City of Ryde

Water Quality Monitoring Report

Spring 2023 & Autumn 2024

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Acknowledgement of Country

Sydney Water respectfully acknowledges the Traditional Custodians of the land and waters on which we work, live, and learn. We pay respect to Elders past and present.

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Cover image: Buffalo Creek core site, Autumn 2024

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Executive Summary

This report provides water quality results for the Ryde area for Spring 2023 and Autumn 2024. For this project, fourteen sites across five creek catchment zones were sampled (Shrimptons, Archers, Buffalo, Terrys, and Porters creeks) to provide an overall representation of waterway health in the region. A range of methods were used to collect data for the following parameters: (i) Macroinvertebrate community indices, (ii) Physico-chemical water quality and (iii) Rapid Riparian Assessment.

For each creek catchment, freshwater macroinvertebrate samples were collected. Two indices, SIGNAL_SF and Taxa Richness scores, were used to assess macroinvertebrate community health and diversity. SIGNAL scores were found to be consistent between Spring 2023 and Autumn 2024. During Spring 2023 the highest SIGNAL result was observed at Buffalo Creek (4.54), while the lowest was observed at Shrimptons Creek (4.04). Autumn 2024 results fell within a similar range. In Spring, the highest SIGNAL result was observed at Buffalo Creek (4.73) while the lowest was at Shrimptons Creek (3.99).

Taxa Richness scores (total number of taxa identifed) are indicative of macroinvertebrate community diversity. Average Richness results were variable between sites and sampling seasons. During Spring 2023, Buffalo Creek had the highest richness result with a score of 10. The lowest richness result was 6 and observed at Porters Creek site. In contrast, during Autumn 2024 Porters Creek had the highest observed richness result (14.5). The lowest result was at Shrimptons Creek (8).

At each site, in-field and analytical water quality testing was conducted. All results were collected and compared to the threshold limits outlined in the ANZECC guidelines for waterways (2000). Metrics such as pH were relatively stable across sampling sites and most sites recorded low turbidity. Dissolved oxygen results were highly variable with some falling below the recommended guideline level. During both Spring and Autumn seasons three sites exceeded the recommended faecal coliform concentration guideline limit. As in previous seasons, nutrient results were elevated above guideline limits for most sites. Additional heavy metals testing at Porters Creek sites saw a reduction in copper and zinc concentration at most sites in Autumn 2024.

During Spring 2022 and Spring 2023 Rapid Riparian Assessments (RRA) were performed at the five core sites. Most sites had consistent riparian results between seasons aside from Shrimptons Creek core site at Wilga Park. The score for this site declined from 26.3 (Spring 2022) to 2.4 (Spring 2023) although it maintained it's 'fair' category. In contrast, Porters Creek saw an improvement in RRA score category from 'good' to 'excellent'.

Water quality data was also collected throughout the year by the City of Ryde's Streamwatch program. This data has been collated and provided in the appendix of this report.

1 Background

Water quality monitoring is carried out by the City of Ryde to inform environmental management and development decisions. The aims of this report are:

- Assess physical and chemical water properties of five major creeks (Shrimptons, Archers, Terrys, Buffalo and Porters creeks) within the City of Ryde local government area during dry and wet weather conditions
- Assess diversity and abundance of macroinvertebrate communities at five creeks within the study area
- Analyse environmental and ecosystem health data which will assist in monitoring the impact of future developments, creek restoration, stormwater management, bushland rehabilitation and general anthropogenic activities and incidents within the catchment
- Provide on-going information to assist the direction of future water quality monitoring plans
- Provide an easy to interpret report for the community
- Report any relevant environmental initiatives carried out by City of Ryde

Biological and chemical monitoring enables the City of Ryde to:

- Build on baseline data to provide long-term picture of waterway health
- Identify and track new and existing impacts affecting the catchments
- Provide direction and monitor potential infrastructural works within the LGA, i.e. in-stream or riparian rehabilitation and stormwater treatment projects
- Build on the known taxa list for each catchment and to aid in the identification of key indicator taxa

The format and style of this annual report is a simplified version of the reports produced from 2004-2019. The technical details for the methods used, the quality procedures, accreditation and journal references are the same as previous years and are available in the Appendix.

2 Study Area

The City of Ryde is located 12 km North-West of central Sydney with a local government area of 40.651 km². It consists primarily of residential housing and is comprised of 16 suburbs and 14 separate stormwater catchments. It includes several important commercial and industrial sectors. Limited areas of natural bushland border urban infrastructure, including several significant natural bush corridors and areas of open space that support recreation and sporting activities. There are small sections of Lane Cove National Park present on the eastern and northern borders of Shrimptons, Porters and Buffalo creeks. All five creeks drain into the greater Parramatta River catchment. Archers Creek enters Parramatta River directly, and the remaining creeks flow through the Lane Cove River catchment.

Figure 1 City of Ryde Water Quality Management Program Sites Map of sites for chemical and ecological monitoring across five creeks

3 Sampling Sites

At each of the five catchments there is one core sampling site. At each core site macroinvertebrate sampling, rapid riparian assessment (Spring only), and water quality sampling are conducted (Table 1). The other nine sites are water quality sampling only.

Table 1 Survey sites for monitoring chemical and ecological attributes. Core sites are denoted by (*)

Site	Location	Coordinates		Water Quality (wet & dry weather)	Macroinvertebrates	Rapid Riparian Assessment
CR1S*	Shrimptons Ck at Wilga Park	-33.78053,	151.118628	✓	✓	✓
CR1SA	Shrimptons Creek at Kent Rd	-33.789246	151.113419	✓		
CR1SB	Shrimptons Creek at Bridge St	-33.794061	151.109779	✓		
CR1SC	Shrimptons Creek at Quarry Rd	-33.796856	151.106775	✓		
CR2A*	Archers Creek at Maze Park	-33.805555	151.074272	✓	✓	✓
CR3T*	Terrys Creek at Somerset Park	-33.765792	151.098345	✓	✓	✓
CR3TA	Terrys Creek at Forrester Park	-33.777417	151.093497	✓		
CR4B*	Buffalo Creek	-33.816451	151.125705	✓	✓	✓
CR4BA	Buffalo Creek d/s Burrows Park	-33.814392	151.116656	✓		
CR4BB	Buffalo Creek u/s Burrows Park	-33.81506	151.113502	✓		
CR5P*	Porters Creek d/s of depot	-33.783362	151.137671	✓	✓	✓
CR5PA	Porters Creek main branch	-33.7865	151.134839	✓		
CR5PB	Porters Creek spur branch	-33.784181	151.134708	✓		
CR5PC	Porters Creek at Wicks Rd	-33.788613	151.133557	✓		

4 Method Descriptions

4.1 Macroinvertebrates

Aquatic macroinvertebrates are small (>1mm), spineless animals that naturally occur in water bodies. Macroinvertebrates are useful as bioindicators because some are more sensitive to pollution than others. As a result, a water pollution problem may be indicated if a stream is found to have a macroinvertebrate community dominated by pollution-tolerant animals and missing the more pollution-sensitive animals.

For this project, two replicate macroinvertebrate samples were collected at each of the five core sampling sites. Collection was performed using a fine mesh net to upwell the water and dislodge the animals. After sampling macroinvertebrates were picked out from the debris, preserved, and taken to the laboratory for identification.

Figure 2 Collecting macroinvertebrates from Buffalo Creek (Spring 2023)

4.1(i) SIGNAL SF

SIGNAL SF stands for *Stream Invertebrate Grade Number Average Level- Sydney Family.* It is a biotic index for freshwater macroinvertebrates examined at the family level to assess stream health.

This index assigns sensitivity scores to each individual family. They range from “1” being tolerant to poor stream health to “10” being very sensitive to poor stream health.

Figure 3 Preserved macroinvertebrates

4.1(ii) Taxa Richness

This is the total number of different types of animals or taxa collected. In healthier ecosystems there is typically a greater variety of different animals collected, and therefore a higher taxa diversity.

Figure 4 Macroinvertebrate collection; this water bug is a backswimmer (*Notonectidae*)

4.2 Water Quality

Physical, chemical, and biological conditions of the five main catchments in the City of Ryde local government area were assessed following the same methods as previous years (See Appendix for detailed methodology). This provides information that can create a snapshot of what was happening in the creek at that point in time.

Figure 5 In-field water quality testing

Water quality samples were collected at the same time as the macroinvertebrate samples to ensure the data was suitable for comparison.

Water quality samples were collected at all 14 sites. Several analyses were conducted in the field, and additional water was collected for lab analysis. Laboratory analyses are conducted at the Sydney Water Laboratories located in West Ryde.

Figure 6 Collecting water samples for analysis

Water quality results are compared to the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) guidelines. These guidelines outline a framework for assessing water quality in terms of whether the water is suitable for a range of environmental and community values. Exceedances of the ANZECC guidelines may indicate environmental disturbance. Historical data is used during result analysis to compare the current results over what would be expected. Table 2 outlines the analytes tested in this study.

Table 2 Water quality testing parameters

Parameter Measured	Examples
Physicochemical	Temperature, Dissolved Oxygen, pH, Turbidity, Conductivity, Alkalinity
Nutrients	Ammonia, Total Nitrogen, Total Kjeldahl Nitrogen, Oxidised Nitrogen, Total Phosphorus
Metals	Total Magnesium, Total Hardness, Heavy Metals (Lead, Mercury, Cadmium, Arsenic)
Biological	Faecal Coliforms

4.3 Rapid Riparian Assessment

The riparian zone is the area where a body of water or stream, meets the land. The Rapid Riparian Assessment (RRA) provides a summary of the features of a stream and the vegetation community surrounding it.

The methods used were originally developed by Ku-ring-gai Council and researchers from Macquarie University.

The main categories assessed are:

- ❖ Site features
- ❖ Channel features
- ❖ Depositional features
- ❖ Erosional features
- ❖ Riparian vegetation
- ❖ Vegetation structure

The variables within these categories are ranked and collated to form an overall site score. This final numerical score is associated with a final riparian health result ranging from 'very poor' to 'excellent'. This scoring system is summarised in Table 3.

Table 3 Riparian health categories

Category	Score range	Colour code
Excellent	≥60	Green
Good	27 to 59.99	Yellow
Fair	-6 to 26.99	Orange
Poor	-39 to -6.99	Light red
Very Poor	-72 to -39.99	Dark red

Figure 7 Archers Creek core site at Maze Park (CR2) looking upstream (Autumn 2024). This site has a consistently high density of riparian vegetation. This includes a range of weedy riparian types including: ground cover, shrubs, and an extensive tree canopy.

5 Rainfall and Sampling

Rainfall volume and frequency can have a significant impact on environmental conditions influencing the chemical and biological components of waterways.

High rainfall volume can lead to flushing events particularly in narrow creek channels. Such events can detrimentally impact the health and diversity of macroinvertebrate communities and increase the influx of chemicals into the waterway from adjacent urban sources including residential zones, park spaces and roadways.

Conversely, very low rainfall leads to a reduction in flow volume. This can contribute to a reduction in dissolved oxygen concentration, and over time this can create anoxic conditions.

Water quality sampling is scheduled to avoid high volume rain events to provide accurate data for baseline conditions. Figure 8 below provides a summary of the rainfall data from August 2023 to April 2024.

Spring sampling was conducted on the 5th of September 2023. Rainfall during September was relatively low with a monthly total of 23mm. The highest daily rainfall for this month was 11mm. Autumn sampling was carried out on the 26th of March 2024. The total monthly rainfall was 41mm. The highest daily rainfall for March was 22mm.

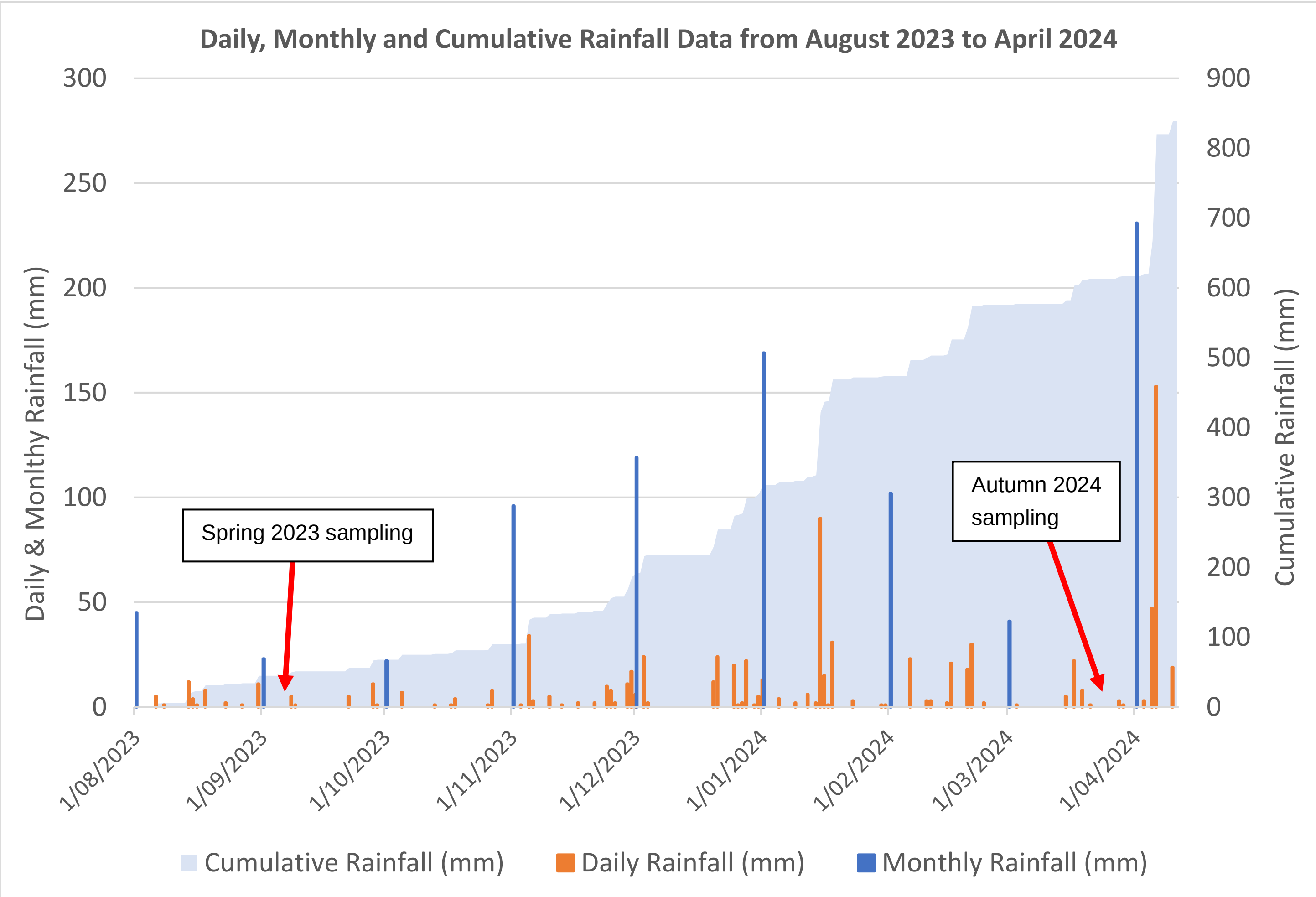

Figure 8 Daily, monthly, and cumulative rainfall data from August 2023 to April 2024

6 Shrimptons Creek

6.1 Sites CR1S, CR1SA, CR1SB, CR1SC

The Shrimptons Creek catchment (Figure 9) contains three water quality sites and one core site (macroinvertebrate, water quality and riparian assessment).

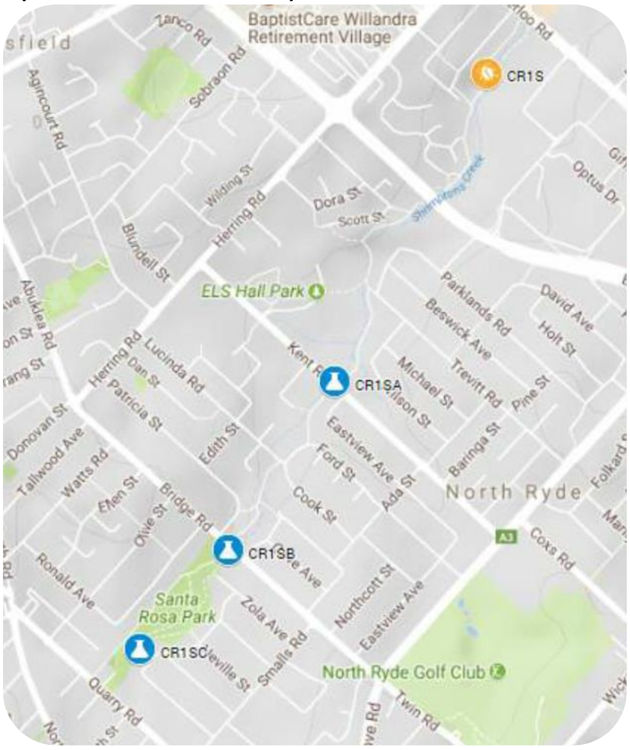

Figure 9 Shrimptons Creek Catchment Area

CR1S Shrimptons Creek at Wilga Park (Core Site)

The Shrimptons Creek core site is located within Wilga Park in the suburb of Macquarie Park. Land use in this area is primarily residential, commercial, and light industrial. The creek flows through a thin riparian corridor, which is a combination of native and exotic species. The creek bed is predominately bedrock and sand/silt. During both Spring 2023 and Autumn 2024 (Figures 10 and 11) the downstream zone of the site had very low flow with only small, ponded areas

Figure 10 Shrimptons Creek at Wilga Park looking upstream (Autumn 2024)

Figure 11 Shrimptons Creek at Wilga Park looking downstream (Autumn 2024)

CR1SA Shrimptons Creek at Kent Road

The Kent Road site is situated at ELS Hall Park amongst a residential area and is lined by a thin section of riparian vegetation comprised of native and exotic species that completely shades the creek (Figure 12).

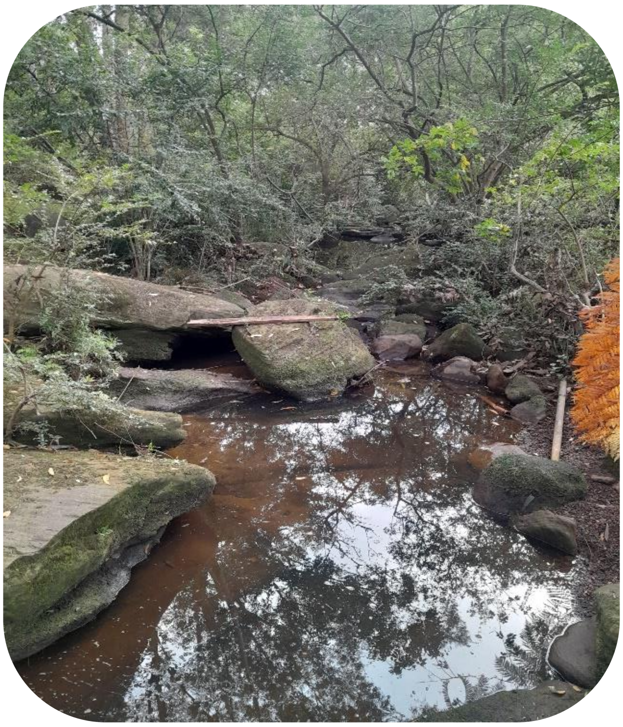

Figure 12 Shrimptons Creek at Kent Road looking downstream (Autumn 2024)

CR1SB Shrimptons Creek at Bridge Road

This site is located at the downstream section of Santa Rosa Park, just before it flows under Bridge Road and is surrounded by residential areas (Figure 13). Revegetation of the riparian area has enhanced the physical buffer improving bank stabilisation and filtration.

Figure 13 Shrimptons Creek at Bridge Road looking downstream (Autumn 2024)

CR1SC Shrimptons Creek at Quarry Road

The Quarry Road site is located at the upstream section of Santa Rosa Park, at the point where Shrimptons Creek emerges from the underground stormwater system (Figure 14). This site has sandstone blocks around the drain for bank stabilisation.

Figure 14 Shrimptons Creek at Quarry Road looking downstream (Autumn 2024)

6.2 Results and Interpretation

Macroinvertebrates

SIGNAL SF

The average SIGNAL_SF score for Shrimptons Creek during Autumn 2024 was 3.99 (Figure 15) which was the lowest score for the season. This result was consistent with the previous season (4.04, Spring 2023) as well as the historical average for the site.

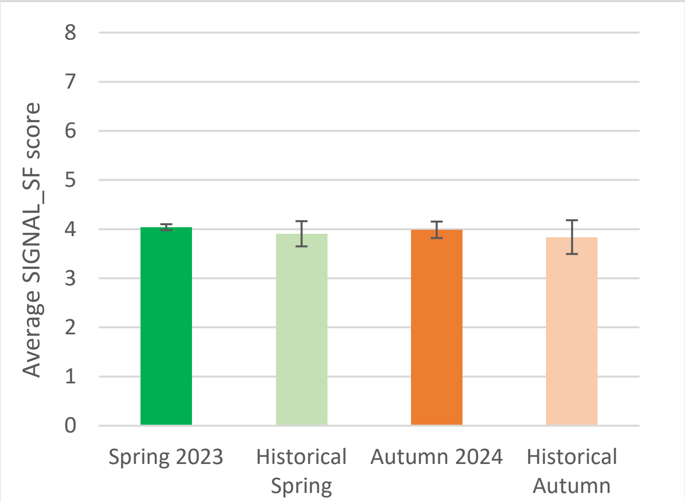

Figure 15 Shrimptons Creek average SIGNAL_SF results

Taxa Richness

During Autumn 2024, Shrimptons Creek average richness was 8 (Figure 16). This was lower than the Autumn average (9.8) although it was still within range of this result. Similarly, Spring 2023 had an average richness result of 9 which was lower than the historical Spring average of 11.4, although within range of this result.

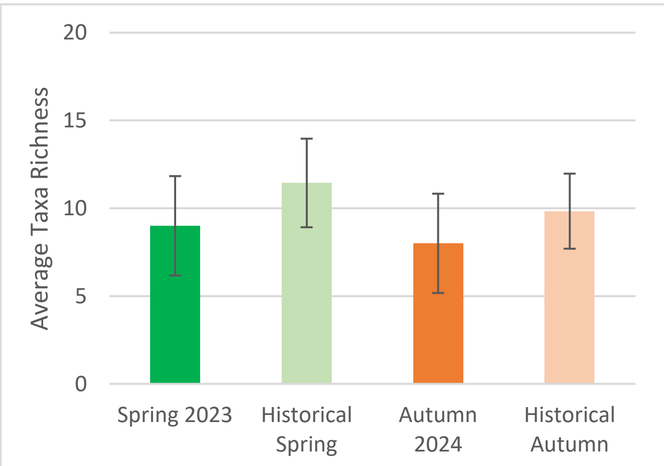

Figure 16 Shrimptons Creek average richness results

Macroinvertebrate Community Composition

During both seasons samples were dominated by Aquatic Snails and True Flies groups (Figure 17). Caddisflies were only observed at the site during Spring 2023, while Crustaceans were only observed during Autumn 2024. The Autumn season had a slightly lower prevalence of dragonfly families.

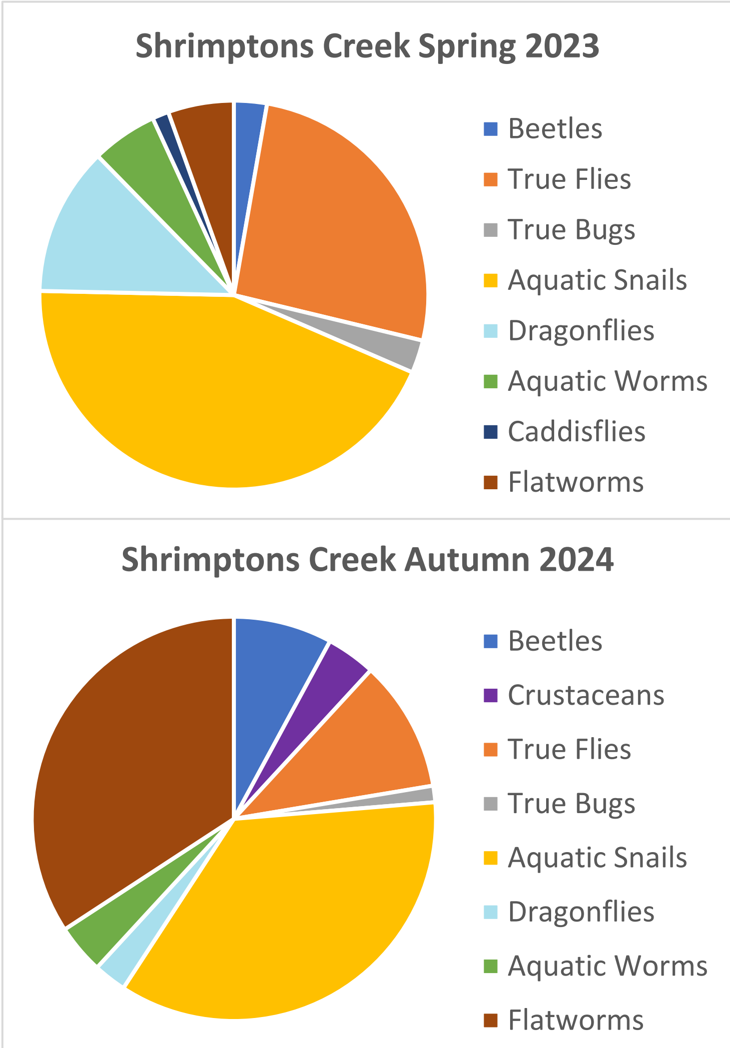

Figure 17 Shrimptons Creek community composition charts for Spring 2023 (top) and Autumn 2024 (bottom)

Macroinvertebrates summary

SIGNAL_SF results were consistent between Spring 2023 and Autumn 2024. Taxa Richness was slightly lower than the historical average for both seasons. Community composition was similar across seasons with a dominance of aquatic snail groups.

Water Quality

At the Shrimptons catchment, Wilga Park site (CR1S) had the lowest dissolved oxygen result (%) for both Spring 2023 (36.8%) and Autumn 2024 (38.6%). In contrast, Shrimptons Creek at Quarry Road site (CR1SC) had the highest dissolved oxygen result for both Spring (81.2%) and Autumn (84.3), although these results were still lower than the guideline limit (85%). For both Kent Rd (CR1SA) and Bridge Road (CR1SB) sites, dissolved oxygen results were lower in Autumn than in Spring. Turbidity results were consistently low between sampling seasons. The lowest Spring 2023 result was at Kent Road site (3.94 NTU) while the highest was at Quarry Road site (9.59 NTU). In contrast, during Autumn 2024 Quarry Road site had the lowest turbidity result (2.10 NTU) while Wilga Park core site had the highest (7.24 NTU).

All sites in the Shrimptons Creek catchment had conductivity results within ANZECC guideline limits. Most sites had results comparable between seasons, however Wilga Park site saw an increase in conductivity from 270 µS/cm in Spring 2023 to 624 µS/cm in Autumn 2024. In contrast, Quarry Road site saw conductivity reduce from 979 µS/cm (Spring 2023) to 646 µS/cm (Autumn 2024). All Shrimptons Creek sites had pH results ranging between 7.02 – 7.24 pH units for both seasons which was within the ANZECC guideline range (6.5 – 8.5).

Faecal coliform results were below the guideline limit (<1000 CFU/100mL) for all Shrimptons Creek sites during Spring 2023. During the following season the core site at Wilga Park saw an exceedance in coliform concentration result. It rose from 950 CFU/100mL (Spring 2023) to 9300 CFU/100mL (Autumn 2024). During the Autumn season, several sites saw an increase in coliform concentration. For example, Bridge Road saw coliform concentration increase from 150 CFU/100mL to 780 CFU/100mL.

During both Spring 2023 and Autumn 2024 seasons most nutrient concentration results at Shrimptons Creek catchment were above ANZECC guideline limits. During Spring 2023, Wilga Park site had a nitrogen result of 550 µg/L which was above the guideline limit of 350 µg/L. In Autumn 2024 this rose to 2670 µg/L. Kent Road and Bridge Road site also had observed increases in nitrogen results. In contrast, Quarry Road site saw a decrease in nitrogen concentration from 1030 µg/L in Spring 2023 to 870 µg/L Autumn 2024, although this was still above the guideline limit.

Total phosphorus results were consistent between seasons. As with Spring 2023, Autumn 2024 results for each site were elevated above the concentration threshold. Wilga Park core site had the greatest increase in phosphorous concentration from 56 µg/L in Spring 2023 to 505 µg/L in Autumn 2024. Bridge Road and Quarry Road sites had lower results during Spring 2023 (33 µg/L and 31 µg/L, respectively) and Autumn 2024 (32 µg/L and 29 µg/L respectively) while Kent Road site elevated results during both Spring 2023 (57 µg/L) and Autumn 2024 (62 µg/L).

Water quality summary

Dissolved oxygen results were variable across sites while turbidity was consistently low. Most faecal coliform results were below guideline limits during both seasons. Most nutrient results were above guideline limits for this catchment.

7 Archers Creek

7.1 Site CR2A (core site)

This site is located in Maze Park, West Ryde and is upstream of the Victoria Rd crossing (Figure 18). The land use upstream of this site is largely residential while a golf course is present downstream. The creek bed is mostly bedrock bordered by banks of sediment (sand, silt and organic matter, Figure 19). The creek channel has been previously relined with sandstone blocks. The vegetation within and adjacent to the creek is a combination of native and introduced species.

Figure 18 Archers Creek Catchment Area

Figure 19 Archers Creek site at Maze Park looking downstream (left) and upstream (right), Autumn 2024

7.2 Results and Interpretation

Macroinvertebrates

SIGNAL SF

SIGNAL_SF results were comparable between seasons. The average result for Spring 2023 was 4.26 (Figure 20). This was consistent with the historical Spring average of 4.46. The Autumn 2024 result was slightly higher with an average of 4.62. As with Spring, this result was within range of the Autumn average (4.51).

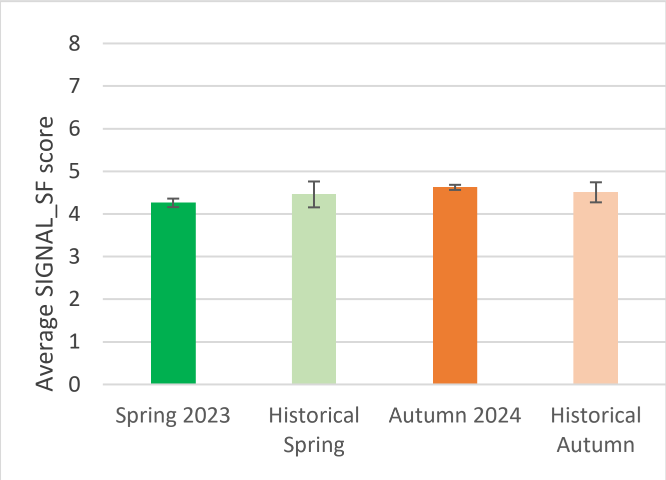

Figure 20 Archers Creek average SIGNAL_SF results

Taxa Richness

During Spring 2023 the average taxa richness result for Archers Creek was 9. This was lower than the average Spring result (15.3) and below the historical range for this season. During Autumn 2024, average richness rose to 11.5. This score was within the historical result range for Autumn.

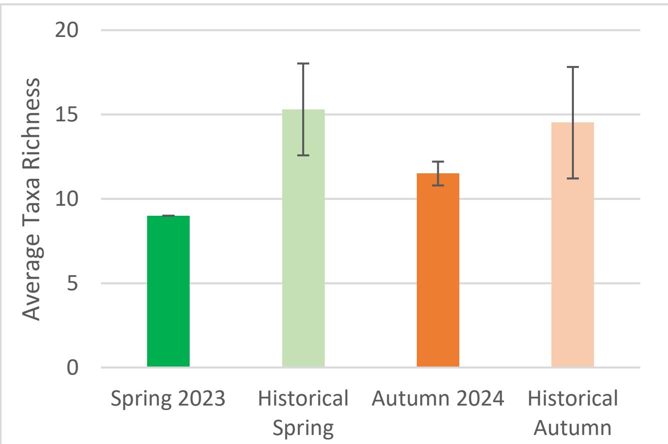

Figure 21 Archers Creek average richness results

Macroinvertebrate Community Composition

The community composition of Archers Creek site was comparable between seasons. During both seasons the site was dominated by True Flies, Beetles, Dragonflies, and Aquatic Snail groups. There was a higher incidence of Dragonfly families during Autumn 2024. Caddisflies were only observed during Spring 2023, while True Bugs were only observed in samples collected during the Autumn 2024 season.

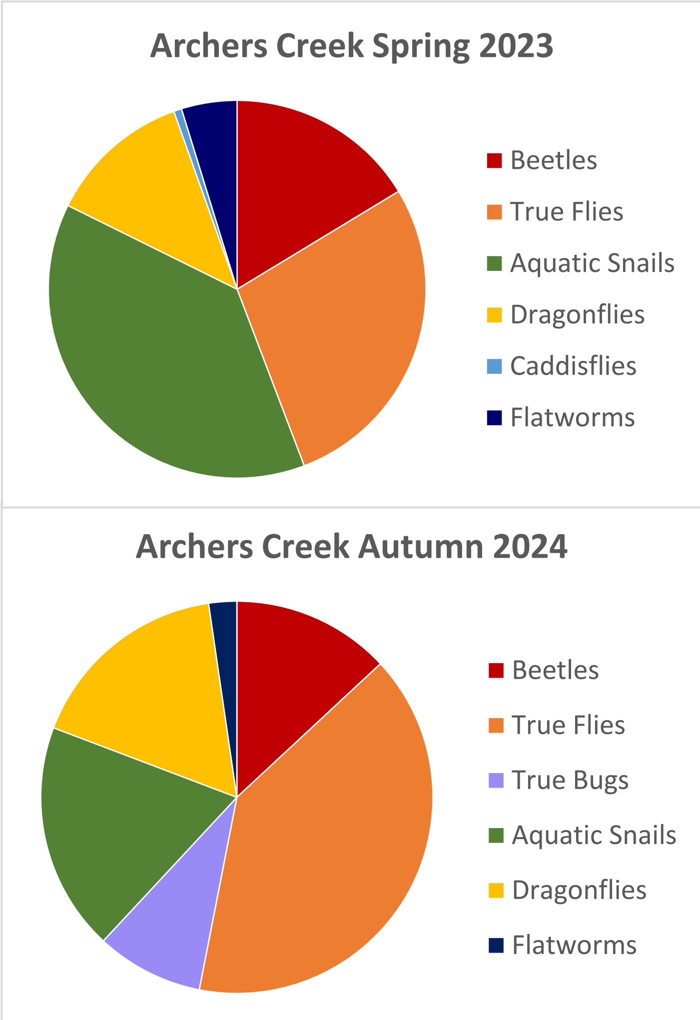

Figure 22 Archers Creek community composition charts for Spring 2023 (top) and Autumn 2024 (bottom)

Macroinvertebrates summary

SIGNAL_SF scores were consistent between Spring and Autumn seasons. Taxa richness results improved in Autumn 2024. The same taxa groups dominated the macroinvertebrate community for both sampling seasons.

Water Quality

For both Spring 2023 and Autumn 2024 seasons Archers Creek recorded low dissolved oxygen (%) with results of 51.2% and 46.1% respectively. This was below the recommended ANZECC guideline lower limit of 85%. Turbidity results were relatively low for both seasons. Spring 2023 had a turbidity result of 2.00 NTU while the result for Autumn 2024 was slightly higher at 5.94 NTU.

Conductivity results were variable between seasons. Spring 2023 had a conductivity reading of 838 µS/cm. This was reduced to 293 µS/cm in the following Autumn season. Spring and Autumn recorded similar pH results ranging between 7.01 – 7.07 pH units.

Faecal coliform concentration increased from Spring 2023 to Autumn 2024. Spring 2023 had a concentration result of 17 CFU/100mL. During Autumn 2024 this rose to 230 CFU/100mL. This result was still lower than the ANZECC guideline threshold of 1000 CFU/100mL.

The total nitrogen result for Spring 2023 was 290 µg/L. This was lower than the ANZECC guideline limit of 350 µg/L. However, during Autumn 2024 this result rose above the guideline limit to 440 µg/L. During Spring 2023 the total phosphorus result at Archers Creek was 16 µg/L. This result was below the ANZECC threshold for this analyte (50 µg/L). During Autumn 2024 the total phosphorus result rose to 52 µg/L, exceeding the recommended concentration limit. Total hardness results reduced from 140 mg CaCO3/L (Spring 2023) to 77 mg CaCO3/L (Autumn 2024).

Water quality summary

Dissolved oxygen and turbidity results were low for both Spring 2023 and Autumn 2024 seasons. Conductivity results were variable between seasons. Faecal coliform concentration increased during Autumn 2024. Total nitrogen and phosphorus results increased above guideline limits during Autumn 2024.

8 Terrys Creek

8.1 Sites CR3T, CR3TA

CR3T Terrys Creek (core site)

This site is located within Somerset Park under the M2 overpass in the suburb of Epping (Figure 23). The surrounding land use is residential, and the creek flows through a bushland corridor. The riparian area bordering the creek contains both native and exotic plant species. The creek bed is predominately bedrock, gravel, and sand (Figure 24).

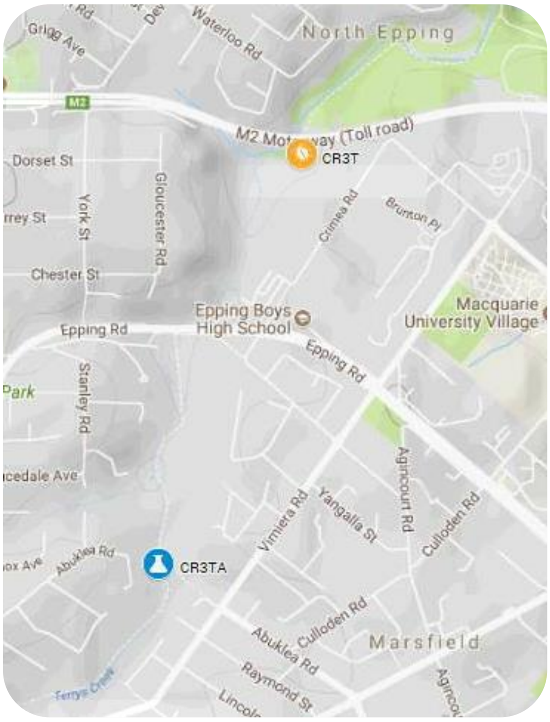

Figure 23 Terrys Creek Catchment Area

CR3TA Terrys Creek at Forrester Park

This site is located downstream of Terrys Creek Waterfall, which is an area surrounded by bushland (Figure 25). Dense vegetation covers both banks and consists of a mixture of native and introduced species. The bank is comprised of sediment (mostly sand and silt) and river rocks, which create riffle zones.

Figure 24 Terrys Creek core site at Somerset Park (CR3T) looking downstream (Autumn 2024)

Figure 25 Terrys Creek site at Forrester Park (CR3TA) looking downstream (Autumn 2024)

8.2 Results and Interpretation

Macroinvertebrates

SIGNAL SF

Terrys Creek average SIGNAL_SF scores were consistent between seasons. During Spring 2023 the SIGNAL_SF result was 4.14. This was within range of the historical Spring average (4.17). Similarly, Autumn 2024 had an average SIGNAL_SF score of 4.17 which was comparable to the historical Autumn average for this site (4.19).

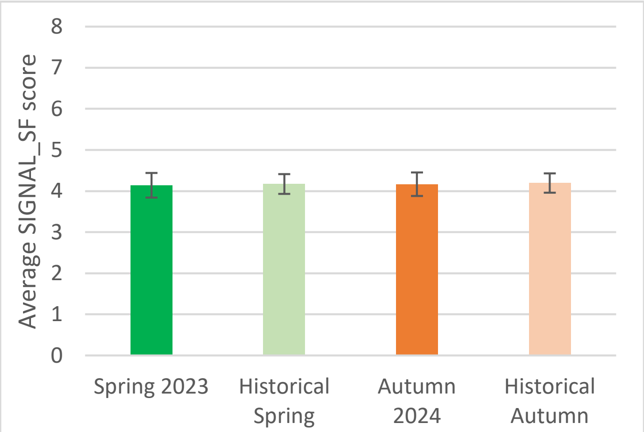

Figure 26 Terrys Creek average SIGNAL_SF results

Taxa Richness

The average taxa richness result during Spring 2023 was 9. This result was lower than the historical Spring average for this site (13.65). During Autumn 2024 the average richness result was higher (12.5) and was within range of the historical Autumn average (14.77).

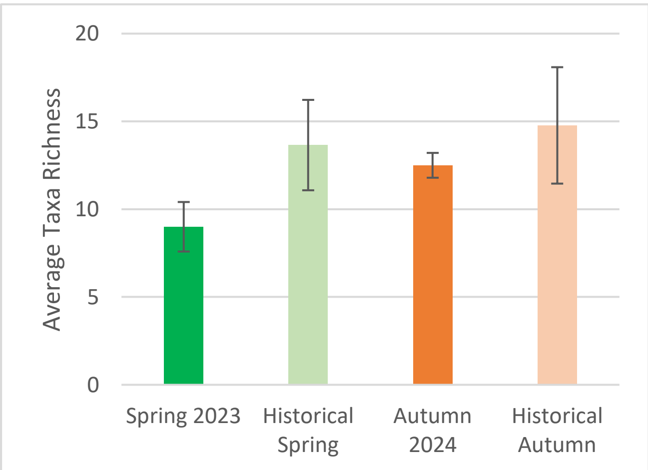

Figure 27 Terrys Creek average Taxa Richness

Macroinvertebrate Community Composition

Community composition at Terrys Creek catchment was consistent between Spring 2023 and Autumn 2024. Both seasons were dominated by the Aquatic Snails and Dragonfly groups. The same range of taxa was identifed during both sampling periods.

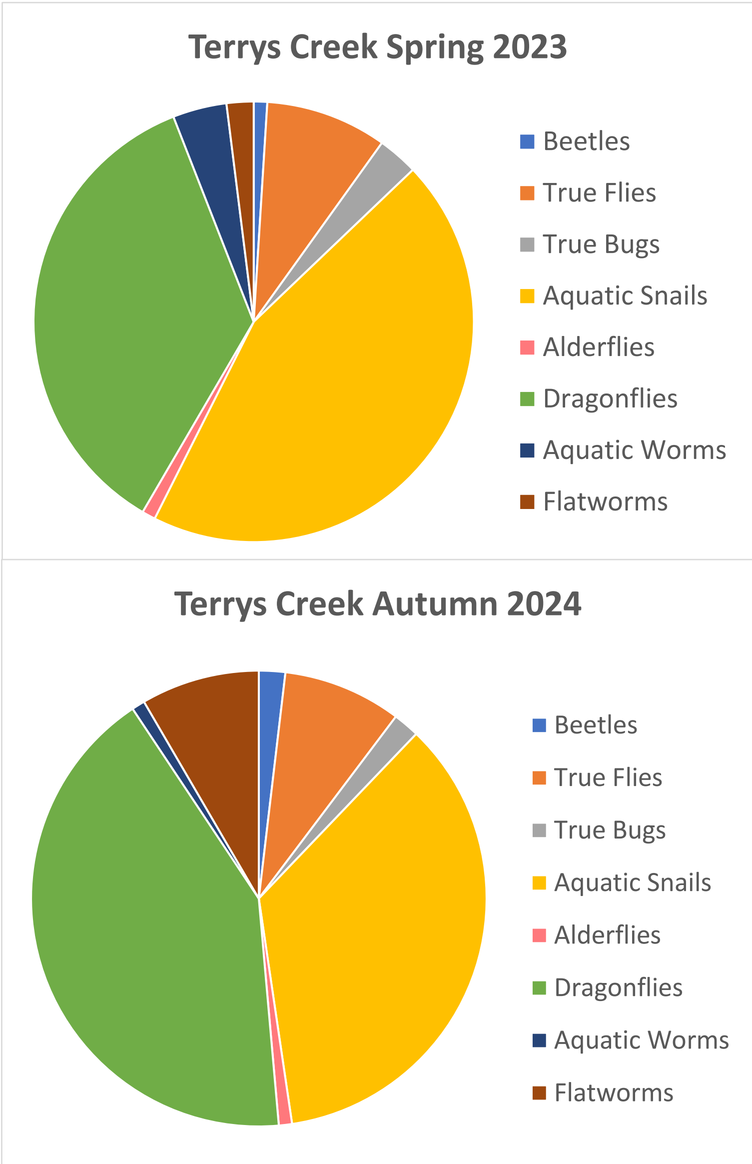

Figure 28 Terrys Creek community composition charts for Spring 2023 (top) and Autumn 2024 (bottom)

Macroinvertebrates summary

SIGNAL_SF scores were consistent between seasons. Autumn 2024 had a higher observed taxa richness result. The same macroinvertebrate orders were observed during both seasons.

Water Quality

Dissolved oxygen results at Terrys Creek catchment were relatively consistent between seasons. During Spring 2023, Terrys Creek core site (CR3T) had a dissolved oxygen result of 53.4%. During Autumn 2023 this result was higher at 66.8%. Both results were lower than the ANZECC guideline limit of 85%. Terrys Creek at Forrester Park site (CR3TA) had higher dissolved oxygen readings for both seasons. During Spring 2023 the result was 86.2. In the following Autumn season this fell slightly to 82.1%.

Both sites within this catchment recorded low turbidity results for Spring and Autumn seasons. The turbidity result at Terrys Creek core site during Spring 2023 was 2.88 NTU. This was slightly lower in Autumn 2024 (2.55 NTU). For both seasons, the Forrester Park site recorded lower turbidity than the core site with results of 1.62 NTU (Spring 2023) and 1.16 NTU (Autumn 2024).

Conductivity results were higher during the Spring 2023 season for both sites. Terrys Creek core site had a result of 630 µS/cm which was higher than the result during Autumn 2024 (479 µS/cm). Similarly, Forrester Park site had a Spring result of 517 µS/cm which was higher than the Autumn 2024 result (472 µS/cm). Terrys Creek pH results were comparable between sites. The core site results were 7.07 (Spring 2023) and 7.30 pH units (Autumn 2024) while Terrys Creek at Forrester Park results were slightly higher at 7.52 (Spring 2023) and 7.49 pH units (Autumn 2024).

Terrys Creek core site had low faecal coliform results for both sampling seasons. All results were below the ANZECC guideline limit of 1000 CFU/100mL. In Spring 2023, Terrys Creek core site had a result of 28 CFU/100mL while the Autumn 2024 result was 50 CFU/100mL. The coliform result for Forrester Park during Autumn 2024 was 75 CFU/100mL. This was an improvement from the previous season which had a higher concentration result (600 CFU/100mL, Spring 2023).

Most nutrient results for this catchment exceeded the recommended guideline limit. The Total Nitrogen result for Terrys Creek core site during Spring 2023 was 260 µg/L. This was within the recommended guideline limit (350 µg/L). However, during Autumn 2024, this concentration increased to 470 µg/L. During the Spring 2023 season Total Phosphorus concentration at the core site was 25 µg/L. This concentration also rose during the following Autumn (43 µg/L)

Forrester Park site had more consistent Total Nitrogen results between seasons with concentrations from 610 µg/L (Spring 2023) to 580 µg/L (Autumn 2024). The Total Phosphorus result rose from 35 µg/L in Spring 2023 to above guideline value at 62 µg/L in Autumn 2024.

Water quality summary

Dissolved oxygen results were higher at Forrester Park site for both seasons. Faecal coliform concentrations were low at both Terrys Creek sites for Spring and Autumn seasons. Most nutrient results exceeded ANZECC guideline limits.

9 Buffalo Creek

9.1 Sites CR4B, CR4BA, CR4BB

Buffalo Creek catchment has one core site in the Field of Mars Reserve. The two remaining sites are water quality only and are located upstream in Burrows Park (Figure 29).

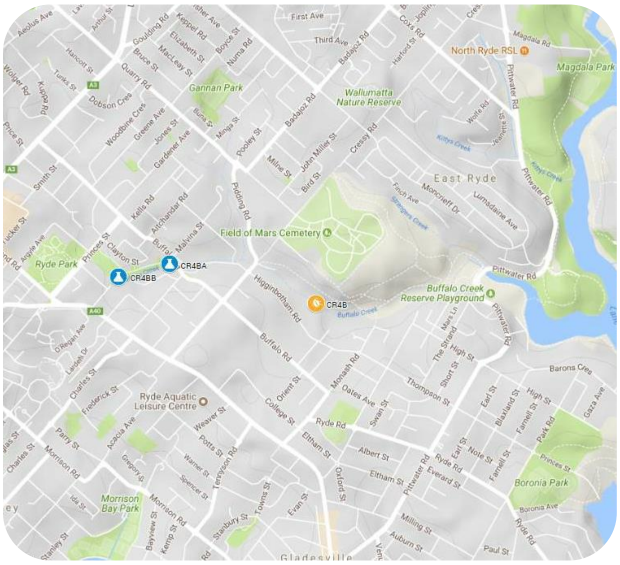

Figure 29 Buffalo Creek Catchment Area

Figure 30 Buffalo Creek core site (CR4B) looking downstream, Autumn 2024

CR4B Buffalo Creek (core site)

The Buffalo Creek core sampling site is located along the Southern border of the Field of Mars Reserve in the suburb of Gladesville and is accessed through private property (Figure 30, 31). The surrounding land use is a mix of residential, light industry/commercial and reserves. The surrounding vegetation is a mix of native and exotic species, with exotic species dominating. The southern bank is mostly residential lawns.

The creek bed is a mixture of sand, silt, and gravel. There is usually some macrophyte growth, (*Egeria* and *Potamogeton*), and a small amount of algal growth observed in the channel. Sedimentation has occurred in the creek channel periodically.

Figure 31 Buffalo Creek core site (CR4B) looking upstream, Autumn 2024

CR4BA Buffalo Creek Downstream of Burrows Park

The downstream Burrows Park site is accessed off Buffalo Rd and is positioned just before the creek flows under the road (Figure 32). The surrounding land use is residential, and Burrows Park consists mostly of a bush corridor. There are usually obvious signs of bird activity around this site, including extensive bird droppings.

Figure 32 Buffalo Creek Downstream of Burrows Park, Autumn 2024

CR4BB Buffalo Creek Upstream Burrows Park

The upstream Burrows Park site is about 300 metres upstream of Buffalo Road and lies in the middle of a bush corridor (Figure 33). The site is surrounded by vegetation that completely shades the creek. The creek is shallow at this point and has little flow.

Figure 33 Buffalo Creek Upstream Burrows Park, Autumn 2024

9.2 Results and Interpretation

Macroinvertebrates

SIGNAL SF

Buffalo Creek had the highest average SIGNAL_SF scores for both Spring and Autumn seasons. The SIGNAL_SF score for Spring 2023 was 4.54 (Figure 34). This was within range of the historical average (4.16). The average SIGNAL_SF score for Autumn 2024 was 4.73. This result was higher than the historical data range for this season which had an average result of 4.01.

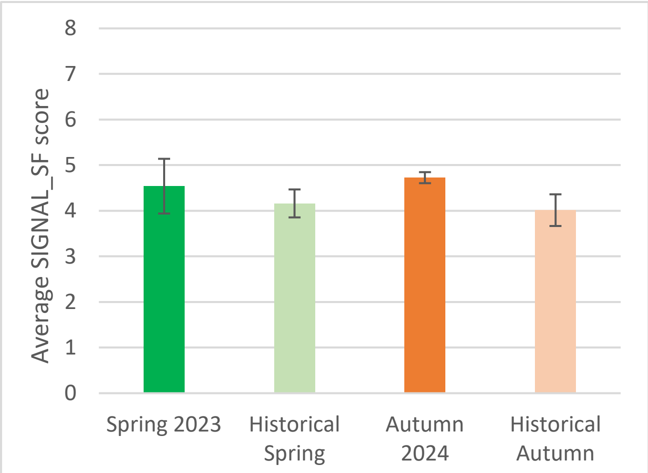

Figure 34 Buffalo Creek average SIGNAL_SF

Taxa Richness

Richness results were similar between seasons (Figure 35). Spring 2023 had an average richness result of 10 which was consistent with the historical average.

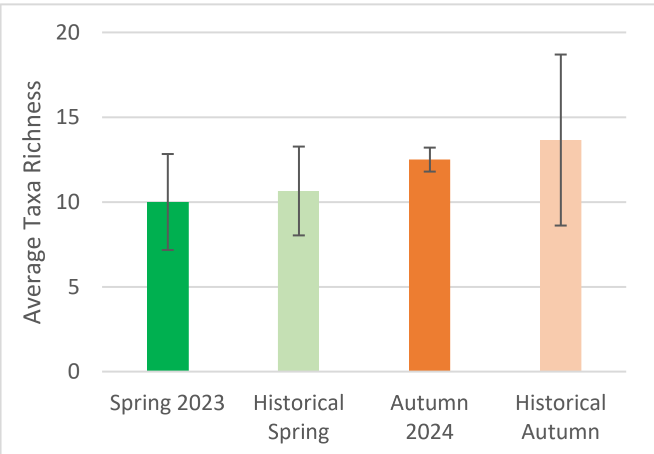

Figure 35 Buffalo Creek average taxa richness results

Autumn 2024 had a higher richness result of 12.5. This was within range of the historical Autumn data range which had a higher average result of 13.65.

Macroinvertebrate Community Composition

The Buffalo Creek macroinvertebrate community was dominated by Aquatic Snail and True Fly groups during both Spring 2023 and Autumn 2024 seasons (Figure 36). There was a higher prevalence of Beetle families during Spring 2023. The Autumn 2024 had a higher diversity of taxa with Aquatic Mites and True Bug groups additionally observed during this season.

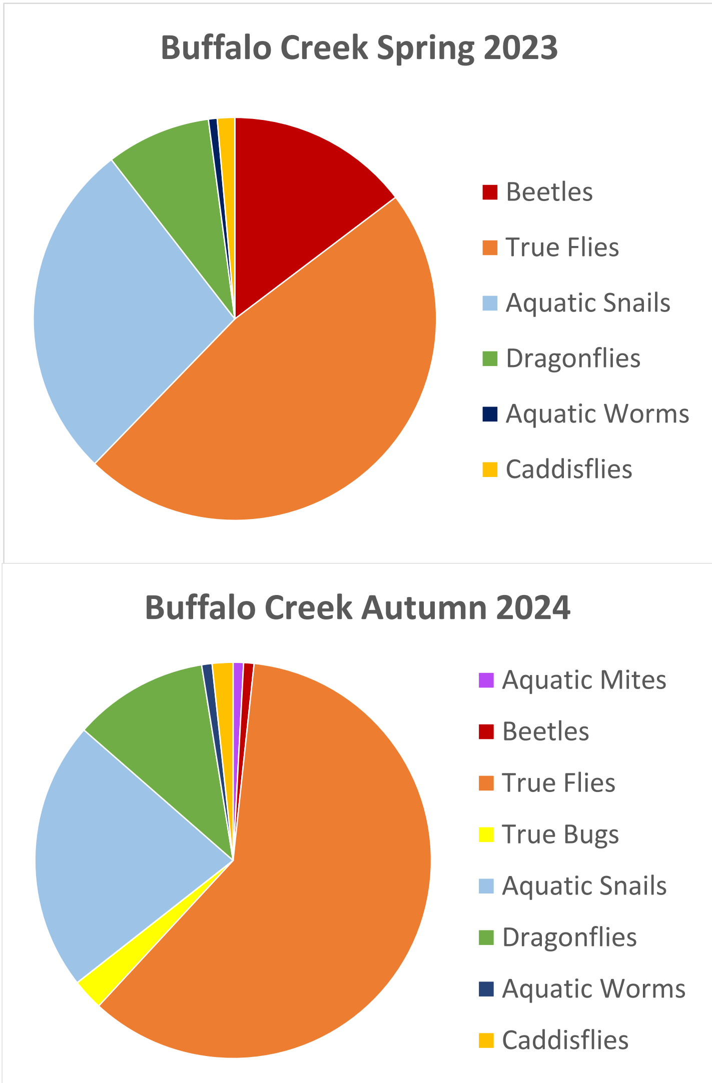

Figure 36 Buffalo Creek community composition charts for Spring 2023 (top) and Autumn 2024 (bottom)

Macroinvertebrates summary

Buffalo Creek had the highest average SIGNAL_SF scores for both Spring 2023 and Autumn 2024 seasons. The Autumn season had a slightly higher taxa richness result. This can be attributed to the additional presence of aquatic mites and true bug groups during this season.

Water Quality

Buffalo Creek catchment had relatively high dissolved oxygen results across all sites and sampling seasons. Buffalo Creek core site (CR4B) had a dissolved oxygen result of 89.6% during Spring 2023. During Autumn 2024 this result remained high (86.8%). Both results were within the recommended ANZECC guideline range (85-110%). Buffalo Creek downstream of Burrows Park (CR4BA) had dissolved oxygen results of 77.8% (Spring 2023) and 78.2% (Autumn 2024). Buffalo Creek upstream of Burrows Park (CR4BB) had a higher dissolved oxygen result in Spring 2023 (84.0%) than Autumn 2024 (67.3%) however, as with the downstream site, these results were below the lower ANZECC guideline limit (<85%).

Turbidity results were low in the Buffalo Creek catchment. Downstream of Burrows Park site had the highest turbidity readings for both Spring 2023 (5.79 NTU) and Autumn 2024 (8.94 NTU). The lowest results were observed at the core site during Spring 2023 (2.72 NTU) and Buffalo Creek upstream of Burrows Park site during Autumn 2024 (1.22 NTU).

Conductivity results were higher during the Autumn 2024 season. The highest conductivity result was at Buffalo Creek downstream of Burrows Park site during Autumn 2024 (896 µS/cm) which was an increase from the result observed during the previous Spring (599 µS/cm, 2023). The lowest conductivity result was observed at Buffalo Creek upstream of Burrows Park (436 µS/cm, Spring 2023). This result increased to 679 µS/cm during Autumn 2024.

Faecal coliform concentrations were generally lower during the current sampling season when compared to results of the previous Spring season. During Spring 2023, Buffalo Creek downstream of Burrows Park site had a coliform concentration above the ANZECC threshold limit (>1000 CFU/100mL) at 24000 CFU/100mL. This result was reduced to 990 CFU/100mL in Autumn 2024 and was back below the guideline concentration limit. Similarly, Buffalo Creek upstream of Burrows Park had a previous coliform concentration of 11000 CFU/100mL (Spring 2023), this was reduced to 580 CFU/100mL in Autumn 2024.

Total nitrogen results exceeded the threshold limit for all sites during both Spring and Autumn seasons. During Spring 2023 the highest nitrogen result was observed at Buffalo Creek Downstream of Burrows Park at 1780 µg/L which was above the threshold limit of 350 µg/L. The lowest result for this season was observed at Buffalo Creek core site at 670 µg/L. During Autumn 2024 the highest nitrogen result was observed at Buffalo Creek Upstream Burrows Park at 1670 µg/L. As with the previous Spring, the core site had the lowest nitrogen result for this season (600 µg/L). Total phosphorus results also exceeded the guideline limit at the most Buffalo Creek sites. During Spring 2023 the highest phosphorus result was at Burrows Creek upstream (121 µg/L). This was higher than the ANZECC guideline limit. The lowest result for this season was recorded at the core site. Similarly, during Autumn 2024, Burrows Park Upstream also recorded the highest phosphorus result (217 µg/L) while the lowest was again observed at the core site (31 µg/L).

Alkalinity results in Spring 2023 were consistent between the three Buffalo Creek sites with results ranging from 62 – 67 mg/L. In Autumn 2024, alkalinity was higher across each of the sites and the results range was from 93 to 114 mg/L.

Water quality summary

Most sites had high dissolved oxygen and low turbidity results. In general, faecal coliform concentration was reduced during Autumn 2024. Faecal coliform results greatly improved at Burrows Park sites during Autumn 2024 after very high results during the previous Spring. Nitrogen and phosphorus concentrations were elevated above guideline limits for all sites.

10 Porters Creek

10.1 Sites CR5P, CR5PA, CR5PB, CR5PC

There is one core site and three water quality only sites within the Porters Creek Catchment (Figure 37). From 1969 to 1986 the Council's Porters Creek site operated as a landfill site. It now operates as a construction waste recycling facility.

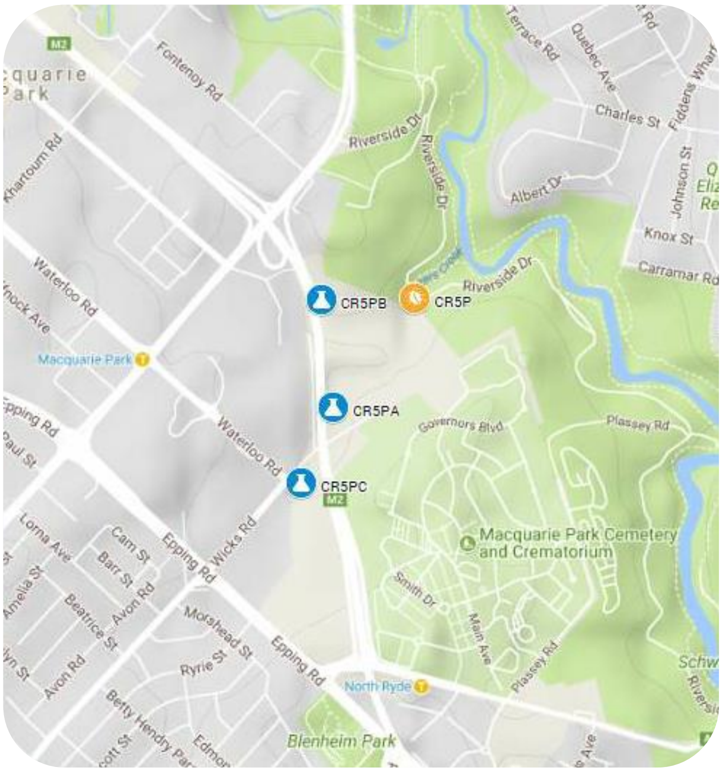

Figure 37 Porters Creek Catchment Area

CR5P Porters Creek (core site)

This site is in the Lane Cove National Park, North of the Council's Environmental Construction Materials Recycling Facility (Figure 38). It is at this point that Porters Creek emerges after flowing mostly underground in its upper section. Water quality and macroinvertebrate sampling was conducted near the Porters Creek Bridge.

The surrounding riparian area is dominated by native plants with a small number of exotic species. The creek bed is mostly bedrock with some cobble, boulder, and sand. No macrophyte growth has been observed although there has been algal growth present.

Figure 38 Porters Creek core site (CR5P) looking upstream (left) and downstream (right) Autumn 2024

CR5PA Porters Creek at Main Branch

This site is located on the western boundary of the construction waste recycling facility and consists of an open concrete channel. Samples are collected from the retention basin at the end of the channel. During Autumn 2024 this site could not be accessed due to construction works in the area.

Figure 39 Porters Creek at Main Branch facing downstream

CR5PB Porters Creek at Spur Branch

This site is in the north-western corner of the centre in an underground drainage pit where several underground stormwater lines meet before joining and draining to the main Porters Creek line (Figure 41). During Autumn 2024 the channel was mostly dry but there was a pooled section at the top that could be accessed.

CR5PC Porters Creek at Wicks Road

This site is the first point that Porters Creek emerges from the underground stormwater system. The site is surrounded by commercial and industrial land uses. The banks have been re-lined with sandstone and surrounding area vegetated with native plants.

Figure 40 Porters Creek at Wicks Road, Autumn 2024

Figure 41 Porters Creek at Spur Branch channel looking downstream (left) and pooled section in the upper channel (right) Autumn 2024

10.2 Results and Interpretation

Macroinvertebrates

SIGNAL SF

The Autumn 2024 SIGNAL_SF score was 4.53 (Figure 42). This was within range of the historical Autumn average (4.37). This result was also consistent with the previous Spring SIGNAL_SF score of 4.51. This score was also within range of the historical Spring average (4.28).

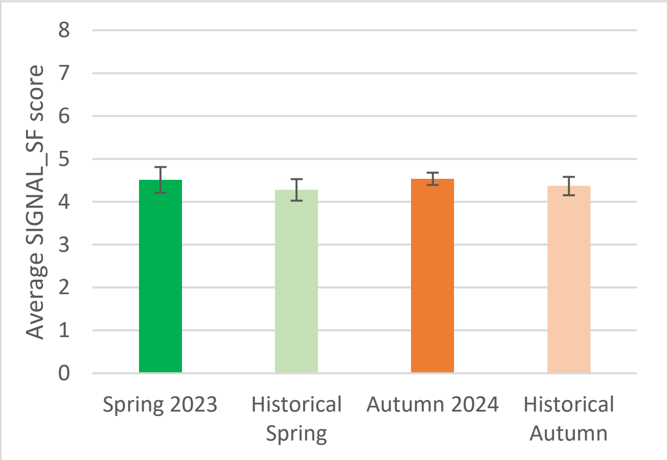

Figure 42 Porters Creek average SIGNAL_SF results

Taxa Richness

Porters Creek richness score improved during Autumn 2024. In Spring 2023, the average richness result was 6 (Figure 43.) which was below the historical average (11.5). During Autumn 2024 season the richness result improved to 14.5 and shifted back into historical range for Autumn which had an average result of 13.96.

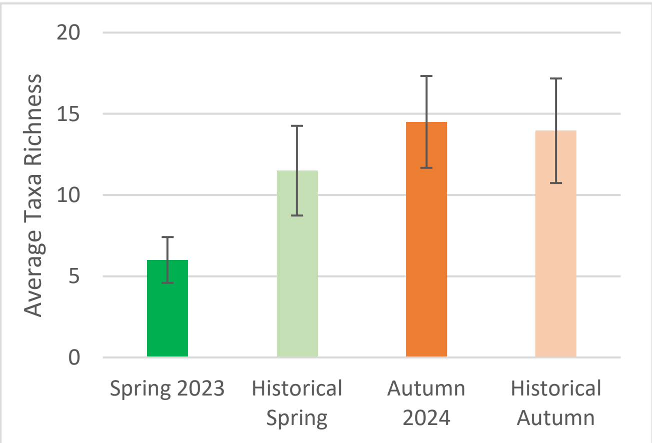

Figure 43 Porters Creek average taxa richness results

Macroinvertebrate Community Composition

During Spring 2023, Porters Creek had a relatively homogenous community dominated by the True Flies group (Figure 44). There was also a high representation of Aquatic Snails. The following Autumn season saw an improvement in community diversity. This included the presence of True Bug and Caddisfly groups as well as an increase in the number of dragonfly families identified.

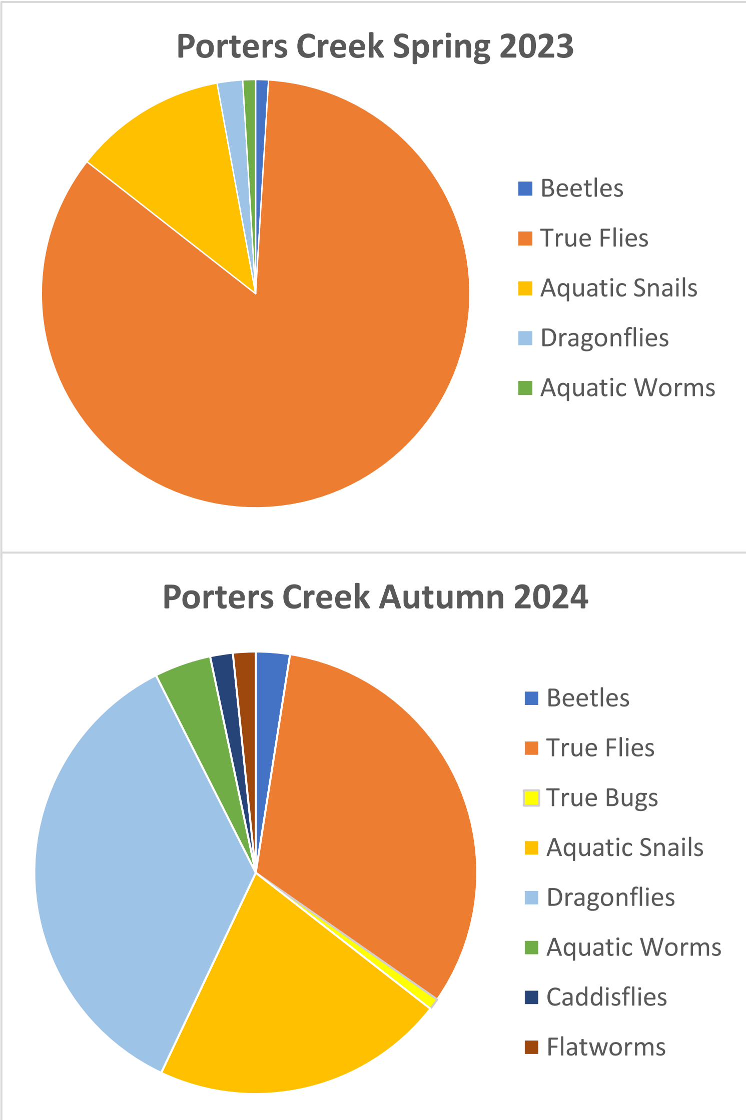

Figure 44 Porters Creek community composition charts for Spring 2023 (top) and Autumn 2024 (bottom)

Macroinvertebrates summary

SIGNAL_SF scores were consistent between seasons. Taxa Richness greatly improved during the Autumn 2024 season.

Water Quality

Dissolved oxygen results at Porters Creek core site (CR5P) improved during the current sampling season. The Autumn 2024 result was 85.3% which was within the ANZECC guideline threshold limit. In contrast, the result of the previous season was much lower and below the recommended guideline range (64.3%, Spring 2023). Porters Creek at Spur Branch site (CR5PB) saw a lower result in Autumn 2024 (78.1%) when compared to Spring 2023 (90.4%). Porters Creek at Wicks Road site (CR5PC) had the highest dissolved oxygen results for Spring 2023 and Autumn 2024 with concentrations of 100.9% and 96.7% respectively. Dissolved oxygen at Porters Creek Main Branch site (CR5PA) during Spring 2023 was 59.8% which was below the lower ANZECC guideline limit.

Autumn 2024 saw an improvement in turbidity results for Porters Creek core site. During the previous Spring season, a sewer overflow event greatly increased turbidity in the channel (91.40 NTU, Spring 2023) above the upper ANZECC guideline limit (50 NTU). During Autumn 2024 turbidity was reduced to 2.58 NTU. Porters Creek at Spur Branch had consistently low turbidity results; 1.12 NTU (Spring 2023) and 2.50 NTU (Autumn 2024). Porters Creek at Wicks Road site had a higher result in Autumn 2024 (9.12 NTU) when compared with Spring 2023 (3.24 NTU). Porters Creek Main Branch site had moderately low turbidity (11.00 NTU, Spring 2023).

Conductivity results in the Porters Creek catchment were within ANZECC guideline limits for all sites. At Porters Creek core site conductivity was higher in Spring 2023 (516 µS/cm) than in Autumn 2024 (356 µS/cm). The highest conductivity for Spring 2023 was observed at Porters Creek Main Branch site (777 µS/cm) while the highest Autumn 2024 result was observed at Porters Creek Wicks Road (455 µS/cm).

A sewer overflow event at Porters Creek core site during Spring 2023 caused an extremely high faecal coliform concentration result (100,000 CFU/100mL) was which was well above the guideline limit of 1000 CFU/100mL. During the next Autumn season this result had reduced to 9100 CFU/100mL although this was still above the threshold limit. For Porters Creek at Spur Branch site (CR5PB) coliform concentrations were below guideline limits for both seasons with results of 60 CFU/100mL (Spring 2023) and 270 CFU/100mL (Autumn 2024). Porters Creek at Wicks Road site (CR5PC) saw an increase in coliform concentration from 450 CFU/100mL in Spring 2023 to 2800 CFU/100mL in Autumn 2024 which exceeded the guideline limit. Porters Creek Main Branch site (CR5PA) had very low coliform concentration result (1 CFU/100mL, Spring 2023).

Both Spring 2023 and Autumn 2024 had exceedances in nutrient concentrations across most sampling sites. During Spring 2023, Porters Creek core site had the highest nitrogen concentration (24200 µg/L) for the season which was above the threshold limit of 350 µg/L. The lowest result for the season was at Spur branch site (CR5PC) which had a result of 330 µg/L and below the guideline limit (<350 µg/L). During Autumn 2024, all sites exceeded the guideline limit for nitrogen. The highest nitrogen result was at Wicks Road site (5500 µg/L) while the lowest was at Spur branch site (430 µg/L).

Similarly, most total phosphorus results exceeded the guideline limit. During Spring 2023 Porters Creek core site recorded a phosphorus result of 3500 µg/L. This was well above the guideline limit of 50 µg/L. In Autumn 2024 this result was lower at 32 µg/L.

In Spring 2023 Porters Creek at Spur Branch site had a result of 14 µg/L. This was the only site that had a result below the guideline threshold. During Spring 2023 the highest alkalinity result was at Porters Creek Main Branch site (319 mg/L). This was the highest alkalinity result for this season. This result may be due to the location of the sampling zone in a concrete basin with little to no flow. Concrete is an alkaline material, a property which is important in construction as it protects against the corrosion of steel components. During Spring 2023 the lowest alkalinity result was at Porters Creek at Wicks Road site (72 mg/L). Autumn 2024 had a lower range of alkalinity with the lowest observed at Spur branch site (67 mg/L) and the highest at the core site (82 mg/L).

Porters Creek Heavy metals results

The four Porters Creek sites had additional heavy metals testing conducted during Spring 2023 and Autumn 2024 seasons the results of which are summarised in Table 4 below. The analytes tested were mercury, arsenic, cadmium, chromium, copper, iron, lead, manganese, and zinc. The concentration result for each analyte was compared to the toxicant default guideline value (95% level of species protection limit, ANZECC 2000). Respective Total Hardness results were used to adjust threshold limits accordingly (Summary Table 4 – Appendix). ANZECC (2000) recommends that the toxicity trigger values for hardness-related metals (in this study: cadmium, copper, lead, and zinc) are adjusted to account for local water hardness. This is important because the trigger values for these metals have been derived for soft waters (30 g/m3 CaCO3), corresponding to high toxicity.

Table 4 Porters Creek heavy metal results for Spring 2023 and Autumn 2024 seasons. Adjusted guideline limit values used as applicable

	Total Mercury (µg/L)	Total Arsenic (µg/L)	Total Cadmium (µg/L)	Total Chromium (µg/L)	Total Copper (µg/L)	Total Iron (µg/L)	Total Lead (µg/L)	Total Manganese (µg/L)	Total Zinc (µg/L)
Spring 2023									
CR5P	<0.3	<20	<5	<5	90	2390	10	209	130
CR5PA	<0.3	<20	<5	<5	<5	1010	<10	253	10
CR5PB	<0.3	<20	<5	<5	5	180	<10	31	10
CR5PC	<0.3	<20	<5	<5	7	260	<10	16	20
Autumn 2024									
CR5P	<0.3	<20	<5	<5	<5	430	<10	13	10
CR5PA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CR5PB	<0.3	<20	<5	<5	<5	280	<10	19	<10
CR5PC	<0.3	<20	<5	<5	9	430	<10	11	50

The adjusted threshold limits are listed in Table 4.1 below. During both sampling seasons the concentration results for analytes; mercury, arsenic, cadmium, and chromium were below detection limits. During Spring 2023 several sites had exceedances in total copper (µg/L) concentration. The highest result was observed at Porters Creek core site (CR5P) with a result of 90 µg/L which was above the standard ANZECC guideline limit of 1.4 µg/L (Table 4).

Porters Creek at Spur Branch (CR5PB) and Porters Creek at Wicks Road (CR5PC) sites also had exceedances with results of 5 µg/L and 7 µg/L respectively (above adjusted limit 3.5 µg/L). Only site Porters Creek at Main Branch (CR5PA) had a copper result below the detection limit.

Autumn 2024 saw an improvement in copper results with only one site exceeding the guideline limit (9 µg/L, CR5PC).

Total lead concentrations were below the detection limit (<10 µg/L) for most sites during both seasons. During Spring 2023, only Porters Creek core site (CR5P) had a result of 10 µg/L which was higher than the guideline limit of 3.4 µg/L. Autumn 2024 saw an improvement in lead concentrations with all sites recording concentrations below detection limits.

During Spring 2023, Porters Creek core site had a Zinc concentration result of 130 µg/L which was above the guideline limit of 8 µg/L. Porters Creek at Wicks Road site had a result of 20 µg/L which was the same as the adjusted guideline limit for zinc. Porters Creek at Main Branch and Porters Creek at Spur branch sites had results below the adjusted concentration limit.

During Autumn 2024, only Porters Creek at Wicks Road site had an elevated zinc concentration of 50 µg/L which was higher than the adjusted threshold limit of 31.2 µg/L.

Total Manganese results were below the guideline limit (1900 µg/L) for each site across both sampling periods.

Table 4.1 Adjusted guideline limit values for Porters Creek sites

		Adjusted limit				Adjusted limit		
Site	Spring 2023 Hardness Result	Copper	Lead	Zinc	Autumn 2024 Hardness Result	Copper	Lead	Zinc
CR5P	x	1.4	3.4	8	100	3.5	13.6	20
CR5PA	290	7.28	40.12	41.6	x	x	x	x
CR5PB	100	3.5	13.6	20	75	3.5	13.6	20
CR5PC	110	3.5	13.6	20	130	5.46	25.84	31.2

Water quality summary

Dissolved oxygen results improved for most sites during Autumn 2024. In Spring 2023, turbidity and faecal coliform concentrations at Porters Creek core site were extremely high. During the following Autumn season these results were greatly improved. Most heavy metal results were below detection limit although there were exceedances for copper and zinc during both seasons.

11 Rapid Riparian Assessment

Rapid Riparian Assessments (RRA) are conducted annually during the Spring sampling season at each of the five catchments. The process of this assessment involves the observation of stream features and vegetation community surrounding the stream. Table 5 summarises results from the two most recent Spring sampling seasons. Most rapid riparian scores were found to be consistent between Spring 2023 and Spring 2022 seasons with most sites maintaining the same score category.

Shrimptons Creek catchment RRA score category for the Spring 2023 season was 'Fair'. This was consistent with the result of the previous Spring season. However, the individual site score declined from 26 in 2022 to 2.4 in 2023. This could be attributed to the nearby State Significant Development that has involved vegetation removal in the riparian zone and in-creek works associated with the construction of the bridge. Additionally, during Spring 2023 there was an observed reduction in organic material and woody debris within the creek channel.

The 'Fair' score achieved by Archers Creek in Spring 2022 was maintained in Spring 2023. The high density and complex riparian vegetation observed in Spring 2022 was also present during the current sampling period.

In Spring 2023, Terrys, and Buffalo Creek sites both maintained the 'Good' RRA score observed during the previous Spring period.

Terrys Creek catchment is situated in a bushland corridor with extensive vegetation bordering both creek banks. The creek runs through a complex natural channel containing pool and riffle sequences. The channel has a high level of overhanging vegetation, and weed infiltration in the site was minimal.

The high score associated with Buffalo Creek catchment can be attributed to factors including the high density of bushland on the left creek bank, a moderate amount of in-channel woody debris present, the presence of both pool and riffle sequences as well as low litter presence.

During Spring 2023, the RRA score at Porters Creek increased from "Good" to 'Excellent". This improvement was associated with a higher presence of woody debris in-channel, an increase in the density of over-hanging vegetation and a reduction in the presence of weeds.

Table 5 Rapid Riparian results for Spring 2022 & Spring 2023

Catchment	Season	
	Spring 2023	Spring 2022
Shrimptons	2	26
Archers	14	13
Terrys	57	56
Buffalo	38	37
Porters	68	50

12 Spring 2023 & Autumn 2024 Data

This section provides a summary of selected in-field and analytical laboratory data collected during the Spring 2023 and Autumn 2024 sampling seasons for each of the 14 sampling sites. Data from both sampling periods have been plotted together on the same graph for seasonal comparison.

Figure 45 Dissolved oxygen (%) results for Spring 2023 and Autumn 2024

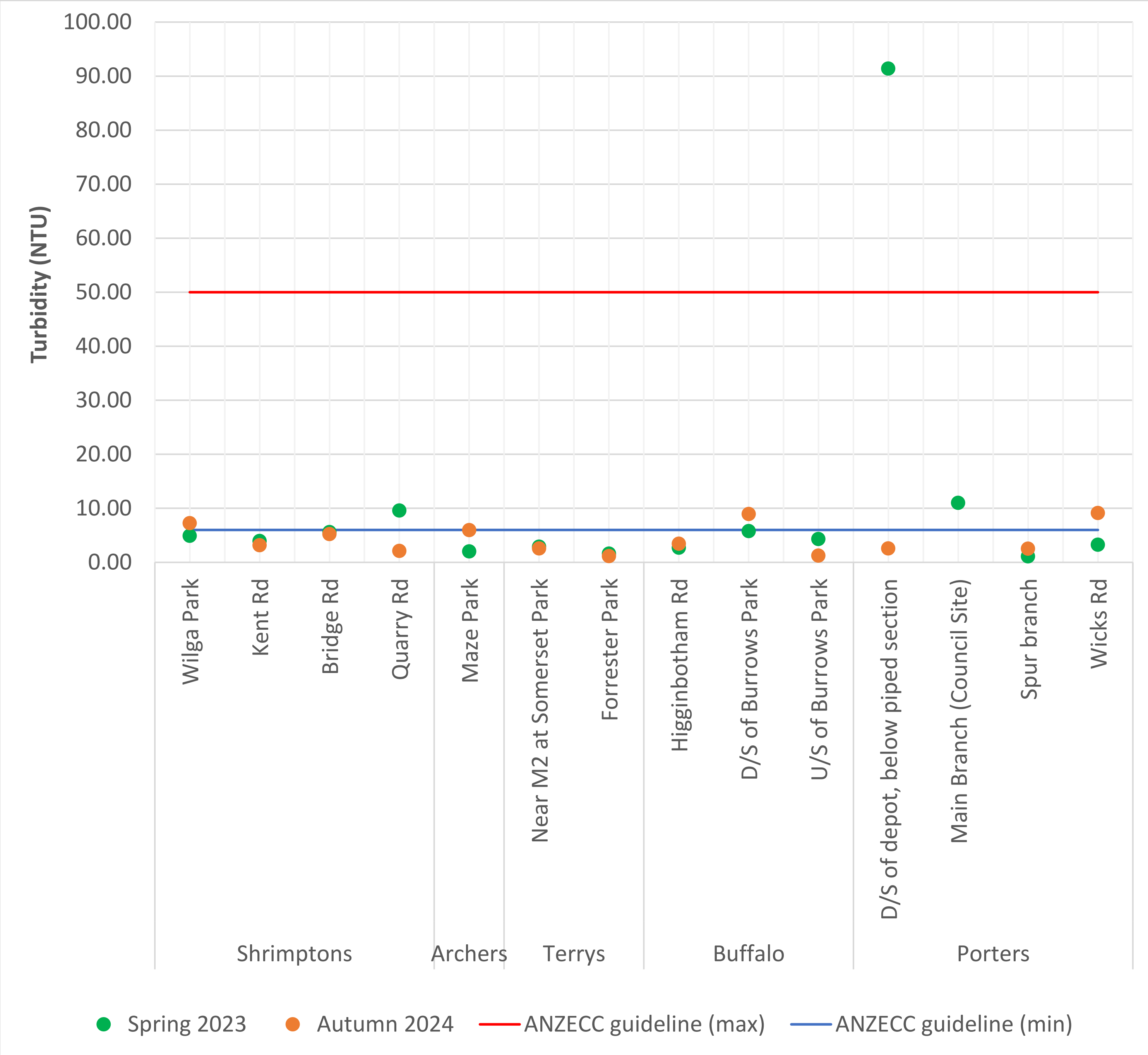

Figure 46 Turbidity (NTU) results for Spring 2023 and Autumn 2024

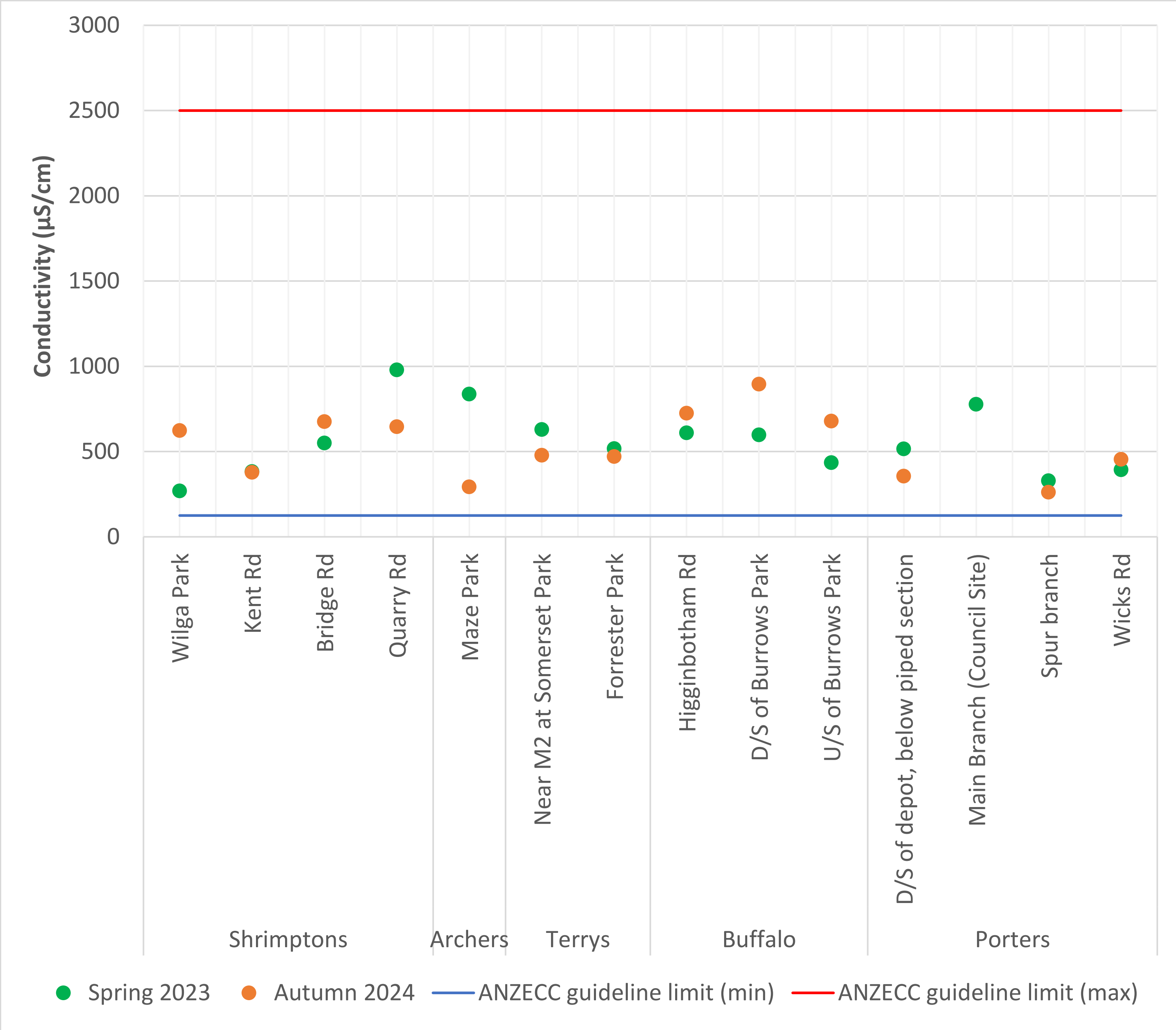

Figure 47 Conductivity (µS/cm) results for Spring 2023 and Autumn 2024

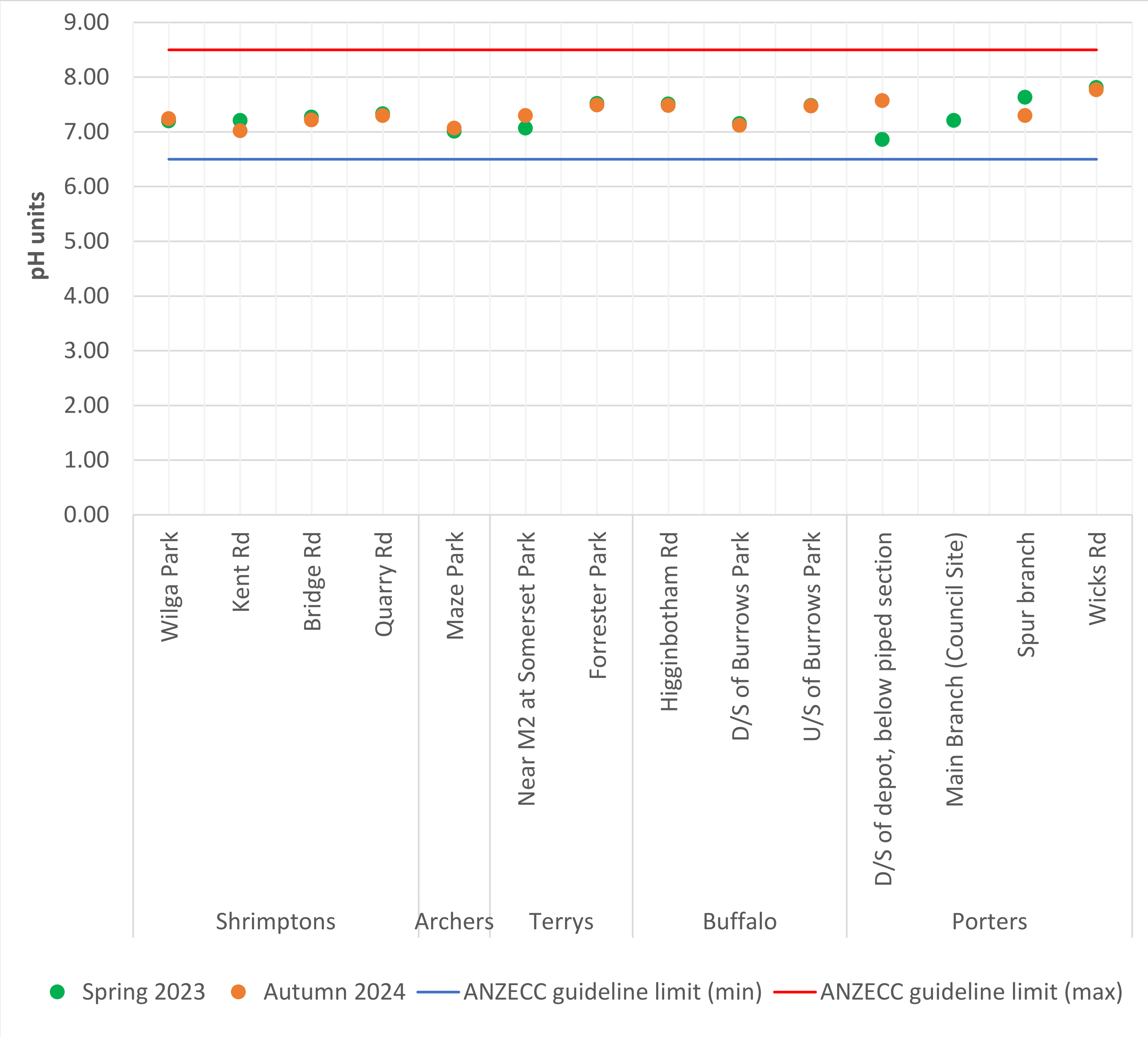

Figure 48 pH results (pH units) for Spring 2023 and Autumn 2024

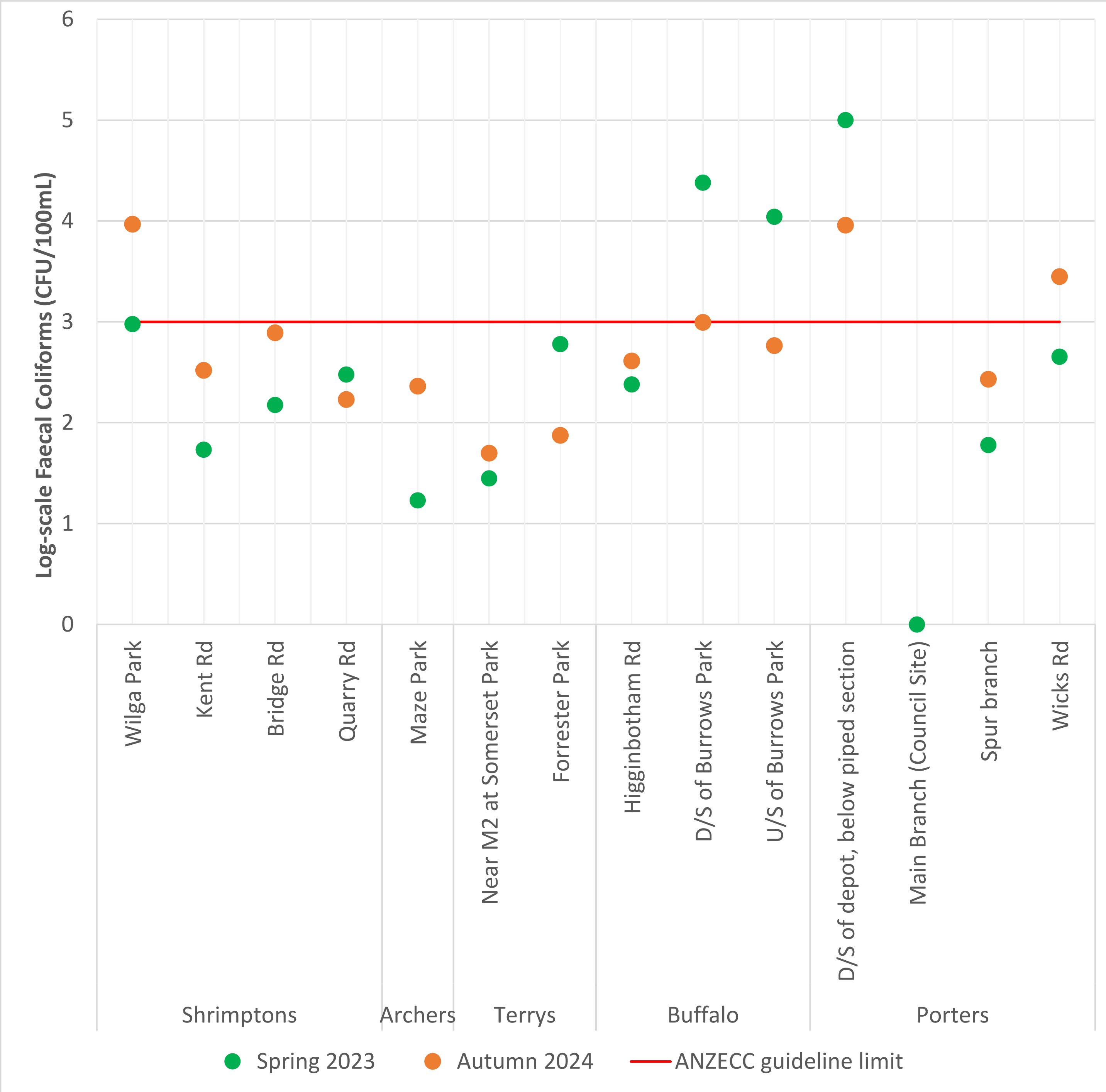

Figure 49 Faecal Coliform Concentration (CFU/100mL) results for Spring 2023 and Autumn 2024 (log values used)

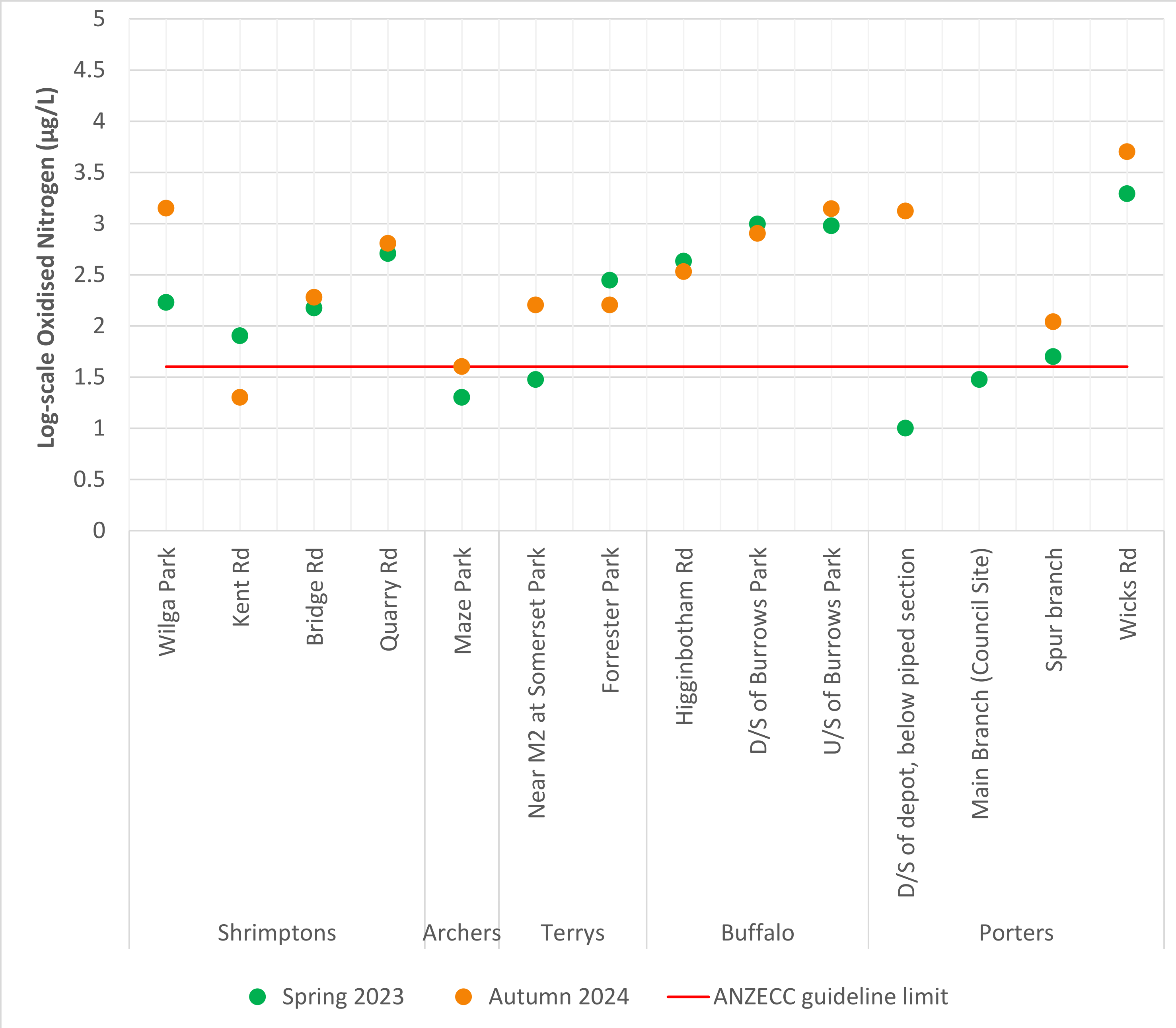

Figure 50 Oxidised Nitrogen (µg/L) results for Spring 2023 and Autumn 2024 (log values used)

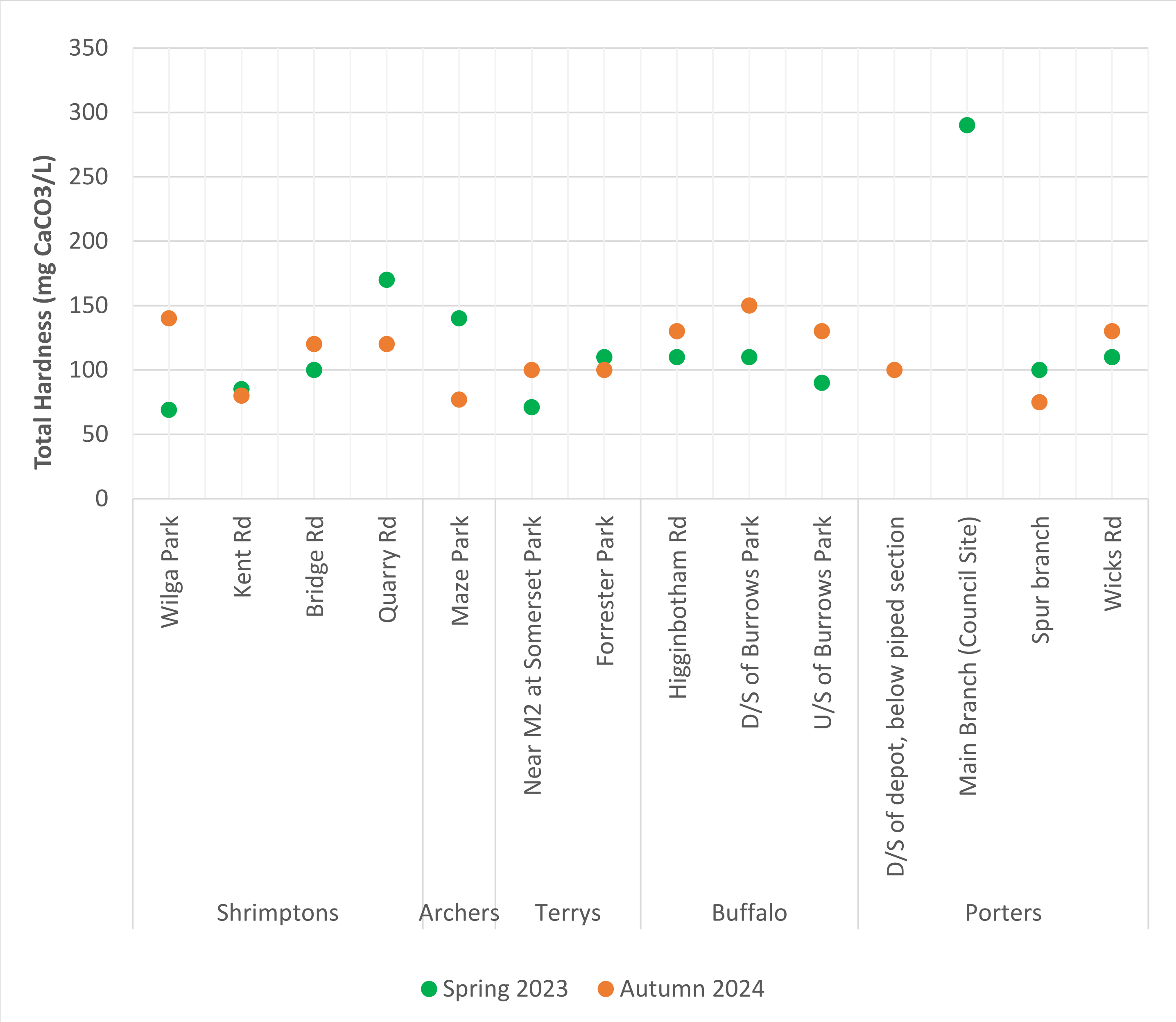

Figure 51 Total Hardness (mg CaCO3/L) results for Spring 2023 and Autumn 2024

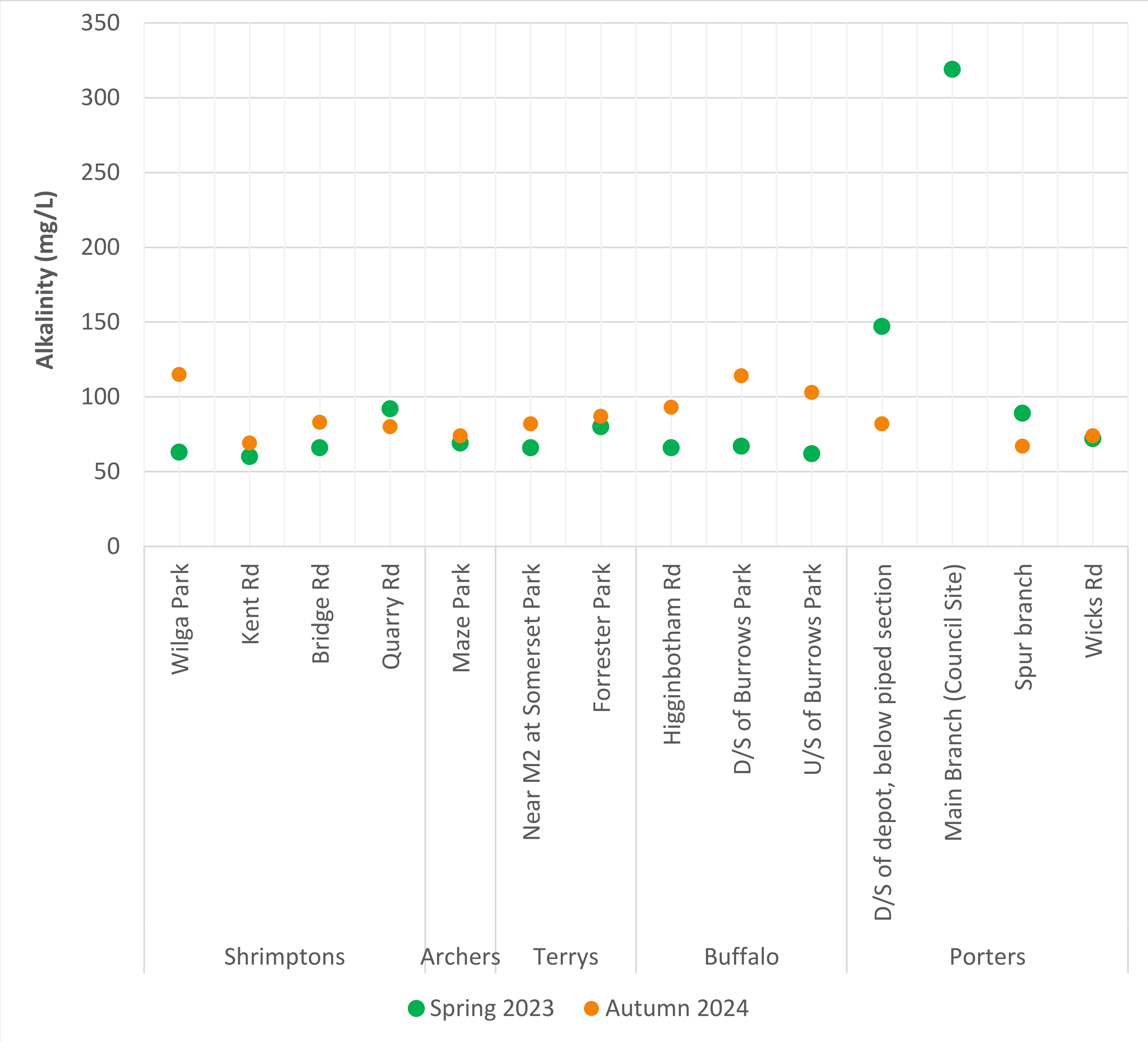

Figure 52 Total Alkalinity (mg/L) results for Spring 2023 and Autumn 2024

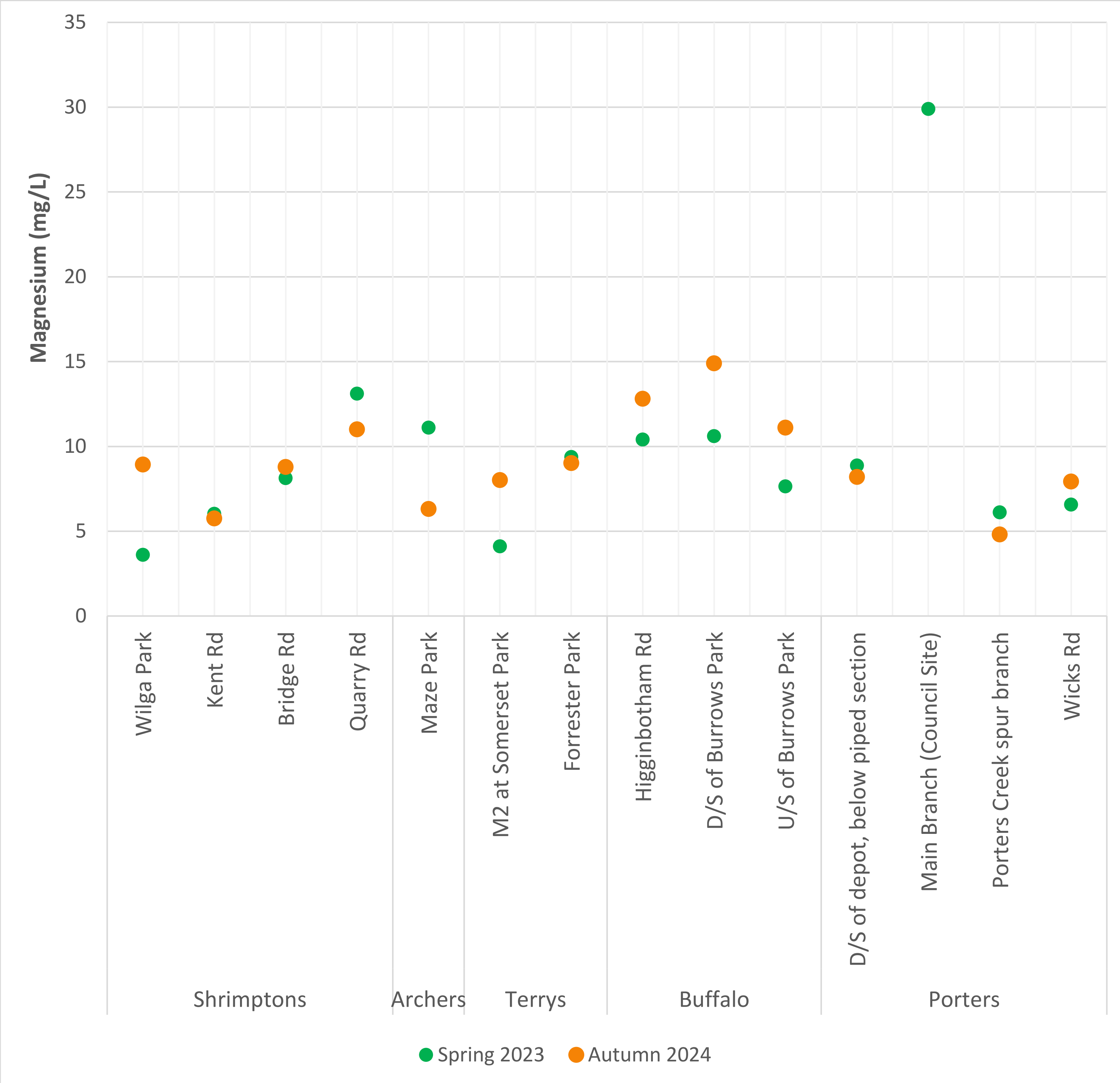

Figure 53 Magnesium (mg/L) results for Spring 2023 and Autumn 2024

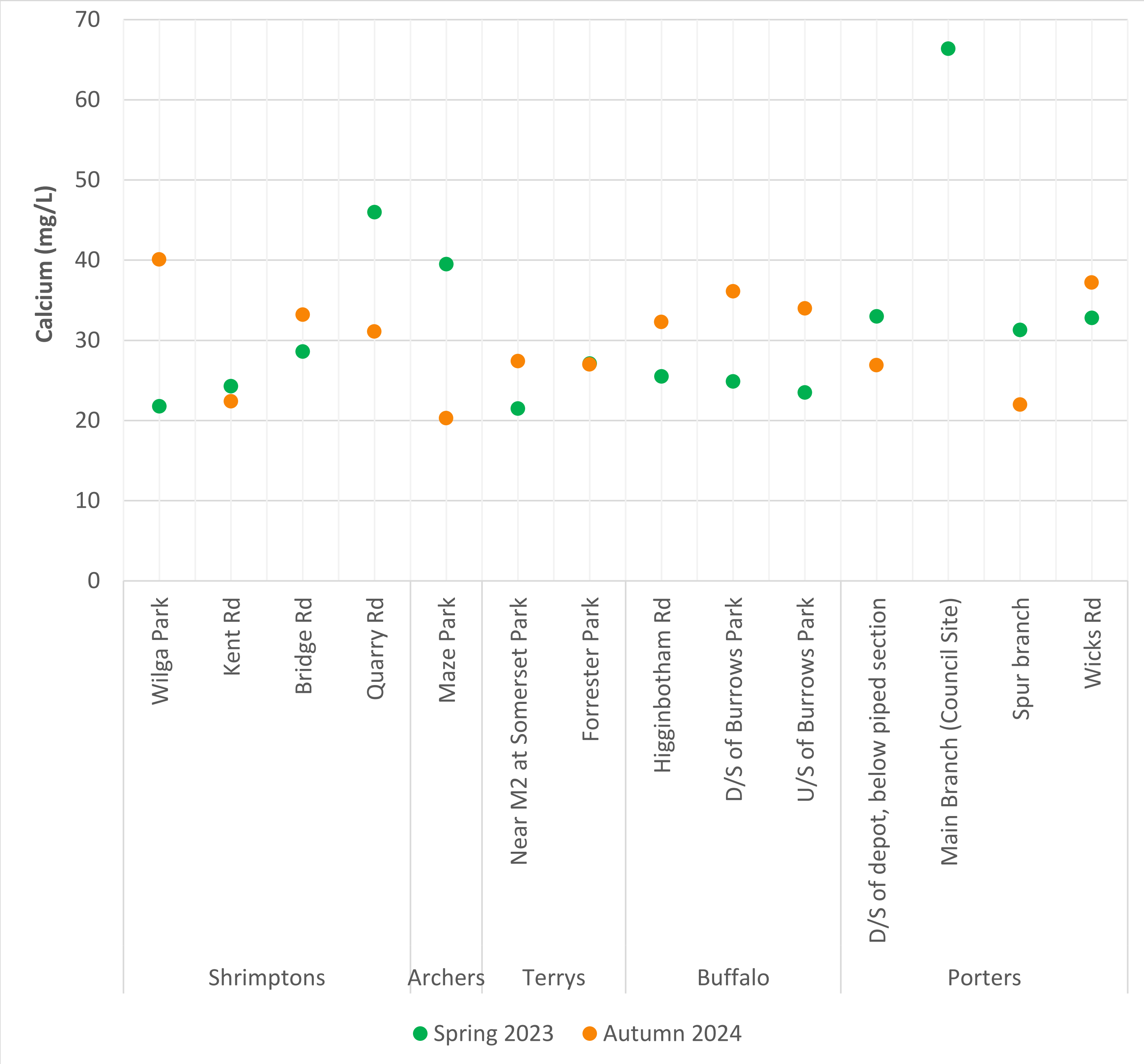

Figure 54 Calcium (mg/L) results for Spring 2023 and Autumn 2024

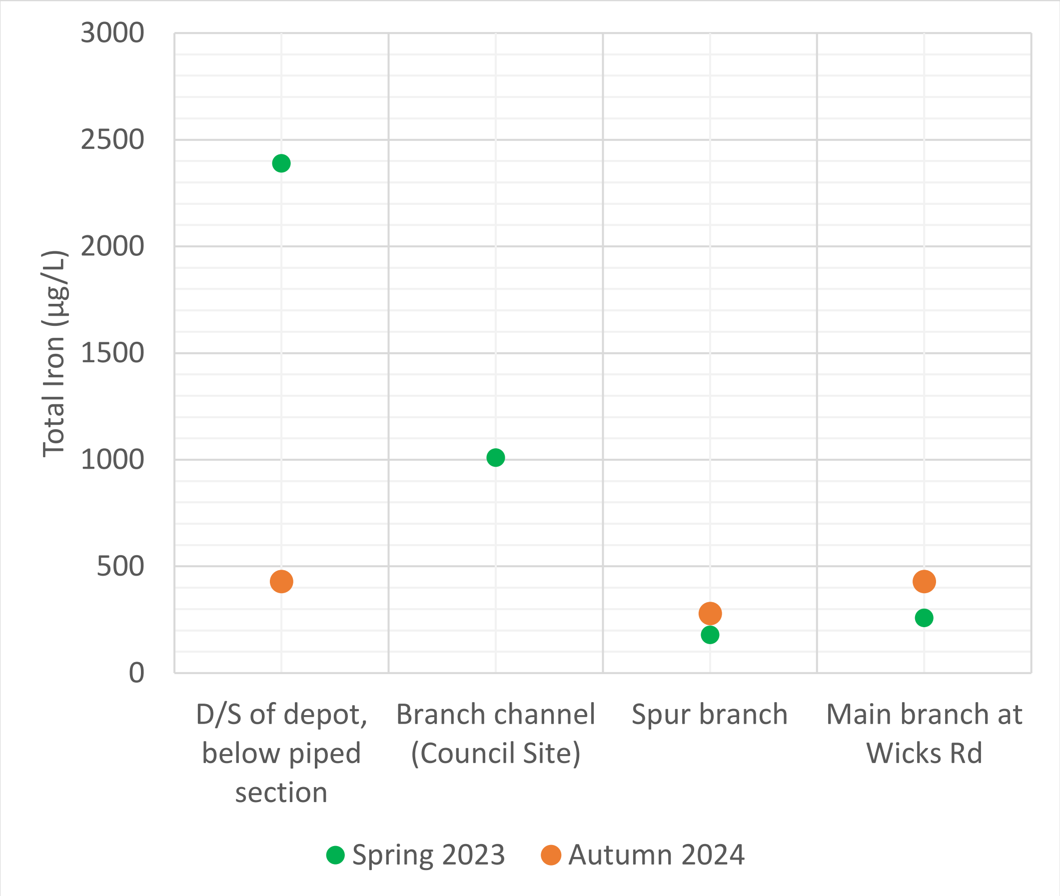

Figure 55 Total Iron (µg/L) results for Spring 2023 and Autumn 2024

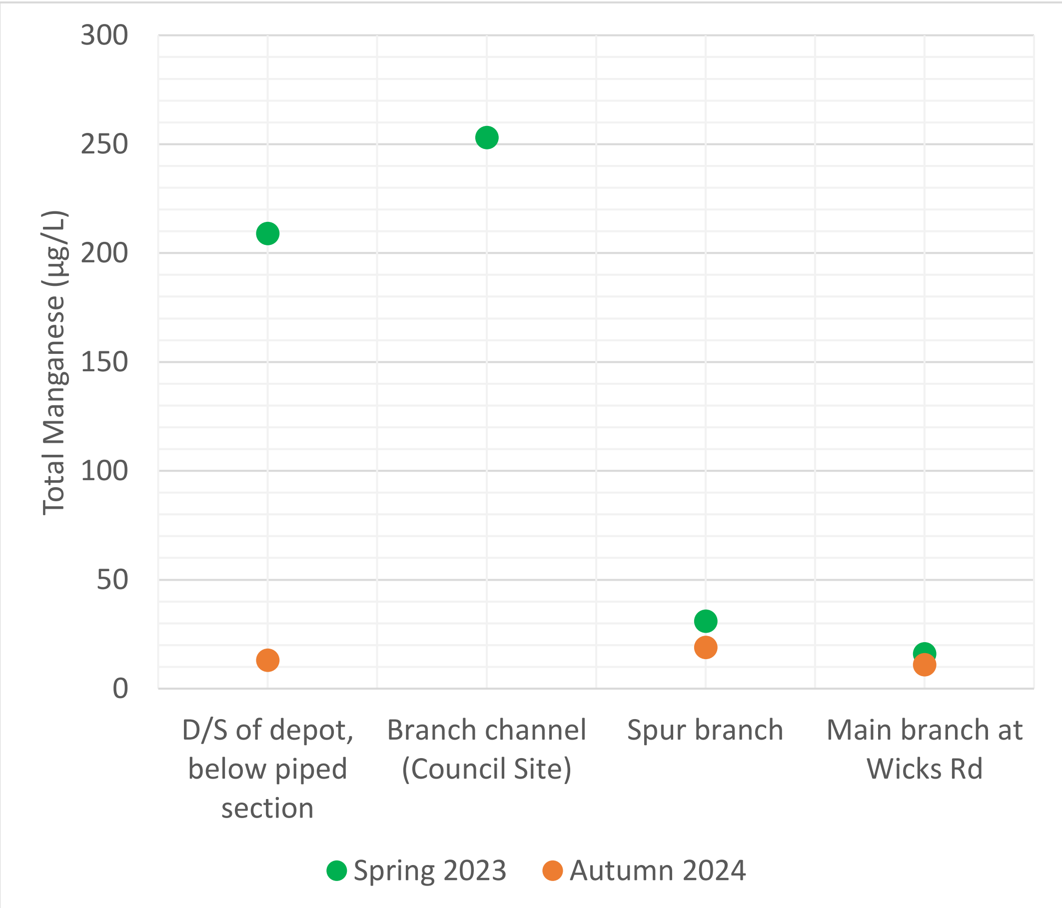

Figure 56 Total Manganese (µg/L) results for Spring 2023 and Autumn 2024

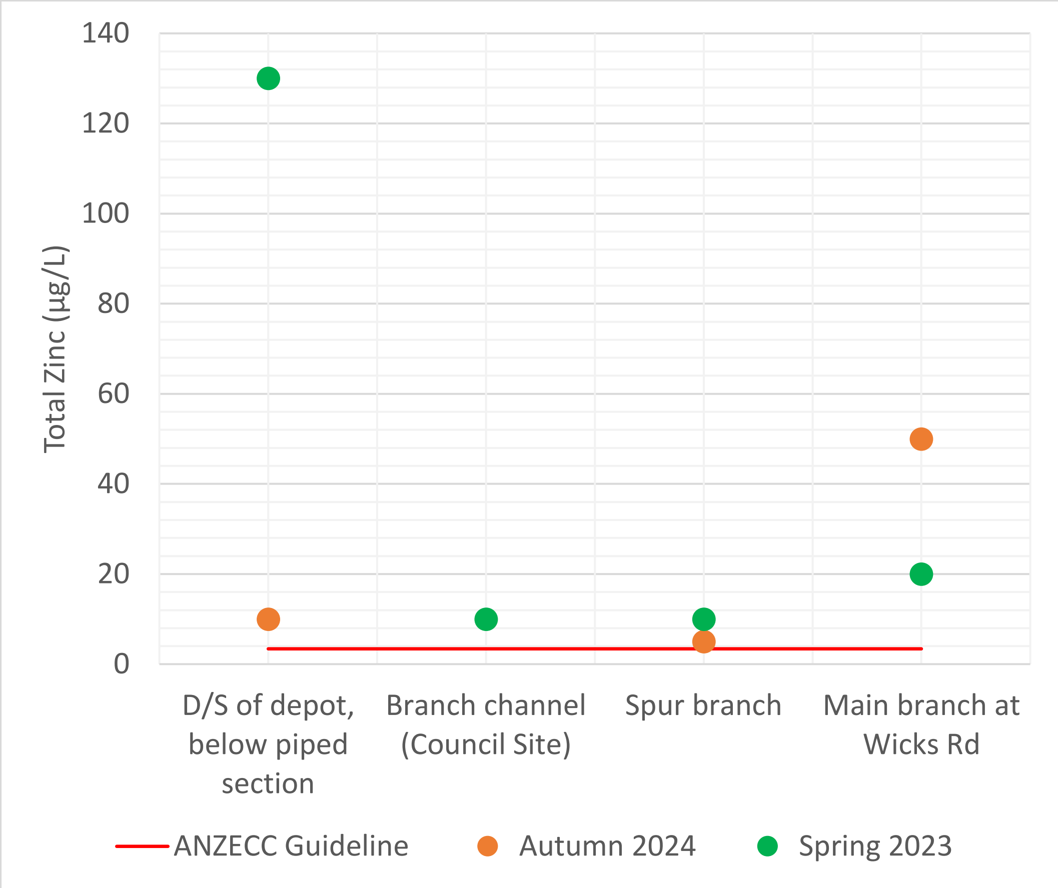

Figure 56 Total Zinc (µg/L) results for Spring 2023 and Autumn 2024. Note: Spur Branch Autumn result was <10 µg/L approximated to 5 µg/L for graphing purposes

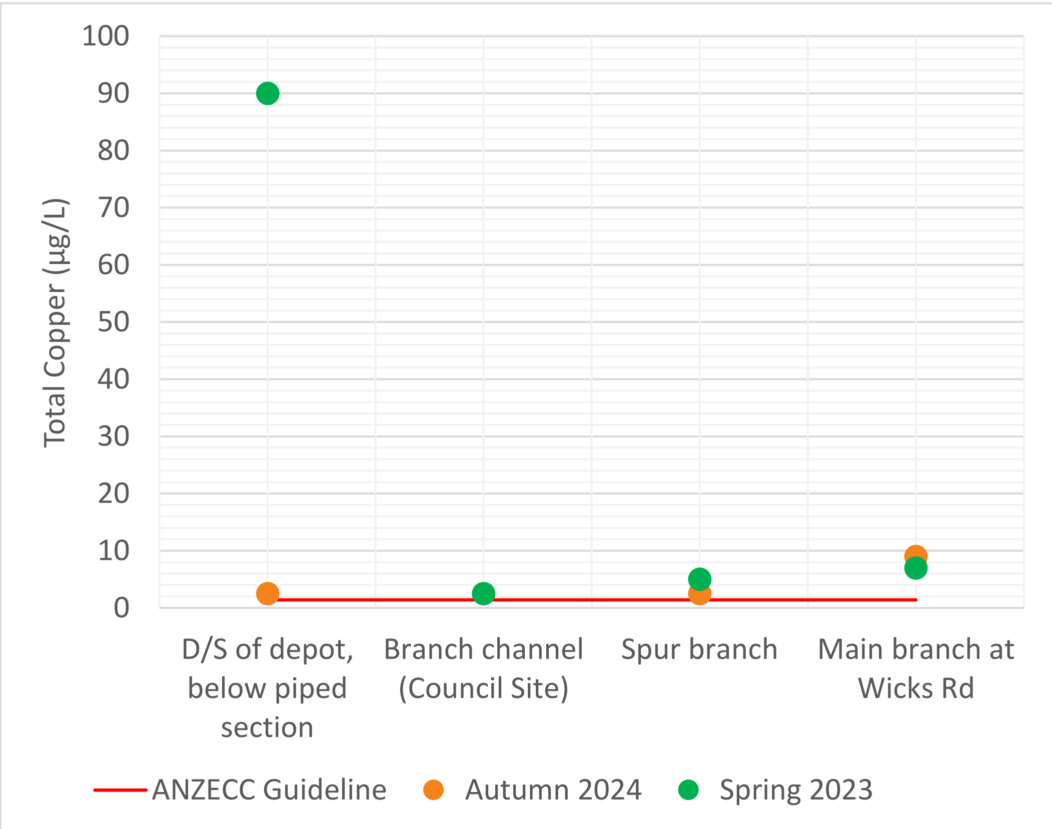

Figure 57 Total Copper (µg/L) results for Spring 2023 and Autumn 2024. Note: Values reported as <5 µg/L have been graphed as 2.5 µg/L

13 Discussion & Conclusion

Macroinvertebrates

SIGNAL_SF and taxa richness results were observed to be generally consistent between Spring 2023 and Autumn 2024 seasons for most catchment zones. Sampling sites were dominated by taxa including aquatic snails and true flies. The prominence of these tolerant taxa is indicative of the classification of these sites as impacted urban streams.

Shrimptons Creek catchment had the lowest observed SIGNAL_SF scores for Spring and Autumn seasons. During both seasons, in-field dissolved oxygen readings were very low and ponded areas were observed in the creek channel. In their 2019 study *Galic et al.* detailed the importance of dissolved oxygen availability on the reproductive and respiration rates of aquatic invertebrates. Shrimptons Creek is in proximity to residential and light industrial zones which may contribute to an influx of chemicals into waterways, impacting macroinvertebrate communities.

Buffalo Creek had the highest SIGNAL_SF score during Spring 2023. This result was consistently high for the following Autumn period. Buffalo Creek is within the Field of Mars Reserve, which is comprised of native sclerophyll forest, with zones of vegetated gullies. The creek channel contains a range of sediments including bedrock, cobble, and gravel. The creek structure is complex, with pool and riffle sequences and aquatic plant growth. The complexity of adjacent vegetation and in-channel features provide habitat which may have contributed to this score. Archers Creek catchment also had one of the higher SIGNAL_SF scores observed during this study, Terrys Creek saw an improvement in taxa richness during Autumn 2024. This may also stem from the location of these sites in zones with diverse vegetation buffer and complex stream channel composition.

Porters Creek had the lowest richness score for Spring 2023. This can be attributed to a sewer overflow event during this season which led to a reduction in water quality. This event resulted in an increase in coliform concentration, water flow, and turbidity. Each of these factors can adversely impact macroinvertebrate communities. This was evidenced by a reduction in macroinvertebrate taxa richness and a proliferation of tolerant taxa. Following this event, site remediation was carried out. This process included immediate containment to stop the overflow from travelling further. The pipe blockage was cleared using a high-pressure water jetter and a clean-up crew removed all wastewater materials and cleaned the impacted site. Following this, a final assessment of the site was conducted. This included follow-up sampling and laboratory analysis to confirm that the site has returned to pre-overflow condition. During the following Autumn 2024 season, water quality improved in the catchment. There was a restoration of the macroinvertebrate community as taxa richness improved from 6 to 13 taxa.

Water quality

In-field and analytical laboratory water quality testing was conducted for each of the 14 sampling sites. Variability was observed within catchments and between seasons. Faecal coliform concentrations were below the guideline limit for most sites although there were still some exceeding results. Shrimptons Creek core site at Wilga Park had a coliform concentration result that exceeded the guideline limit during the Autumn 2024 season. Two Buffalo Creek sites; Burrows Creek Upstream and Burrows Creek Downstream both had exceeding coliform results during the Spring 2023 season only. In contrast, Buffalo Creek core site at Higginbotham Road had a concentration result below the guideline limit for both seasons. During Spring 2023, Porters Creek core site had a very high faecal coliform concentration result. Remediation was undertaken at the site, and the following Autumn season saw a dramatic reduction in coliform concentration although the result was still elevated above the guideline limit. Porters Creek at Wicks Road site also had a coliform concentration result above the guideline limit during the Autumn 2024 season.

For both Spring 2023 and Autumn 2024 seasons, nutrient concentrations exceeded guideline limits at most catchments. These results were consistent with a history of high nutrient levels observed in the long-term dataset. Urban streams can be impacted by a range of environmental stressors. The proximity of roadways, public parks, and residential areas can lead to an influx of nutrient run-off into waterway environments. There are also natural sources of nutrient concentrations. For example, bird droppings can also contribute to the nutrient load in creek environments. At Burrows Park (Buffalo Creek catchment) both upstream and downstream sites had elevated nitrogen and ammonia results for Spring and Autumn seasons. The location of these sites in a public park adjacent to residential zones may have contributed to these results. Increased rainfall can also influence nutrient concentrations. For example, increased rainfall in the narrow channel of Archers Creek may have contributed to an increased flushing of nutrients in the waterway.

The Porters Creek core site had the highest exceedances in nutrient concentrations during Spring 2023. This can be associated with the sewer overflow incident. During the following Autumn, concentrations were reduced. At the Porters Creek catchment additional heavy metals testing was performed. For both Spring and Autumn seasons, most heavy metal analyte concentrations were observed to be below the limit of detection. However, during Spring 2023 there were several exceedances for copper and zinc concentrations. Porters Creek core site also had an exceeding lead concentration result during this season. The influx of these analytes is associated with the location of this catchment in an urban environment. These analytes can come from a range of different sources including automotive traffic (Lerat-Hardy *et al*), construction materials, plumbing and stormwater pipes. During the Autumn season, there was a reduction in the number of sites with heavy metal exceedances. This may be attributed to higher average monthly rainfall preceding Autumn 2024 sampling. Higher rainfall volume can cause flushing events in small creek channels contributing to a dilution of chemical concentrations.

Rapid Riparian Assessment

At each of the five core sites Rapid Riparian Assessments (RRA) were performed to assess a range of environmental characteristics. Results for four of the five catchments indicated no change in score. The Archers Creek catchment recorded a “Fair” score while Terrys and Buffalo catchments each maintained a “Good” score. The only site that saw a major score decline was Shrimptons Creek core site at Wilga Park. The score declined from 26.3 (2022) to 2.4 (2023). This could be attributed to the nearby State Significant Development that has involved vegetation removal and in-creek works associated with bridge construction. The Porters Creek core site saw an improvement in Riparian score from “Good” to “Excellent”. This improvement was associated with a higher presence of woody debris in-channel, an increase in the density of over-hanging vegetation and a reduction in the presence of weeds.

13 Recommendations

- At each of the established sampling sites, continue to monitor:

  i) Macroinvertebrate communities (SIGNAL SF and Taxa Richness indices)

  ii) Chemical water quality parameters

  iii) Riparian condition

  iv) Additional heavy metals analysis at Porters Creek sites

  v) Seasonal and annual scorecards to provide concise summary of health indices

- Continue Gross Pollutant Trap maintenance and rubbish removal
- Consider collecting pre-and post-work water quality data on any Council projects that aim to improve water quality
- Continued collection of data, sampled in parallel with Sydney Water sites and time periods

14 Appendix: Detailed Methodology

Water Quality

City of Ryde council provided the water quality monitoring design and study locations for this sampling program. The procedures are consistent with their previous monitoring programs. Water quality sampling was conducted by trained Sydney Water staff who conformed to standard [AS/NZS 5667:1998] and relevant Sydney Water occupational health and safety procedures. Samples were collected in bottles pre-labelled with a unique identifying laboratory number as well as the sample site code, location, and date of collection. Field measurements and observations for each site were recorded at the time of sampling. The sampling procedures used for this program are detailed below.

(i) Sampling schedule and frequency

A bi-annual sampling schedule was prepared by the Aquatic Ecology Project Leader in communication with the client to ensure milestones and deliverables were met according to the agreed timeframes. Routine water quality monitoring was undertaken in September 2023 (Spring) and March 2024 (Autumn) at the five core sites and nine water quality only sites.

(ii) Sampling procedure

The below procedure was followed to avoid contamination during sample collection:

- sampling officers wore disposable latex gloves
- samples were collected using aseptic techniques
- sampling equipment was sterilised and rinsed between sites
- sample bottles not containing preservative were rinsed before filling
- microbiological samples were collected before other samples

The following procedures were followed to ensure the representativeness of samples:

- disturbed areas of the creek bank were avoided; where disturbance was evident the sample was collected upstream
- rinse water was discarded downstream or away from the sampling point
- issues impacting sample integrity, such as distance from bank(s), number and distribution of samples, substrate, ponds and aeration, were considered in determining sampling sites
- surface scum was avoided

Samples were collected from 20-30 cm below the water surface. Where the depth was less than 50 cm, the sample was taken at half the depth. In the instance where the waterway was shallow, surface samples were collected to allow sampling without disturbing the sediment. This has the potential to compromise sample quality as surface samples may contain surface contaminates, such as scum, dust or pollen, which may not be present below the waterway surface. Therefore, where applicable, collection of surface samples was noted on the Water Quality Sampling Field Sheet. A sampling pole and/or jug were used to collect samples. A list of water chemistry analytes sampled, along with their unit of measurement and collection container are provided in Table 3.

(iii) Field measurements

It is necessary to measure some water chemistry analytes in the field using various instruments (Table 1). To ensure accuracy of results, instruments are calibrated according to the manufacturers' recommendations, field procedure requirements, relevant sections of NATA ISO/IEC 17025 Field Application Document and other reference material.

Table 1 Water chemistry parameters and field analysis methods

Analyte	Method
Dissolved Oxygen (% saturation)	WTW Multiliner Universal Meter
Dissolved Oxygen (mg/L)	WTW Multiliner Universal Meter
Conductivity (µS/cm)	WTW Multiliner Universal Meter
pH (pH units)	WTW Multiliner Universal Meter
Turbidity (NTU)	HACH Turbidimeter
Temperature (°C)	Digital Thermometer

To ensure traceability of calibration in accordance with NATA ISO/IEC 17025 Sydney Water uses both in-house and purchased calibration standards. In-house standards are made only from analytical grade materials of appropriate purity. The assays of these materials are traceable to the National Institute of Standards & Testing (NIST). Purchased calibration standards are regarded as critical materials and are accompanied with a certificate of analysis showing traceability to NIST.

(iiii) Field observations

Field observations were recorded to assist in the interpretation of results. At each site the field observations listed below were recorded:

- sample clarity
- algae presence
- recent rain
- visual pollution
- flow rate (visual assessment)

(v) Sample preservation and transportation

Water samples collected for laboratory analysis that required refrigeration were placed in an ice filled esky immediately after collection. Samples were delivered to the Sydney Water analytical laboratory at West Ryde with the appropriate Chain of Custody form.

(vi) Analysis

All Sydney Water laboratory analytical work was performed as per the requirements of AS ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories. In general, most of the methodologies used are American Public Health Association (APHA) or United States Environmental Protection Agency (USEPA) standard methods. Where standard methods are not available, analytical procedures have been developed from in-house research or published methods from analytical journals. All analysis was carried out according to the requirements of the customer and the laws and regulations of relevant authorities. Sydney Water laboratories' NATA technical accreditation numbers are listed in Table 2 below.

Table 2 Sydney Water laboratories NATA accreditation numbers

Field of Testing	Number	Accredited	Standard
Chemical testing	63	1952	ISO/IEC 17025
Biological testing	610	1966	ISO/IEC 17025

Macroinvertebrates

The Sydney Water Biology Group carry out sampling activities according to the requirements of the in-house test method *SS0001 Rapid Field Assessment of Macroinvertebrates for River, Stream (lotic) and Wetland (lentic) Waters*. All field sampling staff must be competent in identifying macroinvertebrates to a family-level. This requirement ensures that field staff are experienced in identifying animals of varying morphologies to facilitate high quality field sampling and processing techniques. As identifiers they must comply with the requirements of the In-house test method *SSWI433 Macroinvertebrate Cataloguing, Identification and Counting*.

(i) Sampling Procedure

At each of the five core sampling sites, two replicate macroinvertebrate samples were collected from edge habitat using a hand-held dip net. An 'edge' habitat is defined as a zone with little to no current, for example, areas adjacent to stream banks. The sampling net was swept from open water towards the stream bank, working over a bank length of approximately 10 meters. This process stirs up deposits of silt and detritus so that benthic and surface-dwelling animals are suspended and caught in the net.

(ii) Qualitative sample collection

The net contents were emptied into a large white sorting tray with a small amount of water to allow live macroinvertebrate specimens to be picked out with fine forceps and pipettes for a minimum period of 40 minutes. If new taxa were collected between 30 and 40 minutes, sorting continued for a further 10 minutes. If no new taxa were found after 10 minutes, picking ceased. If new taxa were found, the 10-minute processing cycle continued up to a maximum total sorting time of 1 hour. All specimens collected were preserved in small glass specimen jars containing 85% un-denatured ethanol with a clear label indicating site code and location, date, habitat, and initials of both the sampler and picker. Sampling equipment was washed thoroughly between samples to prevent the cross contamination of animals.

(ii) Sample processing

Macroinvertebrate samples were processed as per *SSWI433 In-house Test Method Macroinvertebrate Cataloguing, Identification and Counting*. Quality assurance was conducted as per *SSWI434 In-house test method Quality Control of Macroinvertebrate Identification, Counting and Archiving of Collections.* Both methods comply with the requirements of AS ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories under technical accreditation number 610 issued by the National Association of Testing Authorities (NATA). Macroinvertebrate identifications were performed using compound and stereo microscopes (Leica Microsystems) that are maintained via a strict calibration schedule.

Reference material used in the Aquatic Ecology laboratory includes:

- Current published taxonomic keys
- Voucher specimens, many confirmed by national experts
- Sydney Water in-house keys and digital voucher photographic database

Macroinvertebrates were identified and enumerated to the family taxonomic level, except Chironomids which were identified to sub-family. Aquatic worms were identified to Naididae sub-families as required while Aquatic mites were identifed to Order level (Acarina). Identification data was verified before being entered into Sydney Water's electronic database (LIMNOS). Raw macroinvertebrate data files were extracted and verified by a senior staff member before analyses were performed. At the end of this process, quality assurance was conducted on 5% of edge samples identified for this study. Identifications are chosen at random for quality assessment.

(iii) Rainfall data

Rainfall data was extracted from the Australian Bureau of Meteorology website. The North Ryde Bureau station (066213) data was used for this report. Daily, monthly, and cumulative rainfall data prior to the sampling date was collated and graphed. Rainfall levels were observed to ensure that rainfall volume did not exceed 10 mm in the days preceding sampling to ensure representative sample collection.

Analysis Methods

(i) Water quality

Water quality results were used to characterise each study creek against ANZECC (2000) guidelines for Aquatic Ecosystems (Lowland River in South-Eastern Australia), Recreational Water Quality and Aesthetics (Secondary) and toxicants (95% species protection level). The ANZECC (2000) toxicant trigger values have been used for metals. These guidelines provide four sets of protection levels derived as chemical-specific estimates of the concentrations of contaminants that should have no adverse effects on aquatic ecosystems (ANZECC 2000). The 95% species protection level is commonly applied to aquatic ecosystems that have been modified in some way and has been used in this report as a comparison for the stream water quality results. ANZECC (2000) recommends that the toxicity trigger values for hardness-related metals (in this study: cadmium, copper, lead, and zinc) are adjusted to account for local water hardness. This is important because the trigger values for these metals have been derived for soft waters (30 g/m3 CaCO3), corresponding to high toxicity. The adjustment values for water hardness categories are detailed in Table 4.

Table 3 ANZECC (2000) indicator analytes and associated trigger values

Indicator	Guideline value	Unit	Analysis	Source
Dissolved oxygen	85 to 110	% saturation and mg/L	In-field	Protection of aquatic ecosystem (ANZECC 2000)
pH	6.5 to 8.5	pH unit	In-field	Protection of aquatic ecosystem (ANZECC 2000)
Turbidity	50	NTU	In-field	Protection of aquatic ecosystem (ANZECC 2000)
Conductivity	125 – 2500	µS/cm	In-field	Protection of aquatic ecosystem (ANZECC 2000)
Ammonia nitrogen	900	µg/L	Laboratory	Protection of aquatic ecosystem (ANZECC 2000)
Oxidised nitrogen	40	µg/L	Laboratory	Protection of aquatic ecosystem (ANZECC 2000)
Total nitrogen	350	µg/L	Laboratory	Protection of aquatic ecosystem (ANZECC 2000)
Total phosphorus	50	µg/L	Laboratory	Protection of aquatic ecosystem (ANZECC 2000)
Faecal coliforms	1000	CFU/100mL	Laboratory	Secondary contact recreation (ANZECC 2000)
Chromium	0.001	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Manganese	1.9	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Iron	ID	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Copper	0.0014	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Zinc	0.008	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Arsenic	0.013	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Cadmium	0.002	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Lead	0.0034	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)
Mercury	ID	mg/L	Laboratory	Toxicants at 95% level of protection (ANZECC 2000)

Table 4 Relevant ANZECC (2000) trigger value (TV) adjustments for water hardness

Hardness category mg/L as $CaCO_3$)	Hardness range (mg/L as $CaCO_3$)	Cadmium	Copper	Lead	Zinc
Soft	0 – 59	TV	TV	TV	TV
Moderate	60 -119	x 2.7	x 2.5	x 4.0	x 2.5
Hard	120 – 179	x 4.2	x 3.9	x 7.6	x 3.9
Very hard	180 – 240	x 5.7	x 5.2	x 11.8	x 5.2
Extremely hard	400	x 10.0	x 9.0	x 26.7	x 9.0

3 Analysis Methods
(ii) Macroinvertebrates

Two biological indices were used to analyse macroinvertebrate data: SIGNAL_SF and Taxa Richness.

SIGNAL

The SIGNAL (*Stream Invertebrate Grade Number Average Level*) biotic index is a relatively simple and inexpensive method to assess stream health. This index assigns 'sensitivity scores' to macroinvertebrate taxa that are collected using the rapid assessment sampling method. The original version was developed for Sydney Water for assessing the Hawkesbury-Nepean catchment and required identifications to the Family taxonomic level (Chessman, 1995). The original SIGNAL index was refined to include the response of SIGNAL to natural and anthropogenic environmental factors (Growns et al. 1995), variations in sampling and sample processing methods (Growns et al. 1997;) and the objective setting of sensitivity grades of the taxa (Chessman et al. 1997; Chessman et al. 2002).

SIGNAL_SF

Chessman et al. (2007) saw the development of a Sydney-specific SIGNAL biotic index that drew on family and genus level macroinvertebrate data from the greater Sydney region. The water quality status of 'clean water' was established using data from near pristine reference sites in the bushland fringes of Sydney and determining the 10th percentile of the average score of those sites (Table 5). SIGNAL-SF allows a direct measure of test site condition and incorporates abundance information gathered from the rapid assessment sampling. 'S' indicates the Sydney region version and 'F' indicates that the taxonomy is at the family level. The first step in calculating a SIGNAL-SF score is to apply predetermined sensitivity grade numbers (from 1, tolerant to 10, highly sensitive) to each family count for a given habitat sample. Families without a grade score that are present in a sample are removed from the SIGNAL-SF calculation. The square root transformed count (treated to remove bias of taxa with high abundance counts) of each family is then multiplied by the sensitivity grade. The products are summed and then divided by the total square root transformed number of individuals in all families. A location-specific average is then calculated for each sampling site.

Table 5 Interpretation of SIGNAL-SF scores (Chessman *et al.,* 2007)

SIGNAL-SF score	Water quality status
>6.5	Clean water
5.2 – 6.5	Possible mild organic pollution
3.8 – 5.2	Possible moderate organic pollution
<3.8	Possible severe organic pollution

Taxa Richness

Taxa richness is the overall variety (total taxa) of macroinvertebrates observed in a community assemblage. It is an indicator of stream health that can be measured at any specific taxonomic level and operates under the assumption that taxa richness will be higher in healthy streams and lower in streams of poor health. The composition of macroinvertebrate abundances within taxa groups was included in this report. Taxa were for the most part placed into Class and Order groups.

The composition of macroinvertebrate abundance at the basic level is limited in its ability to indicate water body health. However, it can give an indication of the habitat and biological holding capacity of the waterways being studied. Taxa richness can be a useful tool for indicating the general health of a water body. However, it should be used with caution, as taxa numbers may be attributable to factors other than stream health and/or anthropogenic impacts. For example, taxa richness may increase with elevated levels of organic pollution and may not be a good indication that stream health is better than areas with lower levels of organic pollution.

14 Appendix: Streamwatch Data

City of Ryde Council provided Streamwatch water quality data for several sites within the catchment zones currently sampled by Sydney Water. It is to be noted that the Streamwatch data was collected by trained Bushcare groups throughout the year using standardised equipment and methodologies. Data from the Council is verified before being stored as a permanent public record that is available for non-commercial purposes. Sydney Water and the Sydney Catchment Authority do not accept responsibility for the use of this information. Data is uncontrolled if printed or downloaded.

This section consists of three data sets organised as below:

1). The sites used in this study as sampled by Sydney Water and Streamwatch volunteers on the same day (Table 1). As only 10 sites were sampled by Streamwatch the matching 10 sites sampled by Sydney Water have been included.

2). The sites used in this study as sampled by Sydney Water and Streamwatch data collected by volunteers at several adjacent sampling sites (Table 2) within the same creek catchment.

For data set (2) as water quality sampling was conducted at different locations and on different sampling dates direct comparisons cannot be made for this data. A best-match approach was taken when selecting data for graphing. *Turbidity results below detectable limit from Streamwatch data ie; <10 NTU have been approximated at 5 NTU for graphing purposes.

Table 1 Selected Sydney Water and Streamwatch sites sampled on 26th March 2024

Sampling Sites	
Wilga Park (Shrimptons)	Higginbotham Rd (Buffalo Creek)
Kent Rd (Shrimptons)	Downstream Burrows Park (Buffalo Creek)
Bridge Rd (Shrimptons)	Upstream Burrows Park (Buffalo Creek)
Quarry Rd (Shrimptons)	Near M2 at Somerset Park (Terrys Creek)
Maze Park (Archers Creek)	Forrester Park (Terrys Creek)

Temperature results collected by Sydney Water and Streamwatch volunteers were within a similar range (Figure i). Result variability could be attributed to the time that the data was collected. For example, Sydney Water sampled Terrys Creek at Forrester Park site at 9:50AM while Streamwatch data at this site was collected at 12:55PM.

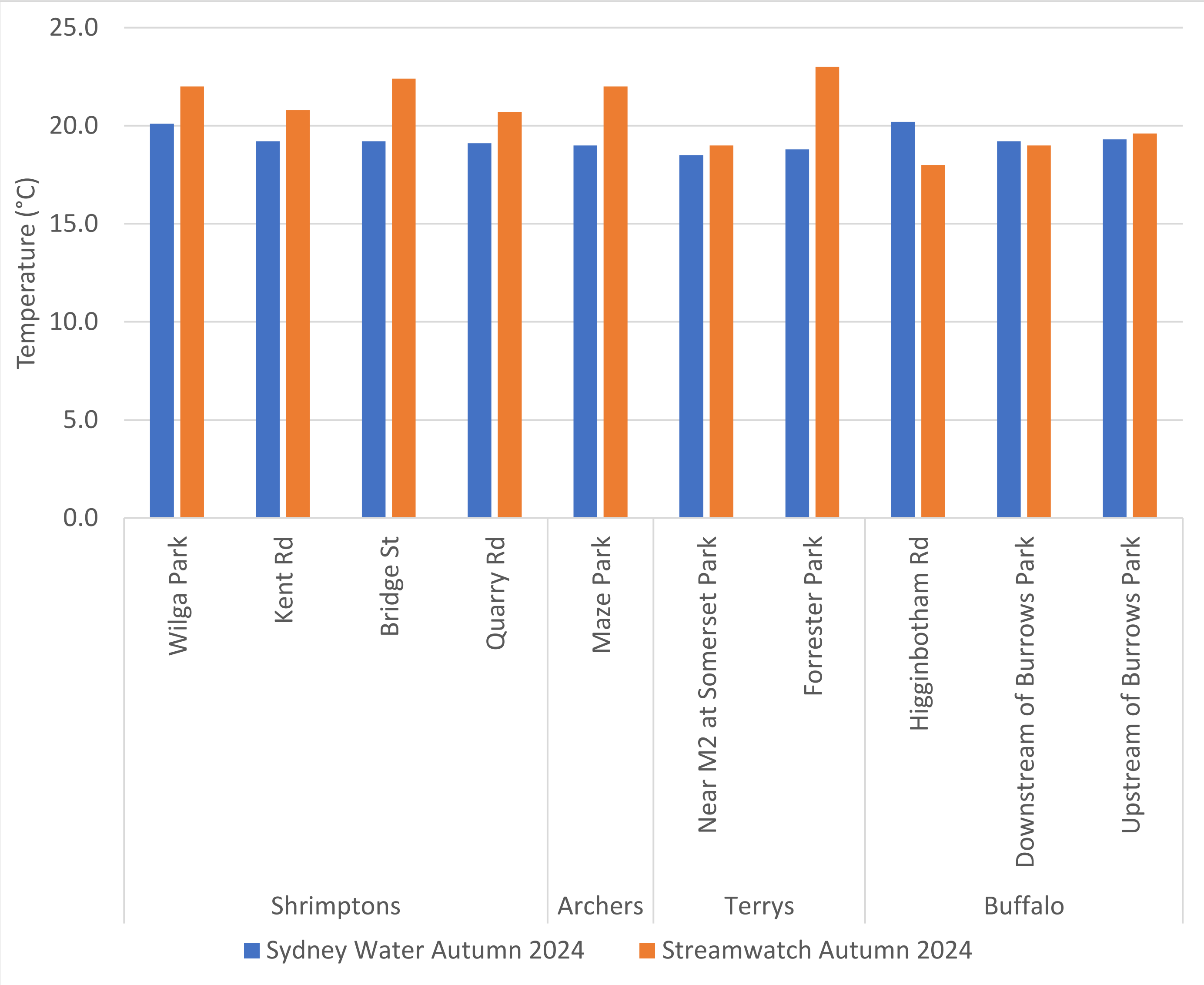

Figure i Autumn 2024 Temperature (°C) data from Sydney Water and Streamwatch sampling

Dissolved oxygen (%) results were variable between sampling sites (Figure ii). In general, dissolved oxygen results collected by Sydney Water were higher than Streamwatch results.

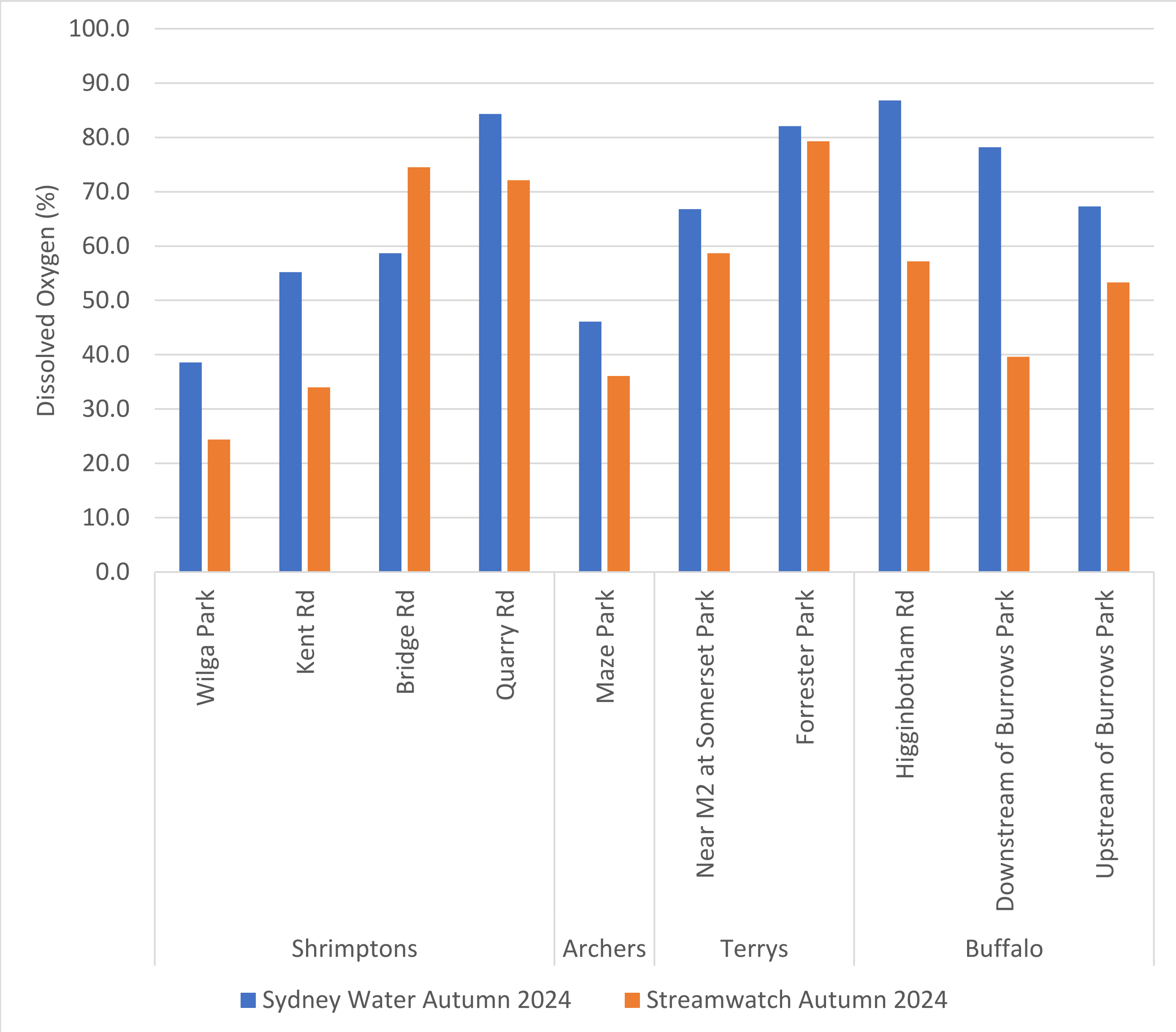

Figure ii Autumn 2024 Dissolved oxygen (%) data from Sydney Water and Streamwatch sampling

Sydney Water recorded higher pH results when compared to Streamwatch data at all sites.

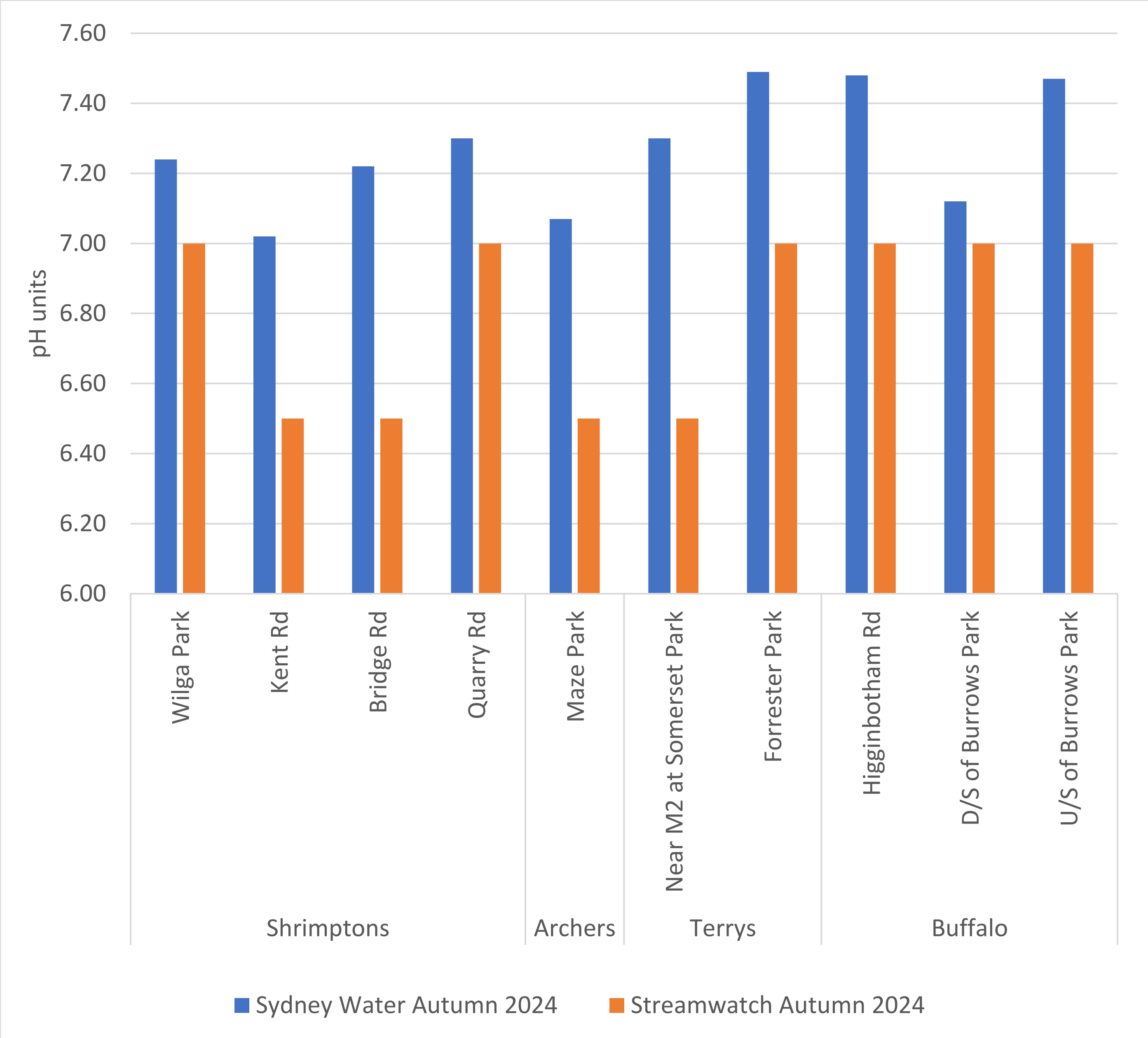

Figure iii Autumn 2024 pH data from Sydney Water and Streamwatch sampling

Sydney Water and Streamwatch conductivity data was relatively similar for each of the sampling sites (Figure iv).

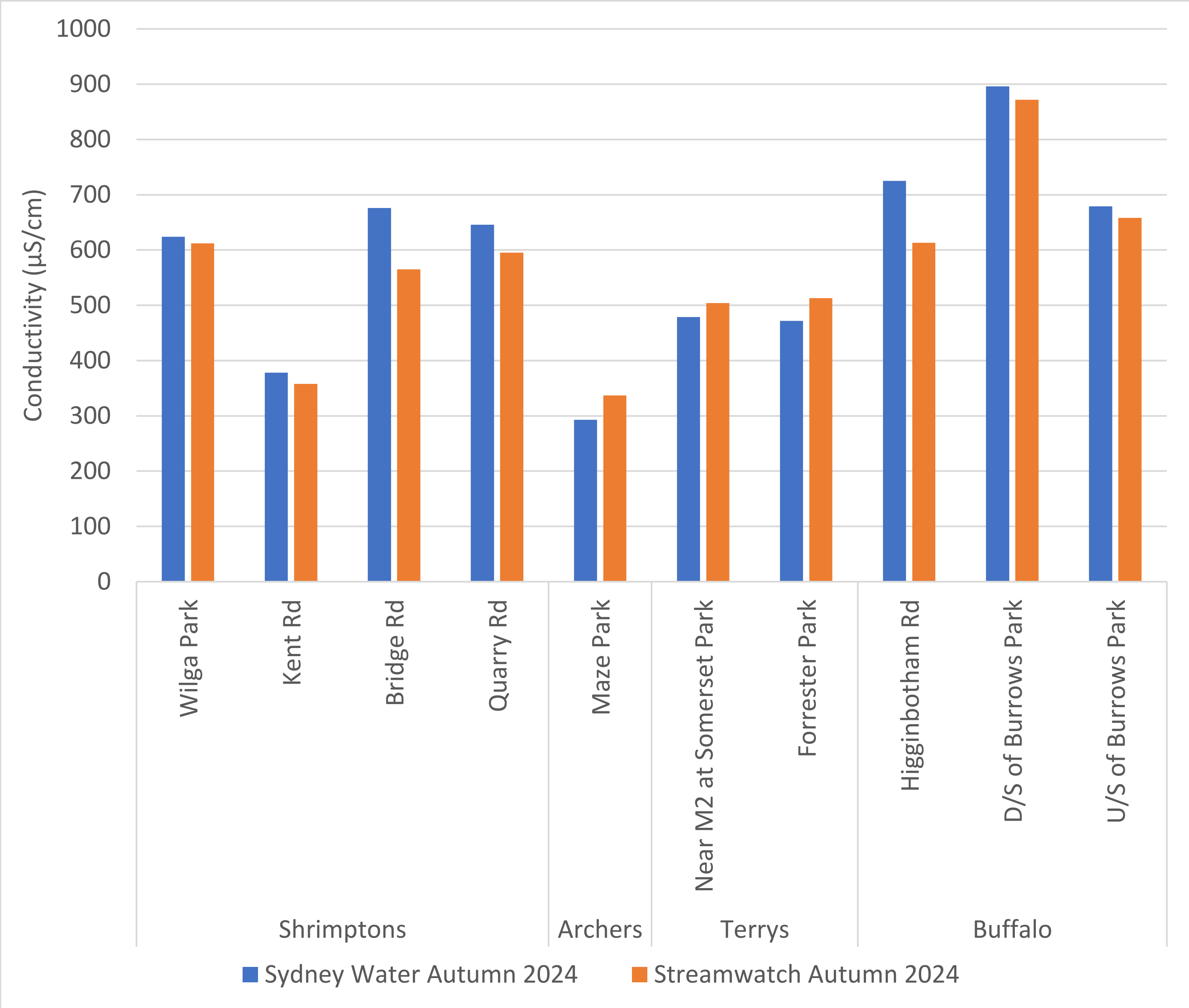

Figure iv Autumn 2024 conductivity (µS/cm) data from Sydney Water and Streamwatch sampling

Table 2 Buffalo and Shrimptons catchment zones sampled by Sydney Water and Streamwatch

Catchment	Site name	Sydney Water	Streamwatch
Buffalo Creek	Visitors Centre		✓
Buffalo Creek	Minga Reserve		✓
Buffalo Creek	Downstream Burrows Park	✓	
Buffalo Creek	Upstream Burrows Park	✓	
Buffalo Creek	Higginbotham Rd	✓	
Shrimptons Creek	Wilga Park	✓	
Shrimptons Creek	Kent Rd	✓	
Shrimptons Creek	Bridge Rd	✓	
Shrimptons Creek	Quarry Rd	✓	
Shrimptons Creek	Santa Rosa Park		✓
Shrimptons Creek	Greenwood Park		✓
Terrys Creek	Forsyth Park		✓
Terrys Creek	Somerset Park	✓	
Terrys Creek	Forrester Park	✓	

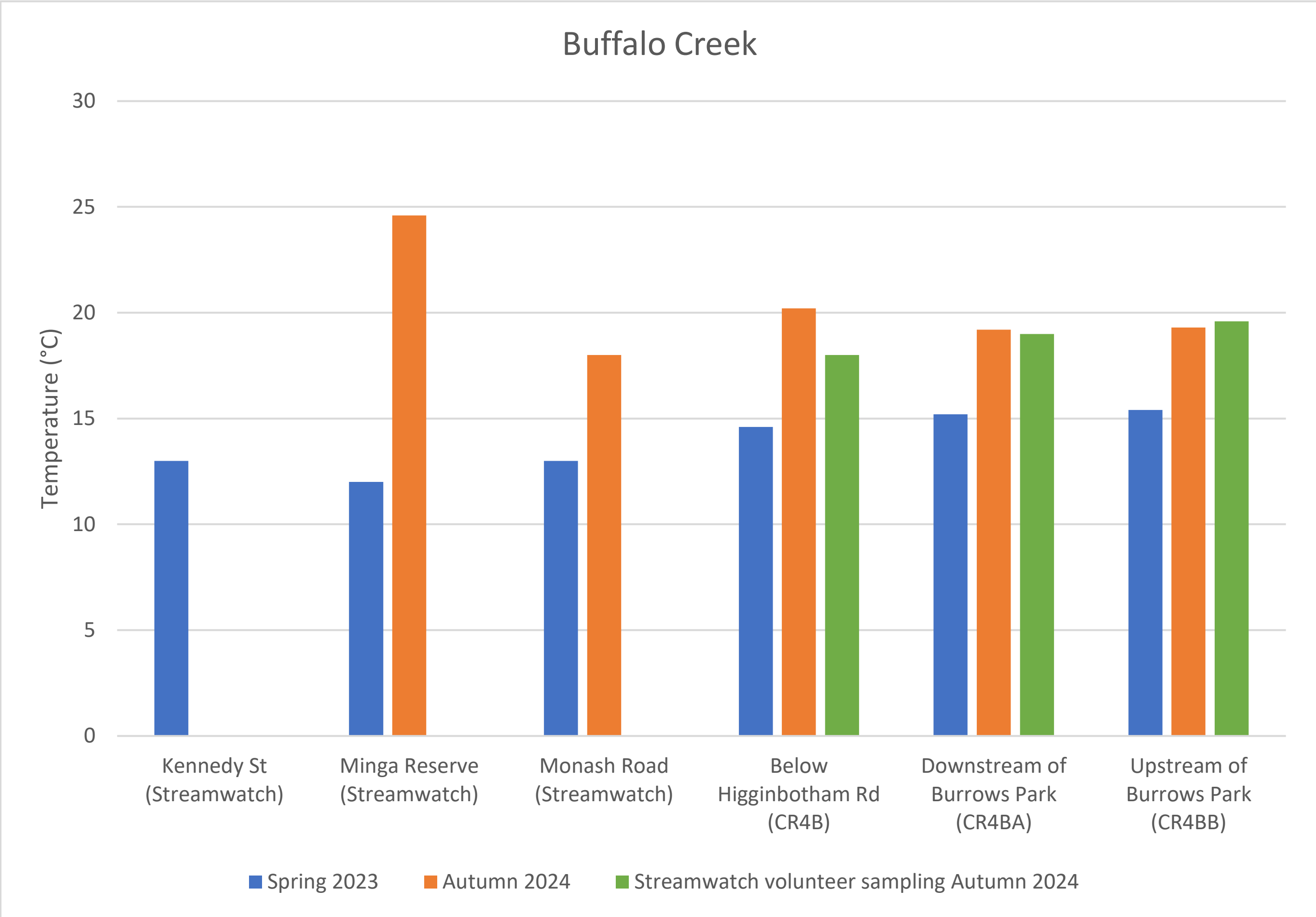

Figure v Spring 2023 and Autumn 2024 Temperature (°C) data from Sydney Water sites (Higginbotham Rd, Burrows Park Downstream and Burrows Park Upstream) and Buffalo Creek Streamwatch sites

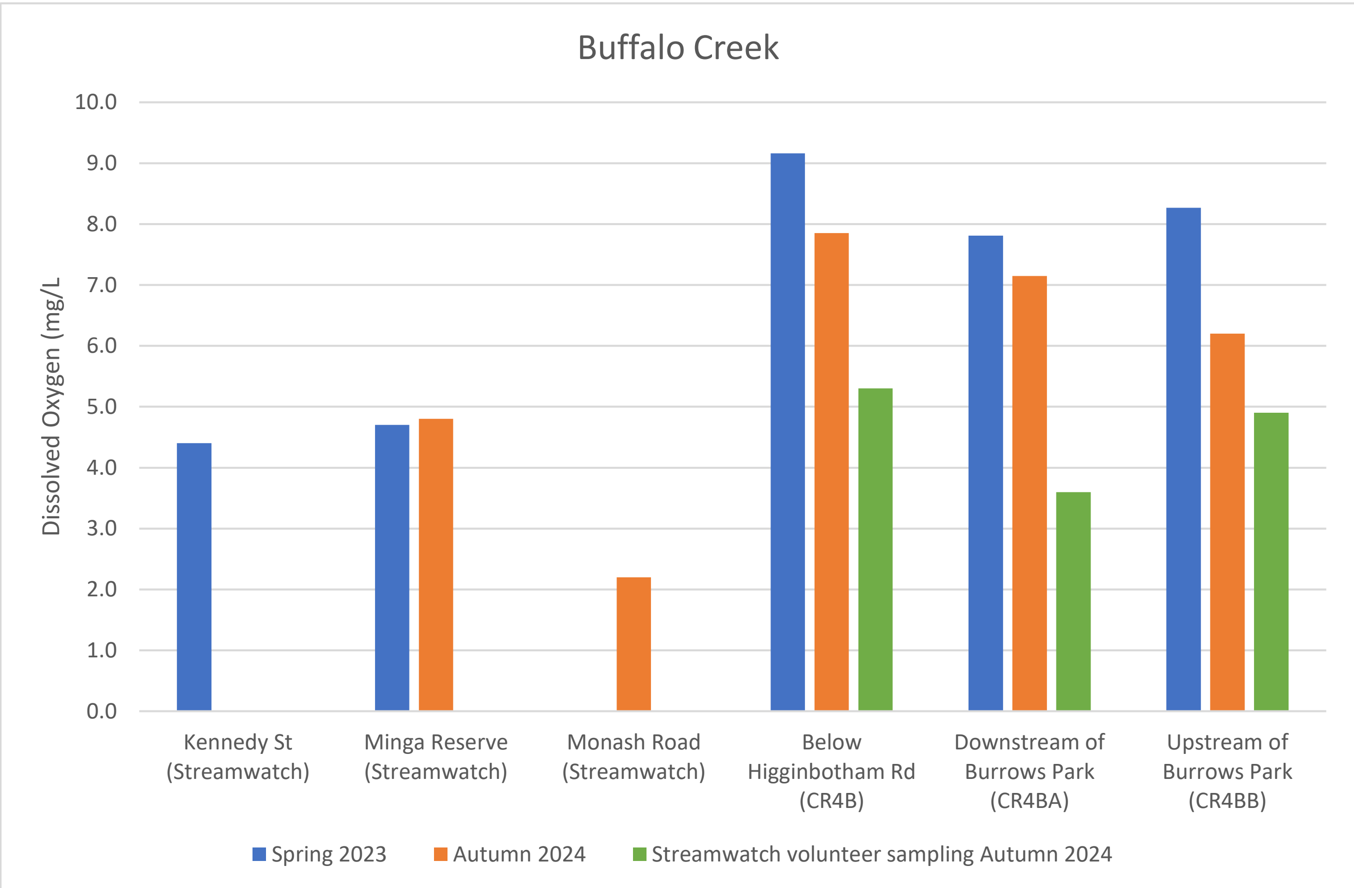

Figure vi Autumn 2024 dissolved oxygen (%) data from Sydney Water sites (Higginbotham Rd, Burrows Park Downstream and Burrows Park Upstream) and Buffalo Creek Streamwatch sites

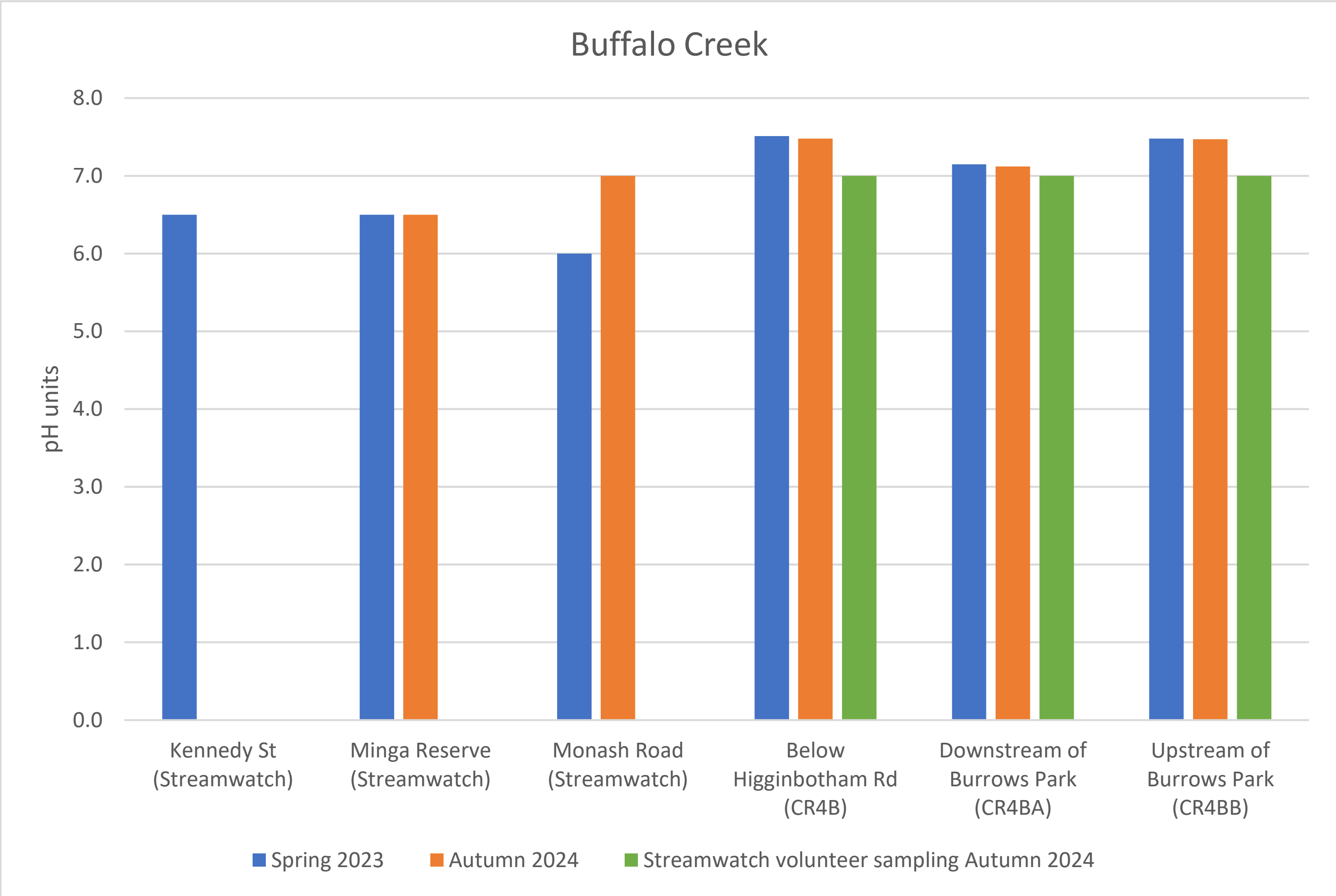

Figure vii Spring 2023 and Autumn 2024 pH data from Sydney Water sites (Higginbotham Rd, Burrows Park Downstream and Burrows Park Upstream) and Buffalo Creek Streamwatch sites

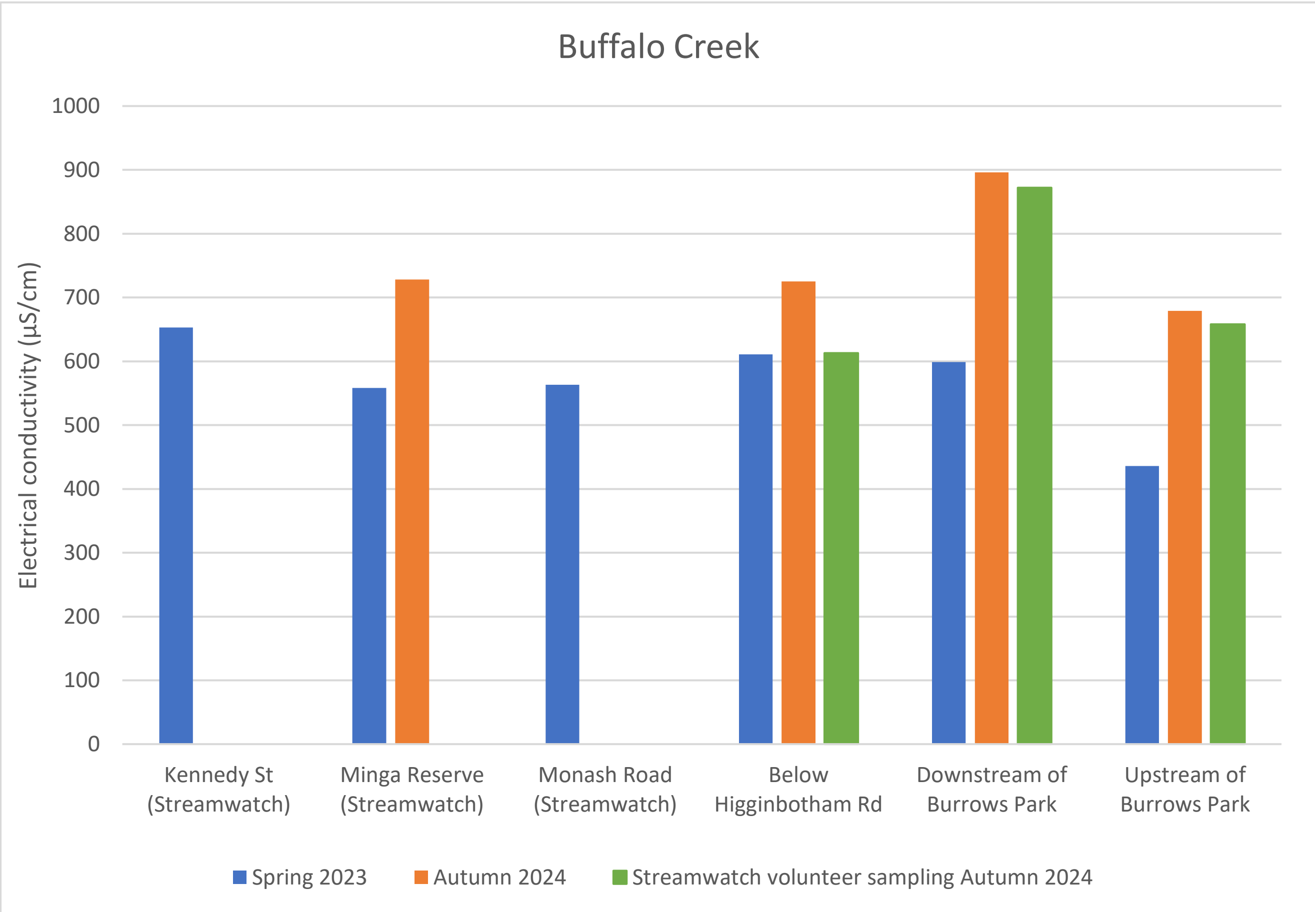

Figure viii Spring 2023 and Autumn 2024 Conductivity (µS/cm) data from Sydney Water sites (Higginbotham Rd, Burrows Park Downstream and Burrows Park Upstream) and Buffalo Creek Streamwatch sites

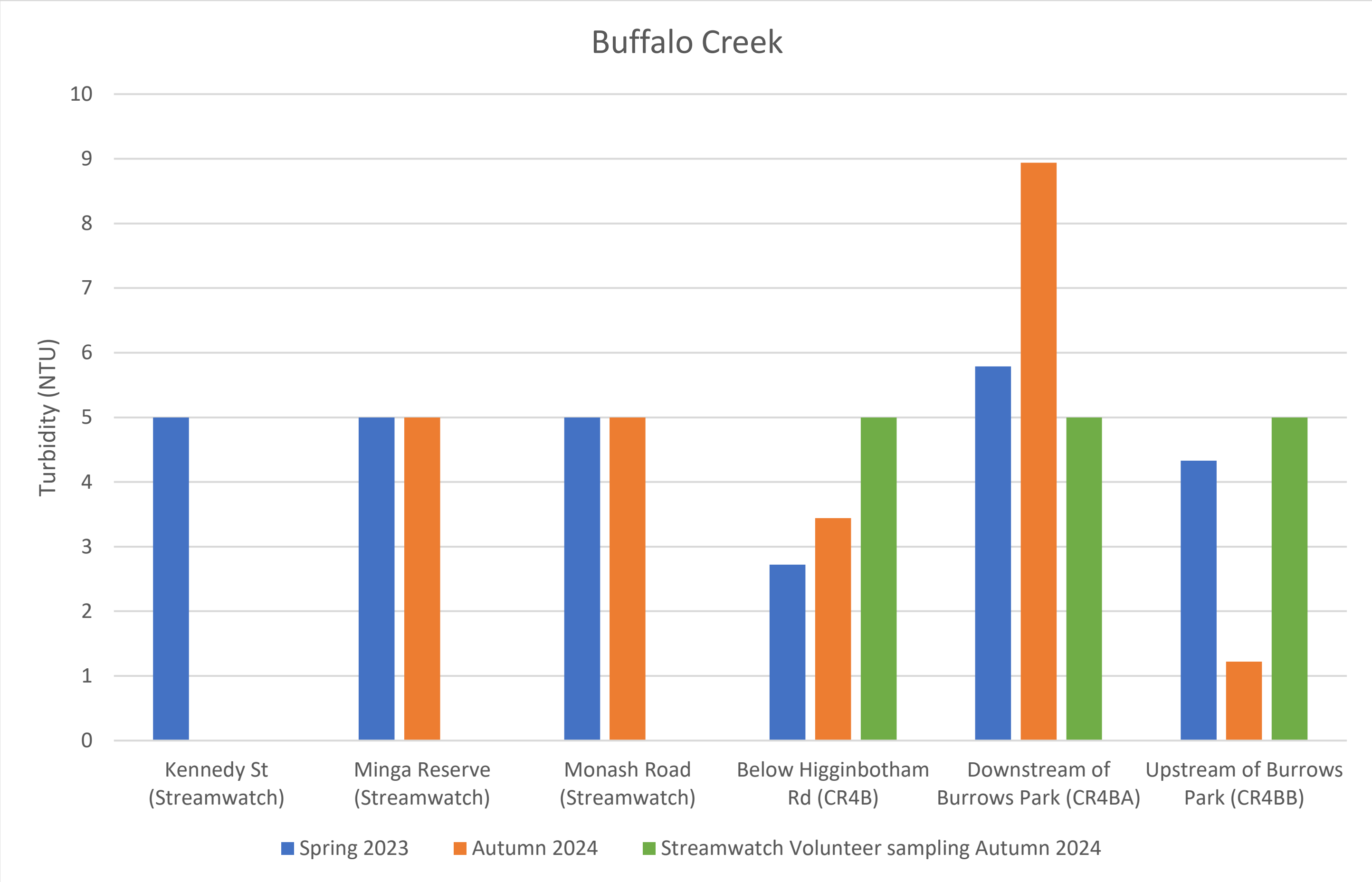

Figure ix Spring 2023 and Autumn 2024 turbidity (NTU) data from Sydney Water sites (Higginbotham Rd, Burrows Park Downstream and Burrows Park Upstream) and Buffalo Creek Streamwatch sites – turbidity values approximated.

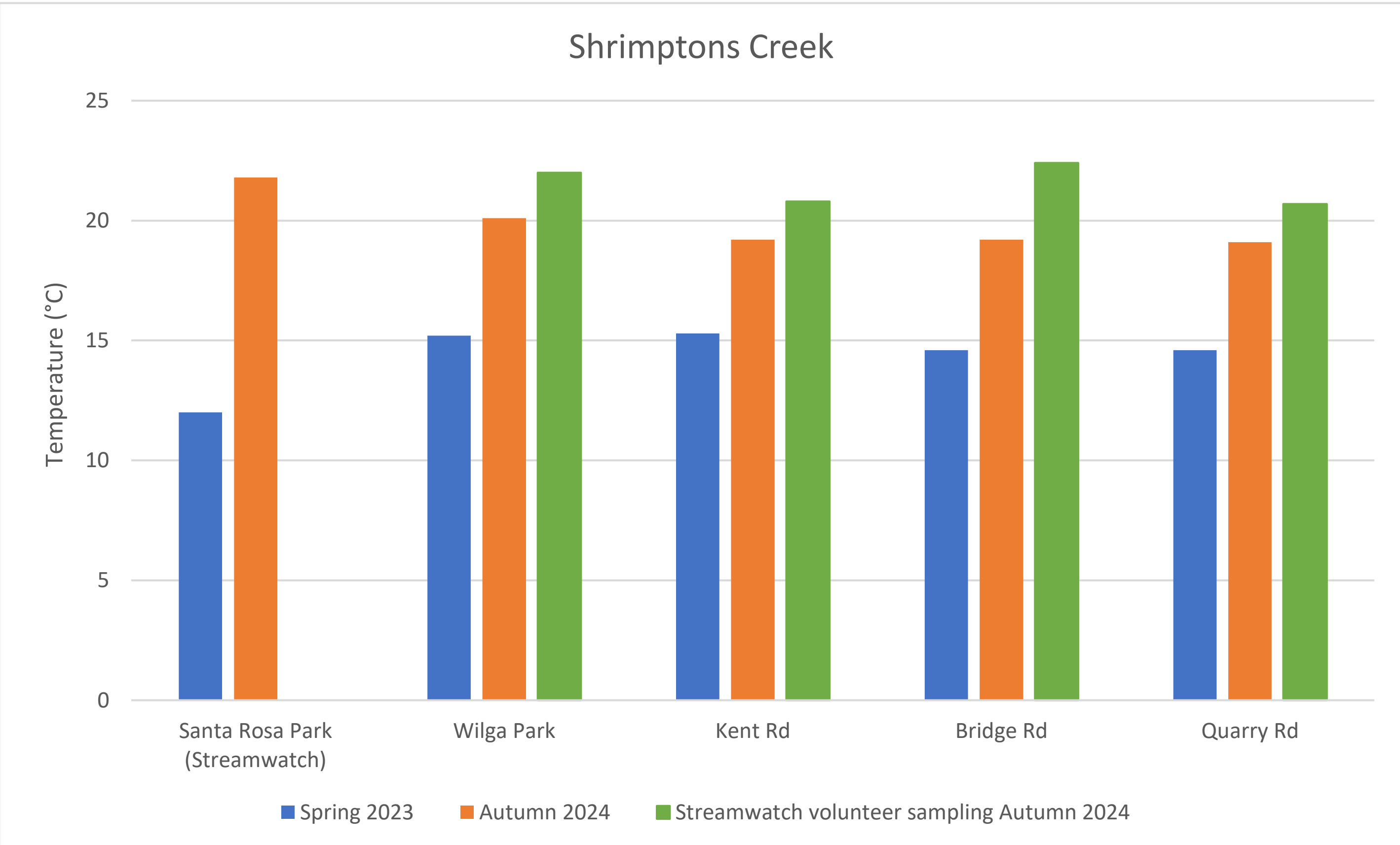

Figure x Spring 2023 and Autumn 2024 temperature (°C) data from Sydney Water sites (Wilga Park, Kent Road, Bridge Road, and Quarry Road) and Shrimpton Creek Streamwatch sites

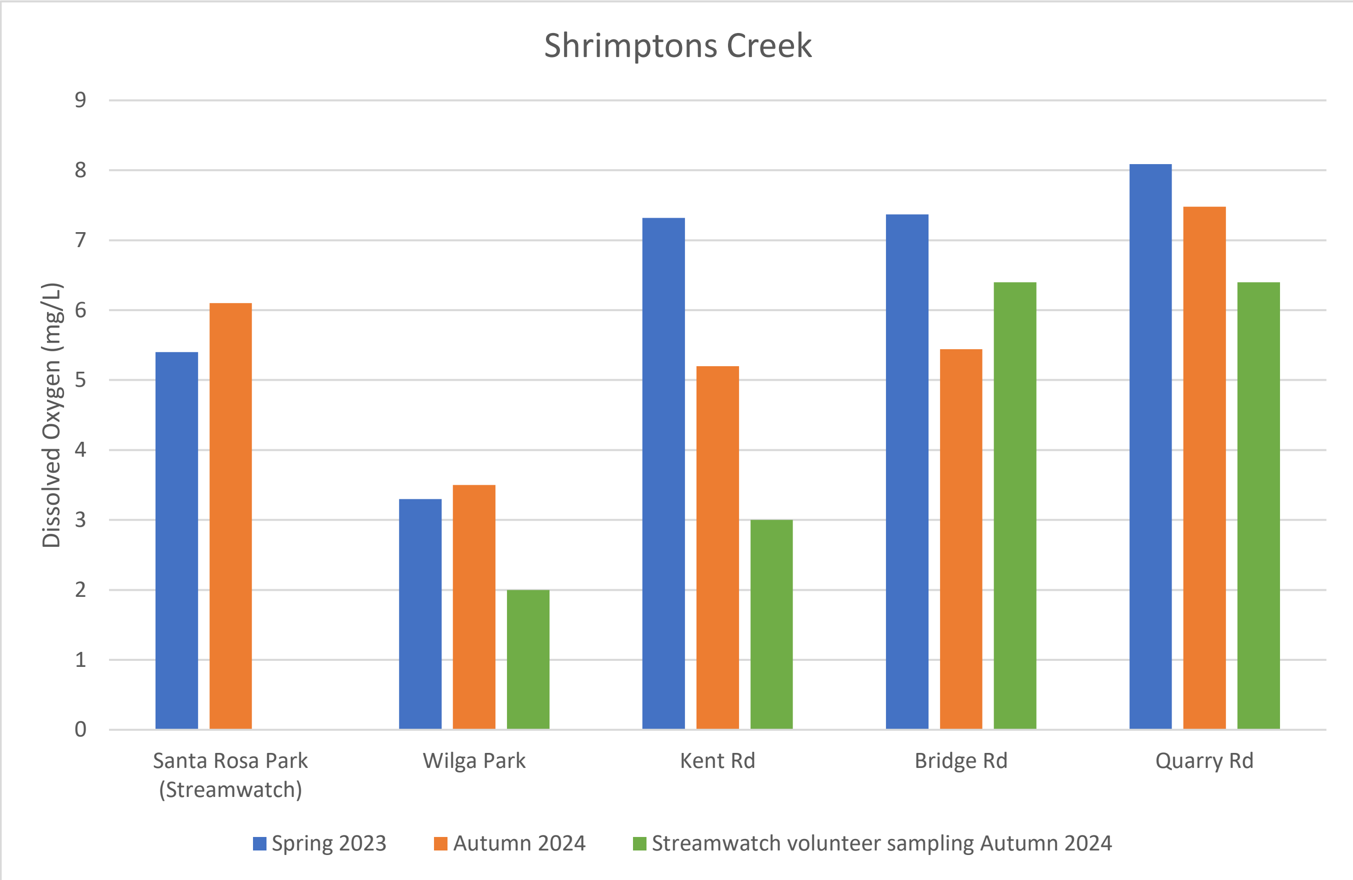

Figure xi Spring 2023 and Autumn 2024 dissolved oxygen (%) data from Sydney Water sites (Wilga Park, Kent Road, Bridge Road, and Quarry Road) and Shrimpton Creek Streamwatch sites

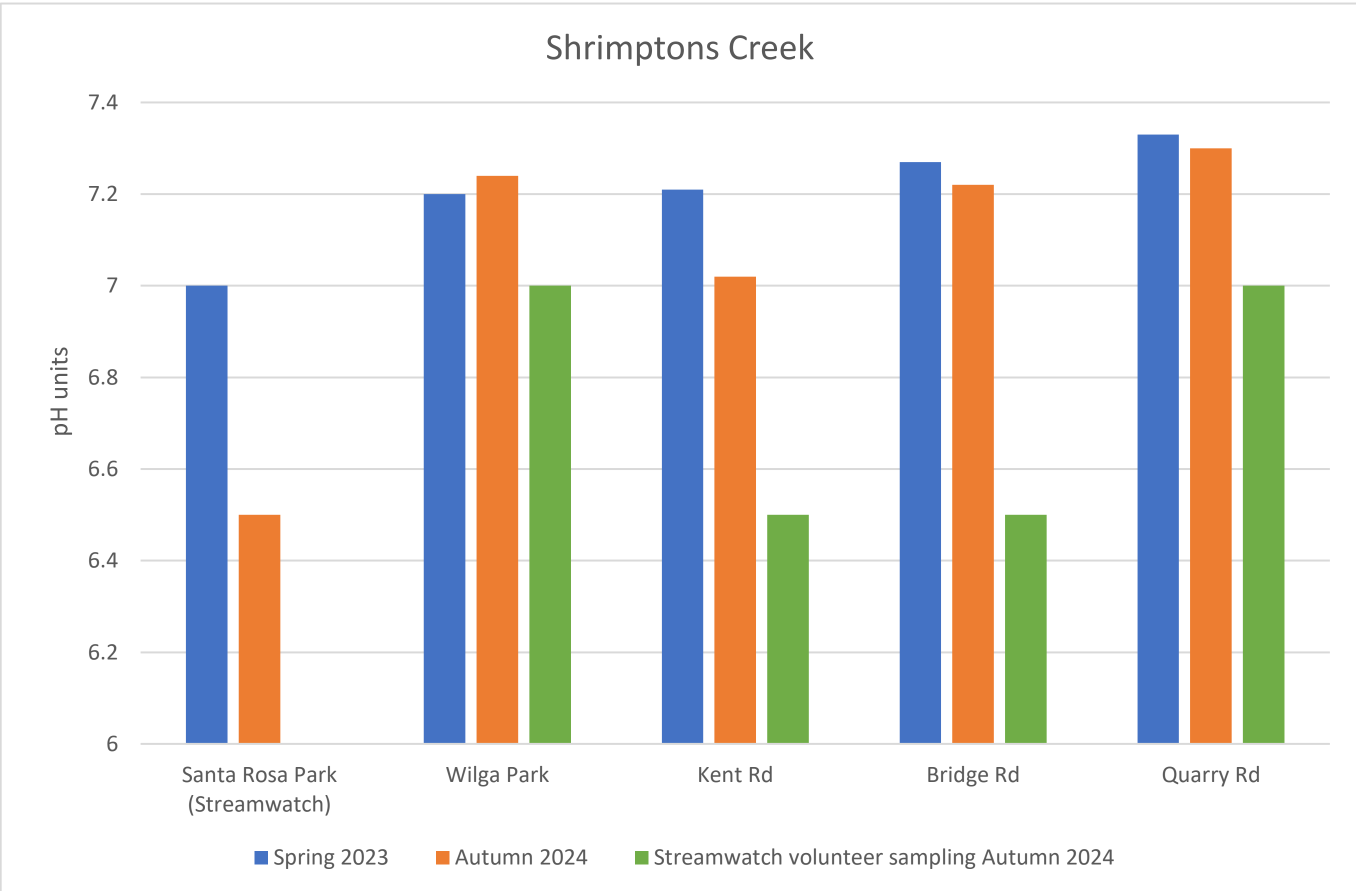

Figure xii Spring 2023 and Autumn 2024 pH data from Sydney Water sites (Wilga Park, Kent Road, Bridge Road and Quarry Road) and Shrimpton Creek Streamwatch sites

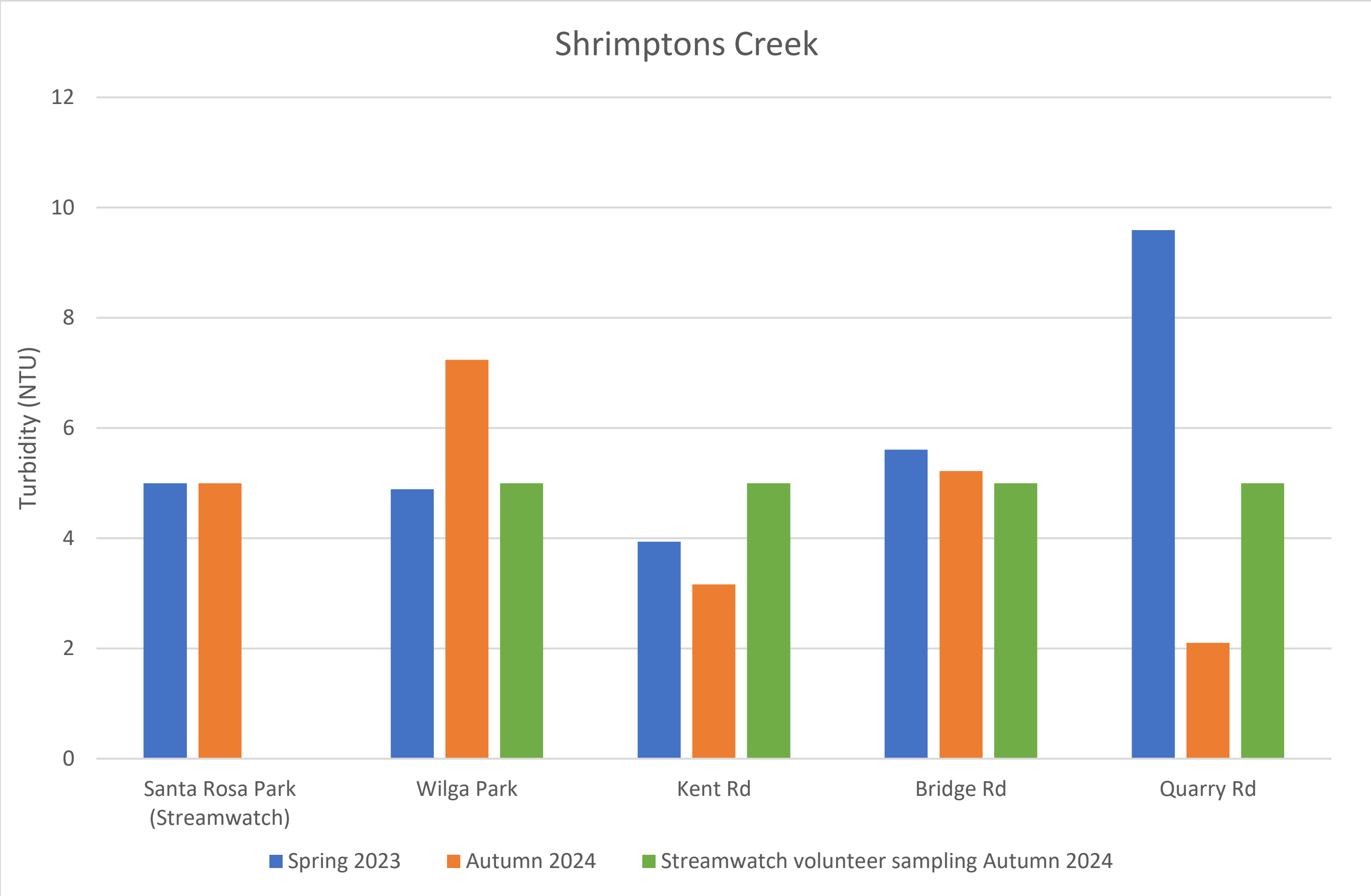

Figure xiii Spring 2023 and Autumn 2024 turbidity (NTU) data from Sydney Water sites (Wilga Park, Kent Road, Bridge Road and Quarry Road) and Shrimpton Creek Streamwatch sites

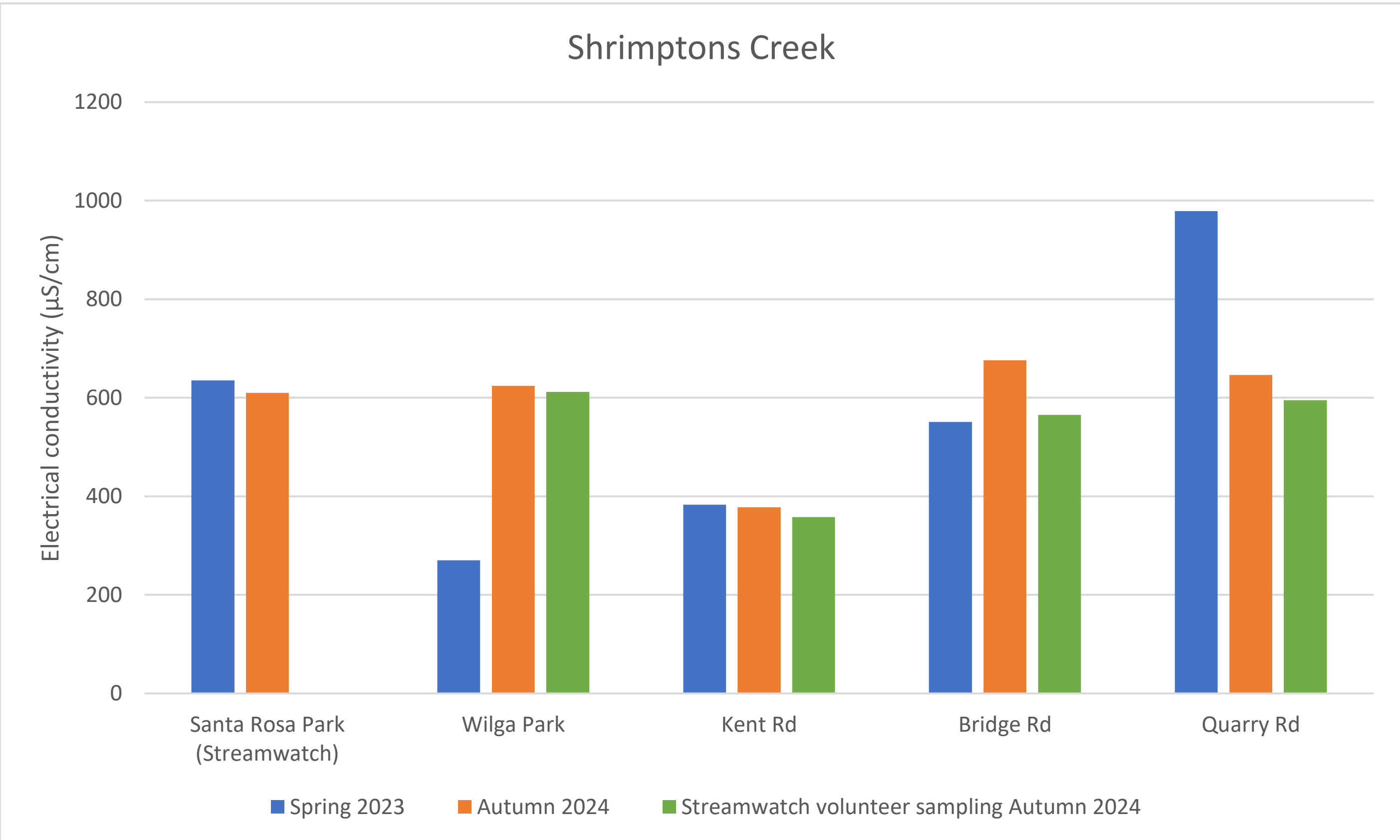

Figure xiv Spring 2023 and Autumn 2024 conductivity (µS/cm) data from Sydney Water sites (Wilga Park, Kent Road, Bridge Road and Quarry Road) and Shrimpton Creek Streamwatch sites

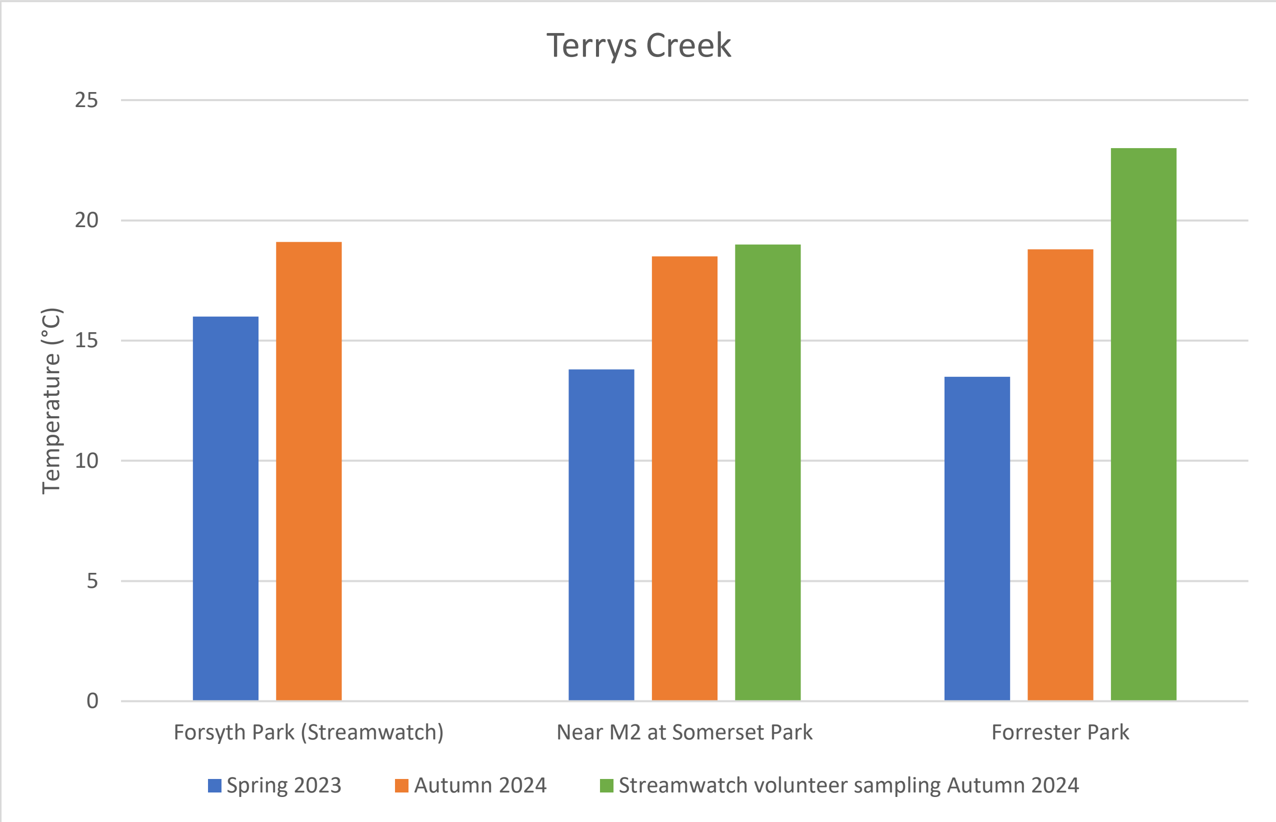

Figure xv Spring 2023 and Autumn 2024 temperature (°C) data from Sydney Water sites (Somerset Park and Forrester Park) and Terrys Creek Streamwatch site (Forsyth Park)

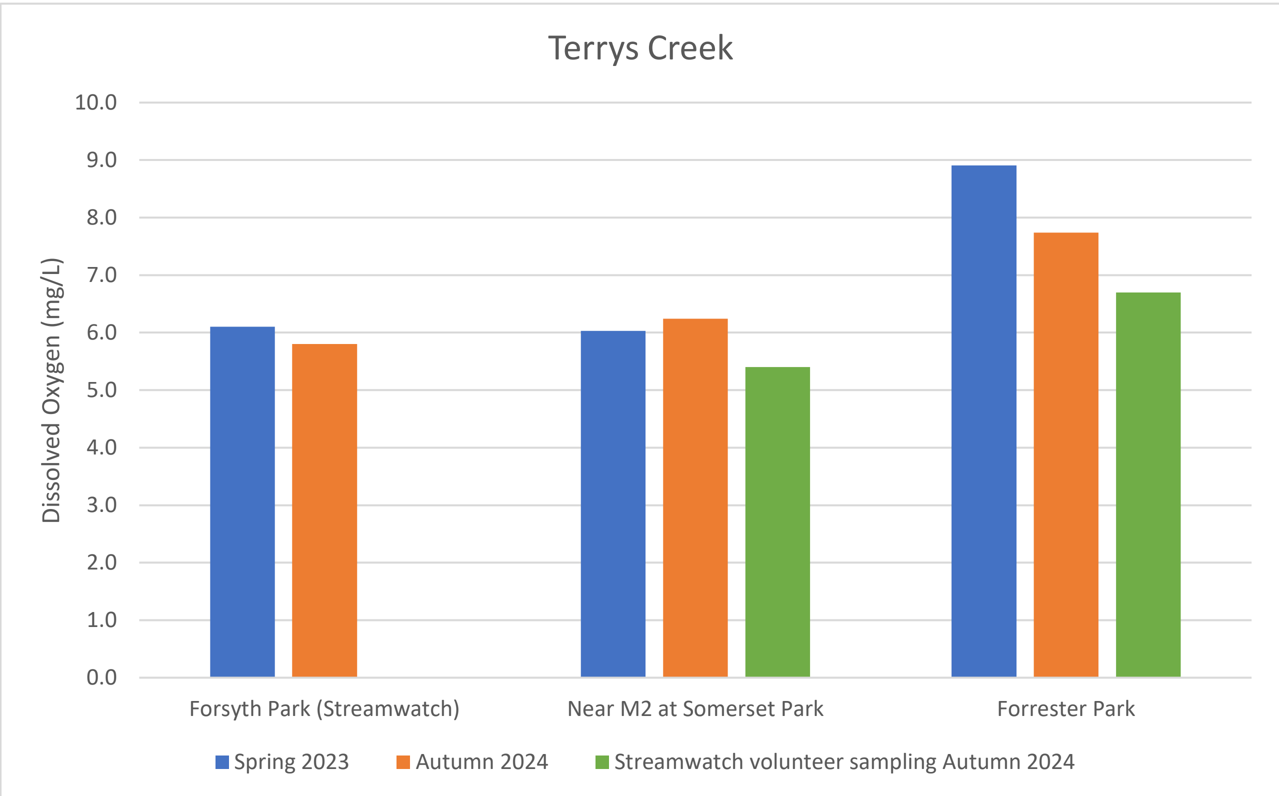

Figure xvi Spring 2023 and Autumn 2024 dissolved oxygen (%) data from Sydney Water sites (Somerset Park and Forrester Park) and Terrys Creek Streamwatch site (Forsyth Park)

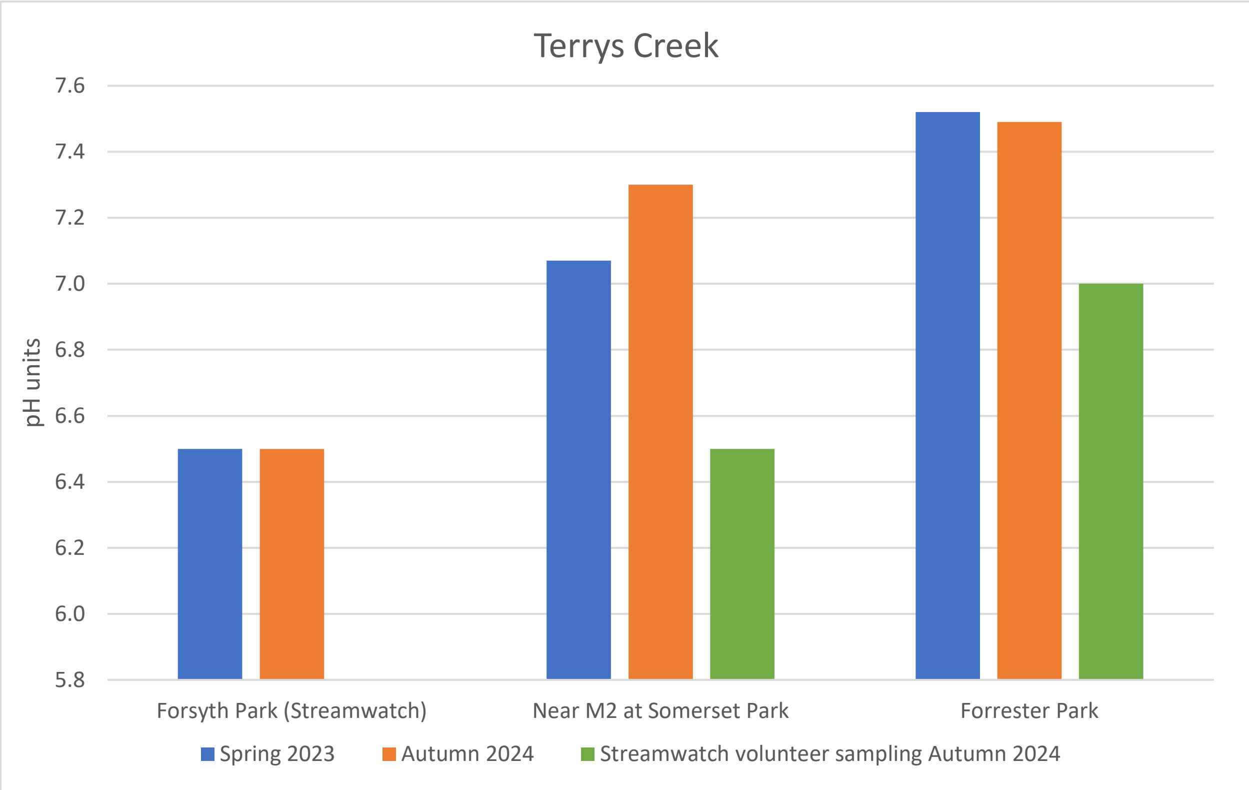

Figure xvii Spring 2023 and Autumn 2024 pH data from Sydney Water sites (Somerset Park and Forrester Park) and Terrys Creek Streamwatch site (Forsyth Park)

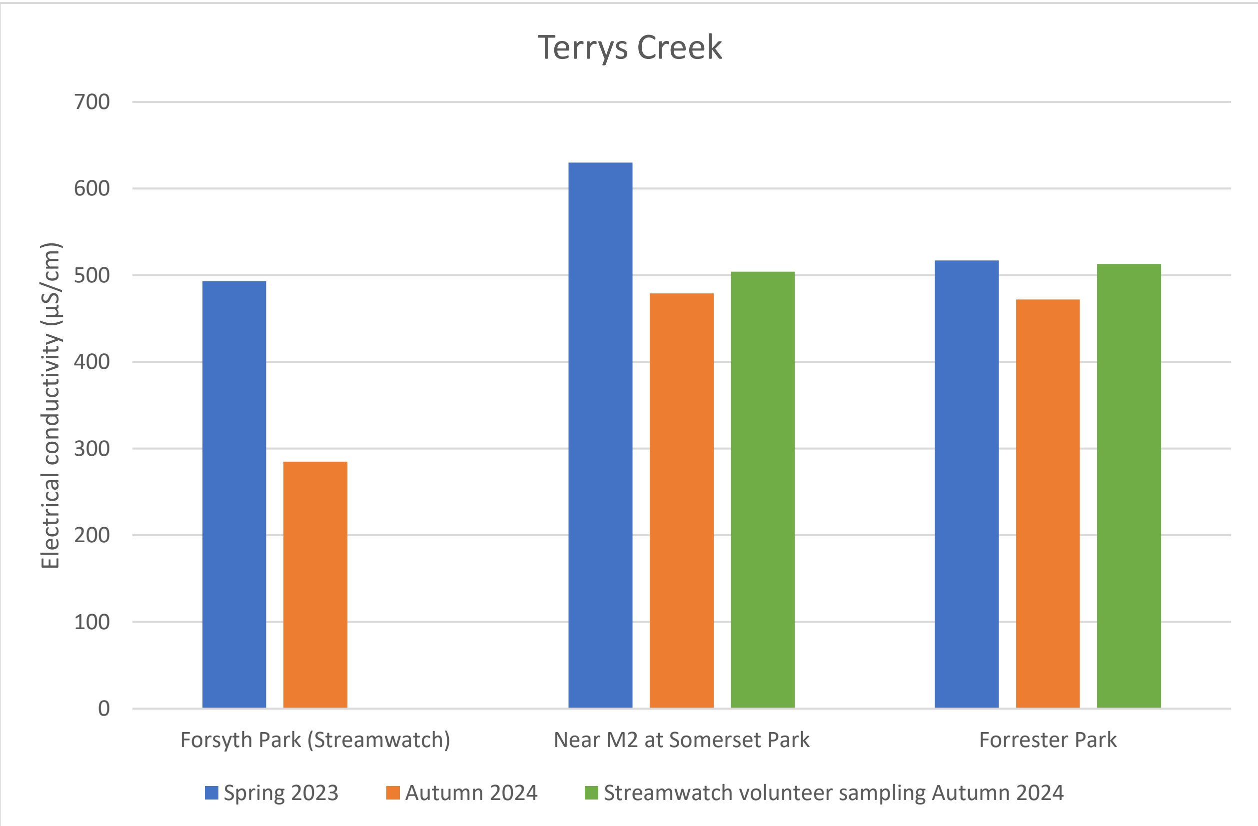

Figure xviii Spring and Autumn 2024 Conductivity (µS/cm) data from Sydney Water sites (Somerset Park and Forrester Park) and Terrys Creek Streamwatch site (Forsyth Park)

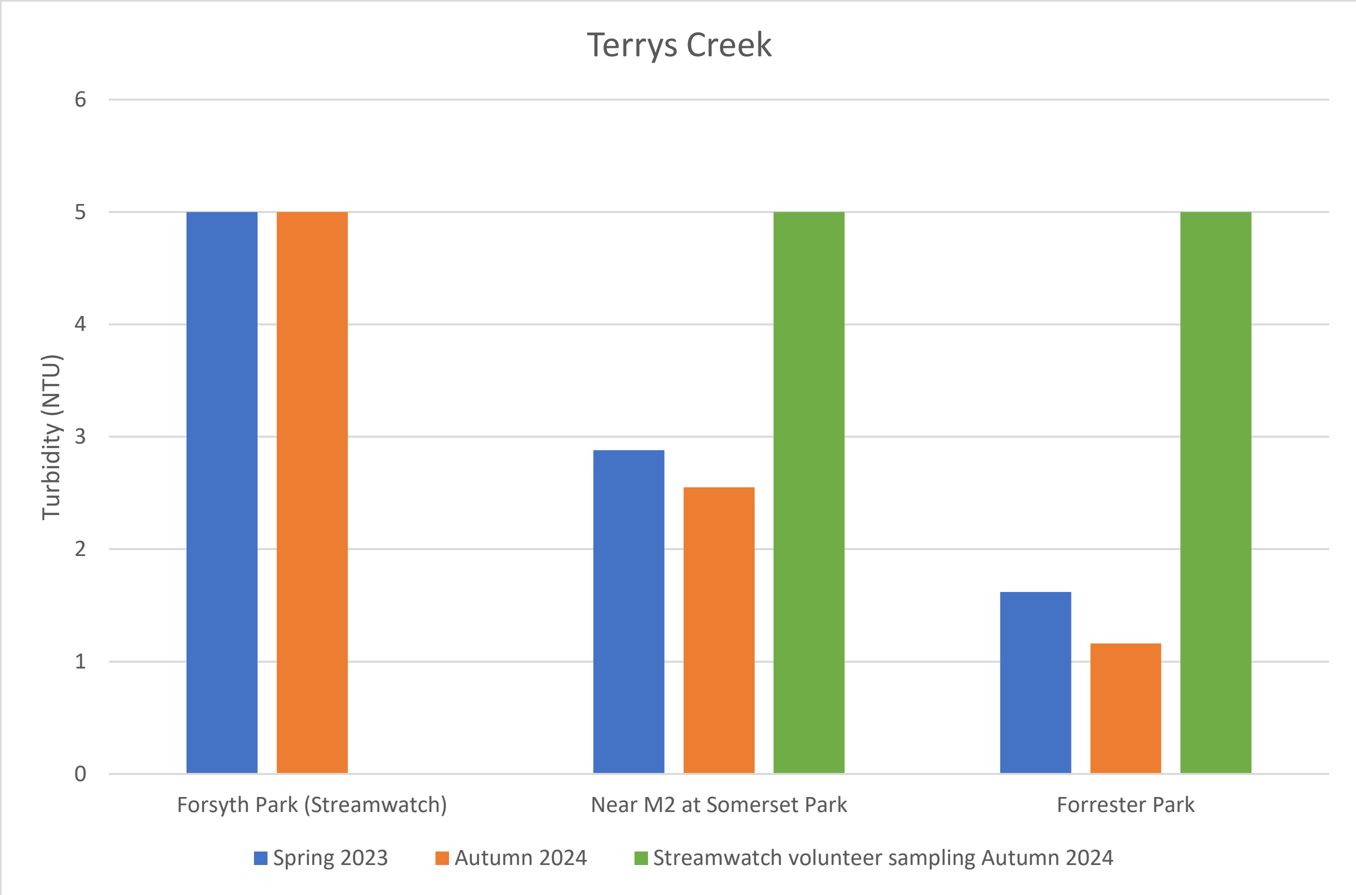

Figure xix Spring 2023 and Autumn 2024 turbidity (NTU) data from Sydney Water sites (Somerset Park and Forrester Park) and Terrys Creek Streamwatch site (Forsyth Park)

Glossary

Item	Meaning
Abundance	The total number of individual specimens; in a sample, community, ecosystem etc.
Algae	Comparatively simple chlorophyll-bearing plants, most of which are aquatic and microscopic in size.
Alkalinity	The ability of a solution to neutralise acid (or buffer).
Ammonia	A colourless gas. In the aquatic environment, it exists in the relatively harmless form ammonium (NH4) and the toxic form ammonia (NH3).
Analyte	The physical and chemical parameters (indicators) to be measured.
Anthropogenic	Impacts on an environment that are produced or caused by humans
ANZECC	ANZECC is a forum for member governments to develop coordinated policies about national and international environment and conservation issues.
Catchment	The area that is drained by a river, lake or other water body.
Community	Assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another.
Concentration	The quantifiable amount of a chemical divided by the total volume of a mixture.
Conductivity	The measure of salt content in soil or water; it refers to the ability of the substance to transfer an electrical charge.
Dissolved Oxygen	The measurement of the concentration of oxygen that is dissolved in a water body.
Diversity (Biological)	The measure of the number and/or degree of available organisms in an environment.
Eutrophication	Enrichment of a water body with nutrients that results in increased aquatic plant growth and low oxygen levels.
Faecal Coliforms	Bacteria which inhabit the intestines of humans and other vertebrates and are present in faeces. Used as a primary indicator of sewage pollution in the environment.
Guideline (water quality)	Concentration limit or narrative statement recommended to support and maintain a designated water use.
Habitat	The place where a population lives and its surroundings, both living and non-living.
Indicator	A parameter (chemical, biological or geological) that can be used to provide a measure of the quality of water or the condition of an ecosystem.
Macroinvertebrate (Aquatic)	Animals without backbones that when mature are greater than 1 millimetre; live in the water column, on the water surface or on the bottom of a waterway.
Nitrogen (Aquatic)	An element that is essential for plant and animal growth, it occurs in three forms Nitrate, Nitrite and ammonium.
Nutrients	Compounds required for growth by plants and other organisms. Major plant nutrients are phosphorus and nitrogen.
pH	A measure of the degree of acidity or alkalinity; expressed on a logarithmic scale of 1 to 14 (1 is most acid, 7 neutral and 14 most alkaline).
Phosphorus	Is an element that is essential for plant and animal growth, excess concentrations can lead to eutrophication.
Physico-Chemical (Aquatic)	The measure and relationship between the physical and chemical identities of a water body.
Sensitive organism	An organism that’s survival is highly susceptible to shifts in environmental conditions.

Sewage	The wastewater from homes, offices, shops, factories and other premises discharged to the sewer. Is usually 99% water.
SIGNAL SF	SIGNAL (Stream Invertebrate Grade Number Average Level) is a biotic index using aquatic macroinvertebrates to assess stream health.
Stormwater	Rainwater that runs off the land, frequently carrying various forms of pollution such as litter and detritus, animal droppings and dissolved chemicals. This untreated water is carried in stormwater channels and discharged directly into water bodies.
Stormwater system	The system of pipes, canals and other channels used to carry stormwater to bodies of water, such as rivers or oceans. The system does not usually involve any significant form of treatment.
Tolerant organism	Is an organism that can survive in highly variable environmental conditions.
Turbidity	A measure of the amount of suspended solids (usually fine clay or silt particles) in water and thus the degree of scattering or absorption of light in the water.

Acronyms and abbreviations

Acronyms/ Abbreviation	Meaning
ANZECC	Australian and New Zealand Environment and Conservation Council
CFU	Colony Forming Unit
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
SIGNAL SF	Stream Invertebrate Grade Number Average Level – Sydney Family
µg/L	Micrograms per litre
µS/cm	Micro-siemens per centimetre (unit of conductivity)

References

Galic, N.; Hawkins, T.; Forbes, V.E. Adverse impacts of hypoxia on aquatic invertebrates: A meta-analysis. *Sci. Total Environ.* **2019**, *652*, 736–743

Lerat-Hardy, A., Coynel, A., Schäfer, J. *et al.* Impacts of Highway Runoff on Metal Contamination Including Rare Earth Elements in a Small Urban Watershed: Case Study of Bordeaux Metropole (SW France). *Arch Environ Contam Toxicol* **82**, 206–226 (2022). https://doi.org/10.1007/s00244-021-00816-4

ANZECC (2000). *Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment and Conservation Council.*

Chessman, B.C. (1995). Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family-level identification, and a biotic index. *Australian Journal of Ecology*, 20, 122-129.

Chessman, B.C, Kotlash, A. and Growns, J. (1997). Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNALHU97B biotic index: application to the Hunter River system, New South Wales. *Marine and Freshwater Research*, 48, 159-172.

Chessman, B.C., Trayler, K.M., and Davis, J.A. (2002). Family- and species-level biotic indices for macroinvertebrates of wetlands on the Swan Coastal Plain, Western Australia. *Marine and Freshwater Research*, 53, 919-930.

Chessman B.C., Williams S.A. & Besley C.H. (2007). Bioassessment of streams with macroinvertebrates: effect of sampled habitat and taxonomic resolution. *Journal of the North American Benthological Society*. 26 (3), (546-563).

Growns, J.E, Chessman, B.C., McEvoy, P.K. & Wright, I.A. (1995). Rapid assessment of rivers using macroinvertebrates: Case studies in the Nepean River and Blue Mountains, NSW. *Australian Journal of Ecology*, 20, 130-141.

Growns, J.E., Chessman, B.C., Jackson, J.E., & Ross, D.G. (1997). Rapid assessment of Australian rivers using macroinvertebrates: cost efficiency of 6 methods of sample processing. *Journal of North American Benthological Society*, 16, 682-693.