

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Appendices

Appendix A Historical Surveys, Sites and Sampling Components, 1999-2025

Table A 1: Historical surveys, sites and sampling components implemented within Freshwater Lake, the Augustus River, and regional reference sites in the Lunenburgh River, Brunswick River and Ernest River (1999-2025).

Date Sampled	Survey	Type	Waterway	Sampling Site	Methods
March 1999 December 1999	Hale *et al.* (2000)	Potential Impact	Freshwater Lake	FWL5_99	• Shallow-water mussel transect
		Regional Reference	Brunswick River	RR10_99	• Shallow-water mussel transect
			Ernest River	RR02_99	• Shallow-water mussel transect
October 2004	WRM (2005)	Potential Impact	Augustus River	AR3_21	• Sediment quality
May 2021	Stantec (2021b)	Potential Impact	Freshwater Lake	FWL_Dive1_21	• Diving
			Freshwater Lake	FWL03_21	• Quantitative mussel sampling (shoreline) • Sediment quality • Targeted mussel inspection (shoreline) • Water quality
			Freshwater Lake		
			Freshwater Lake		
			Freshwater Lake		
			Freshwater Lake	FWL4_21	• Quantitative mussel sampling (shoreline) • Sediment quality • Targeted mussel inspection (shoreline) • Water quality
			Freshwater Lake		
			Freshwater Lake		
			Freshwater Lake		
			Freshwater Lake	FWL_Dive2_21	• Diving
			Freshwater Lake	FWL_Dive3_21	• Diving
			Augustus River	AR3_21	• Shallow-water mussel transect
		Regional Reference	Lunenburgh River Dam	LRDam_21	• Shallow-water mussel transect
May 2021 July 2021	Stantec (2021b)	Potential Impact	Freshwater Lake	FWL1_21	• Quantitative mussel sampling (shoreline) • Sediment quality • Targeted mussel inspection (shoreline) • Water Quality
				FWL2_21	• Quantitative mussel sampling (shoreline)

Date Sampled	Survey	Type	Waterway	Sampling Site	Methods
					• Sediment quality • Targeted mussel inspection (shoreline) • Water quality
				FWL05_21	• Quantitative mussel sampling (shoreline) • Sediment quality • Targeted mussel inspection (shoreline) • Water quality
			Augustus River	AR1_21	• Shallow-water mussel transect
				AR2_21	• Shallow-water mussel transect
July 2021	Stantec (2021b)	Potential Impact	Freshwater Lake	FWL6_21	• Quantitative mussel sampling (shoreline) • Sediment quality • Targeted mussel inspection (shoreline) • Water Quality
November 2023	Stantec (2024)	Potential Impact	Freshwater Lake	FWL03_23	• Shallow-water mussel transect • Water quality • Sediment quality • Shallow-water mussel transect • Fish sampling
				FWL07_23	• Fish sampling • Sediment quality • Shallow-water mussel transect • Water quality
				FWL08_23	• Sediment quality • Shallow-water mussel transect • Water quality
				FWL09_23	• Sediment quality • Shallow-water mussel transect • Water quality

Date Sampled	Survey	Type	Waterway	Sampling Site	Methods
				FWL5_99	• Sediment quality • Shallow-water mussel transect • Water quality
				FWL_Dive1_21	• Snorkeling/free-diving mussel transects
				FWL_Dive2_24	• Snorkeling / free-diving mussel transects
				FWL_Dive3_24	• Snorkeling/free-diving mussel transects
			Augustus River	AR1_21	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
				AR2_21	• Fish sampling • Shallow-water quantitative mussel transect • Sediment quality • Water quality
				AR3_21	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
		Regional Reference	Brunswick River	RR10_99	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
			Ernest River	RR02_99	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
			Lunenburgh River Dam	LRDam_21	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
			Augustus River	AR1_21	• Sediment quality • Water quality

Date Sampled	Survey	Type	Waterway	Sampling Site	Methods
					• Shallow-water quantitative mussel transect
				AR2_21	• Sediment quality • Water quality • Shallow-water quantitative mussel transect
February 2025	Stantec (2025)	Impact	Freshwater Lake	FWL1_24	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				FWL2_24	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				FWL3_23	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				FWL4_24	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				FWL_Dive1_21	• Deep-water targeted mussel searches
				FWL_Dive2_24	• Deep-water targeted mussel searches
				FWL_Dive3_24	• Deep-water targeted mussel searches
			Augustus River	AR1_21	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				AR2_21	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
				AR3_21	• Water quality • Sediment quality

Date Sampled	Survey	Type	Waterway	Sampling Site	Methods
					• Shallow-water quantitative mussel transect
		Regional Reference	Lunenburgh River	LR_Dam_21	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
			Ernest River	RR02_99	• Water quality • Sediment quality • Shallow-water quantitative mussel transect
			Brunswick River	RR10_99	• Water quality • Sediment quality • Shallow-water quantitative mussel transect

Table A 2: Site Location data and sampling dates 2021 – 2025.

Waterbody	Site ID	Zone	Easting	Northing	2021	2022	2023	2024	2025
Freshwater Lake	FWL1_21	50 H	410038	6322976	May-21			Feb-25	Nov-25
	FWL2_21	50 H	410402	6322104	May-21		Nov-23		
	FWL2_24	50 H	410399	6322159				Feb-25	Nov-25
	FWL3_21	50 H	410361	6323082	May-21				Nov-25
	FWL3_23	50 H	409879	6323153			Nov-23	Feb-25	
	FWL4_21	50 H	410846	6323500	May-21				Nov-25
	FWL4_24	50 H	410838	6323502				Feb-25	
	FWL5_99	50 H	410594	6323648	May-21		Nov-23		Nov-25
	FWL6	50 H	410138	6323314	Jul-21				
	FWL7_23	50 H	410771	6323491			Nov-23		
	FWL8_23	50 H	410240	6322996			Nov-23		
	FWL9_23	50 H	410084	6322865			Nov-23		
Freshwater Lake	FWL_Dive 1_21	50 H	410038	6322976	Jul-21			Feb-25	Feb-26
	FWL Dive 2_21	50 H	410079	6322894	Jul-21				
	FWL Dive 3_21	50 H	410361	6323082	Jul-21				

Waterbody	Site ID	Zone	Easting	Northing	2021	2022	2023	2024	2025
	FWL_Dive 1_23	50 H	409988	6323015			Mar-24		
	FWL Dive 2_23	50 H	410256	6322698			Mar-24		
	FWL Dive 3_23	50 H	410852	6323444			Mar-24		
	FWL Dive2_24	50H	410216	6322781				Feb-25	Feb-26
	FWL Dive3_24	50H	410362	6323083				Feb-25	Feb-26
Augustus River	AR1_21_app	50H	409050	6323852	May-21				
	AR2_21_app	50H	409255	6323795	May-21				
	AR3_21_app	50H	408538	6324014	May-21				
	AR1_24	50H	409047	6323850				Feb-25	Nov-25
	AR2_24	50H	409233	6323778				Feb-25	Nov-25
	AR3_24	50H	408538	6324014				Feb-25	Nov-25
Regional Reference	LR Dam	50 H	405531	6319539	May-21		Nov-23	Feb-25	Nov-25
	LR1	50 H	402455	6319957	May-21				
	LR Farmland	50 H	406882	6316007	May-21				
	LR2	50 H	404147	6319111	May-21				
	LR3	50 H	403053	6319581	May-21				
	LR4	50 H	401994	6320240	May-21				
	Trib. 1	50 H	402494	6319534	May-21				
	Trib. 2	50 H	404424	6318426	May-21				
Regional Reference	Trib. 3	50 H	404678	6318530	May-21				
	RR10_99	50 H	406012	6324676			Nov-23	Feb-25	Nov-25
	RR02_99	50H	408648	6328622				Feb-25	Nov-25
	BRUN01_25	50 H	392029	6319488					Nov-25
	CESA16_25	50 H	420525	6319148					Nov-25

Appendix B Site Photographs

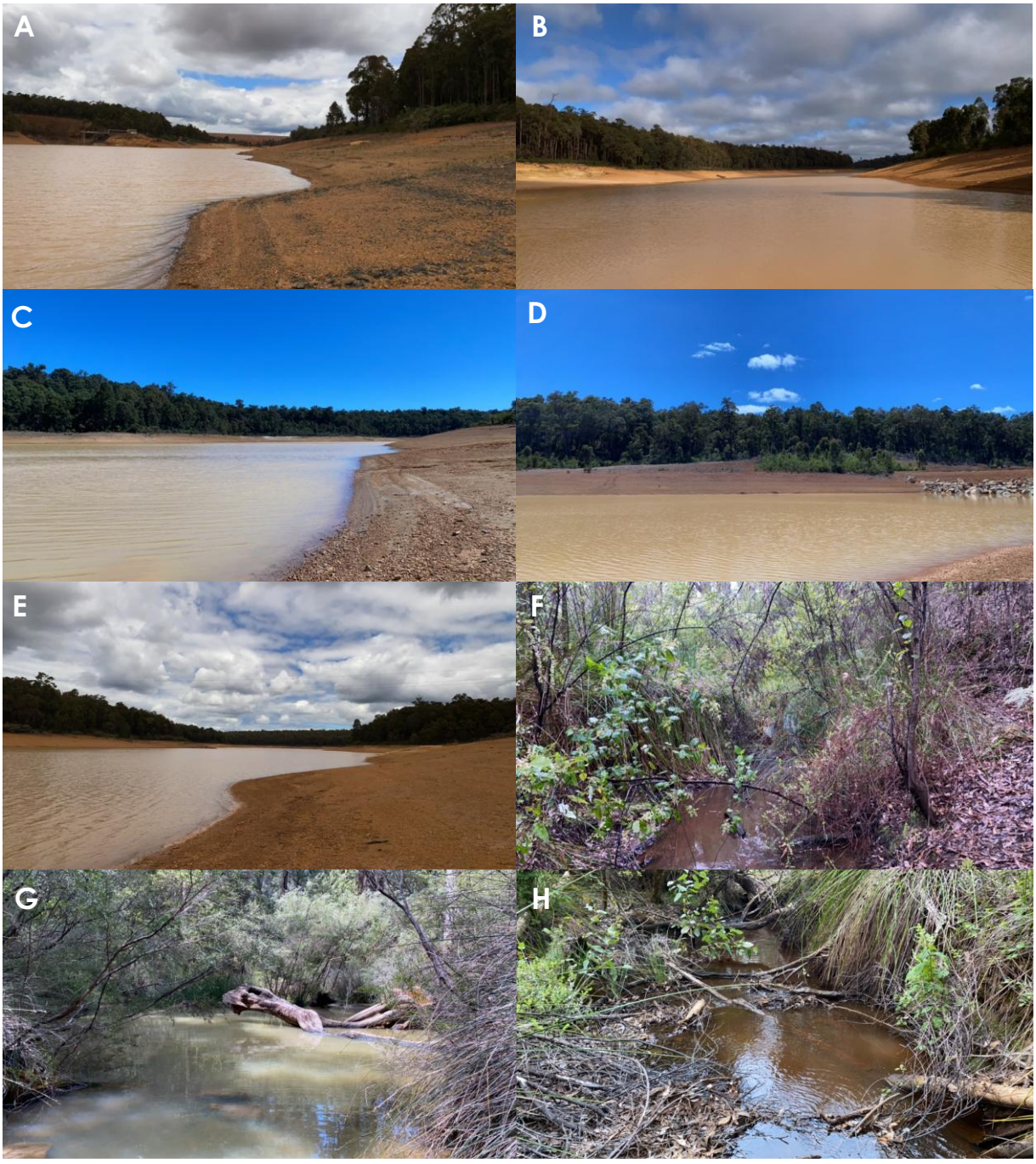

Plate B 1: Potential Impacts Sites: A) FWL1, B) FWL2, C) FWL3, D) FWL4, E) FWL5, F) AR1, G) AR2 and H) AR3.



Plate B 2: Regional Reference Sites: A) Brunswick River, RR10_99, B) Emest River, RR02_99, C) Lunderburgh River, LR Dam. Replacement Regional Reference Sites: D) Brunswick River, BRUN01_25, E) Harris River CESA16.

Appendix C Habitat Characterisation and *In-situ* Water Quality Results

Table C-1: Habitat characterisation of shallow-water sampling sites.

Classification	Waterbody	Site ID	2025 Description
Impact	Freshwater Lake	FWL1	Water present. Substrate is dominated by abundant cobble overlying hard clay. Benthic matts within shallows . Woody debris is absent to negligible, and riparian vegetation is absent.
		FWL2	Dry conditions in November 2025, with a 10 cm wide inundated stream entering the lake. WQ captured from nearest flowing surface water within the lake. Dominant substrate comprising soft moist unconsolidated clay. Water present in February 2025, with wide (15 m) and deep (±3m depth) waterbody.
		FWL3	Water present. Dominant substrate 75% cobble and 25% compacted clay; little to no woody debris and no riparian vegetation in proximity of water
		FWL4	Water present. Dominant substrate 75% cobble and 25% compacted clay; little to no woody debris and no riparian vegetation in proximity of water.
		FWL 5	Water present. Dominant substrate 75% cobble and 25% compacted clay; little to no woody debris and no riparian vegetation within proximity of water.
	Augustus River	AR1	Water present, narrow (1m wide) shallow (<10cm depth) stream with a slow flow rate caused by v-notch weir. Upstream of weir the creek is wide (2m wide) and deep (>2m) until its flow is restricted at the v-notch weir. Mussels surveyed downstream of weir, fyke nets set upstream of weir. Dominant substrate comprising rocky sand with abundant large and small woody debris and leaf litter; riparian vegetation abundant with a *Eucalyptus marginata* canopy cover of about 40-50% and thick understorey except in the main channel of the river.
		AR2	Water present, wide (<15m) and deep (2m depth) creek with a slow flow rate. Upstream of v-notch weir and downstream of the FWL Dam. Dominant substrate comprising a deep layer (<30cm) of soft unstructured sandy silt with occasional leaf litter and fallen trees. Emergent sedges abundant along the water's edge and relatively open waterway with occasional shrubs and trees; site inundated with standing water and reduced flow due to weir. Upstream from v-notch weir.
		AR3	Water present, narrow (<1m wide), shallow (<20cm depth) natural stream with a slow flow rate. Downstream of v-notch weir. Dominant substrate comprising rocky sand with abundant large and small woody debris, logs and leaf litter; riparian vegetation abundant with a canopy cover of about 40-50% and thick understorey.
Regional Reference	Lunenburgh River	LR Dam	Water present, wide (<20m) and deep (±4m depth) creek that is obstructed by dam, preventing further southern flow regime. Steep elevated banks comprising clayey sand, some small woody debris, leaf litter and extensive macrophytes; occasional fringing

Classification	Waterbody	Site ID	2025 Description
			vegetation and some woody debris. Jarrah and Marri woodland provides shade over waterway.
	Ernest River	RR02	Water present, narrow (<2m wide), shallow (±1.5 m depth) stagnant stream. Dominant substrate comprising sandy silt with bedrock and cobble; overlain by extensive layer (<30cm) of leaf litter, woody debris and fallen trees. Emergent sedges and flooded gums, overhang the banks.
	Brunswick River	RR10	Water present, narrow (5m wide), shallow (3m depth) stream with slow flow rate. Small bridge intersects stream. Dominant substrate comprising sandy cobble overlain by extensive layer of leaf litter, woody debris with fallen trees across waterway. Emergent sedges and flooded gums, overhang the banks.
		BRUN-01	Water present, a narrow (4m wide), shallow (<1m depth) stream with a moderate flow rate. Main bridge to enter Brunswick intersects stream. Agricultural and residential land use along the shoreline of the stream. Dominant substrate comprising bedrock overlain by small cobbles with some leaf litter and woody debris. Extensive grasses and scattered sedges along the riparian zone.
	Harris River	CESA-16	Wate present, a narrow (5m wide), shallow (<2m depth) river with a moderate flow rate. Small bridge intersects stream. Dominant substrates ranging from small cobbles interlaced in coarse sands, with mud and silt around the bridge. Emergent sedges and rushes populate the banks.

Table C-2: Habitat characterisation of deep-water sampling sites.

Depth (m)	Temperature (°C)	Visibility (cm)	FWL_Dive1	FWL_Dive2	FWL_Dive3
1	21	>2	Compacted clay with cobble.	Compacted clay with large cobble.	Soft clay.
2	21	>2	Compacted clay with cobble.	Compacted clay with small cobbles.	Soft clay.
3	21	>2	Cobbles overlain by soft silt (20cm deep).	Soft unconsolidated silt (50cm deep).	Soft clay
4	21	>2	Soft unconsolidated silt (30cm deep).	Soft unconsolidated silt (>1m deep).	Soft clay, fallen tree.
5	21	>2	Soft unconsolidated silt (30cm deep).	Soft unconsolidated silt (>1m deep).	Soft silt (±10cm deep).
6	19	>2	Soft unconsolidated silt (40cm deep).	-	Soft mud (±10cm deep).
7	19	>2	-	-	Soft mud (±15cm deep).
8	19	>2	-	-	Soft mud (±10cm deep).

Table C-3: *In situ* surface water quality data recorded from Freshwater Lake, the Lunenburgh River Dam, Ernest River and Brunswick River, November 2025.

Water Quality Parameters	Potential Impact Sites								Regional Reference Sites				ANZG (2018) Upland River GV		Carter's Freshwater Mussel (Klunzinger *et al.* 2015; Perera 2023)	
	Freshwater Lake					Augustus River			Lunenburgh River Dam		Ernest River	Brunswick River				
	November 2025															
	FWL1	FWL2	FWL3	FWL4	FWL5	AR1	AR2	AR3	LR Dam	RR02	RR10	Brun-01	Lower	Upper	LD_{50}	LD_{95}
pH (unit)	7.6	7.58	7.59	7.37	7.50	6.73	6.72	6.32	7.15	6.17	6.40	7.14	6.8	8.0	-	-
Electrical Conductivity (µS/cm)	219.47	219.50	211.10	209.13	220.50	252.10	246.63	255.50	203.57	213.67	220.57	125.07	120	300	-	-
Dissolved Oxygen (mg/L)	9.04	9.12	8.92	8.76	9.07	7.59	7.43	7.09	9.31	5.94	5.36	8.52	-	-	-	-
Temperature (C°)	18.50	16.70	18.33	18.07	19.37	16.93	18.23	16.57	19.20	14.07	14.13	20.10	-	-	32.8	33.4

Note: all units are mg/L unless otherwise specified; yellow shading indicates values in exceedance of the ANZG (2018) lower GV for upland rivers in southwest Western Australia; red shading indicates exceedance of the ANZG (2018) upper GV for upland rivers in southwest Western Australia; Given laboratory pH was analysed outside the maximum holding time of 6 hours, values presented are indicative only.

Appendix D Carter's Freshwater Mussel Shell Measurement Data

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
2021	Freshwater Lake	FWL1	1	51	Dead	2021
2021	Freshwater Lake	FWL1	1	60	Dead	2021
2021	Freshwater Lake	FWL1	5	66	Dead	2021
2021	Freshwater Lake	FWL3	1	54	Dead	2021
2021	Freshwater Lake	FWL3	5	72	Dead	2021
2021	Freshwater Lake	FWL5	4	62	Dead	2021
2021	Freshwater Lake	FWL5	5	49	Dead	2021
2021	Freshwater Lake	FWL Dive 2_21	Na	61.5	Live	2021
2021	Freshwater Lake	FWL Dive 2_21	Na	46	Live	2021
2021	Freshwater Lake	FWL Dive 2_21	Na	57	Live	2021
2021	Freshwater Lake	FWL Dive 2_21	Na	65	Live	2021
2021	Freshwater Lake	FWL Dive 2_21	Na	66	Live	2021
2021	Augustus River	AR1	1	63	Live	2021
2021	Augustus River	AR1	1	57	Live	2021
2021	Augustus River	AR1	1	55	Live	2021
2021	Augustus River	AR1	1	54	Live	2021
2021	Augustus River	AR1	1	41	Live	2021
2021	Augustus River	AR1	1	45	Live	2021
2021	Augustus River	AR1	1	46	Live	2021
2021	Augustus River	AR1	1	42	Live	2021
2021	Augustus River	AR1	1	38	Live	2021
2021	Augustus River	AR1	1	34	Live	2021
2021	Augustus River	AR1	1	42	Live	2021
2021	Augustus River	AR1	2	55	Live	2021
2021	Augustus River	AR1	2	53	Live	2021
2021	Augustus River	AR1	2	54	Live	2021
2021	Augustus River	AR1	2	48	Live	2021
2021	Augustus River	AR1	2	48	Live	2021
2021	Augustus River	AR1	2	48	Live	2021
2021	Augustus River	AR1	2	40	Live	2021
2021	Augustus River	AR1	2	35	Live	2021
2021	Augustus River	AR1	3	46	Live	2021
2021	Augustus River	AR1	3	46	Live	2021
2021	Augustus River	AR1	3	43	Live	2021
2021	Augustus River	AR1	3	43	Live	2021

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
2021	Augustus River	AR1	3	41	Live	2021
2021	Augustus River	AR1	4	58	Dead	2021
2021	Augustus River	AR1	4	57	Live	2021
2021	Augustus River	AR1	4	57	Live	2021
2021	Augustus River	AR1	4	44	Dead	2021
2021	Augustus River	AR1	4	39	Live	2021
2021	Augustus River	AR1	4	67	Live	2021
2021	Augustus River	AR1	4	50	Live	2021
2021	Augustus River	AR1	4	53	Live	2021
2021	Augustus River	AR1	4	40	Live	2021
2021	Augustus River	AR1	4	44	Live	2021
2021	Augustus River	AR1	4	59	Live	2021
2021	Augustus River	AR1	4	53	Live	2021
2021	Augustus River	AR1	4	47	Live	2021
2021	Augustus River	AR1	4	50	Live	2021
2021	Augustus River	AR1	5	49	Live	2021
2021	Augustus River	AR1	5	55	Live	2021
2021	Augustus River	AR1	6	59	Dead	2021
2021	Augustus River	AR1	6	54	Live	2021
2021	Augustus River	AR1	6	55	Live	2021
2021	Augustus River	AR1	6	41	Dead	2021
2021	Augustus River	AR1	6	62	Live	2021
2021	Augustus River	AR1	6	54	Live	2021
2021	Augustus River	AR1	6	54	Live	2021
2021	Augustus River	AR1	6	54	Dead	2021
2021	Augustus River	AR1	6	55	Live	2021
2021	Augustus River	AR1	7	58	Live	2021
2021	Augustus River	AR1	7	59	Live	2021
2021	Augustus River	AR1	7	45	Live	2021
2021	Augustus River	AR1	7	64	Live	2021
2021	Augustus River	AR1	7	58	Live	2021
2021	Augustus River	AR1	7	59	Live	2021
2021	Augustus River	AR1	7	51	Live	2021
2021	Augustus River	AR1	7	60	Live	2021
2021	Augustus River	AR1	7	56	Live	2021
2021	Augustus River	AR1	7	54	Live	2021
2021	Augustus River	AR1	7	43	Live	2021
2021	Augustus River	AR1	8	65	Dead	2021
2021	Augustus River	AR1	8	55	Live	2021
2021	Augustus River	AR1	8	52	Live	2021



Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
2021	Augustus River	AR1	8	43	Live	2021
2021	Augustus River	AR1	8	66	Dead	2021
2021	Augustus River	AR1	8	67	Live	2021
2021	Augustus River	AR1	8	54	Dead	2021
2021	Augustus River	AR1	8	52	Live	2021
2021	Augustus River	AR1	8	53	Dead	2021
2021	Augustus River	AR1	8	63	Dead	2021
2021	Augustus River	AR1	8	48	Live	2021
2021	Augustus River	AR1	8	48	Live	2021
2021	Augustus River	AR1	8	42	Live	2021
2021	Augustus River	AR1	9	58	Live	2021
2021	Augustus River	AR1	9	50	Live	2021
2021	Augustus River	AR1	10	46	Live	2021
2021	Augustus River	AR2	2	71	Live	2021
2021	Augustus River	AR2	2	83	Live	2021
2021	Augustus River	AR2	3	68	Live	2021
2021	Augustus River	AR2	3	70	Live	2021
2021	Augustus River	AR2	3	60	Live	2021
2021	Augustus River	AR2	3	57	Live	2021
2021	Augustus River	AR2	4	42	Live	2021
2021	Augustus River	AR2	5	80	Live	2021
2021	Augustus River	AR2	5	65	Live	2021
2021	Augustus River	AR2	5	68	Live	2021
2021	Augustus River	AR2	5	66	Live	2021
2021	Augustus River	AR2	6	70	Dead	2021
2021	Augustus River	AR2	7	67	Live	2021
2021	Augustus River	AR2	7	67	Live	2021
2021	Augustus River	AR2	7	60	Live	2021
2021	Augustus River	AR2	8	55	Live	2021
2021	Augustus River	AR2	8	49	Live	2021
2021	Augustus River	AR2	9	54	Live	2021
2021	Augustus River	AR2	9	76	Live	2021
2021	Augustus River	AR2	9	53	Live	2021
2021	Augustus River	AR2	9	53	Live	2021
2021	Augustus River	AR2	9	64	Live	2021
2021	Augustus River	AR2	9	60	Live	2021
2021	Augustus River	AR2	9	58	Live	2021
2021	Augustus River	AR2	9	57	Live	2021
2021	Augustus River	AR2	9	50	Live	2021
2021	Augustus River	AR2	9	55	Live	2021

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
2021	Augustus River	AR2	9	58	Live	2021
2021	Augustus River	AR2	9	47	Dead	2021
2021	Augustus River	AR2	9	49	Live	2021
2021	Augustus River	AR2	10	54	Live	2021
2021	Augustus River	AR2	10	57	Live	2021
2021	Augustus River	AR2	10	55	Dead	2021
2021	Lunenburgh River	LR Dam	2	70	Live	2021
2021	Lunenburgh River	LR Dam	2	66	Live	2021
2021	Lunenburgh River	LR Dam	3	72	Live	2021
2021	Lunenburgh River	LR Dam	3	69	Live	2021
2021	Lunenburgh River	LR Dam	5	27	Live	2021
2021	Lunenburgh River	LR Dam	5	56	Live	2021
2021	Lunenburgh River	LR Dam	6	45	Live	2021
Nov-23	Augustus River	AR1_21	1	52	Live	2023
Nov-23	Augustus River	AR1_21	1	51	Live	2023
Nov-23	Augustus River	AR1_21	1	49	Live	2023
Nov-23	Augustus River	AR1_21	1	51	Live	2023
Nov-23	Augustus River	AR1_21	1	47	Live	2023
Nov-23	Augustus River	AR1_21	2	48	Live	2023
Nov-23	Augustus River	AR1_21	2	48	Dead	2023
Nov-23	Augustus River	AR1_21	2	46	Live	2023
Nov-23	Augustus River	AR1_21	2	48	Live	2023
Nov-23	Augustus River	AR1_21	2	50	Live	2023
Nov-23	Augustus River	AR1_21	3	54	Live	2023
Nov-23	Augustus River	AR1_21	3	54	Live	2023
Nov-23	Augustus River	AR1_21	3	51	Live	2023
Nov-23	Augustus River	AR1_21	3	62	Live	2023
Nov-23	Augustus River	AR1_21	3	35	Live	2023
Nov-23	Augustus River	AR1_21	3	53	Live	2023
Nov-23	Augustus River	AR1_21	3	43	Live	2023
Nov-23	Augustus River	AR1_21	3	60	Live	2023
Nov-23	Augustus River	AR1_21	3	26	Live	2023
Nov-23	Augustus River	AR1_21	3	37	Live	2023
Nov-23	Augustus River	AR1_21	3	37	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023
Nov-23	Augustus River	AR1_21	3	41	Live	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	46	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	50	Live	2023
Nov-23	Augustus River	AR1_21	3	54	Live	2023
Nov-23	Augustus River	AR1_21	3	54	Live	2023
Nov-23	Augustus River	AR1_21	3	54	Live	2023
Nov-23	Augustus River	AR1_21	3	61	Live	2023
Nov-23	Augustus River	AR1_21	3	61	Live	2023
Nov-23	Augustus River	AR1_21	4	63	Live	2023
Nov-23	Augustus River	AR1_21	4	58	Live	2023
Nov-23	Augustus River	AR1_21	4	66	Dead	2023
Nov-23	Augustus River	AR1_21	4	51	Live	2023
Nov-23	Augustus River	AR1_21	4	50	Live	2023
Nov-23	Augustus River	AR1_21	4	35	Live	2023
Nov-23	Augustus River	AR1_21	4	31	Live	2023
Nov-23	Augustus River	AR1_21	5	62	Live	2023
Nov-23	Augustus River	AR1_21	5	57	Live	2023
Nov-23	Augustus River	AR1_21	5	60	Live	2023
Nov-23	Augustus River	AR1_21	5	52	Dead	2023
Nov-23	Augustus River	AR1_21	5	55	Live	2023
Nov-23	Augustus River	AR1_21	5	53	Live	2023
Nov-23	Augustus River	AR1_21	5	41	Live	2023
Nov-23	Augustus River	AR1_21	5	40	Live	2023
Nov-23	Augustus River	AR1_21	5	50	Live	2023
Nov-23	Augustus River	AR1_21	5	47	Live	2023
Nov-23	Augustus River	AR1_21	5	53	Dead	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Augustus River	AR1_21	5	32	Live	2023
Nov-23	Augustus River	AR1_21	5	34	Live	2023
Nov-23	Augustus River	AR1_21	6	62	Live	2023
Nov-23	Augustus River	AR1_21	6	56	Live	2023
Nov-23	Augustus River	AR1_21	6	59	Live	2023
Nov-23	Augustus River	AR1_21	6	50	Live	2023
Nov-23	Augustus River	AR1_21	6	44	Live	2023
Nov-23	Augustus River	AR1_21	6	42	Live	2023
Nov-23	Augustus River	AR1_21	6	41	Live	2023
Nov-23	Augustus River	AR1_21	6	66	Dead	2023
Nov-23	Augustus River	AR1_21	7	65	Dead	2023
Nov-23	Augustus River	AR1_21	7	64	Live	2023
Nov-23	Augustus River	AR1_21	7	61	Live	2023
Nov-23	Augustus River	AR1_21	7	53	Live	2023
Nov-23	Augustus River	AR1_21	7	49	Live	2023
Nov-23	Augustus River	AR1_21	7	44	Live	2023
Nov-23	Augustus River	AR1_21	7	47	Live	2023
Nov-23	Augustus River	AR1_21	7	45	Live	2023
Nov-23	Augustus River	AR1_21	7	49	Live	2023
Nov-23	Augustus River	AR1_21	7	49	Live	2023
Nov-23	Augustus River	AR1_21	7	47	Live	2023
Nov-23	Augustus River	AR1_21	7	47	Live	2023
Nov-23	Augustus River	AR1_21	7	47	Live	2023
Nov-23	Augustus River	AR1_21	7	47	Live	2023
Nov-23	Augustus River	AR1_21	7	36	Live	2023
Nov-23	Augustus River	AR1_21	8	66	Dead	2023
Nov-23	Augustus River	AR1_21	8	70	Live	2023
Nov-23	Augustus River	AR1_21	8	63	Live	2023
Nov-23	Augustus River	AR1_21	8	63	Live	2023
Nov-23	Augustus River	AR1_21	8	53	Live	2023
Nov-23	Augustus River	AR1_21	8	58	Dead	2023
Nov-23	Augustus River	AR1_21	8	50	Live	2023
Nov-23	Augustus River	AR1_21	8	60	Live	2023
Nov-23	Augustus River	AR1_21	8	61	Live	2023
Nov-23	Augustus River	AR1_21	8	61	Live	2023
Nov-23	Augustus River	AR1_21	8	60	Live	2023
Nov-23	Augustus River	AR1_21	8	63	Live	2023
Nov-23	Augustus River	AR1_21	8	55	Live	2023
Nov-23	Augustus River	AR1_21	8	55	Live	2023
Nov-23	Augustus River	AR1_21	8	55	Live	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Augustus River	AR1_21	8	60	Live	2023
Nov-23	Augustus River	AR1_21	8	60	Live	2023
Nov-23	Augustus River	AR1_21	8	55	Live	2023
Nov-23	Augustus River	AR1_21	8	55	Live	2023
Nov-23	Augustus River	AR1_21	8	50	Live	2023
Nov-23	Augustus River	AR1_21	8	50	Live	2023
Nov-23	Augustus River	AR1_21	8	50	Live	2023
Nov-23	Augustus River	AR1_21	8	50	Live	2023
Nov-23	Augustus River	AR1_21	8	42	Live	2023
Nov-23	Augustus River	AR1_21	8	42	Live	2023
Nov-23	Augustus River	AR1_21	8	42	Live	2023
Nov-23	Augustus River	AR1_21	8	40	Live	2023
Nov-23	Augustus River	AR1_21	8	40	Live	2023
Nov-23	Augustus River	AR1_21	8	40	Live	2023
Nov-23	Augustus River	AR1_21	8	40	Live	2023
Nov-23	Augustus River	AR1_21	8	37	Live	2023
Nov-23	Augustus River	AR1_21	8	37	Live	2023
Nov-23	Augustus River	AR1_21	8	37	Live	2023
Nov-23	Augustus River	AR1_21	8	37	Live	2023
Nov-23	Augustus River	AR1_21	8	35	Live	2023
Nov-23	Augustus River	AR1_21	8	35	Live	2023
Nov-23	Augustus River	AR1_21	8	43	Dead	2023
Nov-23	Augustus River	AR1_21	9	60	Dead	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	60	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	57	Live	2023
Nov-23	Augustus River	AR1_21	9	50	Live	2023
Nov-23	Augustus River	AR1_21	9	50	Live	2023
Nov-23	Augustus River	AR1_21	9	50	Live	2023
Nov-23	Augustus River	AR1_21	9	50	Live	2023
Nov-23	Augustus River	AR1_21	9	50	Live	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	42	Live	2023
Nov-23	Augustus River	AR1_21	9	40	Live	2023
Nov-23	Augustus River	AR1_21	9	40	Live	2023
Nov-23	Augustus River	AR1_21	10	52	Dead	2023
Nov-23	Augustus River	AR2_21	1	57	Dead	2023
Nov-23	Augustus River	AR2_21	1	61	Dead	2023
Nov-23	Augustus River	AR2_21	1	65	Dead	2023
Nov-23	Augustus River	AR2_21	1	66	Live	2023
Nov-23	Augustus River	AR2_21	1	67	Live	2023
Nov-23	Augustus River	AR2_21	1	70	Live	2023
Nov-23	Augustus River	AR2_21	1	71	Live	2023
Nov-23	Augustus River	AR2_21	1	71	Live	2023
Nov-23	Augustus River	AR2_21	1	71	Live	2023
Nov-23	Augustus River	AR2_21	2	62	Live	2023
Nov-23	Augustus River	AR2_21	2	62	Live	2023
Nov-23	Augustus River	AR2_21	2	64	Live	2023
Nov-23	Augustus River	AR2_21	3	62	Live	2023
Nov-23	Augustus River	AR2_21	3	63	Live	2023
Nov-23	Augustus River	AR2_21	3	66	Live	2023
Nov-23	Augustus River	AR2_21	3	67	Live	2023
Nov-23	Augustus River	AR2_21	3	72	Dead	2023
Nov-23	Augustus River	AR2_21	3	72	Live	2023
Nov-23	Augustus River	AR2_21	3	75	Live	2023
Nov-23	Augustus River	AR2_21	4	57	Live	2023
Nov-23	Augustus River	AR2_21	4	69	Dead	2023
Nov-23	Augustus River	AR2_21	4	76	Live	2023
Nov-23	Augustus River	AR2_21	5	62	Dead	2023
Nov-23	Augustus River	AR2_21	5	63	Live	2023
Nov-23	Augustus River	AR2_21	5	66	Live	2023
Nov-23	Augustus River	AR2_21	5	70	Live	2023
Nov-23	Augustus River	AR2_21	5	71	Live	2023
Nov-23	Augustus River	AR2_21	5	73	Live	2023
Nov-23	Augustus River	AR2_21	6	38	Dead	2023
Nov-23	Augustus River	AR2_21	7	56	Live	2023
Nov-23	Augustus River	AR2_21	7	62	Live	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Augustus River	AR2_21	7	65	Live	2023
Nov-23	Augustus River	AR2_21	7	66	Live	2023
Nov-23	Augustus River	AR2_21	7	77	Live	2023
Nov-23	Augustus River	AR2_21	8	47	Live	2023
Nov-23	Augustus River	AR2_21	8	53	Live	2023
Nov-23	Augustus River	AR2_21	8	55	Live	2023
Nov-23	Augustus River	AR2_21	8	56	Live	2023
Nov-23	Augustus River	AR2_21	8	60	Dead	2023
Nov-23	Augustus River	AR2_21	8	61	Live	2023
Nov-23	Augustus River	AR2_21	9	44	Live	2023
Nov-23	Augustus River	AR2_21	9	48	Live	2023
Nov-23	Augustus River	AR2_21	9	52	Live	2023
Nov-23	Augustus River	AR2_21	9	52	Dead	2023
Nov-23	Augustus River	AR2_21	9	60	Live	2023
Nov-23	Augustus River	AR2_21	9	61	Live	2023
Nov-23	Augustus River	AR2_21	9	62	Live	2023
Nov-23	Augustus River	AR3_21	8	26	Live	2023
Nov-23	Augustus River	AR3_21	8	41	Live	2023
Nov-23	Augustus River	AR3_21	10	25	Live	2023
Nov-23	Augustus River	AR3_21	10	25	Live	2023
Nov-23	Augustus River	AR3_21	10	28	Live	2023
Nov-23	Augustus River	AR3_21	10	31	Live	2023
Nov-23	Augustus River	AR3_21	10	39	Dead	2023
Nov-23	Augustus River	AR3_21	10	39	Dead	2023
Nov-23	Augustus River	AR3_21	10	44	Live	2023
Nov-23	Augustus River	AR3_21	10	45	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	60	Live	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	61	Live	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	56	Live	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	62	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	68	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	66	Live	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	49	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	63	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	59	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	70	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	55	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	65	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	73	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	71	Dead	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	68	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive1_21	n/a	71	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	61	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	74	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	60	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	63	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	65	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	68	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	66	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	71	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	68	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	56	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	64	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	66	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	52	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	59	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	59	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	78	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	64	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	74	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	49	Live	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	63	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	62	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	69	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive2_24	n/a	66	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	63	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	70	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	62	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	58	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	61	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	58	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	71	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	51	Live	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	62	Live	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	67	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	65	Dead	2023
Nov-23	Freshwater Lake	FWL_Dive3_24	n/a	71	Dead	2023
Nov-23	Brunswick River	RR10_99	3	40	Live	2023
Nov-23	Brunswick River	RR10_99	3	50	Live	2023
Nov-23	Brunswick River	RR10_99	3	53	Dead	2023

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-23	Brunswick River	RR10_99	4	50	Live	2023
Nov-23	Brunswick River	RR10_99	5	35	Live	2023
Nov-23	Brunswick River	RR10_99	8	44	Live	2023
Nov-23	Brunswick River	RR10_99	10	33	Live	2023
Nov-23	Brunswick River	RR10_99	10	44	Live	2023
Nov-24	Augustus River	AR1_21	1	55	dead	2024
Nov-24	Augustus River	AR1_21	1	50	dead	2024
Nov-24	Augustus River	AR1_21	1	51	dead	2024
Nov-24	Augustus River	AR1_21	1	49	dead	2024
Nov-24	Augustus River	AR1_21	1	45	dead	2024
Nov-24	Augustus River	AR1_21	1	37	dead	2024
Nov-24	Augustus River	AR1_21	1	50	live	2024
Nov-24	Augustus River	AR1_21	1	54	live	2024
Nov-24	Augustus River	AR1_21	1	51	live	2024
Nov-24	Augustus River	AR1_21	1	37	live	2024
Nov-24	Augustus River	AR1_21	1	36	live	2024
Nov-24	Augustus River	AR1_21	1	20	live	2024
Nov-24	Augustus River	AR1_21	2	55	live	2024
Nov-24	Augustus River	AR1_21	2	56	live	2024
Nov-24	Augustus River	AR1_21	2	53	live	2024
Nov-24	Augustus River	AR1_21	2	58	live	2024
Nov-24	Augustus River	AR1_21	2	58	live	2024
Nov-24	Augustus River	AR1_21	2	52	live	2024
Nov-24	Augustus River	AR1_21	2	52	live	2024
Nov-24	Augustus River	AR1_21	2	64	live	2024
Nov-24	Augustus River	AR1_21	2	64	live	2024
Nov-24	Augustus River	AR1_21	2	51	live	2024
Nov-24	Augustus River	AR1_21	2	51	live	2024
Nov-24	Augustus River	AR1_21	2	51	live	2024
Nov-24	Augustus River	AR1_21	2	57	live	2024
Nov-24	Augustus River	AR1_21	2	57	live	2024
Nov-24	Augustus River	AR1_21	2	51	live	2024
Nov-24	Augustus River	AR1_21	2	51	live	2024
Nov-24	Augustus River	AR1_21	2	49	live	2024
Nov-24	Augustus River	AR1_21	2	52	live	2024
Nov-24	Augustus River	AR1_21	2	46	live	2024
Nov-24	Augustus River	AR1_21	2	46	live	2024
Nov-24	Augustus River	AR1_21	2	45	live	2024
Nov-24	Augustus River	AR1_21	2	45	live	2024
Nov-24	Augustus River	AR1_21	2	60	live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-24	Augustus River	AR1_21	2	60	live	2024
Nov-24	Augustus River	AR1_21	2	55	live	2024
Nov-24	Augustus River	AR1_21	2	55	live	2024
Nov-24	Augustus River	AR1_21	2	58	live	2024
Nov-24	Augustus River	AR1_21	2	58	live	2024
Nov-24	Augustus River	AR1_21	2	40	live	2024
Nov-24	Augustus River	AR1_21	2	40	live	2024
Nov-24	Augustus River	AR1_21	2	40	live	2024
Nov-24	Augustus River	AR1_21	3	60	dead	2024
Nov-24	Augustus River	AR1_21	3	60	dead	2024
Nov-24	Augustus River	AR1_21	3	60	dead	2024
Nov-24	Augustus River	AR1_21	3	53	dead	2024
Nov-24	Augustus River	AR1_21	3	42	live	2024
Nov-24	Augustus River	AR1_21	3	42	live	2024
Nov-24	Augustus River	AR1_21	3	48	live	2024
Nov-24	Augustus River	AR1_21	3	48	live	2024
Nov-24	Augustus River	AR1_21	3	55	live	2024
Nov-24	Augustus River	AR1_21	3	45	live	2024
Nov-24	Augustus River	AR1_21	3	45	live	2024
Nov-24	Augustus River	AR1_21	3	63	live	2024
Nov-24	Augustus River	AR1_21	3	53	live	2024
Nov-24	Augustus River	AR1_21	3	42	live	2024
Nov-24	Augustus River	AR1_21	3	46	live	2024
Nov-24	Augustus River	AR1_21	3	46	live	2024
Nov-24	Augustus River	AR1_21	3	50	live	2024
Nov-24	Augustus River	AR1_21	3	50	live	2024
Nov-24	Augustus River	AR1_21	3	56	live	2024
Nov-24	Augustus River	AR1_21	3	56	live	2024
Nov-24	Augustus River	AR1_21	3	49	live	2024
Nov-24	Augustus River	AR1_21	3	49	live	2024
Nov-24	Augustus River	AR1_21	3	51	live	2024
Nov-24	Augustus River	AR1_21	3	51	live	2024
Nov-24	Augustus River	AR1_21	3	52	live	2024
Nov-24	Augustus River	AR1_21	3	52	live	2024
Nov-24	Augustus River	AR1_21	3	45	live	2024
Nov-24	Augustus River	AR1_21	3	45	live	2024
Nov-24	Augustus River	AR1_21	3	48	live	2024
Nov-24	Augustus River	AR1_21	3	48	live	2024
Nov-24	Augustus River	AR1_21	3	48	live	2024
Nov-24	Augustus River	AR1_21	3	37	live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-24	Augustus River	AR1_21	3	66	live	2024
Nov-24	Augustus River	AR1_21	4	-	-	2024
Nov-24	Augustus River	AR1_21	5	46	dead	2024
Nov-24	Augustus River	AR1_21	5	60	live	2024
Nov-24	Augustus River	AR1_21	5	48	live	2024
Nov-24	Augustus River	AR1_21	5	48	live	2024
Nov-24	Augustus River	AR1_21	5	45	live	2024
Nov-24	Augustus River	AR1_21	5	45	live	2024
Nov-24	Augustus River	AR1_21	5	42	live	2024
Nov-24	Augustus River	AR1_21	5	42	live	2024
Nov-24	Augustus River	AR1_21	5	43	live	2024
Nov-24	Augustus River	AR1_21	5	36	live	2024
Nov-24	Augustus River	AR1_21	6	45	dead	2024
Nov-24	Augustus River	AR1_21	6	37	dead	2024
Nov-24	Augustus River	AR1_21	6	38	dead	2024
Nov-24	Augustus River	AR1_21	6	54	dead	2024
Nov-24	Augustus River	AR1_21	6	53	live	2024
Nov-24	Augustus River	AR1_21	6	57	live	2024
Nov-24	Augustus River	AR1_21	6	43	live	2024
Nov-24	Augustus River	AR1_21	6	55	live	2024
Nov-24	Augustus River	AR1_21	6	51	live	2024
Nov-24	Augustus River	AR1_21	6	41	live	2024
Nov-24	Augustus River	AR1_21	6	43	live	2024
Nov-24	Augustus River	AR1_21	6	38	live	2024
Nov-24	Augustus River	AR1_21	6	44	live	2024
Nov-24	Augustus River	AR1_21	6	36	live	2024
Nov-24	Augustus River	AR1_21	7	45	dead	2024
Nov-24	Augustus River	AR1_21	7	37	dead	2024
Nov-24	Augustus River	AR1_21	7	38	dead	2024
Nov-24	Augustus River	AR1_21	7	54	dead	2024
Nov-24	Augustus River	AR1_21	7	53	live	2024
Nov-24	Augustus River	AR1_21	7	57	live	2024
Nov-24	Augustus River	AR1_21	7	43	live	2024
Nov-24	Augustus River	AR1_21	7	55	live	2024
Nov-24	Augustus River	AR1_21	7	51	live	2024
Nov-24	Augustus River	AR1_21	7	41	live	2024
Nov-24	Augustus River	AR1_21	7	43	live	2024
Nov-24	Augustus River	AR1_21	7	38	live	2024
Nov-24	Augustus River	AR1_21	7	44	live	2024
Nov-24	Augustus River	AR1_21	7	36	live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-24	Augustus River	AR1_21	8	65	dead	2024
Nov-24	Augustus River	AR1_21	8	60	dead	2024
Nov-24	Augustus River	AR1_21	8	60	dead	2024
Nov-24	Augustus River	AR1_21	8	47	dead	2024
Nov-24	Augustus River	AR1_21	8	47	dead	2024
Nov-24	Augustus River	AR1_21	8	42	dead	2024
Nov-24	Augustus River	AR1_21	8	36	live	2024
Nov-24	Augustus River	AR1_21	8	40	live	2024
Nov-24	Augustus River	AR1_21	8	40	live	2024
Nov-24	Augustus River	AR1_21	8	58	live	2024
Nov-24	Augustus River	AR1_21	8	53	live	2024
Nov-24	Augustus River	AR1_21	8	52	live	2024
Nov-24	Augustus River	AR1_21	8	59	live	2024
Nov-24	Augustus River	AR1_21	9	65	dead	2024
Nov-24	Augustus River	AR1_21	9	55	dead	2024
Nov-24	Augustus River	AR1_21	9	48	dead	2024
Nov-24	Augustus River	AR1_21	9	48	dead	2024
Nov-24	Augustus River	AR1_21	9	56	live	2024
Nov-24	Augustus River	AR1_21	9	47	live	2024
Nov-24	Augustus River	AR1_21	9	47	live	2024
Nov-24	Augustus River	AR1_21	9	47	live	2024
Nov-24	Augustus River	AR1_21	9	47	live	2024
Nov-24	Augustus River	AR1_21	9	36	live	2024
Nov-24	Augustus River	AR1_21	9	36	live	2024
Nov-24	Augustus River	AR1_21	9	48	live	2024
Nov-24	Augustus River	AR1_21	9	50	live	2024
Nov-24	Augustus River	AR1_21	9	42	live	2024
Nov-24	Augustus River	AR1_21	9	42	live	2024
Nov-24	Augustus River	AR1_21	9	44	live	2024
Nov-24	Augustus River	AR1_21	9	40	live	2024
Nov-24	Augustus River	AR1_21	9	40	live	2024
Nov-24	Augustus River	AR1_21	9	37	live	2024
Nov-24	Augustus River	AR1_21	10	60	dead	2024
Nov-24	Augustus River	AR1_21	10	48	dead	2024
Nov-24	Augustus River	AR1_21	10	63	live	2024
Nov-24	Augustus River	AR1_21	10	65	live	2024
Nov-24	Augustus River	AR1_21	10	55	live	2024
Nov-24	Augustus River	AR1_21	10	55	live	2024
Nov-24	Augustus River	AR1_21	10	53	live	2024
Nov-24	Augustus River	AR1_21	10	53	live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-24	Augustus River	AR1_21	10	57	live	2024
Nov-24	Augustus River	AR1_21	10	57	live	2024
Nov-24	Augustus River	AR1_21	10	47	live	2024
Nov-24	Augustus River	AR1_21	10	47	live	2024
Nov-24	Augustus River	AR1_21	10	43	live	2024
Nov-24	Augustus River	AR1_21	10	43	live	2024
Nov-24	Augustus River	AR2_21	1	-	-	2024
Nov-24	Augustus River	AR2_21	2	75	live	2024
Nov-24	Augustus River	AR2_21	2	58	live	2024
Nov-24	Augustus River	AR2_21	3	70	dead	2024
Nov-24	Augustus River	AR2_21	3	47	dead	2024
Nov-24	Augustus River	AR2_21	3	62	dead	2024
Nov-24	Augustus River	AR2_21	3	73	live	2024
Nov-24	Augustus River	AR2_21	3	65	live	2024
Nov-24	Augustus River	AR2_21	3	66	live	2024
Nov-24	Augustus River	AR2_21	3	74	live	2024
Nov-24	Augustus River	AR2_21	3	67	live	2024
Nov-24	Augustus River	AR2_21	4	67	dead	2024
Nov-24	Augustus River	AR2_21	4	74	live	2024
Nov-24	Augustus River	AR2_21	4	65	live	2024
Nov-24	Augustus River	AR2_21	5	65	live	2024
Nov-24	Augustus River	AR2_21	6	76	live	2024
Nov-24	Augustus River	AR2_21	7	65	dead	2024
Nov-24	Augustus River	AR2_21	7	55	dead	2024
Nov-24	Augustus River	AR2_21	7	74	live	2024
Nov-24	Augustus River	AR2_21	7	64	live	2024
Nov-24	Augustus River	AR2_21	7	70	live	2024
Nov-24	Augustus River	AR2_21	7	61	live	2024
Nov-24	Augustus River	AR2_21	7	61	live	2024
Nov-24	Augustus River	AR2_21	7	69	live	2024
Nov-24	Augustus River	AR2_21	8	60	dead	2024
Nov-24	Augustus River	AR2_21	8	55	dead	2024
Nov-24	Augustus River	AR2_21	8	60	dead	2024
Nov-24	Augustus River	AR2_21	8	60	live	2024
Nov-24	Augustus River	AR2_21	8	65	live	2024
Nov-24	Augustus River	AR2_21	8	62	live	2024
Nov-24	Augustus River	AR2_21	8	60	live	2024
Nov-24	Augustus River	AR2_21	8	69	live	2024
Nov-24	Augustus River	AR2_21	8	57	live	2024
Nov-24	Augustus River	AR2_21	8	50	live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-24	Augustus River	AR2_21	9	65	live	2024
Nov-24	Augustus River	AR2_21	9	71	live	2024
Nov-24	Augustus River	AR2_21	9	67	live	2024
Nov-24	Augustus River	AR2_21	9	41	live	2024
Nov-24	Augustus River	AR2_21	10	57	live	2024
Nov-24	Augustus River	AR2_21	10	62	live	2024
Feb-25	Augustus River	AR1_21	1	58	Live	2024
Feb-25	Augustus River	AR1_21	1	59.99	Live	2024
Feb-25	Augustus River	AR1_21	1	58.86	Live	2024
Feb-25	Augustus River	AR1_21	1	62.25	Live	2024
Feb-25	Augustus River	AR1_21	1	57.76	Live	2024
Feb-25	Augustus River	AR1_21	1	61.16	Live	2024
Feb-25	Augustus River	AR1_21	1	65.55	Live	2024
Feb-25	Augustus River	AR1_21	1	59.96	Live	2024
Feb-25	Augustus River	AR1_21	1	63.37	Live	2024
Feb-25	Augustus River	AR1_21	1	55.56	Live	2024
Feb-25	Augustus River	AR1_21	1	54.44	Live	2024
Feb-25	Augustus River	AR1_21	1	60.05	Live	2024
Feb-25	Augustus River	AR1_21	1	42.3	Live	2024
Feb-25	Augustus River	AR1_21	1	43.45	Live	2024
Feb-25	Augustus River	AR1_21	1	38.85	Live	2024
Feb-25	Augustus River	AR1_21	1	37.8	Live	2024
Feb-25	Augustus River	AR1_21	1	37.8	Dead	2024
Feb-25	Augustus River	AR1_21	1	39.9	Dead	2024
Feb-25	Augustus River	AR1_21	1	42.26	Dead	2024
Feb-25	Augustus River	AR1_21	1	43.38	Dead	2024
Feb-25	Augustus River	AR1_21	1	53.43	Dead	2024
Feb-25	Augustus River	AR1_21	1	55.53	Dead	2024
Feb-25	Augustus River	AR1_21	1	56.7	Dead	2024
Feb-25	Augustus River	AR1_21	1	57.75	Dead	2024
Feb-25	Augustus River	AR1_21	1	58.88	Dead	2024
Feb-25	Augustus River	AR1_21	1	58.93	Dead	2024
Feb-25	Augustus River	AR1_21	1	59.93	Dead	2024
Feb-25	Augustus River	AR1_21	1	59.97	Dead	2024
Feb-25	Augustus River	AR1_21	1	60.06	Dead	2024
Feb-25	Augustus River	AR1_21	1	61.15	Dead	2024
Feb-25	Augustus River	AR1_21	1	63.27	Dead	2024
Feb-25	Augustus River	AR1_21	1	63.4	Dead	2024
Feb-25	Augustus River	AR1_21	1	64.48	Dead	2024
Feb-25	Augustus River	AR1_21	1	65.62	Dead	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR1_21	2	57.77	Dead	2024
Feb-25	Augustus River	AR1_21	2	58.92	Dead	2024
Feb-25	Augustus River	AR1_21	2	54.47	Live	2024
Feb-25	Augustus River	AR1_21	2	45.5	Live	2024
Feb-25	Augustus River	AR1_21	2	40.07	Live	2024
Feb-25	Augustus River	AR1_21	3	39.9	Dead	2024
Feb-25	Augustus River	AR1_21	3	39.95	Dead	2024
Feb-25	Augustus River	AR1_21	3	43.4	Dead	2024
Feb-25	Augustus River	AR1_21	3	45.6	Dead	2024
Feb-25	Augustus River	AR1_21	3	51.17	Dead	2024
Feb-25	Augustus River	AR1_21	3	54.47	Dead	2024
Feb-25	Augustus River	AR1_21	3	56.74	Dead	2024
Feb-25	Augustus River	AR1_21	3	51.16	Live	2024
Feb-25	Augustus River	AR1_21	3	48.87	Live	2024
Feb-25	Augustus River	AR1_21	3	53.4	Live	2024
Feb-25	Augustus River	AR1_21	3	45.57	Live	2024
Feb-25	Augustus River	AR1_21	3	40	Live	2024
Feb-25	Augustus River	AR1_21	3	41.16	Live	2024
Feb-25	Augustus River	AR1_21	3	39.98	Live	2024
Feb-25	Augustus River	AR1_21	3	45.56	Live	2024
Feb-25	Augustus River	AR1_21	3	41.15	Live	2024
Feb-25	Augustus River	AR1_21	4	31.17	Dead	2024
Feb-25	Augustus River	AR1_21	4	38.85	Dead	2024
Feb-25	Augustus River	AR1_21	4	39.97	Dead	2024
Feb-25	Augustus River	AR1_21	4	44.5	Dead	2024
Feb-25	Augustus River	AR1_21	4	45.6	Dead	2024
Feb-25	Augustus River	AR1_21	4	50.02	Dead	2024
Feb-25	Augustus River	AR1_21	4	50.06	Dead	2024
Feb-25	Augustus River	AR1_21	4	51.18	Dead	2024
Feb-25	Augustus River	AR1_21	4	53.38	Dead	2024
Feb-25	Augustus River	AR1_21	4	53.4	Dead	2024
Feb-25	Augustus River	AR1_21	4	53.4	Dead	2024
Feb-25	Augustus River	AR1_21	4	55.6	Dead	2024
Feb-25	Augustus River	AR1_21	4	58.85	Dead	2024
Feb-25	Augustus River	AR1_21	4	58.87	Dead	2024
Feb-25	Augustus River	AR1_21	4	58.9	Dead	2024
Feb-25	Augustus River	AR1_21	4	59.93	Dead	2024
Feb-25	Augustus River	AR1_21	4	59.95	Dead	2024
Feb-25	Augustus River	AR1_21	4	63.35	Dead	2024
Feb-25	Augustus River	AR1_21	4	68.87	Dead	2024



Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR1_21	4	47.85	Live	2024
Feb-25	Augustus River	AR1_21	4	52.28	Live	2024
Feb-25	Augustus River	AR1_21	4	64.44	Live	2024
Feb-25	Augustus River	AR1_21	4	40.1	Live	2024
Feb-25	Augustus River	AR1_21	4	38.85	Live	2024
Feb-25	Augustus River	AR1_21	4	49.95	Live	2024
Feb-25	Augustus River	AR1_21	4	53.44	Live	2024
Feb-25	Augustus River	AR1_21	4	45.6	Live	2024
Feb-25	Augustus River	AR1_21	4	47.75	Live	2024
Feb-25	Augustus River	AR1_21	4	39.94	Live	2024
Feb-25	Augustus River	AR1_21	4	46.72	Live	2024
Feb-25	Augustus River	AR1_21	4	53.4	Live	2024
Feb-25	Augustus River	AR1_21	4	50.04	Live	2024
Feb-25	Augustus River	AR1_21	4	41.2	Live	2024
Feb-25	Augustus River	AR1_21	4	45.54	Live	2024
Feb-25	Augustus River	AR1_21	4	60.04	Live	2024
Feb-25	Augustus River	AR1_21	4	38.95	Live	2024
Feb-25	Augustus River	AR1_21	4	50.1	Live	2024
Feb-25	Augustus River	AR1_21	4	57.8	Live	2024
Feb-25	Augustus River	AR1_21	4	43.37	Live	2024
Feb-25	Augustus River	AR1_21	4	46.67	Live	2024
Feb-25	Augustus River	AR1_21	4	35.6	Live	2024
Feb-25	Augustus River	AR1_21	4	41.2	Live	2024
Feb-25	Augustus River	AR1_21	4	42.26	Live	2024
Feb-25	Augustus River	AR1_21	4	53.4	Live	2024
Feb-25	Augustus River	AR1_21	4	45.54	Live	2024
Feb-25	Augustus River	AR1_21	4	43.4	Live	2024
Feb-25	Augustus River	AR1_21	4	60.06	Live	2024
Feb-25	Augustus River	AR1_21	4	51.2	Live	2024
Feb-25	Augustus River	AR1_21	4	44.46	Live	2024
Feb-25	Augustus River	AR1_21	4	40.07	Live	2024
Feb-25	Augustus River	AR1_21	4	45.55	Live	2024
Feb-25	Augustus River	AR1_21	4	53.42	Live	2024
Feb-25	Augustus River	AR1_21	4	37.8	Live	2024
Feb-25	Augustus River	AR1_21	4	46.7	Live	2024
Feb-25	Augustus River	AR1_21	4	44.52	Live	2024
Feb-25	Augustus River	AR1_21	4	48.9	Live	2024
Feb-25	Augustus River	AR1_21	4	46.7	Live	2024
Feb-25	Augustus River	AR1_21	4	50	Live	2024
Feb-25	Augustus River	AR1_21	4	44.46	Live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR1_21	4	51.2	Live	2024
Feb-25	Augustus River	AR1_21	4	44.5	Live	2024
Feb-25	Augustus River	AR1_21	4	39.94	Live	2024
Feb-25	Augustus River	AR1_21	4	39.97	Live	2024
Feb-25	Augustus River	AR1_21	4	35.6	Live	2024
Feb-25	Augustus River	AR1_21	4	52.27	Live	2024
Feb-25	Augustus River	AR1_21	4	45.55	Live	2024
Feb-25	Augustus River	AR1_21	4	43.37	Live	2024
Feb-25	Augustus River	AR1_21	4	38.88	Live	2024
Feb-25	Augustus River	AR1_21	4	40.1	Live	2024
Feb-25	Augustus River	AR1_21	4	48.85	Live	2024
Feb-25	Augustus River	AR1_21	4	54.45	Live	2024
Feb-25	Augustus River	AR1_21	4	38.94	Live	2024
Feb-25	Augustus River	AR1_21	4	39.9	Live	2024
Feb-25	Augustus River	AR1_21	4	45.55	Live	2024
Feb-25	Augustus River	AR1_21	4	46.74	Live	2024
Feb-25	Augustus River	AR1_21	4	47.84	Live	2024
Feb-25	Augustus River	AR1_21	4	43.37	Live	2024
Feb-25	Augustus River	AR1_21	4	52.3	Live	2024
Feb-25	Augustus River	AR1_21	4	51.2	Live	2024
Feb-25	Augustus River	AR1_21	4	40.08	Live	2024
Feb-25	Augustus River	AR1_21	4	35.5	Live	2024
Feb-25	Augustus River	AR1_21	4	48.85	Live	2024
Feb-25	Augustus River	AR1_21	4	33.39	Live	2024
Feb-25	Augustus River	AR1_21	4	35.52	Live	2024
Feb-25	Augustus River	AR1_21	4	46.75	Live	2024
Feb-25	Augustus River	AR1_21	4	52.35	Live	2024
Feb-25	Augustus River	AR1_21	4	43.4	Live	2024
Feb-25	Augustus River	AR1_21	4	40.06	Live	2024
Feb-25	Augustus River	AR1_21	4	46.65	Live	2024
Feb-25	Augustus River	AR1_21	4	47.82	Live	2024
Feb-25	Augustus River	AR1_21	4	42.3	Live	2024
Feb-25	Augustus River	AR1_21	4	44.49	Live	2024
Feb-25	Augustus River	AR1_21	4	44.48	Live	2024
Feb-25	Augustus River	AR1_21	4	40.1	Live	2024
Feb-25	Augustus River	AR1_21	4	46.74	Live	2024
Feb-25	Augustus River	AR1_21	4	43.45	Live	2024
Feb-25	Augustus River	AR1_21	4	47.8	Live	2024
Feb-25	Augustus River	AR1_21	4	21.18	Live	2024
Feb-25	Augustus River	AR1_21	4	40.05	Live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR1_21	4	38.94	Live	2024
Feb-25	Augustus River	AR1_21	4	49	Live	2024
Feb-25	Augustus River	AR1_21	4	30.15	Live	2024
Feb-25	Augustus River	AR1_21	4	40.07	Live	2024
Feb-25	Augustus River	AR1_21	4	26.7	Live	2024
Feb-25	Augustus River	AR1_21	4	52.3	Live	2024
Feb-25	Augustus River	AR1_21	4	32.34	Live	2024
Feb-25	Augustus River	AR1_21	4	55.64	Live	2024
Feb-25	Augustus River	AR1_21	4	35.52	Live	2024
Feb-25	Augustus River	AR1_21	4	37.78	Live	2024
Feb-25	Augustus River	AR1_21	4	23.42	Live	2024
Feb-25	Augustus River	AR1_21	4	39.98	Live	2024
Feb-25	Augustus River	AR1_21	4	25.5	Live	2024
Feb-25	Augustus River	AR1_21	5	43.4	Dead	2024
Feb-25	Augustus River	AR1_21	5	45.58	Dead	2024
Feb-25	Augustus River	AR1_21	5	53.35	Dead	2024
Feb-25	Augustus River	AR1_21	5	55.58	Dead	2024
Feb-25	Augustus River	AR1_21	5	56.67	Dead	2024
Feb-25	Augustus River	AR1_21	5	57.77	Dead	2024
Feb-25	Augustus River	AR1_21	5	57.78	Dead	2024
Feb-25	Augustus River	AR1_21	5	57.83	Dead	2024
Feb-25	Augustus River	AR1_21	5	60.1	Dead	2024
Feb-25	Augustus River	AR2_21	1	57.82	Dead	2024
Feb-25	Augustus River	AR2_21	10	61.19	Dead	2024
Feb-25	Augustus River	AR2_21	10	71.05	Live	2024
Feb-25	Augustus River	AR2_21	10	66.64	Live	2024
Feb-25	Augustus River	AR2_21	2	53.45	Live	2024
Feb-25	Augustus River	AR2_21	2	62.23	Live	2024
Feb-25	Augustus River	AR2_21	2	36.75	Live	2024
Feb-25	Augustus River	AR2_21	2	58.86	Live	2024
Feb-25	Augustus River	AR2_21	2	58.9	Live	2024
Feb-25	Augustus River	AR2_21	2	61.16	Live	2024
Feb-25	Augustus River	AR2_21	2	59.95	Live	2024
Feb-25	Augustus River	AR2_21	2	47.76	Live	2024
Feb-25	Augustus River	AR2_21	2	59.97	Live	2024
Feb-25	Augustus River	AR2_21	2	57.78	Live	2024
Feb-25	Augustus River	AR2_21	2	48.94	Live	2024
Feb-25	Augustus River	AR2_21	2	56.67	Live	2024
Feb-25	Augustus River	AR2_21	2	44.5	Live	2024
Feb-25	Augustus River	AR2_21	3	53.39	Dead	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR2_21	3	55.65	Live	2024
Feb-25	Augustus River	AR2_21	4	66.76	Live	2024
Feb-25	Augustus River	AR2_21	5	56.65	Dead	2024
Feb-25	Augustus River	AR2_21	5	59.9	Dead	2024
Feb-25	Augustus River	AR2_21	5	61.18	Dead	2024
Feb-25	Augustus River	AR2_21	5	74.48	Live	2024
Feb-25	Augustus River	AR2_21	5	63.45	Live	2024
Feb-25	Augustus River	AR2_21	5	75.5	Live	2024
Feb-25	Augustus River	AR2_21	5	60.04	Live	2024
Feb-25	Augustus River	AR2_21	5	58.7	Live	2024
Feb-25	Augustus River	AR2_21	5	60.05	Live	2024
Feb-25	Augustus River	AR2_21	5	76.64	Live	2024
Feb-25	Augustus River	AR2_21	5	73.36	Live	2024
Feb-25	Augustus River	AR2_21	5	65.54	Live	2024
Feb-25	Augustus River	AR2_21	5	55.53	Live	2024
Feb-25	Augustus River	AR2_21	5	59.99	Live	2024
Feb-25	Augustus River	AR2_21	5	56.72	Live	2024
Feb-25	Augustus River	AR2_21	5	57.82	Live	2024
Feb-25	Augustus River	AR2_21	5	55.64	Live	2024
Feb-25	Augustus River	AR2_21	5	46.74	Live	2024
Feb-25	Augustus River	AR2_21	5	65.53	Live	2024
Feb-25	Augustus River	AR2_21	5	71.17	Live	2024
Feb-25	Augustus River	AR2_21	5	56.65	Live	2024
Feb-25	Augustus River	AR2_21	5	77.8	Live	2024
Feb-25	Augustus River	AR2_21	5	62.3	Live	2024
Feb-25	Augustus River	AR2_21	5	60.06	Live	2024
Feb-25	Augustus River	AR2_21	5	62.3	Live	2024
Feb-25	Augustus River	AR2_21	5	71.2	Live	2024
Feb-25	Augustus River	AR2_21	5	58.88	Live	2024
Feb-25	Augustus River	AR2_21	5	65.5	Live	2024
Feb-25	Augustus River	AR2_21	5	61.18	Live	2024
Feb-25	Augustus River	AR2_21	5	73.35	Live	2024
Feb-25	Augustus River	AR2_21	5	61.16	Live	2024
Feb-25	Augustus River	AR2_21	6	71.18	Live	2024
Feb-25	Augustus River	AR2_21	6	67.75	Live	2024
Feb-25	Augustus River	AR2_21	6	72.26	Live	2024
Feb-25	Augustus River	AR2_21	6	68.92	Live	2024
Feb-25	Augustus River	AR2_21	6	58.94	Live	2024
Feb-25	Augustus River	AR2_21	6	82.28	Live	2024
Feb-25	Augustus River	AR2_21	6	60.05	Live	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR2_21	6	70	Live	2024
Feb-25	Augustus River	AR2_21	6	62.24	Live	2024
Feb-25	Augustus River	AR2_21	6	65.64	Live	2024
Feb-25	Augustus River	AR2_21	6	62.26	Live	2024
Feb-25	Augustus River	AR2_21	6	51.14	Live	2024
Feb-25	Augustus River	AR2_21	6	55.5	Live	2024
Feb-25	Augustus River	AR2_21	6	53.34	Live	2024
Feb-25	Augustus River	AR2_21	6	48.85	Live	2024
Feb-25	Augustus River	AR2_21	7	77.73	Live	2024
Feb-25	Augustus River	AR2_21	8	71.12	Live	2024
Feb-25	Augustus River	AR2_21	9	55.53	Dead	2024
Feb-25	Augustus River	AR2_21	9	81.15	Live	2024
Feb-25	Augustus River	AR2_21	9	72.28	Live	2024
Feb-25	Augustus River	AR2_21	9	71.2	Live	2024
Feb-25	Augustus River	AR2_21	9	69.9	Live	2024
Feb-25	Augustus River	AR2_21	9	56.69	Live	2024
Feb-25	Augustus River	AR2_21	9	67.79	Live	2024
Feb-25	Augustus River	AR2_21	9	79.91	Live	2024
Feb-25	Augustus River	AR2_21	9	69.84	Live	2024
Feb-25	Augustus River	AR2_21	9	52.31	Live	2024
Feb-25	Augustus River	AR2_21	9	52.35	Live	2024
Feb-25	Augustus River	AR3_21	10	34.5	Dead	2024
Feb-25	Augustus River	AR3_21	10	34.5	Dead	2024
Feb-25	Augustus River	AR3_21	10	40.09	Dead	2024
Feb-25	Augustus River	AR3_21	10	46.67	Dead	2024
Feb-25	Augustus River	AR3_21	10	33.84	Live	2024
Feb-25	Augustus River	AR3_21	10	31.11	Live	2024
Feb-25	Augustus River	AR3_21	10	31.2	Live	2024
Feb-25	Augustus River	AR3_21	10	45.61	Live	2024
Feb-25	Augustus River	AR3_21	10	39.99	Live	2024
Feb-25	Augustus River	AR3_21	10	43.36	Live	2024
Feb-25	Augustus River	AR3_21	10	38.77	Live	2024
Feb-25	Augustus River	AR3_21	2	49.99	Dead	2024
Feb-25	Augustus River	AR3_21	3	33.41	Dead	2024
Feb-25	Augustus River	AR3_21	3	51.22	Dead	2024
Feb-25	Augustus River	AR3_21	5	25.5	Dead	2024
Feb-25	Augustus River	AR3_21	6	46.65	Live	2024
Feb-25	Augustus River	AR3_21	6	38.83	Live	2024
Feb-25	Augustus River	AR3_21	6	25.6	Live	2024
Feb-25	Augustus River	AR3_21	7	25.55	Dead	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Augustus River	AR3_21	7	51.13	Dead	2024
Feb-25	Augustus River	AR3_21	8	30	Dead	2024
Feb-25	Augustus River	AR3_21	8	32.24	Dead	2024
Feb-25	Augustus River	AR3_21	8	32.25	Dead	2024
Feb-25	Augustus River	AR3_21	8	36.74	Dead	2024
Feb-25	Augustus River	AR3_21	8	37.78	Dead	2024
Feb-25	Augustus River	AR3_21	8	37.8	Dead	2024
Feb-25	Augustus River	AR3_21	8	38.94	Dead	2024
Feb-25	Augustus River	AR3_21	8	40.15	Dead	2024
Feb-25	Augustus River	AR3_21	8	41.17	Dead	2024
Feb-25	Augustus River	AR3_21	8	46.69	Dead	2024
Feb-25	Augustus River	AR3_21	9	39.98	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	61.17	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	62.28	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	69	Live	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	53	Live	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	47	Live	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	62	Live	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	49	Live	2024
Feb-25	Freshwater Lake	FWL_Dive1_21	n/a	46	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	66.7	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	65.58	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	65.5	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	63.32	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	69.95	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	59.97	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	63.36	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	62.25	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	67.77	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	65.5	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	70.04	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	65.55	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	58.83	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	63.35	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	66.72	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	61.18	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	56.65	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	58.88	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	55.63	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	58	Dead	2024

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	66	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	70	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	55	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	20	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	63	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	50	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	50	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	53	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	51	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	52	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	55	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	56	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	58	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	63	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	58	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	54	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	54	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	51	Live	2024
Feb-25	Freshwater Lake	FWL_Dive2_24	n/a	41	Live	2024
Feb-25	Freshwater Lake	FWL_Dive3_24	n/a	51.2	Dead	2024
Feb-25	Freshwater Lake	FWL_Dive3_24	n/a	69.93	Dead	2024
Nov-25	Augustus River	AR1_24	1	41	Live	2025
Nov-25	Augustus River	AR1_24	1	40	Live	2025
Nov-25	Augustus River	AR1_24	1	33	Live	2025
Nov-25	Augustus River	AR1_24	1	40	Live	2025
Nov-25	Augustus River	AR1_24	1	32	Live	2025
Nov-25	Augustus River	AR1_24	1	54	Live	2025
Nov-25	Augustus River	AR1_24	2	36	Live	2025
Nov-25	Augustus River	AR1_24	2	39	Live	2025
Nov-25	Augustus River	AR1_24	2	42	Live	2025
Nov-25	Augustus River	AR1_24	2	32	Live	2025
Nov-25	Augustus River	AR1_24	2	30	Live	2025
Nov-25	Augustus River	AR1_24	3	39	Live	2025
Nov-25	Augustus River	AR1_24	3	42	Live	2025
Nov-25	Augustus River	AR1_24	3	38	Live	2025
Nov-25	Augustus River	AR1_24	4	51	Live	2025
Nov-25	Augustus River	AR1_24	4	42	Live	2025
Nov-25	Augustus River	AR1_24	4	36	Live	2025
Nov-25	Augustus River	AR1_24	4	52	Live	2025
Nov-25	Augustus River	AR1_24	4	43	Live	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-25	Augustus River	AR1_24	5	43	Live	2025
Nov-25	Augustus River	AR1_24	6	61	Live	2025
Nov-25	Augustus River	AR1_24	6	58	Live	2025
Nov-25	Augustus River	AR1_24	6	54	Live	2025
Nov-25	Augustus River	AR1_24	6	42	Live	2025
Nov-25	Augustus River	AR1_24	6	50	Live	2025
Nov-25	Augustus River	AR1_24	6	49	Live	2025
Nov-25	Augustus River	AR1_24	6	39	Live	2025
Nov-25	Augustus River	AR1_24	6	40	Live	2025
Nov-25	Augustus River	AR1_24	6	40	Live	2025
Nov-25	Augustus River	AR1_24	6	43	Live	2025
Nov-25	Augustus River	AR1_24	6	35	Live	2025
Nov-25	Augustus River	AR1_24	6	52	Live	2025
Nov-25	Augustus River	AR1_24	6	35	Live	2025
Nov-25	Augustus River	AR1_24	7	51	Live	2025
Nov-25	Augustus River	AR1_24	7	47	Live	2025
Nov-25	Augustus River	AR1_24	7	40	Live	2025
Nov-25	Augustus River	AR1_24	7	36	Live	2025
Nov-25	Augustus River	AR1_24	7	36	Live	2025
Nov-25	Augustus River	AR1_24	7	36	Live	2025
Nov-25	Augustus River	AR1_24	8	51	Live	2025
Nov-25	Augustus River	AR1_24	8	56	Live	2025
Nov-25	Augustus River	AR1_24	8	34	Live	2025
Nov-25	Augustus River	AR1_24	8	50	Live	2025
Nov-25	Augustus River	AR1_24	8	55	Live	2025
Nov-25	Augustus River	AR1_24	8	34	Live	2025
Nov-25	Augustus River	AR1_24	10	50	Live	2025
Nov-25	Augustus River	AR1_24	10	55	Live	2025
Nov-25	Augustus River	AR1_24	10	42	Live	2025
Nov-25	Augustus River	AR1_24	10	56	Live	2025
Nov-25	Augustus River	AR1_24	10	56	Live	2025
Nov-25	Augustus River	AR1_24	10	47	Live	2025
Nov-25	Augustus River	AR1_24	10	41	Live	2025
Nov-25	Augustus River	AR1_24	10	39	Live	2025
Nov-25	Augustus River	AR1_24	10	45	Live	2025
Nov-25	Augustus River	AR1_24	10	43	Live	2025
Nov-25	Augustus River	AR1_24	10	42	Live	2025
Nov-25	Augustus River	AR1_24	10	43	Live	2025
Nov-25	Augustus River	AR1_24	n/a	46	Live	2025
Nov-25	Augustus River	AR1_24	n/a	17	Dead	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-25	Augustus River	AR1_24	n/a	11	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	20	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	31	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	34	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	23	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	25	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	35	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	21	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	35	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	33	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	22	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	23	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	26	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	25	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	25	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	18	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	32	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	21	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	36	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	22	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	31	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	30	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	25	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	31	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	28	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	32	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	30	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	24	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	28	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	30	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	32	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	24	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	25	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	23	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	30	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	26	Dead	2025
Nov-25	Augustus River	AR1_24	n/a	19	Dead	2025
Nov-25	Augustus River	AR2_24	1	42	Live	2025
Nov-25	Augustus River	AR2_24	2	53	Live	2025
Nov-25	Augustus River	AR2_24	4	42	Live	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-25	Augustus River	AR2_24	4	53	Live	2025
Nov-25	Augustus River	AR2_24	5	42	Live	2025
Nov-25	Augustus River	AR2_24	5	53	Live	2025
Nov-25	Augustus River	AR2_24	5	42	Live	2025
Nov-25	Augustus River	AR2_24	5	53	Live	2025
Nov-25	Augustus River	AR2_24	5	42	Live	2025
Nov-25	Augustus River	AR2_24	5	53	Live	2025
Nov-25	Augustus River	AR2_24	8	65	Live	2025
Nov-25	Augustus River	AR2_24	9	61	Live	2025
Nov-25	Augustus River	AR2_24	10	70	Live	2025
Nov-25	Augustus River	AR3_24	4	26	Live	2025
Nov-25	Augustus River	AR3_24	5	40	Live	2025
Nov-25	Augustus River	AR3_24	5	33	Live	2025
Nov-25	Augustus River	AR3_24	5	20	Live	2025
Nov-25	Augustus River	AR3_24	5	23	Live	2025
Nov-25	Augustus River	AR3_24	5	26	Live	2025
Nov-25	Augustus River	AR3_24	5	28	Live	2025
Nov-25	Augustus River	AR3_24	6	31	Live	2025
Nov-25	Augustus River	AR3_24	6	22	Live	2025
Nov-25	Augustus River	AR3_24	6	32	Live	2025
Nov-25	Augustus River	AR3_24	7	36	Live	2025
Nov-25	Augustus River	AR3_24	n/a	42	Dead	2025
Nov-25	Augustus River	AR3_24	n/a	32	Dead	2025
Nov-25	Augustus River	AR3_24	n/a	35	Dead	2025
Nov-25	Augustus River	AR3_24	n/a	31	Dead	2025
Nov-25	Augustus River	AR3_24	n/a	41	Dead	2025
Nov-25	Brunswick River	BRUN01_25	1	54	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	52	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	51	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	54	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	48	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	48	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	54	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	57	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	52	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	40	Live	2025
Nov-25	Brunswick River	BRUN01_25	2	37	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	14	Live	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-25	Brunswick River	BRUN01_25	3	22	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	12	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	69	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	32	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	52	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	56	Live	2025
Nov-25	Brunswick River	BRUN01_25	3	46	Live	2025
Nov-25	Brunswick River	BRUN01_25	4	60	Live	2025
Nov-25	Brunswick River	BRUN01_25	4	61	Live	2025
Nov-25	Brunswick River	BRUN01_25	4	53	Live	2025
Nov-25	Brunswick River	BRUN01_25	6	29	Live	2025
Nov-25	Brunswick River	BRUN01_25	6	48	Live	2025
Nov-25	Brunswick River	BRUN01_25	9	32	Live	2025
Nov-25	Brunswick River	BRUN01_25	9	21	Live	2025
Nov-25	Brunswick River	BRUN01_25	9	44	Live	2025
Nov-25	Brunswick River	BRUN01_25	10	53	Live	2025
Nov-25	Brunswick River	BRUN01_25	10	56	Live	2025
Nov-25	Brunswick River	BRUN01_25	10	34	Live	2025
Nov-25	Brunswick River	BRUN01_25	10	37	Live	2025
Nov-25	Harris River	CESA16	1	32	Live	2025
Nov-25	Harris River	CESA16	2	27	Live	2025
Nov-25	Harris River	CESA16	2	50	Live	2025
Nov-25	Harris River	CESA16	3	40	Live	2025
Nov-25	Harris River	CESA16	3	45	Live	2025
Nov-25	Harris River	CESA16	3	58	Live	2025
Nov-25	Harris River	CESA16	3	50	Live	2025
Nov-25	Harris River	CESA16	4	44	Live	2025
Nov-25	Harris River	CESA16	4	41	Live	2025
Nov-25	Harris River	CESA16	4	53	Live	2025
Nov-25	Harris River	CESA16	4	45	Live	2025
Nov-25	Harris River	CESA16	4	48	Live	2025
Nov-25	Harris River	CESA16	4	44	Live	2025
Nov-25	Harris River	CESA16	4	45	Live	2025
Nov-25	Harris River	CESA16	4	43	Live	2025
Nov-25	Harris River	CESA16	5	45	Live	2025
Nov-25	Harris River	CESA16	5	43	Live	2025
Nov-25	Harris River	CESA16	5	48	Live	2025
Nov-25	Harris River	CESA16	5	42	Live	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Nov-25	Harris River	CESA16	5	46	Live	2025
Nov-25	Harris River	CESA16	6	48	Live	2025
Nov-25	Harris River	CESA16	6	50	Live	2025
Nov-25	Harris River	CESA16	7	48	Live	2025
Nov-25	Harris River	CESA16	7	53	Live	2025
Nov-25	Harris River	CESA16	7	49	Live	2025
Nov-25	Harris River	CESA16	8	46	Live	2025
Nov-25	Harris River	CESA16	8	42	Live	2025
Nov-25	Harris River	CESA16	10	35	Live	2025
Nov-25	Freshwater Lake	FWL3	n/a	70	Dead	2025
Nov-25	Freshwater Lake	FWL3	n/a	70	Dead	2025
Nov-25	Freshwater Lake	FWL3	n/a	70	Dead	2025
Nov-25	Freshwater Lake	FWL3	n/a	70	Dead	2025
Nov-25	Freshwater Lake	FWL3	n/a	70	Dead	2025
Nov-25	Freshwater Lake	FWL5	n/a	70	Dead	2025
Nov-25	Brunswick River	RR10_99	n/a	50	Dead	2025
Mar-26	Freshwater Lake	FWL_Dive1_21	n/a	65.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive1_21	n/a	60	Live	2025
Mar-26	Freshwater Lake	FWL_Dive1_21	n/a	50.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	42.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	71	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	53	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	73	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	70	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	73.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	66	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	50	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	45	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	56	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	51.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	60	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	52	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	55	Live	2025
Mar-26	Freshwater Lake	FWL_Dive2_24	n/a	64.5	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	64	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	64	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	45	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	72	Live	2025

Date	Waterbody	Site Code	Quadrat	Length	Live/Dead	Report Year
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	67	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	63	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	60	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	51	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	58	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	72	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	66	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	57	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	60	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	51	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	71	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	66	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	52	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	61	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	66	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	52	Live	2025
Mar-26	Freshwater Lake	FWL_Dive3_24	n/a	66	Live	2025

Appendix E Freshwater Fish Monitoring Fyke Net Photos



Plate E 1: Photos of fyke nets set at potential impact sites: AR1 (A and B), AR2 (C and D), FWL1 (E), FWL3 (F), FWL4 (G), FWL5 (H).

Appendix F Historical Water and Sediment Quality Data

Table F 1: Historical (2021-2023) surface water quality data recorded from Freshwater Lake and the Augustus River.

Water Quality Parameters		Freshwater Lake										Augustus River					
		FWL1	FWL2	FWL3	FWL4	FWL5	FWL03_23	FWL05_99	FWL07_23	FWL08_23	FWL09_23	AR1	AR2	AR3	AR1_21	AR2_21	AR3_21
		2021	2021	2021	2021	2021	2023	2023	2023	2023	2023	2021	2021	2021	2023	2023	2023
Basic	pH (unit)	7.28	7.15	7.03	7.15	6.91	**8.1**	**7.5**	**7.9**	**7.9**	**7.8**	**6.61**	**6.59**	**6.69**	**7.1**	**7.0**	**6.9**
	Total Dissolved Solids	136	536	132	128	120	148	143	147	154	152	134	137	132	142	139	141
	Electrical Conductivity (µS/cm)	185	84	169.7	184.61	190.7	**242**	**251**	**241**	**242**	**244**	**217.14**	**225.26**	**159.23**	**253**	**253**	**252**
	Dissolved Oxygen (% Saturation)	122.52	128.46	120.25	126.5	124.49	83.2	93.9	92.1	111.3	94.6	108.6	100.93	113.07	82.8	67.8	69.7
	Turbidity (NTU)	24.5	662	28.2	26.5	34.7	**31.0**	**33.0**	**38.0**	**36.0**	**50.0**	**4.5**	**4.4**	**2.3**	**3.9**	**1.5**	**3.1**
	Suspended Solids	<5	577	10	<5	8						<5	<5	<5			
Major Ions	Sodium	34	21	32	32	33	41	42	40	41	40	35	35	36	40	40	41
	Magnesium	4	<1	4	4	4	4	4	4	4	4	5	5	5	4	4	4
	Calcium	5	1	4	4	4	5	5	5	5	5	4	4	3	4	4	4
	Potassium	2	<1	2	2	2	2	2	2	2	1	2	2	2	1	1	2
	Chloride	47	19	46	46	46	55	57	54	47	56	54	54	57	64	64	64
	Bicarbonate	13	10	8	12	12	26	27	26	26	27	13	13	11	22	21	20
	Sulphate	12	11	17	13	12	15	15	14	15	15	10	11	11	11	12	12
	Carbonate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nutrients	Total Nitrogen	0.4	1.2	0.4	0.4	0.3	**0.30**	**0.30**	**0.30**	**0.30**	**0.40**	**0.3**	**0.4**	**0.1**	**0.10**	**0.20**	<0.1
	Total Kjeldahl Nitrogen	0.3	0.9	0.3	0.3	0.2	0.10	0.10	0.10	0.10	0.20	0.3	0.3	0.1	0.10	0.20	<0.1
	Nitrite + Nitrate	0.09	0.28	0.14	0.1	0.1	0.17	0.16	0.17	0.17	0.17	0.03	0.06	0.01	<0.01	0.01	0.01
	Total Phosphorus	0.06	0.12	0.01	0.02	0.01	**0.02**	<0.01	<0.01	<0.01	**0.03**	**0.02**	<0.01	**0.01**	<0.01	<0.01	<0.01
Metals & Metalloids	Aluminum	0.02	0.658	0.017	0.024	0.025	0.030	0.030	0.040	0.040	0.030	0.024	0.022	0.015	<0.01	<0.01	<0.01
	Arsenic	<0.0002	0.0003	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.001
	Barium	0.008	0.0015	0.0078	0.0079	0.008	0.0060	0.0070	0.0060	0.0060	0.0060	0.0153	0.0156	0.016	0.0120	0.0120	0.0140
	Boron	0.008	0.005	0.007	0.007	0.007	<0.05	<0.05	<0.05	<0.05	<0.05	0.006	0.005	0.005	<0.05	<0.05	<0.05
	Cadmium	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.00005	<0.00005	<0.0001	<0.0001	<0.0001
	Chromium	<0.0002	0.0008	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.001
	Cobalt	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	0.0002	<0.0001	<0.001	<0.001	<0.001
	Copper	0.0006	0.0006	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	0.0007	0.0006	<0.0005	<0.001	<0.001	<0.001
	Iron	0.021	0.548	0.018	0.024	0.024	<0.05	<0.05	<0.05	<0.05	<0.05	0.45	0.268	0.27	<0.05	<0.05	<0.05
	Lead	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001
	Manganese	0.0008	0.0064	0.0016	0.0032	0.0036	<0.001	0.002	<0.001	<0.001	<0.001	0.0047	0.0275	0.0062	0.014	<0.001	0.017
	Mercury	0.0002	0.0003	0.0002	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Molybdenum	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.002	0.002	0.002	0.002	0.002	<0.00004	<0.00004	<0.00004	<0.001	<0.001	<0.001
	Nickel	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	0.0007	0.001	<0.0005	<0.001	<0.001	<0.001
	Selenium	0.0003	0.001	0.0003	0.0003	0.0003	<0.01	<0.01	<0.01	<0.01	<0.01	<0.0002	<0.0002	<0.0002	<0.01	<0.01	<0.01
	Uranium	<0.00005	0.00012	<0.00005	<0.00005	<0.00005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.00005	<0.00005	<0.00005	<0.001	<0.001	<0.001
	Vanadium	<0.0002	0.0017	<0.0002	<0.0002	<0.0002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.0002	<0.0002	<0.0002	<0.01	<0.01	<0.01
	Zinc	0.002	0.001	<0.001	0.004	0.002	<0.005	<0.005	<0.005	<0.005	<0.005	0.02	0.004	0.002	<0.005	<0.005	<0.005

Note: all units are mg/L unless otherwise specified; LoR = limit of reporting, yellow shading indicates values below the lower limit of the ANZG (2018) GV range for upland rivers and red shading indicates exceedances of the ANZG (2018) GVs for upland rivers; bolded values indicates exceedances against the ANZG (2018) DVGs for the protection of 95% of species in pristine freshwater systems. a. ANZG (2026) at pH 7.5, temp 20°C; b.(Paice and Beatty 2022)

Table F 2: Historical (2024-25) surface water quality data recorded from Freshwater Lake and the Augustus River.

Water Quality Parameters		Freshwater Lake				Augustus River					Regional Reference		
		FWL1	FWL2	FWL3	FWL4	AR1_21	AR1_21	AR1_21	AR2_21	AR3_21	LR_DAM_21	RR02_99	RR10_99
		2024	2024	2024	2024	2024	2024	2024	2024	2024	2024	2024	2024
Basic	pH (unit)	7.8	7.8	7.8	7.7	7.35	7.31	7.3	7.4	dry	7.3	dry	dry
	Total Dissolved Solids	134	137	132	135	114	114	165	151	dry	158	dry	dry
	Electrical Conductivity (µS/cm)	250	248	247	262	247	240	272	270	dry	281	dry	dry
	Dissolved Oxygen (% Saturation)	113.7	112.3	105.5	109.0	99.9	100.6	dry	67.9	dry	92.7	dry	dry
	Turbidity (NTU)	24.43	26.00	25.10	24.77	1.9	1.6	dry	22.63	dry	26.93	dry	dry
	Suspended Solids	40	42	41	46	38	38	40	42	dry	43	dry	dry
Major Ions	Sodium	4	4	4	4	5	4	6	6	dry	6	dry	dry
	Magnesium	4	5	5	5	4	4	5	4	dry	4	dry	dry
	Calcium	1	2	2	2	1	1	2	2	dry	2	dry	dry
	Potassium	65	66	65	69	48	47	84	82	dry	92	dry	dry
	Chloride	33	32	33	32	28	25	32	26	dry	12	dry	dry
	Bicarbonate	14	15	15	15	13	13	5	10	dry	8	dry	dry
	Sulphate	<1	<1	<1	<1	<1	<1	<1	<1	dry	<1	dry	dry
	Carbonate	0.4	0.4	0.6	0.3	0.2	<0.1	0.1	0.3	dry	0.3	dry	dry
Nutrients	Total Nitrogen	0.2	0.2	0.4	0.1	0.2	<0.1	0.1	0.3	dry	0.3	dry	dry
	Total Kjeldahl Nitrogen	0.18	0.15	0.18	0.17	0.04	0.03	<0.01	<0.01	dry	<0.01	dry	dry
	Nitrite + Nitrate	<0.01	<0.01	<0.01	<0.01	0.03	0.03	<0.01	<0.01	dry	<0.01	dry	dry
	Total Phosphorus	<0.01	0.04	0.02	<0.01	0.02	0.01	<0.01	0.03	dry	<0.01	dry	dry
Metals & Metalloids	Aluminum	<0.01	0.04	0.02	<0.01	0.02	<0.01	<0.01	0.03	dry	<0.01	dry	dry
	Arsenic	0.03	0.03	0.03	0.05	<0.005	<0.005	<0.01	<0.01	dry	0.02	dry	dry
	Barium	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.001	<0.001	dry	<0.001	dry	dry
	Boron	0.006	0.006	0.006	0.006	0.0125	0.0118	0.02	0.014	dry	0.012	dry	dry
	Cadmium	<0.05	<0.05	<0.05	<0.05	0.007	0.007	<0.05	<0.05	dry	<0.05	dry	dry
	Chromium	<0.0001	<0.0001	<0.0001	<0.0001	<0.00005	<0.00005	<0.0001	<0.0001	dry	<0.0001	dry	dry
	Cobalt	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.001	<0.001	dry	<0.001	dry	dry
	Copper	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	dry	<0.001	dry	dry
	Iron	<0.001	<0.001	0.001	<0.001	<0.0005	<0.0005	<0.001	<0.001	dry	0.001	dry	dry
	Lead	<0.05	<0.05	<0.05	<0.05	0.111	0.107	0.28	0.15	dry	0.06	dry	dry
	Manganese	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.0001	<0.001	<0.001	dry	<0.001	dry	dry
	Mercury	<0.001	0.002	<0.001	<0.001	0.0152	0.0138	0.049	0.019	dry	<0.001	dry	dry
	Molybdenum	<0.0001	<0.0001	<0.0001	<0.0001	<0.00004	<0.00004	<0.0001	<0.0001	dry	<0.0001	dry	dry
	Nickel	0.001	0.002	0.002	0.001	0.0004	0.0005	<0.001	<0.001	dry	<0.001	dry	dry
	Selenium	<0.001	<0.001	<0.001	<0.001	<0.0005	0.0006	<0.001	<0.001	dry	<0.001	dry	dry
	Uranium	<0.01	<0.01	<0.01	<0.01	0.0008	0.0008	<0.01	<0.01	dry	<0.01	dry	dry
	Vanadium	<0.001	<0.001	<0.001	<0.001	<0.00005	<0.00005	<0.001	<0.001	dry	<0.001	dry	dry
	Zinc	<0.01	<0.01	<0.01	<0.01	<0.0002	<0.0002	<0.01	<0.01	dry	<0.01	dry	dry

Note: all units are mg/L unless otherwise specified; LoR = limit of reporting, yellow shading indicates values below the lower limit of the ANZG (2018) GV range for upland rivers and red shading indicates exceedances of the ANZG (2018) GVs for upland rivers; bolded values indicates exceedances against the ANZG (2018) DVGs for the protection of 95% of species in pristine freshwater systems. a. ANZG (2026) at pH 7.5, temp 20°C; b.(Paice and Beatty 2022).

Table F 3: Historical (2021-2023) sediment quality data recorded from Freshwater Lake and the Augustus River.

Sediment Quality Parameters		Freshwater Lake									Augustus River				
		FWL1	FWL2	FWL5	FWL6	FWL03_23	FWL05_99	FWL07_23	FWL08_23	FWL09_23	AR1	AR2	AR1	AR2	AR3
		2021	2021	2021	2021	2023	2023	2023	2023	2023	2021	2021	2023	2023	2023
Basic	pH (Unit)	6.7	5.7	5.9	6.2	6.5	6.8	7.2	7.7	7.2	6.3	6.2	6.1	6.6	6
	Electrical Conductivity (µS/cm)	10	30	11	19	24	22	37	55	21	19	30	47	37	43
	Moisture Content (%)	17.9	46.4	21	25.7	22.1	24.7	43.2	26.6	22.4	29.4	35	46.6	28.6	52.6
Cations and Anions	Sodium	<10	40	10	20	40	20	60	50	20	20	40	110	60	100
	Calcium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Magnesium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Potassium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Chloride	<10	40	<10	10	20	10	30	20	10	20	30	50	30	70
	Sulphate	<10	40	20	30	20	20	30	30	10	20	40	250	20	40
	Bicarbonate	10	7	<5	10	26	27	44	59	25	22	32	36	32	23
	Carbonate	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nutrients	Total Nitrogen	200	1,950	110	50	200	190	1330	150	100	560	680	1560	440	3400
	Total Phosphorus	71	192	52	70	79	36	134	166	65	70	128	99	67	197
	Total Organic Carbon (%)	0.57	3.06	0.76	0.5	0.37	1.11	0.88	0.42	0.24	2.54	2.61	5.72	-	4.46
	Total Kjeldahl Nitrogen	200	1950	110	50	200	190	1330	150	100	560	680	1560	440	3400
	Nitrite + Nitrate	<0.1	2.1	<0.1	<0.1	0.7	<0.1	0.5	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
Metals and Trace Elements	Aluminium	20,200	46,400	18,100	20,300	28,600	18,200	38,200	22,600	20,500	6,040	22,300	9,050	17,600	13,700
	Arsenic	<5	<5	<5	<5	<1	<1	<1	<1	<1	<5	<5	<1	<1	<1
	Boron	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	Cadmium	<1	<1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<1	<0.1	<0.1	<0.1
	Chromium	25	19	8	23	40.9	14.8	30.6	69.4	19.8	6	16	7.5	7	10.6
	Cobalt	<2	5	<2	4	1.2	0.9	6	0.9	0.6	9	10	10.7	4.2	4.5
	Copper	9	6	<5	19	8.5	4.2	7.8	44.8	5.8	<5	14	4	2.1	7.4
	Lead	<5	7	<5	<5	5.6	7.8	13.2	9.6	3	<5	<5	4	8.9	7.8
	Manganese	35	28	<5	37	19	16	188	30	12	182	49	252	45	47
	Mercury	<0.1	<0.1	<0.1	<0.1						<0.1	<0.1			
	Molybdenum	<2	<2	<2	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nickel	3	5	<2	3	3.1	2.8	6	3.1	1.6	7	8	12	4.6	6.7
	Selenium	<5	<5	<5	<5	0.1	0.1	0.3	0.1	0.1	<5	<5	0.4	0.2	0.7
	Uranium	0.7	2.7	1	1.1	1.4	0.6	2.6	1.5	0.8	0.4	1.2	0.5	0.9	0.8
	Vanadium	71	52	25	83	125	43	83	186	67	17	52	22	23	37
	Zinc	8	15	<5	6	7	3.3	21.5	3.9	3.2	9	16	15	11.1	15.1

Note: all units are mg/kg unless otherwise specified.

Table F 4: Historical (2004-25) sediment quality data recorded from Freshwater Lake, the Augustus River, Lunenburgh River Dam, Ernest River and Brunswick River.

Sediment Quality Parameters		LOR	Freshwater Lake				Augustus River					February 2025		
			February 2025				November 2024		February 2025			Lunenburgh River Dam	Brunswick River	Ernest River
			FWL1_24	FWL2_24	FWL3_23	FWL4_24	AR 1_21	AR 2_21	AR 1_21	AR 2_21	AR 3_21	LR_Dam_21	RR10_99	RR02_99
Basic	pH (Unit)	0.1	6.4	6.5	7.0	6.9	5.6	5.6	5.7	5.9	6.2	6.6	6.2	6.6
	Total Soluble Salts (TSS)	5	82	293	125	239	77	167	173	98	244	103	143	94
	Moisture Content (%)	1	27.0	40.1	19.6	39.2	26.6	73.8	40.3	21.7	5.6	35.6	5.5	<1.0
Cations and Anions	Sodium	10	40	80	40	110	30	170	70	20	60	50	40	20
	Calcium	10	<10	<10	<10	<10	<10	30	<10	<10	<10	<10	<10	<10
	Magnesium	10	<10	<10	<10	<10	<10	20	<10	<10	<10	<10	<10	<10
	Potassium	10	<10	<10	<10	<10	<10	20	<10	<10	<10	<10	<10	<10
	Chloride	10	30	110	30	110	20	120	40	20	60	50	30	20
	Sulphate	10	30	10	20	70	30	390	100	50	40	20	20	10
	Bicarbonate	5	8	8	82	47	<5	<5	<5	6	468	20	296	143
	Carbonate	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nutrients	Total Nitrogen	20	860	950	560	1,360	510	2,810	1,540	500	1,010	1,290	1,140	160
	Total Phosphorus	2	123	127	86	128	60	243	124	86	177	115	116	85
	Total Organic Carbon (%)	0.02	1.68	-	1.79	-	1.19	4.86	-	-	2.60	0.68	1.89	0.97
	Total Kjeldahl Nitrogen	20	860	950	560	1,360	510	2810	1,540	500	1,010	1,290	1,130	160
	Nitrite + Nitrate	0.1	0.2	0.2	0.2	0.4	<0.1	0.1	0.1	0.1	3.5	0.2	5.9	0.3
Metals and Trace Elements	Aluminium	50	32,900	20,100	18,600	37,900	10,000	41,300	19,800	26,600	12,600	18,900	17,900	5,950
	Arsenic	1	<1.00	<1.00	<1.00	1	<1.00	2.40	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
	Boron	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	Cadmium	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Chromium	1	29	20	14	34	8.4	28.8	15	36	8	18	8	8
	Cobalt	0.5	4.0	2.0	0.6	7.2	2.6	38.2	8.5	2.1	20.9	14.3	6.6	2.6
	Copper	1	20	2	1	14	3.6	24.1	15	3	6	13	6	2
	Lead	1	12	7	13	13	5.0	15.5	11	7	8	14	8	4
	Manganese	10	45	157	48	134	15	128	52	52	660	102	60	34
	Mercury	0.01	0.03	0.04	0.01	0.02	<0.01	0.09	0.03	<0.01	0.02	0.02	0.02	<0.01
	Molybdenum	0.1	0.7	0.4	0.4	1.3	<2.0	<2.0	0.4	0.7	0.4	0.3	0.2	0.1
	Nickel	1	7	2	2	7	4.8	36.8	8	6	7	7	5	3
	Selenium	0.1	0.2	0.3	<0.1	0.2	0.3	1.4	0.3	<0.1	0.4	0.3	0.2	<0.1
	Uranium	0.1	1.7	1.3	1.5	2.1	-	-	1.3	0.8	1.0	0.9	0.7	0.3
	Vanadium	2	81	45	35	110	-	-	51	105	34	52	31	24
	Zinc	1	12	7	2	25	6.9	45.2	22	7	16	8	7	6

Note: all units are mg/kg unless otherwise specified.

Stantec

Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

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