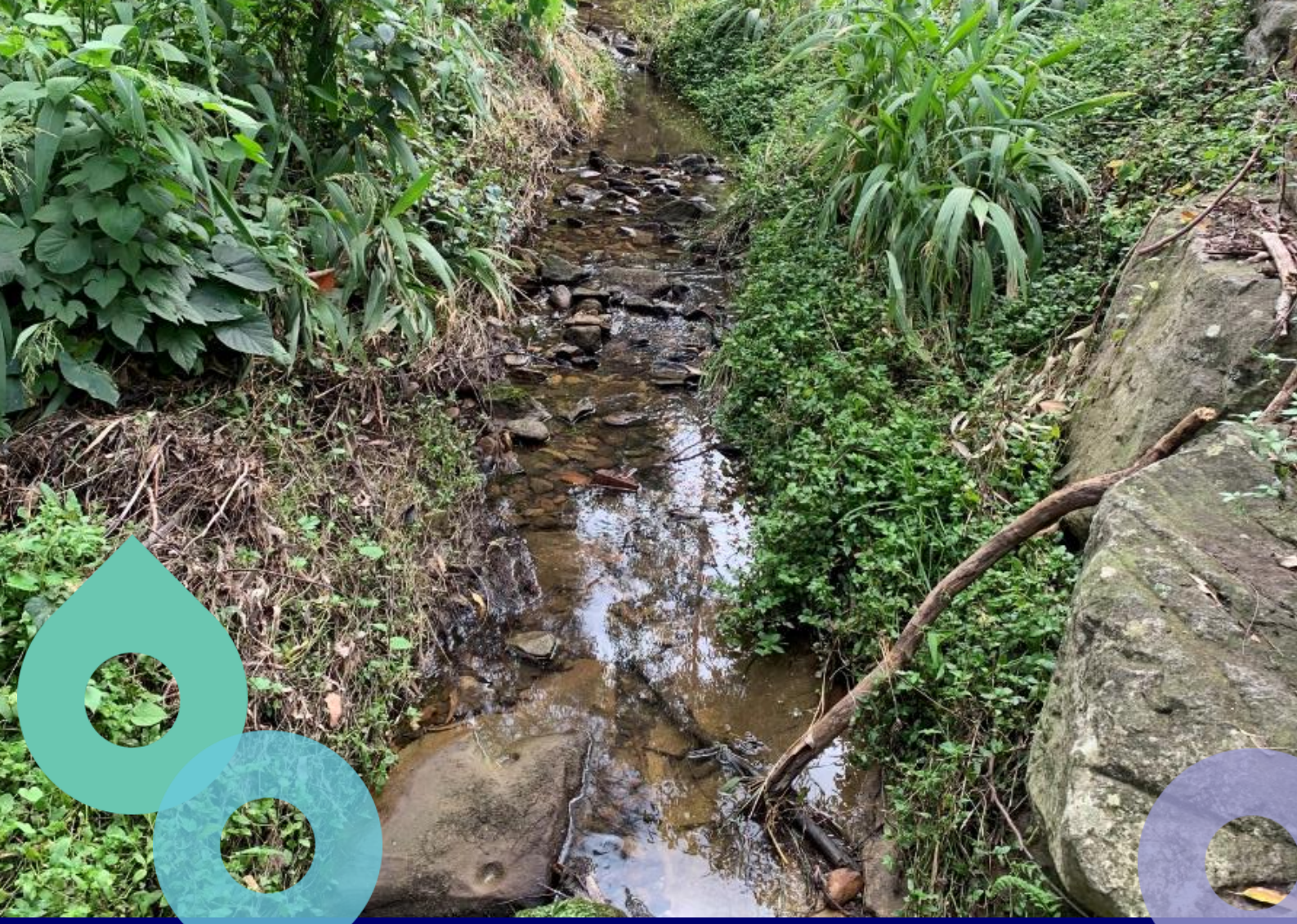

City of Ryde

Water Quality Monitoring Report
Spring 2020 – Autumn 2021

This report was produced by Sydney Water Monitoring Services™
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Cover image: Archers Creek (Core Site, CR2) upstream at Maze Park

Contents

Executive summary

This report presents the findings of water quality monitoring conducted in Spring 2020 and Autumn 2021. The survey area included the Archers, Buffalo, Porters, Shrimptons and Terrys Creek catchments. Biological and chemical observations from the most current sampling periods were in general, comparable to the historical averages for both seasons.

Environmental conditions at the time of sampling had an influence on seasonal trends. During the Autumn 2021 season, a significant rain event occurred in the region prior to sampling. The influence of this event must be considered when comparing data from the previous season (Spring 2020) and in comparisons with the previous report (Spring 2018 & Autumn 2019) where sampling was conducted during drought conditions.

Freshwater Macroinvertebrate analysis was conducted at the five core sampling sites. For each site SIGNAL SF scores were calculated. Values calculated for this current period of sampling were observed to be consistent with the results of previous sampling seasons and historical averages. The highest SIGNAL SF score was observed at Archers Creek in Spring 2020.

For each of the five core sites Macroinvertebrate Taxa Richness was also calculated. This value is an indicator of macroinvertebrate diversity and can infer the health status of a waterway. In general, Taxa Richness results for this current sampling period were lower than historical averages. There was a consistent seasonal trend for this indicator where Autumn 2021 richness results were higher than Spring 2020 results. The highest Taxa Richness score for this report period was observed at Porters Creek in Autumn 2021.

For each of the 14 sites a range of water quality parameters were tested. Water quality results were compared with thresholds outlined in the ANZECC guidelines (2018). In general, water quality results were consistent between sampling seasons and when compared with historical averages.

The current sampling season (Autumn 2021) saw high results for faecal coliforms with exceedances at most sites. This season also saw high values across most sampling sites for both turbidity and nutrient results (total nitrogen and total phosphorus). Conversely, there was a general trend of decline in faecal coliform results reported for Spring 2020 when compared to Spring 2018 values and historical averages.

Rapid Riparian Assessment (RRA) scores were calculated for the five core sites. Most of the sites received a *Fair* score. Porters Creek had the highest reported RRA score for this report period (*Excellent* – Autumn 2021) while Archers Creek had the lowest *(Poor* – Autumn 2021). Scores were consistent with historical data, however, scores for both seasons were generally lower than those reported from the previous sampling period.

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 that enables the temporal evaluation and analysis of the health of the catchments of the strategy
- 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, quality procedures, accreditation and journal references are the same as previous years and can be found in previous reports. The data tables, additional graphs, and method details for Rapid Riparian Assessment and wet weather sampling have been reported in a separate document.

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 through the Lane Cove River catchment.

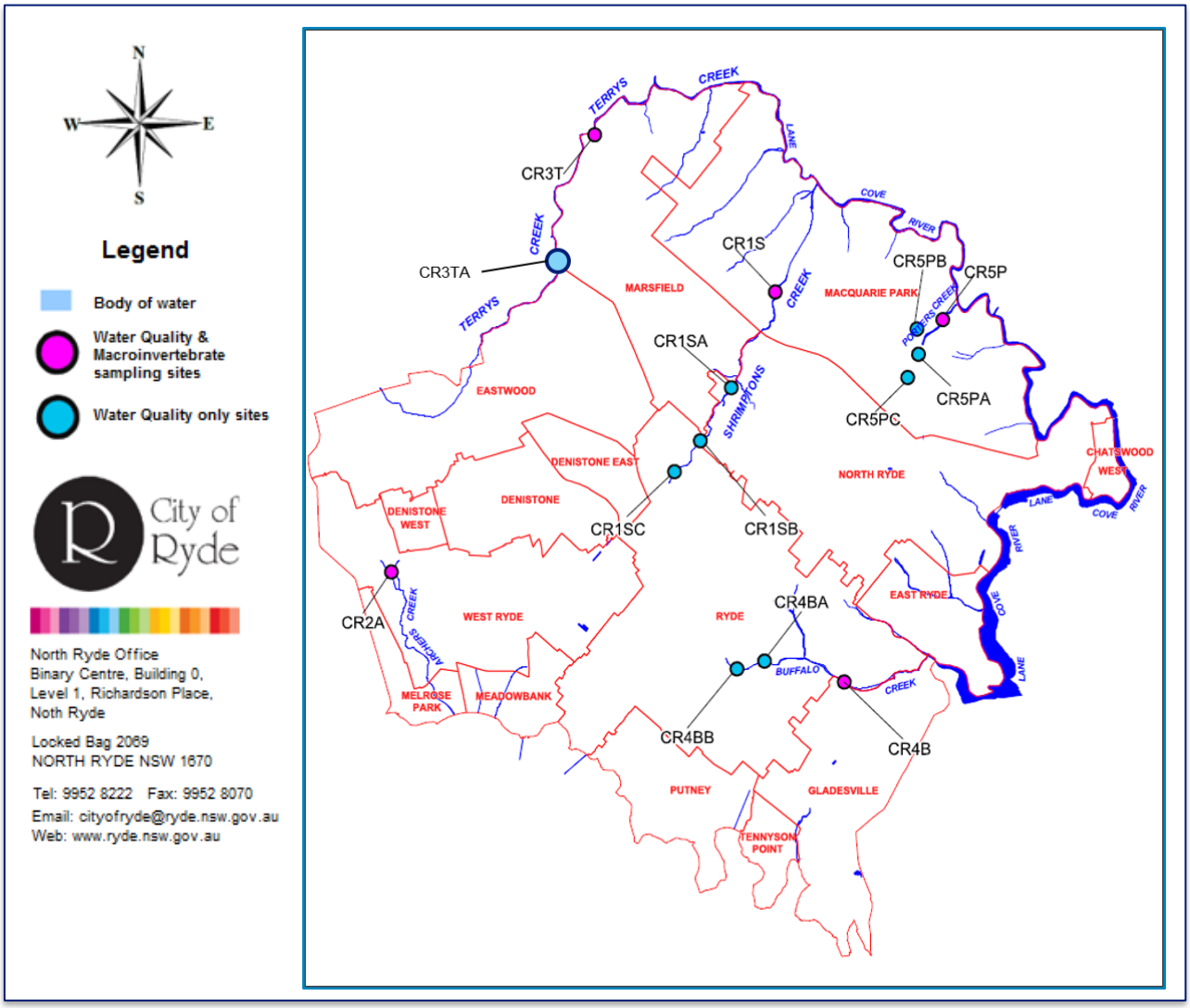


Figure 1 City of Ryde Water Quality Management Program Sites Map of sites for chemical and ecological monitoring across five creeks.

3 Sites

For each of the catchments there is a core site where macroinvertebrates, instream and riparian features, and water quality are assessed and additional water quality only sites (Table 1). Refer to the method description section for method information.

Table 1 Survey sites for monitoring chemical and ecological attributes.

** indicates a new site added to the program in Spring 2017*

Site	Location	Water Quality (wet & dry weather)	Macroinvertebrates	Rapid Riparian Assessment
CR1S	Shrimptons Creek at Wilga Park	✓	✓	✓
CR1SA	Shrimptons Creek at Kent Rd	✓		
CR1SB	Shrimptons Creek at Bridge St	✓		
CR1SC	Shrimptons Creek at Quarry Rd	✓		
CR2A	Archers Creek at Maze Park	✓	✓	✓
CR3T	Terrys Creek at Somerset Park	✓	✓	✓
*CR3TA	Terrys at Foresters Park	✓		
CR4B	Buffalo Creek	✓	✓	✓
CR4BA	Buffalo Creek d/s Burrows Park	✓		
CR4BB	Buffalo Creek u/s Burrows Park	✓		
CR5P	Porters Creek d/s of depot	✓	✓	✓
CR5PA	Porters Creek main branch	✓		
CR5PB	Porters Creek spur branch	✓		
CR5PC	Porters Creek at Wicks Rd	✓		

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.

Figure 2 Collecting macroinvertebrates from Buffalo Creek (Autumn 2019)

They are collected from the core sites following a standard method detailed in previous reports. This involves using a fine mesh net to upwell the water and dislodge the animals. They are picked from the debris and preserved for lab-based identification and enumeration.

4.1.1 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* from 1 being tolerant to poor stream health and 10 being very sensitive to poor stream health for each individual family.

Figure 3 Preserved macroinvertebrates

4.1.2 Taxa Richness

This is the total number of different types of animals collected. Generally, in healthier ecosystems, there will be higher diversity, which is 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. This provides information that can create a snapshot of what was happening in the creek at that point in time.

Figure 5 Collecting water samples for analysis

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

Water quality samples are collected at all 14 sites. Several analyses are conducted in the field and additional water is collected for lab analysis. The lab analysis is performed at the Sydney Water Laboratory located in West Ryde.

Water quality results are then compared to the Australian and New Zealand Environment and Conservation Council (ANZECC) 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. The analytes measured during this project are summarised in Table 2.

Figure 6 In-field water quality testing

Table 2 Water Quality parameters measured

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 Calcium, Total Hardness
Biological	Faecal Coliforms

4.3 Rapid Riparian Assessment

Rapid Riparian Assessments were added to the monitoring program in Spring 2017 to cover the areas of data, such as stream features, that aren't covered in macroinvertebrate and water quality sampling.

The riparian zone is the area where a body of water or stream, meets the land. The Rapid Riparian Assessment provides information on and assessment of the features of the stream and the vegetation community surrounding the stream.

Ku-ring-gai and Willoughby councils use these types of assessment. 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

Each variable within these categories are scored and form a score that will fall into an overall riparian health category (See Table 3).

Table 3 Rapid Riparian Assessment Categories

Category	Score range	Colour code
Excellent	≥60	
Good	27 to 59.99	
Fair	-6 to 26.99	
Poor	-39 to -6.99	
Very Poor	-72 to -39.99	

Figure 7 Shrimptons Creek core site, high level of riparian vegetation

5 Rainfall and Sampling

In the weeks preceding the sampling period significant rainfall and severe weather impacted the Sydney region with localised flooding of the Parramatta River. The region of North Ryde experienced days of significant rain. On March 20th, 2021 a volume of 130 mm fell in the Ryde region. Daily, monthly, and cumulative rainfall for the sampling period is summarised in Figure 8.

Heavy rainfall can have a significant impact on both chemical and biological parameters of waterway health. Large flows of water can significantly impact the community assemblages of macroinvertebrates, especially those confined to smaller creek systems. This may be evident in a reduction in macroinvertebrate taxa diversity and abundance. Flushing events can also reduce the concentrations of chemical toxicants in aquatic systems.

On the day of sampling (April 7th), two creeks; CR1S (Shrimptons Creek) and CR3T (Terrys Ck) experienced flash flooding events during sample collection. This rapid increase in water flow and volume at these sites, compounded with recent heavy rainfall can have a significant impact on both chemical and biological parameters.

These environmental sampling conditions were markedly different from the preceding season (Spring 2018 -Autumn 2019) where sampling was conducted during drought conditions.

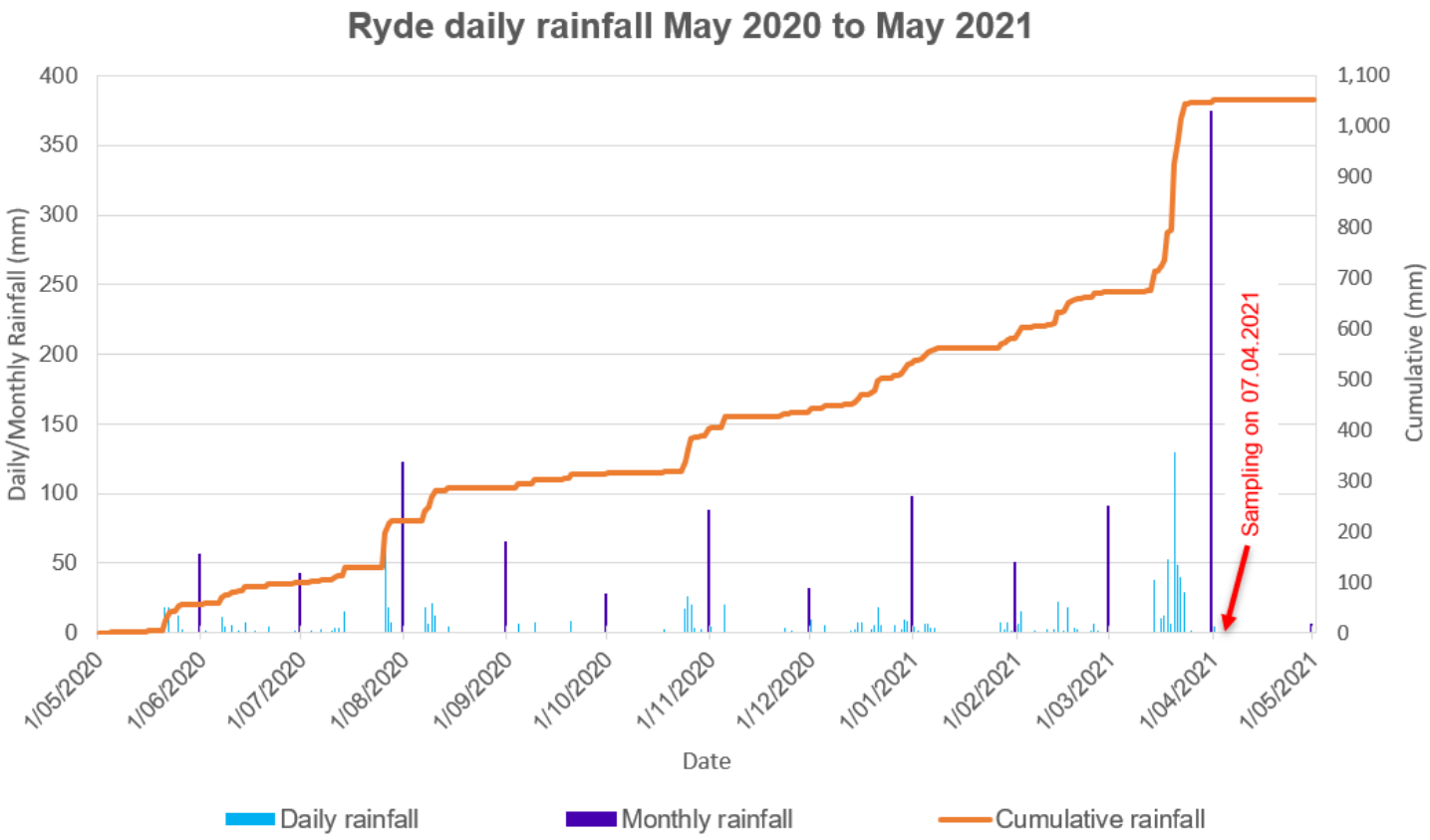


Figure 8 Rainfall and sampling events for Spring 2020 and Autumn 2021. Note cumulative rainfall scale is on the right.

6 Shrimptons Creek

6.1 Site Profile

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

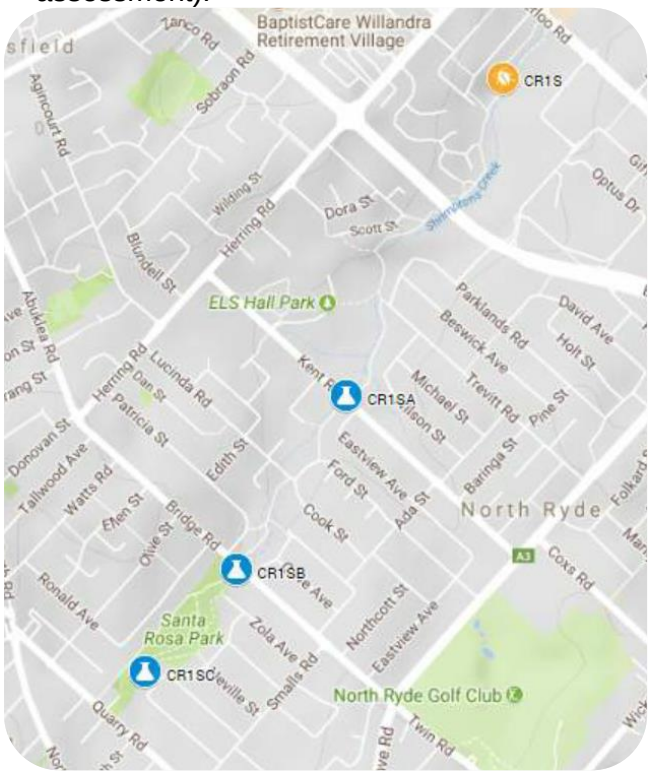


Figure 9 Shrimpton Creek Catchment Area

CR1S Shrimptons Creek (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 mix of native and exotic species. The creek bed is predominately bedrock and sand/silt.

During Autumn 2021 sampling, the area was impacted by localised flooding which significantly impacted the volume and flow of water in the channel (Figures 10 and 11).

Figure 10 Flooding at Shrimptons Creek, view from upstream

Figure 11 Flooding at Shrimptons Creek, view from downstream

CR1SA Shrimptons Creek at Kent Road

The Kent Road site is situated amongst a residential area and is lined by a thin section of riparian vegetation that completely shades the creek and comprises a mix of native and exotic species.

Figure 12 Shrimptons Creek at Kent Rd facing downstream

CR1SB Shrimptons Creek at Bridge Street

This site is located at the downstream section of Burrows Park, just before it flows under Bridge St and is surrounded by residential areas. The revegetation of the riparian area is now established adding to bank stabilisation, physical buffer and filtration.

Figure 13 Shrimptons Creek at Bridge St facing downstream facing downstream

CR1SC Shrimptons Creek at Quarry Road

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

Figure 14 Shrimptons Creek at Quarry Rd facing downstream

6.2 Results and Interpretation

6.2.1 Macroinvertebrates

SIGNAL SF

The SIGNAL SF results for Autumn 2021 were consistent with values recorded historically (Figure 15). However, the result for Spring 2020 was observed to be slightly lower than the historical average.

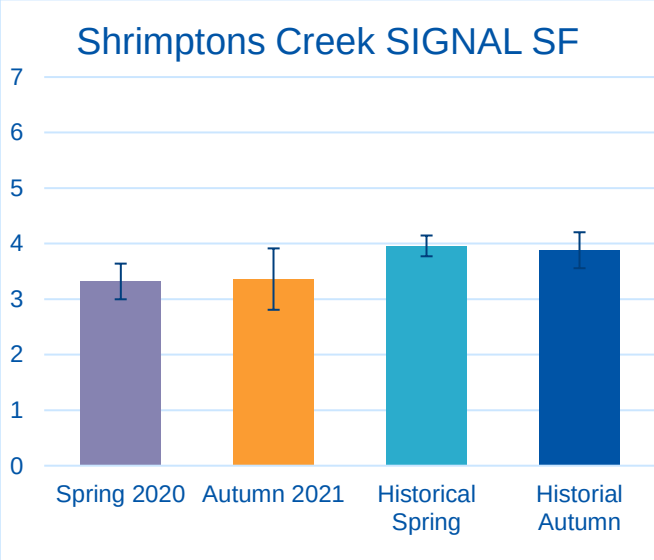


Figure 15 SIGNAL SF results for Shrimptons Creek

Taxa richness

The taxa richness result for Autumn 2021 was comparable to the historical average for the season (Figure 16). This contrasts with the observations for Spring sampling where Taxa Richness for Spring 2020 was lower than the historical average. This result was consistent with the previous sampling period (Spring 2018) which was also lower than the historical average for this season.

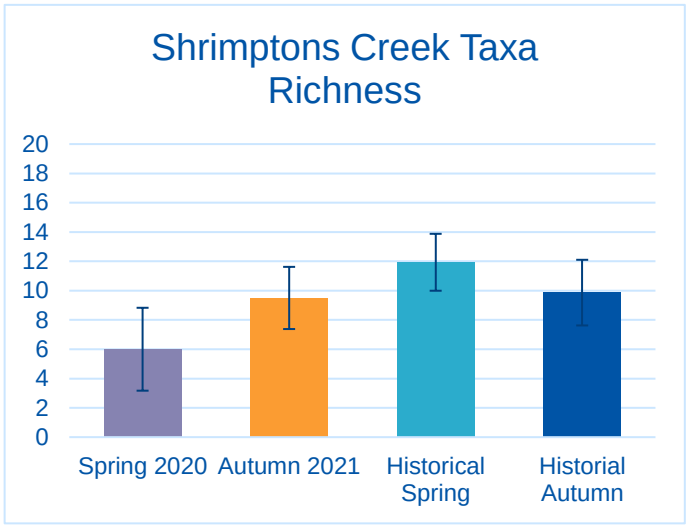


Figure 16 Taxa Richness results for Shrimptons Creek

Macroinvertebrates summary

SIGNAL SF Spring 2020 & Autumn 2021 results were consistent with historical averages

Taxa Richness Spring 2020 result was lower than the historical average for Spring

6.2.2 Water Quality

CR1S (Core Site)

- For Spring 2020 dissolved oxygen, conductivity, alkalinity, pH, and metals were consistent with historical results.
- Turbidity during Autumn 2021 sampling extremely high (367 NTU) and was the highest recorded result for this site across both recent seasons and sampling and compared with historical averages.
- An alkalinity of 104 mg CaCO3/L was the highest recorded result.

- Total nitrogen and total phosphorous values exceeded the ANZECC guideline values for Autumn 2021 and Spring 2020.
- Autumn 2021 saw the highest faecal coliform reading for this site at ~22,000 CFU/100mL (historical average 960 CFU/100mL) for this season, although not the highest on record (32,000 CFU/100mL, Spring 2005).
- In contrast, Spring 2020 faecal coliform results were ~620 CFU/100mL, which was below the Spring historical average and slightly lower than Spring 2018 (720 CFU/100mL).

CR1SA

- Turbidity in Autumn 2021 was the highest recorded (23.4 NTU) higher than previous season and the historical average (3.28 NTU).
- Total nitrogen and total phosphorous values exceeded the ANZECC guideline values for Autumn and Spring.
- Faecal coliform exceeded guidelines and was the highest on record (~12,000 CFU/100mL) compared with 350 Autumn 2019. Spring 2020 results were lower than Spring 2018 (15 and 310 CFU/100mL respectively).
- Dissolved oxygen, pH, and conductivity results were consistent across current sampling seasons and historical results.
- Total hardness for Spring 2020 (130 mg CaCO3/L) was the highest recorded value for this site.

CR1SB

- Autumn 2021 saw a new high for turbidity (30.5 NTU) compared to historical average (6.97 NTU), and dissolved oxygen (90.4%). Spring 2020 values for these parameters were consistent with previous seasonal values.
- Conductivity was high in Spring 2020 (874 µS/cm), greater than the historical average (606 µS/cm). In contrast to Autumn 2021 (165.8 µS/cm) which was lower than the result of Autumn 2019 (607 µS/cm) which was comparable to the historical average (657.5 µS/cm).
- Alkalinity results for Autumn 2021 were lower than Autumn 2019 (21 and 73 CaCO3 mg/L respectively), in contrast to Spring were values were more stable between sampling periods.
- Total nitrogen values exceeded the ANZECC guideline values for Autumn and Spring. Total phosphorous exceeded guidelines during Autumn only.
- Faecal coliforms for Autumn 2021 were the highest recorded (~34,000 CFU/100mL), contrasting to Autumn 2019 (1,300 CFU/100mL). Conversely for Spring the result of ~61 CFU/100mL in 2020 was much lower than the value recorded in 2018 (1,900 CFU/100mL).

CR1SC

- Dissolved oxygen, turbidity, pH total calcium and total magnesium results were consistent with previous years.
- Both Spring and Autumn conductivity results (234 and 974 µS/cm, respectively) exceeded the ANZECC guideline limit of 125 µS/cm.
- Faecal coliform results exceeded ANZECC guidelines in Autumn 2021 (~76,000 CFU/100mL) but were within limitations during Spring 2020 (~740 CFU/100mL).
- Both seasons saw exceedances for total nitrogen and total phosphorous results.

Water quality summary

In general, Spring 2020 water quality results consistent with previous years

Autumn 2021 saw new high values for turbidity, and exceedances for faecal coliform and nutrient results, likely a result of elevated rainfall prior to sampling

6.2.3 Rapid Riparian Assessment

A Rapid Riparian Assessment (RRA) assessment was conducted for Shrimptons Creek Core Site (CR1S).

This site is dominated by a combination of bushland and industrial space. The site comprises a natural channel environment with pool and riffle sequences and a moderate density of overhanging vegetation.

For both Spring 2020 and Autumn 2021 seasons, the Rapid Riparian Assessment scores were calculated at *Fair*.

For Spring 2020, this represented a reduction in RRA score from the previous season (*Good*, Spring 2018). For Autumn 2021, this was an improvement in RRA score from the *Poor* result in 2018.

Rapid Riparian Assessment score

- Spring 2020 (13.1 - Fair)
- Autumn 2021 (5.0 – Fair)

7 Archers Creek

7.1 Site Profile

CR2A Archers Creek (core site)

This site is located in Maze Park, West Ryde and is upstream of the Victoria Rd crossing (Figure 17). The upstream surrounding land use is residential and a golf course is present downstream. The bank was relined in the past with sandstone blocks. The creek bed is mostly bedrock with banks of sediment (sand, silt and organic matter, Figure 18). The vegetation within and around the creek is a mix of native and introduced species.

Figure 17 Archers Creek Catchment Area

7.2 Results and Interpretation

7.2.1 Macroinvertebrates

SIGNAL SF

The SIGNAL SF score for Archers Creek in Autumn 2021 was lower than the historical average (Figure 19). SIGNAL SF results for Spring 2020 were consistent with previous years.

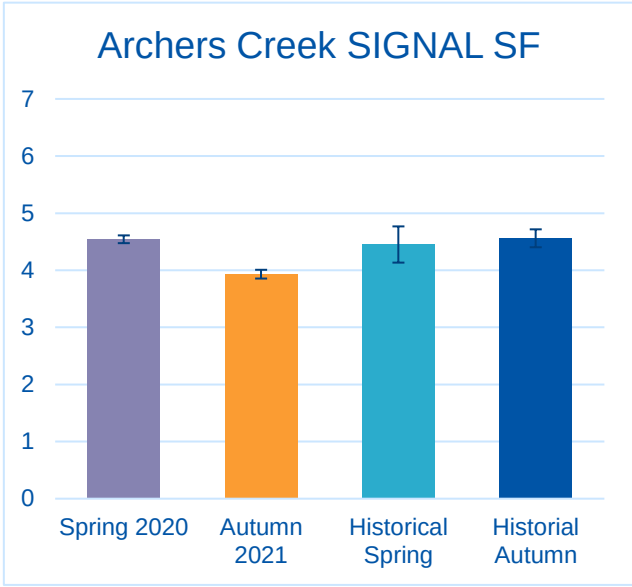


Figure 18 Archers Creek SIGNAL SF

Figure 18 Archers Creek Site upstream (left) and downstream (right)

Taxa richness

Autumn 2021 taxa richness result was within a similar range to previous values (Figure 20). Spring 2020 results were lower than the historical average.

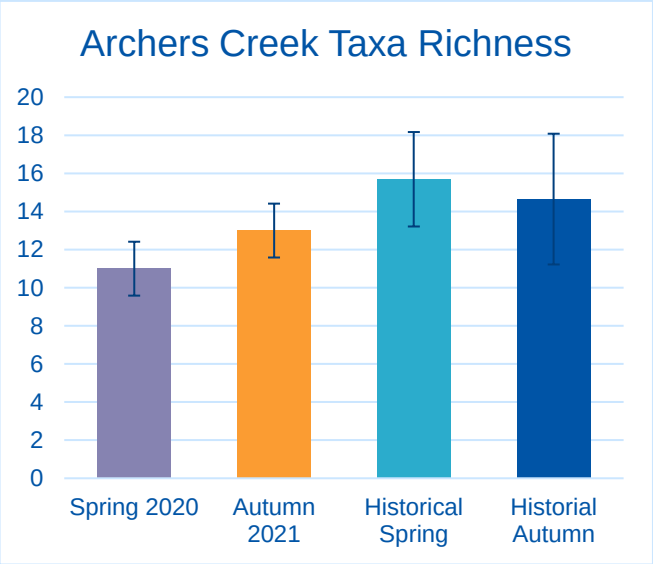


Figure 19 Archers Creek Taxa Richness

Macroinvertebrates summary

SIGNAL SF results for both Autumn 2021 and Spring 2020 were consistent with historical averages

Taxa Richness results for both seasons were slightly lower than historical scores

7.2.2 Water Quality

- Dissolved oxygen, turbidity, pH, metals results were consistent with the seasonal trends of previous sampling.
- Alkalinity value for Spring (37 mg CaCO3/L) was lower than Spring 2018 (72 mg CaCO3/L). Autumn values were comparable.
- Autumn conductivity declined from 738 µS/cm in 2019 to 391 µS/cm in 2020.
- The ANZECC guideline for total nitrogen (350 NTU) was exceeded for both Autumn (930 NTU) and Spring sampling (890 NTU).
- Faecal coliform result for Autumn 2021 was 2,900 CFU/100mL exceeding ANZECC guidelines (1,000 CFU/100mL). This was an increase from the previous season (99 CFU/100mL). Coliform result was within threshold for Spring 2020 (~690 CFU/100mL) and consistent with previous season.

Water quality summary

In general data was consistent with historical averages

Autumn 2021 values for faecal coliform and total nitrogen exceeded guidelines

7.2.3 Rapid Riparian Assessment

The zone of Archers Creek at Maze park is predominated by a combination of residential areas and parkland. The channel is a modified, rock-lined environment with riffle and pool sequences present.

Both Autumn 2021 and Spring 2020 results saw a reduction in RRA score in comparison to the previous season. The RRA score for Autumn 2021 *Poor* which was a decline from Autumn 2019 with a RRA score of *Good.* A similar trend was observed in Spring 2020 where the RRA score declined from *Good* in Spring 2018 to *Fair* in Spring 2020.

Rapid Riparian Assessment score

Spring 2020 (-1.1–Fair)

Autumn 2021 (-17.7 – Poor)

8 Terrys Creek

8.1 Site Profiles

CR3T Terrys Creek (core site)

This site is located within Somerset Park under the M2 overpass in the suburb of Epping (Figure 21). The surrounding land use is residential, and the creek flows through a bushland corridor. The surrounding riparian area and bank edge is a mix of native and exotic plant species. The creek bed is predominately bedrock, gravel, and sand.

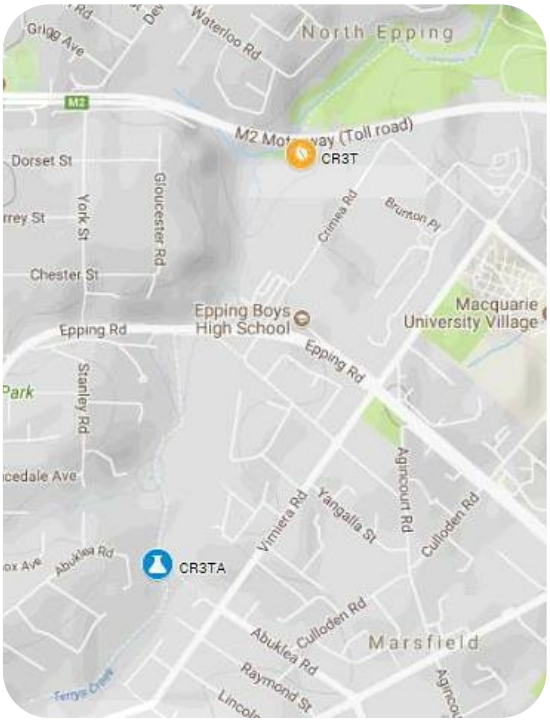


Figure 20 Terrys Creek Catchment Area

CR3TA Terrys Creek @ Foresters Park

This site is located downstream of Terrys Creek Waterfall, which is an area surrounded by bushland. 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 areas of broken water.

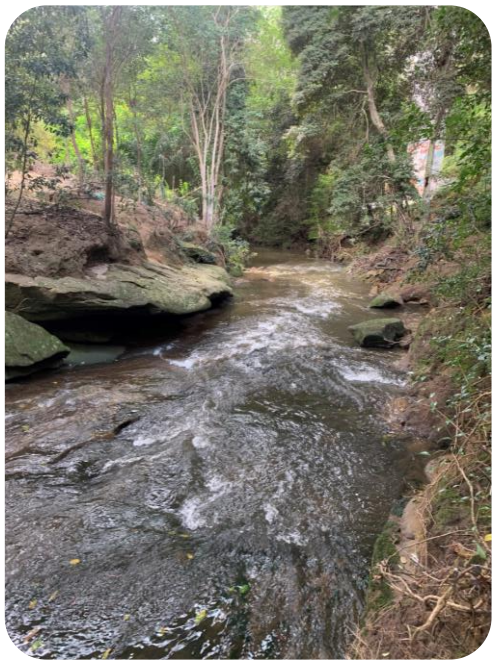


Figure 21 Terrys Creek CR3T (core site) downstream

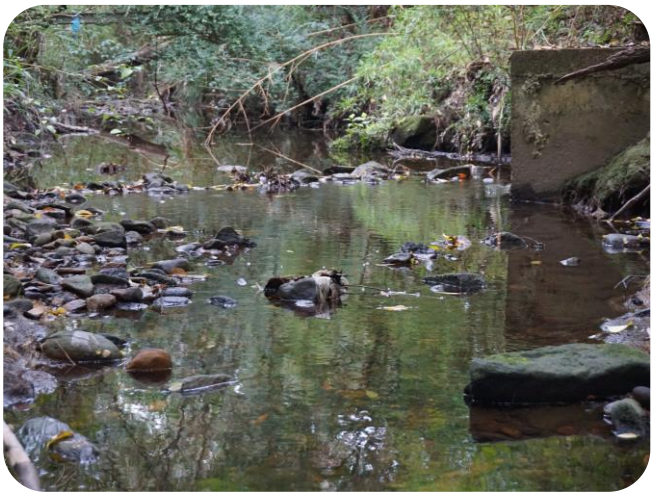


Figure 22 Terrys Creek at Foresters Park (CR3TA) facing upstream

8.2 Results and Interpretation

8.2.1 Macroinvertebrates

SIGNAL SF

SIGNAL SF results for Terrys Creek were observed to be consistent with historical averages for both Spring and Autumn sampling seasons (Figure 24).

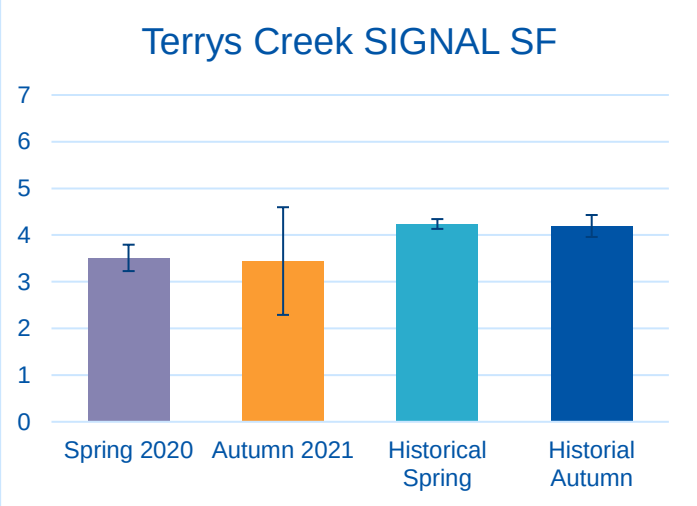


Figure 24 Terrys Creek SIGNAL SF

Taxa richness

Current Spring and Autumn season results were slightly lower than historical averages (Figure 25). The richness score for Spring 2020 was 9.5 which declined from the previous season (Spring 2018, 14).

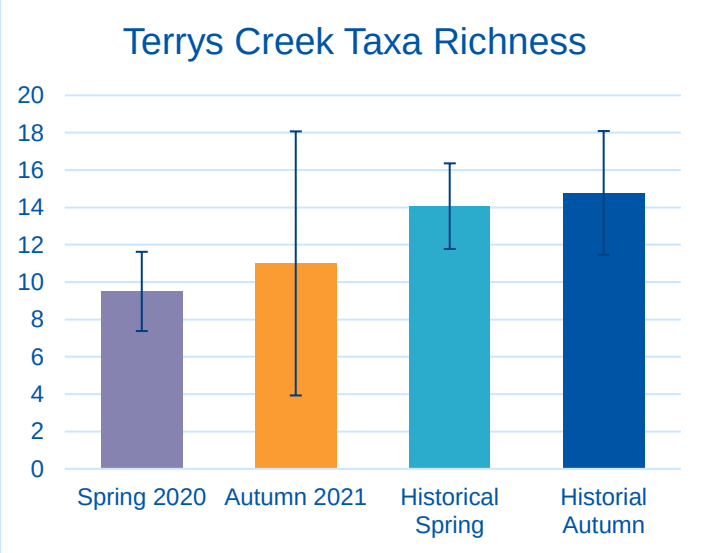


Figure 25 Terrys Creek Taxa Richness

Macroinvertebrates summary

SIGNAL SF results for both seasons were comparable to historical averages

Taxa Richness results for both seasons were lower than historical averages. Spring 2020 saw a decline in richness

8.2.2 Water Quality

CR3T (Core Site)

- In general, results across a range of parameters were consistent with recent seasons and historical averages
- Turbidity for Autumn 2021 was consistent with previous seasons. Conductivity for Autumn 2021 was 5.67 µS/cm which was the lowest recorded value for this site, below the historical average for Autumn (416 µS/cm).
- Total nitrogen and total phosphorous exceeded ANZECC guidelines but were consistent with historical averages.
- Autumn 2021 had the highest recorded total hardness result for this site (130 mg CaCO3/L)
- Faecal coliforms for Autumn 2021 (~700 CFU/100mL) increased from the previous Autumn (220 CFU/100mL, 2019). However, this was still lower than historical average for the season (3332 CFU/100mL) and within threshold values. Coliform results for Spring 2020 were low (18 CFU/100mL) and less than the result for Spring 2018 (210 CFU/100mL).

CR3TA

- Limited data set for historical values (data collection from 2018). As with CR3T, values in general were similar previous results for dissolved oxygen, pH, alkalinity
- Turbidity was the highest recorded during Autumn 2021 (25.1 NTU), seasonality and for historical averages.
- Spring 2020 observed a new high value for conductivity (1,036 µS/cm) which was an increased from Spring 2018 (591µS/cm).
- Total nitrogen and total phosphorous exceeded ANZECC guidelines for both Autumn 2021 and Spring 2020.
- Faecal coliforms result was above ANZECC threshold and was the highest value recorded for the site (~11,000 CFU/100mL). Spring results were consistent with the historical average.

Water quality summary

CR3T faecal coliform results were within guidelines.

Total nitrogen and total phosphorous values exceeded thresholds for both seasons

CR3TA Autumn 2021 had an exceedance for faecal coliforms.

8.2.3 Rapid Riparian Assessment

Rapid Riparian scores were calculated for Terrys Creek core site (CR3T). The Spring 2020 score was consistent with the Spring 2018 score with both seasons falling into the *Fair* category.

In contrast, there was an increase in RRA score between Autumn 2019 (*Fair*) to Autumn 2021 (*Good*).

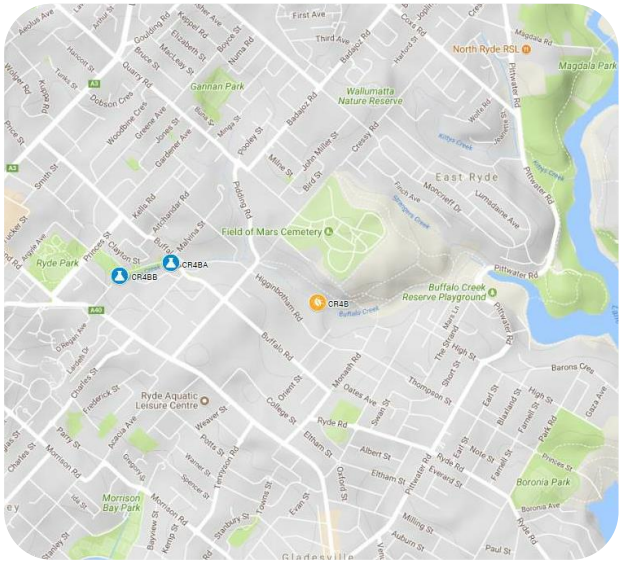
Rapid Riparian Assessment score

- Spring 2020 (20.8 - Fair)
- Autumn 2021 (42.8 - Good)

9 Buffalo Creek

9.1 Site Profiles

Buffalo Creek catchment has one core site and two water quality sites. In creek trash removal was carried out at Laurel Park wihtin the Buffalo Creek Catchment by City of Ryde.



CR4B Buffalo Creek (core site)

The Buffalo Creek core sampling site is in a bush corridor in the suburb of Gladesville and is accessed through private property. 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 has a mix of sand, silt and gravel. There is usually some macrophyte growth, *Egeria* and *Potamogeton*, and little algal growth has been observed. Sedimentation has occurred periodically, along with a significant amount of organic debris and domestic rubbish.

Figure 24 Buffalo Creek core site (CR4B) upstream

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. 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 25 Figure 28 Buffalo Creek Downstream of Burrows Park facing upstream

CR4BB Buffalo Creek Upstream of Burrows Park

The upstream Burrows Park site is about 300 metres upstream of Buffalo Rd, and lies in the middle of a bush corridor. The site is surrounded by vegetation that completely shades the creek. The creek is shallow at this point and has little flow. The site is positioned just downstream from a stormwater tributary/pipe.

Figure 26 Buffalo Creek Upstream of Burrows Park

9.2 Results and Interpretation

9.2.1 Macroinvertebrates

SIGNAL SF

Buffalo Creek SIGNAL SF results for Spring 2020 and Autumn 2021 were consistent between seasons and with historical averages (Figure 27)

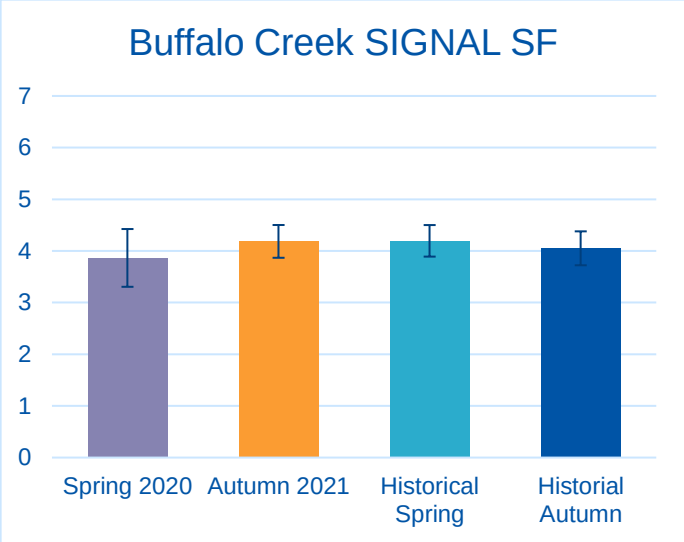


Figure 27 Buffalo Creek SIGNAL SF

Taxa richness

The taxa richness value for Spring 2020 was lower than the historical average for this season. The taxa richness result for Autumn 2021 was only slightly lower than the historical average.

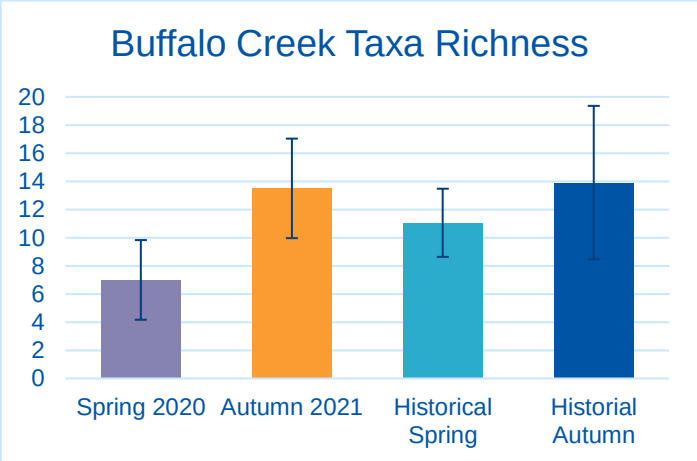


Figure 28 Buffalo Creek Taxa Richness

Macroinvertebrates summary

SIGNAL SF scores were consistent with historical averages

Taxa Richness Autumn 2021 score was consistent with historical values. Spring 2020 score was lower than historical values

9.2.2 Water Quality

CR4B (Core Site)

- Dissolved oxygen, conductivity, alkalinity, turbidity, pH comparable with historical averages.
- Total nitrogen and total phosphorous values exceeded ANZECC guidelines in both Autumn 2021 and Spring 2020.
- Faecal coliform result for Autumn 2021 was higher than Autumn 2019 (~670, and ~210 CFU/100mL respectively) but within guideline limits.
- Conversely, Spring 2020 saw a decline in coliform results from Spring 2018 (250 CFU/100mL) to Spring 2020 (~93 CFU/100mL).

CR4BA

- Autumn 2021 conductivity was lower than the historical average, but consistent with previous results.
- Dissolved oxygen, total hardness and pH results were consistent between current seasons and when compared with historical averages.
- Faecal coliforms had the highest recorded result for Autumn 2021 (5,800 CFU/100mL. In contrast, the Spring 2020 was within threshold (410 CFU/100mL), and lower than the Spring 2018 result (1,400 CFU/100mL).
- Total nitrogen and total phosphorous values exceeded ANZECC guidelines in both Autumn 2021 and Spring 2020.

CR4BB

- The faecal coliform result (~8,700 CFU/100mL) exceeded the ANZECC guideline and was higher than Autumn 2019 (1,200 CFU/100mL).
- Spring 2020 coliform value (~850 CFU/mL) was slightly higher than the previous season (Spring 2018; 650 CFU/mL) but both values were within ANZECC threshold.

Water quality summary

CR4B had exceedances in nutrient results, but faecal coliforms were within threshold

CR4BA and CR4BB had coliform results exceeding ANZECC guidelines

Coliform results were higher in Autumn than in the Spring

9.2.3 Rapid Riparian Assessment

Rapid Riparian Assessment results for the core Buffalo Creek site (CR4B) categorised the site to be in a 'Fair' condition for the most recent sampling seasons of Spring and Autumn. This was a decline in RRA score compared with previous seasons where both Spring 2018 and Autumn 2019 received 'Good' RRA results.

Rapid Riparian Assessment score

- Spring 2020 (22.1 - Fair)
- Autumn 2021 (19.1 - Fair)

10 Porters Creek

10.1 Site Profiles

There is one core site and three water quality only sites within the Porters Creek Catchment.

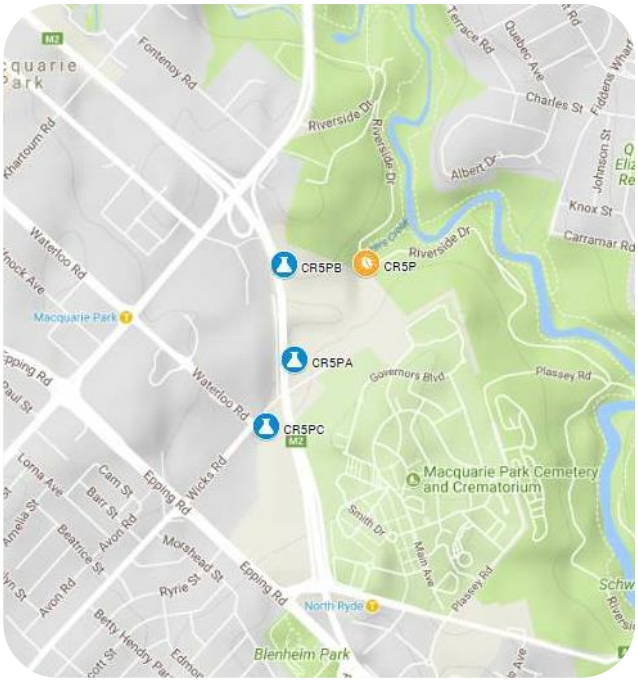


Figure 29 Porters Creek Catchment Area

CR5P Porters Creek (core site)

This site is located on the eastern boundary of the SUEZ Ryde Resource Recovery Centre, where Porters Creek emerges after flowing mostly underground in its upper section. Water quality samples were collected within the Centre close to where Porters Creek drains from an underground system. Macroinvertebrates were collected within the boundaries of the Lane Cove National Park

just downstream of the depot and the bridge for the main park access road.

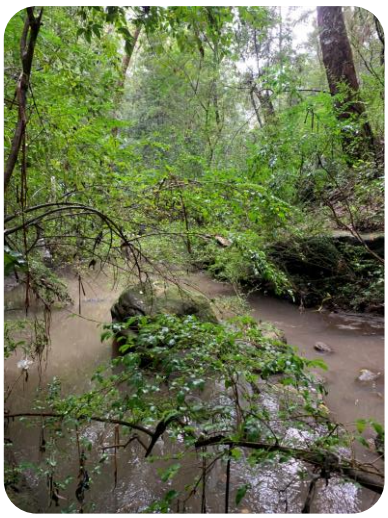


Figure 30 Porters Creek Core Site facing downstream

The surrounding riparian area is dominated by native plants with a small amount of exotic species. The creek bed is mostly bedrock with some cobble, boulder and sand. No macrophyte growth has been observed at the site however there has been varying levels of algal growth present.

CR5PA Porters Creek @ Main Branch

This site is located on the western boundary of the centre and consists of an open concrete channel. Samples are collected from the retention basin at the end of the channel.

Figure 31 Porters Creek @ Main Branch facing downstream

CR5PB Porters Creek @ 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. The exact location has changed over the years due to access issues.

Figure 32 Porters Creek @ Spur Branch

CR5PC Porters Creek @ Wicks Road

This site is the first point that Porters Creek drains 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 33 Porters Creek @ Wicks Road

10.2 Results and Interpretation

10.2.1 Macroinvertebrates

SIGNAL SF

Results were within thresholds of historical averages for both Spring 2020 and Autumn 2021 sampling seasons. This was consistent with results of Spring 2018 and Autumn 2019.

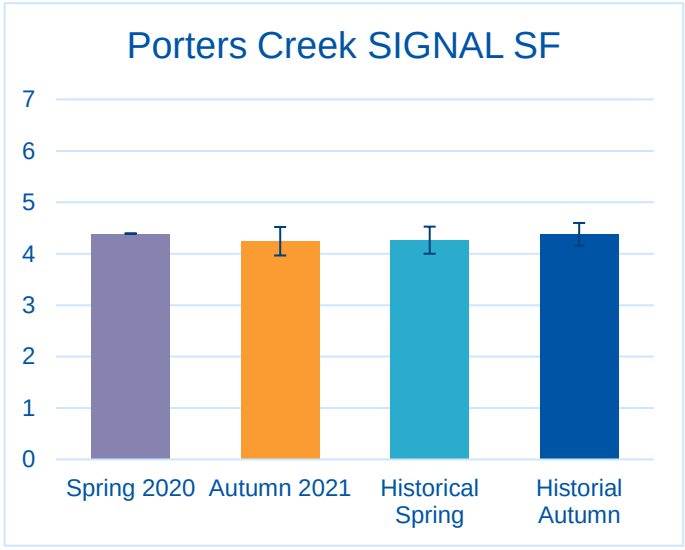


Figure 34 Porters Creek SIGNAL SF

Taxa richness

Spring 2020 had a taxa richness result beneath the Spring historical average. In contrast, Autumn 2021 taxa richness was higher than the Autumn historical average.

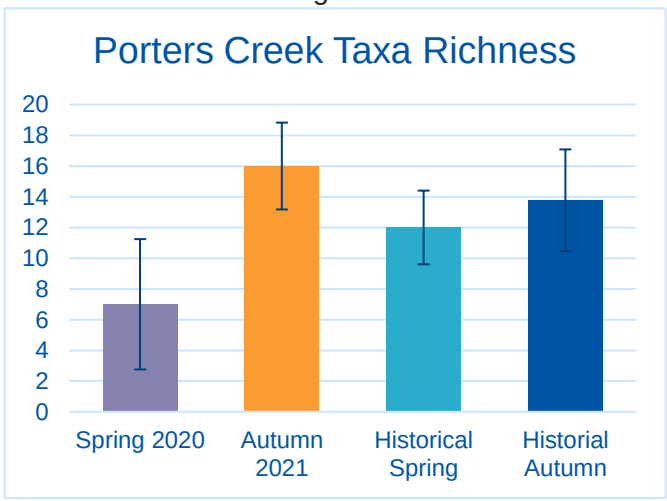


Figure 36 Porters Creek Taxa Richness

Macroinvertebrates summary

SIGNAL SF results for both Spring and Autumn were comparable to historical averages

Taxa Richness results were lower than historical averages. Autumn 20

21 richness was far greater than Spring 2020

10.2.2 Water Quality

CR5P (Core Site)

- Dissolved oxygen and conductivity results were consistent.
- Autumn 2021 had the highest recorded turbidity value observed for this site at 79.1 NTU (Autumn historical average; 6.17 NTU).
- In Autumn 2021 faecal coliform result exceeded ANZECC guidelines and was the highest recorded result for this indicator for this site (~100,000 CFU/100mL).
- Faecal coliform result for Spring 2020 was lower than that of Spring 2018 (140 and 550 CFU/100mL, respectively). Both results were within ANZECC guidelines.

CR5PA

- Dissolved oxygen, turbidity, and pH results consistent.
- Autumn 2021 observed a new overall high value for conductivity (1,149 µS/cm). Spring 2020 had the highest recorded value for this season (999 µS/cm)
- Autumn 2021 had the highest recorded total hardness (430 mg CaCO3/L) result.
- In contrast to other sites, faecal coliform result increased in Spring 2020 (~1,100 CFU/100mL) compared with Spring 2018 (220 CFU/100mL). This was the highest coliform result recorded.
- Conversely, coliform results declined from Autumn 2019 to Autumn 2021 (500 and 30 CFU/100mL respectively).
- Autumn 2021 had the highest recorded total nitrogen result for this site (1,570 µg/L) compared with Autumn 2019 (470 µg/L). Spring results were comparable with previous seasons.

CR5PB

- In general, results were consistent with historical averages
- Spring 2020 had the highest alkalinity value recorded (125 mg CaCO3/L).
- Faecal coliform results were within threshold for both seasons.
- Spring 2020 saw the highest recorded result for total hardness across both seasons (150 mg CaCO3/L)

CR5PC

- Dissolved oxygen, pH and conductivity results consistent with previous seasons.
- Autumn 2021 had a high turbidity result (33.9 NTU), although not the highest recorded value historically.
- Alkalinity for Autumn 2021 was the lowest on record (22 mg CaCO3/L).

- Faecal coliform result for Spring 2020 (540 CFU/100mL) was lower than those observed in Spring 2018 (32,000 CFU/100mL) which had the highest result on record for this season.
- Autumn 2021 had the highest recorded value (~80,000 CFU/100mL) compared with Autumn 2019 (800 CFU/100mL).
- Autumn 2021 had the lowest total magnesium and total calcium results on record (1.65 mg/L and 9.41 mg/L respectively).

Water quality summary

Autumn 2021 saw new high values for several parameters

CR5PA faecal coliform results were higher in Spring 2020 than in Autumn 2021

CR5PB coliform results were within guidelines

10.2.3 Rapid Riparian Assessment

The Rapid Riparian scores for Porters Creek core site were high which were consistent with results from the previous season.

In Spring 2020 the score for this site was *Good* which was only slightly lower than the result for Spring 2018 (60 – *Excellent*). The Autumn RRA improved from *Good* in 2019 to *Excellent* in 2021. This was the highest RRA score observed across both seasons for this period of sampling.

Rapid Riparian Assessment score

- Spring 2020 (53.6 - Good)
- Autumn 2021 (64.0 - Excellent)

11 Conclusions and recommendations

11.1 Macroinvertebrates

The results for both SIGNAL SF and Taxa Richness varied greatly amongst and between sites in both Spring 2020 and Autumn 2021.

SIGNAL SF scores were within the historical average standard deviation in Spring 2020 for Archers, Buffalo and Porters creeks and slightly lower for Shrimptons and Terrys creeks. The Autumn 2021 result for Archers Creek was below average. Archers Creek had the highest SIGNAL SF score (5.54 Spring 2020) and Shrimptons Creek the lowest (3.32 Spring 2020).

Taxa richness was within the historical average standard deviation at all sites in Autumn 2021, and lower for Shrimptons, Archers and Terry creeks for Spring 2020.

Seasonal and ecological factors influence macroinvertebrate abundance and diversity. During Spring 2018 and Autumn 2019 sampling, it was observed that the flow was much lower, continuing the trend of the previous year (Spring 2017 and Autumn 2018). A reduction in flow can lead to reduced habitat for macroinvertebrates and areas of stagnant water. Rainfall in late March 2021 resulted in increased flows for Autumn 2021 sampling, particularly in Shrimptons and Terrys creeks. However, this seems not to have impacted Autumn SIGNAL and taxa richness scores for this season.

11.2 Water Quality

The water quality results for Spring 2020 and Autumn 2021 were generally reflective of the historical data collected. Most sites had typically high total phosphorus, total nitrogen and ammonia results.

Rainfall in late March 2021 may have resulted in the higher than usual faecal coliform results for the Autumn 2021 sampling. Higher turbidity results were also recorded during this sampling, with Shrimpton's Creek at Wilga Park (CR1S) recording a record high 367 NTU.

Water quality is highly dependent on natural and anthropogenic factors. They all can impact on the water quality of streams.

During rainfall events, there will be changes in hydrology, organic matter, and pollutant levels. This can occur in pristine areas, where dead leaves, sediment and other debris can be washed into a stream. This can result in increased turbidity, which can impact on the diversity and abundance of aquatic animals including fish and macroinvertebrates.

In urban areas, there are more pollution sources and impervious surfaces, which can magnify the effects on water quality. In zones with a high density of impervious surfaces, such as roads, footpaths and buildings, the volume and speed of rainwater is increased. These impervious surfaces are often a source of pollutants, such as oils, metals and nutrients, which are then deposited in streams.

Although the streams monitored in this program are highly altered, they each still retain ecological and conservation values. A realistic objective would be to maintain present water quality to retain a functional, albeit modified, ecosystem that would support the management goals assigned to it.

11.3 Rapid Riparian Assessment

This was the third year of rapid riparian assessments for the five City of Ryde creek catchments.

Shrimptons, Archers, Terrys and Buffalo Creek sites were in the *fair* category for rapid riparian assessment in Spring 2020, with Porters Creek in the *good* category. Archers creek fell into the *poor* category for Autumn 2021, while Terrys and Porters creeks showed improvement moving into the *good* and *excellent* categories respectively.

The areas of the assessment that have the highest impact on the overall scores for the five catchments are:

- Land use
- Litter present
- Stream confinement and meanders
- Vegetation community composition
- Weed infestation

Some variables are likely to not change, specifically land use, sewer lines, and stream confinement and meanders.

The riparian zone is a buffer between the creek and the surrounding land, but its effectiveness is reduced when water sources such as stormwater and sewer overflows are present.

11.4 Recommendations

- Continue monitoring macroinvertebrate, water quality and riparian condition at current sites
- Continue Gross Pollutant Trap maintenance and rubbish removal as currently conducted to help maintain and improve Rapid Riparian Assessment results
- Consider collecting pre-and post-work water quality data on any Council projects that aim to improve water quality

12 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.

Item	Meaning
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 waste water 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)