

Barwon River and Boundary Creek Macroinvertebrate Monitoring Program - Spring 2025

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Abbreviations

The following abbreviations have been used within this document:

Abbreviation	Definition
AUSRIVAS	Australian River Assessment System
Austral	Austral Research and Consulting
ASS	Acid Sulphate soils
BOM	Bureau of Meteorology
CPOM	Coarse particulate organic matter
D/S	Downstream
DO	Dissolved oxygen
EPA	Environment Protection Authority
EPT	Ephemeroptera, Plecoptera, Trichoptera
ERS	Environment Reference Standard
mg/L	milligrams per litre
NATA	National Association of Testing Authorities
nMDS	Non-metric multidimensional scaling
NTU	Nephelometric Turbidity Unit
O/E	Observed/Expected
PERMANOVA	Permutational multivariate analysis of variance
REPP	Remediation and Environmental Protection Plan (for Boundary Creek, Big Swamp and Surrounding Environment)
SIGNAL2	Stream Invertebrate Grade Number Average Level
SIMPER	Similarity percentages analysis
SPC	Specific conductivity at 25 °C
U/S	Upstream
°C	Degrees Celsius
µm	micrometre
µS/cm	microsiemens per centimetre
%tile	Percentile

Glossary

The following terms are used in this report:

AUSRIVAS reference sites = For any given site the AUSRIVAS model will generate an expected list of macroinvertebrate species based on data termed or referred to as reference sites.

Project reference sites = Sites selected and sampled that provide baseline/background data in the absence of the impacts of the acid sulphate soils from Big Swamp. These sites may be impacted by other factors such as altered hydrology and agriculture and are not considered to be unimpacted reference sites with a complete macroinvertebrate assemblage.

Historical water-quality data = For the current project historical water quality refers to the water quality data collected as part of the ongoing monitoring program and has excluded data from other sources such as gauging stations.

Abstract

This report presents the results of spring 2025 macroinvertebrate monitoring undertaken as part of the Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan's supporting environmental monitoring program. *In-situ* water quality, soluble metals, habitat condition and edge-habitat macroinvertebrate communities were assessed in Boundary Creek and the Barwon River from 20 to 23 November 2025. Results were generally within site-specific historical ranges and did not indicate a clear improvement or deterioration relative to previous spring surveys. However, Boundary Creek impact sites BO12 and BO13 continued to exhibit low pH (indicating more acidic conditions), elevated conductivity and soluble-metal concentrations, lower macroinvertebrate indices and AUSRIVAS Band B classifications. Multivariate analyses indicated separation between Boundary Creek project reference and impact sites, although the pairwise PERMANOVA comparison was not statistically significant. Some water quality differences were recorded downstream of the Boundary Creek confluence, but no statistically significant difference in macroinvertebrate community composition was detected between Barwon River project reference and impact sites. Overall, the results indicate continuing ecological impairment in Boundary Creek downstream of Big Swamp but no statistically detectable difference in macroinvertebrate community composition between Barwon River project reference and impact sites. Future monitoring should prioritise consistent access to project reference sites, adequate sampling coverage and analysis of the long-term dataset to better quantify ecological responses and their relationships with environmental conditions.

1. Introduction

1.1. Overview

Austral Research and Consulting (Austral) was contracted by Barwon Water to undertake macroinvertebrate and water quality monitoring to assess environmental responses to the remedial actions implemented under Barwon Water's Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan (REPP; Barwon Water 2024).

1.2. Objectives

This report presents the results of spring 2025 monitoring and has the following objectives:

- Assess water quality, habitat condition, and macroinvertebrate communities at project reference and impact sites.
- Monitor the influence of Boundary Creek on the Barwon River.
- Identify any trends and/or changes in ecological condition.

1.3. Background

Boundary Creek, Big Swamp, and the Barwon River form an interconnected aquatic system within the Barwon catchment, supporting a range of ecological values and providing habitat for aquatic species. However, this system has been, and continues to be, impacted by development and changes in land use, hydrological modifications, water harvesting practices, fire, and climate. Specifically, Barwon Water's historical groundwater pumping at the Barwon Downs borefield between 1982 and 2016 reduced flows in Big Swamp and the lower reaches of Boundary Creek, contributing to the drying and oxidation of acid sulphate soils (ASS) within Big Swamp. The resulting ASS disturbance continues to affect the condition and ecological function of Boundary Creek and Big Swamp and has the potential to produce flow-on effects in the Barwon River.

Since early 2020, Barwon Water has been implementing the REPP to identify and address impacts associated with the historical groundwater pumping activities at the Barwon Downs borefield.

The REPP also outlines the controls and actions that have been or will be implemented to:

- Ensure no further harm to aquatic habitat within Boundary Creek, Big Swamp, or the Barwon River from Barwon Water's historical groundwater pumping or remediation actions.
- Protect the water quality and ecological values of the Barwon River.
- Improve the water quality and stream flows within Boundary Creek.
- Improve the ecological values of Big Swamp.

1.4. Remediation actions and additional monitoring

In line with the REPP, the following key actions have been implemented under the REPP:

- Cessation of groundwater pumping activities.
- Decommissioning of the Barwon Downs borefield extraction bores.
- Provision of supplementary flows, where required, to maintain flows in the lower reaches of Boundary Creek.
- Provide suitable condition for wetland species to recolonise impacted areas.
- Development of risk-based contingency measures to be implemented in the unlikely event that additional actions are required to minimise the potential for high-risk events, should these persist following the implementation of remedial actions.

These are underpinned by a robust environmental monitoring program that has been developed to monitor how the system is responding to these actions and identify whether any additional actions are required.

1.5. Monitoring program (2019–2025)

As part of a broader environmental monitoring program conducted under the REPP, a macroinvertebrate and *in-situ* water quality monitoring program has been running since 2019. The program collects seasonal data each year during spring and autumn at sites within Boundary Creek and the Barwon River to:

- Evaluate how the aquatic ecosystem is responding to the remedial actions outlined in the REPP.
- Determine whether remediation objectives have been achieved or whether further action, such as implementing contingency measures, is required.
- Identify whether further monitoring or investigation is required and whether the existing monitoring program should be refined.

The REPP's macroinvertebrate monitoring program has evolved over time to improve the assessment of ecological responses to Barwon Water's remedial actions. Initial monitoring between 2019 and 2022 focused on the lower reaches of Boundary Creek and the Barwon River. In spring 2022, the program was expanded to include additional sites within Boundary Creek and Big Swamp to improve spatial coverage across the system. In 2025, the site network and monitoring methods were further refined based on previous results and the ecological significance of individual sites. Some downstream sites were removed because they provided little additional information about downstream impacts. The spring 2025 survey forms part of this ongoing program and provides current information on water quality, habitat condition and macroinvertebrate communities at project reference and impact sites.

2. Methods

2.1. Survey design

Macroinvertebrate community data were collected at sites distributed across two waterways: the Barwon River and Boundary Creek. Sites were classified as either project reference (unimpacted by inputs from Boundary Creek), or impact (has the potential to be impacted by discharges from Big Swamp) sites. The monitoring program uses a spatial reference-impact design with repeated seasonal sampling.

The current macroinvertebrate monitoring network comprises 14 sites across the Barwon River and Boundary Creek (Table 1; Figure 1), grouped as follows:

- Barwon River upstream of the Boundary Creek confluence – four project reference sites.
- Boundary Creek upstream of Big Swamp – five sites representing conditions before Boundary Creek is influenced by ASS from Big Swamp and considered project reference sites.
- Boundary Creek downstream of Big Swamp – two sites to detect monitor the ongoing effects from the discharge of acidity and metals to the lower reaches of Boundary Creek.
- Barwon River downstream of Boundary Creek confluence – three sites used to assess the potential flow-on effects of Boundary Creek discharges on the Barwon River.

Table 1: Monitoring locations – Key Information summary

Site Code	Site Name	Waterway	Treatment	Latitude	Longitude
BA1	@ Kents Rd	Barwon River	Project Reference	-38.5122	143.7325
BA2	@ Dewings Bridge Rd			-38.4349	143.7479
BA3	@ Seven Bridges Rd			-38.4747	143.6894
BA4	@ Upstream Boundary Ck			-38.4182	143.7420
BA14	@ Downstream Boundary Ck	Boundary Creek	Impact	-38.4167	143.7424
BA15	@ Plantation boundary			-38.4023	143.7576
BA16	@ Colac-Lorne Rd			-38.3888	143.7690
BO5 ^	@ Colac-Lavers Hill Rd			-38.4191	143.5830
BO6	@ Barongarook	Boundary Creek	Project Reference	-38.4147	143.6335
BO7 *	@ Upstream McDonalds Dam			-38.4038	143.6747
BO8 *	@ Downstream McDonalds Dam			-38.4086	143.6819
BO9	@ Upstream Big Swamp			-38.4229	143.6922
BO12	@ Colac-Forrest Rd	Boundary Creek	Impact	-38.4211	143.7105
BO13	@ Upstream Barwon Rv			-38.4206	143.7343

Notes: * sites not sampled during spring 25 due to restrictions on private land access; ^ sites not sampled during spring 25 as the site was inaccessible due to overgrown vegetation.

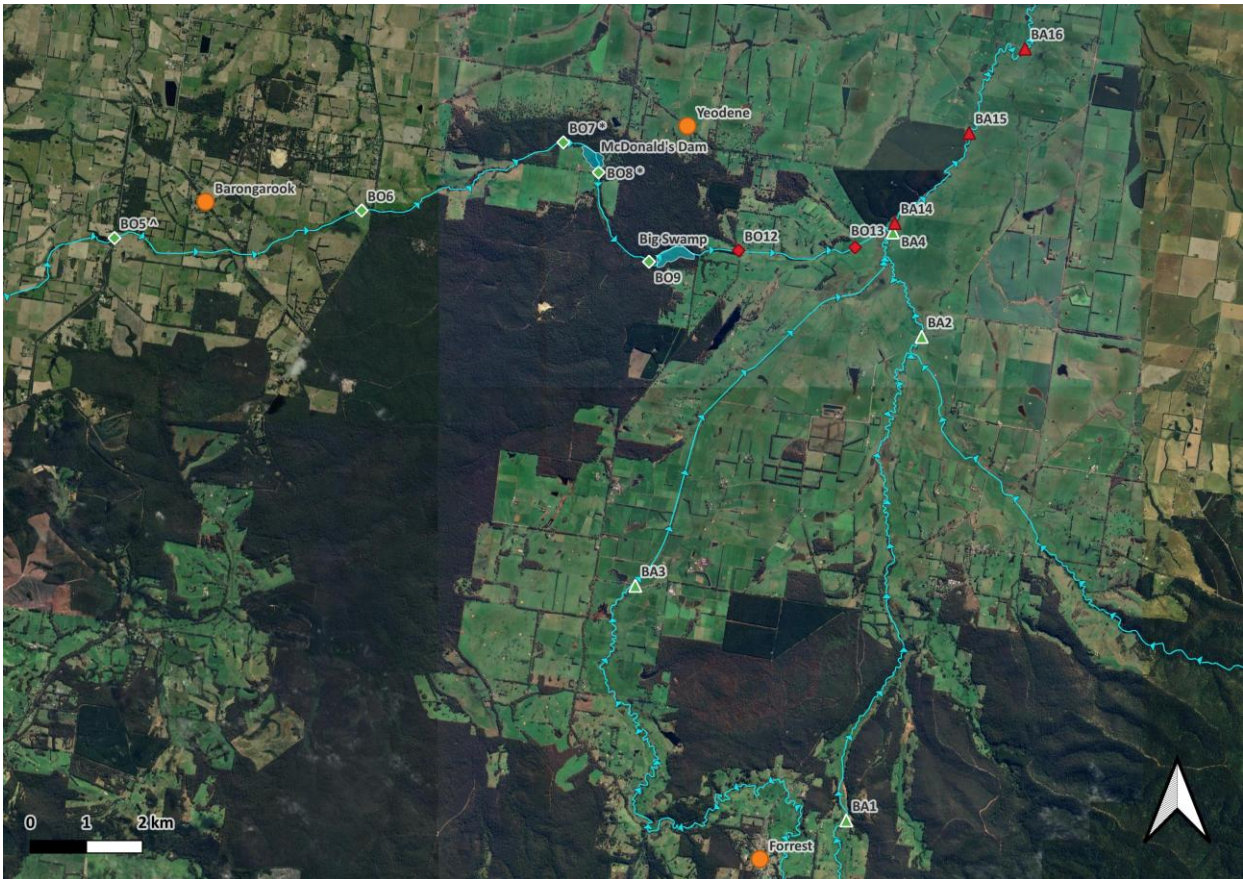


Figure 1: Map of monitoring site network. Notes: Boundary Creek sites are indicated by diamonds and Barwon River sites by triangles. Project reference sites are shown as white symbols with green outlines, and impact sites are shown as red symbols. Blue lines show waterways, with arrows indicating flow direction. Satellite imagery was sourced from Google Earth (accessed 23 March 2026).

2.2. Survey timing and hydrological context

The spring 2025 macroinvertebrate sampling event was conducted between 20 and 23 November 2025. Rainfall was substantially below the long-term monthly mean between January and May 2025, corresponding with very low flows in the Barwon River and Boundary Creek during late summer and autumn (Figure 2–Figure 4). Following this, rainfall and flows increased, with multiple flow peaks occurring between August and November. At the time of the survey, flows had receded from the earlier peaks but remained higher than the low flows recorded during the first half of 2025. Although supplementary flow releases may occur between 1 November and 30 June when the private on-stream dam must pass all inflows, Barwon Water did not release supplementary flows into the upper reaches of Boundary Creek before or during the survey due to private-land access restrictions (Figure 4).

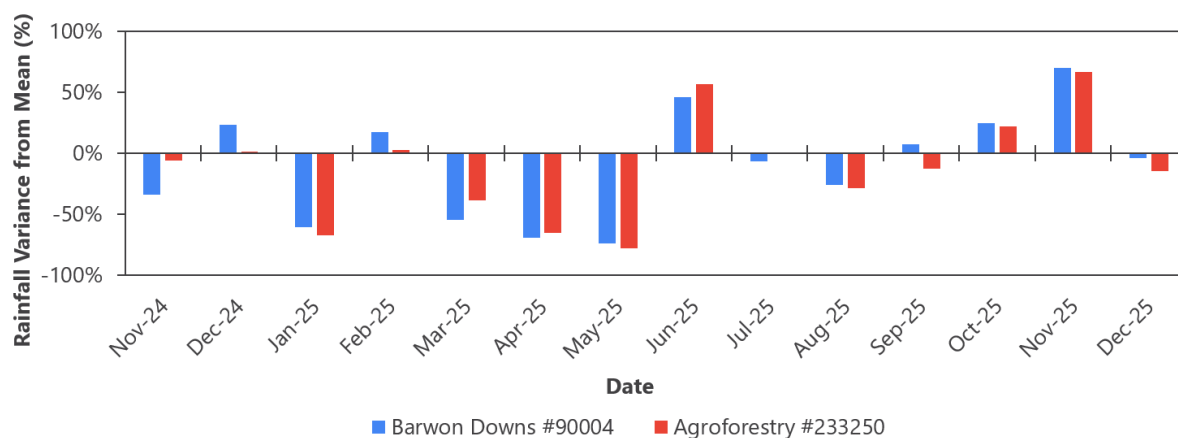


Figure 2: Rainfall variance from the mean for the two BOM stations, Barwon Downs (BOM #090004) and Agroforestry (BOM #233250). Positive and negative values indicate above- and below-average rainfall, respectively. Mean was based on all mean average monthly data from the BOM.

Mean daily flow in the Barwon River downstream of the Boundary Creek confluence varied substantially between November 2024 and December 2025 (Figure 3). Flows ranged from lows of approximately 0.1 ML/day in March and April 2025 to several peaks above 100 ML/day between July and December, with a maximum of approximately 600 ML/day in September 2025.

Boundary Creek showed a broadly similar temporal pattern, although flows were generally lower than those in the Barwon River (Figure 4). Supplementary flow releases were provided from 5 November 2024 to 11 June 2025 and again from 23 December 2025. These releases generally occurred when flows in Boundary Creek get close to or below 1 ML/day.

Current and historical flow conditions can affect water quality and macroinvertebrate communities by influencing parameters such as pH, dissolved oxygen, temperature and salinity. These flow-on effects may increase or decrease macroinvertebrate abundance and diversity, potentially affecting the AUSRIVAS results presented in this monitoring program.

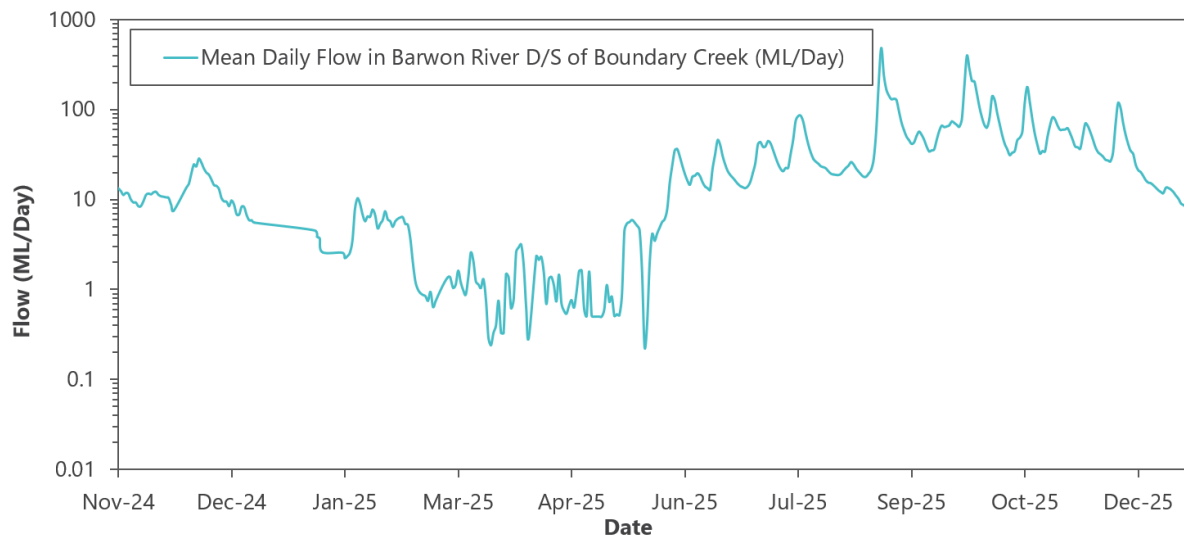


Figure 3: Mean daily flows in the Barwon River downstream of the confluence with Boundary Creek (BOM #233233).

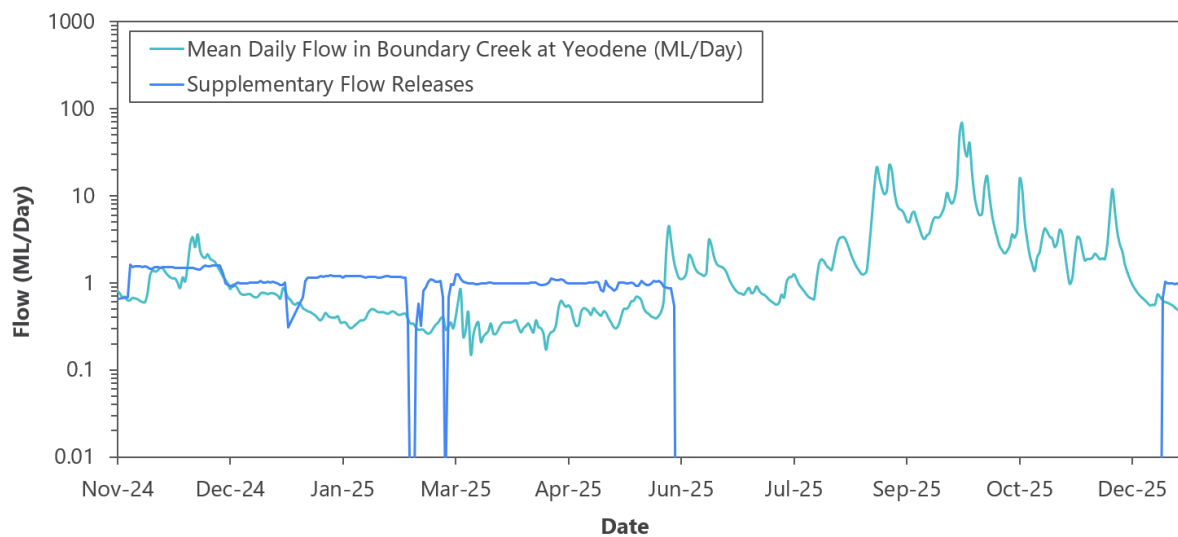


Figure 4: Mean daily flows in Boundary Creek at Yeodene (BOM #233228) with Barwon Water supplementary flow overlaid.

2.3. Water quality sampling

In-situ water quality parameters were measured at each site using a YSI Pro Plus multiparameter meter. Parameters included pH, dissolved oxygen (mg/L and percentage saturation), water temperature (°C) and specific conductivity (µS/cm, corrected to 25 °C). Turbidity was measured using a Hach 2100Q portable turbidity meter and reported in nephelometric turbidity units (NTU). Alkalinity was measured in the field using a Hach Alkalinity Test Kit (Model AL-TA).

Water samples were also collected in laboratory supplied sample bottles for analysis of three soluble metals: aluminium, iron, and zinc. Samples were immediately filtered in the field using 0.45 µm membrane filters and transferred to bottles containing nitric acid (HNO₃) preservative. Following collection, the samples were kept on ice and stored below 4 °C until delivery to Australian Laboratory Services, a National Association of Testing Authorities (NATA) accredited laboratory, for analysis.

2.3.1. Water quality analysis and presentation

In-situ water quality results were presented by site and compared with historical data from the current monitoring program using the median and 20th–80th percentile range. Because monitoring results have consistently not met the relevant water quality objectives in the Victorian Environment Reference Standard (ERS; EPA Victoria 2022), the current results were assessed against site-specific historical conditions. The ERS objectives are provided in Appendix B for broader environmental context.

2.3.2. Soluble metals

Soluble metal concentrations were compared with the Tier 2 guideline values developed by Nation Partners (2025). These values refine the default guideline values by incorporating relevant evidence from recent literature.

Where no Tier 2 guideline value was available, as was the case for zinc, concentrations were compared with the Tier 1 default guideline value for 95% species protection (ANZG 2018). The 95% protection level was applied in accordance with the Victorian ERS, which specifies the applicable level of species protection for the waterway segments containing most of the monitored reaches (EPA Victoria 2022).

2.4. Macroinvertebrate sampling

Macroinvertebrates were collected using methods based on the Rapid Bioassessment Methodology for Rivers and Streams (EPA Victoria 2021). One edge sample and one riffle or run sample are normally collected at each site. Where suitable riffle or run habitat is absent, two edge samples are required. During the spring 2025 survey, only one edge sample was collected at each site. Accordingly, all spring 2025 macroinvertebrate analyses presented in this report are

based on edge-habitat data. Future sampling will include two samples at each site in accordance with EPA Victoria (2021).

Approximately 10 m of edge habitat was sampled using a dip net with a 250 µm mesh. Sample contents were transferred to a white tray and live picked for a standardised period of 30 minutes to maximise the representation of taxa present. Where possible, at least 100 individuals were retained to characterise community composition and relative abundance. Fewer individuals were retained where abundance or diversity was low.

Collected specimens were preserved in 70% ethanol and later identified in the laboratory. Taxonomic resolution followed EPA Victoria (2001) guidelines, with most taxa identified to family, Chironomidae identified to subfamily, and Oligochaeta and Acarina retained at broader taxonomic levels.

2.5. Habitat assessment

Habitat assessments were undertaken at each site to characterise instream and riparian condition and to support interpretation of water quality and macroinvertebrate results. Standardised field and habitat assessment sheets consistent with EPA Victoria (2021) were completed at each site. Recorded variables included substrate composition, coarse particulate organic matter, large woody debris, stream width and riparian shading. Site photographs were also taken to document conditions at the time of sampling.

Habitat information was primarily used to:

- Assist in interpreting observed biological or water quality results.
- Identify notable changes in site condition since previous surveys (e.g., vegetation removal, revegetation or changes in channel structure).

2.6. Data preparation and analytical approach

This report presents analyses of macroinvertebrate data collected from the Barwon River and Boundary Creek. Sites were classified as project reference sites (not impacted by Barwon Water's historic groundwater pumping activities, used as a benchmark) or impact sites (within or downstream of confirmed areas of impact)). All macroinvertebrate analyses were based on edge-habitat data. The goal was to determine whether the community of macroinvertebrates living in and around the waterways differed between these two groups over the course of the monitoring program.

Macroinvertebrate data included records from the spring 2025 survey and previous surveys conducted under the monitoring program. Two complementary analytical approaches were used: stream-condition indices were used to compare spring 2025 with historical spring data, while multivariate analyses were applied to spring 2025 data to examine differences in community composition between waterways and site classifications. Sites not sampled in spring 2025 were

excluded from analyses of the current survey data, although their historical data were retained for context.

All analyses were performed in R version 4.2.1 (R Core Team 2024). Data preparation was undertaken using the tidyverse and openxlsx packages, and multivariate analyses were conducted using the vegan package (Oksanen et al. 2024).

2.7. Stream condition indices

Stream condition indices were calculated to provide a quantitative assessment of ecological condition across sites based on macroinvertebrate community composition. Indices included taxon richness, EPT (Ephemeroptera, Plecoptera and Trichoptera) richness, SIGNAL2 scores and (Chessman 2001) AUSRIVAS observed/expected (O/E) scores and bands (University of Canberra 2003), following EPA Victoria guidelines (EPA Victoria 2004). Indices calculated for spring 2025 were compared with historical spring data from the monitoring program, which were summarised using the median and 20th–80th percentile range.

Taxon richness provides a measure of the number of taxa recorded, with higher values generally indicating better ecological condition. EPT richness represents the number of taxa from pollution-sensitive groups and is commonly used as an indicator of water quality and habitat condition. SIGNAL2 scores reflect the sensitivity of taxa present, with higher scores indicating greater representation of pollution-sensitive taxa.

AUSRIVAS O/E scores compare the observed macroinvertebrate assemblage at a site with that expected under reference conditions. These scores are categorised into bands (X to D), ranging from more biologically diverse than reference conditions (band X) to extremely impaired (band D), providing a standardised assessment of ecological condition. These indices were used collectively to assess spatial patterns in ecological condition between project reference and impact sites and to evaluate responses to remediation actions under the REPP.

Table 2: AUSRIVAS Bands and Observed/Expected Scores (EPA Victoria, 2021)

Band	O/E 50 score Edge	Label Description
X	1.20+	More biologically diverse than the AUSRIVAS reference conditions
A	0.81-1.19	Similar ecological condition to AUSRIVAS reference conditions
B	0.43-0.80	Significantly impaired ecological condition
C	0.05-0.42	Severely impaired ecological condition
D	0-0.04	Extremely impaired ecological condition

Table 3: EPA Victoria Spring Objective Values for Waterway Health (EPA Victoria, 2022)

Segment	Habitat	Taxa Richness	EPT Richness	SIGNAL2	AUSRIVAS
Central Foothills & Coastal Plains	Edge	20	NA	3.4	A
Uplands B	Edge	17	6	4.2	A

Table 4: Objective values for biotic indices for edge habitats in Barwon River and Boundary Creek (EPA Victoria, 2021).

	Taxon richness	SIGNAL2 score	AUSRIVAS band
Spring	20	3.4	A
Autumn	17	3.4	A

2.8. Multivariate statistical analysis

Multivariate analyses were applied to spring 2025 data to examine differences in macroinvertebrate community composition between waterways and between project reference and impact sites. Multivariate analyses comprised non-metric multidimensional scaling (nMDS), permutational multivariate analysis of variance (PERMANOVA) and similarity percentages analysis (SIMPER). Each of the multivariate analyses used Bray-Curtis dissimilarity measure, calculated using vegdist in vegan version 2.5-6.

2.8.1. Non-metric multidimensional scaling (nMDS)

Community composition was visualised using nMDS, an ordination technique that represents rank-order dissimilarities among sites in a low-dimensional space. No transformations of raw macroinvertebrate abundances were needed following exploration using the Shepard plot done using stressplot. Bray-Curtis dissimilarity matrices were calculated using vegdist in vegan package 2.5-6. Non-metric Multidimensional Scaling (nMDS) ordinations were created using the metaMDS. Up to 200 random starting configurations were used to reduce the risk of convergence on a local stress minimum. Stress values below 0.10 generally indicate a good representation of the data, while values between 0.10 and 0.20 indicate a potentially useful but less reliable representation.

Ordination plots show individual sites, with point colour indicating site classification (project reference or impact) and point shape indicating waterway (Barwon River or Boundary Creek). Convex hulls were drawn around site-classification and waterway × site-classification groups to visually summarise community separation.

2.8.2. Permutational multivariate analysis of variance (PERMANOVA)

Differences in macroinvertebrate community composition among project reference and impact sites were tested using Permutational Multivariate Analysis of Variance (PERMANOVA; Anderson 2001), implemented via the *adonis2* function in *vegan*. PERMANOVA partitions multivariate dissimilarity into components attributable to specified factors and tests their significance by comparing observed pseudo-*F* statistics against a null distribution generated by permutation, making it free from assumptions of multivariate normality. The analysis was based on presence/absence-transformed data.

Bray-Curtis dissimilarity, calculated on presence/absence data, was used as the dissimilarity measure. The model included Treatment (Reference vs. Impact) and Waterway (Barwon River vs. Boundary Creek) as fixed factors, along with their interaction term (Treatment × Waterway). The interaction term was the primary focus of inference, as it tests whether the difference between project reference and impact sites is consistent across waterways.

Because sites were nested within Waterway × Treatment combinations, permutations were restricted within sites using the *strata* argument. This ensures that permuted data honour the nested structure of the design, avoiding inflated Type I error rates that would arise from freely exchanging samples between groups. All terms were tested sequentially (Type I sums of squares) using 9,999 permutations.

2.8.3. Similarity percentages analysis (SIMPER)

To identify the taxa contributing most to observed compositional differences, Similarity Percentages analysis (SIMPER; Clarke 1993) was performed using the *simper* function in *vegan*. SIMPER decomposes the average Bray-Curtis dissimilarity between groups into per-taxon contributions, ranked in descending order of contribution.

SIMPER was performed on raw, untransformed abundance data using Bray-Curtis dissimilarity. Three sets of contrasts were examined: (i) project reference versus impact sites; (ii) Barwon River versus Boundary Creek; and (iii) project reference versus impact sites within each waterway separately. The within-waterway contrasts were used to examine taxon abundance patterns associated with the interaction identified by PERMANOVA. The significance of individual taxon contributions was assessed using 999 permutations. Cumulative percentage contributions were reported to show the combined contribution of taxa to compositional differences between groups (Appendix D, Tables D1–D3).

2.9. Limitations

The monitoring program provides a representative assessment of ecological condition across the study area; however, some limitations should be considered when interpreting the results as outlined in section 2.2. Sampling represents a snapshot in time and may not capture short-term variability in environmental conditions, including changes in flow, rainfall, and water quality. The hydrological context described in Section 2.2 should therefore be considered when interpreting the results.

Access restrictions prevented some sites (BO5, BO7, and BO8) from being sampled during the spring 2025 survey. These sites were excluded from analyses of the current survey data, reducing spatial coverage and potentially limiting direct comparisons with previous surveys. Historical data from these sites were retained for context but were not treated as current observations.

3. Results

Results for water quality, soluble metals and macroinvertebrates are presented separately for Boundary Creek and the Barwon River, with comparisons between project reference and impact sites within each waterway. Habitat results are presented across both waterways by habitat characteristic.

- 1) Boundary Creek – with impact sites located downstream of Big Swamp and project reference sites located upstream (Table 1 and Figure 1).
- 2) Barwon River – with impact sites located downstream of the confluence of Boundary Creek and the Barwon River and project reference sites located upstream of the confluence (Table 1 and Figure 1).

Sites not sampled during the spring 2025 survey because of access restrictions are shown using historical data only, where available.

3.1. Water quality

3.1.1. Boundary Creek

Water quality results from the spring 2025 survey indicate noticeable spatial gradients in Boundary Creek with the impact sites BO12 and BO13 demonstrating degraded water quality conditions relative to the sampled project reference sites BO6 and BO9. Spatial gradients were evident in pH (Figure 5) and alkalinity (Figure 6) and conductivity (Figure 7). Turbidity varied among sites but did not show a consistent gradient (Figure 8). pH and alkalinity were lower at the impact sites relative to the upstream project reference sites, while conductivity was higher. Of note was the pH level at BO13 which fell below the 20th %tile for the monitoring program and may influence downstream water quality.

Water temperature in Boundary Creek was relatively consistent, ranging from 10.4°C to 14.6°C (Table 5). This seasonal range is typical for spring and is unlikely to be a primary driver of observed differences in water quality or biotic responses. Dissolved oxygen ranged from 69.4% to 77.2% saturation and is considered sufficient to support aquatic life.

3.1.2. Barwon River

Water quality results from the spring 2025 survey in the Barwon River follow the pattern that would be expected to be observed in a downstream direction for some water quality parameters. Typically, specific conductivity at 25°C (SPC) increases the further downstream sampling occurs, as is the case with the Barwon River (Figure 7).

pH was below the historical median at BA4, BA14 and BA15, and below the historical 20th percentile at BA14 (Figure 5). The lower pH at BA14 and BA15 is consistent with a potential influence from Boundary Creek inflows, while pH at BA16 was close to the historical median.

Alkalinity in the Barwon River was close to the historical median at most sites, while concentrations at BA14 and BA15 were near the historical 80th percentile ranges (60 mg/L). The higher alkalinity at these sites may have provided some buffering against reductions in pH (Figure 6).

Turbidity levels were all above the long-term median (Figure 8) except for site BA14. Turbidity can fluctuate substantially with catchment land practices and can be dependent on hydrological features such as on-stream dams and wetlands and the associated impacts. It is possible that the reduced turbidity levels at BA14 may be attributed in part to the elevated salinity and reduced pH levels which can influence turbidity.

Water temperature in Barwon River was relatively consistent, ranging from 12.1°C to 18.6°C. This seasonal range is typical for spring and is unlikely to be a primary driver of observed differences in water quality or biotic responses.

Dissolved oxygen ranged from 56% to 93% saturation. While most sites maintained oxygen levels sufficient to support aquatic life, lower values at BA4 and BA14 (<60%) indicate potential oxygen depletion associated with reduced flow velocities and localised organic matter decomposition.

Table 5: Water quality results for sampled monitoring sites.

Site Code	Time (24 h)	Temp (°C)	pH (pH Units)	SPC (µS/cm)	DO (% sat)	Turbidity (NTU)	Alkalinity (mg/L)
BA1	9:00	12.1	7.57	109.8	92.9	19.5	40
BA2	15:30	16.8	7.26	217.7	87.5	30.4	40
BA3	12:25	13.2	7.02	167.4	79.1	16.1	40
BA4	10:40	15.6	6.72	239.1	56.0	20.3	40
BA14	12:00	15	6.6	277	59.2	8.95	60
BA15	13:00	17.1	6.75	295	66.5	21.4	60
BA16	15:20	18.6	7.12	339.4	86.2	25.3	40
BO5	Could not be sampled/accessed during sampling event						
BO6	9:00	10.4	6.71	307.3	74.8	15.3	40
BO7	Could not be sampled/accessed during sampling event						
BO8	Could not be sampled/accessed during sampling event						
BO9	11:30	13.8	6.92	368.1	76.9	5.22	<20
BO12	14:30	14.6	3.74	489.2	77.2	5	<20
BO13	10:00	13.7	3.36	655	69.4	7.32	<20

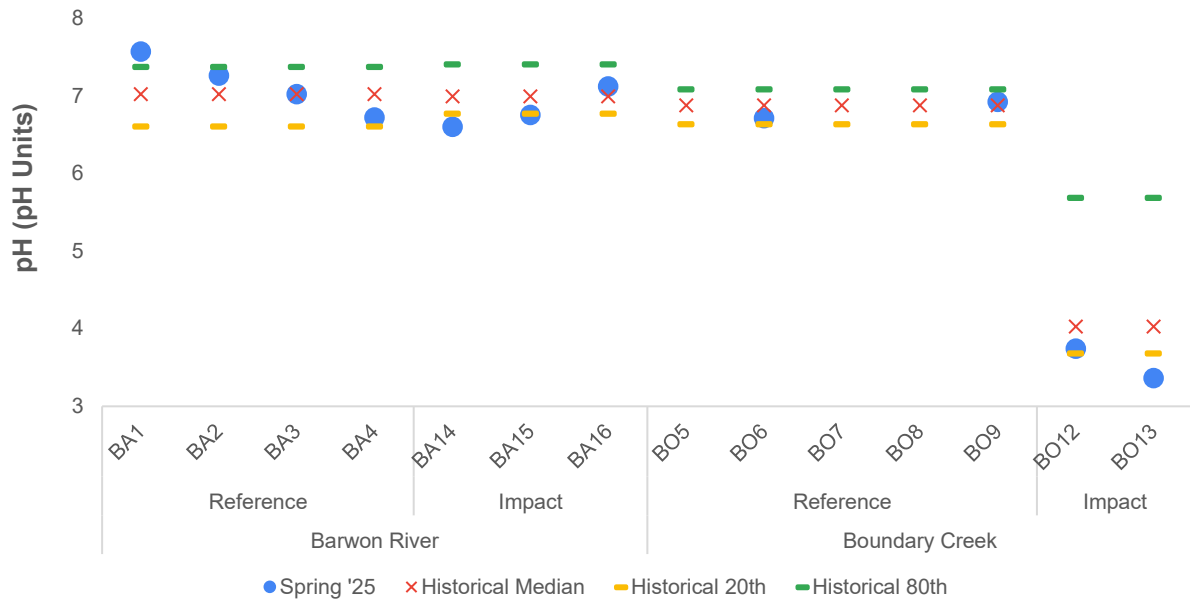


Figure 5: Graph of pH spring 2025 compared to historical data. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

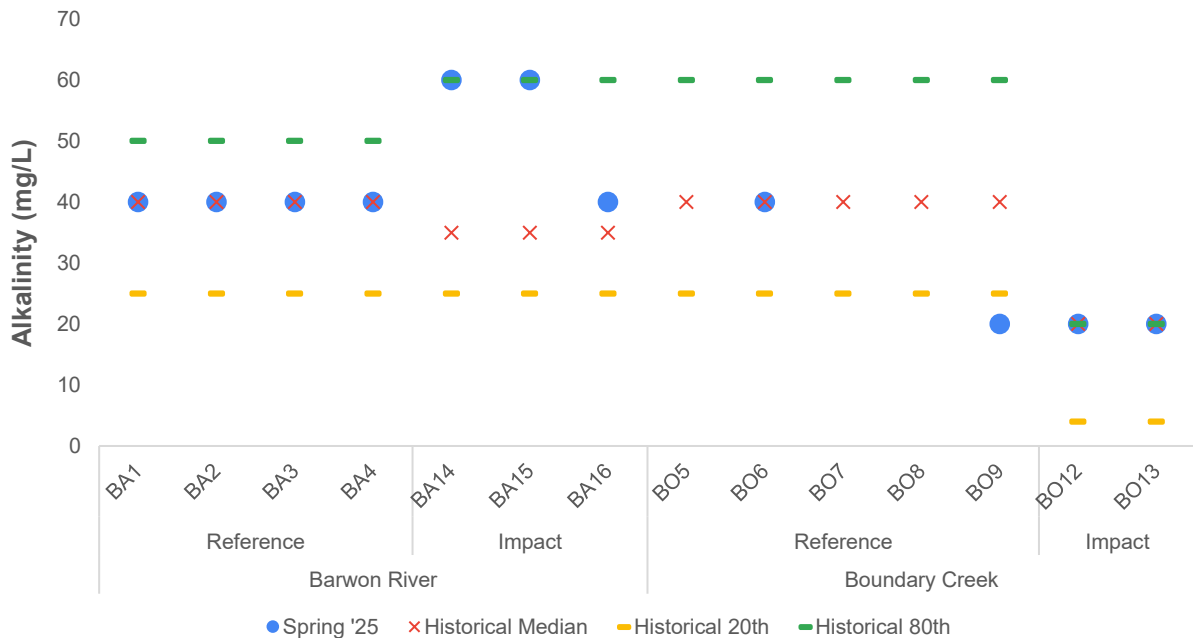


Figure 6: Graph of alkalinity spring 2025 compared to historical data. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

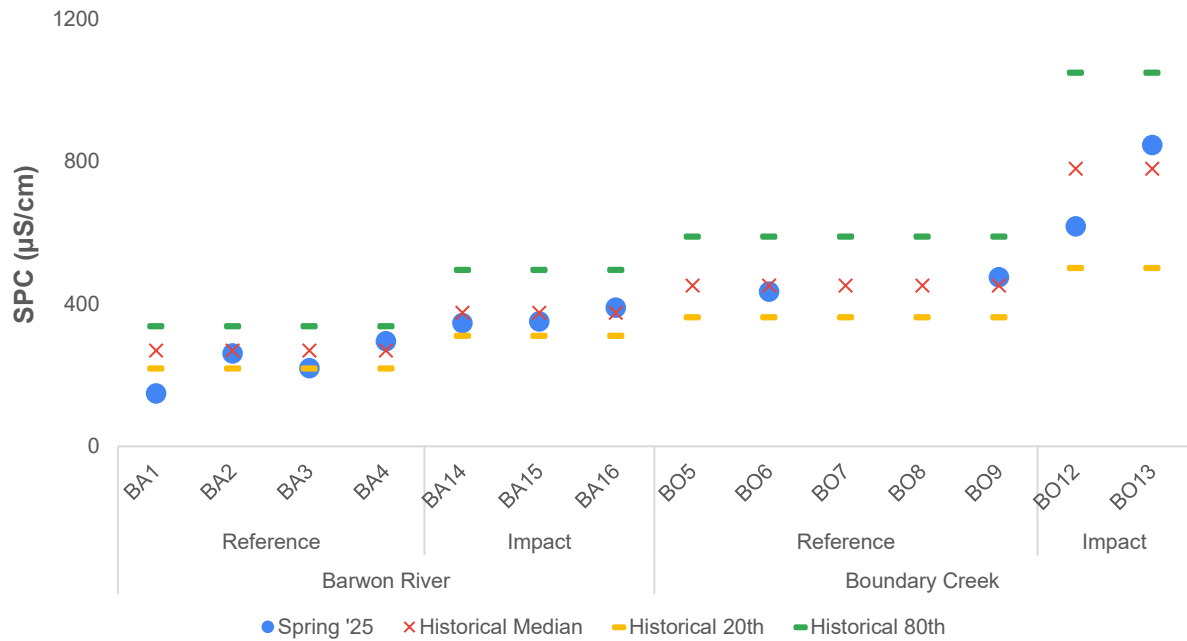


Figure 7: Graph of conductivity spring 2025 compared to historical data. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

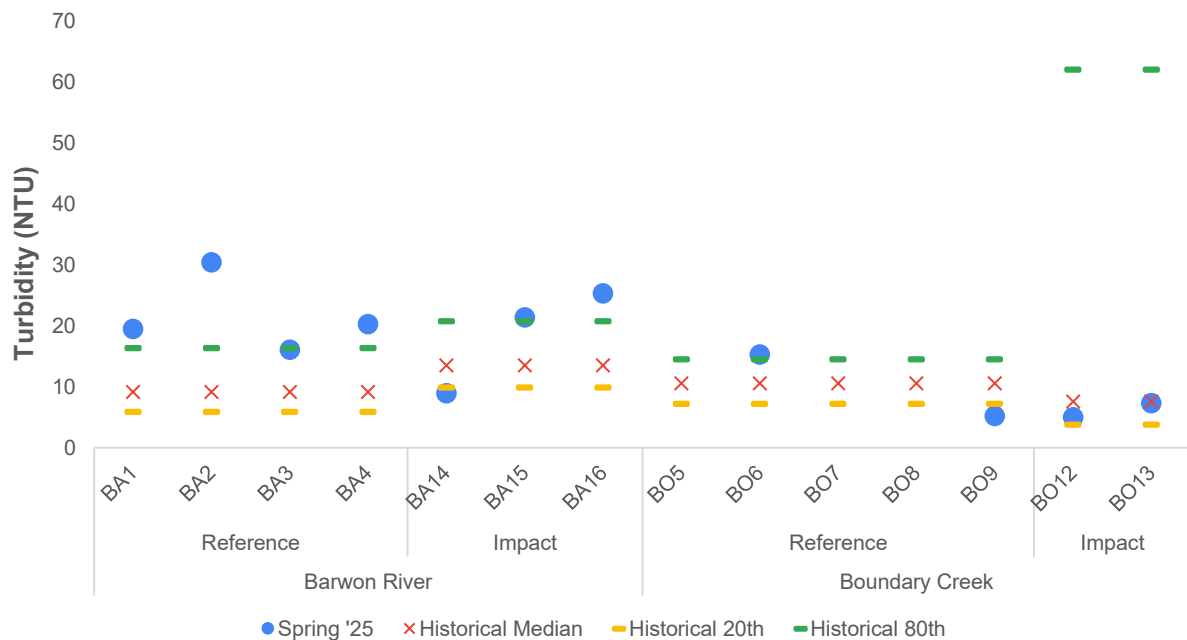


Figure 8: Graph of turbidity spring 2025 compared to historical data. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

3.2. Soluble metals

Provided below is a summary of soluble metals results from field samples discussed in the context of Boundary Creek (project reference and impact sites) and the Barwon River (project reference and impact sites).

3.2.1. Boundary Creek

Soluble metal concentrations were generally within the historical 20th–80th percentile ranges, with the exceptions of aluminium at BO6, which was above the historical 80th %tile, and iron at BO13, which was below the historical 20th percentile range. Aluminium concentrations were generally at the higher end of their site-specific historical ranges, with BO6 above the historical 80th percentile (Figure 9). The available data provide no apparent explanation for the elevated aluminium concentration at BO6. Iron and zinc concentrations at the sampled Boundary Creek project reference sites were within their historical ranges (Figure 10 and Figure 11). Although iron and zinc concentrations were substantially higher at the impact sites than at the project reference sites, they were generally within or below their site-specific historical ranges. The elevated levels for metals are anticipated to be associated with the presence of acid sulphate soils (ASS) that have resulted in acidic conditions, and the mobilisation of metals from the natural sediments.

The lower pH at BO12 and BO13 corresponded with substantially higher soluble aluminium, iron and zinc concentrations relative to the project reference sites (Figure 9–Figure 11). This spatial pattern is consistent with previous results and with the ongoing flushing of acidity and metals from ASS in Big Swamp.

3.2.2. Barwon River

Soluble aluminium concentrations were within their site-specific historical ranges at most Barwon River sites, except BA2 and BA3, where concentrations were above the historical 80th percentile range (Figure 9). At BA4, aluminium was close to the historical median. Aluminium concentrations at the impact sites BA14 and BA15 were above their historical medians but remained within their historical ranges, while the concentration at BA16 was close to the historical median. Aluminium concentrations at the impact sites remained higher than those generally recorded at the Barwon River project reference sites. The current dataset provides no explanation for the increases in aluminium concentrations at reference site BA2 and BA3, given pH levels were not significantly elevated at the site.

Soluble iron concentrations were between the historical median and 80th percentile for all reference and impact sites (Figure 10) on the Barwon River with the exception of BA3. Zinc concentrations at the project reference sites BA2 and BA3 were above their historical medians but remained within their historical ranges (Figure 11). Zinc concentrations were highest at BA14 (closest site to the potential impact) and declined downstream, likely as a result of dilution.

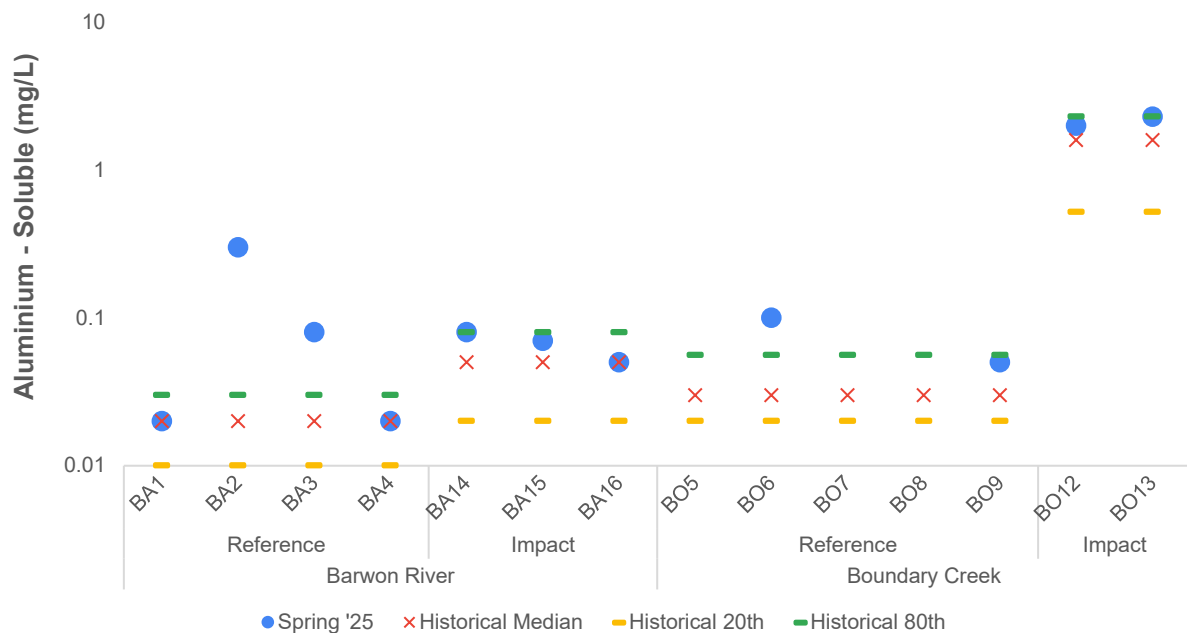


Figure 9: Graph of soluble aluminium spring 2025 compared to historical data. Notes: Y-axis in logarithmic scale. Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

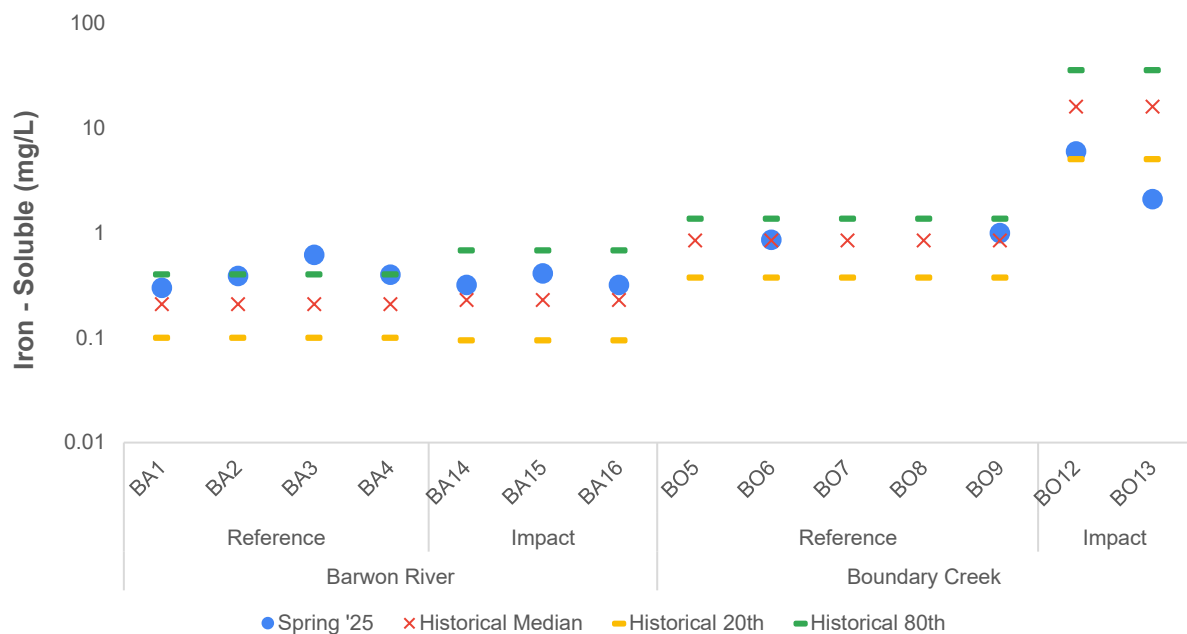


Figure 10: Graph of soluble iron spring 2025 compared to historical data. Notes: Y-axis in logarithmic scale. Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

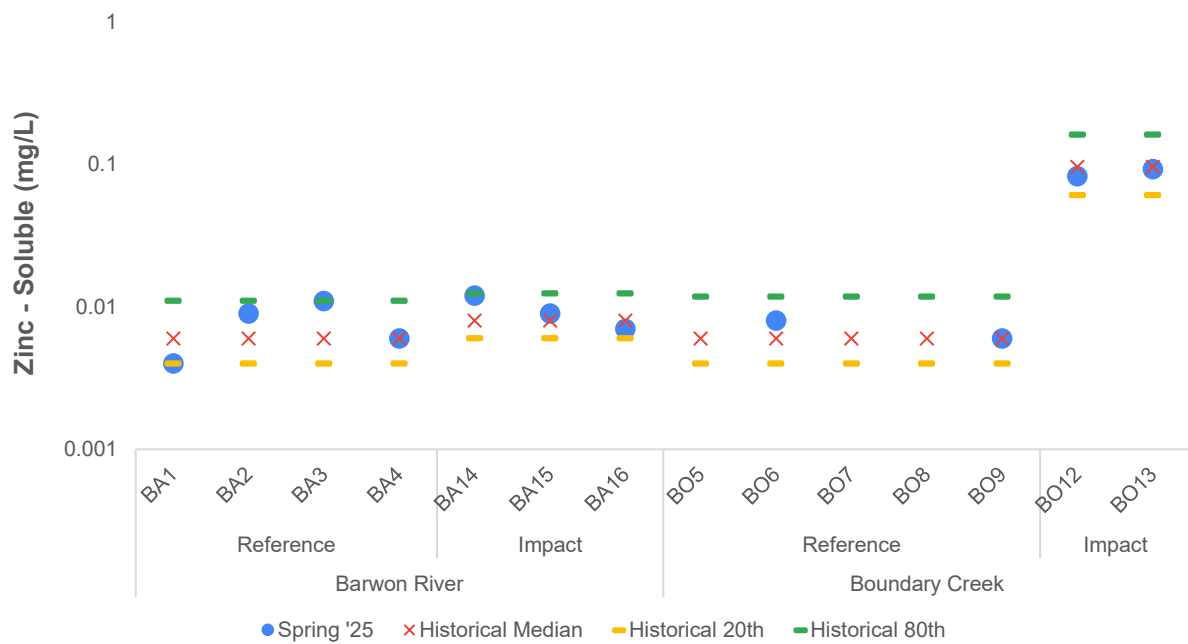


Figure 11: Graph of soluble zinc spring 2025 compared to historical data. Notes: Y-axis in logarithmic scale. Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

3.3. Habitat

Habitat data have not been described separately for Boundary Creek or the Barwon River as these data are descriptive and provide insight into the broader catchment conditions.

3.3.1. Substrate

Substrate composition varied among sites, with fine sediments dominating both waterways (Figure 12). At the Barwon River project reference sites (BA1–BA4), silt/clay was the dominant substrate (60–80%), followed by sand (approximately 15–30%), while coarse materials such as gravel, pebble, and cobble were present only in very low proportions ($\leq 5\%$). At the Barwon River impact sites (BA14–BA16), this pattern was more pronounced, with silt/clay comprising 80–90% and sand comprising 10–20% of the substrate. Coarse substrates were mostly absent from these sites.

The sampled Boundary Creek project reference sites, BO6 and BO9, had more mixed substrate compositions (Figure 12). Silt/clay accounted for approximately 50% at BO6 and 35% at BO9, while sand accounted for approximately 20% and 30%, respectively. BO9 also contained approximately 30% gravel. Boundary Creek impact sites (BO12, BO13) were dominated by fine substrates, with silt/clay ranging from 35–75% and sand from 10–30%. Iron floc was also observed and continues to be present at the impact sites on Boundary Creek.

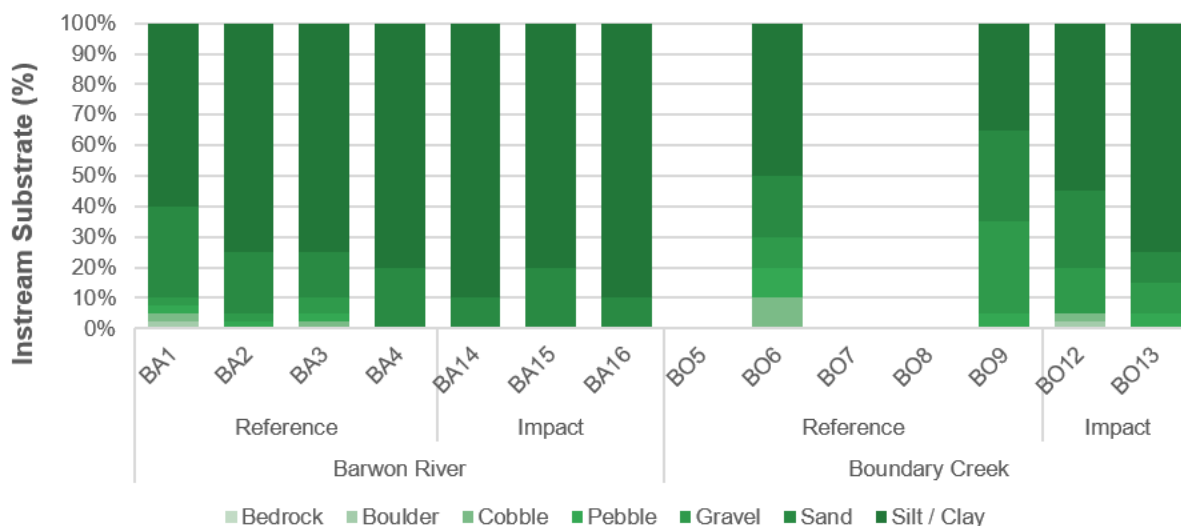


Figure 12: Instream substrate composition at Barwon River and Boundary Creek sampling sites. BO5, BO7, and BO8 do not contain results due to site access restrictions.

3.3.2. Large woody debris

Organic matter and large woody debris were consistently low across the study area, indicating limited structural complexity within both river systems (Figure 13). In the Barwon River project reference sites (BA1–BA4), coarse particulate organic matter (CPOM; <10 cm) ranged from 2.5–30%, with the highest contribution recorded at BA3. In contrast, large woody debris (>10 cm) was uniformly low (2.5%), which may indicate limited recruitment or retention of larger woody material within the channel.

At the Barwon River impact sites (BA14–BA16), CPOM remained low to moderate (2.5–12.5%), while large woody debris was similarly low at most sites (2.5%), with an isolated increase to 12.5% at BA16. Despite this increase, overall woody debris abundance remained limited.

In the Boundary Creek project reference sites surveyed in spring 2025 (BO6 and BO9), CPOM levels were 12.5% and 30%, indicating increased availability of smaller organic material. The Boundary Creek impact sites (BO12, BO13) exhibited moderate CPOM (12.5–30%) but consistently low large woody debris (2.5%). The widespread absence or low abundance of woody debris across both systems indicates reduced channel complexity, limited hydraulic variability, and a lack of stable in-stream habitat features, with likely implications for organic matter retention, geomorphic processes, and aquatic habitat availability (Figure 13).

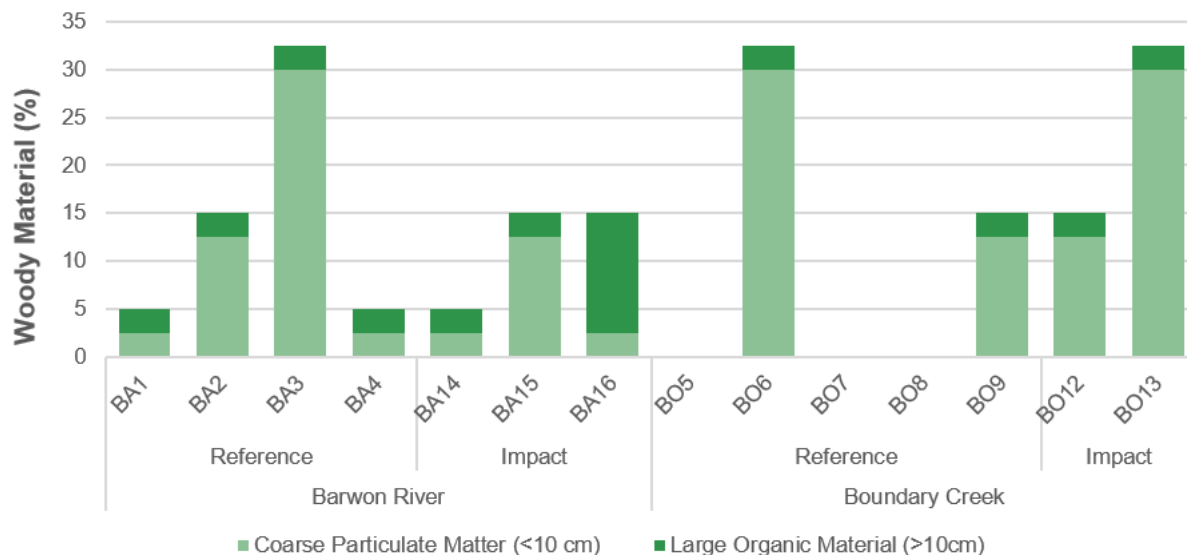


Figure 13: Woody debris composition at Barwon River and Boundary Creek sampling sites. BO5, BO7, and BO8 do not contain results due to site access restrictions.

3.3.3. Stream width

Stream width measurements across the Barwon River project reference sites (BA1–BA3) indicate relatively consistent channel dimensions at the upstream locations, with maximum widths ranging from 3 to 6 m and minimum widths between 2 and 3 m (Figure 14). A substantial increase in channel size was recorded at BA4, where widths ranged from 12 to 17 m, reflecting a transition to a broader channel form. Impact sites along the Barwon River (BA14–BA16) exhibited moderate variability, with maximum widths between 10 and 15 m and minimum widths from 4 to 7 m, suggesting stable but variable channel conditions.

Boundary Creek project reference sites generally exhibited channel widths comparable to the narrower upstream reaches of the Barwon River. In contrast, the downstream Boundary Creek impact sites (BO12 and BO13) were more constrained, with maximum widths between 2 and 2.5 m and minimum widths ranging from 1.25 to 2 m (Figure 14). These narrower dimensions likely reflect the modified, drain-like nature of Boundary Creek downstream of Big Swamp.

Overall, the results highlight morphological differences between the two systems, although these differences vary along their lengths. The Barwon River generally exhibited a wider and more variable channel, particularly at downstream and impact sites. While the upper reaches of Boundary Creek were broadly similar in width to the narrower upstream Barwon River sites, the downstream Boundary Creek reaches remained consistently constrained. These differences in channel form are likely to influence flow dynamics, habitat complexity, and ecological function across the study area.

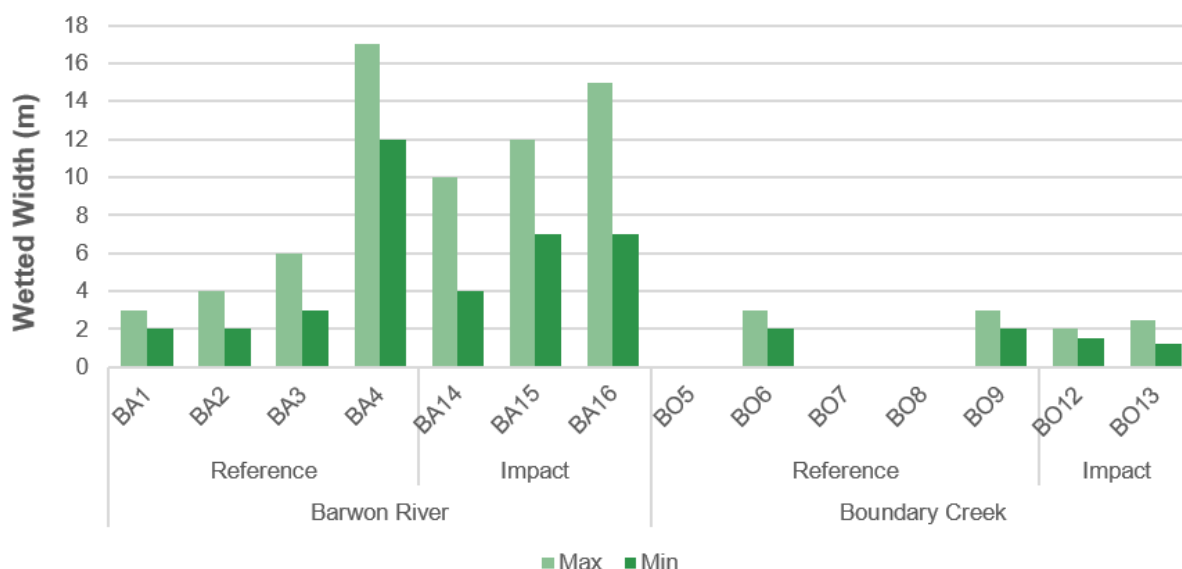


Figure 14: Stream width dimensions at Barwon River and Boundary Creek sampling sites. BO5, BO7, and BO8 contain no results because site accessibility issues during the sampling period prevented sampling from being undertaken.

3.3.4. Riparian shading

Riparian shading exhibited moderate variability across the study area, reflecting differences in vegetation structure and canopy cover (Figure 15). At the Barwon River project reference sites (BA1–BA4), shading ranged from 2.5% at BA2 to 15% at BA1, BA3 and BA4, indicating generally established riparian vegetation with some canopy gaps. A similar pattern occurred at impact sites (BA14–BA16), where shading remained high at BA14 and BA15 (15%) but declined at BA16 (2.5%), suggesting a discontinuity in riparian vegetation.

In Boundary Creek, the sampled project reference sites also showed variable shading, with 15% at BO6 and 32.5% at BO9. Shading was higher at the downstream impact sites, particularly BO12 (37.5%) and BO13 (62.5%), potentially reflecting their narrower channel form (Figure 15).

Overall, shading patterns highlighted a contrast between the generally broader, moderately shaded Barwon River and the narrower, more heavily shaded downstream reaches of Boundary Creek. These differences are likely to influence light availability, primary productivity, and thermal regimes, with higher shading potentially moderating water temperatures and limiting algal growth, while lower shading may enhance instream productivity but increase susceptibility to thermal variability.

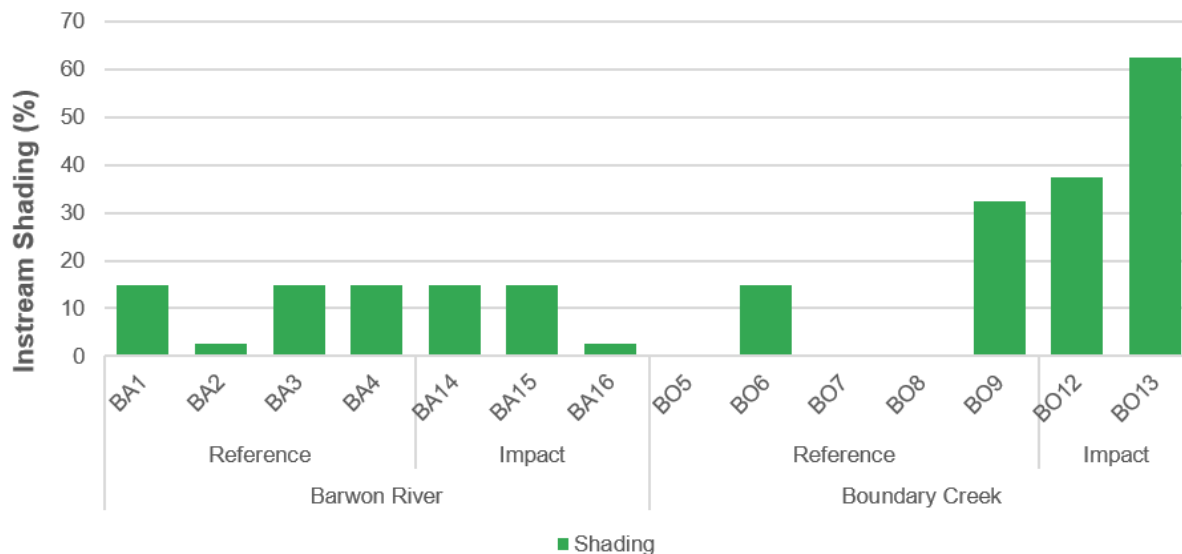


Figure 15: Proportion of instream shading at Barwon River and Boundary Creek sampling sites. BO5, BO7, and BO8 contain no results because site accessibility issues during the sampling period prevented sampling from being undertaken.

3.4. Macroinvertebrate indices

3.4.1. Boundary Creek

Macroinvertebrate indices in Boundary Creek were generally consistent with historical spring conditions, with taxa richness, EPT richness and SIGNAL2 scores remaining within the expected historical range for the sampled sites (Figure 16–Figure 19). Exceptions were taxon richness at BO9 and EPT richness and SIGNAL2 at BO13, which were above their respective historical 80th percentile range. Sampling was not undertaken at BO5, BO7 and BO8 because access restrictions prevented sampling during the monitoring period. Consequently, no current macroinvertebrate data were available for these sites.

AUSRIVAS edge habitat modelling (Table 6) classified BO6 and BO9 as Band A (similar to reference conditions), while BO12 and BO13 were classified as Band B (significantly impaired under the AUSRIVAS classification). Overall, the edge habitat results indicate generally good ecological condition, with evidence of moderate impairment at BO12 and BO13 relative to project reference expectations in line with the long-term dataset collected for the monitoring program.

3.4.2. Barwon River

Macroinvertebrate communities in the Barwon River remained generally consistent with historical spring conditions, with most biological indicators falling within the historical median 20th–80th percentile range (Figure 16–Figure 19). Taxa richness and EPT richness (Figure 16 and Figure 17) were broadly comparable between project reference and impact sites, indicating that overall community diversity and the richness of pollution-sensitive taxa were maintained during the spring 2025 survey. Scores for BA16 (the most downstream site in the Barwon River) were generally the lowest and suggest that additional catchment impacts not attributed to Boundary Creek inputs are present.

SIGNAL2 scores were also generally consistent with historical values, suggesting that the macroinvertebrate assemblages continued to be dominated by taxa indicative of good water quality. Minor variation between project reference and impact sites was evident but did not indicate a consistent decline associated with the impact downstream of Boundary Creek. SIGNAL2 scores for BA2 were the lowest recorded in the Barwon River in spring 2025 and further suggests that additional catchment impacts not attributed to Boundary Creek inputs are occurring.

AUSRIVAS edge habitat modelling classified BA1, BA2, BA3, BA4, BA14 and BA15 as Band A (similar to reference conditions), while BA16 was classified as Band B (significantly impaired under the AUSRIVAS classification) (Table 6). Overall, the edge habitat results indicate that macroinvertebrate communities remain in good ecological condition, with only minor evidence of impairment at BA16 which is the most downstream site and provides further data to suggest that additional catchment impacts not attributed to Boundary Creek inflows are occurring.

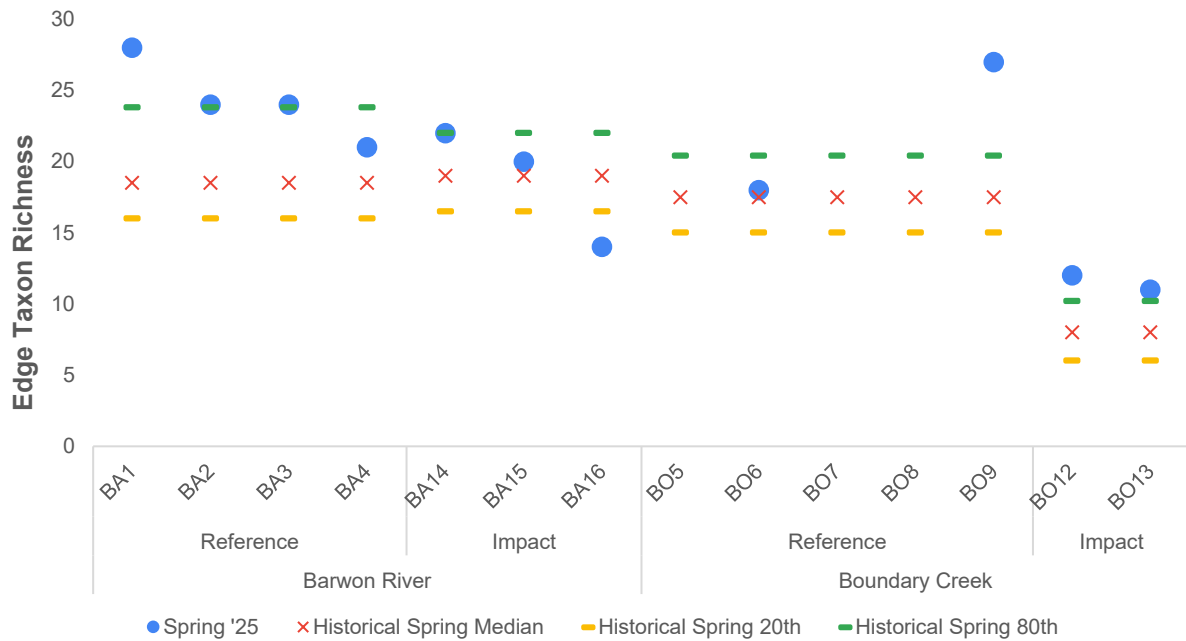


Figure 16: Graph of taxa richness spring 2025: edge habitat. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles for spring season. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

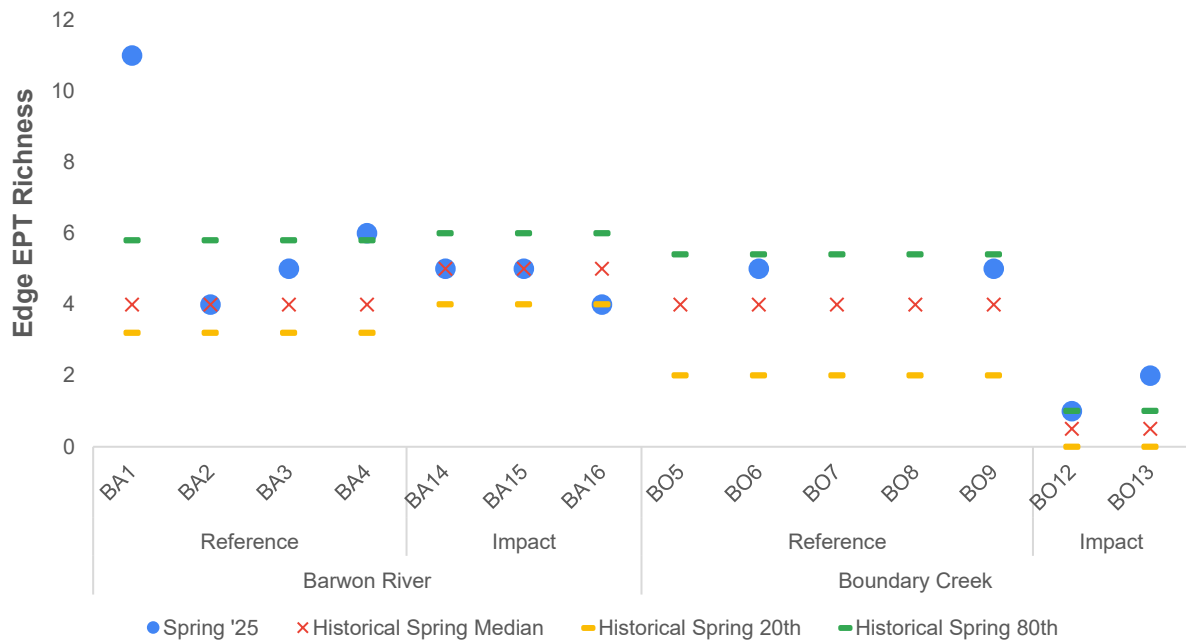


Figure 17: Graph of EPT richness spring 2025: edge habitat. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles for spring season. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

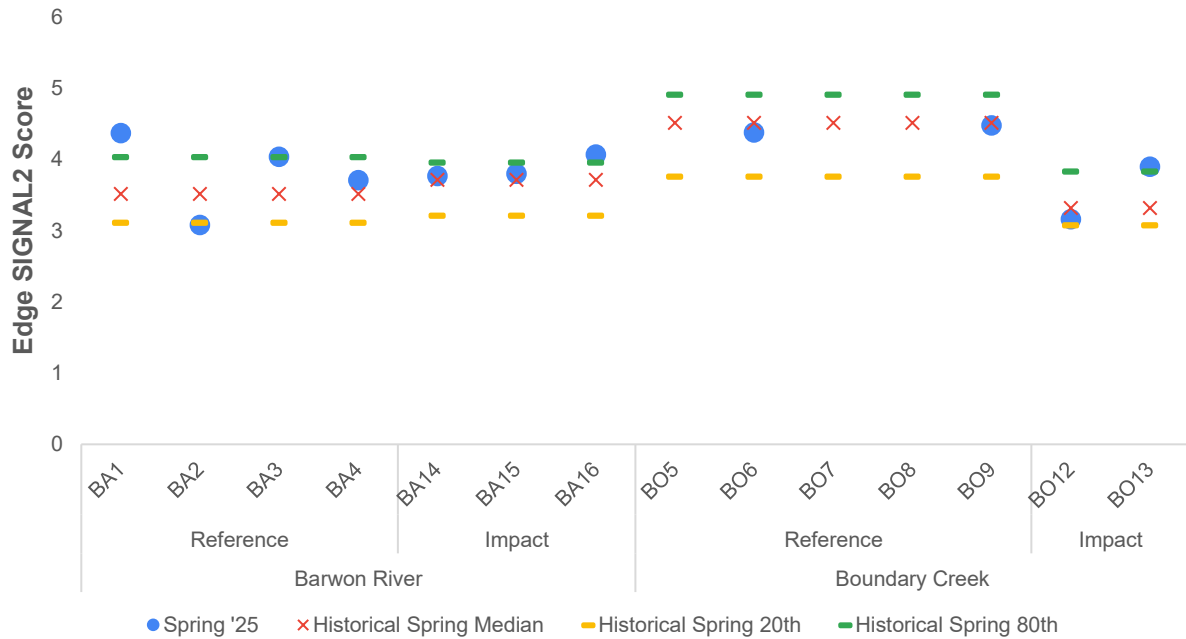


Figure 18: Graph of SIGNAL2 scores spring 2025: edge habitat. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles for spring season. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

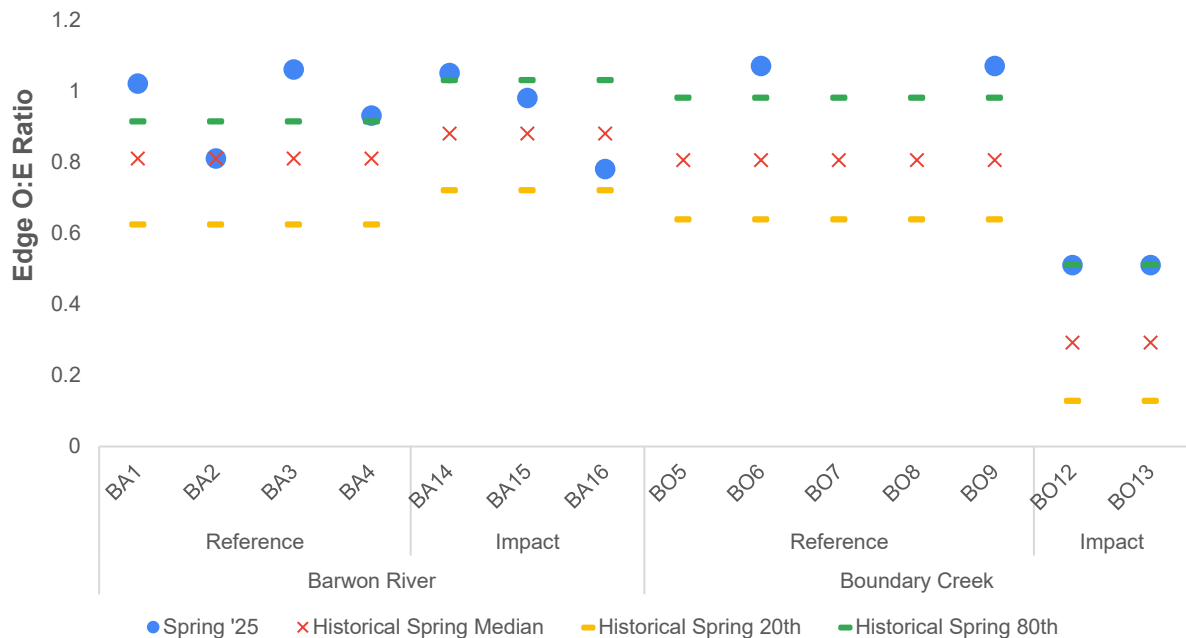


Figure 19: Graph of AUSRIVAS O/E50 scores spring 2025: edge habitat. Notes: Results are compared with historical data collected as part of the current monitoring program since 2019 and are summarised by the median and 20th–80th percentiles for spring season. BO5, BO7 and BO8 contain no results because site accessibility issues during the sampling period prevented sampling at these sites.

Table 6: Results from AUSRIVAS modelling: BO5, BO7, and BO8 contain no results because site accessibility issues during the sampling period prevented sampling from being undertaken.

Habitat	Barwon River							Boundary Creek						
	Reference			Impact				Reference			Impact			
	BA1	BA2	BA3	BA4	BA14	BA15	BA16	BO5	BO6	BO7	BO8	BO9	BO12	BO13
Edge	A	A	A	A	A	A	B	-	A	-	-	A	B	B

3.5. Macroinvertebrate analysis

The nMDS ordination indicated clear separation between project reference and impact sites in Boundary Creek, while the corresponding groups in the Barwon River showed partial separation with some overlap (Figure 20). Separation between site classifications was greater in Boundary Creek than in the Barwon River.

PERMANOVA (Table 7) identified significant differences in community composition between waterways (pseudo- $F_{1,7} = 8.608$, $p = 0.0003$) and site classifications (pseudo- $F_{1,7} = 2.753$, $p = 0.044$). A significant waterway $\times$ site-classification interaction was also detected (pseudo- $F_{1,7} = 3.945$, $p = 0.015$), indicating that differences between project reference and impact sites varied between waterways.

Results from the nMDS and PERMANOVA are not unexpected and further analysis and results are presented and discussed below for each waterway.

3.5.1. Barwon River

The nMDS ordination indicated that macroinvertebrate assemblages in the Barwon River differed between project reference and impact sites, with the two treatment groups forming two clusters with some overlap (Figure 20). The PERMANOVA pairwise comparison indicated that the difference between Barwon River project reference and impact sites was not statistically significant (pseudo- $F = 1.812$, $R^2 = 0.266$, $p = 0.0857$; Table 8).

Although the PERMANOVA comparison was not statistically significant, SIMPER was conducted and identified no taxa with statistically significant contributions to the average dissimilarity between project reference and impact sites (Appendix D, Table D3). Overall, the analyses provided limited statistical evidence of a difference in macroinvertebrate community composition between the two site classifications.

3.5.2. Boundary Creek

The nMDS ordination showed stronger separation between project reference and impact sites in Boundary Creek, with no overlap between treatment groups and greater dispersion among project reference sites (Figure 20).

The complete separation of groups in the ordination suggests substantial differences in community composition between project reference and impact sites, with impact sites supporting relatively homogeneous assemblages compared with the more variable communities observed at project reference sites. This pattern is consistent with environmental disturbance leading to reduced species diversity and an increase in the abundance of pollution- and/or disturbance-tolerant species.

The PERMANOVA pairwise comparison indicates that there were large but non-significant differences between the Boundary Creek project reference and impact sites (pseudo- $F = 3.432$, $R^2 = 0.632$, $p = 0.33$) (Table 8).

SIMPER identified Leptophlebiidae, Leptoceridae, Tanypodinae and Janiridae as the four largest contributors to differences between project reference and impact sites. Together, these taxa accounted for approximately 37% of the average dissimilarity between the groups (Table 9).

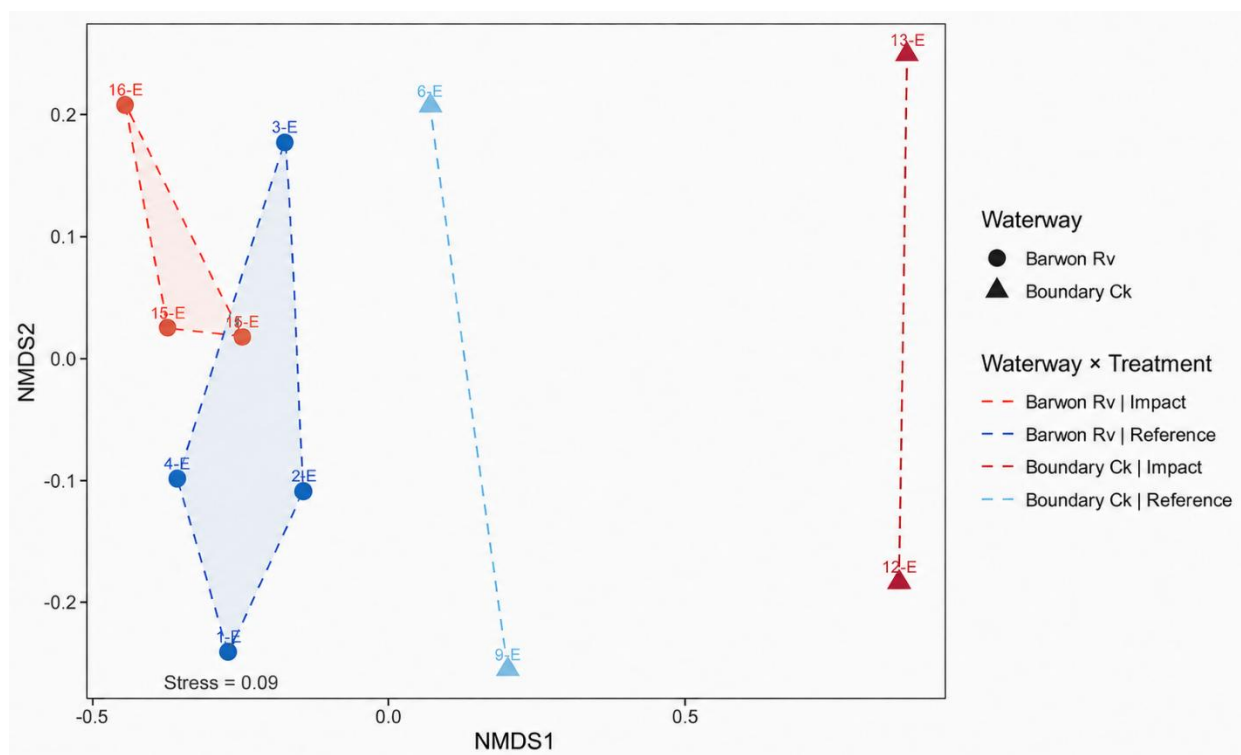


Figure 20: nMDS ordination plots spring 2025: edge habitat. Notes: Analysis based on Bray-Curtis dissimilarity; convex hulls by Waterway x Treatment

Table 7: Results from PERMANOVA Analysis – Edge Habitat

Source of Variation (source)	Degrees of Freedom (df)	Sum of Squares (SumSqs)	Proportion of Variance (R^2)	F-Statistic (F)	p-value (P)
Treatment	1	0.142	0.123	2.753	0.044
Waterway	1	0.446	0.385	8.608	0.0003
Treatment X Waterway	1	0.204	0.176	3.945	0.015
Residual	7	0.362	0.313		
Total	10	1.156	1.000		

Table 8: Pairwise Comparisons – Edge Habitat

Comparison	F	R^2	p
Barwon Rv Reference vs Boundary Ck Reference	2.82648	0.414046	0.066667
Barwon Rv Reference vs Boundary Ck Impact	8.657742	0.683988	0.046667
Barwon Rv Reference vs Barwon Rv Impact	1.811534	0.265951	0.085714
Boundary Ck Reference vs Boundary Ck Impact	3.431727	0.631793	0.333333
Boundary Ck Reference vs Barwon Rv Impact	3.649602	0.548845	0.1
Boundary Ck Impact vs Barwon Rv Impact	10.37815	0.775754	0.1

Table 9: Results from Boundary Creek SIMPER Analysis - Edge Habitat - Treatment x Waterway Interaction*

Contrast	Taxon	Mean A	Mean B	Contribution %	p-value
BO Ref vs BO Imp	Leptophlebiidae	22.000	0.000	15.602	0.002
BO Ref vs BO Imp	Leptoceridae	15.500	1.000	10.471	0.002
BO Ref vs BO Imp	Tanypodinae	12.500	2.500	6.619	0.031
BO Ref vs BO Imp	Janiridae	0.000	6.000	4.460	0.006
BO Ref vs BO Imp	Dixidae	4.500	0.500	2.911	0.005
BO Ref vs BO Imp	Synlestidae	3.000	0.000	1.886	0.008
BO Ref vs BO Imp	Koonungidae	0.000	2.500	1.739	0.040
BO Ref vs BO Imp	Temnocephala	2.000	0.000	1.675	0.009
BO Ref vs BO Imp	Elmidae	2.000	0.000	1.675	0.018
BO Ref vs BO Imp	Hydrobiidae	2.000	0.000	1.675	0.009
BO Ref vs BO Imp	Hydrophilidae	1.500	0.000	0.943	0.005
BO Ref vs BO Imp	Hydrobiosidae	1.000	0.000	0.837	0.015
BO Ref vs BO Imp	Haplidae	0.500	0.000	0.419	0.009

Notes: *Only comparisons with significant *p-value* ($\alpha = 0.05$) are displayed, full results are presented in Appendix D; the SIMPER analysis identified several taxa contributing significantly to differences between Boundary Creek reference and impacted edge habitats. Interpreting these results in the context of taxa ecology provides insight into likely impact pathways and ecological responses.

4. Discussion

4.1. Site hydrology

Hydrological data from Boundary Creek below Big Swamp (BOM #233276) show clear seasonal and interannual variability. Water levels were generally higher during winter prior to spring surveys and lower during summer preceding autumn surveys. The lowest water levels occurred in summer 2019/20, while the highest within the monitoring period were recorded in summer 2022/23. In contrast, water levels were comparatively low during autumn 2024 and 2025, and winter 2024, reflecting recent dry climatic conditions. These hydrological patterns are likely to influence water quality and habitat availability, particularly at downstream impact sites, where reduced flows may increase environmental stress through limited dilution capacity and reduced habitat connectivity.

Sampling was undertaken within seasonal windows consistent with previous spring surveys, supporting comparisons with historical spring data since 2019. At the time of the spring 2025 survey, flows had receded from the peaks recorded between August and November but remained higher than the very low flows recorded during late summer and autumn 2025. During 2024–2025, approximately 233 ML of supplementary flow was released into upper Boundary Creek between 5 November 2024 and 11 June 2025 (Barwon Water 2025), with releases recommencing on 23 December 2025, after the survey, as part of the REPP. Notably, Barwon Water did not release supplementary flows into upper Boundary Creek before or during the survey due to private-land access constraints that prevented these occurring sooner.

4.2. *In-situ* water quality

Current water quality results were interpreted relative to site-specific historical conditions from the monitoring program, with the relevant Victorian ERS objectives provided for context. Accordingly, the comparisons indicate relative differences and changes in water quality among sites and surveys, rather than whether individual sites complied with the ERS objectives.

In-situ water quality generally remained within the long-term range that has been recorded at sites during the current monitoring program since 2019 and show ongoing impacts to Boundary Creek downstream of Big Swamp. Notable results included elevated pH (indicating more alkaline conditions) at BA1 and elevated turbidity at BA2 and the upstream Barwon River sites. Elevated turbidity may reflect localised catchment activities such as stock access; however, the cause of elevated pH levels is less easily explained. While the levels observed were only slightly above the 80th percentile, they should be considered during future monitoring.

Alkalinity results from the current survey align with longer term trends. Barwon River sites exhibited moderate buffering capacity (40–60 mg/L), consistent with values recorded since autumn 2020. In contrast, alkalinity in Boundary Creek downstream of Big Swamp remained low (20 mg/L), indicating a limited capacity to neutralise acidic inputs. These results reinforce the

ongoing vulnerability of downstream reaches to acidification, particularly under low-flow or drying conditions.

4.3. Habitat condition

Habitat characteristics varied between the Barwon River and Boundary Creek and among sites within each waterway. Fine sediments dominated the substrate at most sites, while large woody debris was generally limited, indicating limited structural complexity associated with substrate and woody material. Iron floc was also present at the Boundary Creek impact sites, potentially reducing substrate quality for benthic biota. Boundary Creek downstream of Big Swamp was narrower and more heavily shaded than the sampled upstream reaches. These habitat differences may have contributed to variation in macroinvertebrate communities and should be considered alongside water quality differences when interpreting patterns between project reference and impact sites. Notably, the spring 2025 habitat assessment represents conditions at a single point in time and does not establish whether habitat condition has changed during the monitoring program.

4.4. Ecological condition

4.4.1. Boundary Creek

Overall, the spring 2025 water quality and macroinvertebrate results were generally within the site-specific historical ranges and did not indicate a clear improvement or deterioration relative to previous spring surveys. However, the established downstream contrast persisted in Boundary Creek.

Ecological condition remained poorer at impact sites BO12 and BO13 downstream of Big Swamp, consistent with the pattern reported throughout the monitoring program. Both sites remained classified as Band B (significantly impaired) under AUSRIVAS. This gradient reflects the cumulative influence of multiple stressors, including strongly acidic conditions, increasing conductivity, elevated concentrations of soluble metals, accumulation of fine sediments and a general reduction in habitat complexity. The observed pattern is consistent with the continuing influence of acidity and metals associated with ASS in Big Swamp, together with other catchment and habitat pressures.

The sampled project reference sites in Boundary Creek generally supported more diverse macroinvertebrate communities, higher taxon and EPT richness and higher SIGNAL2 and AUSRIVAS O/E scores, consistent with relatively intact water quality and stable habitat conditions. BO6 and BO9 were classified as AUSRIVAS Band A, indicating assemblages similar to AUSRIVAS reference conditions.

The long-term pattern of differences between project reference sites and impact sites in Boundary Creek, based on the macroinvertebrate indices from the monitoring program, was also reflected in differences at the taxonomic level.

Several sensitive taxa were more abundant at the Boundary Creek project reference sites, including Leptophlebiidae (mayflies), Leptoceridae (long-horned caddisflies), odonates (dragonflies) and Hydrobiosidae (caddisflies). These taxa are generally sensitive to changes in water quality and habitat condition and are typically associated with well-oxygenated environments and stable substrates. Many also function as grazers or shredders reliant on high-quality organic matter inputs. Their reduced abundance at impact sites indicates a decline in habitat quality, likely linked to sedimentation, poorer water quality, particularly low pH and the associated soluble metal concentrations resulting from ASS.

In contrast, taxa that were more abundant at Boundary Creek impact sites, such as Chironomidae, Acarina and Oligochaeta are generally more tolerant of disturbance and poorer water quality and can persist under elevated sediment loads or organic enrichment.

The additional multivariate analyses provided further exploratory information on this established spatial pattern. Multivariate analyses, including nMDS ordination, PERMANOVA and SIMPER, further indicated that the macroinvertebrate assemblages at impact sites were compositionally distinct from those at the project reference sites, with greater representation of tolerant taxa and reduced representation of several sensitive taxa. At the broader spatial scale, PERMANOVA also identified a significant difference in macroinvertebrate community composition between Boundary Creek and the Barwon River, accompanied by differences in the abundance of several prominent taxa and likely reflecting waterway-specific environmental and habitat conditions.

While there was a clear separation between the project reference and impact sites in the nMDS ordination, the pairwise PERMANOVA analysis found no statistically significant difference between the project reference and impact sites in Boundary Creek. The lack of a statistically significant result may be due to low statistical power resulting from the limited number of project reference sites sampled in spring 2025 and the collection of only a single edge sample at each site.

Despite the lack of a statistically significant result within Boundary Creek pairwise result, the combined evidence from water quality, macroinvertebrate indices, AUSRIVAS classifications and other multivariate analyses suggest ongoing downstream ecological degradation linked to the historical disturbance, which continues to be a source of poor-quality water associated with the flushing of acidity and metals from ASS in Big Swamp.

4.4.2. Barwon River

Ecological conditions in the Barwon River generally declined at sites located along the flow path based on data collected in spring 2025. This gradient reflects the cumulative influence of multiple stressors and was evident in increasing conductivity, a pattern commonly observed in Australian lowland rivers (Lintern et al., 2018). However, turbidity varied among sites and did not display a consistent downstream pattern. Overall, most water quality measurements and macroinvertebrate indices at the impact sites remained within their site-specific historical ranges.

In addition to the spatial patterns in conductivity and turbidity, soluble-metal concentrations, particularly aluminium, varied among Barwon River sites. Aluminium concentrations at some impact sites were above their site-specific historical medians but remained within the long-term ranges recorded during the monitoring program. Although soluble-metal concentrations have generally remained elevated at the impact sites, aluminium at project reference sites BA2 and BA3 was above the historical 80th percentile in Spring 2025. Consequently, the spring 2025 results do not demonstrate a simple downstream metal gradient attributable solely to Boundary Creek. The cause of the elevated concentrations at BA2 and BA3 could not be determined from the available data, although prolonged dry conditions within the catchment may have contributed.

Project reference and impact sites in the Barwon River broadly supported similar macroinvertebrate communities, with lower values for some indices at BA16, the most downstream site in the Barwon River. The nMDS ordination showed some separation between project reference and impact sites; however, the pairwise PERMANOVA comparison did not detect a statistically significant difference in macroinvertebrate community composition.

Some downstream differences in conductivity and soluble-metal concentrations indicate a potential influence of Boundary Creek on Barwon River water quality. However, the magnitude of this influence varied among sites and indicators and no statistically significant difference in macroinvertebrate community composition was detected between Barwon River project reference and impact sites. The spring 2025 results therefore demonstrate a water quality influence from Boundary Creek but not a statistically detectable macroinvertebrate response in the Barwon River.

5. Conclusion

Multiple lines of evidence from spring 2025, including *in-situ* water quality, soluble-metal concentrations, habitat condition, and macroinvertebrate community structure, indicate that Boundary Creek impact sites BO12 and BO13 remain classified as significantly impaired under AUSRIVAS compared with the upstream project reference sites. However, the elevated soluble-metal concentrations observed at some Boundary Creek project reference sites cannot readily be explained and should be closely monitored during future surveys.

Macroinvertebrate indices suggest that assemblages at the project reference and impact sites in Boundary Creek differed, with a decline in pollution-sensitive taxa at the impact sites. However, the within-Boundary Creek pairwise PERMANOVA comparison was not statistically significant. The lack of statistical significance in this comparison may be attributed to low replication in the spring 2025 dataset, as only a single edge sample was collected at each site, and reduced project reference site coverage because some sites were inaccessible.

The additional multivariate analyses provided useful information beyond the requirements of the REPP. The nMDS ordination helped visualise broad patterns in macroinvertebrate community composition, while PERMANOVA tested differences between waterways and between project reference and impact sites. However, the ability of these analyses to detect within waterway differences was limited by incomplete project reference site coverage and low sampling replication. nMDS and PERMANOVA should therefore be continued where consistent site coverage, and adequate sampling replication can be achieved. SIMPER should be used selectively to identify taxa contributing to observed differences and interpreted as an exploratory analysis rather than as independent evidence of an ecological effect.

While active management has likely mitigated some impacts, the ongoing flushing of acidity and metals from ASS within Big Swamp continues to influence the ecological condition of the lower reaches of Boundary Creek. Overall, the spring 2025 results were generally within the site-specific historical ranges and did not indicate a clear improvement or deterioration relative to previous spring surveys.

Data from this assessment demonstrate a gradient of poorer ecological condition along the Barwon River, in line with patterns observed in other waterways affected by human activities and catchment land-use practices, although a consistent downstream decline was not evident across all indicators. The data presented indicate that the impact sites on the Barwon River were generally within the long-term ranges recorded for the monitoring program across a broad range of indicators (i.e. *in-situ* water quality, soluble metals and macroinvertebrate indices).

Macroinvertebrate communities in the Barwon River remained relatively consistent upstream and downstream of the Boundary Creek confluence, indicating that impacts from Boundary Creek did not have a measurable effect on the Barwon River under the current conditions recorded during the spring 2025 survey. Changes in ecological condition along the flow path may primarily reflect

broader catchment-scale pressures along the Barwon River, including land use intensification, altered flow regimes, and a drying climate.

5.1. Recommendations

Based on the current survey results, the following recommendations are made:

- 1) While the within-waterway pairwise statistical analyses of the spring 2025 dataset did not return any statistically significant results, possibly because of low statistical power and replication, the analyses should be repeated during future sampling events to determine whether the selected analytical methods are suitable for the monitoring program dataset.
- 2) Obtaining access to the additional Boundary Creek project reference sites should be a priority. Where continued access cannot be secured, suitable alternative project reference sites should be identified to maintain spatial coverage and adequate representation of upstream conditions.
- 3) Default environmental protection guideline values relating to water quality, soluble metals and macroinvertebrate indices are rarely achieved at sites included in the monitoring program. The various guideline values are acknowledged; however, for the purpose of monitoring change, the data collected under the current monitoring program have been used to establish historical medians and 20th–80th percentile ranges for each site for use as benchmarks. The use of these site- or region-specific benchmarks will provide a more realistic and ecologically meaningful basis for assessing ecological condition and temporal change in Boundary Creek and the Barwon River. The relevant environmental protection guideline values should continue to be provided for context, and the historical ranges should not be interpreted as replacement ecological objectives because they may represent already degraded conditions.

5.2. Potential future analysis

- 4) Analysis of the complete long-term monitoring dataset could be explored to quantify relationships between macroinvertebrate communities and environmental variables, including flow, rainfall, pH, conductivity, soluble-metal concentrations and habitat condition. Appropriate methods could include, where suitable, classification and regression tree (CART) analysis and mixed-effects models to identify influential variables and potential ecological thresholds, and constrained ordination methods, such as redundancy analysis (RDA) or distance-based redundancy analysis (dbRDA), to assess multivariate relationships between environmental variables and community composition. The suitability and usefulness of these analyses could be assessed as part of the planned 2028/2029 detailed review, particularly in relation to the monitoring program objectives and assessment of whether successful remediation has been achieved.

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Appendix A: Site Photos

Site BA1



Downstream



Upstream

Site BA2



Downstream



Upstream

Site BA3



Downstream



Upstream

Site BA4



Downstream



Upstream

Site BA14



Downstream



Upstream

Site BA15



Downstream



Upstream

Site BA16



Downstream



Upstream

Site BA16



Downstream (additional)



Upstream (additional)

Site BO5



Site BO6



Downstream



Upstream

Site BO7

No site photos available. Could not be sampled/accessed during the sampling event

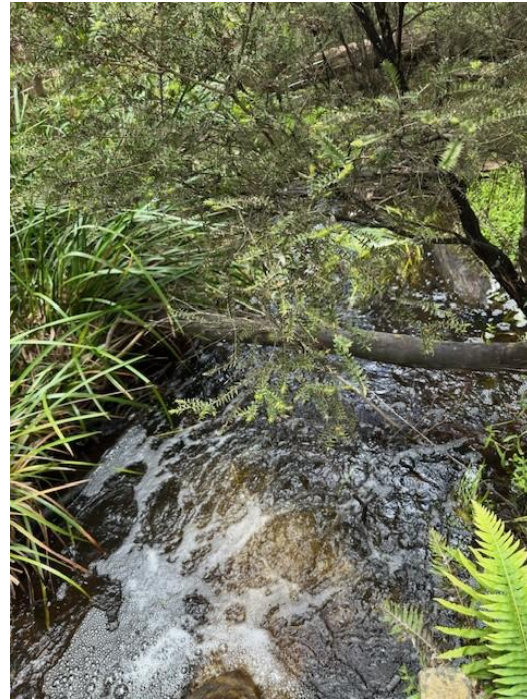
Site BO8

No site photos available. Could not be sampled/accessed during the sampling event

Site BO9



Downstream



Upstream

Site BO12



Downstream



Upstream



Downstream (additional)



Downstream (additional)

Site BO13

No site photos available.

Appendix B: Water Quality

Table B1: Water quality Environmental Reference Standards (EPA March 2022).

	TP (µg/L)	TN (µg/L)	DO %sat		Turb (NTU)	SPC (µS/cm)	pH	(pH units)	Toxicants in water
	75percentile	75percentile	25percentile	Max	75percentile	75percentile	25percentile	75percentile	% protection
Lower Barwon (slightly to moderately modified)	≤60	≤1,100	≥70	130	≤25	≤2,000	≥6.8	≤8.0	95
Otway Ranges	≤25	≤650	≥85	130	≤10	≤200	≥6.5	≤7.5	95

Table B2: Summary of raw *in situ* water quality data

Site Code	Time (24 h)	Temp (°C)	pH	SPC (µS/cm)	DO (% sat)	Turbidity (NTU)	Alkalinity (mg/L)
BA1	09:00	12.1	7.57	109.8	92.9	19.5	40
BA2	15:30	16.8	7.26	217.7	87.5	30.4	40
BA3	12:25	13.2	7.02	167.4	79.1	16.1	40
BA4	10:40	15.6	6.72	239.1	56.0	20.3	40
BA14	12:00	15	6.6	277	59.2	8.95	60
BA15	13:00	17.1	6.75	295	66.5	21.4	60
BA16	15:20	18.6	7.12	339.4	86.2	25.3	40
BO5	Could not be sampled/accessed during the sampling event						
BO6	09:00	10.4	6.71	307.3	74.8	15.3	40
BO7	Could not be sampled/accessed during the sampling event						
BO8	Could not be sampled/accessed during the sampling event						
BO9	11:30	13.8	6.92	368.1	76.9	5.22	<20
BO12	14:30	14.6	3.74	489.2	77.2	5	<20
BO13	10:00	13.7	3.36	655	69.4	7.32	<20

Table B3: Summary of raw laboratory water quality data

Site Code	Aluminium Soluble (mg/L)	Iron Soluble (mg/L)	Zinc Soluble (mg/L)
BA1	0.020	0.300	0.004
BA2	0.300	0.390	0.009
BA3	0.080	0.620	0.011
BA4	0.020	0.400	0.006
BA14	0.080	0.320	0.012
BA15	0.070	0.410	0.009
BA16	0.050	0.320	0.007
BO5	Could not be sampled/accessed during the sampling event		
BO6	0.100	0.860	0.008
BO7	Could not be sampled/accessed during the sampling event		
BO8	Could not be sampled/accessed during the sampling event		
BO9	0.050	1.000	0.006
BO12	2.000	6.000	0.083
BO13	2.300	2.100	0.093

Appendix C: Raw Data – Macroinvertebrates

Table C1: Summary of Raw Macroinvertebrate Community Data – Edge Habitat

Taxa	BA1	BA2	BA3	BA4	BA14	BA15	BA16	BO6	BO9	BO12	BO13
Acarina		17	15		2	14	9	12	7	7	
Temnocephala									4		
Koonungidae										4	1
Janiridae						1				5	7
Oligochaeta	1	1			1	1					
Collembola		1			2					1	
Dugesiiidae		4		4		5					
Chiltoniidae	14	8	2	10	47	5	4	12	2		
Atyidae	18	9	20	22	6	12	11				
Parastacidae									1		1
Leptophlebiidae	5	10	17	5	8	11	2	27	17		
Caenidae	2			3							
Baetidae	7	1	1	15	14	1	4	7			
Oniscigastridae	1			2		5					
Calamoceratidae			3					2			
Leptoceridae	19	9	10	3	4	2	1	17	14	1	1
Hydrobiosidae	1								2		
Hydroptilidae	1	9	4	24	10	5	5				
Atriplectididae	1										
Ecnomidae	1										
Gripopterygidae	30				1			6	5		
Notonemouridae	3								1		1
Elmidae			2						4		
Scirtidae			5				1		2		
Dyticidae	15	9	3	4	4	1		9	2	11	11
Gyrinidae				3	11	2					
Haplidae									1		
Hydrophilidae								3			
Corixidae	36	21	4	36	13	31	21	4	1		
Gerridae			3								
Veliidae	1	2	6	2				2	5	3	4
Notonectidae	1	4								2	
Pleidae		1									
Synlestidae			1					6			
Coengrionidae	4	23	2	10	12	7	1				
Hemicorduliidae	1	2		2	4	4			3		
Aeshnidae	1	8	2		1				1		
Physidae	6	12	2	14	14	16	9	1	3		
Planorbidae			2		10			2	1		
Lymnaeidae		2	1	12							
Hydrobiidae									4		

Taxa	BA1	BA2	BA3	BA4	BA14	BA15	BA16	BO6	BO9	BO12	BO13
Chironominae	15	27	7	25	18	25	4	32	20	39	9
Tanypodinae	3	15	4		4	2		19	6	2	3
Orthocladinae	62		8	52	40	23	34	15	7		6
Ceratopogonidae	2	3	1	1					1		
Simuliidae	5			5	11		1		2		
Tipulidae	1										1
Culcidae		1							1	4	
Dixidae								5	4	1	

Note: Blank cells represent zero observations.

Appendix D: SIMPER Analysis Results

Table D1: SIMPER Analysis Results: Edge habitat – Treatment Main Effect

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Reference Impact	Orthocladinae	0.073	0.050	1.456	24.000	20.6	0.118	0.792
Reference Impact	Corixidae	0.051	0.038	1.327	17.000	13	0.200	0.833
Reference Impact	Chironominae	0.045	0.036	1.226	21.000	19	0.272	0.801
Reference Impact	Leptophlebiidae	0.041	0.036	1.136	13.500	4.2	0.338	0.032
Reference Impact	Chiltoniidae	0.037	0.033	1.102	8.000	11.2	0.398	0.386
Reference Impact	Leptoceridae	0.036	0.021	1.679	12.000	1.8	0.456	0.004
Reference Impact	Atyidae	0.033	0.028	1.174	11.500	5.8	0.511	0.306
Reference Impact	Acarina	0.024	0.021	1.187	8.500	6.4	0.550	0.593
Reference Impact	Physidae	0.023	0.015	1.499	6.333	7.8	0.587	0.685
Reference Impact	Tanypodinae	0.022	0.022	0.998	7.833	2.2	0.623	0.121
Reference Impact	Coengrionidae	0.022	0.024	0.915	6.500	4	0.658	0.734
Reference Impact	Gripopterygidae	0.020	0.029	0.693	6.833	0.2	0.691	0.164
Reference Impact	Hydroptilidae	0.020	0.020	0.996	6.333	4	0.724	0.768
Reference Impact	Dyticidae	0.019	0.015	1.286	7.000	5.4	0.755	0.594
Reference Impact	Baetidae	0.017	0.014	1.176	5.167	3.8	0.783	0.692
Reference Impact	Janiridae	0.011	0.013	0.798	0.000	2.6	0.800	0.083
Reference Impact	Simuliidae	0.009	0.009	1.051	2.000	2.4	0.815	0.548
Reference Impact	Veliidae	0.009	0.006	1.401	3.000	1.4	0.830	0.200
Reference Impact	Lymnaeidae	0.007	0.012	0.598	2.500	0	0.841	0.326
Reference Impact	Planorbidae	0.007	0.008	0.870	0.833	2	0.853	0.332
Reference Impact	Gyrinidae	0.007	0.010	0.698	0.500	2.6	0.864	0.573
Reference Impact	Aeshnidae	0.007	0.009	0.720	2.000	0.2	0.875	0.111

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Reference Impact	Hemiscorduliidae	0.006	0.005	1.235	1.333	1.6	0.885	0.362
Reference Impact	Dixidae	0.006	0.008	0.747	1.500	0.2	0.894	0.192
Reference Impact	Dugesidae	0.005	0.007	0.813	1.333	1	0.903	0.638
Reference Impact	Scirtidae	0.005	0.008	0.640	1.167	0.2	0.911	0.202
Reference Impact	Ceratopogonidae	0.004	0.003	1.390	1.333	0	0.918	0.004
Reference Impact	Elmidae	0.004	0.007	0.612	1.000	0	0.925	0.090
Reference Impact	Synlestidae	0.004	0.008	0.527	1.167	0	0.932	0.270
Reference Impact	Koonungidae	0.004	0.006	0.635	0.000	1	0.938	0.335
Reference Impact	Culcidae	0.004	0.006	0.669	0.333	0.8	0.945	0.671
Reference Impact	Oniscigastridae	0.004	0.005	0.690	0.500	1	0.951	0.648
Reference Impact	Notonectidae	0.003	0.005	0.721	0.833	0.4	0.956	0.883
Reference Impact	Calamoceratidae	0.003	0.005	0.624	0.833	0	0.961	0.135
Reference Impact	Temnocephala	0.003	0.007	0.422	0.667	0	0.966	0.300
Reference Impact	Hydrobiidae	0.003	0.007	0.422	0.667	0	0.971	0.300
Reference Impact	Notonemouridae	0.002	0.003	0.783	0.667	0.2	0.975	0.785
Reference Impact	Caenidae	0.002	0.003	0.660	0.833	0	0.978	0.263
Reference Impact	Gerridae	0.002	0.005	0.423	0.500	0	0.982	0.326
Reference Impact	Hydrobiosidae	0.002	0.003	0.560	0.500	0	0.985	0.182
Reference Impact	Collembola	0.002	0.002	0.869	0.167	0.6	0.988	0.638
Reference Impact	Hydrophilidae	0.002	0.004	0.428	0.500	0	0.990	0.417
Reference Impact	Oligochaeta	0.001	0.002	0.894	0.333	0.4	0.993	0.884
Reference Impact	Parastacidae	0.001	0.002	0.622	0.167	0.2	0.995	0.840
Reference Impact	Tipulidae	0.001	0.002	0.590	0.167	0.2	0.997	0.719
Reference Impact	Haplidae	0.001	0.002	0.422	0.167	0	0.998	0.300
Reference Impact	Pleidae	0.001	0.001	0.429	0.167	0	0.999	0.483
Reference Impact	Atriplectididae	0.000	0.001	0.432	0.167	0	0.999	0.527
Reference Impact	Ecnomidae	0.000	0.001	0.432	0.167	0	1.000	0.527

Table D2: SIMPER analysis results – Edge habitat – waterway main effect

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Boundary Ck	Orthocladinae	0.089	0.060	1.475	31.286	7.000	0.128	0.071
Barwon Rv Boundary Ck	Corixidae	0.075	0.040	1.870	23.143	1.250	0.235	0.014
Barwon Rv Boundary Ck	Chironominae	0.050	0.043	1.183	17.286	25.000	0.307	0.326
Barwon Rv Boundary Ck	Atyidae	0.050	0.024	2.050	14.000	0.000	0.378	0.002
Barwon Rv Boundary Ck	Leptophlebiidae	0.037	0.024	1.558	8.286	11.000	0.432	0.124
Barwon Rv Boundary Ck	Chiltoniidae	0.037	0.042	0.877	12.857	3.500	0.485	0.382
Barwon Rv Boundary Ck	Physidae	0.033	0.018	1.800	10.429	1.000	0.532	0.011
Barwon Rv Boundary Ck	Coengrionidae	0.027	0.024	1.144	8.429	0.000	0.571	0.079
Barwon Rv Boundary Ck	Hydroptilidae	0.027	0.020	1.393	8.286	0.000	0.611	0.025
Barwon Rv Boundary Ck	Acarina	0.026	0.021	1.206	8.143	6.500	0.648	0.359
Barwon Rv Boundary Ck	Leptoceridae	0.026	0.019	1.353	6.857	8.250	0.685	0.354
Barwon Rv Boundary Ck	Dyticidae	0.022	0.018	1.252	5.143	8.250	0.717	0.090
Barwon Rv Boundary Ck	Tanypodinae	0.020	0.019	1.081	4.000	7.500	0.746	0.243
Barwon Rv Boundary Ck	Baetidae	0.019	0.016	1.215	6.143	1.750	0.773	0.202
Barwon Rv Boundary Ck	Gripopterygidae	0.018	0.027	0.689	4.429	2.750	0.799	0.432
Barwon Rv Boundary Ck	Janiridae	0.013	0.014	0.898	0.143	3.000	0.817	0.076
Barwon Rv Boundary Ck	Veliidae	0.010	0.006	1.546	1.571	3.500	0.832	0.047
Barwon Rv Boundary Ck	Simuliidae	0.010	0.011	0.890	3.143	0.500	0.845	0.426
Barwon Rv Boundary Ck	Dixidae	0.008	0.006	1.222	0.000	2.500	0.856	0.071
Barwon Rv Boundary Ck	Gyrinidae	0.007	0.011	0.606	2.286	0.000	0.866	0.363
Barwon Rv Boundary Ck	Lymnaeidae	0.006	0.012	0.544	2.143	0.000	0.875	0.375
Barwon Rv Boundary Ck	Planorbidae	0.006	0.010	0.662	1.714	0.750	0.885	0.466
Barwon Rv Boundary Ck	Dugesidae	0.006	0.008	0.801	1.857	0.000	0.894	0.279
Barwon Rv Boundary Ck	Hemicorduliidae	0.006	0.005	1.134	1.857	0.750	0.902	0.325
Barwon Rv Boundary Ck	Aeshnidae	0.006	0.009	0.646	1.714	0.250	0.911	0.413

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Boundary Ck	Koonungidae	0.005	0.007	0.744	0.000	1.250	0.918	0.081
Barwon Rv Boundary Ck	Scirtidae	0.005	0.008	0.622	0.857	0.500	0.924	0.463
Barwon Rv Boundary Ck	Culcidae	0.005	0.006	0.721	0.143	1.250	0.931	0.312
Barwon Rv Boundary Ck	Synlestidae	0.005	0.007	0.646	0.143	1.500	0.938	0.334
Barwon Rv Boundary Ck	Elmidae	0.004	0.006	0.697	0.286	1.000	0.943	0.362
Barwon Rv Boundary Ck	Oniscigastridae	0.004	0.007	0.588	1.143	0.000	0.949	0.394
Barwon Rv Boundary Ck	Notonectidae	0.004	0.005	0.733	0.714	0.500	0.954	0.684
Barwon Rv Boundary Ck	Temnocephala	0.003	0.006	0.553	0.000	1.000	0.959	0.354
Barwon Rv Boundary Ck	Hydrobiidae	0.003	0.006	0.553	0.000	1.000	0.963	0.354
Barwon Rv Boundary Ck	Ceratopogonidae	0.003	0.003	0.939	1.000	0.250	0.968	0.466
Barwon Rv Boundary Ck	Calamoceratidae	0.003	0.005	0.587	0.429	0.500	0.972	0.407
Barwon Rv Boundary Ck	Notonemouridae	0.003	0.003	0.993	0.429	0.500	0.976	0.296
Barwon Rv Boundary Ck	Hydrophilidae	0.002	0.004	0.557	0.000	0.750	0.979	0.334
Barwon Rv Boundary Ck	Caenidae	0.002	0.003	0.596	0.714	0.000	0.982	0.486
Barwon Rv Boundary Ck	Parastacidae	0.002	0.002	0.908	0.000	0.500	0.985	0.087
Barwon Rv Boundary Ck	Gerridae	0.002	0.005	0.391	0.429	0.000	0.987	0.384
Barwon Rv Boundary Ck	Hydrobiosidae	0.002	0.003	0.647	0.143	0.500	0.990	0.354
Barwon Rv Boundary Ck	Oligochaeta	0.002	0.002	1.088	0.571	0.000	0.993	0.109
Barwon Rv Boundary Ck	Collembola	0.002	0.002	0.788	0.429	0.250	0.995	0.672
Barwon Rv Boundary Ck	Tipulidae	0.001	0.002	0.623	0.143	0.250	0.997	0.315
Barwon Rv Boundary Ck	Haplidae	0.001	0.001	0.553	0.000	0.250	0.998	0.354
Barwon Rv Boundary Ck	Pleidae	0.000	0.001	0.395	0.143	0.000	0.999	0.405
Barwon Rv Boundary Ck	Atriplectididae	0.000	0.001	0.397	0.143	0.000	0.999	0.426
Barwon Rv Boundary Ck	Ecnomidae	0.000	0.001	0.397	0.143	0.000	1.000	0.426

Table D3: SIMPER Analysis Results – Edge habitat – Treatment x Waterway Interaction

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Reference_Boundary Ck Impact	Orthocladinae	0.094	0.082	1.147	30.500	3.000	0.122	0.146
Barwon Rv Reference_Boundary Ck Impact	Corixidae	0.082	0.041	2.029	24.250	0.000	0.229	0.036
Barwon Rv Reference_Boundary Ck Impact	Atyidae	0.067	0.029	2.312	17.250	0.000	0.315	0.004
Barwon Rv Reference_Boundary Ck Impact	Chironominae	0.059	0.045	1.311	18.500	24.000	0.392	0.267
Barwon Rv Reference_Boundary Ck Impact	Leptophlebiidae	0.040	0.033	1.208	9.250	0.000	0.444	0.266
Barwon Rv Reference_Boundary Ck Impact	Coengrionidae	0.036	0.034	1.062	9.750	0.000	0.490	0.105
Barwon Rv Reference_Boundary Ck Impact	Leptoceridae	0.035	0.021	1.706	10.250	1.000	0.536	0.088
Barwon Rv Reference_Boundary Ck Impact	Acarina	0.034	0.031	1.093	8.000	3.500	0.581	0.110
Barwon Rv Reference_Boundary Ck Impact	Hydroptilidae	0.034	0.029	1.174	9.500	0.000	0.624	0.106
Barwon Rv Reference_Boundary Ck Impact	Physidae	0.030	0.017	1.796	8.500	0.000	0.663	0.139
Barwon Rv Reference_Boundary Ck Impact	Chiltoniidae	0.029	0.013	2.274	8.500	0.000	0.701	0.535
Barwon Rv Reference_Boundary Ck Impact	Janiridae	0.024	0.009	2.737	0.000	6.000	0.732	0.011
Barwon Rv Reference_Boundary Ck Impact	Gripopterygidae	0.024	0.044	0.539	7.500	0.000	0.762	0.344
Barwon Rv Reference_Boundary Ck Impact	Dyticidae	0.021	0.015	1.456	7.750	11.000	0.790	0.338
Barwon Rv Reference_Boundary Ck Impact	Baetidae	0.020	0.019	1.043	6.000	0.000	0.815	0.378
Barwon Rv Reference_Boundary Ck Impact	Tanypodinae	0.016	0.020	0.824	5.500	2.500	0.836	0.663
Barwon Rv Reference_Boundary Ck Impact	Lymnaeidae	0.013	0.016	0.803	3.750	0.000	0.853	0.220
Barwon Rv Reference_Boundary Ck Impact	Aeshnidae	0.011	0.013	0.869	2.750	0.000	0.867	0.152
Barwon Rv Reference_Boundary Ck Impact	Koonungidae	0.009	0.006	1.544	0.000	2.500	0.879	0.070
Barwon Rv Reference_Boundary Ck Impact	Veliidae	0.008	0.004	1.987	2.750	3.500	0.889	0.572
Barwon Rv Reference_Boundary Ck Impact	Simuliidae	0.008	0.008	0.933	2.500	0.000	0.900	0.593
Barwon Rv Reference_Boundary Ck Impact	Culcidae	0.007	0.007	0.996	0.250	2.000	0.909	0.181
Barwon Rv Reference_Boundary Ck Impact	Dugesidae	0.007	0.008	0.923	2.000	0.000	0.918	0.323
Barwon Rv Reference_Boundary Ck Impact	Scirtidae	0.007	0.013	0.537	1.250	0.000	0.927	0.281
Barwon Rv Reference_Boundary Ck Impact	Ceratopogonidae	0.007	0.003	1.984	1.750	0.000	0.935	0.011

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Reference_Boundary Ck Impact	Notonectidae	0.006	0.005	1.037	1.250	1.000	0.943	0.194
Barwon Rv Reference_Boundary Ck Impact	Hemicorduliidae	0.004	0.003	1.340	1.250	0.000	0.948	0.816
Barwon Rv Reference_Boundary Ck Impact	Calamoceratidae	0.004	0.008	0.537	0.750	0.000	0.954	0.300
Barwon Rv Reference_Boundary Ck Impact	Gerridae	0.004	0.008	0.537	0.750	0.000	0.959	0.185
Barwon Rv Reference_Boundary Ck Impact	Caenidae	0.004	0.004	0.896	1.250	0.000	0.964	0.089
Barwon Rv Reference_Boundary Ck Impact	Notonemouridae	0.004	0.003	1.056	0.750	0.500	0.969	0.231
Barwon Rv Reference_Boundary Ck Impact	Elmidae	0.003	0.005	0.537	0.500	0.000	0.972	0.636
Barwon Rv Reference_Boundary Ck Impact	Planorbidae	0.003	0.005	0.537	0.500	0.000	0.975	0.825
Barwon Rv Reference_Boundary Ck Impact	Gyrinidae	0.002	0.004	0.539	0.750	0.000	0.979	0.774
Barwon Rv Reference_Boundary Ck Impact	Oniscigastridae	0.002	0.003	0.842	0.750	0.000	0.982	0.653
Barwon Rv Reference_Boundary Ck Impact	Parastacidae	0.002	0.002	0.882	0.000	0.500	0.984	0.212
Barwon Rv Reference_Boundary Ck Impact	Tipulidae	0.002	0.002	0.872	0.250	0.500	0.987	0.188
Barwon Rv Reference_Boundary Ck Impact	Collembola	0.002	0.002	0.895	0.250	0.500	0.989	0.533
Barwon Rv Reference_Boundary Ck Impact	Dixidae	0.002	0.002	0.895	0.000	0.500	0.992	0.863
Barwon Rv Reference_Boundary Ck Impact	Oligochaeta	0.002	0.002	0.923	0.500	0.000	0.994	0.198
Barwon Rv Reference_Boundary Ck Impact	Synlestidae	0.001	0.003	0.537	0.250	0.000	0.996	0.647
Barwon Rv Reference_Boundary Ck Impact	Pleidae	0.001	0.002	0.538	0.250	0.000	0.997	0.187
Barwon Rv Reference_Boundary Ck Impact	Hydrobiosidae	0.001	0.001	0.539	0.250	0.000	0.998	0.655
Barwon Rv Reference_Boundary Ck Impact	Atriplectididae	0.001	0.001	0.539	0.250	0.000	0.999	0.181
Barwon Rv Reference_Boundary Ck Impact	Ecnomidae	0.001	0.001	0.539	0.250	0.000	1.000	0.181
Barwon Rv Reference_Boundary Ck Impact	Temnocephala	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Boundary Ck Impact	Haplidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Boundary Ck Impact	Hydrophilidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Boundary Ck Impact	Hydrobiidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Orthocladinae	0.072	0.027	2.645	30.500	32.333	0.150	0.584
Barwon Rv Reference_Barwon Rv Impact	Chiltoniidae	0.039	0.039	1.001	8.500	18.667	0.231	0.544
Barwon Rv Reference_Barwon Rv Impact	Corixidae	0.036	0.026	1.369	24.250	21.667	0.306	0.988

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Reference_Barwon Rv Impact	Chironominae	0.028	0.024	1.158	18.500	15.667	0.364	0.963
Barwon Rv Reference_Barwon Rv Impact	Atyidae	0.022	0.012	1.921	17.250	9.667	0.410	0.955
Barwon Rv Reference_Barwon Rv Impact	Leptoceridae	0.022	0.016	1.436	10.250	2.333	0.456	0.731
Barwon Rv Reference_Barwon Rv Impact	Acarina	0.021	0.013	1.671	8.000	8.333	0.501	0.757
Barwon Rv Reference_Barwon Rv Impact	Coengrionidae	0.021	0.020	1.079	9.750	6.667	0.545	0.616
Barwon Rv Reference_Barwon Rv Impact	Gripopterygidae	0.018	0.032	0.570	7.500	0.333	0.582	0.623
Barwon Rv Reference_Barwon Rv Impact	Hydroptilidae	0.018	0.016	1.108	9.500	6.667	0.619	0.634
Barwon Rv Reference_Barwon Rv Impact	Physidae	0.017	0.014	1.204	8.500	13.000	0.654	0.975
Barwon Rv Reference_Barwon Rv Impact	Leptophlebiidae	0.017	0.017	0.977	9.250	7.000	0.688	0.989
Barwon Rv Reference_Barwon Rv Impact	Dyticidae	0.017	0.013	1.293	7.750	1.667	0.723	0.766
Barwon Rv Reference_Barwon Rv Impact	Baetidae	0.016	0.013	1.205	6.000	6.333	0.755	0.706
Barwon Rv Reference_Barwon Rv Impact	Tanypodinae	0.013	0.016	0.848	5.500	2.000	0.783	0.859
Barwon Rv Reference_Barwon Rv Impact	Simuliidae	0.011	0.009	1.206	2.500	4.000	0.806	0.418
Barwon Rv Reference_Barwon Rv Impact	Gyrinidae	0.010	0.011	0.947	0.750	4.333	0.826	0.250
Barwon Rv Reference_Barwon Rv Impact	Lymnaeidae	0.009	0.012	0.788	3.750	0.000	0.846	0.319
Barwon Rv Reference_Barwon Rv Impact	Planorbidae	0.008	0.010	0.838	0.500	3.333	0.863	0.454
Barwon Rv Reference_Barwon Rv Impact	Veliidae	0.008	0.008	1.060	2.750	0.000	0.881	0.514
Barwon Rv Reference_Barwon Rv Impact	Aeshnidae	0.007	0.009	0.824	2.750	0.333	0.896	0.436
Barwon Rv Reference_Barwon Rv Impact	Dugesidae	0.006	0.006	1.028	2.000	1.667	0.909	0.412
Barwon Rv Reference_Barwon Rv Impact	Hemicorduliidae	0.006	0.004	1.682	1.250	2.667	0.921	0.489
Barwon Rv Reference_Barwon Rv Impact	Oniscigastridae	0.005	0.006	0.903	0.750	1.667	0.931	0.384
Barwon Rv Reference_Barwon Rv Impact	Scirtidae	0.005	0.007	0.681	1.250	0.333	0.941	0.565
Barwon Rv Reference_Barwon Rv Impact	Ceratopogonidae	0.005	0.002	1.934	1.750	0.000	0.951	0.057
Barwon Rv Reference_Barwon Rv Impact	Notonectidae	0.003	0.005	0.696	1.250	0.000	0.958	0.584
Barwon Rv Reference_Barwon Rv Impact	Caenidae	0.003	0.003	0.906	1.250	0.000	0.964	0.193
Barwon Rv Reference_Barwon Rv Impact	Calamoceratidae	0.003	0.005	0.541	0.750	0.000	0.969	0.581
Barwon Rv Reference_Barwon Rv Impact	Gerridae	0.003	0.005	0.541	0.750	0.000	0.975	0.488

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Barwon Rv Reference_Barwon Rv Impact	Collembola	0.002	0.002	0.885	0.250	0.667	0.979	0.574
Barwon Rv Reference_Barwon Rv Impact	Notonemouridae	0.002	0.003	0.547	0.750	0.000	0.982	0.752
Barwon Rv Reference_Barwon Rv Impact	Elmidae	0.002	0.003	0.541	0.500	0.000	0.986	0.828
Barwon Rv Reference_Barwon Rv Impact	Oligochaeta	0.001	0.001	0.931	0.500	0.667	0.989	0.670
Barwon Rv Reference_Barwon Rv Impact	Janiridae	0.001	0.001	0.665	0.000	0.333	0.990	0.932
Barwon Rv Reference_Barwon Rv Impact	Synlestidae	0.001	0.002	0.541	0.250	0.000	0.992	0.846
Barwon Rv Reference_Barwon Rv Impact	Pleidae	0.001	0.001	0.545	0.250	0.000	0.994	0.518
Barwon Rv Reference_Barwon Rv Impact	Culcidae	0.001	0.001	0.545	0.250	0.000	0.995	0.946
Barwon Rv Reference_Barwon Rv Impact	Hydrobiosidae	0.001	0.001	0.547	0.250	0.000	0.996	0.852
Barwon Rv Reference_Barwon Rv Impact	Atriplectididae	0.001	0.001	0.547	0.250	0.000	0.998	0.547
Barwon Rv Reference_Barwon Rv Impact	Ecnomidae	0.001	0.001	0.547	0.250	0.000	0.999	0.547
Barwon Rv Reference_Barwon Rv Impact	Tipulidae	0.001	0.001	0.547	0.250	0.000	1.000	0.841
Barwon Rv Reference_Barwon Rv Impact	Temnocephala	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Koonungidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Parastacidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Haplidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Hydrophilidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Hydrobiidae	0.000	0.000		0.000	0.000	1.000	1.000
Barwon Rv Reference_Barwon Rv Impact	Dixidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Leptophlebiidae	0.102	0.014	7.186	22.000	0.000	0.156	0.002
Boundary Ck Reference_Boundary Ck Impact	Chironominae	0.072	0.034	2.128	26.000	24.000	0.266	0.161
Boundary Ck Reference_Boundary Ck Impact	Leptoceridae	0.069	0.007	9.198	15.500	1.000	0.371	0.002
Boundary Ck Reference_Boundary Ck Impact	Tanypodinae	0.043	0.028	1.532	12.500	2.500	0.437	0.031
Boundary Ck Reference_Boundary Ck Impact	Orthocladinae	0.035	0.021	1.618	11.000	3.000	0.490	0.951
Boundary Ck Reference_Boundary Ck Impact	Chiltoniidae	0.030	0.022	1.348	7.000	0.000	0.536	0.401
Boundary Ck Reference_Boundary Ck Impact	Janiridae	0.029	0.010	2.975	0.000	6.000	0.580	0.006
Boundary Ck Reference_Boundary Ck Impact	Dyticidae	0.029	0.024	1.197	5.500	11.000	0.624	0.106

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Boundary Ck Reference_Boundary Ck Impact	Acarina	0.029	0.024	1.205	9.500	3.500	0.668	0.273
Boundary Ck Reference_Boundary Ck Impact	Gripopterygidae	0.026	0.003	8.625	5.500	0.000	0.708	0.371
Boundary Ck Reference_Boundary Ck Impact	Dixidae	0.019	0.005	4.083	4.500	0.500	0.737	0.005
Boundary Ck Reference_Boundary Ck Impact	Baetidae	0.014	0.017	0.862	3.500	0.000	0.759	0.680
Boundary Ck Reference_Boundary Ck Impact	Synlestidae	0.012	0.014	0.862	3.000	0.000	0.778	0.008
Boundary Ck Reference_Boundary Ck Impact	Koonungidae	0.011	0.007	1.539	0.000	2.500	0.795	0.040
Boundary Ck Reference_Boundary Ck Impact	Corixidae	0.011	0.006	1.707	2.500	0.000	0.812	0.989
Boundary Ck Reference_Boundary Ck Impact	Temnocephala	0.011	0.013	0.858	2.000	0.000	0.828	0.009
Boundary Ck Reference_Boundary Ck Impact	Elmidae	0.011	0.013	0.858	2.000	0.000	0.845	0.018
Boundary Ck Reference_Boundary Ck Impact	Hydrobiidae	0.011	0.013	0.858	2.000	0.000	0.862	0.009
Boundary Ck Reference_Boundary Ck Impact	Physidae	0.010	0.007	1.420	2.000	0.000	0.878	0.951
Boundary Ck Reference_Boundary Ck Impact	Culcidae	0.009	0.007	1.223	0.500	2.000	0.891	0.137
Boundary Ck Reference_Boundary Ck Impact	Hemicorduliidae	0.008	0.010	0.858	1.500	0.000	0.904	0.155
Boundary Ck Reference_Boundary Ck Impact	Veliidae	0.007	0.003	2.587	3.500	3.500	0.915	0.645
Boundary Ck Reference_Boundary Ck Impact	Planorbidae	0.007	0.002	4.004	1.500	0.000	0.925	0.366
Boundary Ck Reference_Boundary Ck Impact	Hydrophilidae	0.006	0.007	0.862	1.500	0.000	0.935	0.005
Boundary Ck Reference_Boundary Ck Impact	Hydrobiosidae	0.005	0.006	0.858	1.000	0.000	0.943	0.015
Boundary Ck Reference_Boundary Ck Impact	Scirtidae	0.005	0.006	0.858	1.000	0.000	0.952	0.387
Boundary Ck Reference_Boundary Ck Impact	Simuliidae	0.005	0.006	0.858	1.000	0.000	0.960	0.813
Boundary Ck Reference_Boundary Ck Impact	Notonectidae	0.004	0.005	0.852	0.000	1.000	0.967	0.514
Boundary Ck Reference_Boundary Ck Impact	Calamoceratidae	0.004	0.005	0.862	1.000	0.000	0.973	0.339
Boundary Ck Reference_Boundary Ck Impact	Haplidae	0.003	0.003	0.858	0.500	0.000	0.977	0.009
Boundary Ck Reference_Boundary Ck Impact	Aeshnidae	0.003	0.003	0.858	0.500	0.000	0.981	0.638
Boundary Ck Reference_Boundary Ck Impact	Ceratopogonidae	0.003	0.003	0.858	0.500	0.000	0.986	0.548
Boundary Ck Reference_Boundary Ck Impact	Tipulidae	0.003	0.003	0.846	0.000	0.500	0.989	0.155
Boundary Ck Reference_Boundary Ck Impact	Parastacidae	0.002	0.003	0.863	0.500	0.500	0.993	0.197
Boundary Ck Reference_Boundary Ck Impact	Notonemouridae	0.002	0.003	0.863	0.500	0.500	0.997	0.510

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Boundary Ck Reference_Boundary Ck Impact	Collembola	0.002	0.003	0.852	0.000	0.500	1.000	0.471
Boundary Ck Reference_Boundary Ck Impact	Oligochaeta	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Dugesidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Atyidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Caenidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Oniscigastridae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Hydroptilidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Atriplectididae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Ecnomidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Gyrinidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Gerridae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Pleidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Coengrionidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Boundary Ck Impact	Lymnaeidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Orthocladinae	0.069	0.033	2.089	11.000	32.333	0.107	0.644
Boundary Ck Reference_Barwon Rv Impact	Corixidae	0.063	0.031	2.021	2.500	21.667	0.205	0.220
Boundary Ck Reference_Barwon Rv Impact	Leptophlebiidae	0.048	0.025	1.927	22.000	7.000	0.280	0.124
Boundary Ck Reference_Barwon Rv Impact	Chiltoniidae	0.046	0.048	0.961	7.000	18.667	0.351	0.380
Boundary Ck Reference_Barwon Rv Impact	Leptoceridae	0.042	0.012	3.524	15.500	2.333	0.417	0.034
Boundary Ck Reference_Barwon Rv Impact	Chironominae	0.041	0.036	1.138	26.000	15.667	0.480	0.527
Boundary Ck Reference_Barwon Rv Impact	Physidae	0.034	0.008	4.424	2.000	13.000	0.532	0.098
Boundary Ck Reference_Barwon Rv Impact	Tanypodinae	0.033	0.022	1.459	12.500	2.000	0.582	0.075
Boundary Ck Reference_Barwon Rv Impact	Atyidae	0.032	0.014	2.353	0.000	9.667	0.632	0.461
Boundary Ck Reference_Barwon Rv Impact	Hydroptilidae	0.020	0.005	3.972	0.000	6.667	0.664	0.460
Boundary Ck Reference_Barwon Rv Impact	Coengrionidae	0.019	0.013	1.513	0.000	6.667	0.693	0.553
Boundary Ck Reference_Barwon Rv Impact	Baetidae	0.017	0.012	1.450	3.500	6.333	0.720	0.593
Boundary Ck Reference_Barwon Rv Impact	Gripopterygidae	0.017	0.004	3.767	5.500	0.333	0.746	0.479

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Boundary Ck Reference_Barwon Rv Impact	Acarina	0.014	0.008	1.851	9.500	8.333	0.768	0.960
Boundary Ck Reference_Barwon Rv Impact	Dixidae	0.014	0.003	5.353	4.500	0.000	0.790	0.006
Boundary Ck Reference_Barwon Rv Impact	Dyticidae	0.014	0.011	1.286	5.500	1.667	0.812	0.822
Boundary Ck Reference_Barwon Rv Impact	Veliidae	0.012	0.007	1.673	3.500	0.000	0.830	0.133
Boundary Ck Reference_Barwon Rv Impact	Gyrinidae	0.012	0.013	0.859	0.000	4.333	0.848	0.279
Boundary Ck Reference_Barwon Rv Impact	Simuliidae	0.011	0.012	0.949	1.000	4.000	0.865	0.437
Boundary Ck Reference_Barwon Rv Impact	Planorbidae	0.011	0.009	1.187	1.500	3.333	0.882	0.289
Boundary Ck Reference_Barwon Rv Impact	Synlestidae	0.009	0.010	0.892	3.000	0.000	0.895	0.119
Boundary Ck Reference_Barwon Rv Impact	Temnocephala	0.007	0.008	0.883	2.000	0.000	0.906	0.107
Boundary Ck Reference_Barwon Rv Impact	Elmidae	0.007	0.008	0.883	2.000	0.000	0.917	0.144
Boundary Ck Reference_Barwon Rv Impact	Hydrobiidae	0.007	0.008	0.883	2.000	0.000	0.928	0.107
Boundary Ck Reference_Barwon Rv Impact	Hemicorduliidae	0.007	0.005	1.257	1.500	2.667	0.938	0.318
Boundary Ck Reference_Barwon Rv Impact	Dugesidae	0.005	0.008	0.641	0.000	1.667	0.946	0.616
Boundary Ck Reference_Barwon Rv Impact	Oniscigastridae	0.005	0.008	0.641	0.000	1.667	0.955	0.370
Boundary Ck Reference_Barwon Rv Impact	Hydrophilidae	0.004	0.005	0.892	1.500	0.000	0.961	0.111
Boundary Ck Reference_Barwon Rv Impact	Hydrobiosidae	0.004	0.004	0.883	1.000	0.000	0.967	0.129
Boundary Ck Reference_Barwon Rv Impact	Scirtidae	0.003	0.003	1.186	1.000	0.333	0.972	0.564
Boundary Ck Reference_Barwon Rv Impact	Calamoceratidae	0.003	0.003	0.892	1.000	0.000	0.976	0.482
Boundary Ck Reference_Barwon Rv Impact	Oligochaeta	0.002	0.002	1.261	0.000	0.667	0.979	0.203
Boundary Ck Reference_Barwon Rv Impact	Parastacidae	0.002	0.002	0.883	0.500	0.000	0.982	0.367
Boundary Ck Reference_Barwon Rv Impact	Notonemouridae	0.002	0.002	0.883	0.500	0.000	0.985	0.699
Boundary Ck Reference_Barwon Rv Impact	Haplidae	0.002	0.002	0.883	0.500	0.000	0.988	0.107
Boundary Ck Reference_Barwon Rv Impact	Ceratopogonidae	0.002	0.002	0.883	0.500	0.000	0.990	0.848
Boundary Ck Reference_Barwon Rv Impact	Culcidae	0.002	0.002	0.883	0.500	0.000	0.993	0.553
Boundary Ck Reference_Barwon Rv Impact	Collembola	0.002	0.003	0.643	0.000	0.667	0.996	0.584
Boundary Ck Reference_Barwon Rv Impact	Aeshnidae	0.002	0.002	0.864	0.500	0.333	0.998	0.828
Boundary Ck Reference_Barwon Rv Impact	Janiridae	0.001	0.002	0.641	0.000	0.333	1.000	0.813

Contrast	Taxon	Average	Sd	Ratio	Ava	Avb	Cumsum	P
Boundary Ck Reference_Barwon Rv Impact	Koonungidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Caenidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Atriplectididae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Ecnomidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Gerridae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Notonectidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Pleidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Lymnaeidae	0.000	0.000		0.000	0.000	1.000	1.000
Boundary Ck Reference_Barwon Rv Impact	Tipulidae	0.000	0.000		0.000	0.000	1.000	1.000