Water Quality Summary Report

FITZGERALD BIOSPHERE GROUP

Report prepared by:

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Fitzgerald National Park

The Goreng Menang and Wudjari people are the traditional owners of the Fitzgerald River National Park, which covers the Fizgerald, Gairdner and Bremer rivers and much of their catchmnets.

It is one of the larger national parks located in Western Australia (WA) at 330,000 hectares in size and holds significant interantional interest being classed a UNESCO (United Nations Educational, Scientific and Cultural Organisation) approved biosphere reserve. Approximately 20% of WA's plant species (including 75 species found nowhere else), 22 mammal species, 41 reptile species and 200 bird species are known to occur in the reserve, which is one of WA's most flora and fauna rich conservation areas (FBCW n.d.).

REPORT SUMMARY

This report summarises the current water quality conditions of the Fitzgerald, Gairdner, and Bremer rivers based on data collected by the Fitzgerald Biosphere Group (FBG) between 2021 and 2023 and available historical data.

Water quality parameters included are temperature, pH, turbidity, and electrical conductivity.

The first recorded monitoring of rivers in the Fitzgerald National Park occurred in 1983 by the Fitzgerald National Park Association to increase awareness and importance of the river systems. This work took place in response to an increase in salinity across WA resulting from extensive clearing for agriculture. Several projects have undertaken monitoring through the region, however no single project has measured water quality in all three rivers at the same time, until the 2021-23 FBG study.

The FBG project looked at five sites spread along the length of each river (14 sites in total – Fitzgerald River only had four sites). Rainfall and flow data were also analysed to support interpretation of water quality data.

A key outcome of this report is the provision of indicative water quality guideline values for use in future reporting and assessments for the three rivers.

DATA QUALITY

Methods for historical data collections, including equipment type, calibration records, quality assurance and control procedures, were largely unavailable for evaluation. However, field measures of the parameters assessed are rarely impacted by minor changes to field methods and the results reviewed were relatively consistent over time, which suggests data can be trusted.

Some spikes in data were detected, particularly for electrical conductivity, however these results were consistent with natural variability for the study systems in response to periodic conditions such as rainfall events.

Notwithstanding, analysis focused on the data provided from the 2021-23 FBG study, given currency and comparability of the dataset.

DERIVATION OF WATER QUALITY GUIDELINES

As data were not available prior to most of the agriculture development in the region, a natural baseline (from which to assess change) cannot be empirically determined.

This is a common challenge in many monitoring projects as support for data collection only comes after an impact has been identified. However, this can typically be overcome through analysis of conditions at ‘reference sites’ (i.e., unimpacted sites where similar conditions are expected to the study site).

Unfortunately, the uniqueness of these three ecosystems (which is also a key reason for their high conservation status) constrains our ability to apply the standard reference condition approach. An example of this is the high salinity levels that can naturally occur in the region (cmp. Figure 14. Due to this, it can be difficult to determine if a system is naturally saline or has been exposed to secondary salinisation, or both.

The ANZG (2018) guidelines for the parameters of interest were discounted for this reason, as they were derived using different river types.

For the purpose of future assessments, a set of guidelines has been developed using the current and recent (post-impact) historical data provided by the Fitzgerald Biosphere Group (raw data provided in Appendix 1-6). These guidelines provide a current baseline from which to assess future condition.

RECOMMENDATIONS FOR FUTURE MONITORING

1) Keep an accurate record of methodology and equipment used in each sample.
2) Ensure that each piece of equipment is calibrated prior to use and this calibration is recorded.
3) Use the provided guidelines to assess changes in future water quality measurements.

FBG WATER QUALITY GUIDELINES

The Fitzgerald-Bremer-Gairdner Water Quality (FBGWQ) guidelines are not designed to reflect the rivers natural state, rather they provide a current baseline to assess future change. (See Appendix 9-11 for Raw data).

Application of guidelines:
Assessment of water quality against the *FBGWQ guidelines* should focus on maintenance of conditions within the 25th and 75th percentile, and against the median. This can be considered a 'normal' range for future river water quality sampling based on previous (post-impact) data.

It should be noted that seasonal changes in water quality conditions are expected in response to rainfall and ambient temperature patterns (i.e., spikes in response to flow events). Whilst variability wasn't significant enough to warrant separate guidelines values for different periods, this should be considered in analysis. Sustained levels outside of the normal range may indicate issues (See appendix 1-6 for Raw data).

Note: separate guidelines were derived for upstream and downstream sections of each river due to noticeable differences in existing data. These differences are likely associated with land use, as well as natural groundwater variability. (The raw data for this can be found in Appendix 9-11). The sites used to derive guidelines for the different areas are as follows:

Table 1: Coordinates of Sites where data was collected in each region of the three river systems.

Guideline region	Site name	Coordinates
Fitzgerald upstream	FITFBG1 FITFBG2	33°44'56.8"S 119°14'09.7"E 33°45'09.8"S 119°14'19.8"E
Fitzgerald downstream	FITFBG3 FITFBG4	33°49'34.6"S 119°15'39.9"E 33°49'44.5"S 119°15'47.0"E
Gairdner upstream	GAIFBG1 GAIFGB2 GAIFGB3	33°48'55.5"S 118°48'42.1"E 33°51'41.7"S 118°54'55.7"E 33°55'07.8"S 118°58'28.8"E
Gairdner downstream	GAIFBG4 GAIFBG5	33°59'01.9"S 119°02'53.6"E 34°05'24.9"S 119°03'50.2"E
Bremer upstream	BREFBG1 BREFBG2 BREFBG3	34°01'04.2"S 118°59'26.0"E 34°12'52.0"S 119°08'12.1"E 34°07'05.1"S 119°00'48.6"E
Bremer downstream	BREFBG4 BREFBG5	34°14'13.7"S 119°11'23.3"E 34°18'50.3"S 119°14'46.8"E

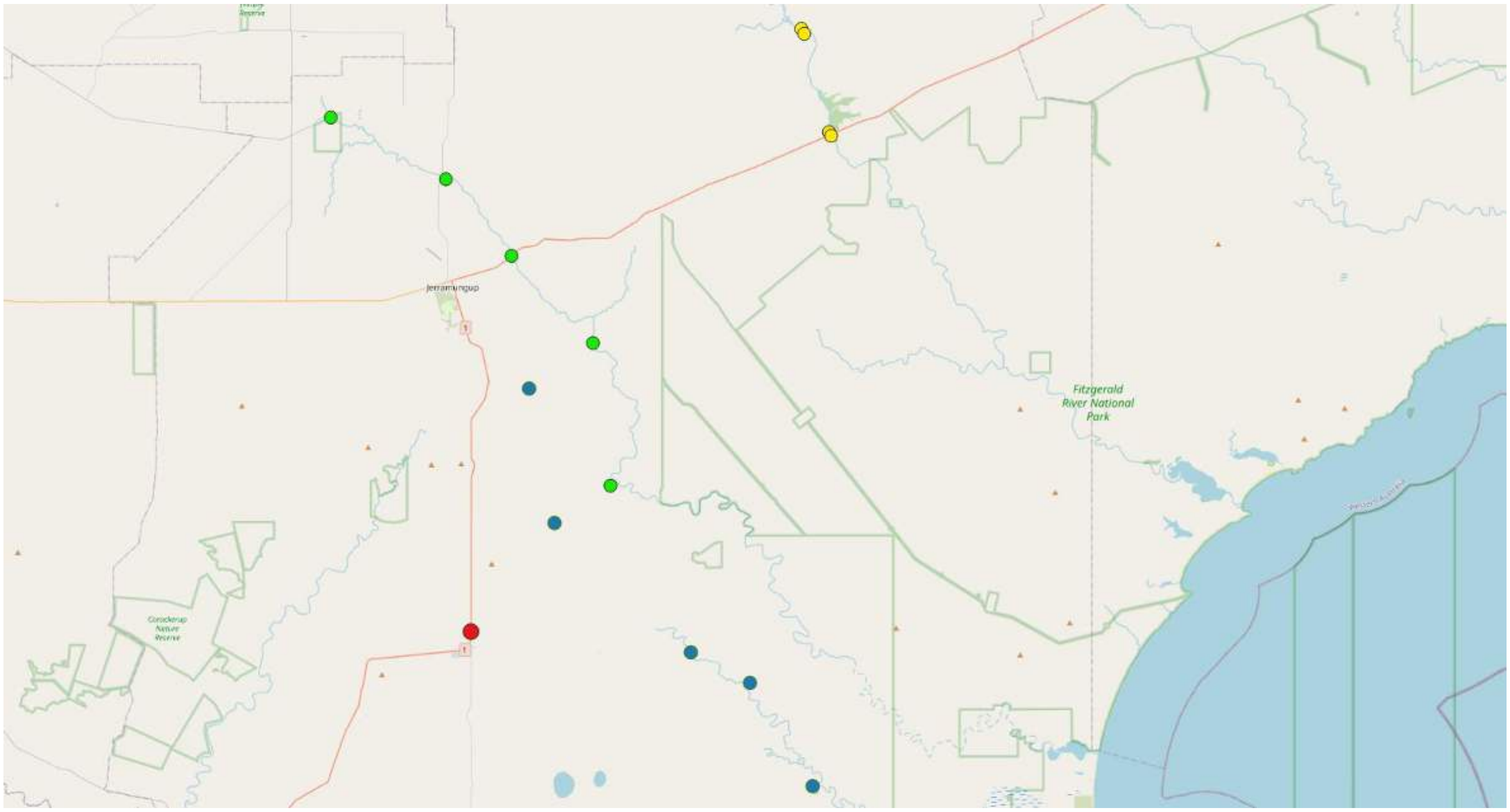
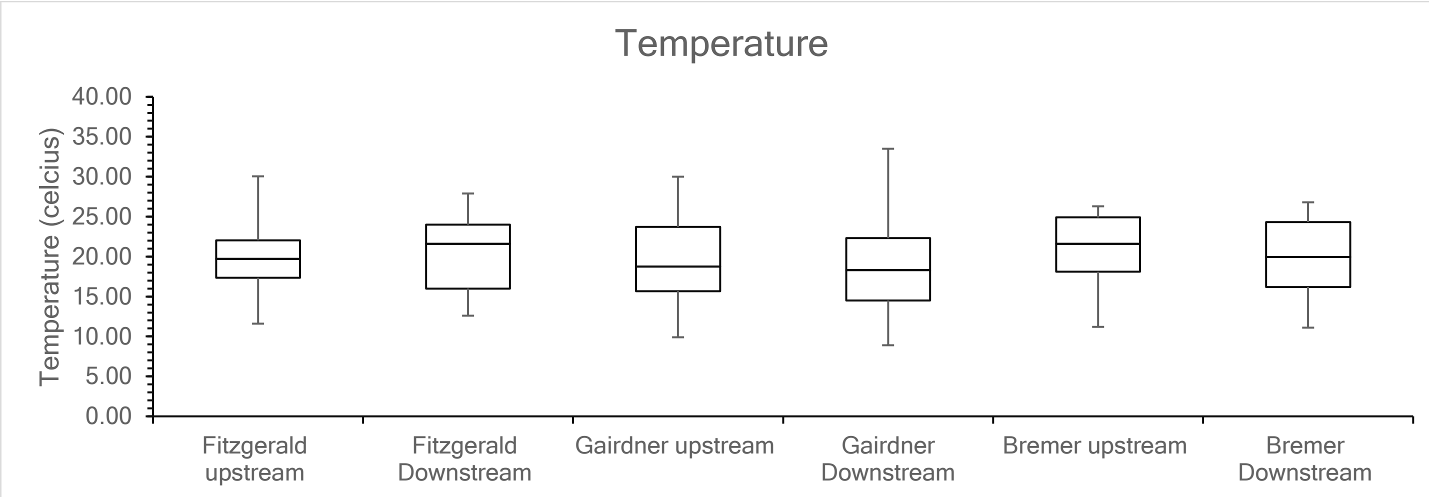


Figure 1: FBG Site locations. Red: rainfall gauging station, Yellow: Fitzgerald River sites, Green: Gairdner River sites, Blue: Bremer River sites

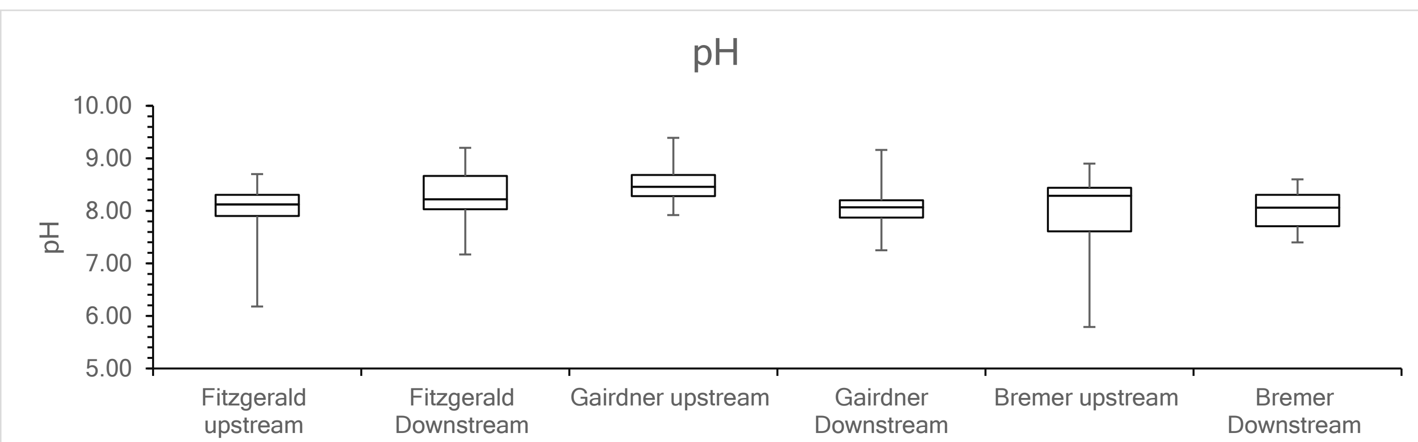
Temperature



	Summary Range Temperature					
	Fitzgerald upstream	Fitzgerald Downstream	Gairdner upstream	Gairdner Downstream	Bremer upstream	Bremer Downstream
minimum	11.60	12.60	9.90	8.90	11.20	11.10
25th percentile	**17.35**	**16.00**	**15.68**	**14.50**	**18.10**	**16.20**
median	19.70	21.60	18.75	18.30	21.60	19.95
75th percentile	**22.05**	**24.00**	**23.73**	**22.30**	**24.90**	**24.33**
maximum	30.05	27.90	30.00	33.50	26.30	26.80

Figure 2 and Table 2: Temperature guidelines for all three river systems identifying the 25th percentile (lower limit) and 75th percentile (upper limit).

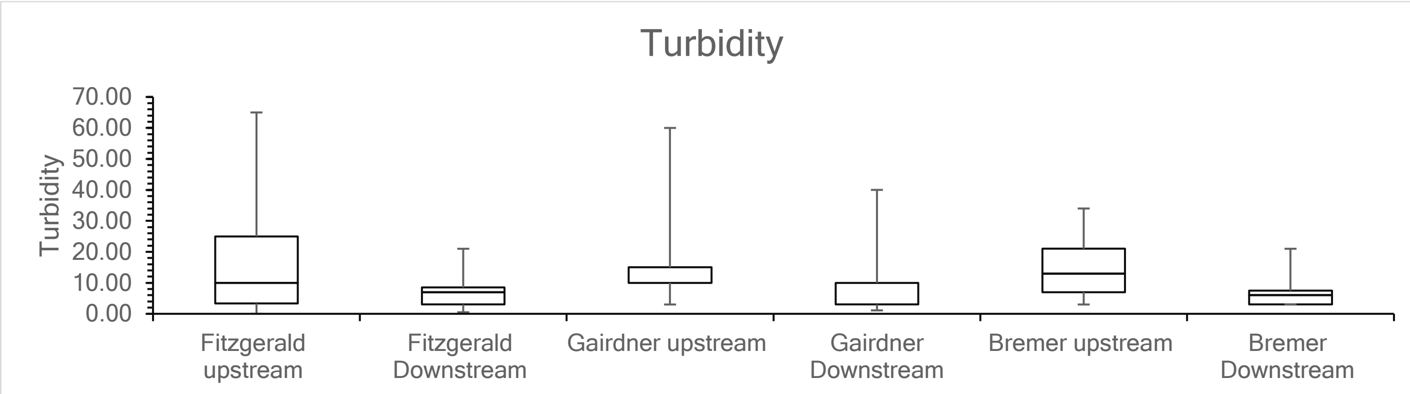
pH



	Summary Range pH					
	Fitzgerald upstream	Fitzgerald Downstream	Gairdner upstream	Gairdner Downstream	Bremer upstream	Bremer Downstream
minimum	6.18	7.17	7.92	7.25	5.79	7.40
25th percentile	**7.90**	**8.03**	**8.28**	**7.87**	**7.61**	**7.71**
median	8.12	8.22	8.46	8.07	8.29	8.06
75th percentile	**8.30**	**8.66**	**8.69**	**8.20**	**8.44**	**8.31**
maximum	8.70	9.20	9.39	9.16	8.90	8.60

Figure 3 and Table 3: pH guidelines for all three river systems identifying the 25th percentile (lower limit) and 75th percentile (upper limit).

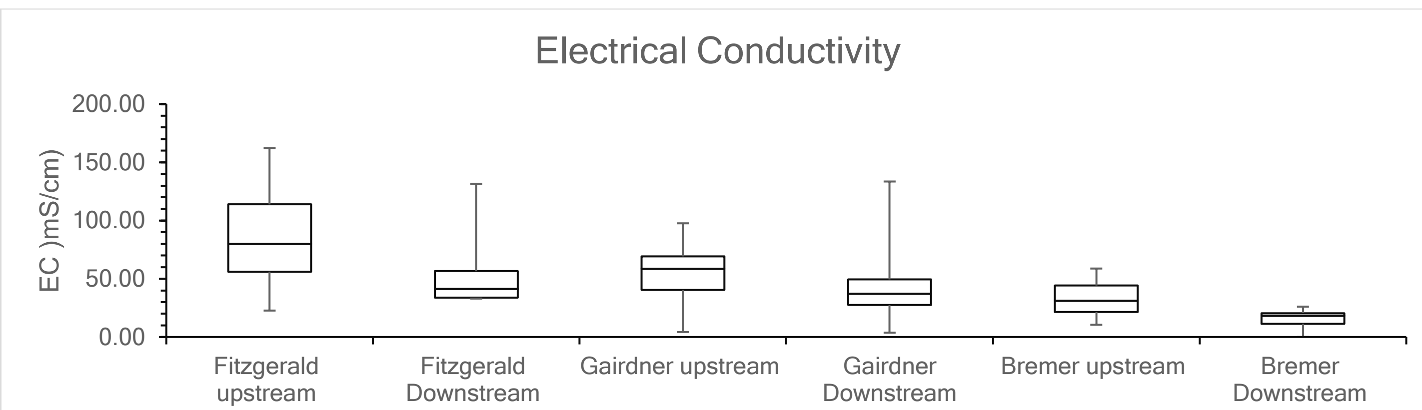
Turbidity



	Summary Range Turbidity					
	Fitzgerald upstream	Fitzgerald Downstream	Gairdner upstream	Gairdner Downstream	Bremer upstream	Bremer Downstream
minimum	0.00	0.50	3.00	1.10	3.00	3.00
25th percentile	**3.33**	**3.00**	**10.00**	**3.00**	**7.00**	**3.00**
median	10.00	7.00	10.00	10.00	13.00	6.00
75th percentile	**25.00**	**8.50**	**15.00**	**10.00**	**21.00**	**7.50**
maximum	65.00	21.00	60.00	40.00	34.00	21.00

Figure 4 and Table 4: Turbidity guidelines for all three river systems identifying the 25th percentile (lower limit) and 75th percentile (upper limit).

Electrical conductivity



	Summary Range Electrical Conductivity					
	Fitzgerald upstream	Fitzgerald Downstream	Gairdner upstream	Gairdner Downstream	Bremer upstream	Bremer Downstream
minimum	22.70	33.00	4.28	3.70	10.50	0.00
25th percentile	**56.15**	**33.70**	**40.40**	**27.40**	**21.44**	**11.40**
median	79.90	41.30	58.55	37.00	31.00	18.28
75th percentile	**113.85**	**56.50**	**69.23**	**49.45**	**44.20**	**20.50**
maximum	162.30	131.60	97.60	133.50	58.80	26.10

Figure 5 and Table 5: Electrical Conductivity guidelines for all three river systems identifying the 25th percentile (lower limit) and 75th percentile (upper limit).

**Date used to create Figure 2-5 and Table 2-5 can be found in Appendix 9-11.*

RESULTS: 2021-23

RAINFALL 2021-23

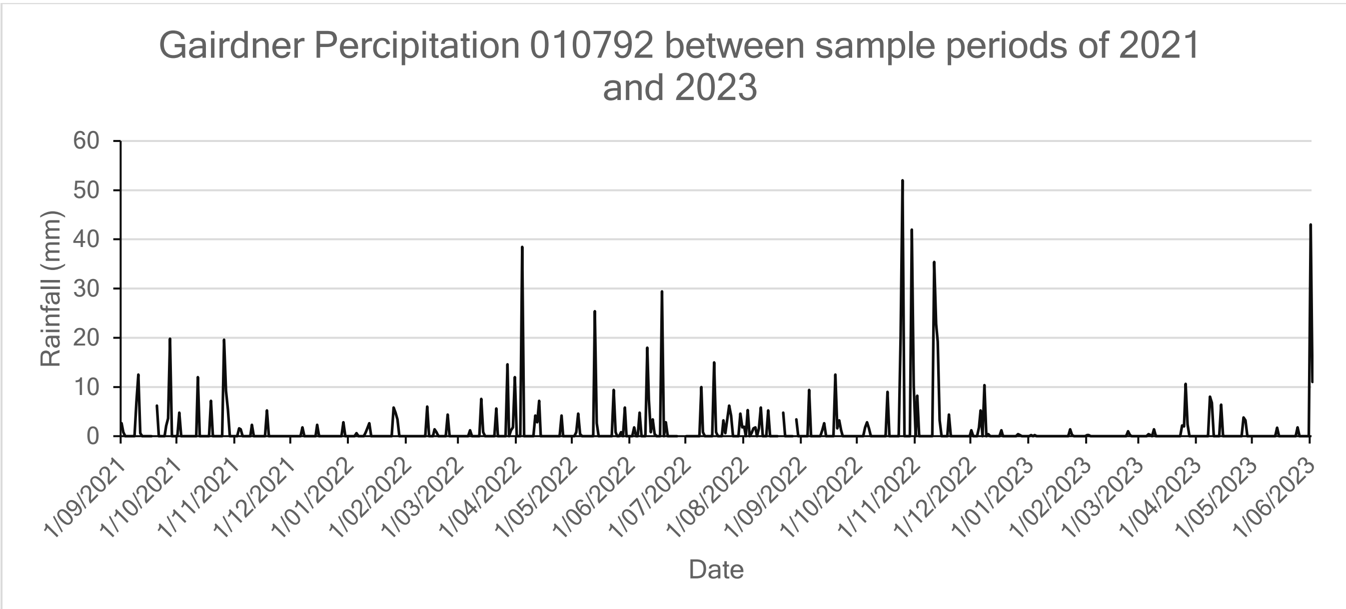


Figure 6: Rainfall recorded at Gairdner River Station 010792 between 2021 and 2023

PH LEVEL

pH is a measure of how acidic or basic a water sample is. It uses a logarithmic scale that ranges from 0 (extremely acidic) to 14 (extremely basic) with 7 representing neutral conditions (USGS 2019). Most life forms can tolerate water pH conditions between 6.5 and 8. pH levels outside of these parameters are often where issues may occur especially if the change in pH is sudden.

The FBG guidelines provided in the section above (cmp. Figure and Table 2-5) can be used on the data below to determine if they are within the historically standard range.

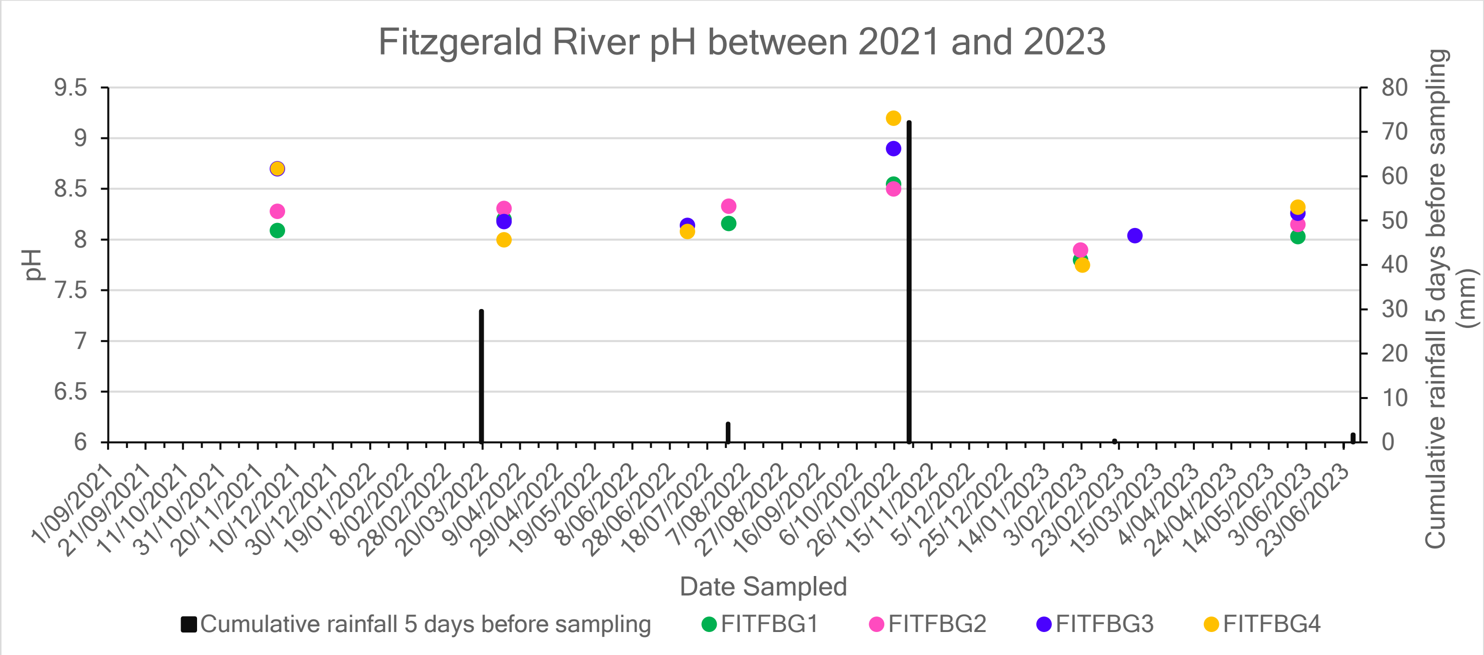


Figure 7: Fitzgerald River pH levels recorded by the Fitzgerald Biosphere Group between 2021 and 2023 and cumulative rainfall of five days prior to sampling.

The Fitzgerald River pH ranges between 7.75 and 9.2, between the measuring period of 2021 and 2023 for all four sites. This range exceeds the upper limit of the FBG water quality guidelines seen in Figure 3 and Table 3. November 2021 and October 2022 are the only two sites where the FBG pH guideline is exceeded for site FITFBG3 and FITFBG4. For the upstream sites (FITFBG1 and FITFBG2), October 2022 sampling period also saw a slightly higher pH than the FBG guidelines provided. However, these spikes only occurred for two sampling periods and dropped back down in February 2023 so should be noted but not treated with high concern. Seasonal effect should also be taken into consideration as the higher pH levels occurred in a relatively dry period as seen in Figure 6. After the heavy rainfall period, pH seemed to go back down for the next sampling period. Therefore, it is possible for rainfall events to impact the pH.

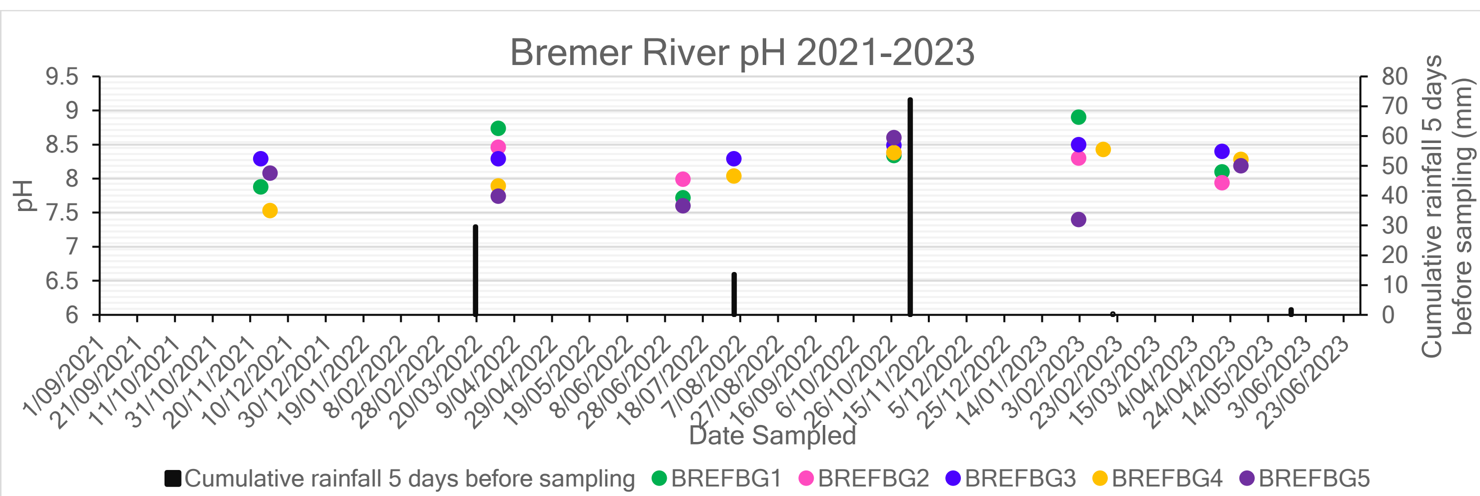


Figure 8: Bremer River pH levels recorded by the Fitzgerald Biosphere Group between 2021 and 2023 and cumulative rainfall of five days prior to sampling.

In comparison to the Fitzgerald River, the Bremer River has a lower pH range which is identified in the FBG water quality guidelines seen in Figure 3 and Table 3. Bremer River's maximum pH recorded at 8.9pH up stream and 7.4 pH downstream during the 2021 to 2023 sampling period. With the guideline suggesting a maximum pH of 8.4 upstream and 8.31 downstream. Most sites were either under this guideline or just slightly over. Overall downstream sites had a lower pH than upstream. BREFBG5 which is the most downstream point of the river recorded the lowest pH with three out of the five samples being under pH 8. Between July 2022 and February 2023 all sites except for BREFBG5 show an increased pH level. BREFBG5 on the other hand decreases in pH between October 2022 and February 2023. BREFBG4 which is at the lower end of the river shows a steady increase in pH over the duration of the sampling period until May 2023, where it decreases from 8.43 to 8.28. BREFBG3 which is in the middle of the river system shows a similar pattern but with a lower difference between lowest pH and highest pH level and again decreasing in May 2023. It should also be noted that downstream and upstream of the river are showing opposing patterns. BREFBG1 (upstream) presents its highest recorded pH during the warmer months of late summer (February) and early autumn (March). Meanwhile BREFBG4 (downstream) shows its lowest pH during the warmer months of late summer (February) and early autumn (March).

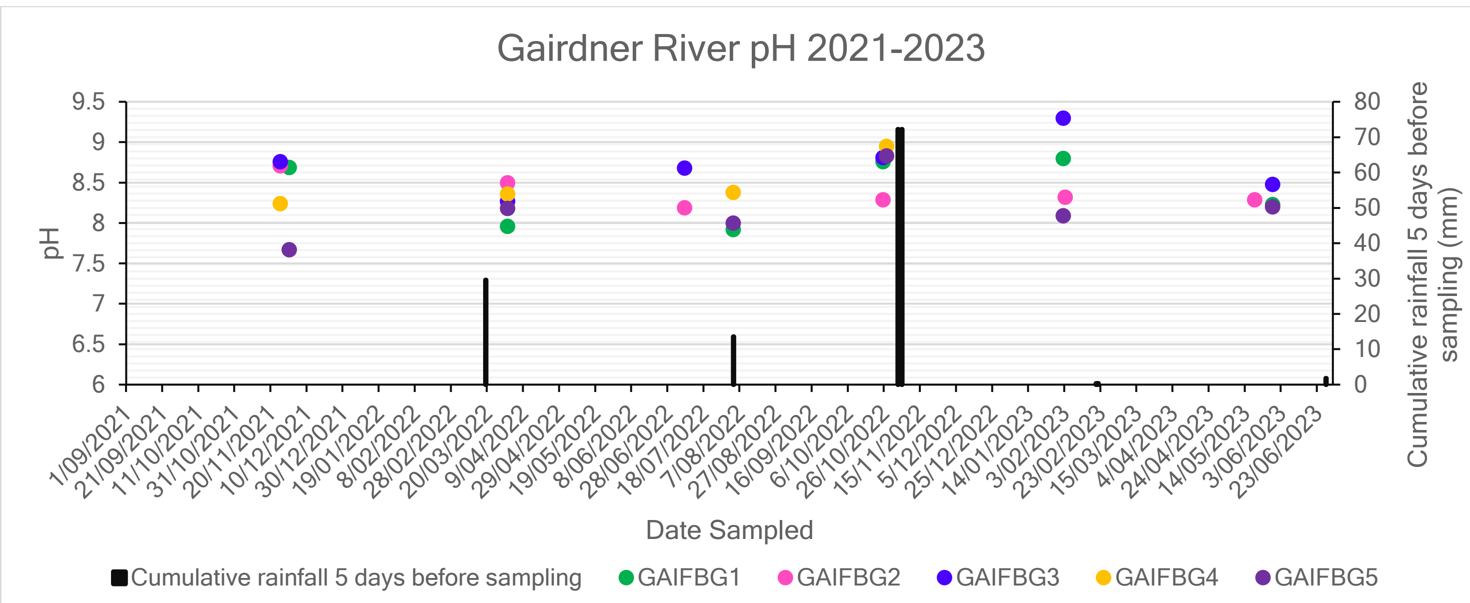


Figure 9: Gairdner River pH levels recorded by the Fitzgerald Biosphere Group between 2021 and 2023 against the ANZECC guidelines and cumulative rainfall of five days prior to sampling.

Like Fitzgerald River, Gairdner River is showing a large pH range between 7.67 and 9.3. Moreover, the Gairdner River is seeing the same timing in spikes as the Fitzgerald River for pH. November 2021 and October 2022 saw a high pH in most sites. However, unlike the Fitzgerald River GAIFBG3 during February 2023 saw a large increase in pH hitting is maximum recorded value of 9.3 pH. This site is also showing higher pH levels during warmer months (November and February) in comparison to winter months. However, this is not the case for all sites. Contrastingly site GAIFBG5 (upstream) shows its lowest pH during the warmer months of November and February.

Overall, the impact of rainfall has not shown any significant effects on pH for any sites for any river. For both Bremer and Gairdner downstream has the lowest pH during the warmer months. This was not the case for the Fitzgerald River. Therefore, it is likely that a range of external impacts may be the cause to variations in pH through the different times of year at different sites.

WATER TEMPERATURE AND FLOW

As stated above the South Coast of WA has a Mediterranean climate which means dry hot summers and wet cool winters. This can be seen in Figures 10 and 11 which show lowest temperatures and highest rainfall in winter and highest temperatures and lowest rainfall in summer. Therefore, it is expected for seasonal changes to occur in the water temperature of each river system recorded by the Fitzgerald Biosphere Group between 2021 and 2023.

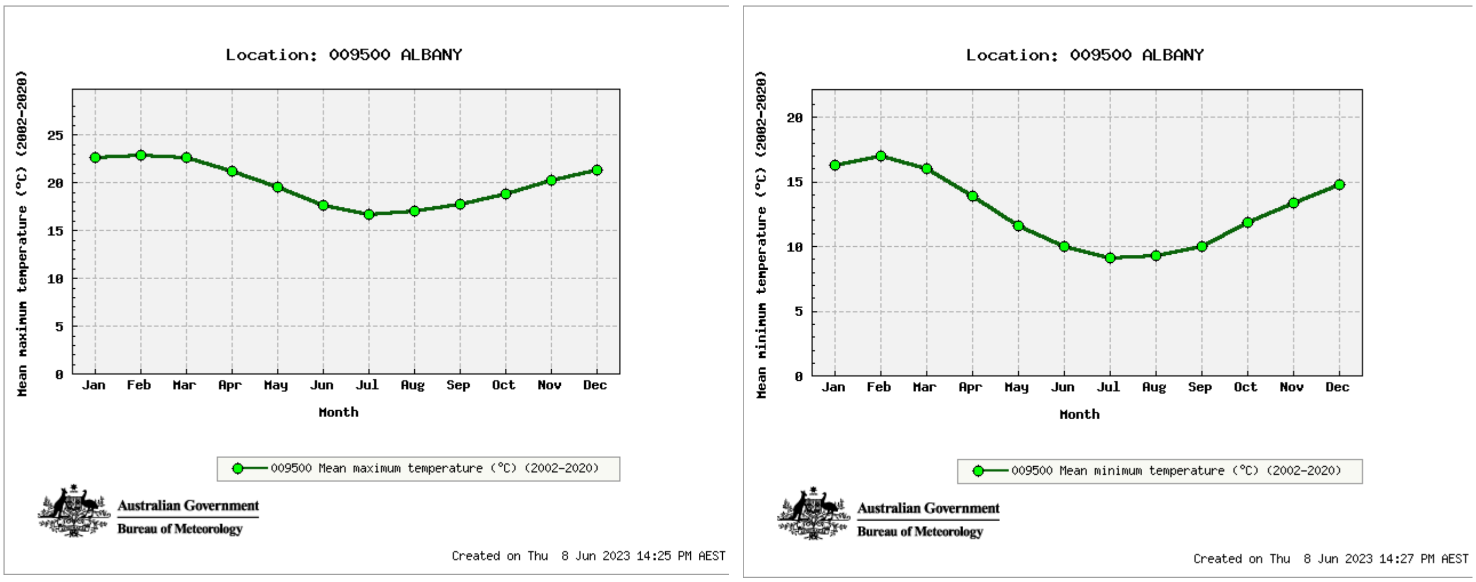


Figure 10: Graphs showing average monthly maximum and minimum air temperatures in Albany Western Australia (Climate statistics for Australian locations (bom.gov.au))

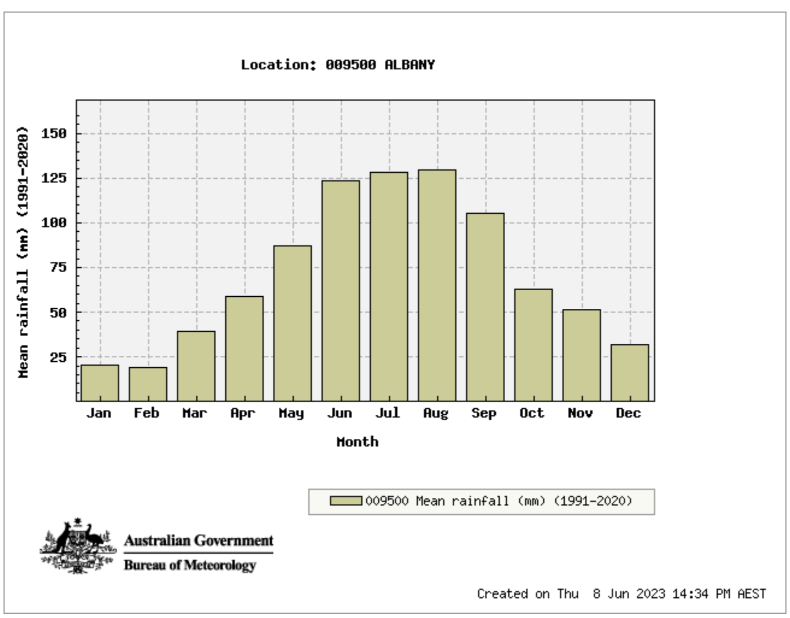


Figure 11: Graphs showing average monthly air temperatures in Albany Western Australia (Climate statistics for Australian locations (bom.gov.au))

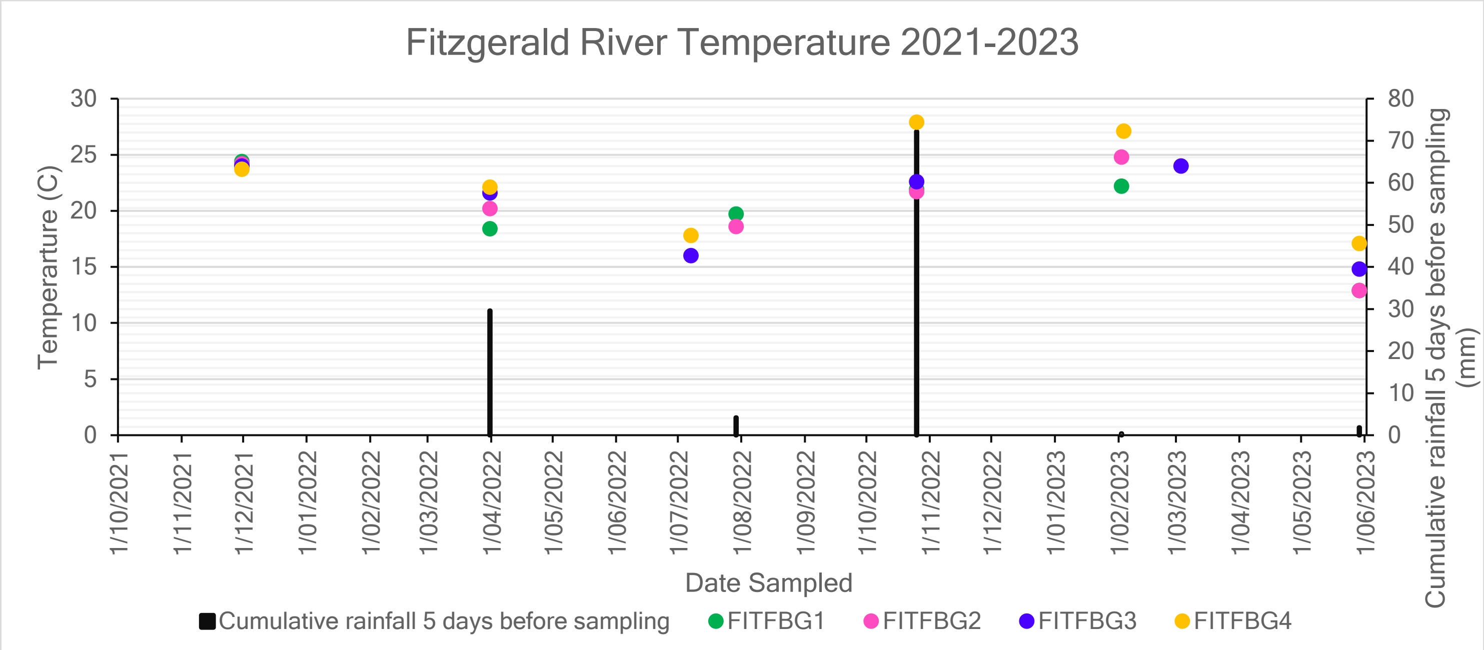


Figure 12: Fitzgerald River Temperature (C) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Table 6: Observational data of Fitzgerald River's flow during sampling between 2021 and 2023.

FITZGERALD RIVER FLOW							
	Nov-21	**Mar-22**	**Jul-22**	**Oct-22**	**Feb-23**	**Mar-23**	**May-23**
FITFBG1	Very Low	Still	Mid-Low	Low	Still		Still
FITFBG2	Low	Still	Mid	Low	Still		Still/Very low
FITFBG3	Low	Still	Mid	Mid		Stagnant Pools	Low
FITFBG4	Very Low	Still	Low	Mid-Low	Still		Still

As expected, the Fitzgerald River shows seasonal changes in both water temperature and flow between 2021 and 2023. November 2021 was the first sampling period for the Fitzgerald River, experiencing higher water temperatures and low to very low flow being the last month of spring. It is expected that during this period temperatures will increase and winter rains ease. This can be seen in Figure 6 showing 2021-2023 rainfall. It is clear from this graph that October – November of 2021 had relatively low rainfall with no days over 20mm. It should also be noted that water has a high heat capacity therefore, the lower the water levels the easier it is for the waters temperature to increase. Thus, with the low and very low flow readings it is expected for air temperatures during warmer months to have a greater impact on water temperature. Winter months on the other hand experience the opposite. June to August experience the highest average rainfall and the coolest temperatures (Figure 10 and Figure 11). Thus, it is expected for the water temperature to be lowest during these months as seen in Figure 12. This time period also showed the highest river flow (Table 6). Lastly March is the start of Autumn thus, the water temperatures are higher. Moreover, observational data shows stagnant pools which is expected due to the minimal rainfall seen between December 2022 and March 2023. Lastly it should be noted that short term rainfall doesn't show an impact on temperature as although there was over 72mm of rain 5 days prior to sampling in October 2022, the temperature was still high.

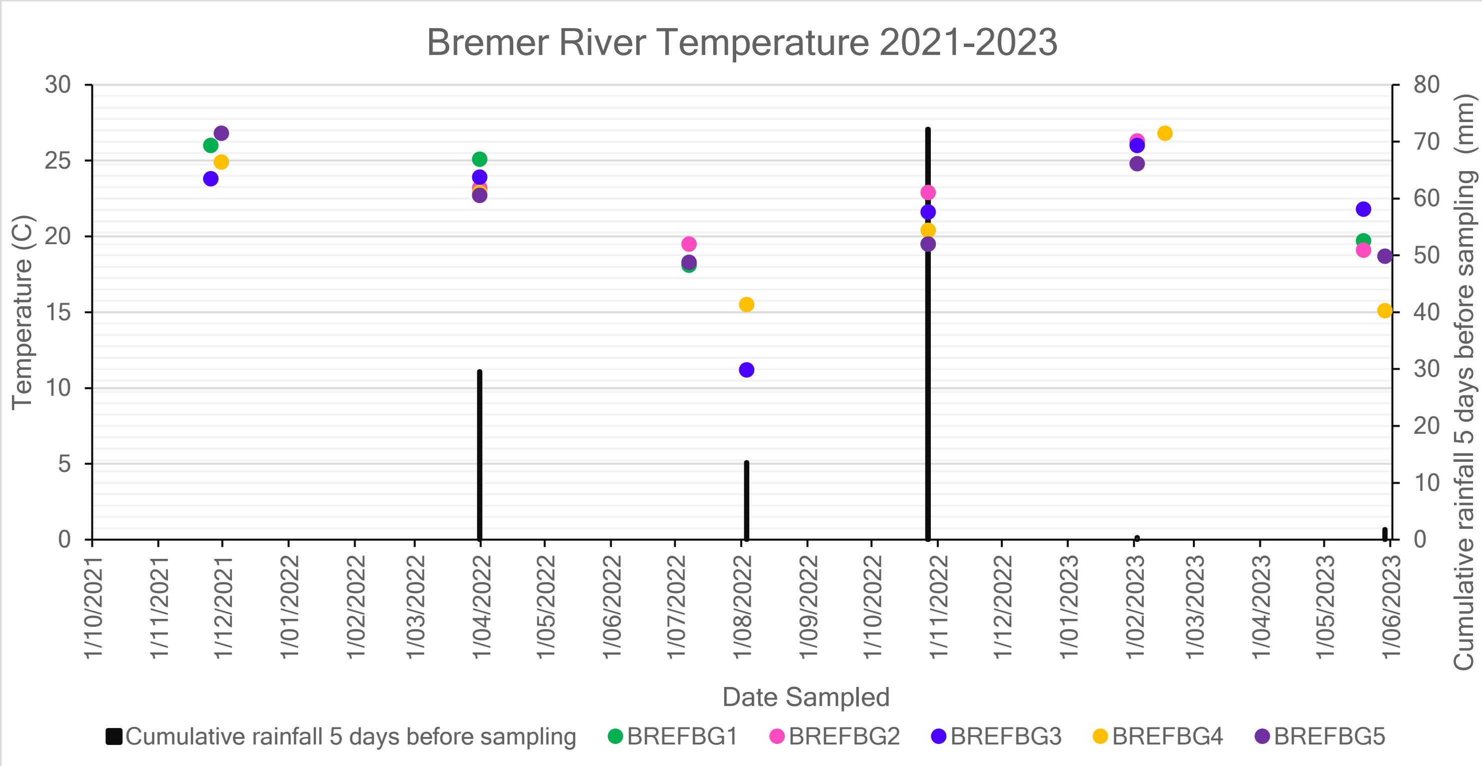


Figure 13: Bremer River Temperature (C) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Table 7: Observational data of Bremer River's flow during sampling between 2021 and 2023.

FLOW							
	Nov-21	**Mar-22**	**Jul-22**	**Aug-22**	**Oct-22**	**Feb-23**	**May-23**
BREFBG1	Very Low	Still	Very Low		Very Low	Still	Still
BREFBG2		Still		Very Low	Low	Very Low	Low
BREFBG3	Very Low	Still		Low-Mid	Low	Still	Low
BREFBG4	Very Low	Still		Mid	High	Still	Still
BREFBG5	Low	Still	Mid		Very High	Still	Still

Bremer River presents similar seasonal water temperature changes as the Fitzgerald River (Figure 12). The cooler months (June to August) present cooler water temperatures. Whereas the warmer months (November to March) present warmer water temperatures. However, Bremer River shows a greater connection between flow and rainfall compared to the Fitzgerald River as with the cumulative 72.2mm of rainfall prior to sampling in October 2022, the lower end of the river (BREFBG4 and BREFBG5) present high and very high flow – being the highest flow and rainfall over the entire sampling period. However, it should be noted that Bremer River is closer to the gauging station than Fitzgerald River, so it is possible that the Fitzgerald River did not receive the same amount of rainfall. However, again like Fitzgerald River, this rainfall showed no obvious impact on temperature. The overall pattern for water temperature at each site presents coolest in cooler wet months and warmer in the hot dry months following the South Coasts Mediterranean climate (Figure 10 and Figure 11).

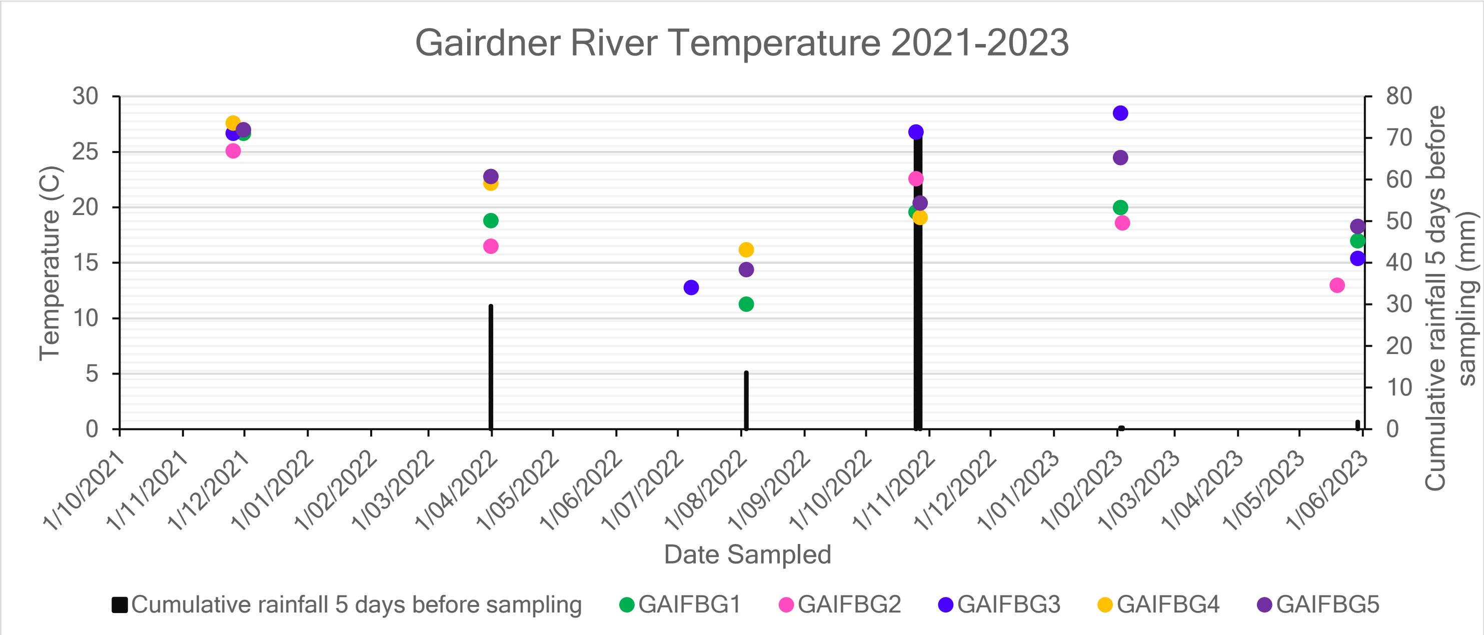


Figure 14: Gairdner River Temperature (C) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Table 8: Observational data of Gairdner River's flow during sampling between 2021 and 2023.

FLOW							
	Nov-21	**Mar-22**	**Jul-22**	**Aug-22**	**Oct-22**	**Feb-23**	**May-23**
GAIFBG1	Low	Still		Low	Very Low	Very Low/Still	Low
GAIFBG2	Low	Low	Low-Mid		Mid	Still	Low
GAIFBG3	Very Low	Very Low	Low-Mid		Mid	Still	Low
GAIFBG4	Very Low	Still		Mid	Mid	DRY	DRY
GAIFBG5	Very Low	Very Low		Low	Low	Very Low	Very Low

As expected, Gairdner Rivers presents seasonal water temperature and flow results. The highest temperatures are in the warmer months and the cooler water temperatures occur in the colder months. Flow follows the same pattern of a Mediterranean climate with flow being lowest in dry months and highest in wet months. However, unexpectedly the high levels of rainfall that occurred five days prior to sampling in October did not present a significant change to flow with flow remaining very low to mid.

Overall, all rivers showed a relationship between temperature and flow with seasonal expectations presented in Figures 9 and 10. However, short term rainfall did not show an evident impact on temperature and flow of all sites at each river. It is, however, possible that different areas of each river experienced a different cumulative rainfall compared to what was measured at the 010792 WIN site (Figure 1).

ELECTRICAL CONDUCTIVITY

Electrical conductivity is the measurement of a water samples ability to conduct electricity. Therefore, it provides an indication of the contained ions within a water body (BOM n.d.). This measure is often related to salinity as salt is an ionic compound which means saline water will have a higher electrical conductivity. It would be expected that electrical conductivity will change upstream and downstream of the river, along with being influenced by rainfall as higher rainfall will cause an influx of fresh water.

The total dissolved salts in a river system can have significant impacts on the rivers overall water quality and is influenced by rainfall, groundwater levels, river flow and land clearing (Government of Western Australia 2023). There are two types of conditions that lead to salinity – primary and secondary. Primary salinity occurs from natural processes such as the weathering of rocks and winds depositing salts. Secondary salinity is a result of widespread land clearing and altered land use that affects the movement of water. The change in vegetation results in a higher water table bringing more salts to the surface (AGI n.d.).

Increased salinity poses threats to the environment, agriculture, and infrastructures. It can cause poor health to ecosystems, corrosion to machinery and infrastructures along with reductions in crop yields that are not salt tolerant (AGI n.d.).

It should be noted that in general most rivers are fed by groundwater systems along with rainfall and runoff. Therefore, it is likely that the salinity of the groundwater may impact the electrical conductivity of each site along the river (see Figure 15).

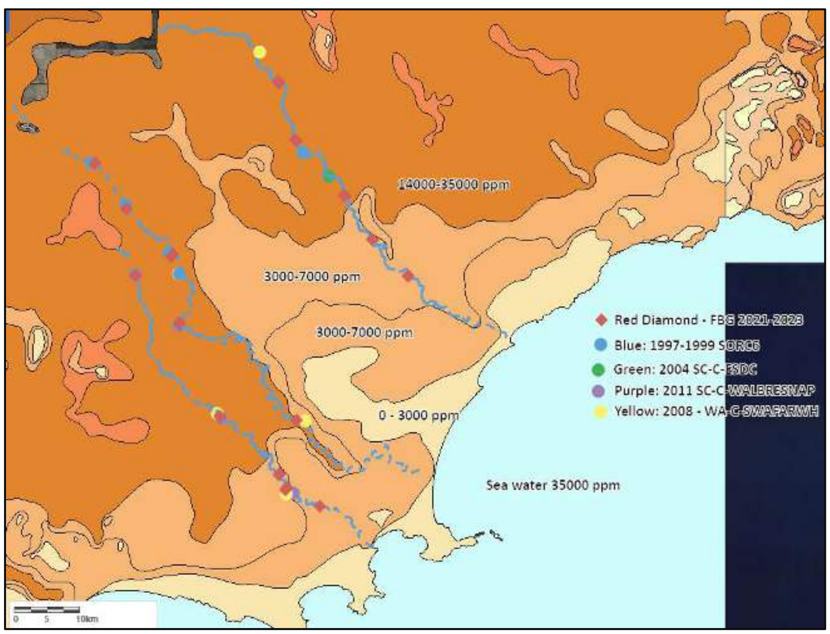


Figure 15: Groundwater salinity levels of Fitzgerald National Park. (Date from Geocortex June 2023)

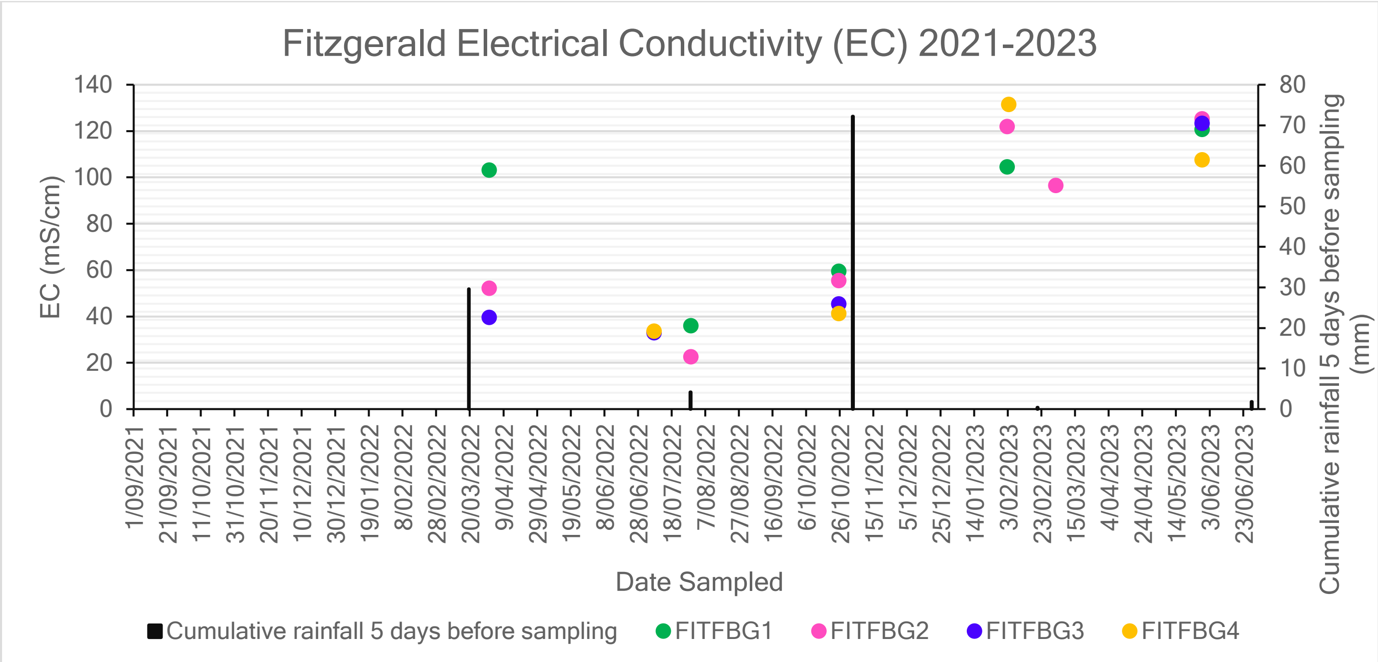


Figure 15: Fitzgerald River Electrical Conductivity (mS/cm) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

The Fitzgerald River shows a seasonal relationship with electrical conductivity (EC) with winter months having a lower EC reading and warmer months having a higher EC reading. This is expected due to the Mediterranean climate and rainfall being less during the summer (Figure 10 and 11). October 2022 also shows this as the 72.2.mm of cumulative rainfall five days prior to sampling presents a lower EC reading. The dry summer months especially when flow is low present a higher EC, thus, assuming hyper salinity with electrical conductivity levels being greater than what is seen in ocean water (53 mS/cm). This is not unusual as warmer months will expect a higher rate of evaporation and a lower rate of freshwater input from rainfall leaving the ionic compounds (such as salt) in the water body, especially when the river flow is still (Table 6). It is interesting however, that site FITFBG1 in March 2022 has an unusually high EC reading of 103.3 mS/cm compared to the other sites being below 60mS/cm. However, looking at figure 11, the location in which FITFBG1 is in an area where the groundwater is of higher salinity (14,000-35,000ppm). Therefore, the saline groundwater may be having an impact on the EC of the river system and site.

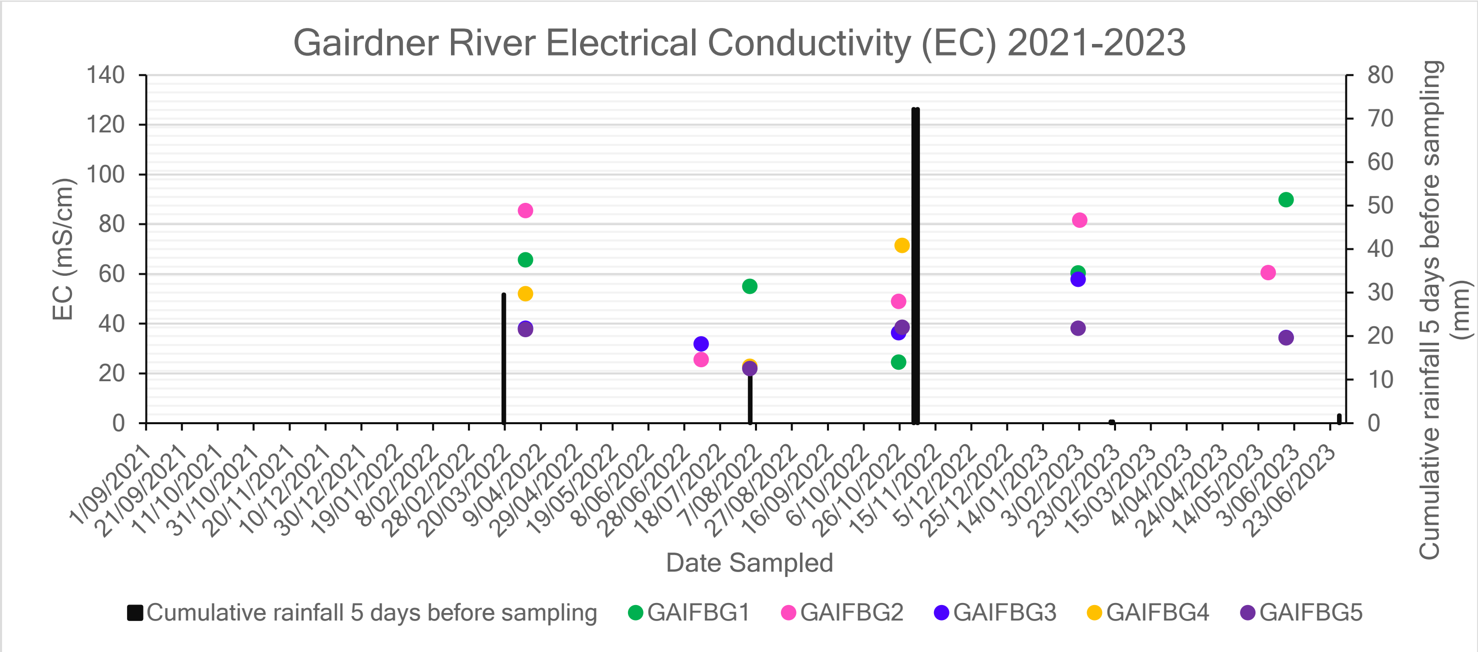


Figure 16: Gairdner River Electrical Conductivity (mS/cm) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Gairdner River like the other rivers also showed a seasonal effect with Electrical conductivity (EC). During cool wet months EC is lower and in hot dry months EC is higher. The highest EC occurred at GAIFBG1 in May 2023 (Autumn) and had a value of 89.9 mS/cm which is significantly higher than that of sea water (53 mS/cm). This site is upstream located in the highest saline ground water (Figure 11). The lowest EC occurred in August 2022 (Winter) at site GAIFBG5 at 22 mS/cm. This site is located downstream in a less a less saline groundwater area (Figure 15). Each site presents a different seasonal pattern, for example, the EC decreases for all sites except GAIFBG2 between August and October 2022 after the heavy rainfall. GAIFBG2 EC increases from 29.7 to 49 mS/cm during this period. It should also be noted that the upstream river sites (GAIFBG1 and GAIFBG2) have much larger extremes with the highest EC being at 85.6 mS/cm and the lowest EC being 24.6 mS/cm. In comparison the most downstream site (GAIFBG5) which has the lowest variation in EC staying below that of sea level for the entire sample period.

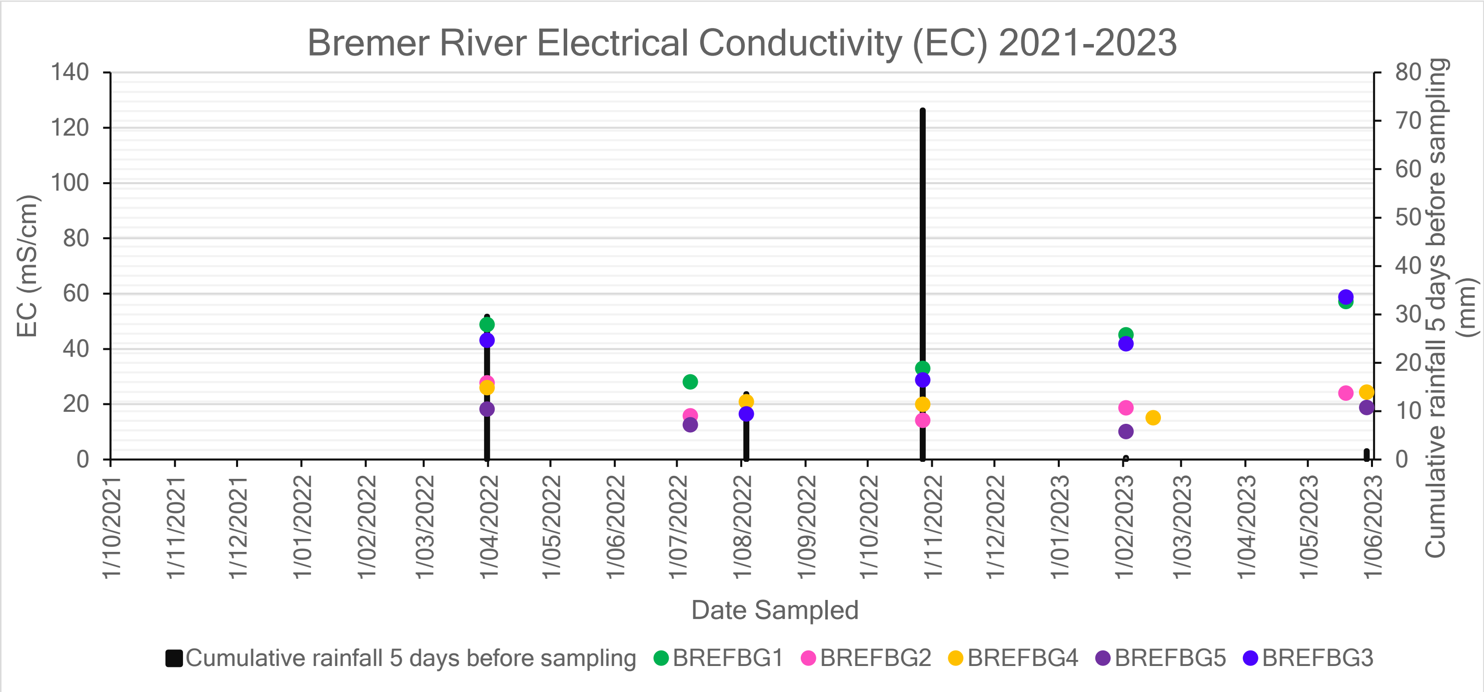


Figure 17: Bremer River Electrical Conductivity (mS/cm) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Bremer River maintains a low EC in comparison to the other two rivers with all sites except for BREFBG1 and BREFBG3 during the May 2023 sampling. The highest EC recorded occurred at BREFBG3 with an EC of 58.8 mS/cm during this May 2023 period. The lowest EC recorded happened at BREFBG5 during July 2022 with an EC of 12.65 mS/cm. Sites BREFBG4 and BREFBG5 have a relatively stable EC during all sampling periods. Contrastingly BREFBG1 and BREFBG3 have a higher variation between lowest EC and highest EC value during the 2021-2023 sampling period.

Overall Bremer River, which is the furthest west, had the lowest overall EC readings and Fitzgerald River which is furthest to the East had the highest EC reading. Therefore, identifying a geographical change in EC from east to west. Moreover, all rivers presented a similar pattern of upstream sites having a higher EC reading in comparison to the downstream sites, which is a known characteristic of South Coast rivers in Western Australia.

TURBIDITY

Turbidity is a measure of the total amount of suspended solids in a water sample. Particulate materials include all types of sediments (e.g., clay, silt, sand), inorganic matter, organic matter, precipitates, and colloids (DCCEEW 2021). The higher the number of suspended solids the higher the turbidity (NSW Government). In most river systems turbidity will increase after rainfall and flooding as a result of soil erosion and increased suspended solids in the water (NSW Government). High turbidity can cause issues to the aquatic environment including the smothering of plants. Moreover, these suspended solids also absorb and transport nutrients, heavy metals, pesticides, and other chemicals (NSW Government), which is why it is important as a water quality measure.

Table 9: Statewide River Water Quality Assessment Classification for lowland rivers

	Turbidity NTU
Classification of Low land rivers	Low: <5
	Moderate: 5 – 10
	High: 10-25
	Very high >25

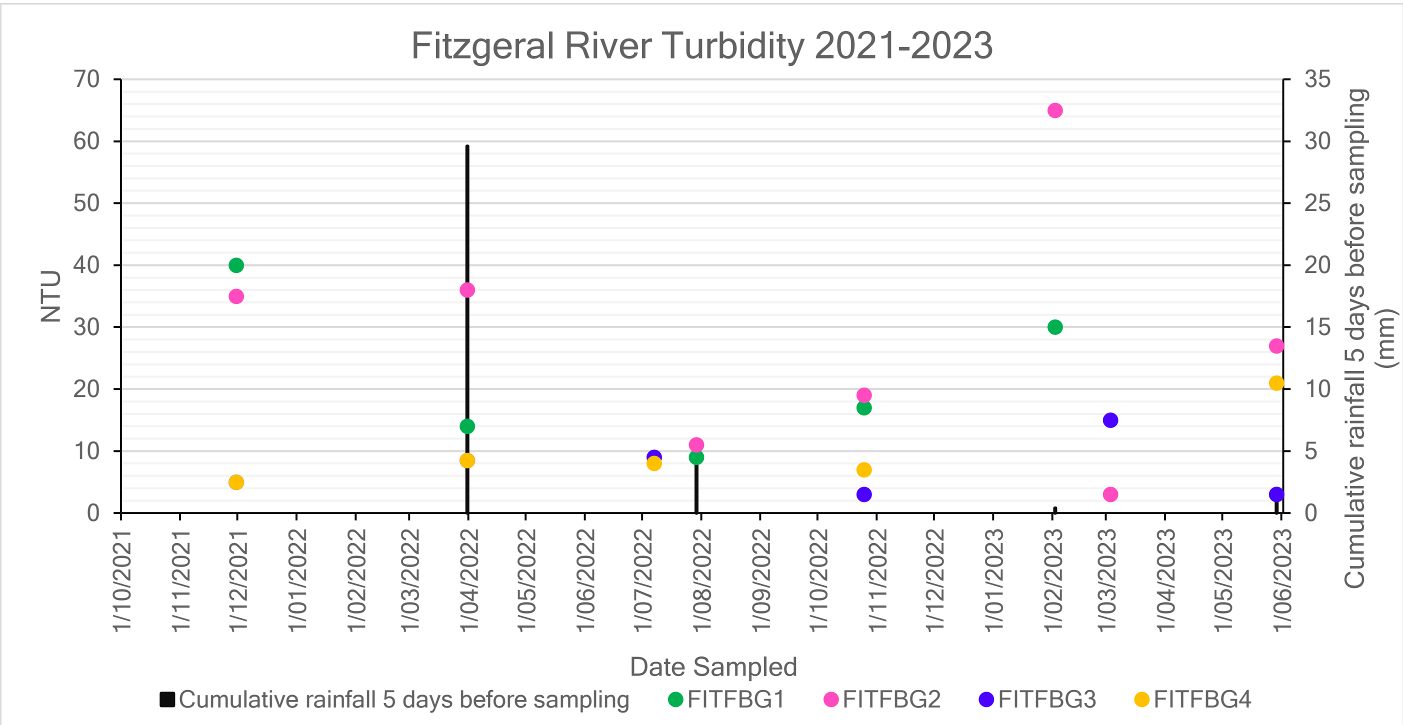


Figure 18: Fitzgerald River Turbidity (NTU) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Fitzgerald River shows varying turbidity levels at each site during the sampling period. Site FITFBG3 and FITFBG4 presented the lowest turbidity of 5 NTU during November 2021. Both sites maintained relatively stable turbidity levels during the entire sampling period remaining under 10 NTU except for FITFBG3 in March 2023 and FITFBG4 in May 2023. The highest recorded turbidity level occurred in FITFBG2 with a level of 65 NTU during February 2023. Interestingly, there had been no significant levels of rainfall prior to this sample taking place. Of greater interest the high level of rainfall prior to sampling in March 2022 FITFBG1 saw a significant drop in turbidity from 40NTU to 14NTU. However, 14NTU is still considered a high reading (Table 9). Overall, the upstream sites presented higher turbidity levels compared to those sites downstream.

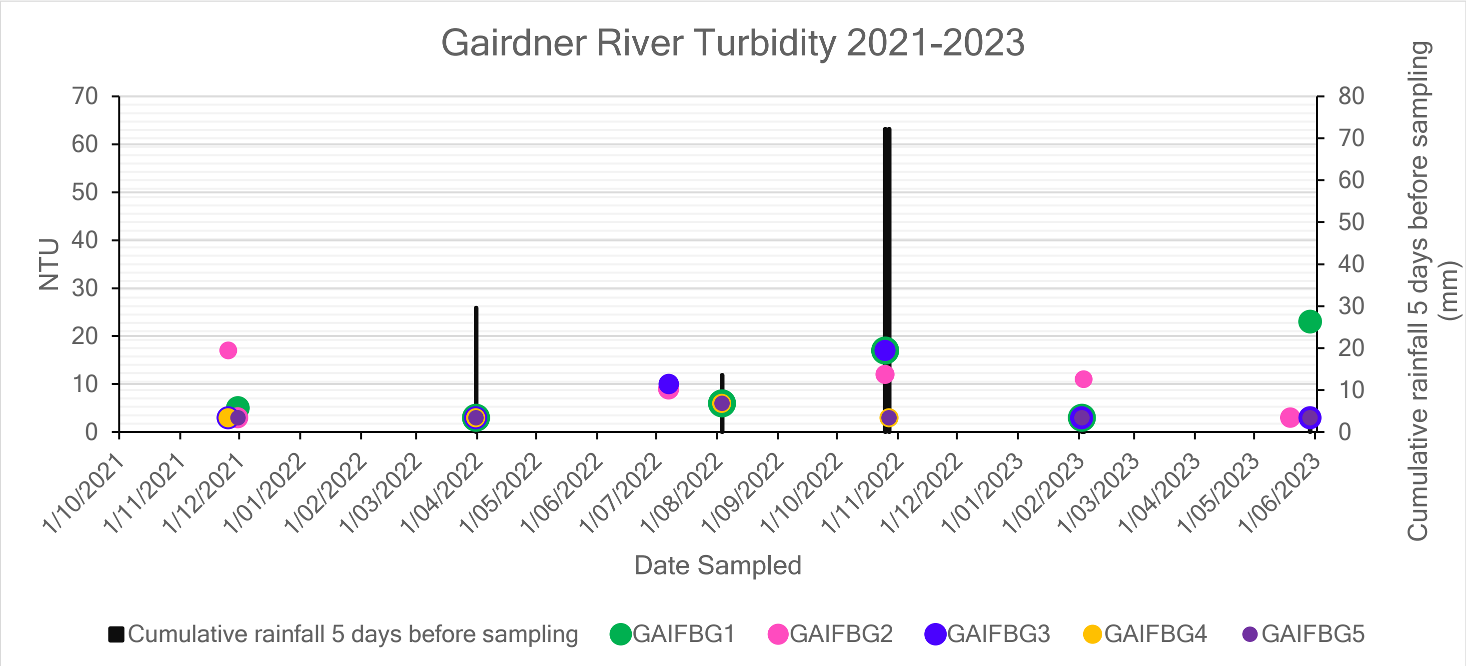


Figure 19: Gardner River Turbidity (NTU) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Gairdner River presents less variation between sites during the sampling period in comparison to the Fitzgerald River. The highest turbidity recorded has a level of 23 NTU at site GAIFBG1 during the May 2023 sampling period. The lowest recorded turbidity level occurred at site GAIFBG4 and GAIFBG5 with an NTU of 3. GAIFBG5 was also the site that maintained a low-moderate turbidity reading of less than 10 (Table 9) during the entire sampling period. However, many of the sites did see overlap having the same turbidity level showing greater consistency during the sampling period. All sites show a low turbidity of 3 (Table 9) during the March sampling period after the 29.6mm of cumulative rainfall five days prior to sampling. Contrastingly, the high rainfall in November 2023 identified an increase in turbidity for GAIFBG1, GAIFBG2, and GAIFBG3. Once again like the Fitzgerald River, the upstream sites presented higher overall turbidity readings in comparison to the downstream sites.

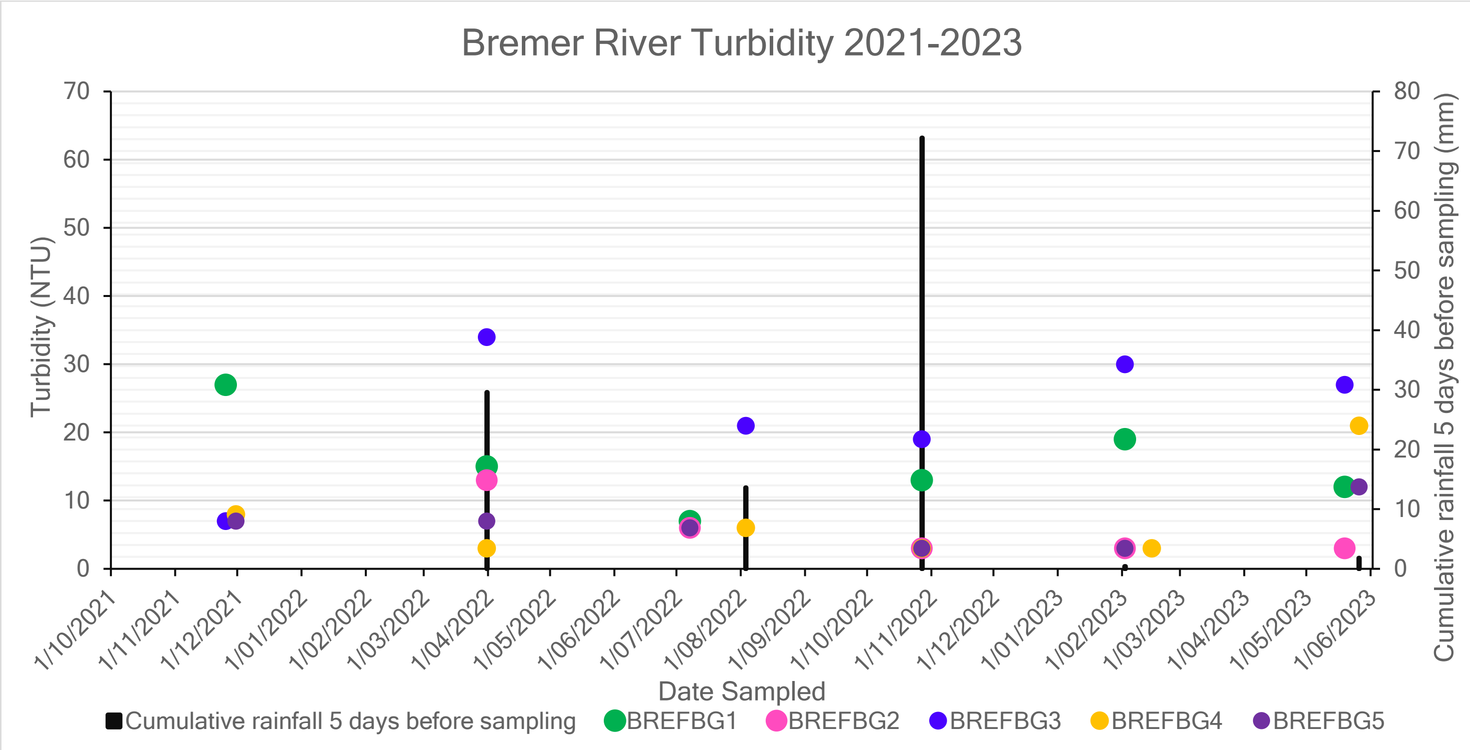


Figure 20: Bremer River Turbidity (NTU) recorded by the Fitzgerald Biosphere Group between 2021 and 2023

Bremer River shows a greater variation in turbidity readings compared to the Gairdner River; however, the variation is less than that shown in Figure 18 for Fitzgerald River. Bremer River also presents a stronger seasonal influence with the warmer months of late summer and Autumn having the high turbidity readings for BREFBG1 and BREFBG3. However, a conclusion on seasonal affects having a strong influence can't be made purely on this data set due to the short time frame. The highest turbidity reading recorded at Bremer River occurred at BREFBG3 with a turbidity reading of 34NTU during March 2023. The lowest recorded turbidity value was 3NTU and occurred at multiple sites during the sampling period. However, it is interesting to note that the highest turbidity of 34NTU at site BREFBG3 happened during the same sampling period that BREFBG2, BREFBG4 and BREFBG5 had the lowest recorded reading of 3NTU.

CONCLUSION

The above data highlights some interesting points regarding changes in water quality. However, it is important to recognize the data's limitations due to minimal recordings at this stage. While the health of the river cannot be identified by only these parameters it is possible to see changes in water quality regarding individual parameters. Overall Fitzgerald River shows the highest pH, electrical conductivity, and turbidity.

EXTRA READING – HISTORICAL DATA FROM THE FITZGERALD BIOSPHERE GROUP

This historical data was provided by the Fitzgerald Biosphere Group; however, it is not possible to have full confidence in the provided data due to having no sampling plan provided to determine both accuracy and relevance to current data. Thus, with the data coming from differing projects, the quality controls and consistencies are unknown. However, this data can be used to get an **idea** of possible annual changes in water quality over time.

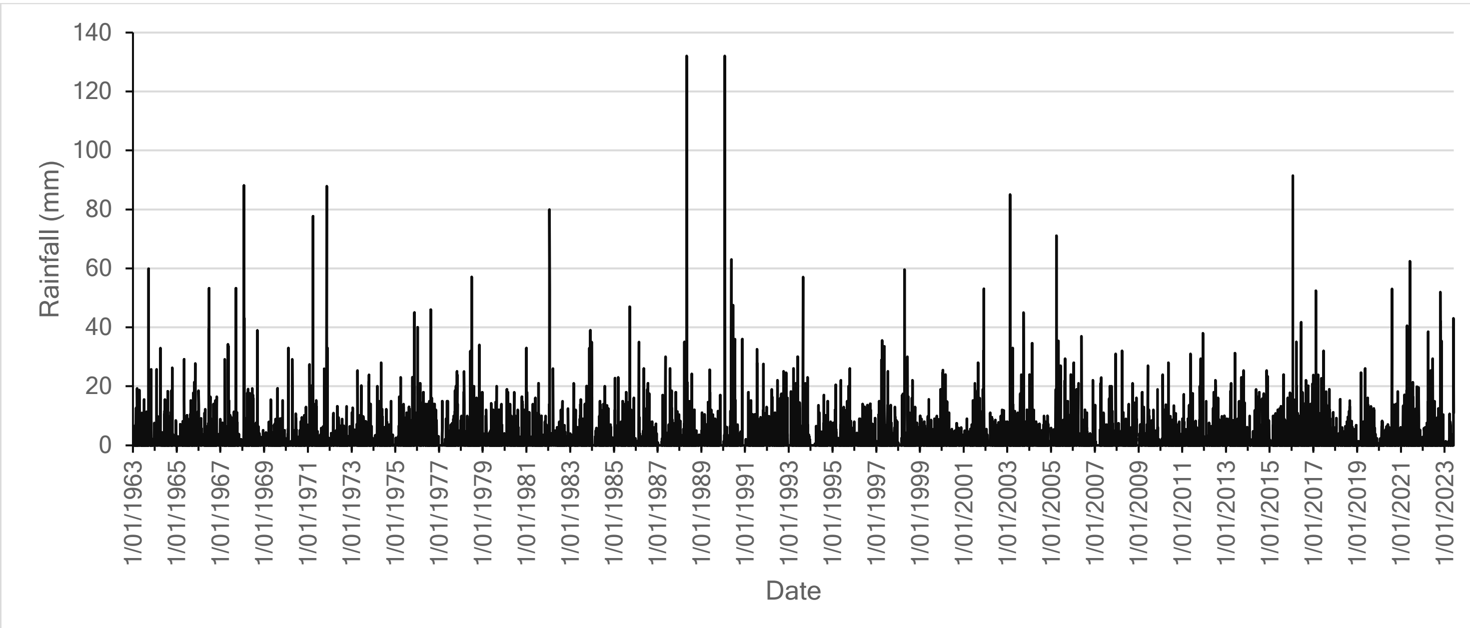


Figure 21: 30 years of historical daily rainfall (mm) between 1993 and 2023

Figure 21 shows an unusually wet period in 1988 with 132mm of rainfall on the 3rd of May. 1990 also presented an unusually high daily rainfall of 132mm on the 29th of January. The rainfall of January 1990 is particularly unusual as January provides a hot dry climate under the Mediterranean climate (Figure 10 and 11). Overall, a general seasonal pattern of high rainfall in the winter months and dry weather during the summer months is prevalent. It should, however, also be noted that rainfall is not equal amongst all years for example 2007 - 2015 present particularly dry years.

HISTORICAL PH

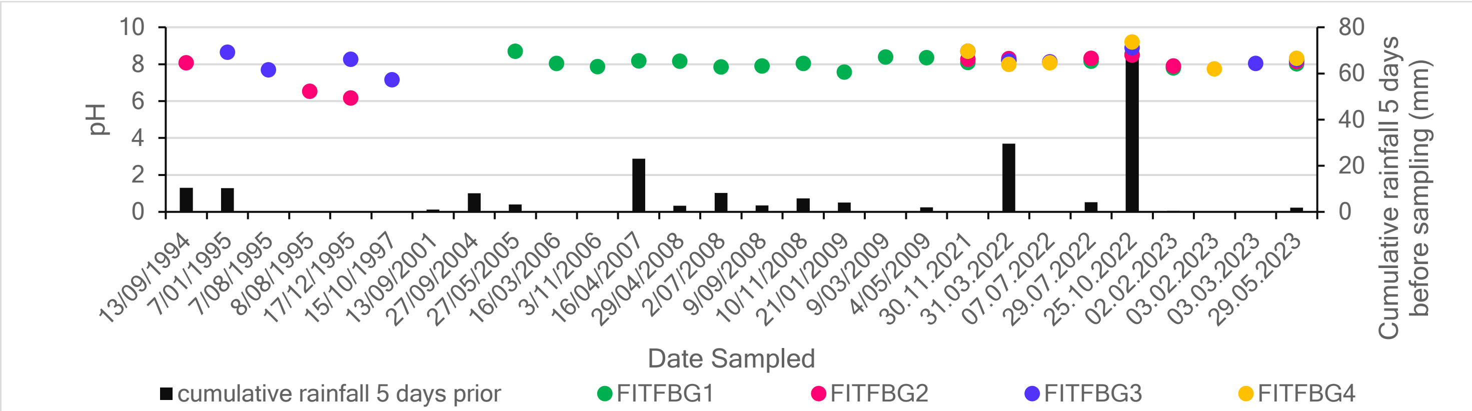


Figure 22: Historical pH at Fitzgerald River in 1994 -2023 for all 4 sites.

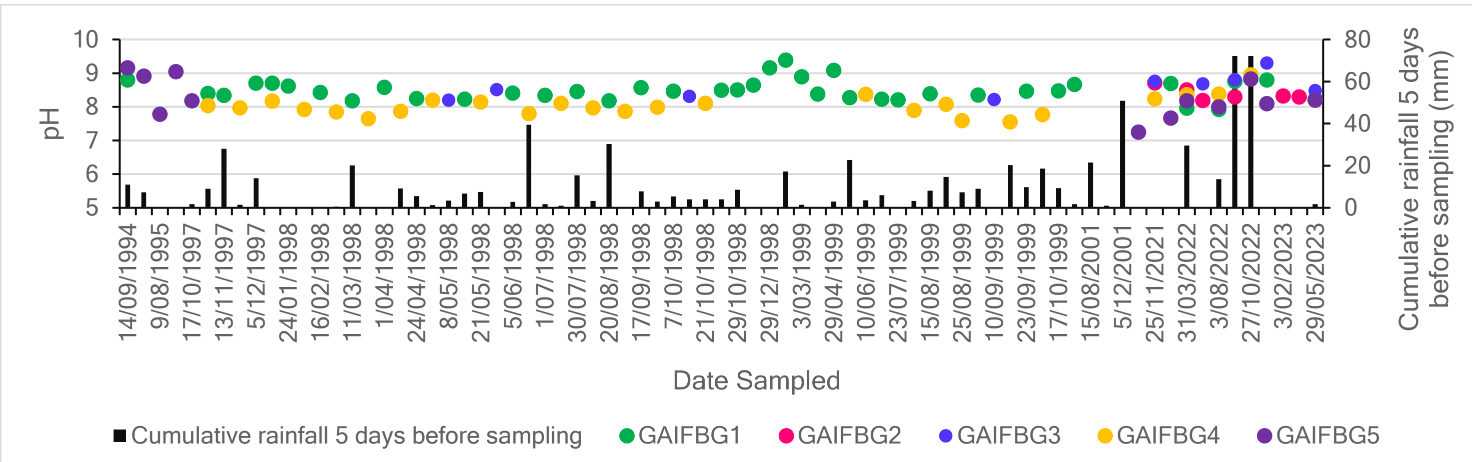


Figure 23: Historical pH at Gairdner River in 1994 -2023 for all 5 sites.

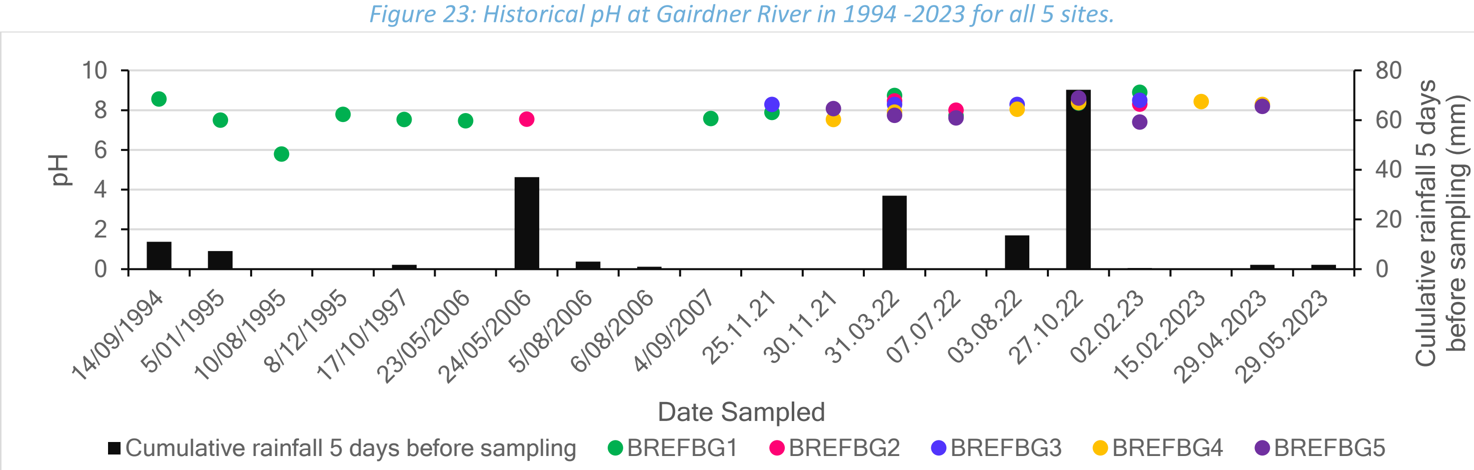


Figure 24: Historical pH at Bremer River in 1994 -2023 for all 5 sites.

Gairdner River presents the highest number of historical samples; however, this is not equal across all sites. GAIFBG1 presented a high pH in 1999 which according to Figure 21 was a dry year. However, site GAIFBG5 and GAIFBG3 also showed a high pH of above 9 during years of lower winter rainfalls (1994 and 2023). The other two rivers presented less historical data points creating a higher challenge in identifying annual differences.

HISTORICAL TEMPERATURE

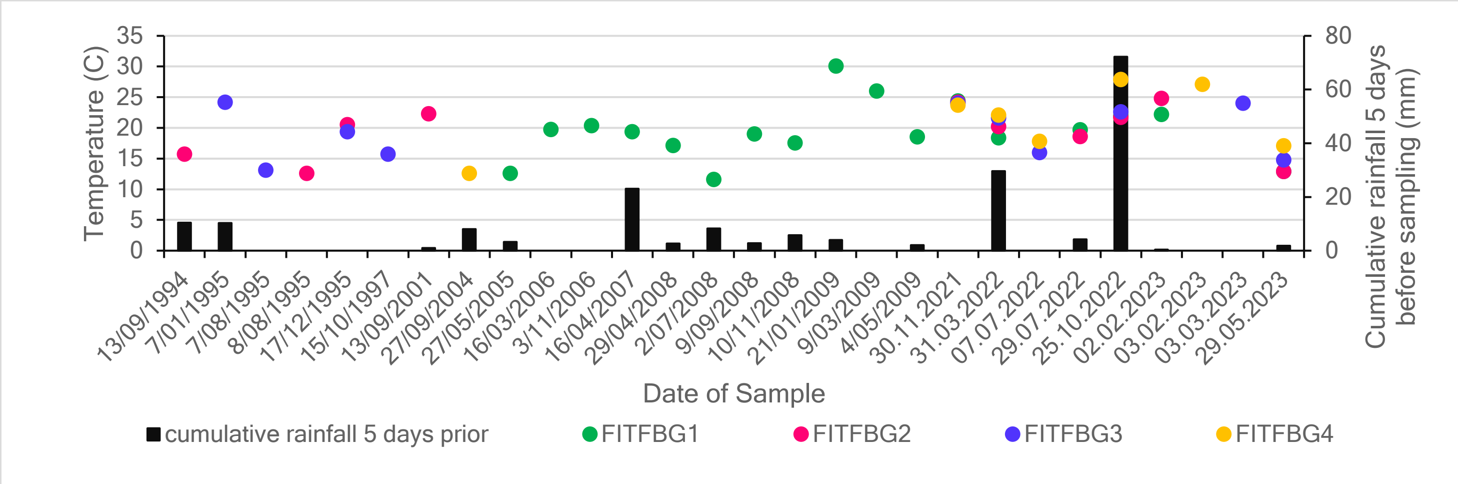


Figure 25: Historical Water Temperature at Fitzgerald River in 1994 -2023 for all 4 sites.

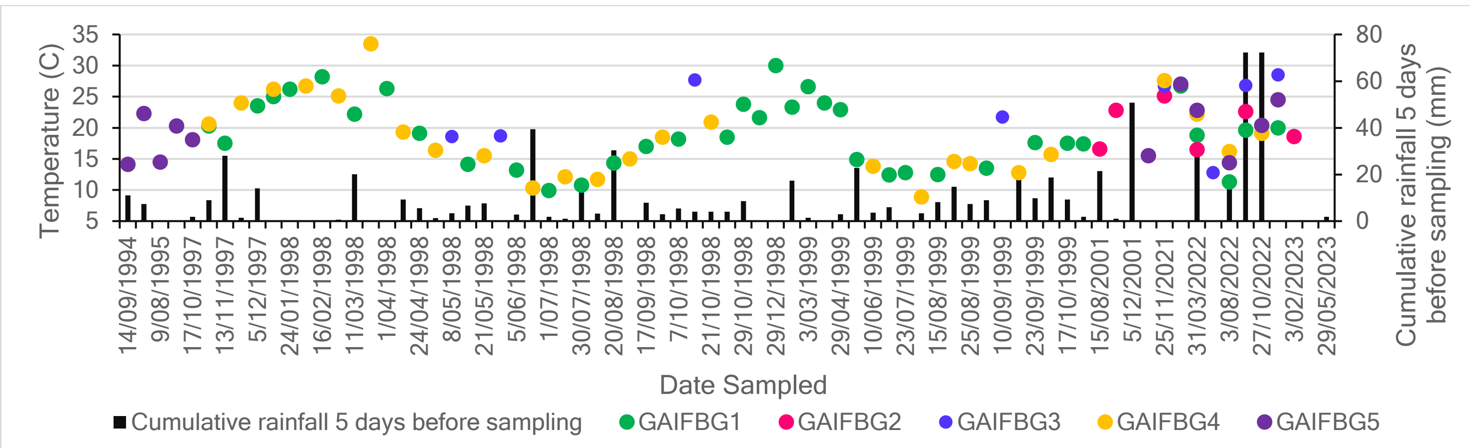


Figure 26: Historical Water Temperature at Gairdner River in 1994 -2023 for all 5 sites

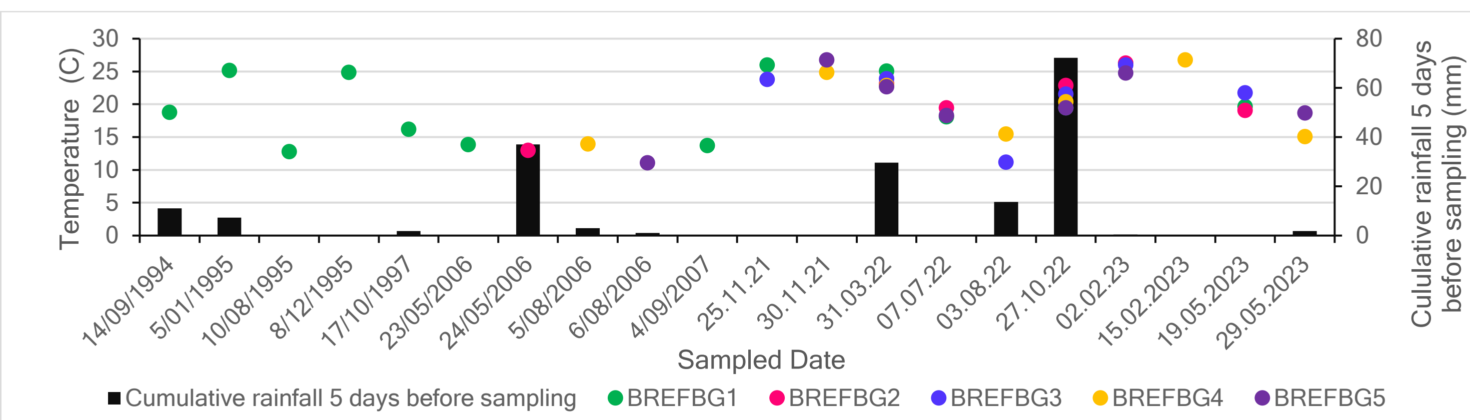


Figure 27: Historical Water Temperature at Bremer River in 1994 -2023 for all 5 sites

The water temperature of all rivers presents a seasonal change with the warmer months of summer having warmer water temperatures and the cooler months of winter having cooler temperatures. Gairdner river shows the highest temperature at site GAIFBG4 of 33.5C in 1998. However, neither of the other rivers have temperature data for 1998. Gairdner also has the coldest site at GAIFBG4 with a temperature of 8.9C in 1998. Overall, each site follows seasonal temperature changes over the years.

HISTORICAL ELECTRICAL CONDUCTIVITY

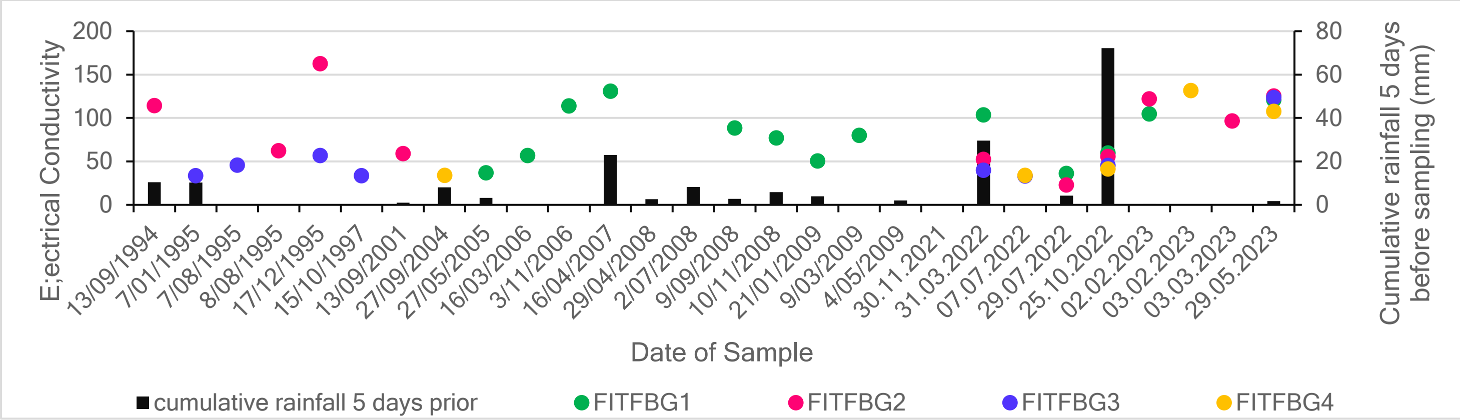


Figure 28: Historical Electrical Conductivity at Fitzgerald River in 1994 - 2023 for all 4 sites

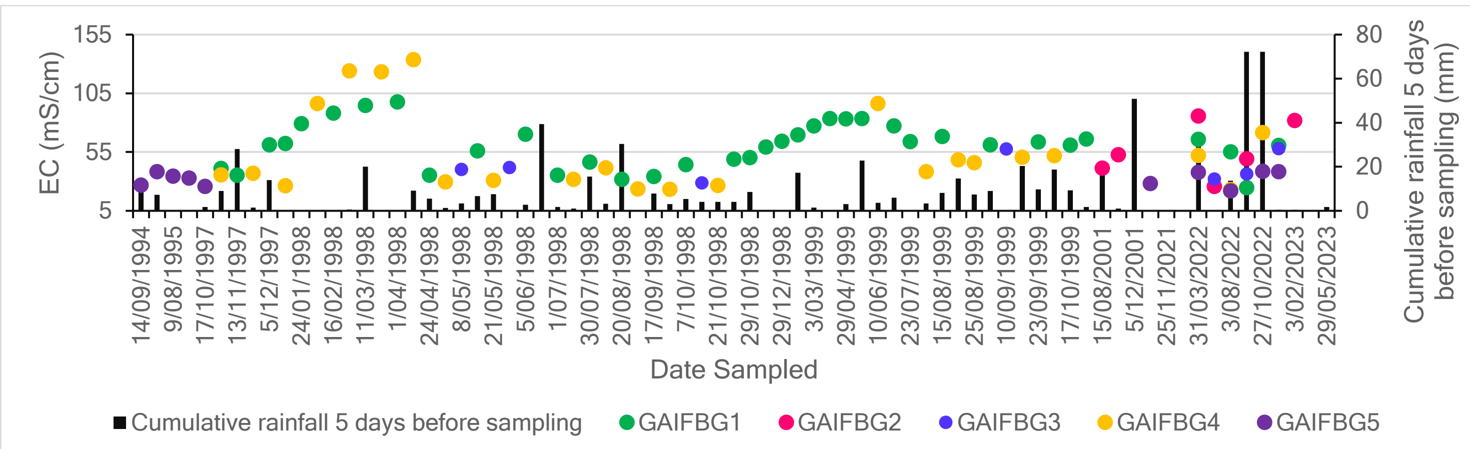


Figure 29: Historical Electrical Conductivity at Gairdner River in 1994 - 2023 for all 5 sites

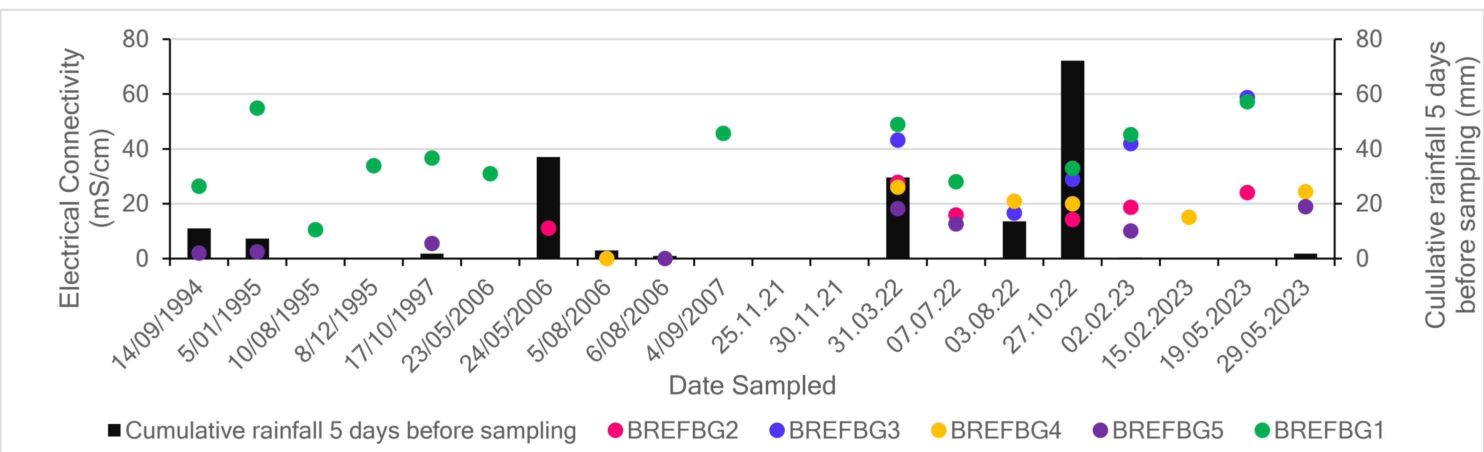


Figure 30: Historical Electrical Conductivity at Bremer River in 1994 - 2023 for all 5 site.

The Electrical conductivity for each river shows variation over time. However, there is no clear seasonal impact as the highest EC reading of Gairdner River occurred in April 1998 reading 133.5 mS/cm. The highest reading of EC in 1999 occurred in June with a reading of 96.3 mS/cm. The highest reading in 2023 occurred in February with 81.7 mS/cm. Therefore, each year the highest annual EC reading occurs during different seasons for Gairdner River. The other rivers do not provide as many data points to draw any conclusions. However, it can be stated that overall, Fitzgerald River had the lowest EC and Fitzgerald River had the highest EC.

HISTORICAL TURBIDITY

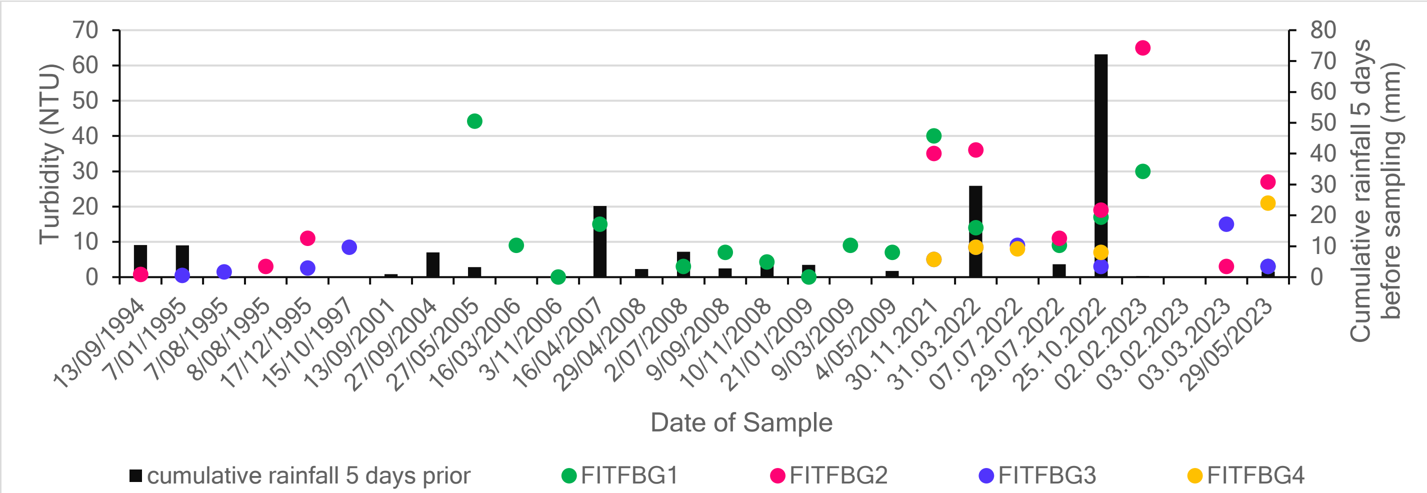


Figure 31: Historical Turbidity (NTU) at Fitzgerald River in 1994 - 2023 for all 4 sites

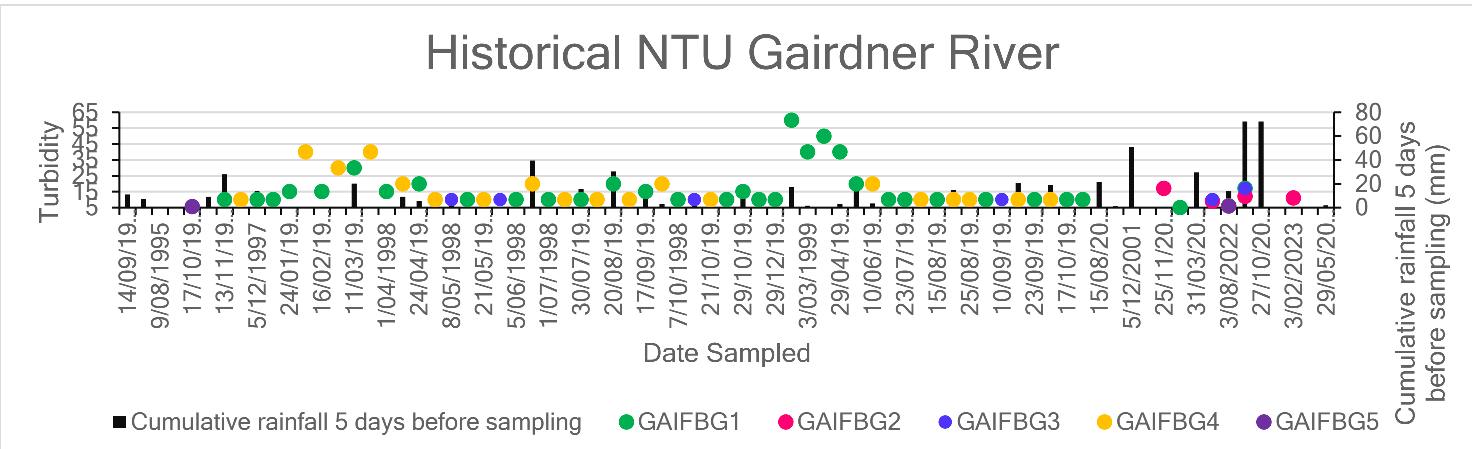


Figure 32: Historical Turbidity (NTU) at Gairdner River in 1994 - 2023 for all 5 sites

Gairdner River show higher turbidity readings during the summer months, However, there is not enough data over the years to determine this as a regular pattern or trend. Fitzgerald River on the other hand has more sporadic readings with the higher turbidity readings occurring in both May (Autumn) and February (summer). Bremer River had no historical sites for turbidity.

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8) USGS (United States Government Science for a changing world) (2019) *pH scale*, accessed 4 June 2023.
9) DWER (Department of Water and Environmental Regulation), DPIRD (Department of Primary Industries and Regional Development) (n.d.) *Data analysis – catchment nutrient reports*, accessed 14 July 2023.

DISCLAIMER

The data in this report has not been collected or qualified by the Department of Water and Environmental Regulation. The Departments role was to support the Fitzgerald Biosphere Group with the data analysis of the data they have provided the Department as of July 2023.

APPENDIX

APPENDIX 1: Gairdner River 2021-2023 Raw Data

Site Code	Date	River System	Lat	Long	pH	Temp	EC (mS/cm)	NTU	Flow	Colour	Shade	Notes
GAIFBG1	30.11.21	Gairdner	33°48'53.60"S	118°48'41.52"E	8.69	26.7	NA	5	L	LB/G	O	
GAIFBG1	31.03.22	Gairdner	33°48'53.60"S	118°48'41.52"E	7.96	18.8	65.8	<5	S	GB	O	
GAIFBG1	03.08.22	Gairdner	33°48'53.60"S	118°48'41.52"E	7.92	11.3	55.1	6	L	BO	O	
GAIFBG1	25.10.22	Gairdner	33°48'53.60"S	118°48'41.52"E	8.76	19.6	24.6	17	VL	VDB	O	60-100mL rainfall across sites in week of sampling
GAIFBG1	02.02.23	Gairdner	33°48'53.60"S	118°48'41.52"E	8.8	20	60.5	<6	VL/S	MB	O	
GAIFBG1	29.05.23	Gairdner	33°48'53.60"S	118°48'41.52"E	8.23	17	89.9	23	L	DB	O	
GAIFBG2	25.11.21	Gairdner	33°51'48.44"S	118°54'55.51"E	8.71	25.1	NA	17	L	DB	O	
GAIFBG2	31.03.22	Gairdner	33°51'48.44"S	118°54'55.51"E	8.5	16.5	85.6	<5	L	LB	O	
GAIFBG2	07.07.22	Gairdner	33°51'48.44"S	118°54'55.51"E	8.19		25.7	9	LM	DB	O	
GAIFBG2	25.10.22	Gairdner	33°51'48.44"S	118°54'55.51"E	8.29	22.6	49.02	12	M	OB	O	60-100mL rainfall across sites in week of sampling
GAIFBG2	03.02.23	Gairdner	33°51'48.44"S	118°54'55.51"E	8.32	18.6	81.7	11	S	LOB	O	
GAIFBG2	19.05.23	Gairdner	33°51'48.44"S	118°54'55.51"E	8.29	13	60.6	<6	L	LB	O	
GAIFBG3	25.11.21	Gairdner	33°55'11.95"S	118°58'26.51"E	8.76	26.7	NA	<5	VL	G/B	O	
GAIFBG3	31.03.22	Gairdner	33°55'11.95"S	118°58'26.51"E	8.27		38.2	<5	VL	C/VLB	O	
GAIFBG3	07.07.22	Gairdner	33°55'11.95"S	118°58'26.51"E	8.68	12.8	32	10	LM	MB	O	
GAIFBG3	25.10.22	Gairdner	33°55'11.95"S	118°58'26.51"E	8.81	26.8	36.4	17	M	B	O	60-100mL rainfall across sites in week of sampling
GAIFBG3	02.02.23	Gairdner	33°55'11.95"S	118°58'26.51"E	9.3	28.5	57.9	<6	S	GB	O	
GAIFBG3	29.05.23	Gairdner	33°55'11.95"S	118°58'26.51"E	8.48	15.4	34.5	<6	L	GB	O	
GAIFBG4	25.11.21	Gairdner	33°59'7.64"S	119°2'47.39"E	8.24	27.6	NA	<5	VL	O/B	O	
GAIFBG4	31.03.22	Gairdner	33°59'7.64"S	119°2'47.39"E	8.36	22.2	52.2	<5	S	LB	O	
GAIFBG4	03.08.22	Gairdner	33°59'7.64"S	119°2'47.39"E	8.38	16.2	23	6	M	LOB	O	
GAIFBG4	27.10.22	Gairdner	33°59'7.64"S	119°2'47.39"E	8.95	19.1	71.6	<6	M	LB	O	60-100mL rainfall across sites in week of sampling
GAIFBG4	02.02.22	Gairdner	33°59'7.64"S	119°2'47.39"E	NA	NA	NA	NA	DRY	NA	O	DRY
GAIFBG4	19.05.23	Gairdner	33°59'7.64"S	119°2'47.39"E	NA	NA	NA	NA	DRY	NA	O	
GAIFBG5	30.11.21	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	7.67	27	NA	<5	VL	LB	MS	
GAIFBG5	31.03.22	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	8.18	22.8	37.8	<5	VL	C/G	MS	
GAIFBG5	03.08.22	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	8	14.4	22	6	L	VLB	MS	
GAIFBG5	27.10.22	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	8.83	20.4	38.6	<6	L	LB	MS	60-100mL rainfall across sites in week of sampling
GAIFBG5	02.02.23	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	8.09	24.5	38.3	<6	VL	LB	MS	
GAIFBG5	29.05.23	Gairdner	34° 5 '13.13"S	119° 3'48.42"E	8.2	18.3	34.4	<6	VL	LOB	MS	

Colou	Colum	Flow	Colum	Shad	Colum
L	Light	V	Very	O	Open
M	Medium	S	Still	S	Slight
V	Very	L	Low	M	Moderate
D	Dark	M	Mid	F	Full
O	Orange	H	High		
B	Brown				
G	Green				

Average EC 896.02
47.15895

APPENDIX 2: Fitzgerald River 2021-2023 Raw Data

Site Code	Date	River System	Lat	Long	pH	Temp	EC (mS/cm)	NTU	Flow	Colour	Shade	Notes
FITFBG1	30.11.2021	Fitzgerald	33°42'17.00"S	119°11'55.00"E	8.09	24.4	NA	40	VL	LB	O	
FITFBG1	31.03.2022	Fitzgerald	33°42'17.00"S	119°11'55.00"E	8.2	18.4	103.3	14	S	MB	O	
FITFBG1	29.07.2022	Fitzgerald	33°42'17.00"S	119°11'55.00"E	8.16	19.7	36	9	ML	LOB	O	
FITFBG1	25.10.2022	Fitzgerald	33°42'17.00"S	119°11'55.00"E	8.55	21.9	59.6	17	L	B	O	heavy rainall across sites during sampling week
FITFBG1	02.03.2023	Fitzgerald	33°42'17.00"S	119°11'55.00"E	7.8	22.2	104.6	30	S	MB	O	
FITFBG1	29.05.2023	Fitzgerald	33°42'17.00"S	119°11'55.00"E	8.03	12.9	120.8	<6	S	MB	O	
FITFBG2	30.11.2021	Fitzgerald	33°44'57.00"S	119°13'58.00"E	8.28	24.2	NA	35	L	LB	O	
FITFBG2	31.03.2022	Fitzgerald	33°44'57.00"S	119°13'58.00"E	8.31	20.2	52.3	36	S	MB	O	
FITFBG2	29.07.2022	Fitzgerald	33°44'57.00"S	119°13'58.00"E	8.33	18.6	22.7	11	M	MB	O	
FITFBG2	25.10.2022	Fitzgerald	33°44'57.00"S	119°13'58.00"E	8.5	21.7	55.5	19	L	B	O	heavy rainall across sites during sampling week
FITFBG2	02.02.2023	Fitzgerald	33°44'57.00"S	119°13'58.00"E	7.9	24.8	122	65	S	OB	O	Very orange north of MP
FITFBG2	29.05.2023	Fitzgerald	33°44'57.00"S	119°13'58.00"E	8.15	12.9	125.3	27	S/VL	MB		
FITFBG3	30.11.2021	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.7	24	NA	5	L	LB	O	
FITFBG3	31.03.2022	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.18	21.6	39.6	8.5	S	LB	O	
FITFBG3	07.07.2022	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.14	16	33	9	M	MB	O	
FITFBG3	25.10.2022	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.9	22.6	45.4	<6	M	LB	O	heavy rainall across sites during sampling week
FITFBG3	03.03.2023	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.04	24	96.6	<6	SP	W/G/B in	O	
FITFBG3	29.05.2023	Fitzgerald	33°45'10.33"S	119°14'19.70"E	8.26	14.8	123.4	<6	LOB	S	O	
FITFBG4	30.11.2021	Fitzgerald	33°49'34.00"S	119°15'37.00"E	8.7	23.7	NA	5	VL	LB	O	
FITFBG4	31.03.2022	Fitzgerald	33°49'34.00"S	119°15'37.00"E	8	22.1	9.94	8.5	S	LOB	O	EC error?
FITFBG4	07.07.2022	Fitzgerald	33°49'34.00"S	119°15'37.00"E	8.08	17.8	33.7	8	L	OB	O	
FITFBG4	25.10.2022	Fitzgerald	33°49'34.00"S	119°15'37.00"E	9.2	27.9	41.3	7	ML	OB	O	heavy rainall across sites during sampling week
FITFBG4	03.02.2023	Fitzgerald	33°49'34.00"S	119°15'37.00"E	7.75	27.1	131.6	15	S	OB	O	
FITFBG4	29.05.2023	Fitzgerald	33°49'34.00"S	119°15'37.00"E	8.32	17.1	107.6	21	S	OB	O	

Colour	Columr	Flow	Columr	Shade	Columr
L	Light	V	Very	O	Open
M	Medium	S	Still	S	Slight
V	Very	L	Low	M	Moderate
D	Dark	M	Mid	F	Full
O	Orange	H	High		
		D	Dry		
B	Brown	SP	Stagnant pools		
G	Green				

APPENDIX 3: Bremer River 2021-2023 Raw Data

Site Code	Date	River System	Lat	Long	pH	Temp	EC (mS/cm)	NTU	Flow	Colour	Shade	Notes
BREFBG1	25.11.2021	Bremer	34°0'59.00"S	118°59'29.00"E	7.88	26	NA	27	VL	DB	O	
BREFBG1	31.03.2022	Bremer	34°0'59.00"S	118°59'29.00"E	8.74	25.1	48.9	150	S	MB/O	O	
BREFBG1	07.07.2022	Bremer	34°0'59.00"S	118°59'29.00"E	7.72	18.1	28.1	7	VL	OB	O	
BREFBG1	27.10.2022	Bremer	34°0'59.00"S	118°59'29.00"E	8.34	19.5	33	13	VL	DB	O	60-100mL rainfall across these sites during week
BREFBG1	02.02.2023	Bremer	34°0'59.00"S	118°59'29.00"E	8.9	26.2	45.2	19	S	DOB	O	
BREFBG1	19.05.2023	Bremer	34°0'59.00"S	118°59'29.00"E	8.1	19.7	57.2	12	E/S	DB	O	
BREFBG2	25.11.2021	Bremer	32°12'50.22"S	119°8'12.02"E	8.36	26.7	NA	<5	VL	DB	O	INVALID - WRONG SITE
BREFBG2	31.03.2022	Bremer	34°12'52.0"S	119°08'12.1"E	8.46	23.2	27.8	13	S	DB	O	
BREFBG2	07.08.2022	Bremer	34°12'52.0"S	119°08'12.1"E	7.99	19.5	15.9	6	VL	MB	O	
BREFBG2	27.10.2022	Bremer	34°12'52.0"S	119°08'12.1"E	8.38	22.9	14.3	<6	L	DB	O	60-100mL rainfall across these sites during week
BREFBG2	02.02.2023	Bremer	34°12'52.0"S	119°08'12.1"E	8.3	26.3	18.77	<6	VL	DB	O	
BREFBG2	19.05.2023	Bremer	34°12'52.0"S	119°08'12.1"E	7.94	19.1	24.1	<6	L	MOB	O	
BREFBG3	25.11.2021	Bremer	34°7'7.63"S	119°0'49.36"E	8.29	23.8	NA	7	VL	MB	O	
BREFBG3	31.03.2022	Bremer	34°7'7.63"S	119°0'49.36"E	8.29	23.9	43.2	34	S	MB/G	O	
BREFBG3	03.08.2022	Bremer	34°7'7.63"S	119°0'49.36"E	8.29	11.2	16.62	21	LM	MB	O	
BREFBG3	27.10.2022	Bremer	34°7'7.63"S	119°0'49.36"E	8.49	21.6	28.9	19	L	MOB	O	60-100mL rainfall across these sites during week
BREFBG3	02.02.2023	Bremer	34°7'7.63"S	119°0'49.36"E	8.5	26	41.9	30	S	MOB	O	
BREFBG3	19.05.2023	Bremer	34°7'7.63"S	119°0'49.36"E	8.4	21.8	58.8	27	L	MOB	O	
BREFBG4	30.11.2021	Bremer	34°14'13.93"S	119°11'23.14"E	7.53	24.9	NA	8	VL	DB	S	
BREFBG4	31.03.2022	Bremer	34°14'13.93"S	119°11'23.14"E	7.89	22.9	26.1	<5	S	MB	S	
BREFBG4	03.08.2022	Bremer	34°14'13.93"S	119°11'23.14"E	8.04	15.5	21	6	M	MOB	S	
BREFBG4	27.10.2022	Bremer	34°14'13.93"S	119°11'23.14"E	8.38	20.4	20	<6	H	VDB	S	60-100mL rainfall across these sites during week
BREFBG4	15.02.2023	Bremer	34°14'13.93"S	119°11'23.14"E	8.43	26.8	15.14	<6	S	VDB	S	
BREFBG4	29.05.2023	Bremer	34°14'13.93"S	119°11'23.14"E	8.28	15.1	24.5	21	S	VDB	S	
BREFBG5	30.11.2021	Bremer	34°18'49.66"S	119°14'47.60"E	8.08	26.8	NA	7	L	VDB	M	
BREFBG5	31.03.2022	Bremer	34°18'49.66"S	119°14'47.60"E	7.74	22.7	18.28	7	S	MB	M	
BREFBG5	07.07.2022	Bremer	34°18'49.66"S	119°14'47.60"E	7.6	18.3	12.65	6	M	LOB	M	
BREFBG5	27.10.2022	Bremer	34°18'49.66"S	119°14'47.60"E	8.6	19.5	EC meter malf	<6	VH	DOB	M	60-100mL rainfall across these sites during week
BREFBG5	02.02.2023	Bremer	34°18'49.66"S	119°14'47.60"E	7.4	24.8	10.14	<6	S	DOB	M	
BREFBG5	29.05.2023	Bremer	34°18'49.66"S	119°14'47.60"E	8.19	18.7	18.93	12	S	VDB	M	

Average E	485.9
	25.5737

Code	Colour	Code2	Flow	Code3	Flow2
L	Light	V	Very	O	Open
M	Medium	S	Still	S	Slight
V	Very	L	Low	M	Moderate
D	Dark	M	Mid	F	Full
O	Orange	H	High		
B	Brown				
G	Green				

APPENDIX 4: Historical data provided by the FBG group. Gairdner River

Project	FBG Project Code	Original Code	EV_sitecode	DOW Project Site Code	WRAE Project Site Code	Sample_date	Ph	Temperature	EC(mS/cm)	turbidity(NTU)	FLOW	Colour	Comments
CURRENT SITE: GAIFBG1 (woolshed rd)													
WRAE		GAI002		GAI002	GAI002_WRAE	6/11/1997	8.4	20.3	41	na	Trickle		Ruppia/ enteromorpha?
WRAE		GAI002		GAI002	GAI002_WRAE	13/11/1997	8.3	17.5	35	10	Moderate		
WRAE		GAI002		GAI002	GAI002_WRAE	5/12/1997	8.7	23.5	61	10	Z-Nil		
WRAE		GAI002		GAI002	GAI002_WRAE	11/12/1997	8.7	25	62	10	Z-Nil		
WRAE		GAI002		GAI002	GAI002_WRAE	24/01/1998	8.6	26.2	79	15	Z-Nil		
WRAE		GAI002		GAI002	GAI002_WRAE	16/02/1998	8.4	28.2	88	15	Z-Nil		Bright green/blueish floating mats
WRAE		GAI002		GAI002	GAI002_WRAE	11/03/1998	8.2	22.2	94.6	30	Z-Nil		Less floating algae but very smelly
WRAE		GAI002		GAI002	GAI002_WRAE	1/04/1998	8.6	26.3	97.6	150	Z-Nil		Bubbly floating green/brown algae, smelly
WRAE		GAI002		GAI002	GAI002_WRAE	24/04/1998	8.3	19.1	35.1	20	Low		
WRAE		GAI002		GAI002	GAI002_WRAE	14/05/1998	8.2	14.1	56	10	Low		Some green algae on bottom, some odour
WRAE		GAI002		GAI002	GAI002_WRAE	5/06/1998	8.41	13.2	70.1	10	Low		Lot of green algae on bottom, active snails
WRAE		GAI002		GAI002	GAI002_WRAE	1/07/1998	8.3	9.9	35.1	10	Moderate		Frothy water in pool
WRAE		GAI002		GAI002	GAI002_WRAE	30/07/1998	8.45	10.8	46.4	10	Moderate		Water brown but clear, live snails have not reappeared
WRAE		GAI002		GAI002	GAI002_WRAE	20/08/1998	8.18	14.3	31.7	20	Moderate		Water Brown, bit murky, large band of vegetation
WRAE		GAI002		GAI002	GAI002_WRAE	17/09/1998	8.57	17	34.2	15	Moderate		Water very brown, some green algae on rocks.
WRAE		GAI002		GAI002	GAI002_WRAE	7/10/1998	8.46	18.2	44.3	10	Low		Small water snails
WRAE		GAI002		GAI002	GAI002_WRAE	22/10/1998	8.49	18.5	48.8	10	Low		Snails more prevalent and active. Lot of underwater invertebrates
WRAE		GAI002		GAI002	GAI002_WRAE	29/10/1998	8.5	23.8	50.1	15	Low		Mats' of floating green algae forming. Lots of debris on surface.
WRAE		GAI002		GAI002	GAI002_WRAE	1/12/1998	8.64	21.6	59.2	10	Very Low		Floating mats of algae on edges, some sea grass. Lots of floating insects on surface.
WRAE		GAI002		GAI002	GAI002_WRAE	29/12/1998	9.16	30	64	100	Z-Nil		Pool stopped flowing
WRAE		GAI002		GAI002	GAI002_WRAE	29/01/1999	9.39	23.3	69.6	60	Z-Nil		Algae on edges, water murky lots of dead snails. I/2 inch rain last night
WRAE		GAI002		GAI002	GAI002_WRAE	3/03/1999	8.89	26.6	77.2	40	Z-Nil		Water green, brown and thick. Banks covered with dead snails. Very smelly
WRAE		GAI002		GAI002	GAI002_WRAE	29/03/1999	8.38	24	83.4	50	Z-Nil		Water thick, yellowish brown. Lots of dead snails
WRAE		GAI002		GAI002	GAI002_WRAE	29/04/1999	9.08	22.9	83.1	400	Z-Nil		Water yellow, brown and 'thick' - yellow bubly scum on edges. Very smelly
WRAE		GAI002		GAI002	GAI002_WRAE	31/05/1999	8.27	14.9	83.4	20	Low		Water now flowing. Algae cleared. No smell
WRAE		GAI002		GAI002	GAI002_WRAE	20/06/1999	8.23	12.4	77.2	10	Low		Cloudy
WRAE		GAI002		GAI002	GAI002_WRAE	23/07/1999	8.21	12.8	63.8	10	Low		Clean looking
WRAE		GAI002		GAI002	GAI002_WRAE	15/08/1999	8.39	12.5	68.1	10	Low		Long strands green algae in flow channel
WRAE		GAI002		GAI002	GAI002_WRAE	3/09/1999	8.35	13.5	61.1	10	Moderate		Green algae growing on bottom of pool
WRAE		GAI002		GAI002	GAI002_WRAE	23/09/1999	8.46	17.6	63.6	10	Low		Algae on bottom & surface. Sea grass growing
WRAE		GAI002		GAI002	GAI002_WRAE	17/10/1999	8.47	17.5	60.8	10	Low		Water very clear. Brown green algae, also sea grass
WRAE		GAI002		GAI002	GAI002_WRAE	31/10/1999	8.66	17.4	65.9	10	Trickle		Only just flowing, lot of green algae on bottom & floating
FBG	GAIFBG1					30/11/2021	8.69	26.7		5	L	LB/G	
FBG	GAIFBG1					31/03/2022	7.96	18.8	65.8	<5	S	GB	
FBG	GAIFBG1					3/08/2022	7.92	11.3	55.1	6	L	BO	
FBG	GAIFBG1					25/10/2022	8.76	19.6	24.6	17	VL	VDB	
URRENT SITE: GAIFBG2 (SCHWY)													
NA42/43/44		Gairdner River	South Coast Highway	NA	50	15/08/2001		16.6	41.1				
		Gairdner River	South Coast Highway	NA	50	13/09/2001		22.8	52.7				
		Gairdner River	South Coast Highway	NA	50	5/12/2001			4.28				
	GAIFBG2					25/11/2021	8.71	25.1	NA	17	L	DB	
	GAIFBG2					31/03/2022	8.5	16.5	85.6	<5	L	LB	
	GAIFBG2					7/07/2022	8.19		25.7	9	LM	DB	
	GAIFBG2					25/10/2022	8.29	22.6	49.02	12	M	OB	
CURRENT SITE: GAIFBG3 (Monkey Rock Rd)													
WRAE		GAIMC003		GAIMC003	GAIMC003_WRAE	8/05/1998	8.2	18.6	40.2	10	Low		Clear flowing over granite
WRAE		GAIMC003		GAIMC003	GAIMC003_WRAE	28/05/1998	8.5	18.7	41.9	10	Low		Very clear, flow over sand
WRAE		GAIMC003		GAIMC003	GAIMC003_WRAE	15/10/1998	8.31	27.7	28.6	10	Low		Lots of invertebrates & larvae, water very clear through sand
WRAE		GAIMC003		GAIMC003	GAIMC003_WRAE	10/09/1999	8.22	21.7	57.6	10	Low		Invertebrates very clear, brownish
FBG	GAIFBG3					31/03/2022	8.27		38.2	<5	VL	C/VLB	
FBG	GAIFBG3					7/07/2022	8.68	12.8	32	10	LM	MB	
FBG	GAIFBG3					7/07/2022	8.81	26.8	36.4	17	M	B	
FBG	GAIFBG3					25/11/2022	8.76	26.7	NA	<5	VL	G/B	
CURRENT SITE: GAIFBG4													
WRAE		GAI003		GAI003	GAI003_WRAE	6/11/1997	8.0	20.6	36	na	Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	20/11/1997	8.0	24	37	10	Trickle		
WRAE		GAI003		GAI003	GAI003_WRAE	11/12/1997	8.2	26.2	26		Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	2/02/1998	7.9	26.7	96	40	Z-Nil		'Soupy' looking ?
WRAE		GAI003		GAI003	GAI003_WRAE	26/02/1998	7.9	25.1	124.1	30	Z-Nil		No obvious algae or smell
WRAE		GAI003		GAI003	GAI003_WRAE	19/03/1998	7.7	33.5	123.1	40	Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	11/04/1998	7.9	19.3	133.5	20	Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	1/05/1998	8.2	16.4	29.6	10	Trickle		Lots of wrigglies
WRAE		GAI003		GAI003	GAI003_WRAE	21/05/1998	8.1	15.5	30.9	10	Trickle		Clear/brown - invertebrates
WRAE		GAI003		GAI003	GAI003_WRAE	11/06/1998	7.8	10.3	3.7	200	Moderate		Pool quite full
WRAE		GAI003		GAI003	GAI003_WRAE	14/07/1998	8.1	12.1	31.8	10	Trickle		Wrigglers, pool deep now
WRAE		GAI003		GAI003	GAI003_WRAE	6/08/1998	7.97	11.7	41.5	10	Low		Water very brown but clear, small invertebrates
WRAE		GAI003		GAI003	GAI003_WRAE	27/08/1998	7.87	15	23.6	10	Trickle		
WRAE		GAI003		GAI003	GAI003_WRAE	24/09/1998	7.99	18.5	23.2	20	Z-Nil		Water very brown, invertebrates
WRAE		GAI003		GAI003	GAI003_WRAE	21/10/1998	8.1	20.9	26.4	10	Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	10/06/1999	8.37	13.8	96.3	20	Z-Nil		Water very low. Murky. Invertebrates
WRAE		GAI003		GAI003	GAI003_WRAE	7/08/1999	7.89	8.9	38.2	10	Trickle		Very clear invertebrates
WRAE		GAI003		GAI003	GAI003_WRAE	20/08/1999	8.07	14.6	48.3	10	Low		Pool rising
WRAE		GAI003		GAI003	GAI003_WRAE	25/08/1999	7.59	14.2	45.8	10	Trickle		
WRAE		GAI003		GAI003	GAI003_WRAE	16/09/1999	7.55	12.8	50.6	10	Z-Nil		
WRAE		GAI003		GAI003	GAI003_WRAE	9/10/1999	7.77	15.7	51.8	10	Trickle		
FBG	GAIFBG4					25/11/2021	8.24	27.6	NA	<5	VL	O/B	
FBG	GAIFBG4					31/03/2022	8.36	22.2	52.2	<5	S	LB	
FBG	GAIFBG4					3/08/2022	8.38	16.2	23	6	M	LOB	
FBG	GAIFBG4					27/10/2022	8.95	19.1	71.6	6	M	LB	
CURRENT SITE: GAIFB5													
AusRivas		ALB10	GAI01		ALB10_AR	14/09/1994	9.16	14.1	26.7	2.0			
AusRivas		ALB10	GAI01		ALB10_AR	5/01/1995	8.91	22.3	38.2	2.5			
AusRivas		ALB10	GAI01		ALB10_AR	9/08/1995	7.78	14.5	34.4	1.1			
AusRivas		ALB10	GAI01		ALB10_AR	9/12/1995	9.04	20.3	32.9	1.3			
AusRivas		ALB10	GAI01		ALB10_AR	17/10/1997	8.18	18.1	25.8	5.5			
EV		ALB10	GAI01		ALB10_EV	17/10/2006	7.25	15.49	28.1	1.4	low 5-10		Devils Creek crossing D.S pool
FBG	GAIFBG5					03.08.22	8	14.4	22	6	L	VLB	
FBG	GAIFBG5					27.10.22	8.83	20.4	38.6	<5	L	LB	
FBG	GAIFBG5					30.11.21	7.67	27	NA	<5	VL	LB	
FBG	GAIFBG5					31.03.22	8.18	22.8	37.8	<5	VL	C/G	

APPENDIX 5: Historical data provided by the FBG group. Fitzgerald River

Project	FBG Project Code	Original Site Code	EV Site Code	DOW Site Code	CDI Project Code	Sample Date	Ph	Temperature	EC(mS/cm)	turbidity(NTU)	FLOW(L/s)	Colour
CURRENT SITE: FITFBG1												
CDI		ALB04	FIT04		ALB04_CDI	4/05/2009	8.36	18.53		7		
CDI		ALB04	FIT04		ALB04_CDI	9/03/2009	8.4	26.03	79.9	9	nil	
CDI		ALB04	FIT04		ALB04_CDI	12/01/2009	7.58	30.05	50.5	0	1-2 L/s low	
CDI		ALB04	FIT04		ALB04_CDI	10/11/2008	8.05	17.54	76.8	4.3	1-10 L/s low	
CDI		ALB04	FIT04		ALB04_CDI	9/09/2008	7.9	19.00	88.4	7	2-5L/s low	
CDI		ALB04	FIT04		ALB04_CDI	2/07/2008	7.86	11.60		3	1-2L/s low	
CDI		ALB04	FIT04		ALB04_CDI	29/04/2008	8.17	17.15		-24.9	trickle	
CDI		ALB04	FIT04		ALB04_CDI	16/04/2007	8.18	19.40	130.8	15		
CDI		ALB04	FIT04		ALB04_CDI	3/11/2006	7.87	20.36	113.6	0		
CDI		ALB04	FIT04		ALB04_CDI	16/03/2006	8.04	19.73	56.8	9	3 - 8	
CDI		ALB04	FIT04		ALB04_CDI	16/03/2006	8.04	19.73	56.8	9	3 - 8	
CDI		ALB04	FIT04		ALB04_CDI	27/05/2005	8.7	12.60	36.8	44.2		
CDI		ALB04	FIT04		ALB04_CDI	27/05/2005	8.7	12.60	36.8	44.2		
FBG	FITFBG1					30.11.2021	8.09	24.4	NA	40	VL	LB
FBG	FITFBG1					31.03.2022	8.2	18.4	103.3	14	S	MB
FBG	FITFBG1					29.07.2022	8.16	19.7	36	9	ML	LOB
FBG	FITFBG1					25.10.2022	8.55	21.9	59.6	17	L	B
CURRENT SITE: FITFB2												
DOW		NA 35		NA 35	ALB05_DOW	13/09/2001		22.3	59		Low	
AusRivas		ALB05			ALB05_AR	7/12/1995	6.18	20.5	162.3	11.0		
AusRivas		ALB05			ALB05_AR	8/08/1995	6.53	12.6	62.3	3.0		
AusRivas		ALB05			ALB05_AR	13/09/1994	8.08	15.7	114.1	0.8		
FBG	FITFBG2					30.11.2021	8.28	24.2	NA	35	L	LB
FBG	FITFBG2					31.03.2022	8.31	20.2	52.3	36	S	MB
FBG	FITFBG2					29.07.2022	8.33	18.6	22.7	11	M	MB
FBG	FITFBG2					25.10.2022	8.5	21.7	55.5	19	L	B
CURRENT SITE: FITFBG3												
AusRivas		ALB12			ALB12_AR	16/10/1997	7.17	15.7	33.4	8.5		
AusRivas		ALB12			ALB12_AR	7/12/1995	8.27	19.4	56.5	2.6		
AusRivas		ALB12			ALB12_AR	7/08/1995	7.70	13.1	45.6	1.5		
AusRivas		ALB12			ALB12_AR	7/01/1995	8.65	24.2	33.5	0.5		
FBG	FITFBG3					30.11.2021	8.7	24	NA	5	L	LB
FBG	FITFBG3					31.03.2022	8.18	21.6	39.6	8.5	S	LB
FBG	FITFBG3					07.07.2022	8.14	16	33	9	M	MB
FBG	FITFBG3					25.10.2022	8.9	2	45.4	<6	LB	LB
CURRENT SITE: FITFBG4												
DOW		NA 31		NA 31	NA 31_DOW	27/09/2004		12.6	33.8		c 10 L/s	
FBG	FITFBG4					30.11.2021	8.7	23.7	NA	5	VL	LB
FBG	FITFBG4					31.03.2022	8	22.1	9.94	8.5	S	LOB
FBG	FITFBG4					07.07.2022	8.08	17.8	33.7	8	L	OB
FBG	FITFBG4					25.10.2022	9.2	27.9	41.3	7	ML	OB

APPENDIX 6: Historical data provided by the FBG group. Bremer River

Project	FBG Project Code	Original_code	EV_sitecode	DOW_sitecode	Site_Project_code	Site_no	Sample_date	Ph	Temperature	EC(mS/cm)	Colour(TCU)	FLOW(L/s)
CURRENT SITE: BREFBG1												
EV		ALB11	BRE05		ALB11_EV	EV_BRE05	4/09/2007	7.57	13.75	45.7		trickle< 1
EV		ALB11	BRE05		ALB11_EV	EV_BRE05	23/05/2006	7.46	13.9	31		nil
AusRivas		ALB11	BRE05		ALB11_AR	ALB11	14/09/1994	8.56	18.8	26.4		
AusRivas		ALB11	BRE05		ALB11_AR	ALB11	5/01/1995	7.49	25.2	54.9		
AusRivas		ALB11	BRE05		ALB11_AR	ALB11	10/08/1995	5.79	12.8	10.5	63	
AusRivas		ALB11	BRE05		ALB11_AR	ALB11	8/12/1995	7.79	24.9	33.9		
AusRivas		ALB11	BRE05		ALB11_AR	ALB11	17/10/1997	7.53	16.2	36.7	83	
FBG	BREFBG1						25/11/2021	7.88	26	NA	DB	VL
FBG	BREFBG1						31/03/2022	8.74	25.1	48.9	MB/O	S
FBG	BREFBG1						7/07/2022	7.72	18.1	28.1	OB	VL
FBG	BREFBG1						27/10/2022	8.34	19.5	33	DB	VL
CURRENT SITE: BREFBG2												
EV		BRE02	BRE02		BRE02_EV		24/05/2006	7.54	13	11.1		low
EV		BRE02	BRE02		BRE02_EV		4/09/2007	dry	dry	dry		dry
FBG	BREFBG2						25/11/2021	NA	NA	NA	NA	NA
FBG	BREFBG2						31/03/2022	8.46	23.2	27.8	DB	S
FBG	BREFBG2						7/07/2022	7.99	19.5	15.9	MB	VL
FBG	BREFBG2						27/10/2022	8.38	22.9	14.3	DB	L
CURRENT SITE: BREFBG3												
DOW		NA 5		NA 5	NA 5_DOW		20/08/2005	7.3	13.8	8.4		c 10 L/s
FBG	BREFBG3						25/11/2021	8.29		NA	MB	VL
FBG	BREFBG3						31/03/2022	8.29		43.2	MB/G	S
FBG	BREFBG3						7/07/2022	8.29		16.62	MB	LM
FBG	BREFBG3						27/10/2022	8.49		28.9	MOB	L
CURRENT SITE: BREFBG4												
DOW		BRE007.1R		BRE007.1R	BRE007.1R_DOW		5/08/2006		14	9.8		50 - 100 L/s
FBG	BREFBG4						25/11/2021	7.53	24.9	NA	DB	VL
FBG	BREFBG4						31/03/2022	7.89	22.9	26.1	MB	S
FBG	BREFBG4						7/07/2022	8.04	15.5	21	MOB	M
FBG	BREFBG4						27/10/2022	8.38	20.4	20	VDB	H
CURRENT SITE: BREFBG5												
DOW		BRE001R		BRE001R	BRE001R_DOW		6/08/2006		11.1	10.1		50 - 100 L/s
FBG	BREFBG5						25/11/2021	8.08	26.8	NA	VDB	L
FBG	BREFBG5						31/03/2022	7.74	22.7	18.28	MB	S
FBG	BREFBG5						7/07/2022	7.6	18.3	12.65	LOB	M
FBG	BREFBG5						27/10/2022	8.6	19.5	neter malfunct	DOB	VH
FBG	BREFBG5											

APPENDIX 7: Historical data provided by the FBG group. Site Location

Site Code	Original Code	River	Easting	Northing	Description of location
GAIFBG1	GAI002	Gairdner	677180	6251333	Rabbit Proof Fence Rd in Nature Reserve
GAIFBG2	NA42	Gairdner	682482	6244961	Near corner of Jerramungup and Woolshed Rd
GAIFBG3	GAIMC003	Gairdner	689037	6237569	SCHWY bridge
GAIFBG4	GAI003	Gairdner	690376	6226278	Along track that comes off Monkey Rock Rd
GAIFBG5	GAI01	Gairdner	708778.59	6211281.63	Near corner of Murray and Devil's Creek Rd
FITFBG1	ALB04	Fiztgerald	707171	6263243	North of Middamidjup Rd
FITFBG2	NA 35/ALB05	Fiztgerald	709236	6254407	SCHWY bridge
FITFBG3	ALB12	Fiztgerald	717046.46	6245711.35	Granite rocks. Just off edge of bush.
FITFBG4	NA31	Fiztgerald	721390	6238731	
FITFBG5	NA32	Fiztgerald	726876	6233054	Track crossing below Roes Pool
BREFBG1	BRE05	Bremer	683879.08	6234238.77	Carlawilip Rd
BREFBG2	BRE02	Bremer	696838	6212057	Corner Devil's Creek and Maringarup Sth
BREFBG3	NA5	Bremer	705847	6203004	North of Doubtful Island Rd
BREFBG4	BRE007	Bremer	707971	6200187	South of Doubtful Island Rd
BREFBG5	BRE001	Bremer	712154	6198055	Date

APPENDIX 8: Additional Historical Data collected by DWER

HISTORICAL DATA

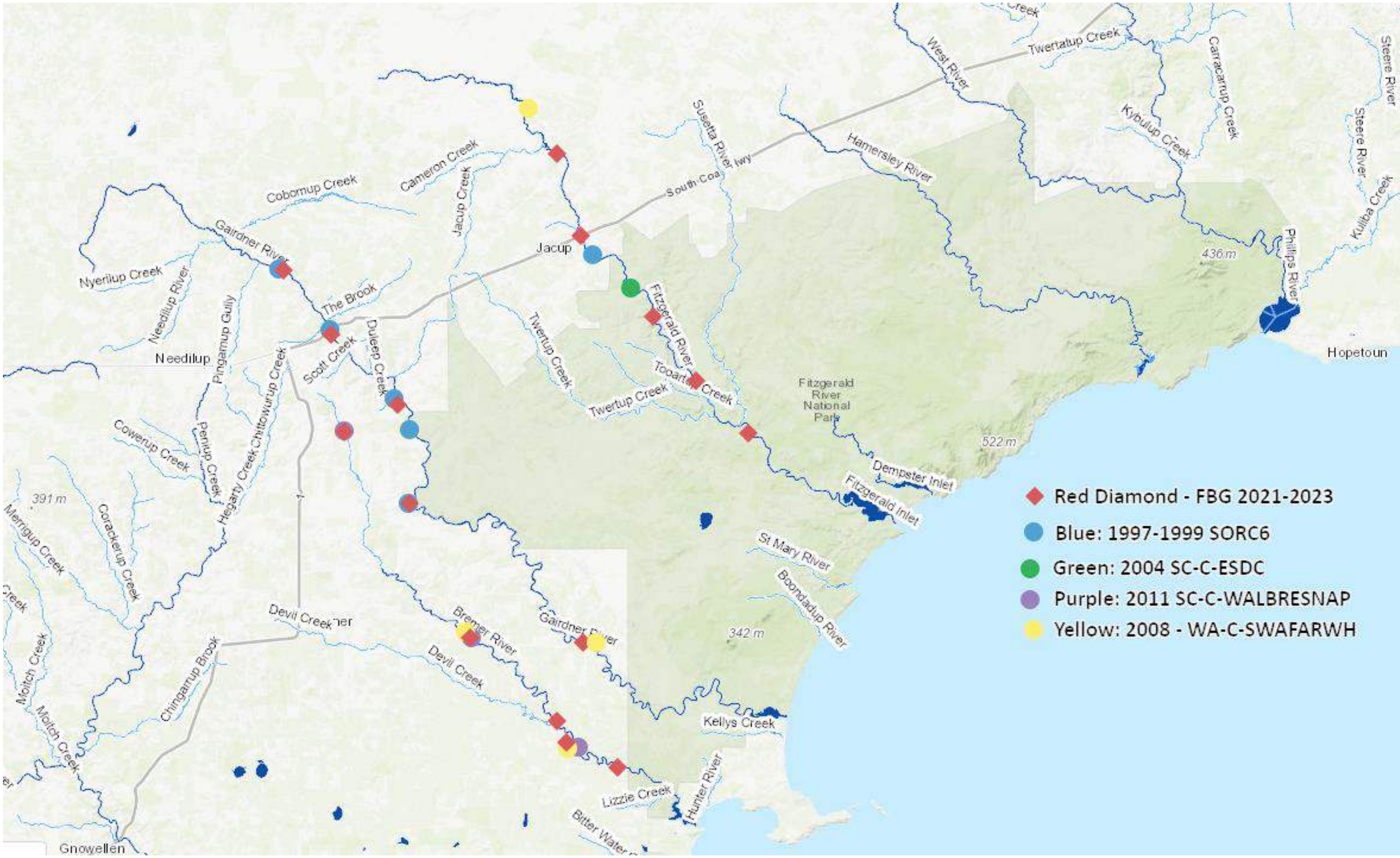
All three of the sampled rivers; Wellstead, Gairdner and Fitzgerald have undergone some type of sampling in the past. Some of this data dates to the late 1990's and is accessible on the Departments 'Water Information Reporting' System. Some of these historical sample site locations are within close proximity to the 2021-2023 Fitzgerald Biosphere Group sampling sites. However, the water information reporting system whilst accessible, does not provide any sampling plan or methodology which makes it challenging to use this data as a direct comparison. However, it may be useful to provide further insight and get a broad understanding of the rivers water quality from the past. It should, however, be noted that the historical data has come from differing projects and time periods therefore the consistency between methodology in each project is also unknown. The projects and sample information of historical data has been listed in the table below and is organised to match that of the Fitzgerald Biosphere Group sample sites. A colour coded map has also been provided to locate each of these sites.

Water Information Reporting URL: https://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx

When using the above link to look at old data sources, the table below provides the WIN sites to use in the search box.

Appendix 8 Table 1: Identifying historical sample sites from 1997 onwards that are within close proximity and may be relevant to the Fitzgerald Biosphere group sampling that occurred between 2021 and 2023.

River	FBG code	Project	Year	WIN Site ID	Tributary river systems	WIN site Up or down stream of tributary river system	WIN site location	Distance between FBG and WIN site	Other comments
Bremer River	BREFBG1	WALBRESNAP	2011	6021557			Downstream of FBG site	190m	
	BREFBG2	FARHWH	2008	6021631			Upstream of FBG site	1135m	
	BREFBG2	WALBRESNAP	2011	6021546			Downstream of FBG site	50m	
	BREFBG4	FARHWH	2008	6021597			Upstream of FBG site	1845m	
	BREFBG4	WALBRESNAP	2011	6021536			Upstream of FBG site	2585m	
Fitzgerald river	FITFBG1	FARHWH	2008	6021620	Jacob's creek	Upstream Jacobs creek	Upstream of FBG site	9300m	Closest historical site
	FITFBG2	SORC6	1997-1999	6021224	Little Jacob Creek	Downstream Little Jacob creek	Downstream of FBG site	2500m	
	FITFBG3	ESDC	2004	602002	Tooartup Creek	Upstream tooartup creek	Upstream of FBG site	4750m	Closest historical site
Gairdner River	GAIFBG1	SORC6	1997-1999	6021225	Pingaul Gully, Spring Creek, The brook, Wilgerup Creek	Downstream Pingamul Gully, upstream of other three	Downstream of FBG site	140m	
	GAIFBG2	SORC6	1997-1999	6021235	Wilgerup Creek	Downstream Wilgerup Creek	Downstream of FBG site	450m	too far
	GAIFBG3	FARHWH	2008	6021604	Southwest Bay Gully	downstream Southwest Bay Gully	Downstream of FBG site	4770m	Closest FARWH site
	GAIFBG3	SORC6	1998-1999	6021234				4770m	Close to FARWH site which can be used as comparison
	GAIFBG3	SORC6	1998-1999	6021396	Southwest Bay Gully	downstream Southwest Bay Gully	Downstream of FBG site	720m	
	GAIFBG4	SORC6	1997-1999	6021227			together	together	together
	GAIFBG5	FARHWH	2008	6021603			Downstream of FBG site	1130m	



Appendix 8 Figure 1: Map showing historical sites colour coded in circles and the FBG sites marked in diamonds. Site one for the FBG sites are upstream. This map correlates to information provided in Table.

Appendix 9:

	Temp				
date	BREFBG1	BREFBG2	BREFBG3	BREFBG4	BREFBG5
14/09/1994	18.8				
5/01/1995	25.2				
10/08/1995	12.8				
8/12/1995	24.9				
17/10/1997	16.2				
23/05/2006	13.9				
24/05/2006		13			
5/08/2006				14	
6/08/2006					11.1
4/09/2007	13.75				
25.11.21	26		23.8		
30.11.21				24.9	26.8
31.03.22	25.1	23.2	23.9	22.9	22.7
07.07.22	18.1	19.5			18.3
03.08.22			11.2	15.5	
27.10.22	19.5	22.9	21.6	20.4	19.5
02.02.23	26.2	26.3	26		24.8
15.02.2023				26.8	
19.05.2023	19.7	19.1	21.8		
29.05.2023				15.1	18.7

	EC (mS/cm)				
date	BREFBG1	BREFBG2	BREFBG3	BREFBG4	BREFBG5
14/09/1994	26.4				
5/01/1995	54.9				
10/08/1995	10.5				
8/12/1995	33.9				
17/10/1997	36.7				
23/05/2006	31				
24/05/2006		11.1			
5/08/2006				0	
6/08/2006					0.01
4/09/2007	45.7				
25.11.21					
30.11.21					
31.03.22	48.9	27.8	43.2	26.1	18.28
07.07.22	28.1	15.9			12.65
03.08.22			16.62	21	
27.10.22	33	14.3	28.9	20	
02.02.23	45.2	18.77	41.9		10.14
15.02.2023				15.14	
19.05.2023	57.2	24.1	58.8		
29.05.2023				24.5	18.93

	pH				
date	BREFBG1	BREFBG2	BREFBG3	BREFBG4	BREFBG5
14/09/1994	8.56				
5/01/1995	7.49				
10/08/1995	5.79				
8/12/1995	7.79				
17/10/1997	7.53				
23/05/2006	7.46				
24/05/2006		7.54			
5/08/2006					
6/08/2006					
4/09/2007	7.57				
25.11.21	7.88		8.29		
30.11.21				7.53	8.08
31.03.22	8.74	8.46	8.29	7.89	7.74
07.07.22	7.72	7.99			7.6
03.08.22			8.29	8.04	
27.10.22	8.34	8.38	8.49	8.38	8.6
02.02.23	8.9	8.3	8.5		7.4
15.02.2023				8.43	
29.04.2023				8.28	8.19

Appendix 9: Raw data used to form the Bremer River Guidelines

Appendix 10:

pH				
date	FITFBG1	FITFBG2	FITFBG3	FITFBG4
13/09/1994		8.08		
7/01/1995			8.65	
7/08/1995			7.70	
8/08/1995		6.53		
17/12/1995		6.18	8.27	
15/10/1997			7.17	
13/09/2001				
27/09/2004				
27/05/2005	8.7			
16/03/2006	8.04			
3/11/2006	7.87			
16/04/2007	8.18			
29/04/2008	8.17			
2/07/2008	7.86			
9/09/2008	7.9			
10/11/2008	8.05			
21/01/2009	7.58			
9/03/2009	8.4			
4/05/2009	8.36			
30.11.2021	8.09	8.28	8.7	8.7
31.03.2022	8.2	8.31	8.18	8
07.07.2022			8.14	8.08
29.07.2022	8.16	8.33		
25.10.2022	8.55	8.5	8.9	9.2
02.02.2023	7.8	7.9		
03.02.2023				7.75
03.03.2023			8.04	
29.05.2023	8.03	8.15	8.26	8.32

Temp				
date	FITFBG1	FITFBG2	FITFBG3	FITFBG4
13/09/1994		15.7		
7/01/1995			24.2	
7/08/1995			13.1	
8/08/1995		12.6		
17/12/1995		20.5	19.4	
15/10/1997			15.7	
13/09/2001		22.3		
27/09/2004				12.6
27/05/2005	12.60			
16/03/2006	19.73			
3/11/2006	20.36			
16/04/2007	19.40			
29/04/2008	17.15			
2/07/2008	11.60			
9/09/2008	19.00			
10/11/2008	17.54			
21/01/2009	30.05			
9/03/2009	26.03			
4/05/2009	18.53			
30.11.2021	24.4	24.2	24	23.7
31.03.2022	18.4	20.2	21.6	22.1
07.07.2022			16	17.8
29.07.2022	19.7	18.6		
25.10.2022	21.9	21.7	22.6	27.9
02.02.2023	22.2	24.8		
03.02.2023				27.1
03.03.2023			24	
29.05.2023	12.9	12.9	14.8	17.1

EC				
date	FITFBG1	FITFBG2	FITFBG3	FITFBG4
13/09/1994		114.1		
7/01/1995			33.5	
7/08/1995			45.6	
8/08/1995		62.3		
17/12/1995		162.3	56.5	
15/10/1997			33.4	
13/09/2001		59		
27/09/2004				33.8
27/05/2005	36.8			
16/03/2006	56.8			
3/11/2006	113.6			
16/04/2007	130.8			
29/04/2008				
2/07/2008				
9/09/2008	88.4			
10/11/2008	76.8			
21/01/2009	50.5			
9/03/2009	79.9			
4/05/2009				
30.11.2021				
31.03.2022	103.3	52.3	39.6	
07.07.2022			33	33.7
29.07.2022	36	22.7		
25.10.2022	59.6	55.5	45.4	41.3
02.02.2023	104.6	122		
03.02.2023				131.6
03.03.2023		96.6		
29.05.2023	120.8	125.3	123.4	107.6

NTU				
date	FITFBG1	FITFBG2	FITFBG3	FITFBG4
13/09/1994		0.8		
7/01/1995			0.5	
7/08/1995			1.5	
8/08/1995		3.0		
17/12/1995		11.0	2.6	
15/10/1997			8.5	
13/09/2001				
27/09/2004				
27/05/2005	44.2			
16/03/2006	9			
3/11/2006	0			
16/04/2007	15			
29/04/2008				
2/07/2008	3			
9/09/2008	7			
10/11/2008	4.3			
21/01/2009	0			
9/03/2009	9			
4/05/2009	7			
30.11.2021	40	35	5	5
31.03.2022	14	36	8.5	8.5
07.07.2022			9	8
29.07.2022	9	11		
25.10.2022	17	19	3	7
02.02.2023	30	65		
03.02.2023				
03.03.2023		3	15	
29/05/2023	3	27	3	21

Appendix 10: Raw data used to form the Fitzgerald River Guidelines

Appendix 11:

	EC (mS/cm)				
date	GAIFBG1	GAIFBG2	GAIFBG3	GAIFBG4	GAIFBG5
14/09/1994					26.7
5/01/1995					38.2
9/08/1995					34.4
9/12/1995					32.9
17/10/1997					25.8
6/11/1997	41			36	
13/11/1997	35				
20/11/1997				37	
5/12/1997	61				
11/12/1997	62			26	
24/01/1998	79				
2/02/1998				96	
16/02/1998	88				
26/02/1998				124.1	
11/03/1998	94.6				
19/03/1998				123.1	
1/04/1998	97.6				
11/04/1998				133.5	
24/04/1998	35.1				
1/05/1998				29.6	
8/05/1998			40.2		
14/05/1998	56				
21/05/1998				30.9	
28/05/1998			41.9		
5/06/1998	70.1				
11/06/1998				3.7	
1/07/1998	35.1				
14/07/1998				31.8	
30/07/1998	46.4				
6/08/1998				41.5	
20/08/1998	31.7				
27/08/1998				23.6	
17/09/1998	34.2				
24/09/1998				23.2	
7/10/1998	44.3				
15/10/1998			28.6		
21/10/1998				26.4	
22/10/1998	48.8				
29/10/1998	50.1				
1/12/1998	59.2				
29/12/1998	64				
29/01/1999	69.6				
3/03/1999	77.2				
29/03/1999	83.4				
29/04/1999	83.1				
31/05/1999	83.4				
10/06/1999				96.3	
20/06/1999	77.2				
23/07/1999	63.8				
7/08/1999				38.2	
15/08/1999	68.1				
20/08/1999				48.3	
25/08/1999				45.8	
3/09/1999	61.1				
10/09/1999			57.6		
16/09/1999				50.6	
23/09/1999	63.6				
9/10/1999				51.8	
17/10/1999	60.8				
31/10/1999	65.9				
15/08/2001		41.1			
13/09/2001		52.7			
5/12/2001		4.28			
17/10/2006					28.1
25/11/2021					
30/11/2021					
31/03/2022	65.8	85.6	38.2	52.2	37.8
7/07/2022		25.7	32		
3/08/2022	55.1			23	22
25/10/2022	24.6	49.02	36.4		
27/10/2022				71.6	38.6
2/02/2023	60.5		57.9		38.3
3/02/2023		81.7			
19/05/2023		60.6			
29/05/2023	89.9		34.5		34.4

	NTU				
date	GAIFBG1	GAIFBG2	GAIFBG3	GAIFBG4	GAIFBG5
14/09/1994					2.0
5/01/1995					2.5
9/08/1995					1.1
9/12/1995					1.3
17/10/1997					5.5
6/11/1997					
13/11/1997	10				
20/11/1997				10	
5/12/1997	10				
11/12/1997	10				
24/01/1998	15				
2/02/1998				40	
16/02/1998	15				
26/02/1998				30	
11/03/1998	30				
19/03/1998				40	
1/04/1998	15				
11/04/1998				20	
24/04/1998	20				
1/05/1998				10	
8/05/1998			10		
14/05/1998	10				
21/05/1998				10	
28/05/1998			10		
5/06/1998	10				
11/06/1998				[illegible]	
1/07/1998	10				
14/07/1998				10	
30/07/1998	10				
6/08/1998				10	
20/08/1998	20				
27/08/1998				10	
17/09/1998	15				
24/09/1998				20	
7/10/1998	10				
15/10/1998			10		
21/10/1998				10	
22/10/1998	10				
29/10/1998	15				
1/12/1998	10				
29/12/1998	10				
29/01/1999	60				
3/03/1999	40				
29/03/1999	50				
29/04/1999	40				
31/05/1999	20				
10/06/1999				20	
20/06/1999	10				
23/07/1999	10				
7/08/1999				10	
15/08/1999	10				
20/08/1999				10	
25/08/1999				10	
3/09/1999	10				
10/09/1999			10		
16/09/1999				10	
23/09/1999	10				
9/10/1999				10	
17/10/1999	10				
31/10/1999	10				
15/08/2001					
13/09/2001					
5/12/2001					
17/10/2006					1.4
25/11/2021		17	3	3	
30/11/2021	5	3			[illegible]
31/03/2022	3		3	3	[illegible]
7/07/2022		9	10		
3/08/2022	6			6	6
25/10/2022	17	12	17		
27/10/2022				3	[illegible]
2/02/2023	5		3		[illegible]
3/02/2023		11			
19/05/2023		3			
29/05/2023	23		3		3

	Temp				
date	GAIFBG1	GAIFBG2	GAIFBG3	GAIFBG4	GAIFBG5
14/09/1994					14.1
5/01/1995					22.3
9/08/1995					14.5
9/12/1995					20.3
17/10/1997					18.1
6/11/1997	20.3			20.6	
13/11/1997	17.5				
20/11/1997				24	
5/12/1997	23.5				
11/12/1997	25			26.2	
24/01/1998	26.2				
2/02/1998				26.7	
16/02/1998	28.2				
26/02/1998				25.1	
11/03/1998	22.2				
19/03/1998				33.5	
1/04/1998	26.3				
11/04/1998				19.3	
24/04/1998	19.1				
1/05/1998				16.4	
8/05/1998			18.6		
14/05/1998	14.1				
21/05/1998				15.5	
28/05/1998			18.7		
5/06/1998	13.2				
11/06/1998				10.3	
1/07/1998	9.9				
14/07/1998				12.1	
30/07/1998	10.8				
6/08/1998				11.7	
20/08/1998	14.3				
27/08/1998				15	
17/09/1998	17				
24/09/1998				18.5	
7/10/1998	18.2				
15/10/1998			27.7		
21/10/1998				20.9	
22/10/1998	18.5				
29/10/1998	23.8				
1/12/1998	21.6				
29/12/1998	30				
29/01/1999	23.3				
3/03/1999	26.6				
29/03/1999	24				
29/04/1999	22.9				
31/05/1999	14.9				
10/06/1999				13.8	
20/06/1999	12.4				
23/07/1999	12.8				
7/08/1999				8.9	
15/08/1999	12.5				
20/08/1999				14.6	
25/08/1999				14.2	
3/09/1999	13.5				
10/09/1999			21.7		
16/09/1999				12.8	
23/09/1999	17.6				
9/10/1999				15.7	
17/10/1999	17.5				
31/10/1999	17.4				
15/08/2001		16.6			
13/09/2001		22.8			
5/12/2001					
17/10/2006					15.49
25/11/2021		25.1	26.7	27.6	
30/11/2021	26.7				27
31/03/2022	18.8	16.5		22.2	22.8
7/07/2022			12.8		
3/08/2022	11.3			16.2	14.4
25/10/2022	19.6	22.6	26.8		
27/10/2022				19.1	20.4
2/02/2023	20		28.5		24.5
3/02/2023		18.6			
19/05/2023		13			
29/05/2023	17		15.4		18.3

	pH				
date	GAIFBG1	GAIFBG2	GAIFBG3	GAIFBG4	GAIFBG5
14/09/1994	8.8				9.16
5/01/1995					8.91
9/08/1995					7.78
9/12/1995					9.04
17/10/1997					8.18
6/11/1997	8.4			8.0	
13/11/1997	8.3				
20/11/1997				8.0	
5/12/1997	8.7				
11/12/1997	8.7			8.2	
24/01/1998	8.6				
2/02/1998				7.9	
16/02/1998	8.4				
26/02/1998				7.9	
11/03/1998	8.2				
19/03/1998				7.7	
1/04/1998	8.6				
11/04/1998				7.9	
24/04/1998	8.3				
1/05/1998				8.2	
8/05/1998			8.2		
14/05/1998	8.2				
21/05/1998				8.1	
28/05/1998			8.5		
5/06/1998	8.41				
11/06/1998				7.8	
1/07/1998	8.3				
14/07/1998				8.1	
30/07/1998	8.45				
6/08/1998				7.97	
20/08/1998	8.18				
27/08/1998				7.87	
17/09/1998	8.57				
24/09/1998				7.99	
7/10/1998	8.46				
15/10/1998			8.31		
21/10/1998				8.1	
22/10/1998	8.49				
29/10/1998	8.5				
1/12/1998	8.64				
29/12/1998	9.16				
29/01/1999	9.39				
3/03/1999	8.89				
29/03/1999	8.38				
29/04/1999	9.08				
31/05/1999	8.27				
10/06/1999				8.37	
20/06/1999	8.23				
23/07/1999	8.21				
7/08/1999				7.89	
15/08/1999	8.39				
20/08/1999				8.07	
25/08/1999				7.59	
3/09/1999	8.35				
10/09/1999			8.22		
16/09/1999				7.55	
23/09/1999	8.46				
9/10/1999				7.77	
17/10/1999	8.47				
31/10/1999	8.66				
15/08/2001					
13/09/2001					
5/12/2001					
17/10/2006					7.25
25/11/2021		8.71	8.76	8.24	
30/11/2021	8.69				7.67
31/03/2022	7.96	8.5	8.27	8.36	8.18
7/07/2022		8.19	8.68		
3/08/2022	7.92			8.38	8
25/10/2022	8.76	8.29	8.81		
27/10/2022				8.95	8.83
2/02/2023	8.8		9.3	NA	8.09
3/02/2023		8.32			
19/05/2023		8.29			
29/05/2023	8.23		8.48		8.2

Appendix 11: Raw data used to form the Gairdner River Guidelines