B. Georges River

This Appendix mainly includes graphical presentation of all monitoring data for the Georges River catchment. Results are presented following the **Pressure, Stressor and Ecosystem Receptor (P-S-ER**) causal pathway elements.

For the **Pressure**, trend plots are included on wastewater quantity (discharge and inflow) and quality. Trends plots on other supplementary data are also included to improve our understanding on:

- weather condition i.e. catchment specific rainfall condition for each WRRF
- wastewater reuse/ recycling volume of the relevant WRRF.

The sequence of wastewater quality and load plots are same as those described for the Hawkesbury-Nepean River WRRFs (Appendix-A).

Stressor and **Ecosystem Receptor** data for the upstream and downstream tributary monitoring sites of each WRRF zone are presented first, then the upstream and downstream monitoring site of main stream river (if any).

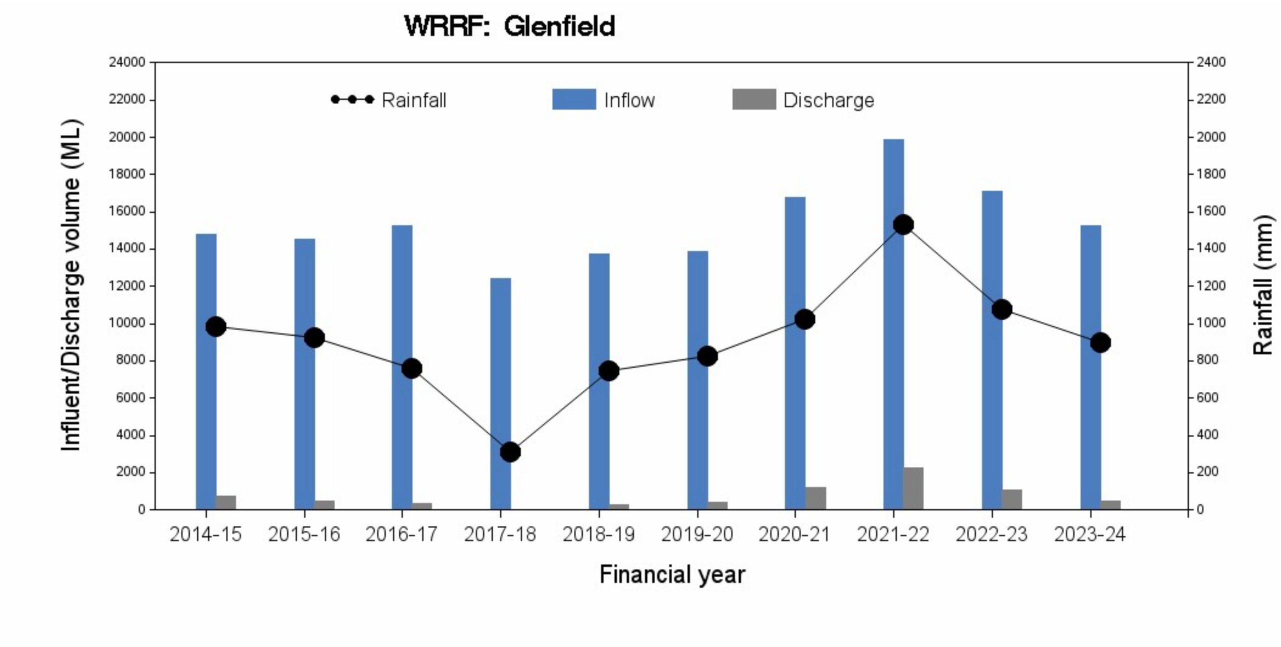
The sequence of water quality box plots and needle plots of paired sites are same as those described for the Hawkesbury-Nepean River WRRFs (Appendix-A).

Tests conducted on wastewater are specified in the Environment Protection Licence (EPL issued by the NSW EPA for each WRRF (B-4). Data for all these measured analytes that have EPL concentration and load limits are included (where applicable).

B.1. Glenfield WRRF

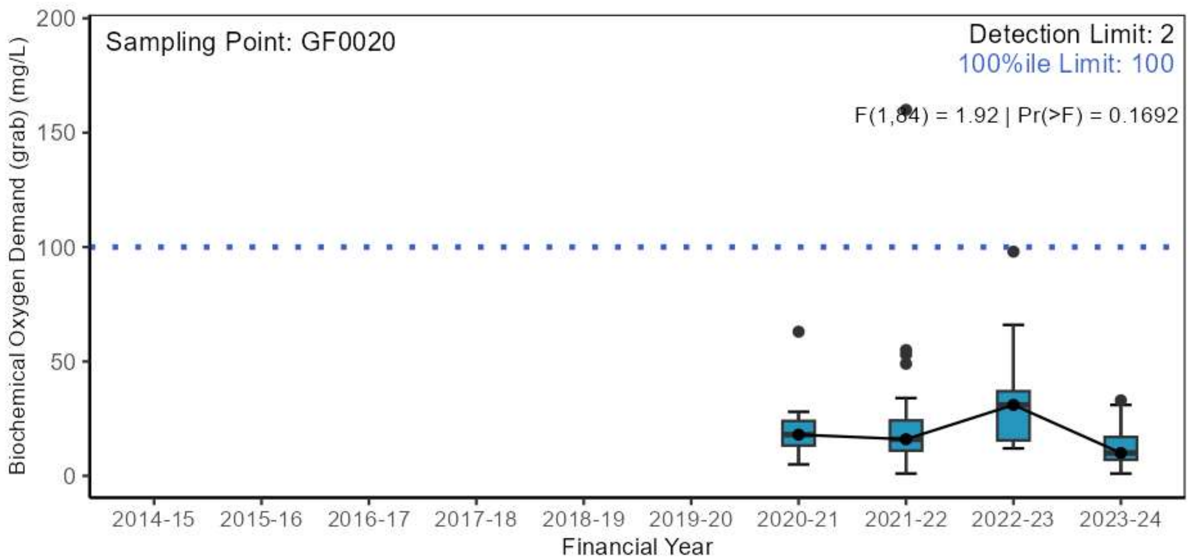
B.1.1. Pressure – Wastewater quantity

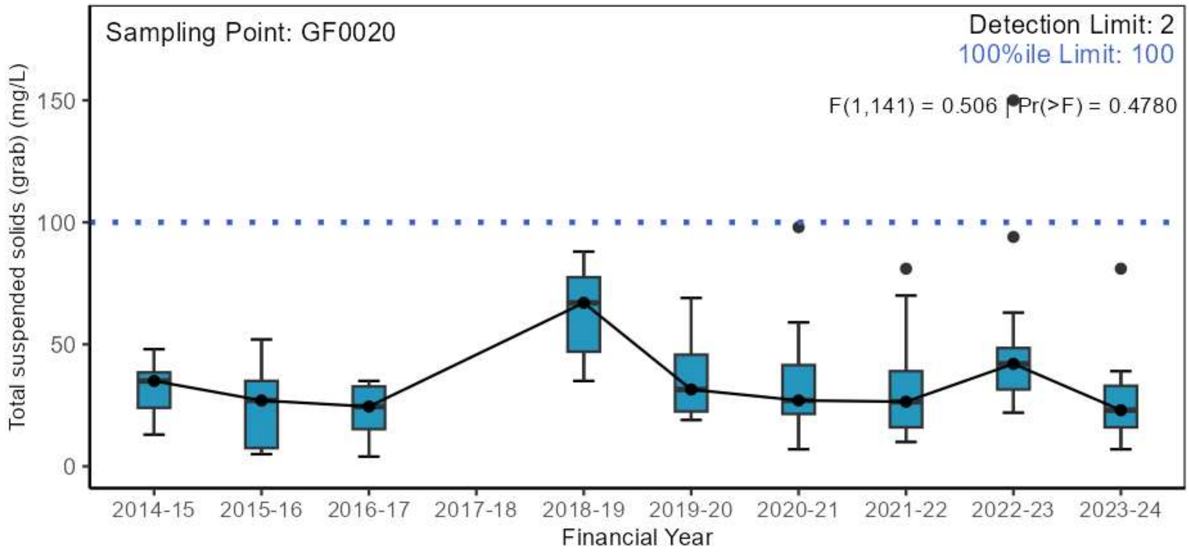
Inflow/discharge volume and rainfall



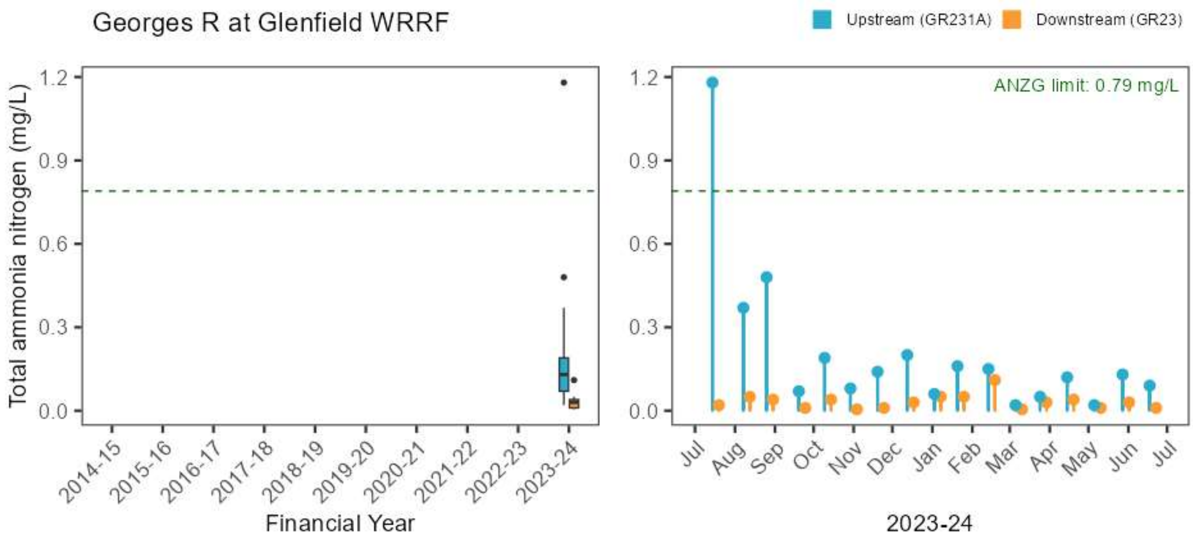
B.1.2. Pressure – Wastewater quality

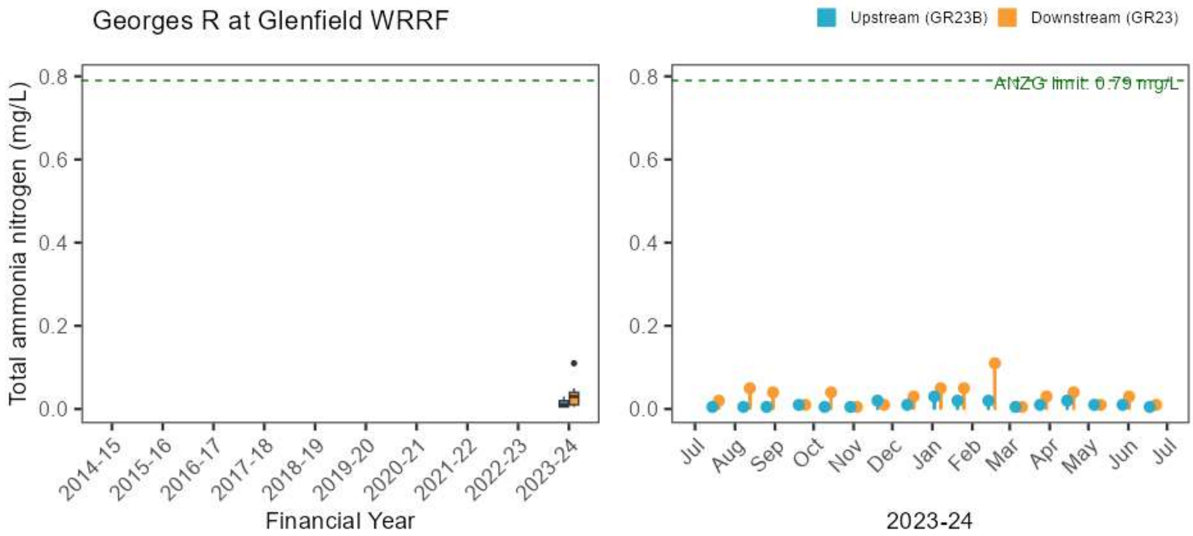
Major conventional analytes



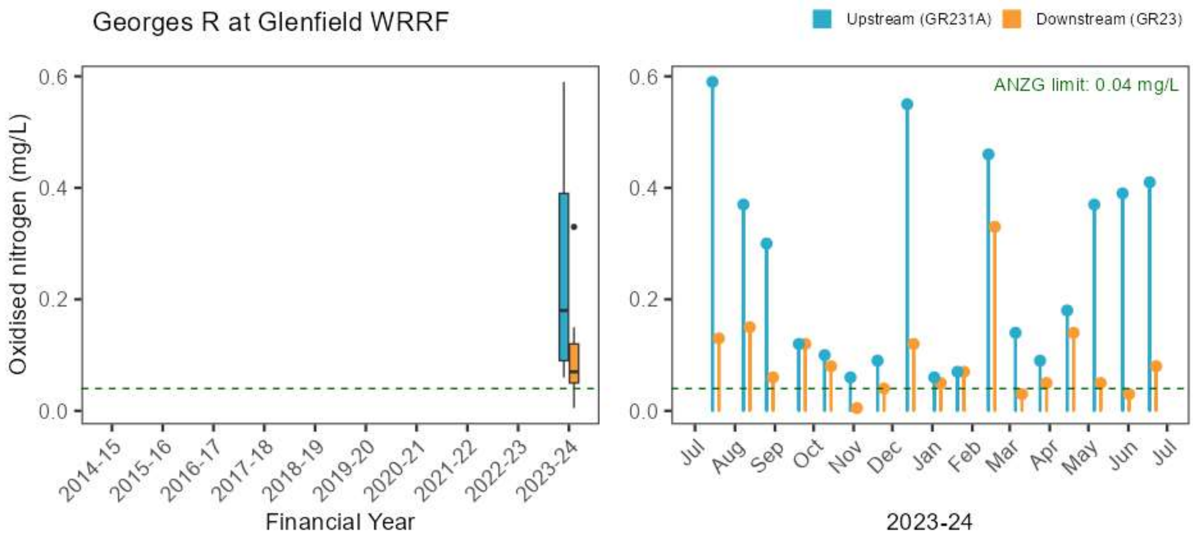


B.1.3. Stressor – Nutrients

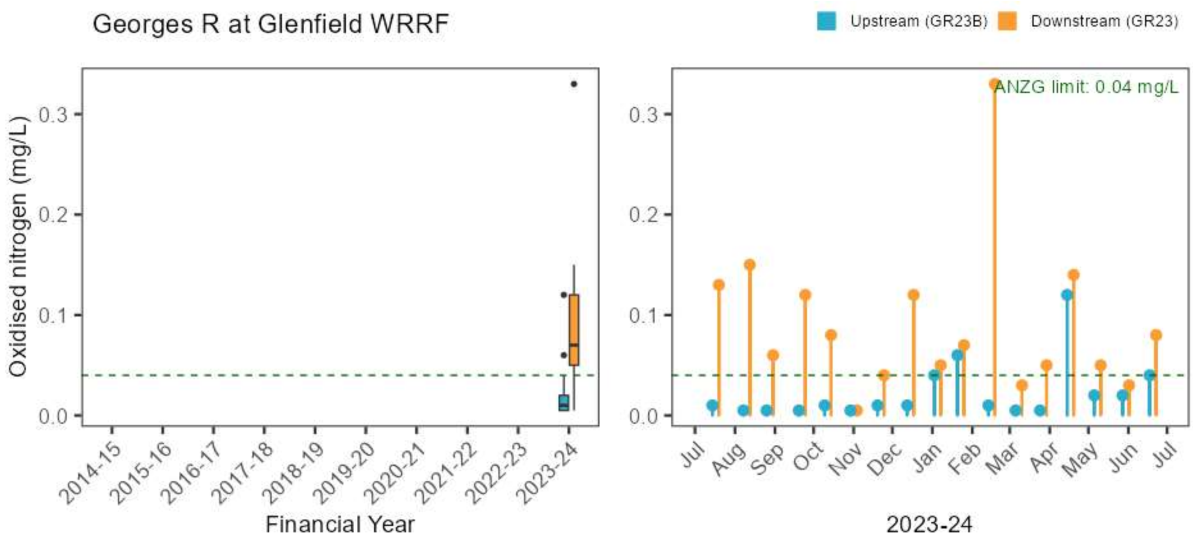




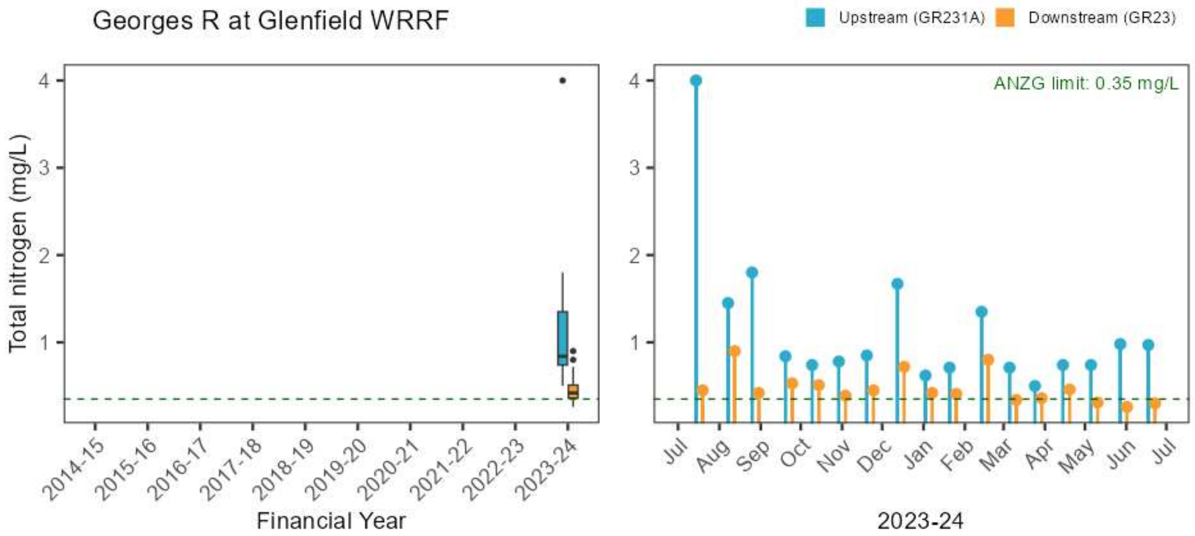
Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Total ammonia nitrogen (mg/L)
ANZG limit: 0.79 mg/L
Financial Year
2023-24

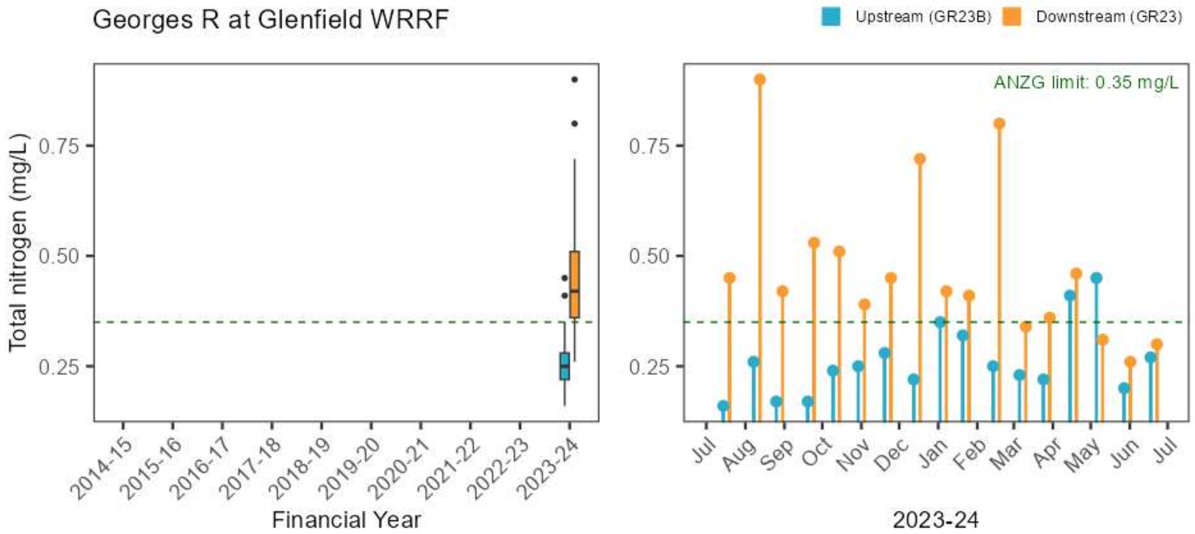


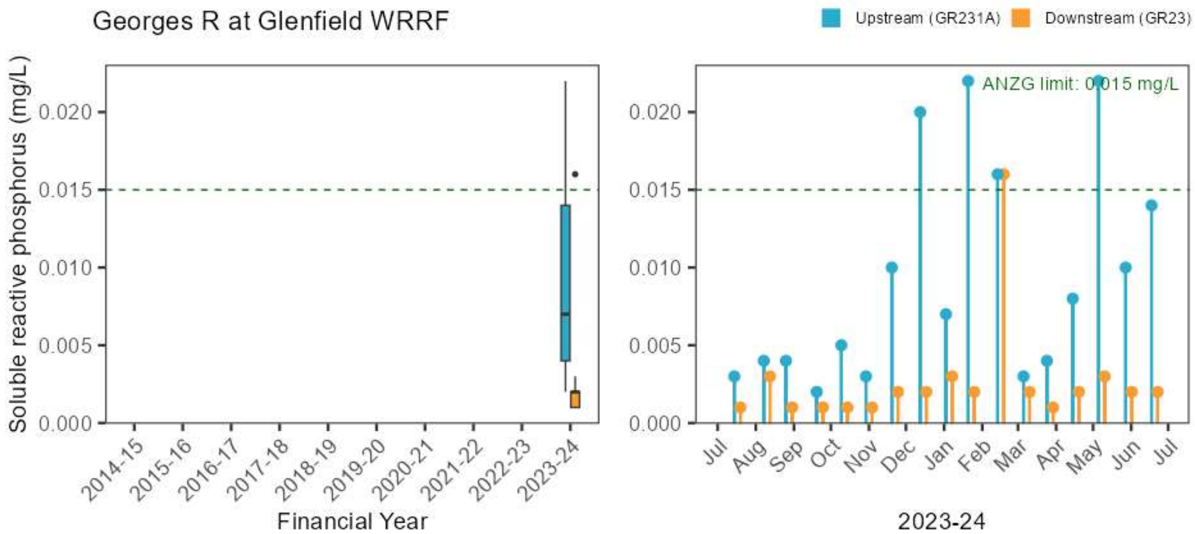
Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Oxidised nitrogen (mg/L)
ANZG limit: 0.04 mg/L
Financial Year
2023-24

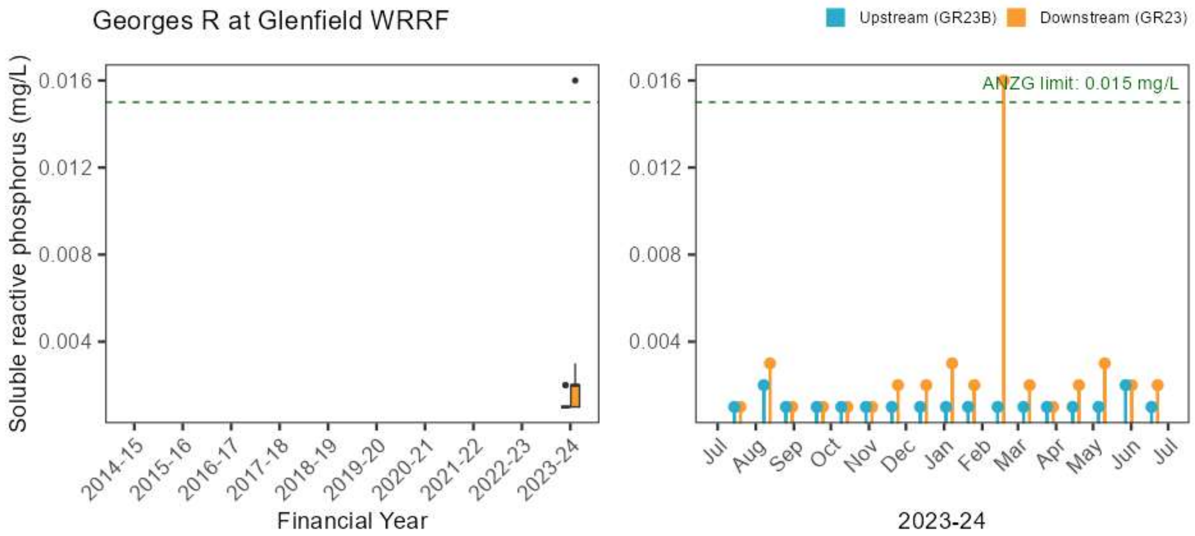


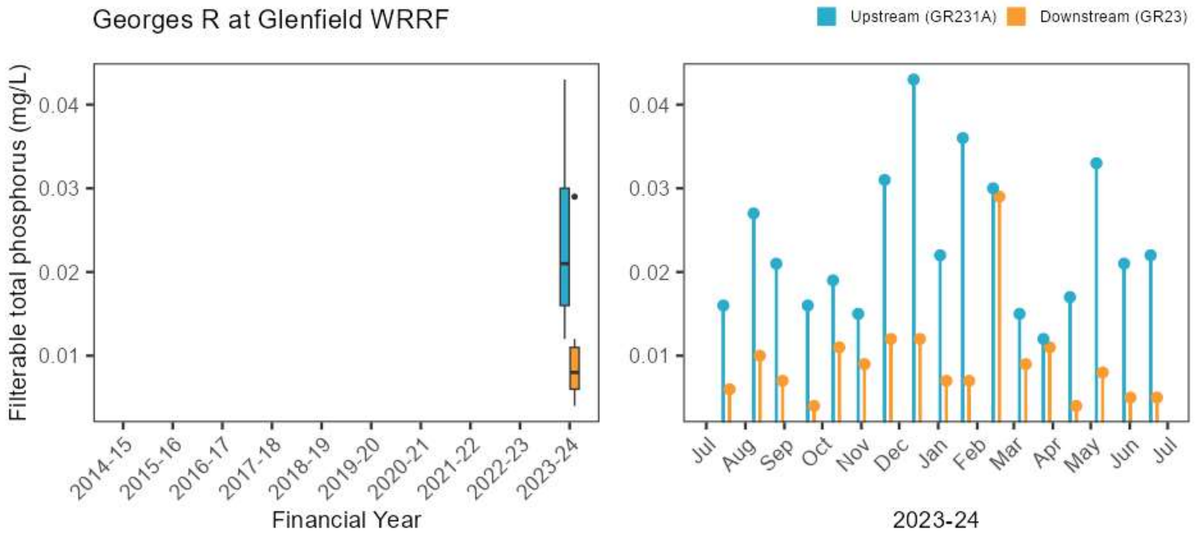
Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Oxidised nitrogen (mg/L)
ANZG limit: 0.04 mg/L
Financial Year
2023-24

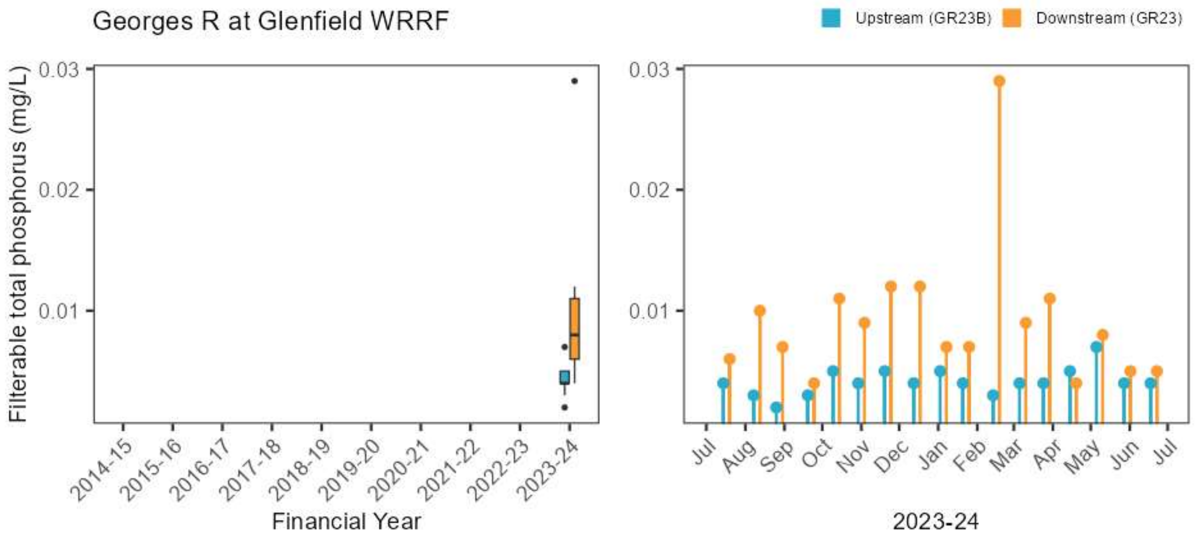

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
ANZG limit: 0.35 mg/L
Total nitrogen (mg/L)
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

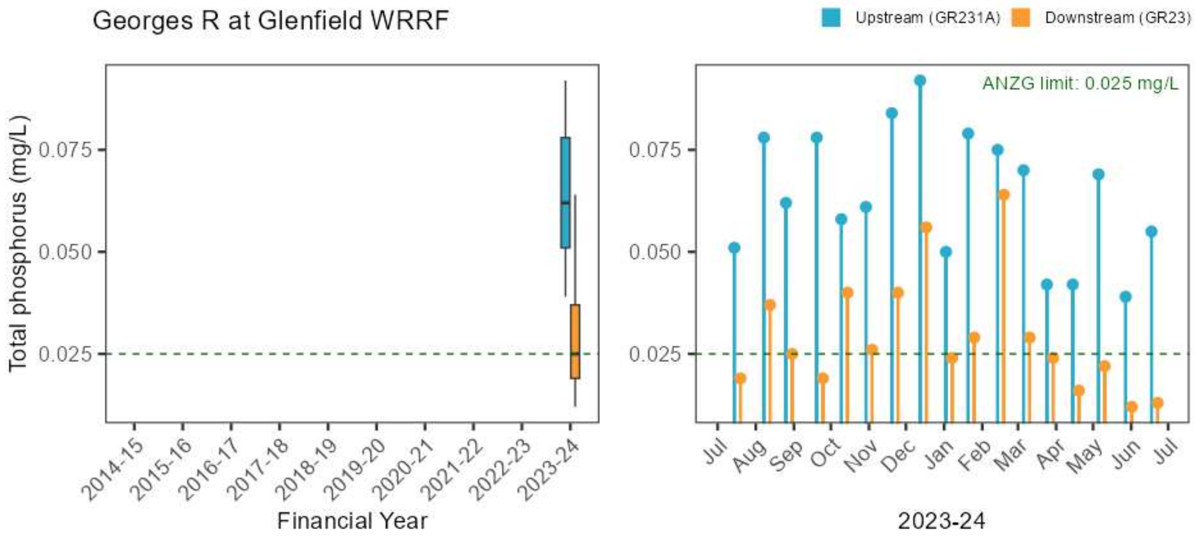

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
ANZG limit: 0.35 mg/L
Total nitrogen (mg/L)
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

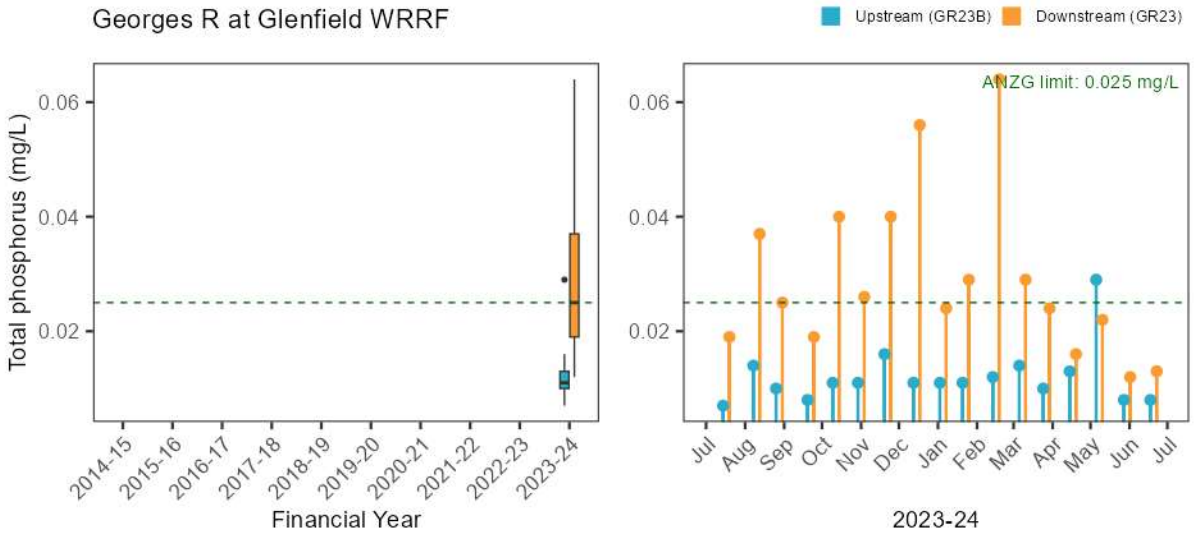

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
ANZG limit: 0.015 mg/L
Soluble reactive phosphorus (mg/L)
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Soluble reactive phosphorus (mg/L)
ANZG limit: 0.015 mg/L
Financial Year
2023-24

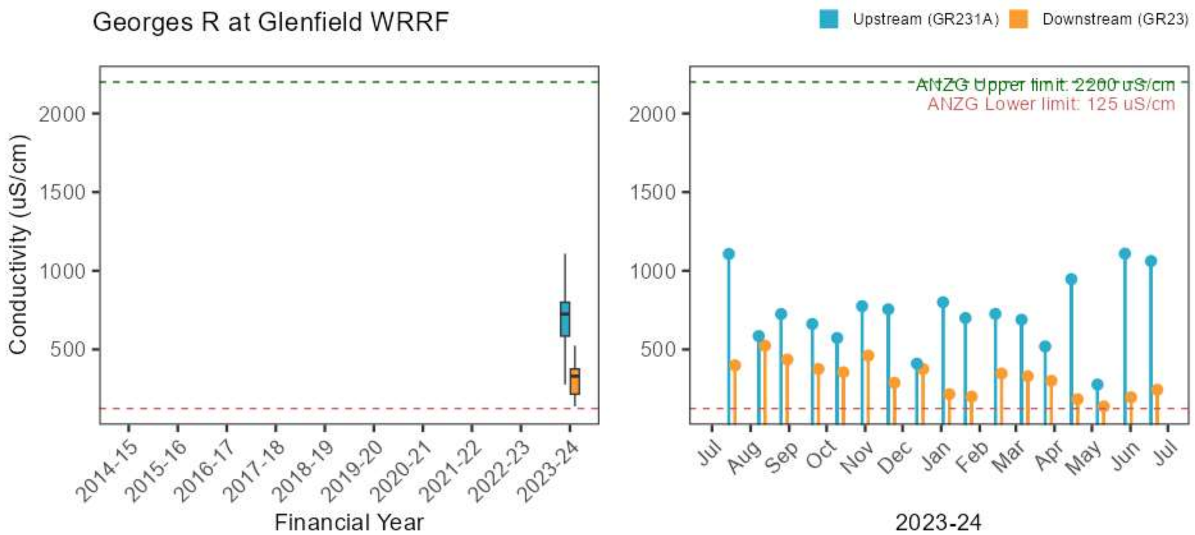

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Filterable total phosphorus (mg/L)
Financial Year
2023-24

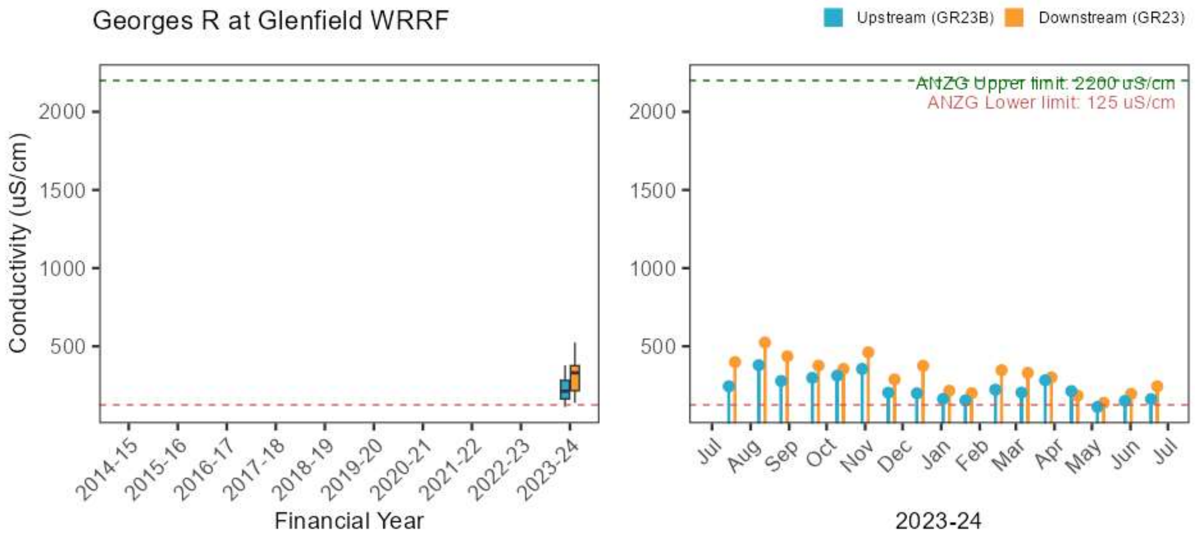

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable total phosphorus (mg/L)
Financial Year
2023-24

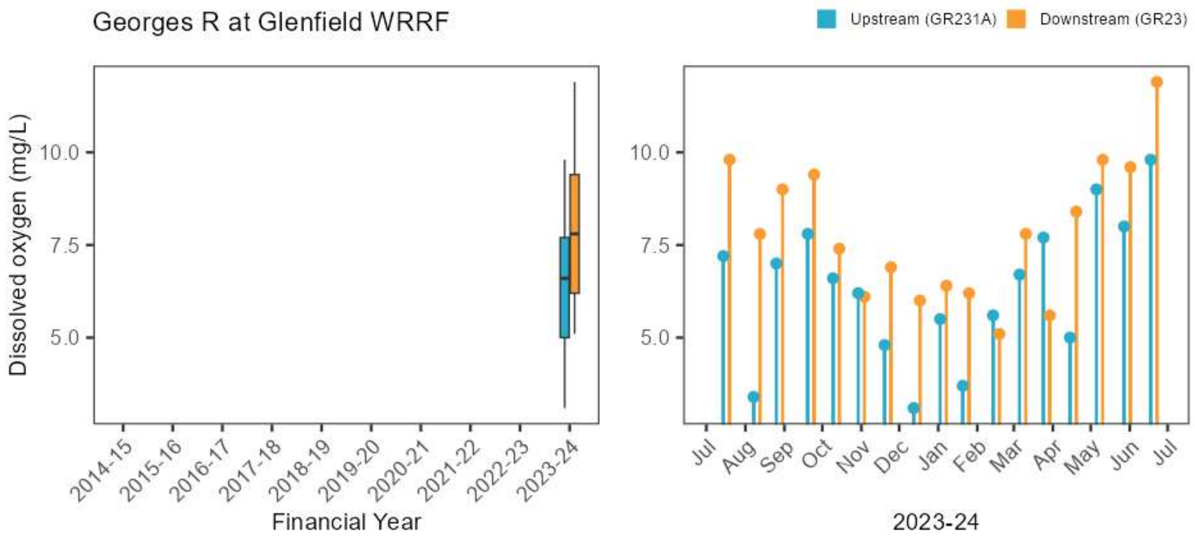


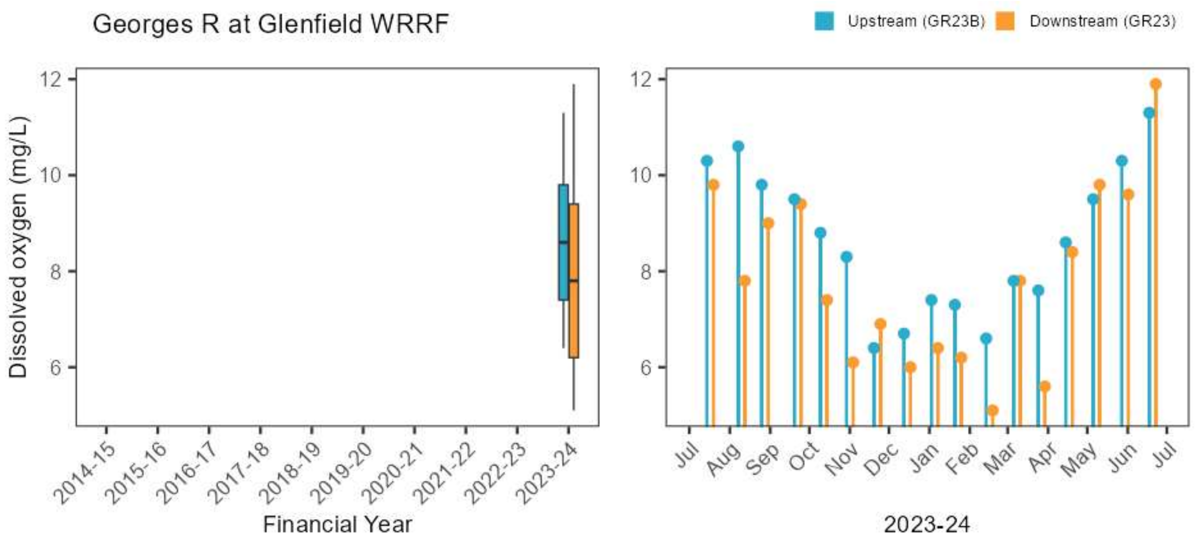


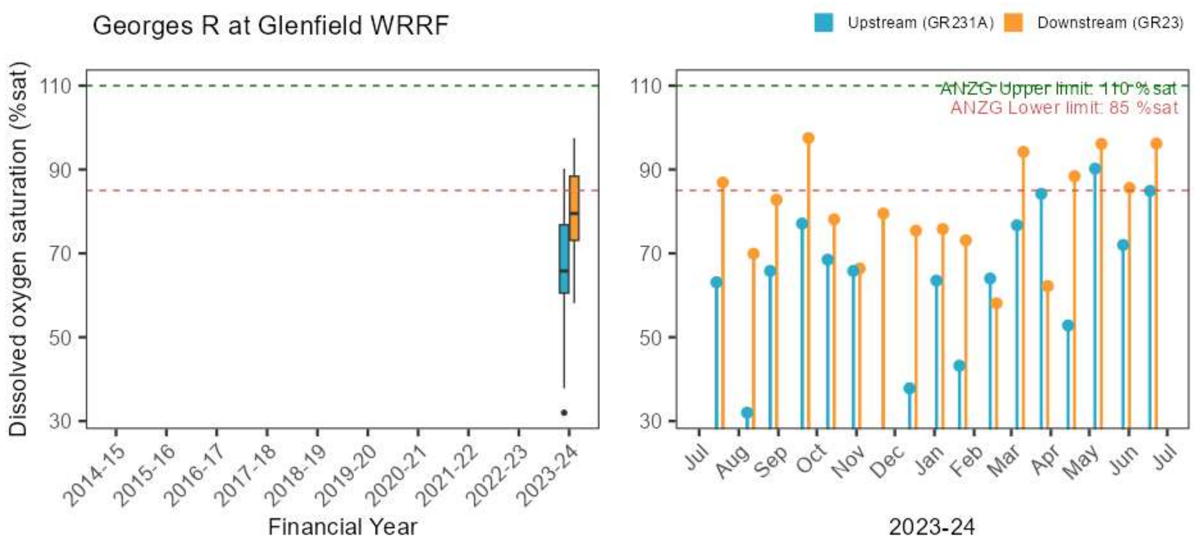
B.1.4. Stressor – Physico-chemical water quality

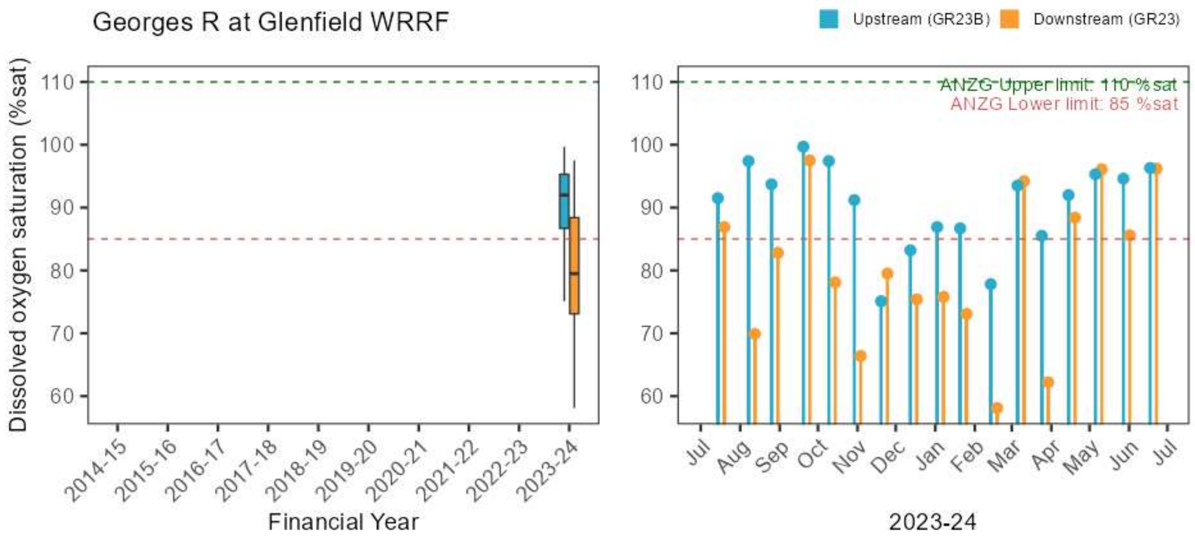


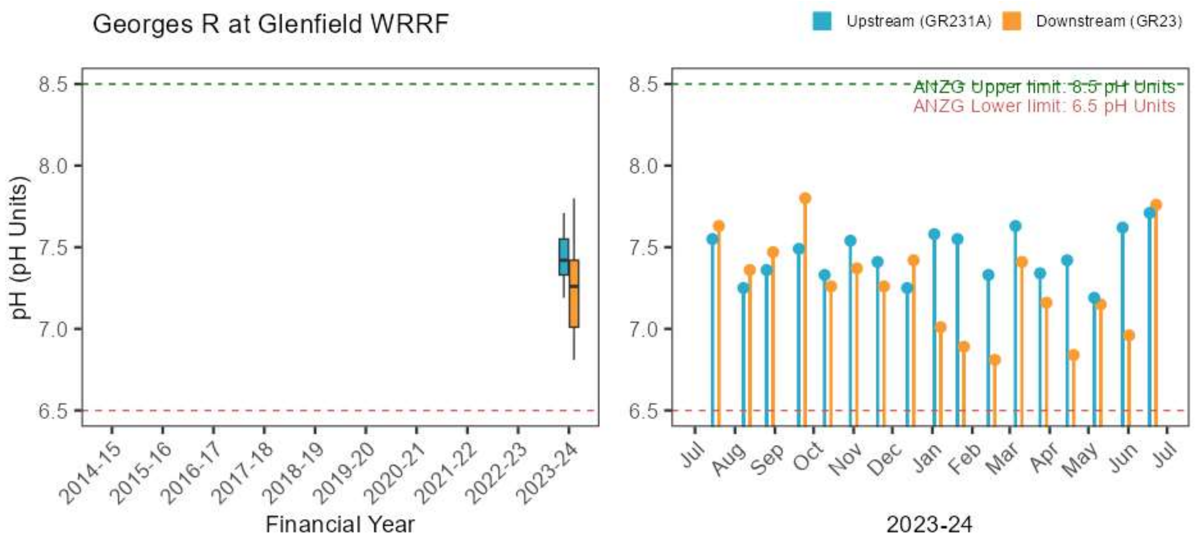

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
ANZG Upper limit: 2200 uS/cm
ANZG Lower limit: 125 uS/cm
Conductivity (uS/cm)
Financial Year
2023-24

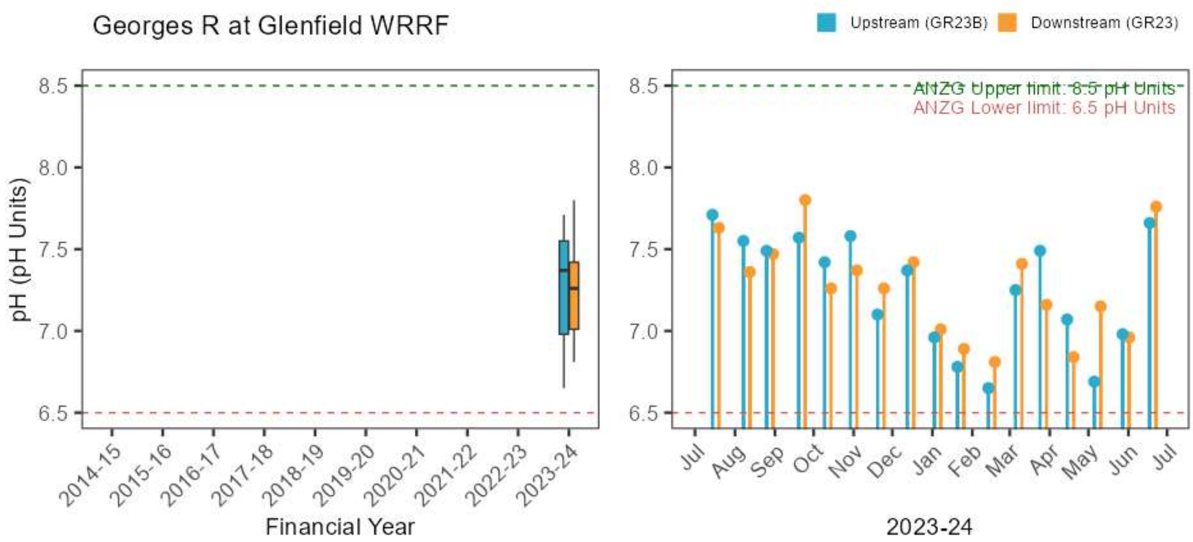

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Dissolved oxygen (mg/L)
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Dissolved oxygen (mg/L)
Financial Year
2023-24

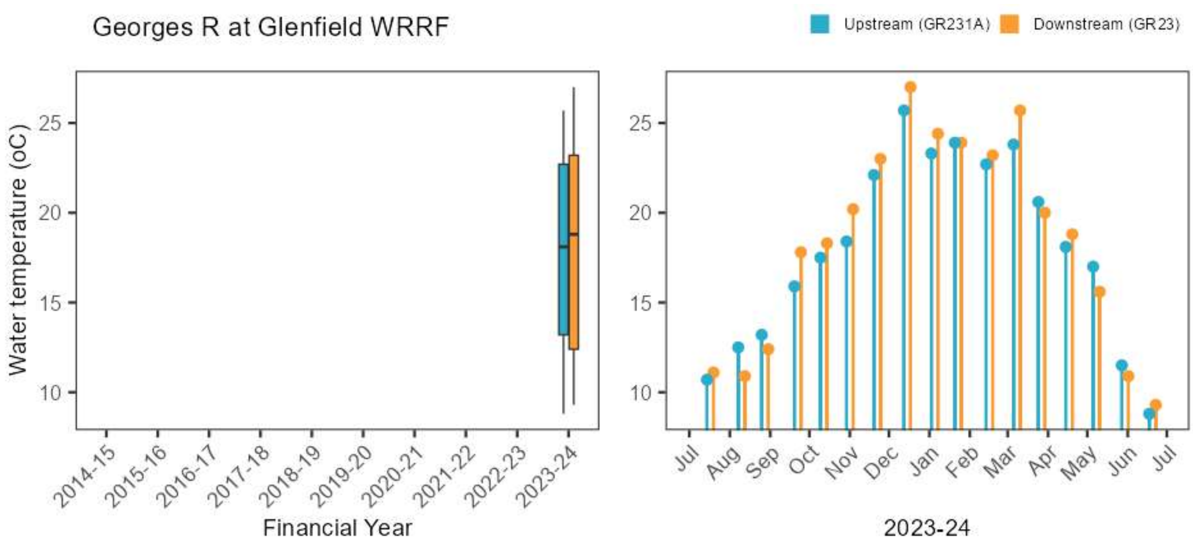

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Dissolved oxygen saturation (%sat)
ANZG Upper limit: 110 %sat
ANZG Lower limit: 85 %sat
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Dissolved oxygen saturation (%sat)
ANZG Upper limit: 110 %sat
ANZG Lower limit: 85 %sat
Financial Year
2023-24

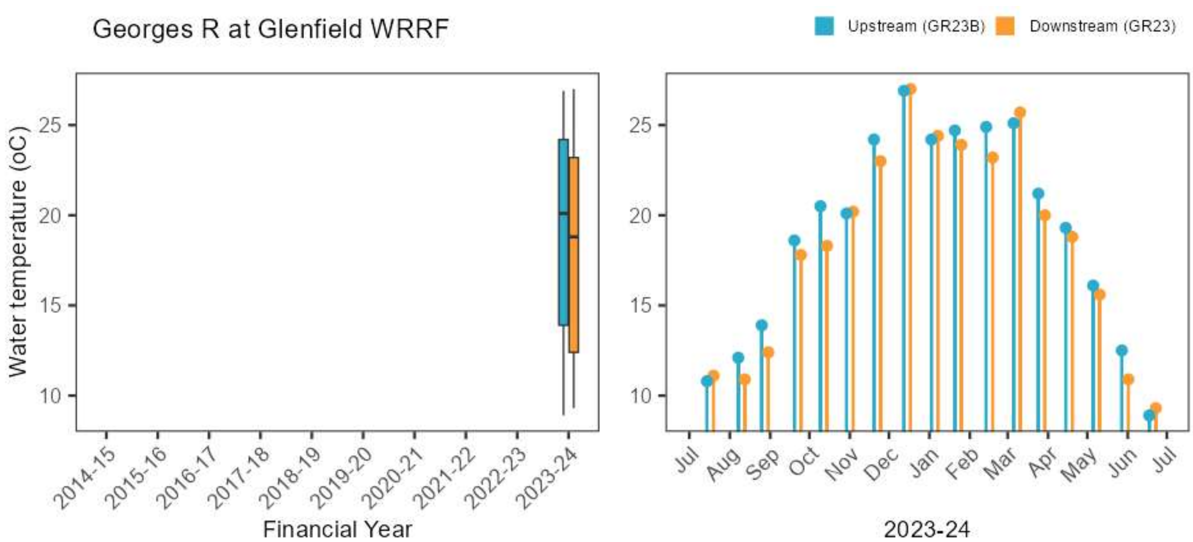

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
pH (pH Units)
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units
Financial Year
2023-24



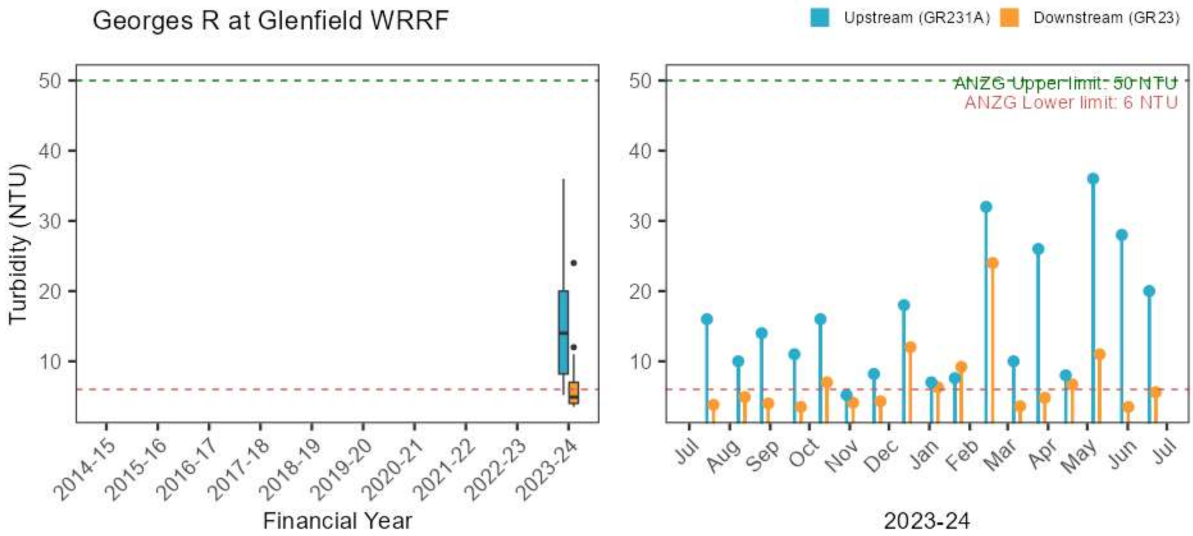
Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units
pH (pH Units)
Financial Year
2023-24

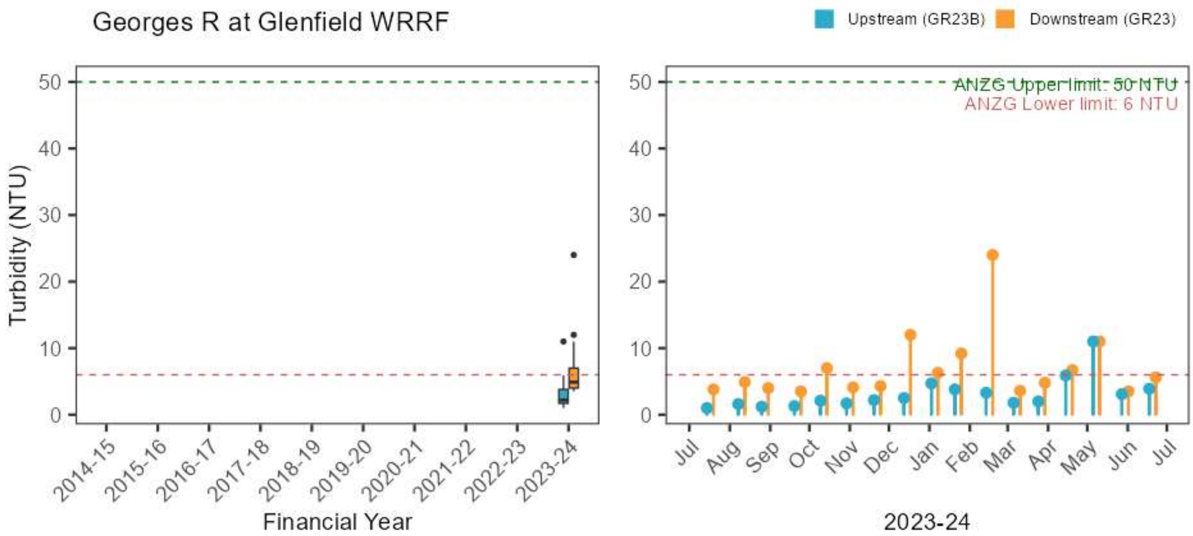


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Water temperature (oC)
Financial Year
2023-24

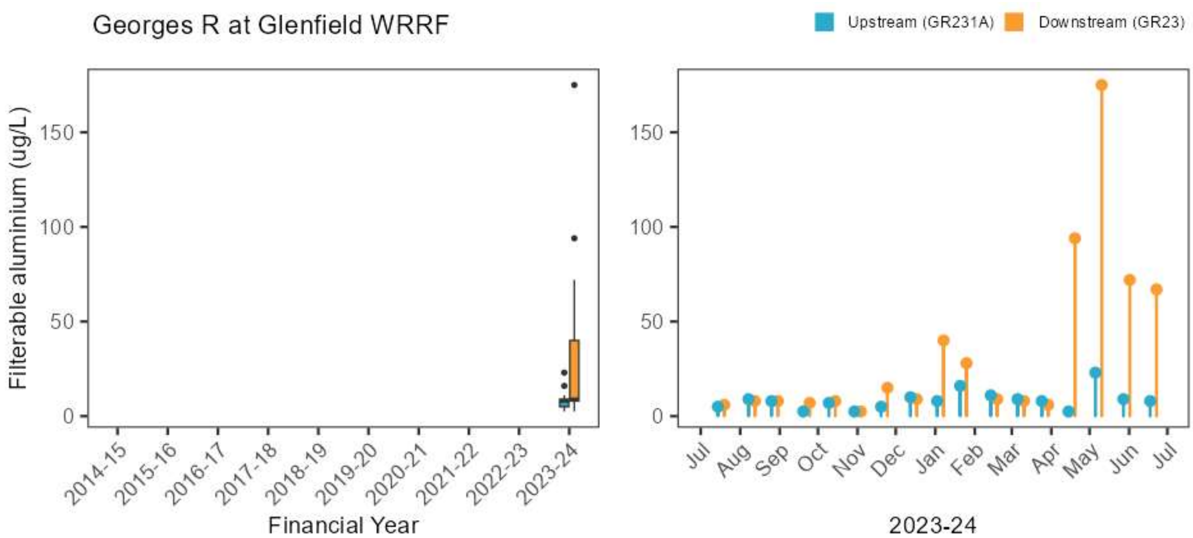


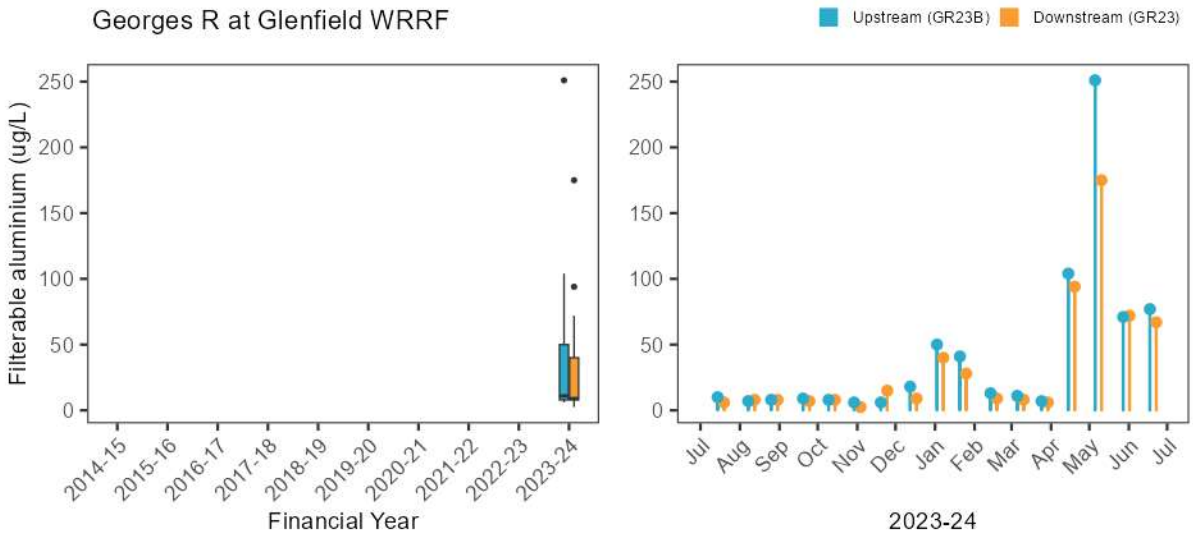
Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Water temperature (oC)
Financial Year
2023-24

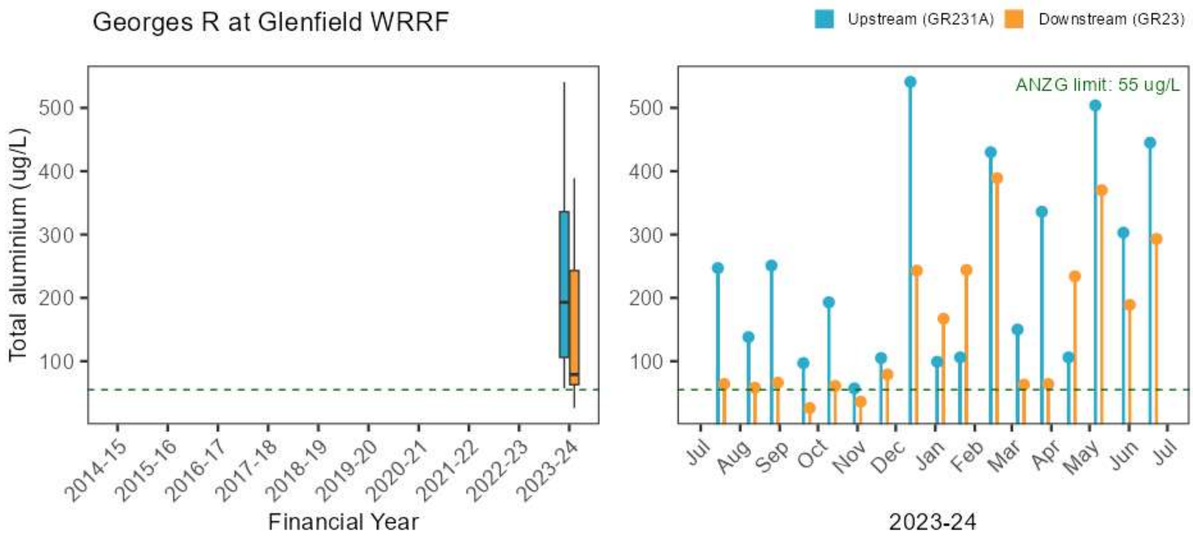


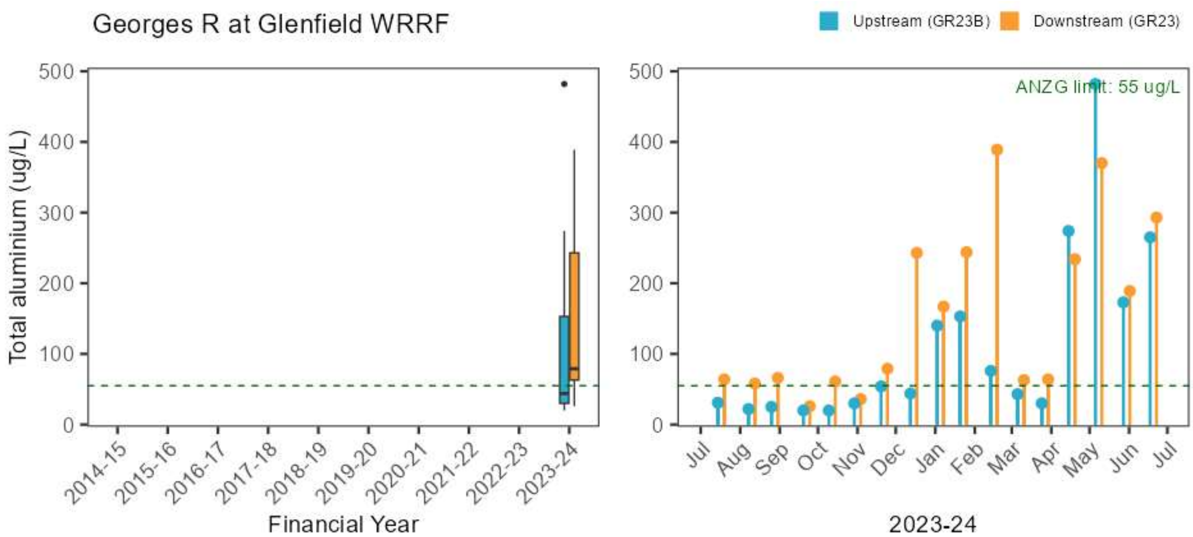


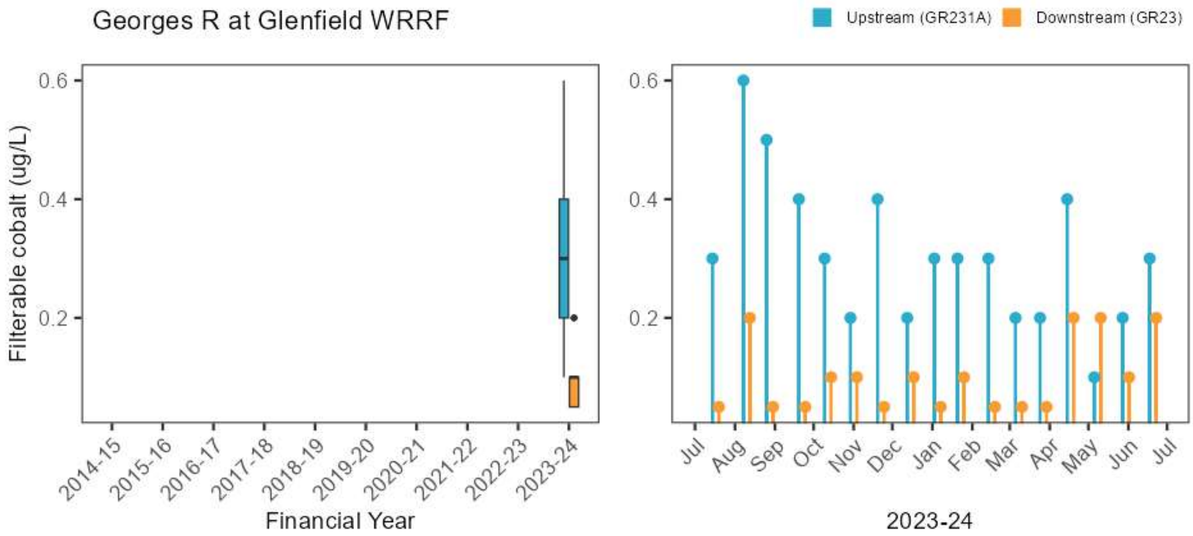
B.1.5. Stressor – Trace metals

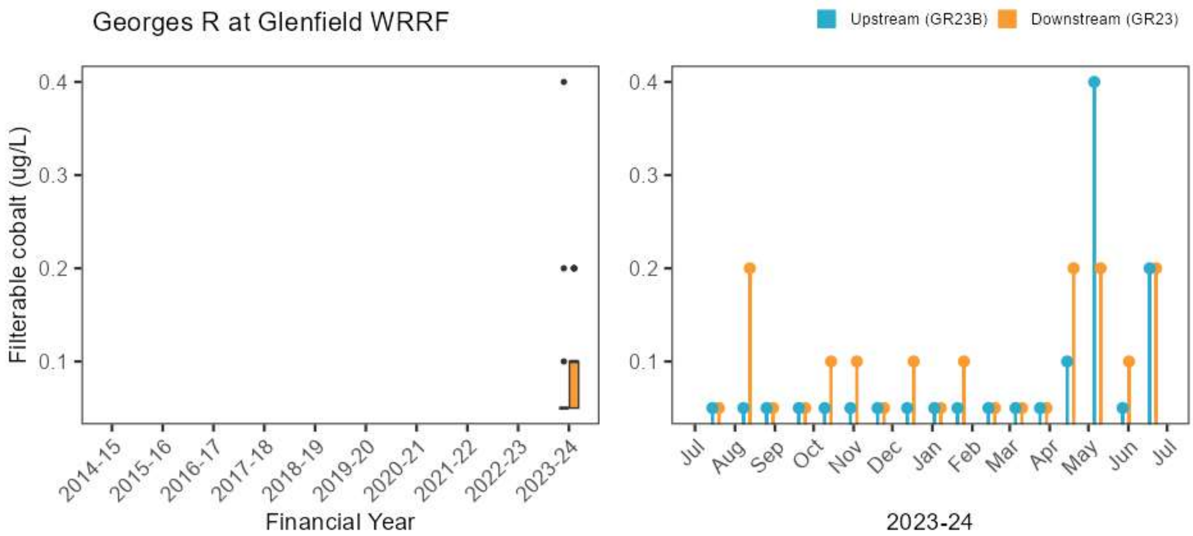


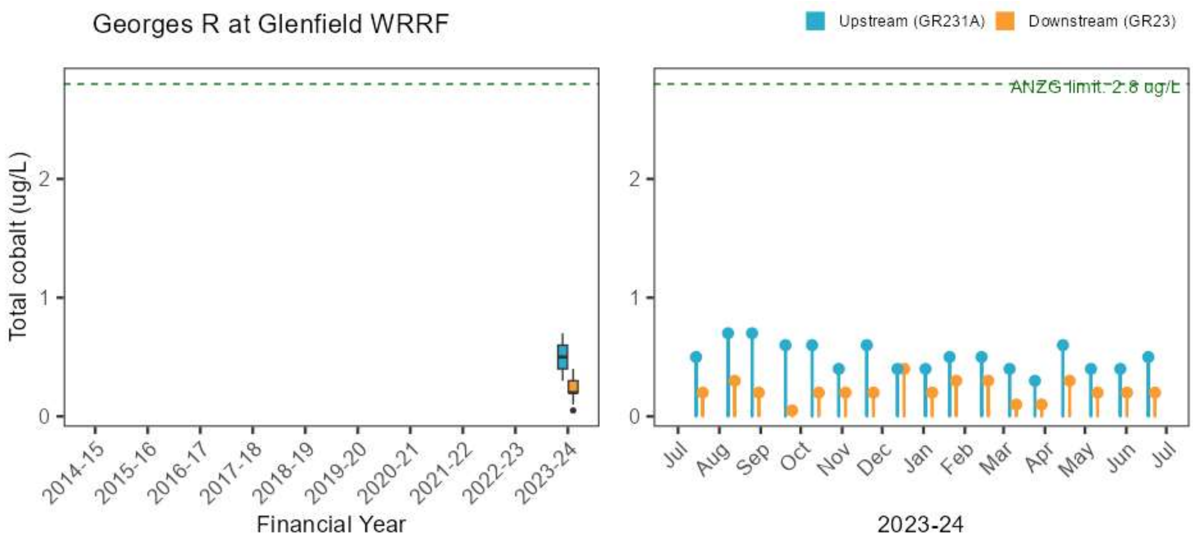

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable aluminium (ug/L)
Financial Year
2023-24

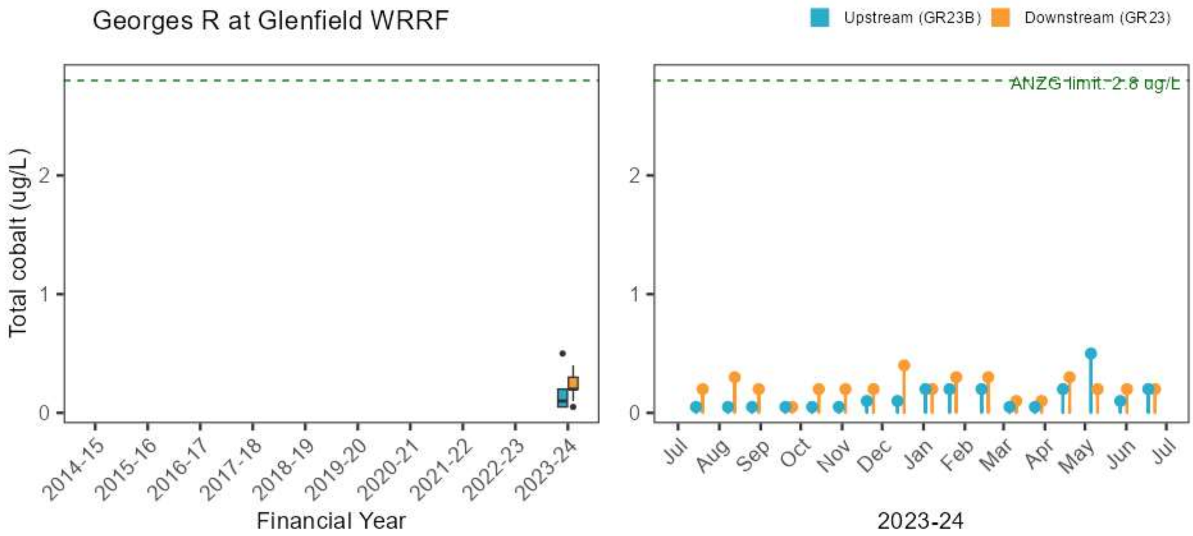

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Total aluminium (ug/L)
ANZG limit: 55 ug/L
Financial Year
2023-24

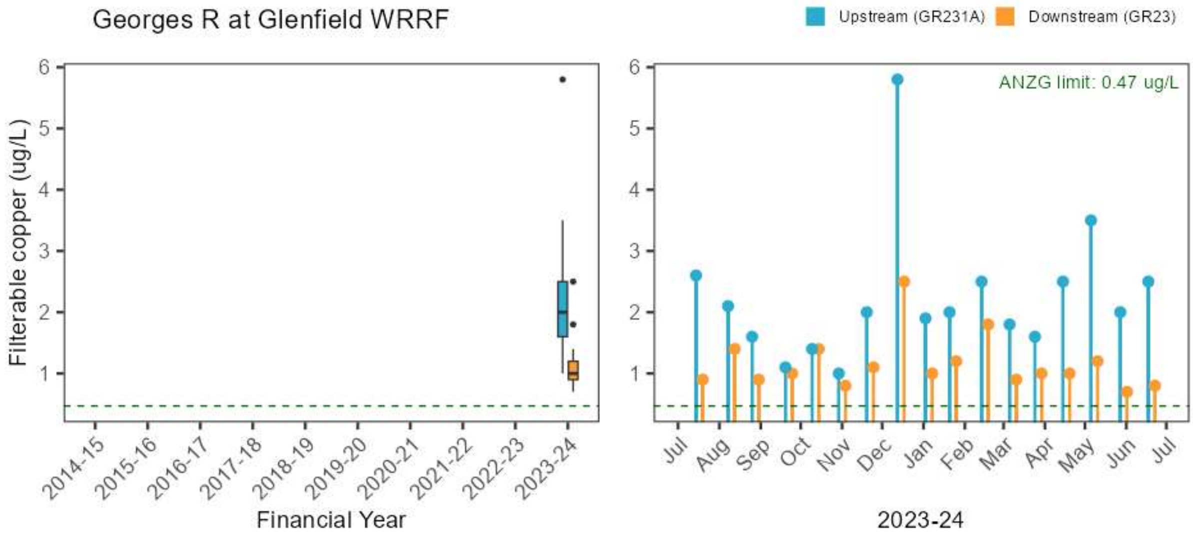

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Total aluminium (ug/L)
ANZG limit: 55 ug/L
Financial Year
2023-24

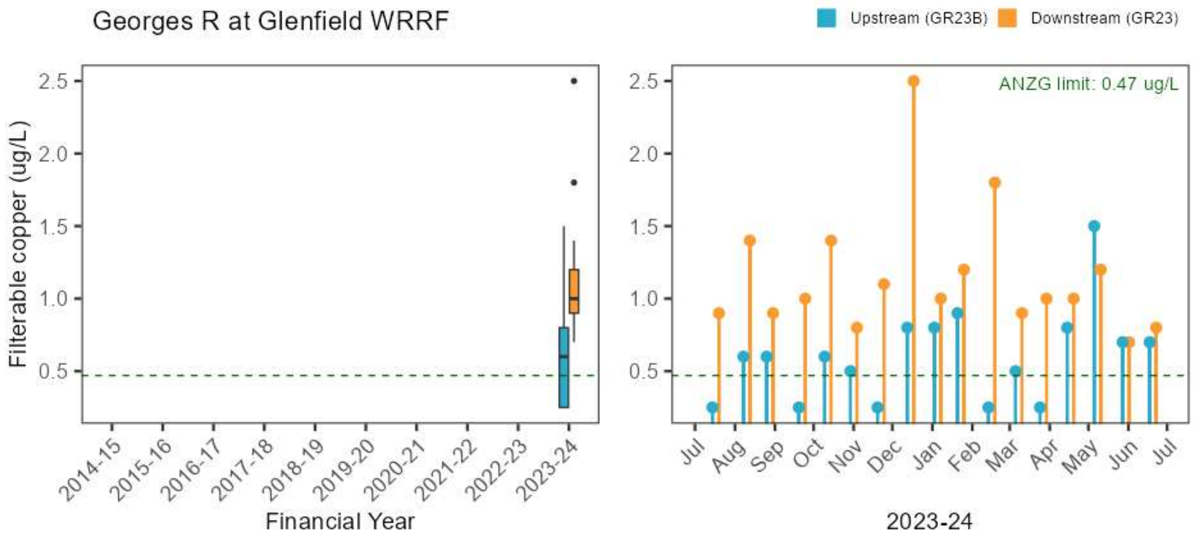

Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Filterable cobalt (ug/L)
Financial Year
2023-24

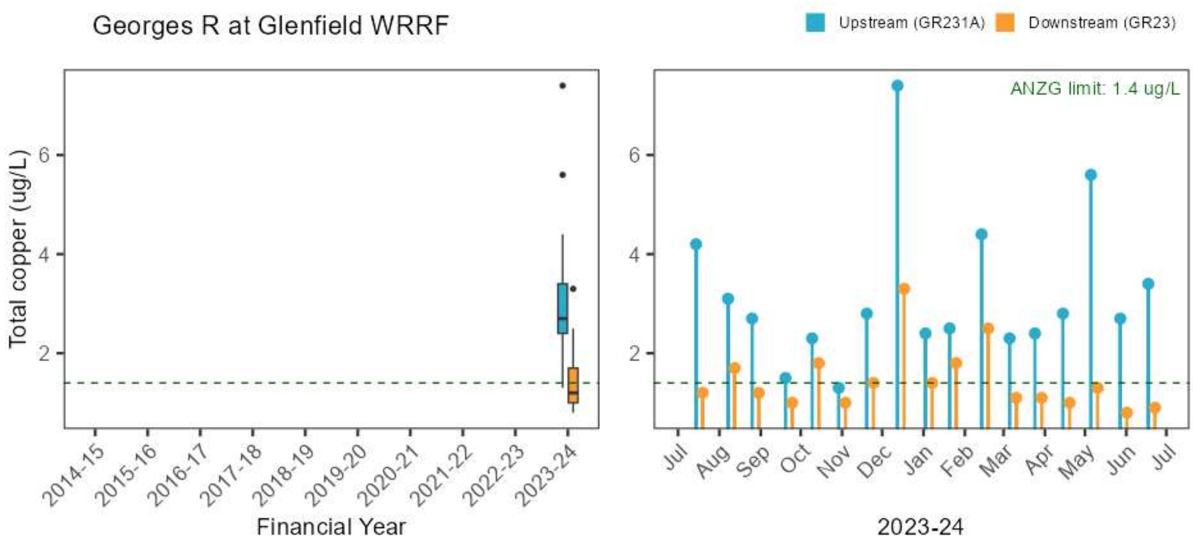

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable cobalt (ug/L)
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Total cobalt (ug/L)
ANZG limit: 2.8 ug/L
Financial Year
2023-24

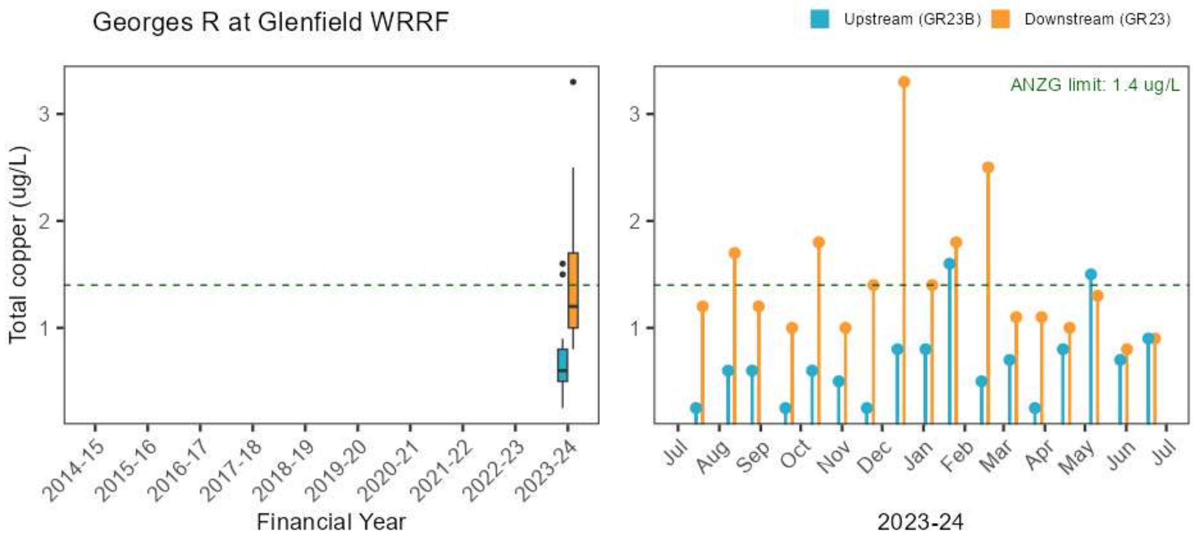

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Total cobalt (ug/L)
ANZG limit: 2.8 ug/L
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Filterable copper (ug/L)
ANZG limit: 0.47 ug/L
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul

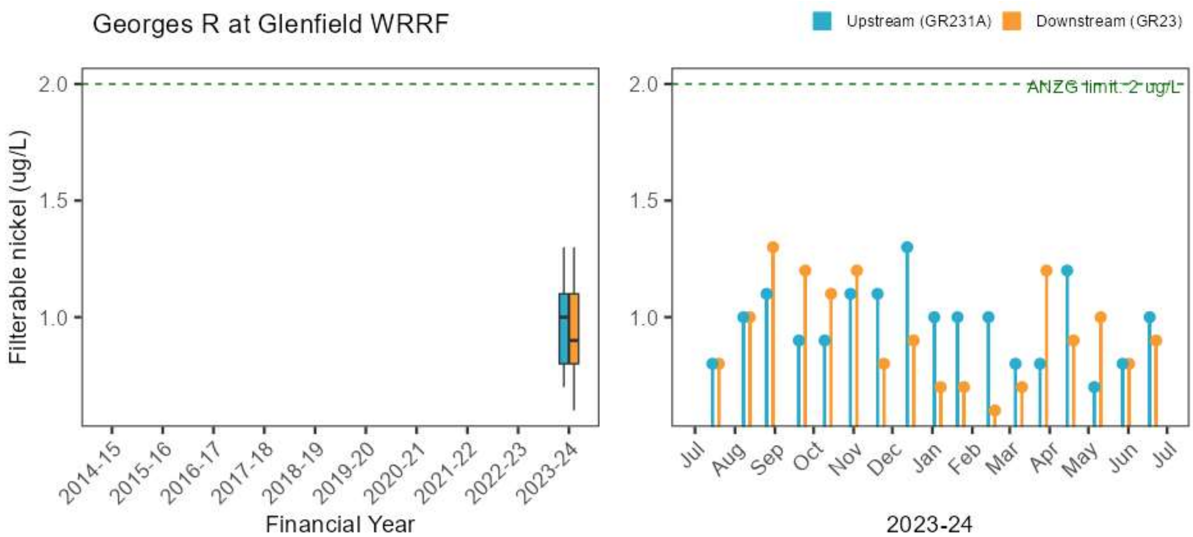

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable copper (ug/L)
ANZG limit: 0.47 ug/L
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul



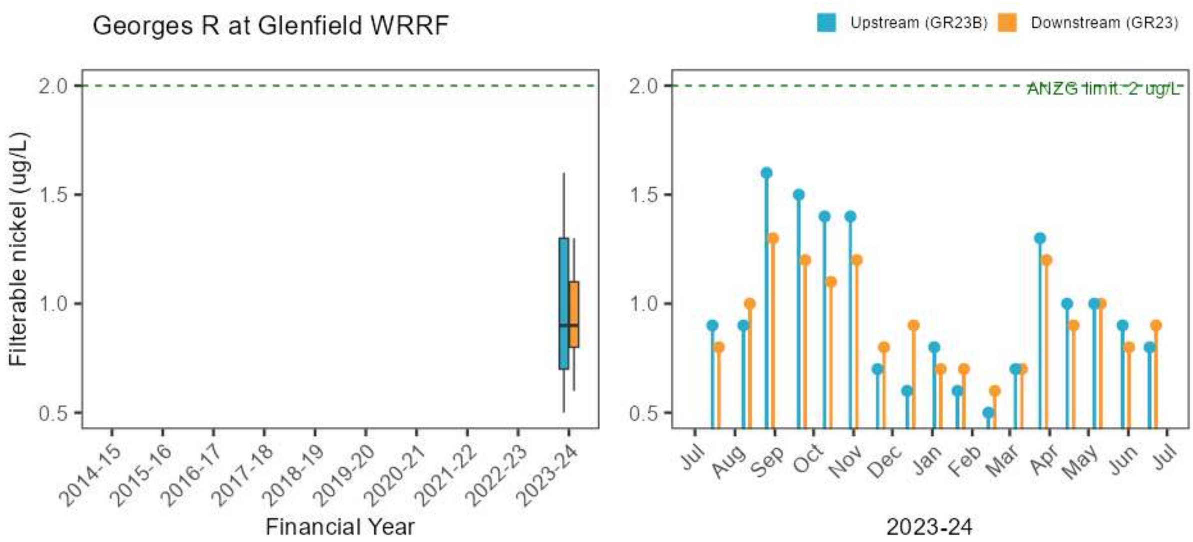
Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Total copper (ug/L)
ANZG limit: 1.4 ug/L
Financial Year
2023-24

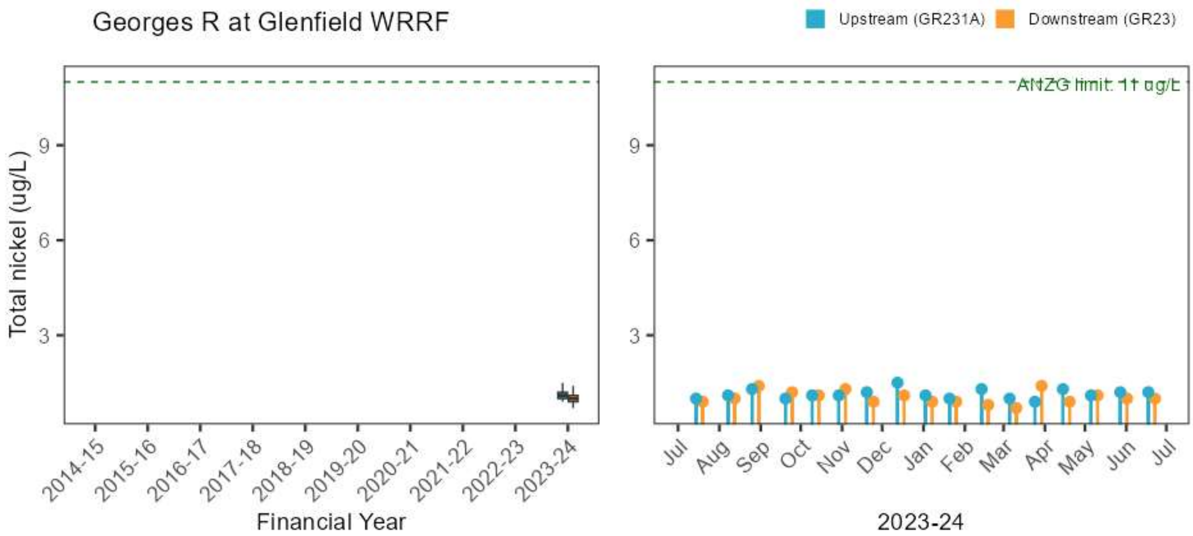


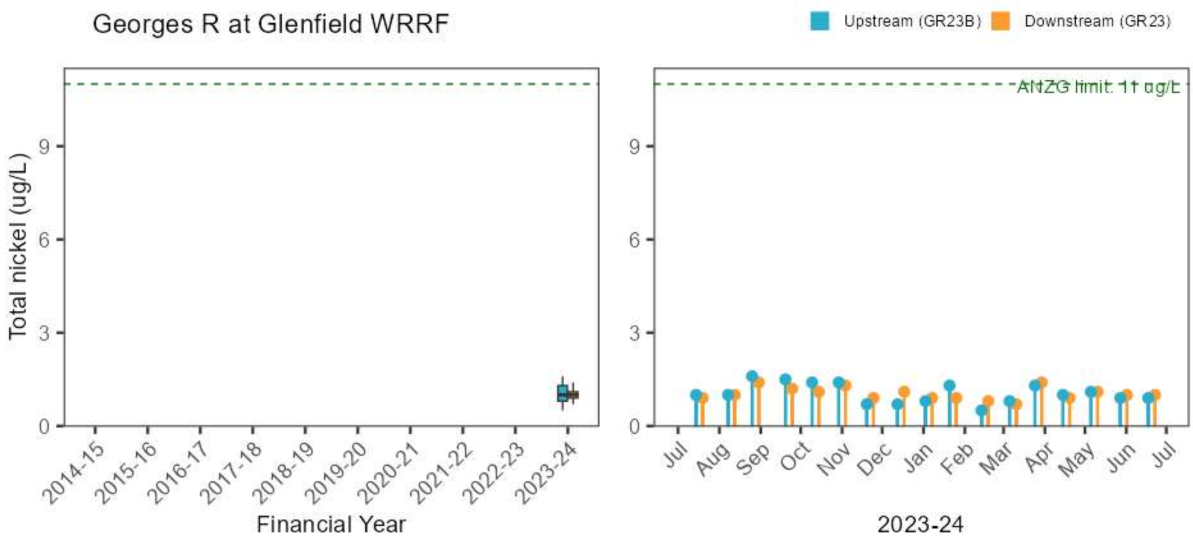
Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Total copper (ug/L)
ANZG limit: 1.4 ug/L
Financial Year
2023-24

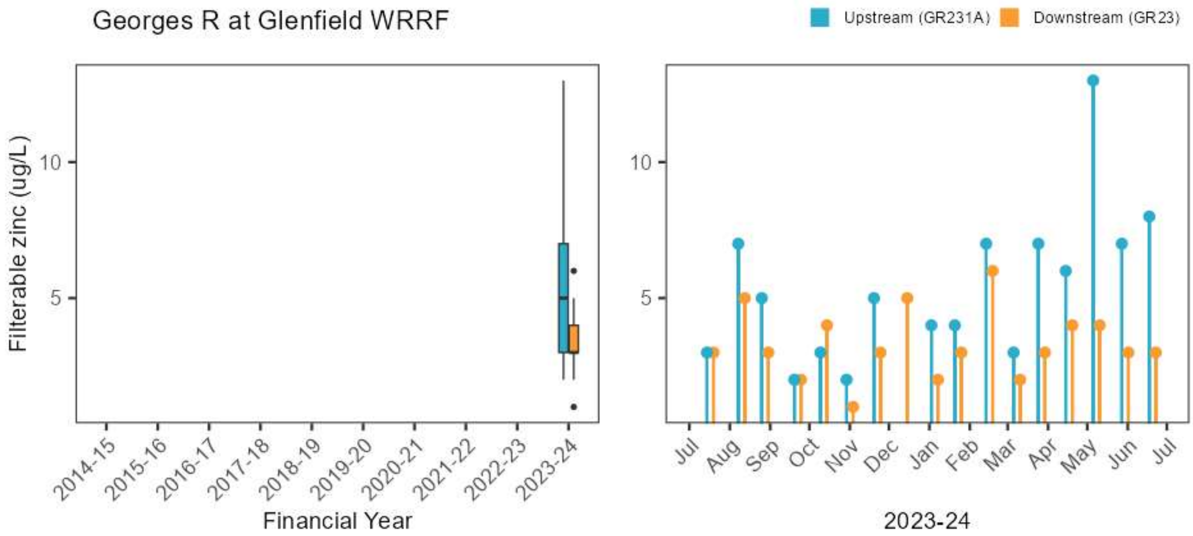


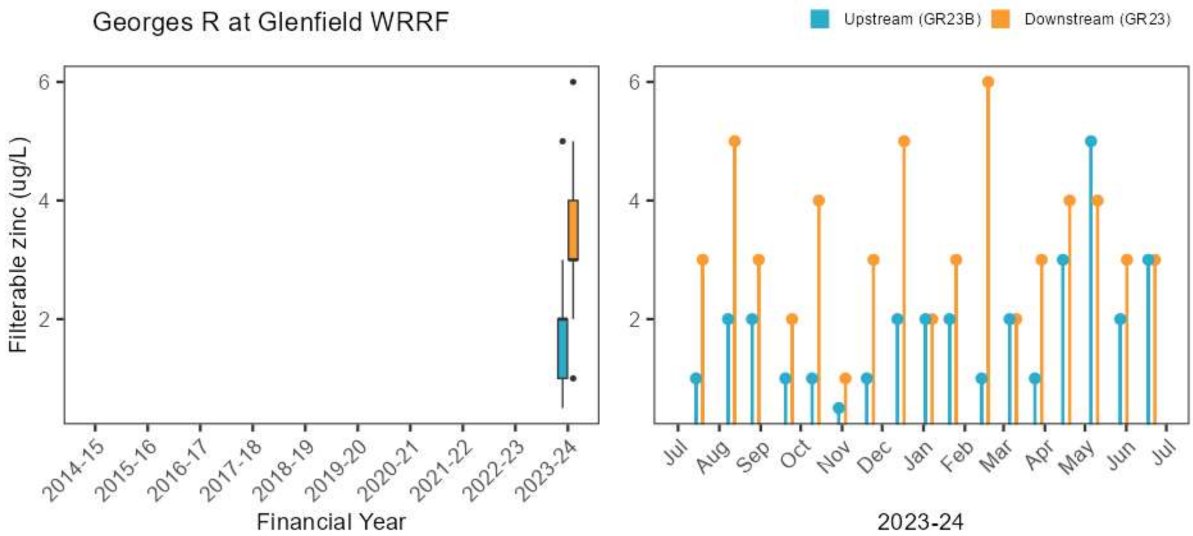
Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Filterable nickel (ug/L)
ANZG limit: 2 ug/L
Financial Year
2023-24

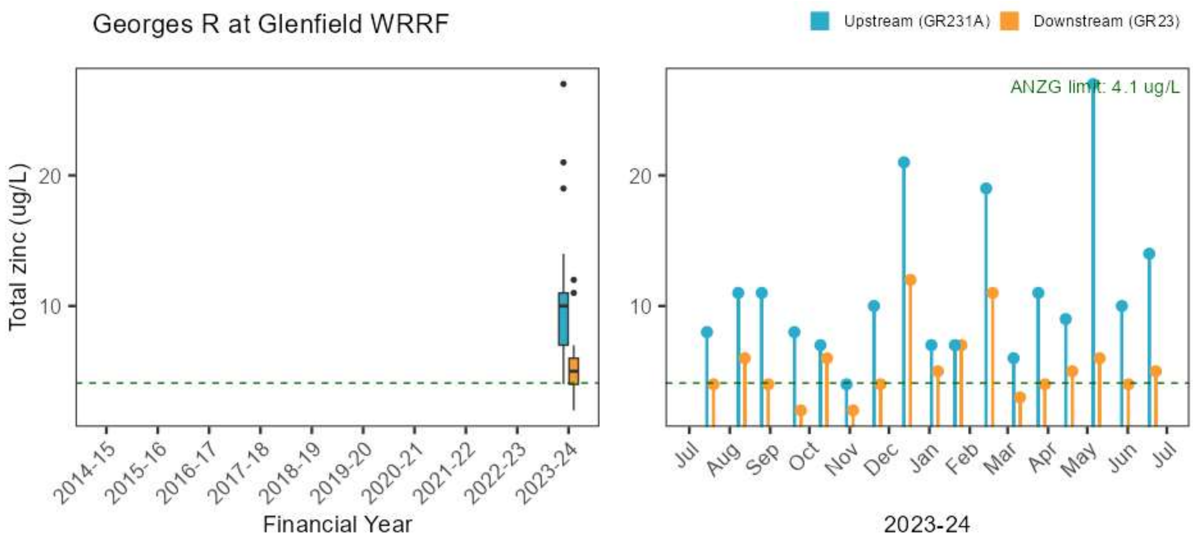

Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable nickel (ug/L)
ANZG limit: 2 ug/L
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Total nickel (ug/L)
ANZG limit: 11 ug/L
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Total nickel (ug/L)
ANZG limit: 11 ug/L
Financial Year
2023-24


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Filterable zinc (ug/L)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Georges R at Glenfield WRRF
Upstream (GR23B)
Downstream (GR23)
Filterable zinc (ug/L)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Georges R at Glenfield WRRF
Upstream (GR231A)
Downstream (GR23)
Total zinc (ug/L)
ANZG limit: 4.1 ug/L
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
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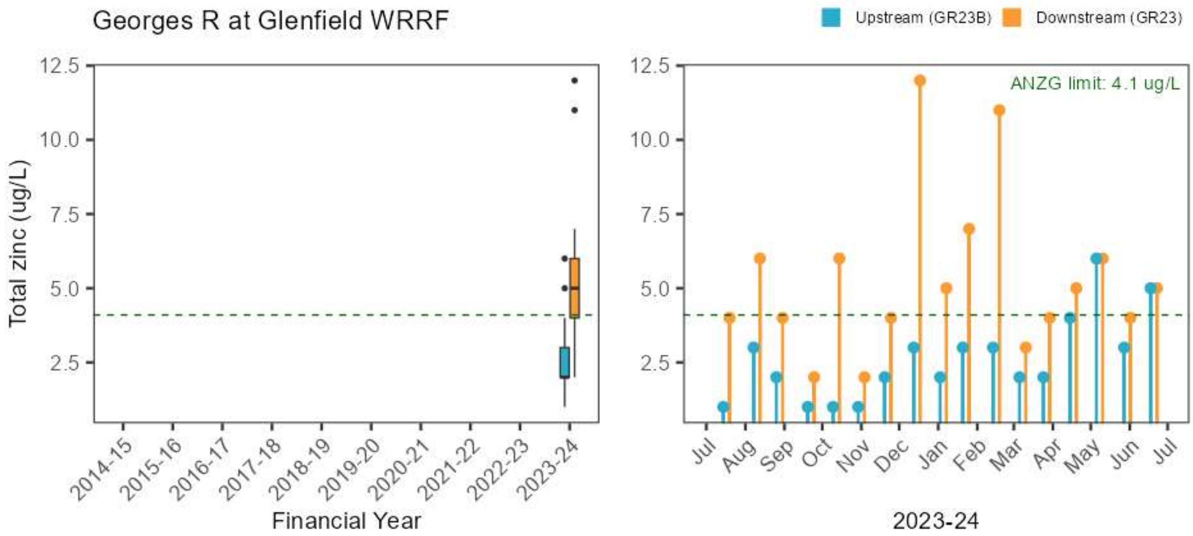
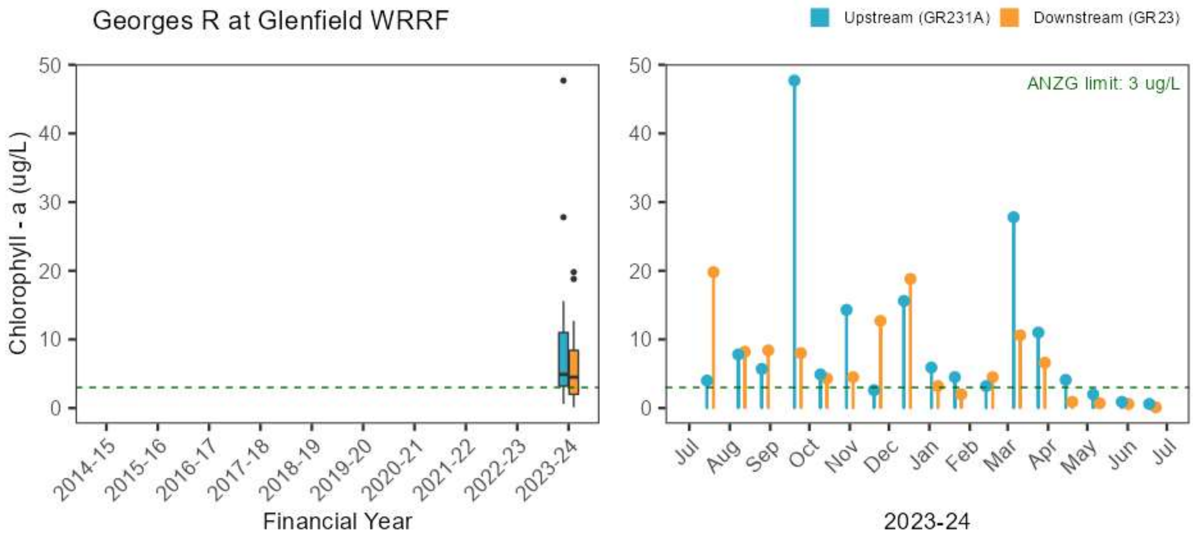
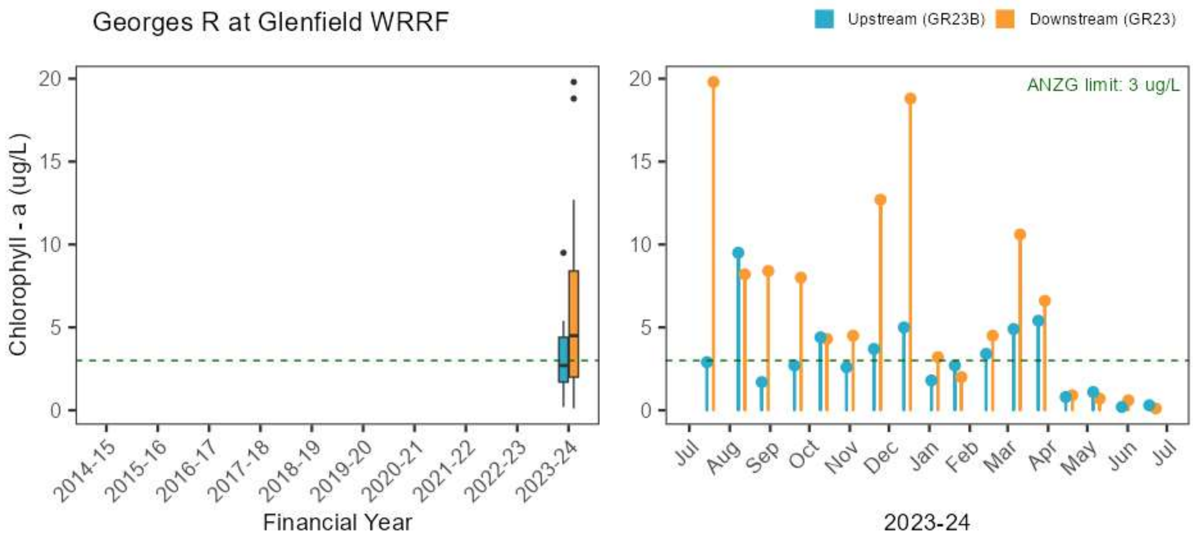
Feb
Mar
Apr
May
Jun
Jul
2023-24



Ecosystem receptor – Phytoplankton





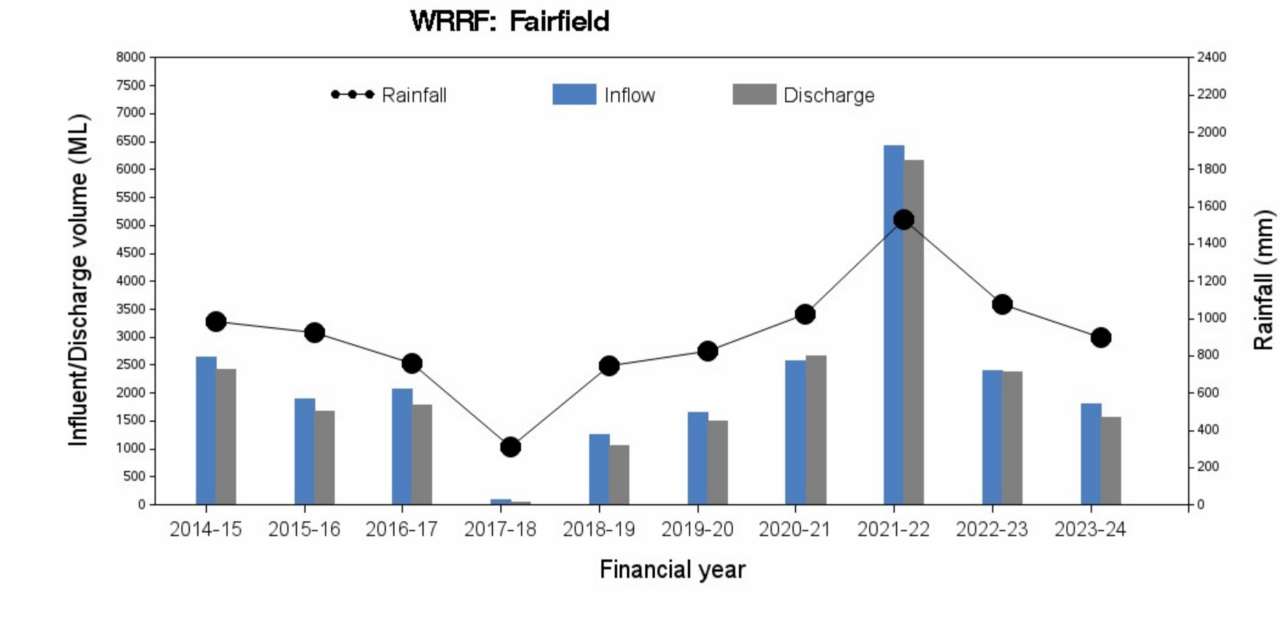
B.1.6. Ecosystem receptor – Macroinvertebrates

Statistical comparisons will be presented in future reports for Glenfield WRRF once more than two years of data is available for visualisation

B.2. Fairfield WRRF

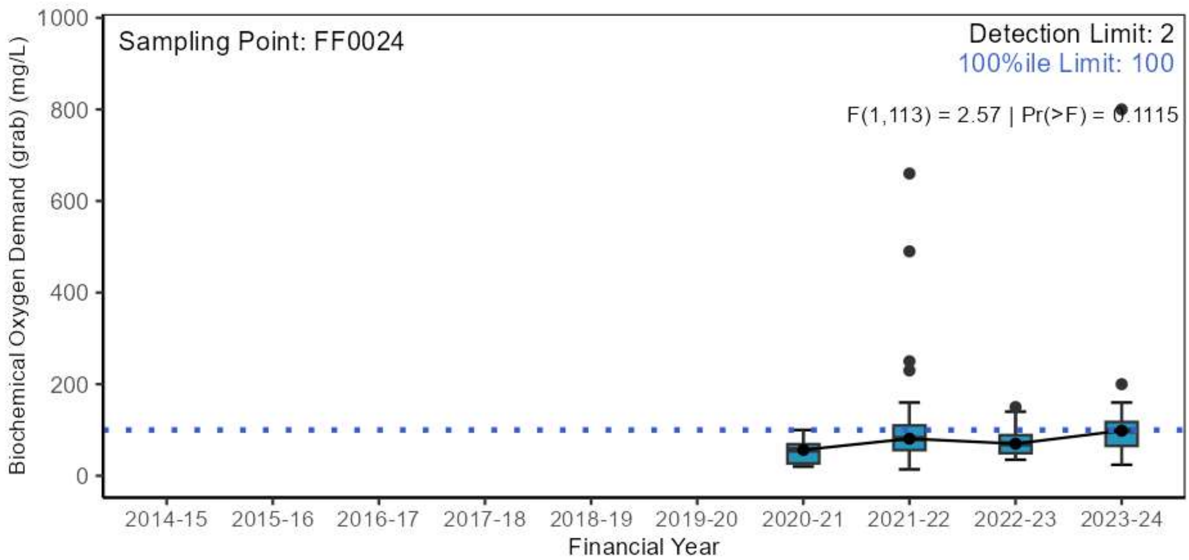
B.2.1. Pressure – Wastewater quantity

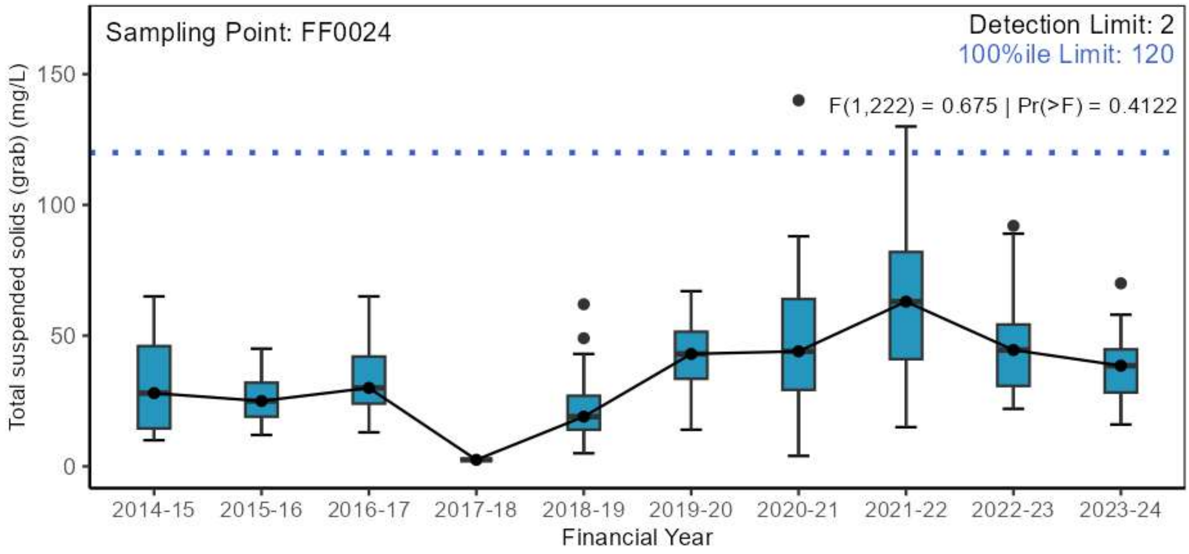
Inflow/discharge volume and rainfall



B.2.2. Pressure – Wastewater quality

Major conventional analytes

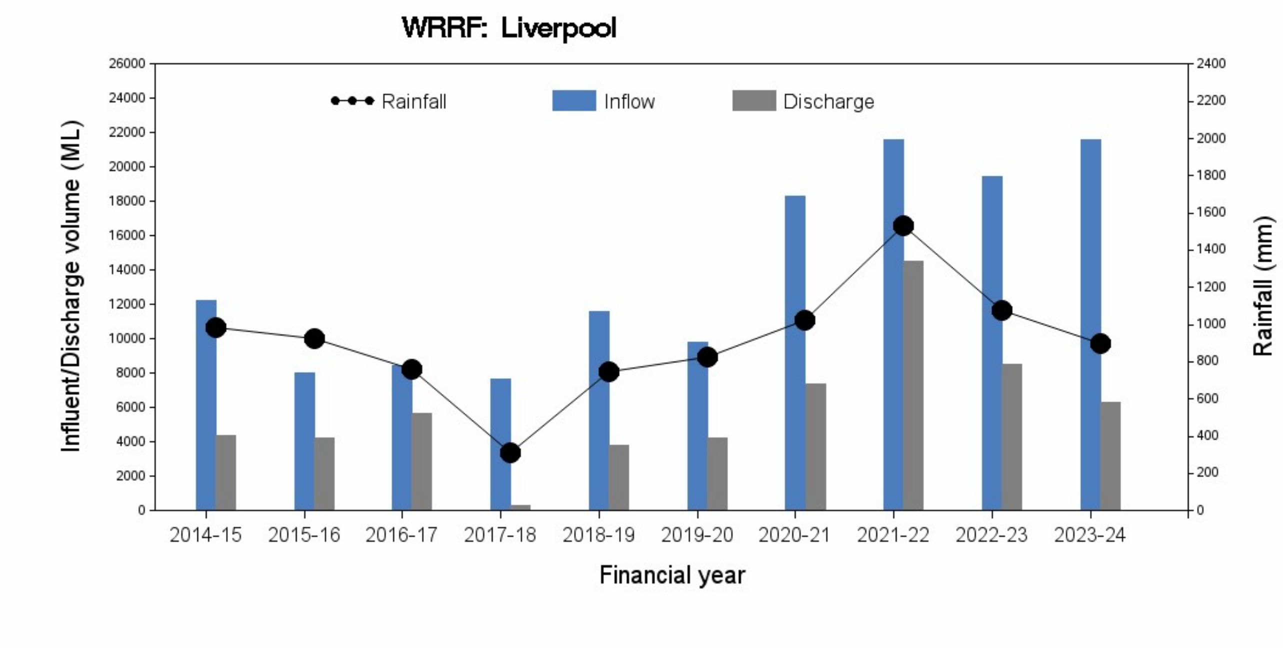




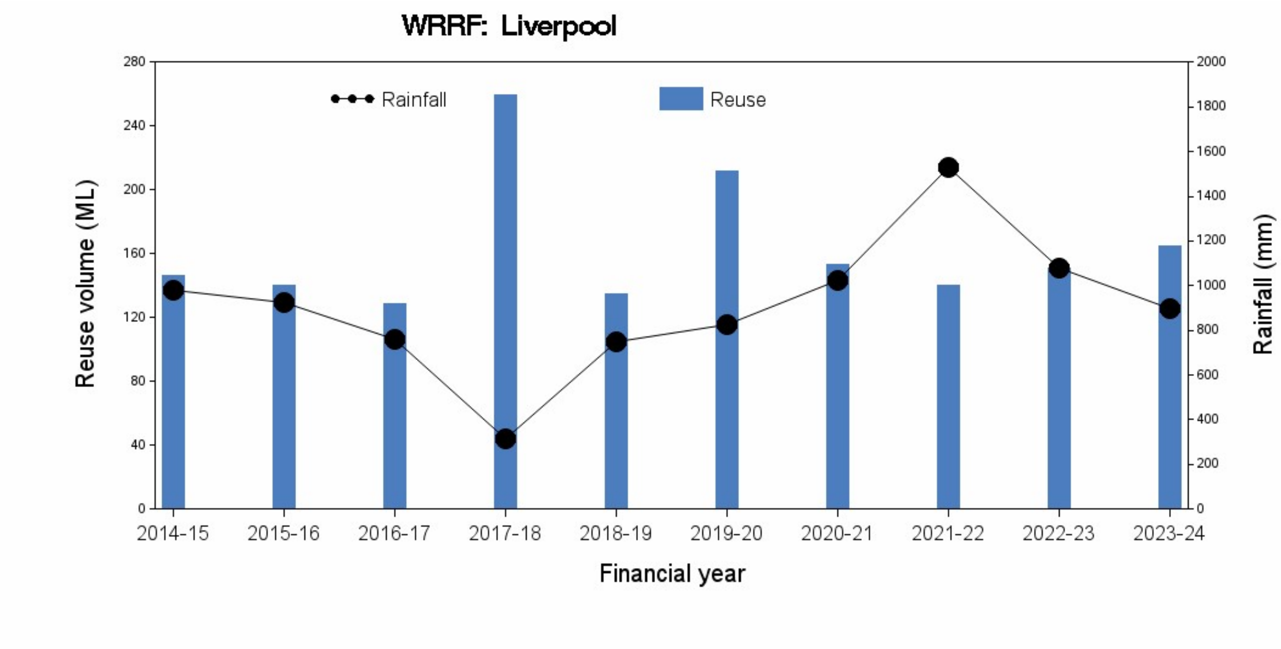
B.3. Liverpool WRRF

B.3.1. Pressure – Wastewater quantity

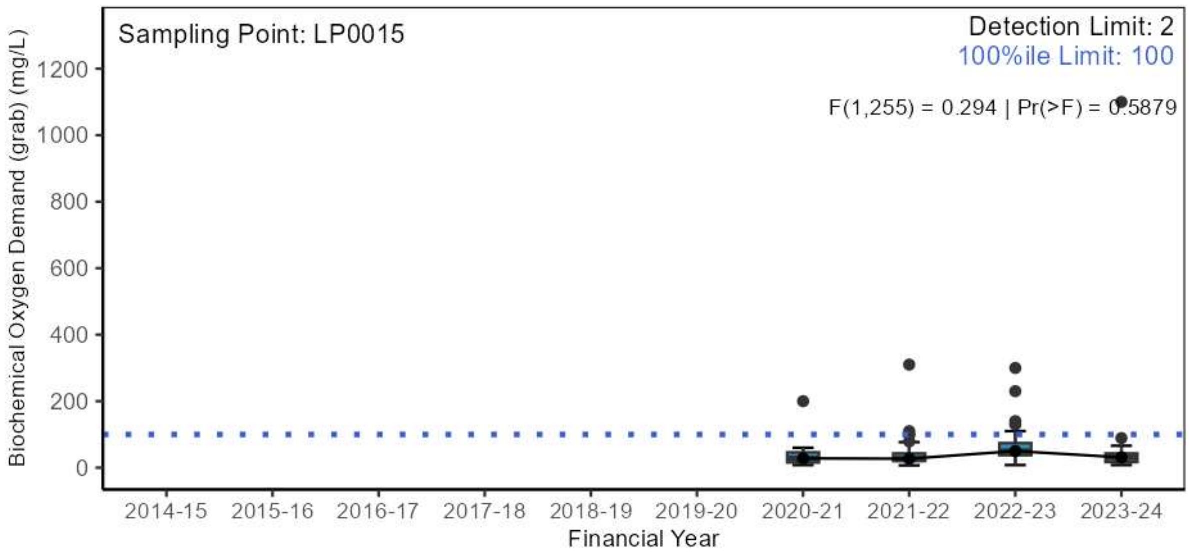
Inflow/discharge volume and rainfall

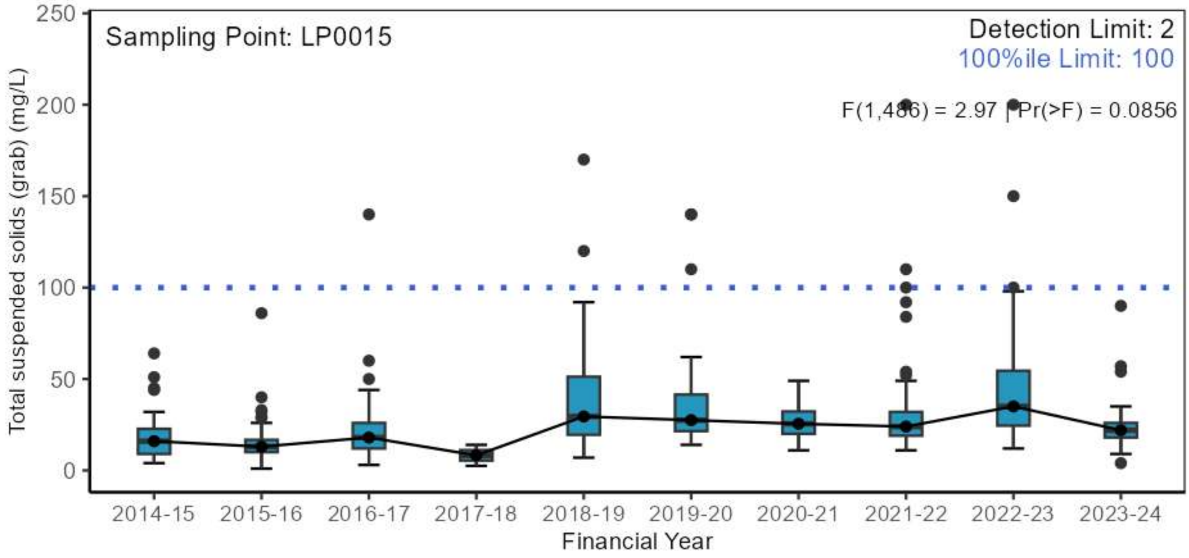


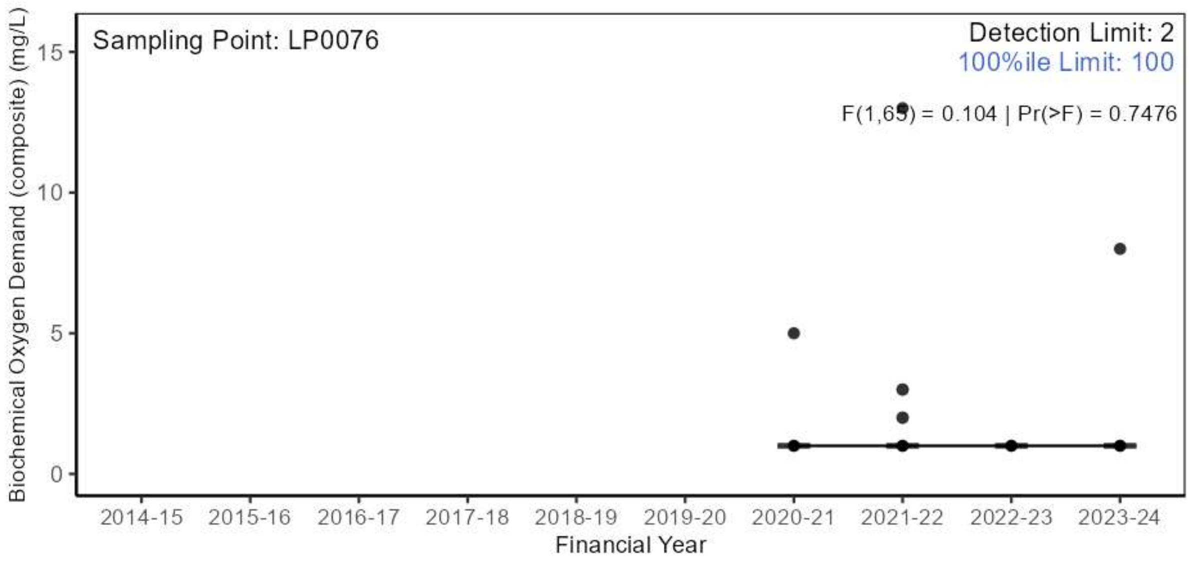
Reuse volume and rainfall

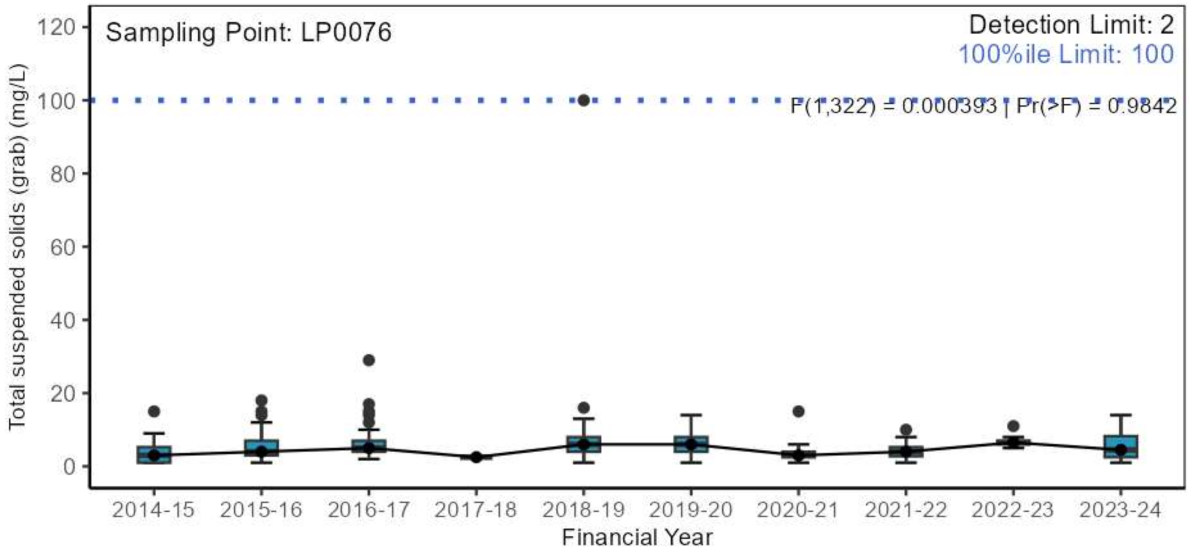


Major conventional analytes

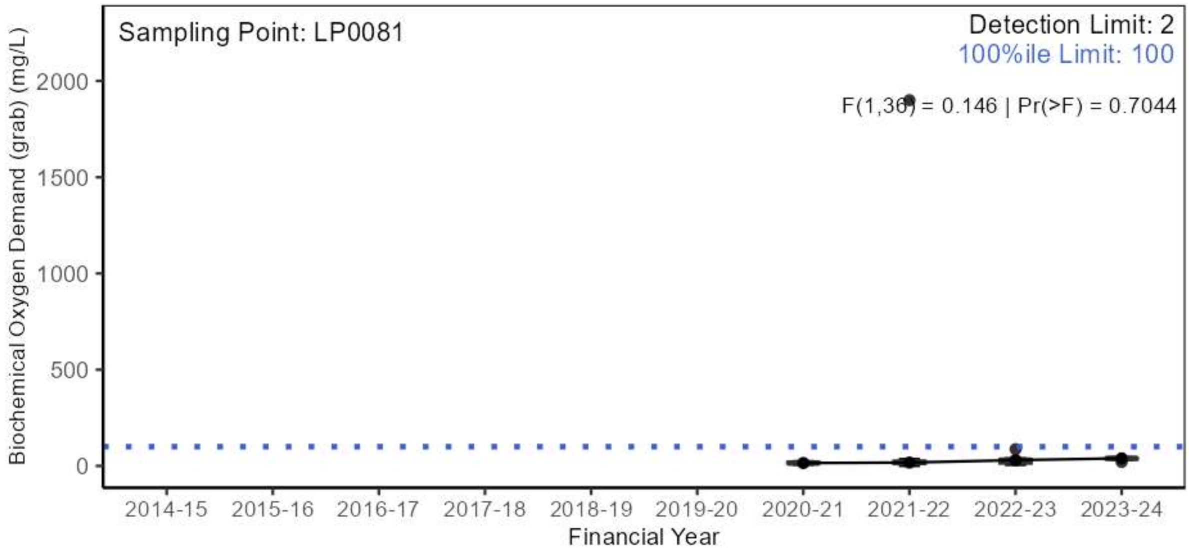



Sampling Point: LP0015
Detection Limit: 2
100%ile Limit: 100
F(1,486) = 2.97 | Pr(>F) = 0.0856
Total suspended solids (grab) (mg/L)
250
200
150
100
50
0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year

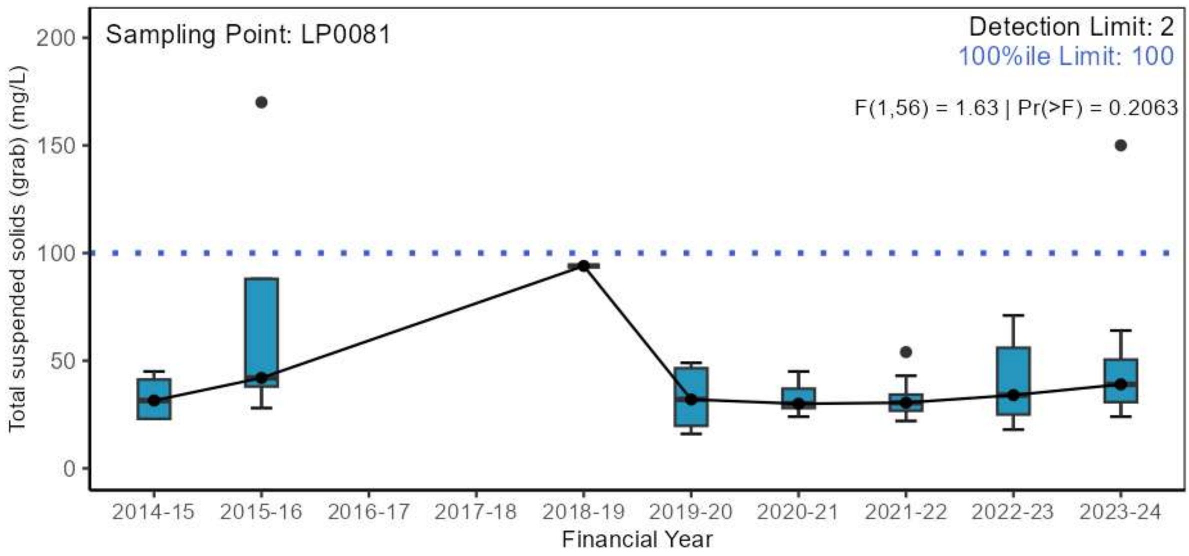

Sampling Point: LP0076
Detection Limit: 2
100%ile Limit: 100
F(1,65) = 0.104 | Pr(>F) = 0.7476
Biochemical Oxygen Demand (composite) (mg/L)
15
10
5
0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



Sampling Point: LP0076
Detection Limit: 2
100%ile Limit: 100
F(1,322) = 0.000393 | Pr(>F) = 0.9842
Total suspended solids (grab) (mg/L)
120
100
80
60
40
20
0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



Sampling Point: LP0081
Detection Limit: 2
100%ile Limit: 100
F(1,36) = 0.146 | Pr(>F) = 0.7044
Biochemical Oxygen Demand (grab) (mg/L)
2000
1500
1000
500
0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



B.3.2. Pressure – Wastewater quantity

B.4. EPL limits of the Georges River WRRF

Table B-1 EPL concentration limits for the Georges River WRRFs (2023-24)

WRRF	Sampling Points	Biochemical Oxygen Demand (mg/L)	Total Suspended Solids (mg/L)
		100th %-ile	100th %-ile
Glenfield	GF0020 (G)	100	100
Fairfield	FF0024 (G)	100	120
Liverpool	LP0015 - discharge (G)	100	100
	LP0076 - irrigation (C)	100	100
	LP0081 - discharge (G)	100	100

C. Other monitoring – Freshwater

C.1. Water quality and chlorophyll-a – Other long term HN River sites (SoE)

Water quality and chlorophyll-a for the 10 SoE sites are presented in the following order from upstream to downstream:

- N44: Nepean River at Yarramundi Bridge
- NS04A: Lower South Creek at Fitzroy Bridge
- N35: Hawkesbury River at Wilberforce
- NC11A: Lower Cattai Creek at Cattai Ridge Road
- N3001: Hawkesbury River off Cattai SRA
- N26: Hawkesbury River at Sackville Ferry
- N2202: Lower Colo River at Putty Road
- N18: Hawkesbury River at Leets Vale
- NB13: Berowra Creek at Calabash Bay
- NB11: Berowra Creek off Square Bay

The water quality box plots and needle plots are presented in the following groups and order of analytes:

- Nutrients
  - Total ammonia nitrogen
  - Oxidised nitrogen
  - Total nitrogen
  - Soluble reactive phosphorus
  - Filterable total phosphorus
  - Total phosphorus
- Physico-chemical analytes
  - Conductivity
  - Dissolved oxygen (mg/L)
  - Dissolved oxygen saturation (%)
  - pH
  - Water temperature
  - Turbidity

- Trace metals
  - Filterable aluminium
  - Total aluminium
  - Filterable cobalt
  - Total cobalt
  - Filterable copper
  - Total copper
  - Filterable nickel
  - Total nickel
  - Filterable zinc
  - Total zinc
- Phytoplankton (paired box plots and needle plots)
  - Chlorophyll-a

Statistical analysis outcome tables for SoE sites for all monitoring analytes are presented first before the plots.

Other supplementary outcomes from statistical analysis on e.g. ANOVA and estimated marginal means on SoE waterway sites are included as electronic appendices sent to the EPA.

C.1.1. Nepean River at Yarramundi Bridge (N44)

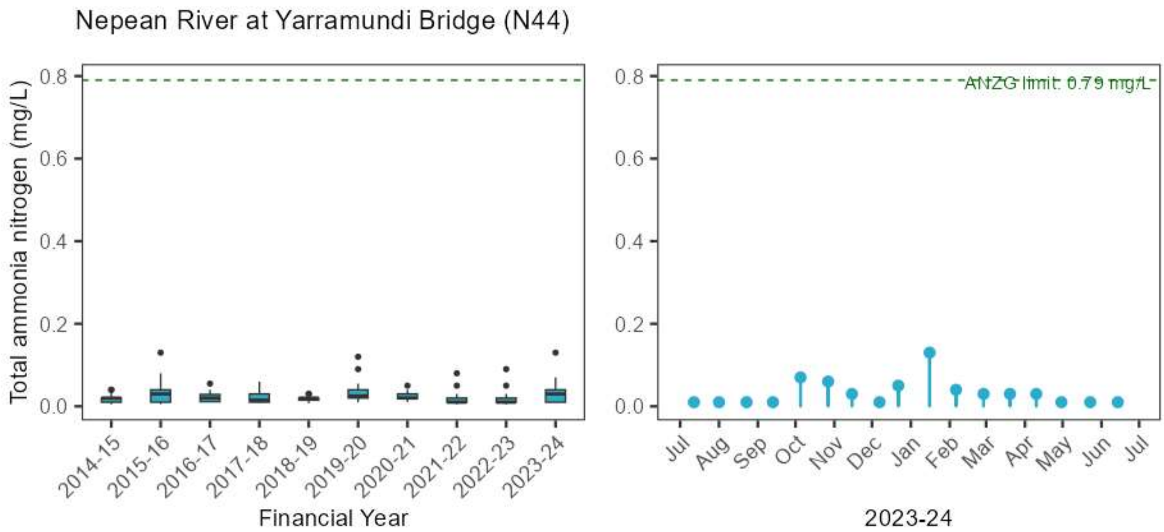
Stressors - Statistical analysis outcomes

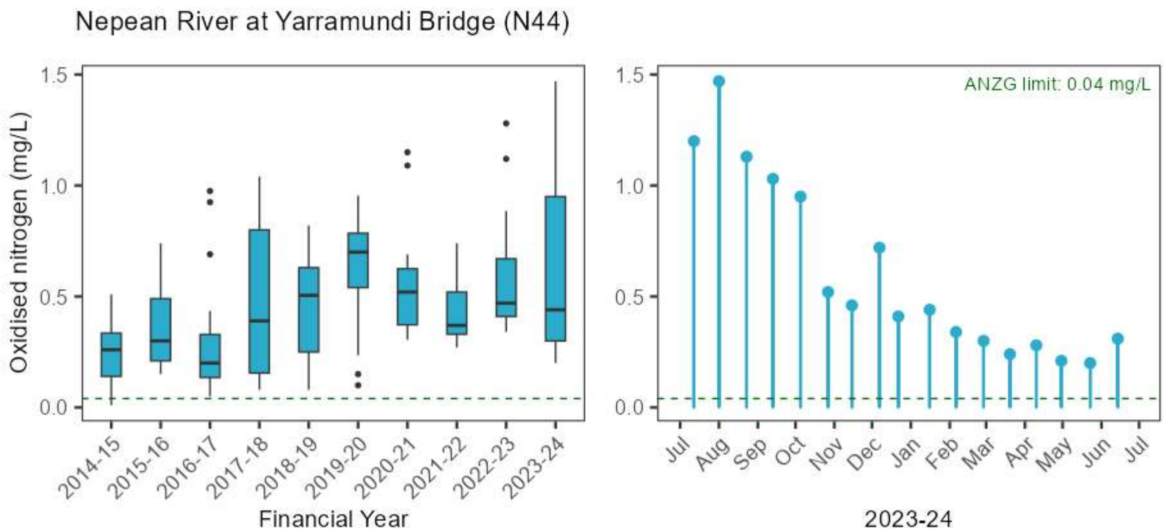
Table C-1 Current period vs previous period comparison contrast outcomes for N44

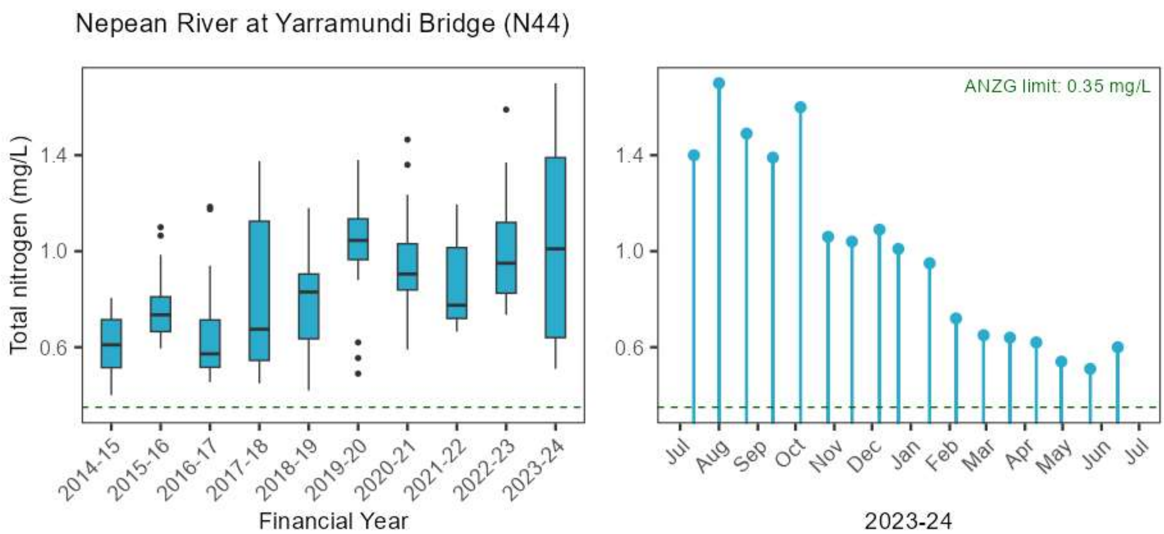
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.21	0.21	160	1.12	0.264
Oxidised nitrogen	1.37	0.25	160	1.75	0.083
Total nitrogen	1.17	0.09	160	2.17	0.032
Filterable total phosphorus	1.33	0.12	160	3.18	0.002
Total phosphorus	1.72	0.13	160	7.04	<0.001
Conductivity	1.17	0.06	160	2.94	0.004
Dissolved oxygen	1.05	0.04	159	1.39	0.167
Dissolved oxygen saturation	6.47	2.36	159	2.75	0.007
pH	0.30	0.11	160	2.70	0.008
Water temperature	1.06	0.08	160	0.78	0.434
Turbidity	1.34	0.19	160	2.03	0.044
Chlorophyll - a	1.55	0.33	158	2.04	0.043

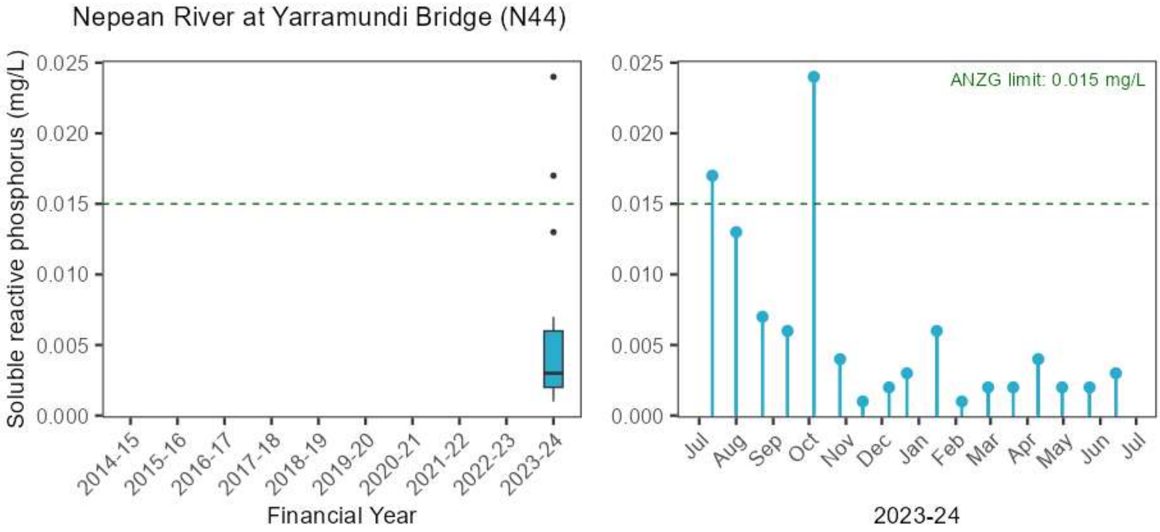
	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

Stressors – Nutrients

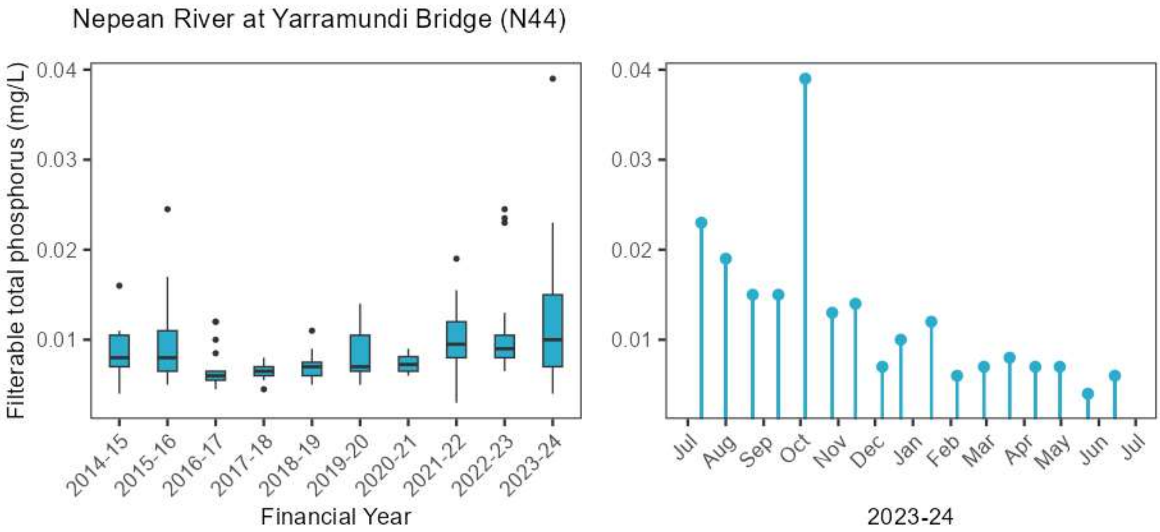




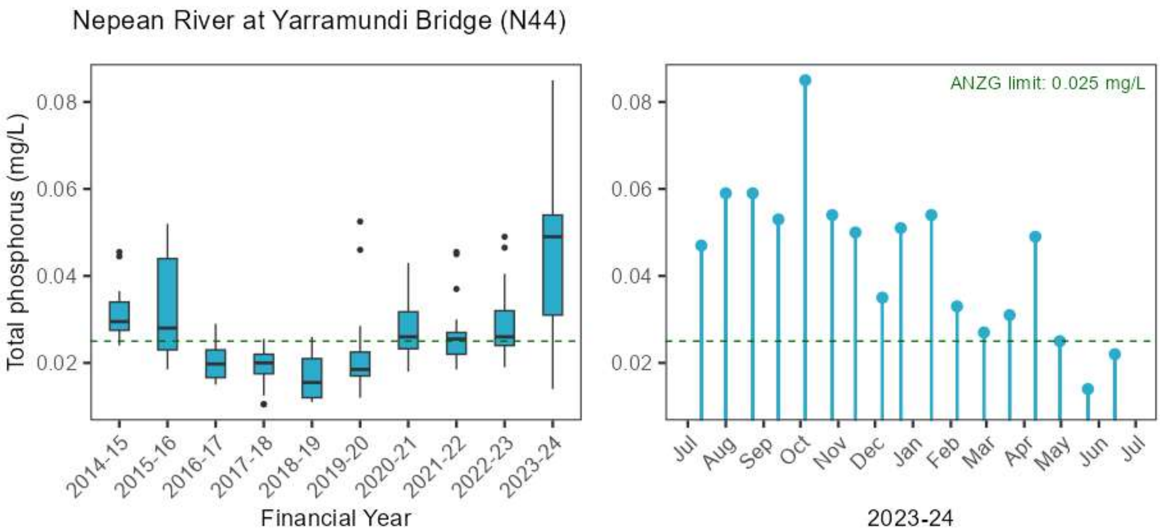




Nepean River at Yarramundi Bridge (N44)
Soluble reactive phosphorus (mg/L)
0.025
0.020
0.015
0.010
0.005
0.000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.015 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

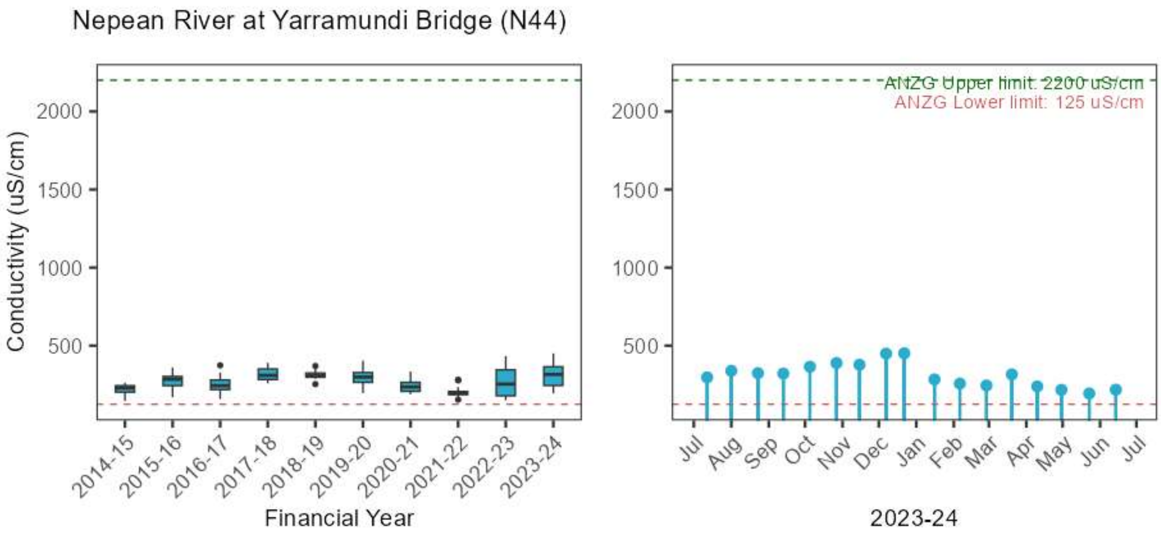


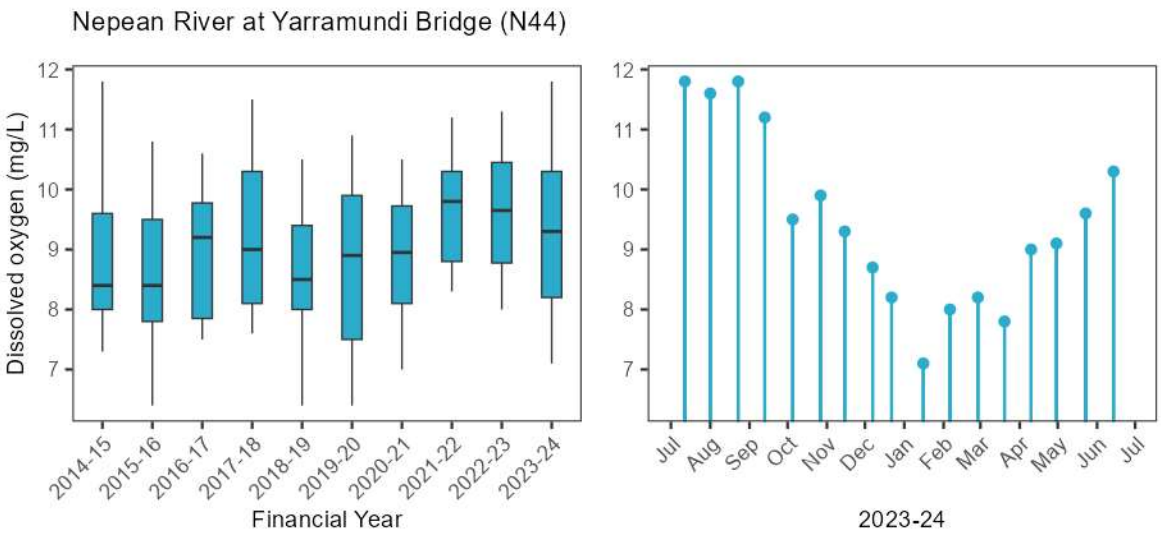
Nepean River at Yarramundi Bridge (N44)
Filterable total phosphorus (mg/L)
0.04
0.03
0.02
0.01
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

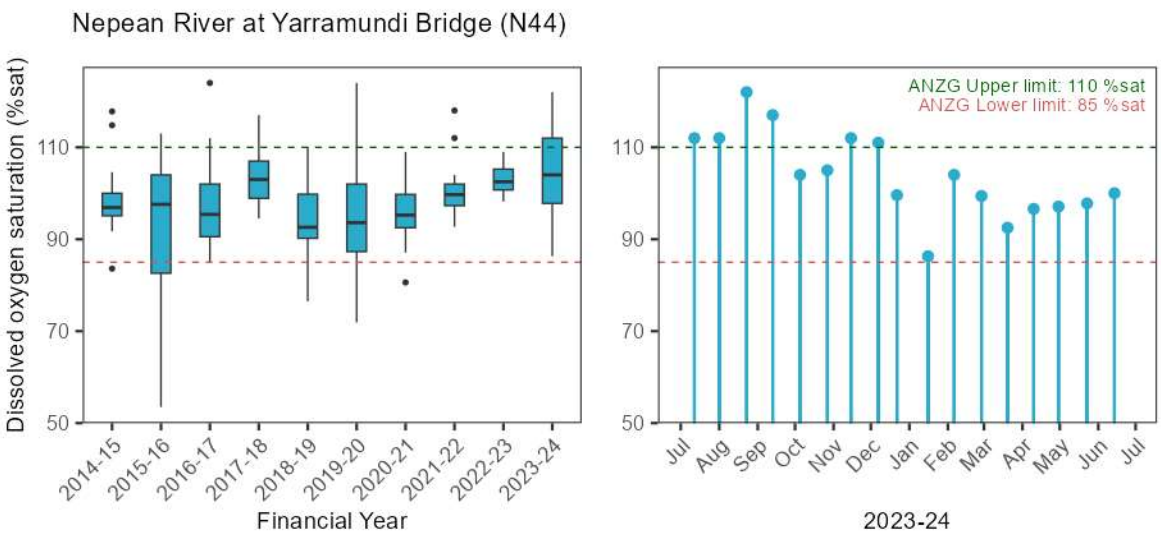


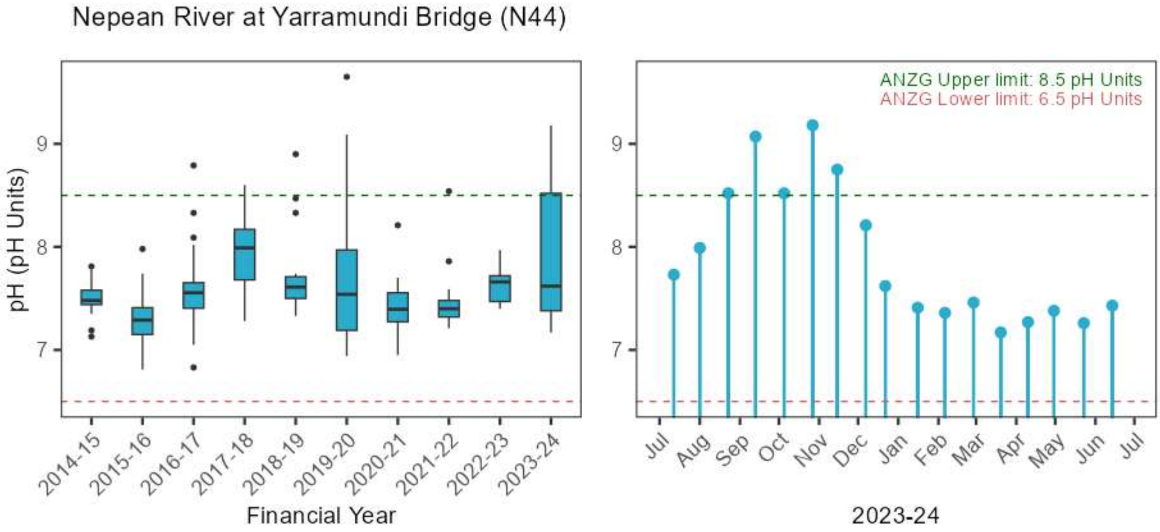
Nepean River at Yarramundi Bridge (N44)
Total phosphorus (mg/L)
0.08
0.06
0.04
0.02
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.025 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

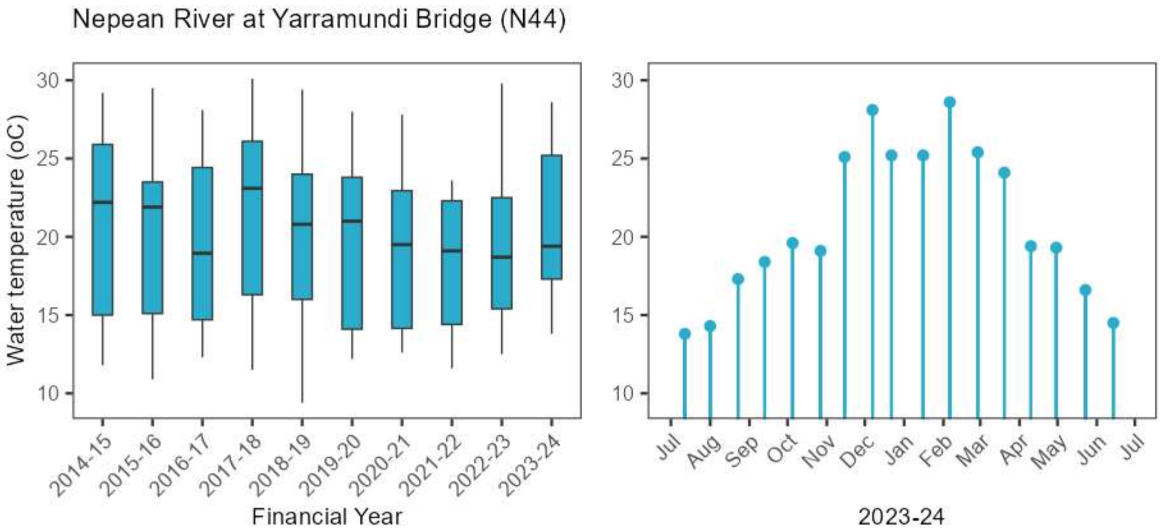
Stressors – Physico-chemical water quality

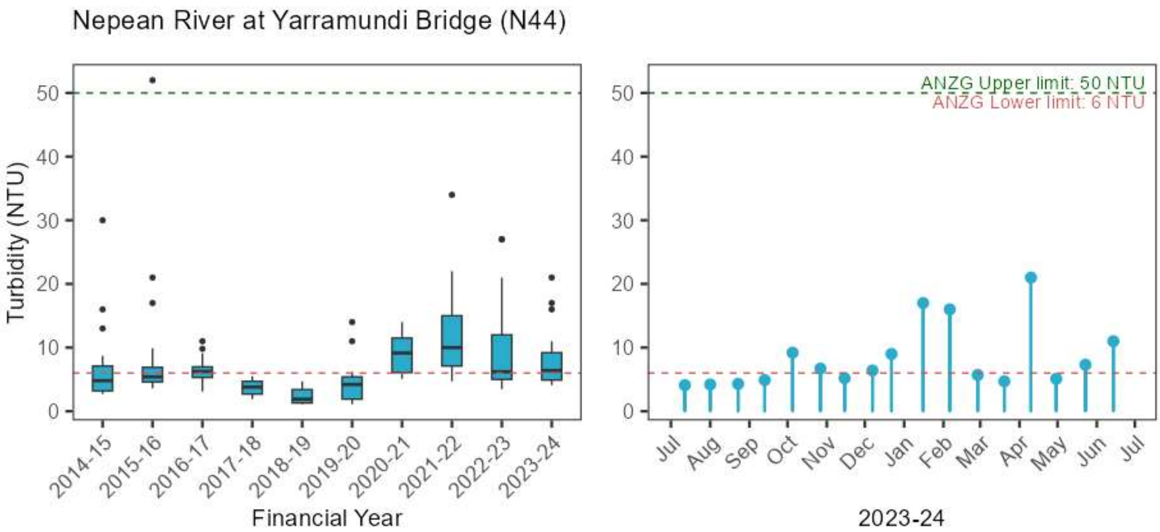




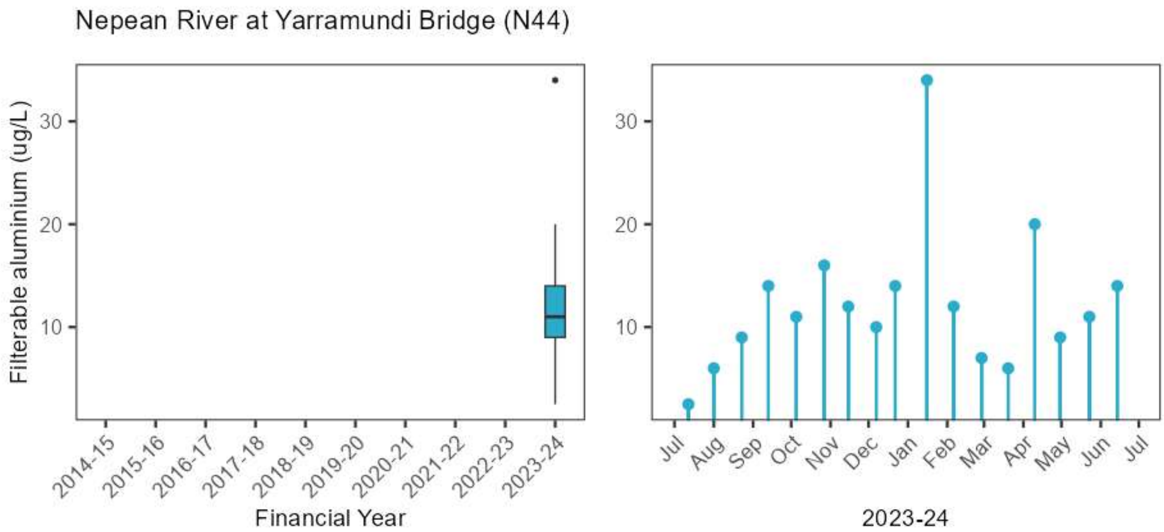


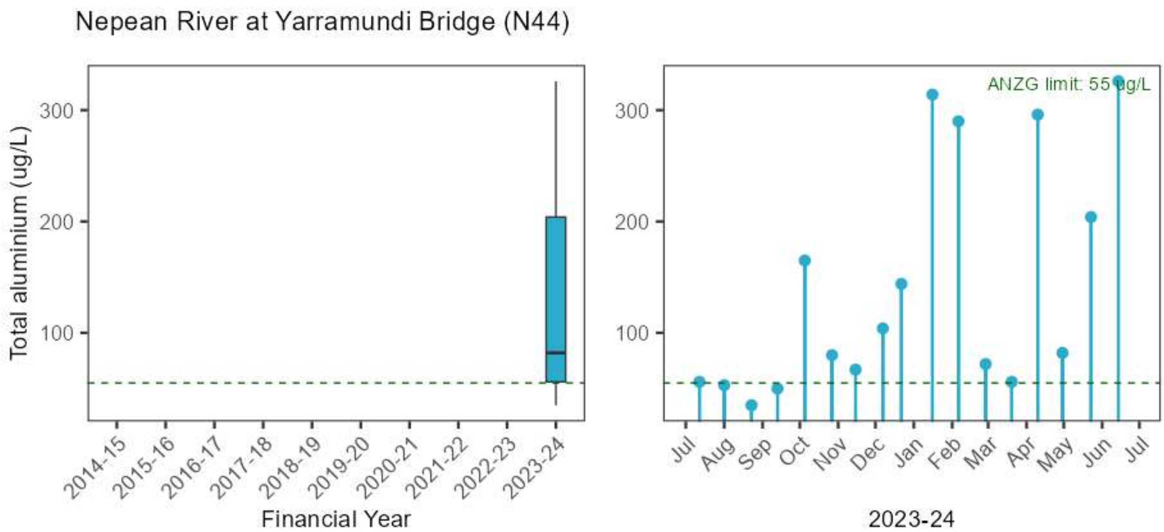

Nepean River at Yarramundi Bridge (N44)
pH (pH Units)
Financial Year
2023-24
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units

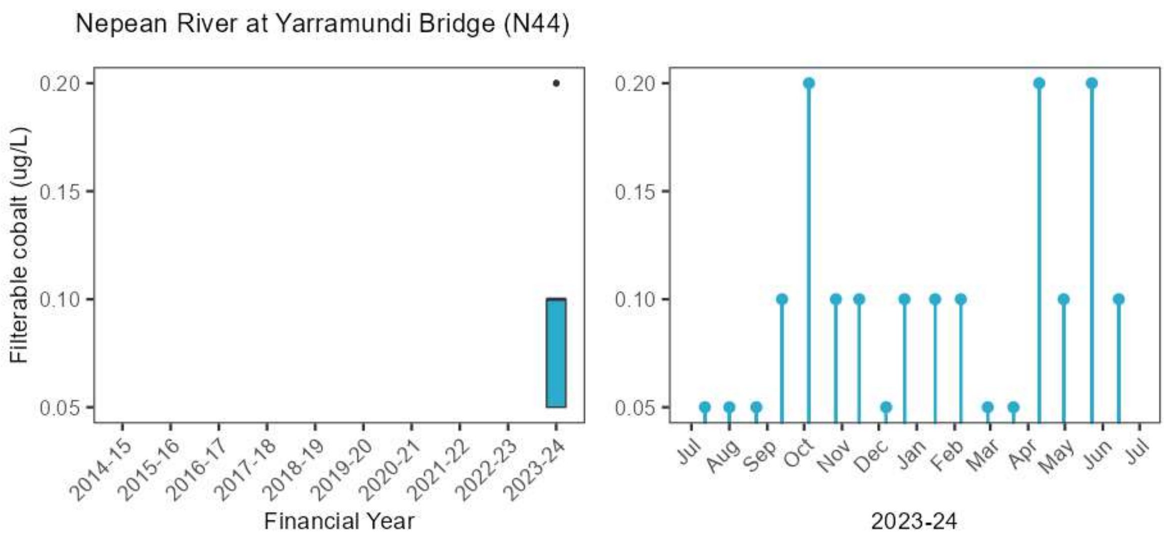

Nepean River at Yarramundi Bridge (N44)
Water temperature (oC)
Financial Year
2023-24

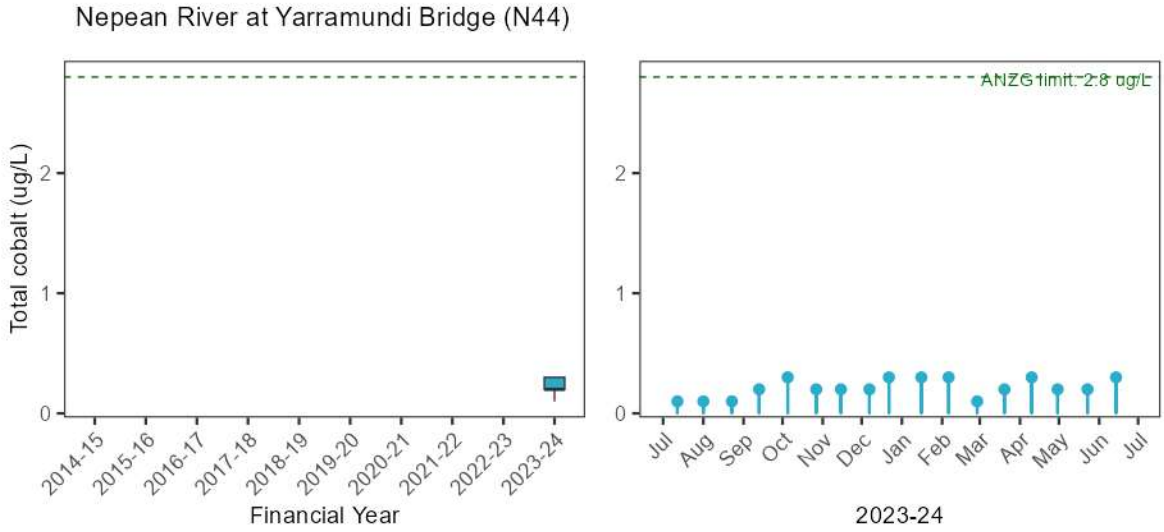

Nepean River at Yarramundi Bridge (N44)
Turbidity (NTU)
Financial Year
2023-24
ANZG Upper limit: 50 NTU
ANZG Lower limit: 6 NTU

Stressors – Trace metals

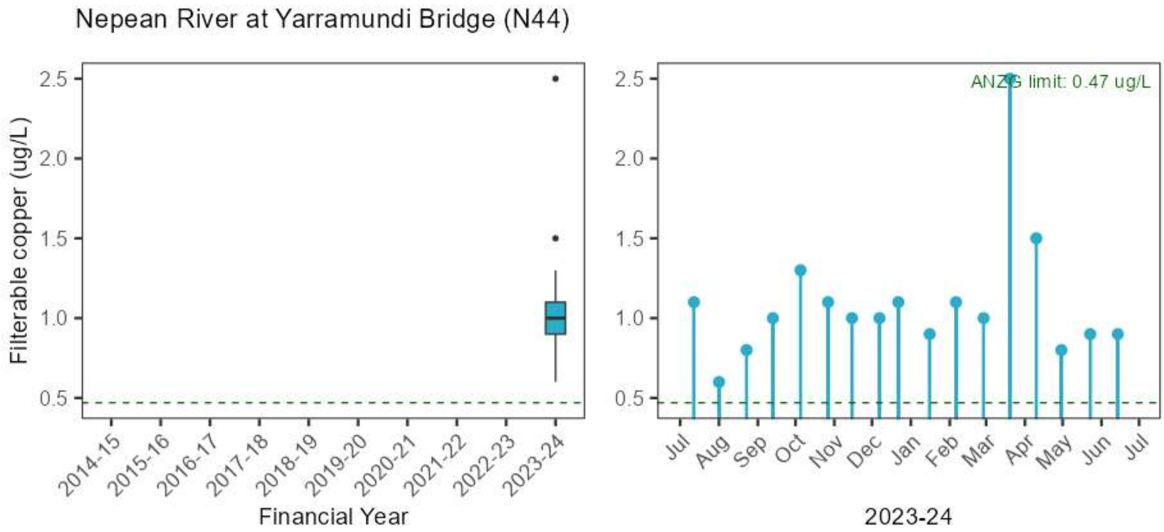




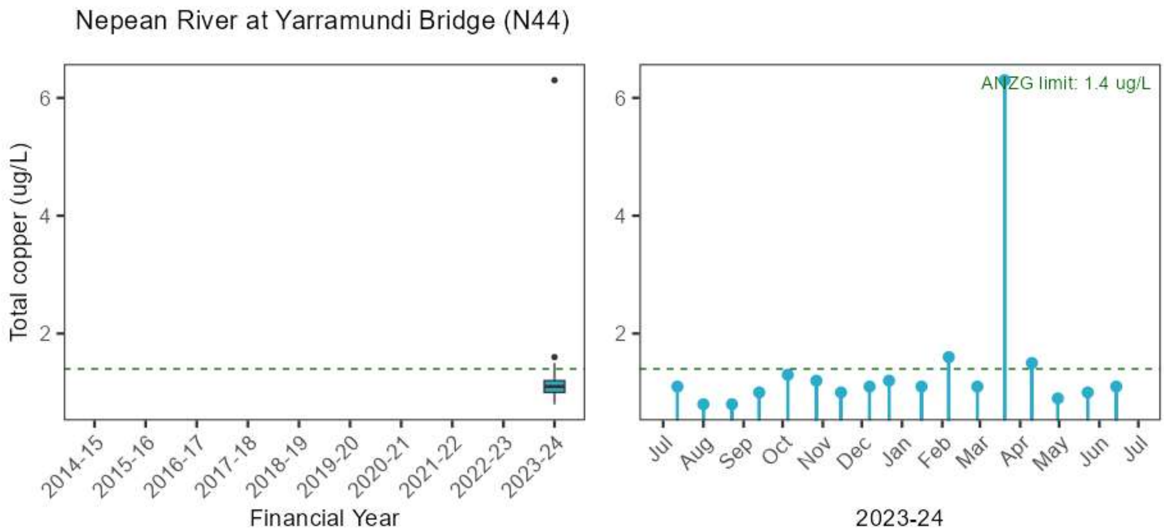




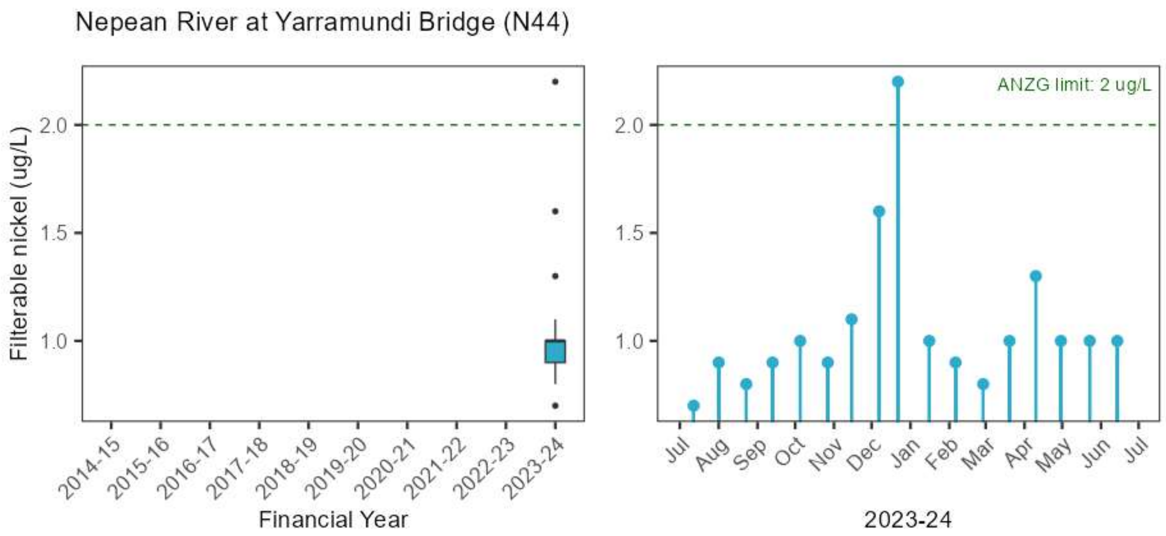
Nepean River at Yarramundi Bridge (N44)
Total cobalt (ug/L)
ANZG limit: 2.8 ug/L
Financial Year
2023-24

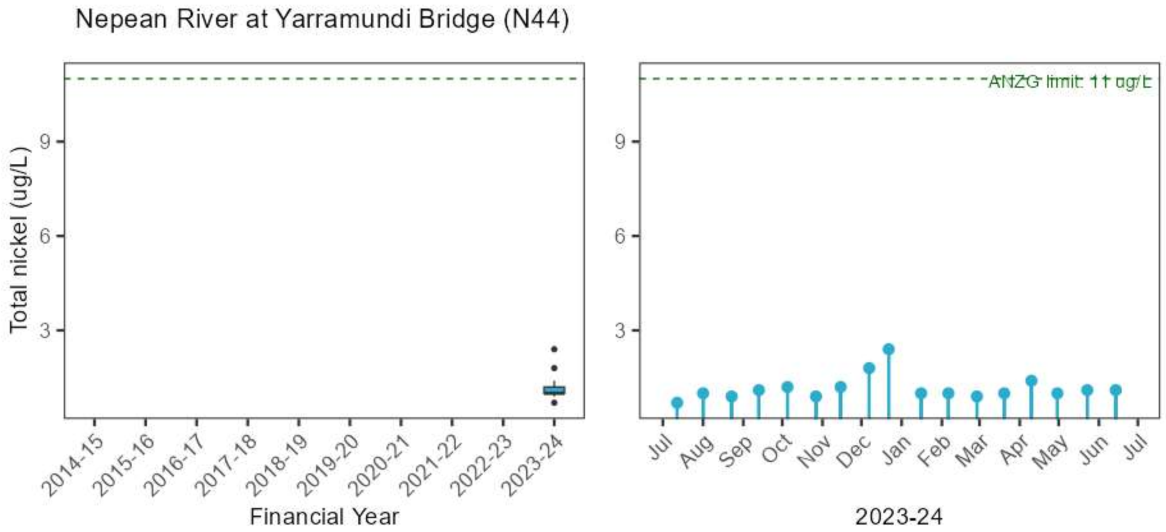


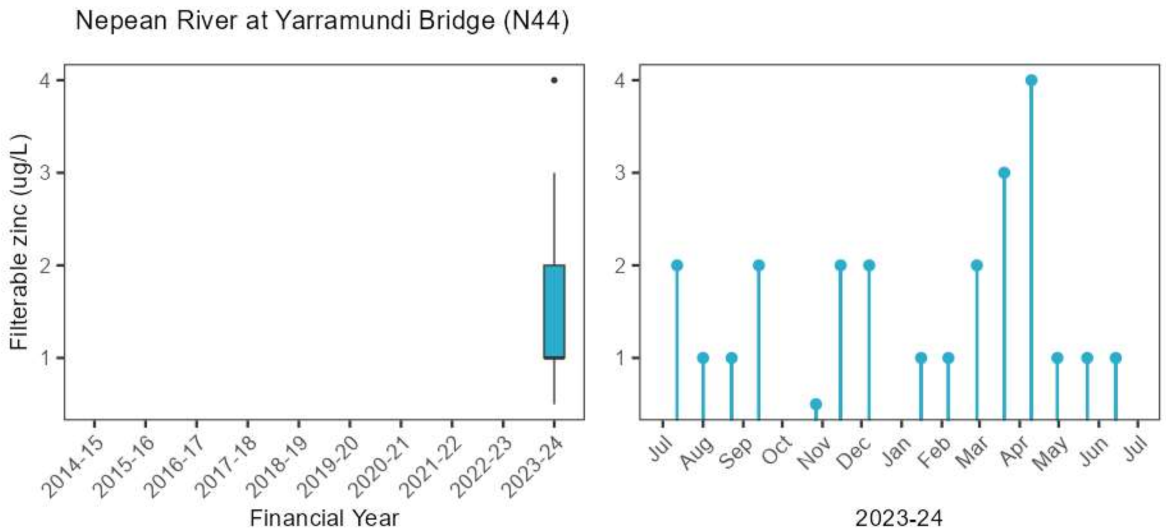
Nepean River at Yarramundi Bridge (N44)
Filterable copper (ug/L)
ANZG limit: 0.47 ug/L
Financial Year
2023-24

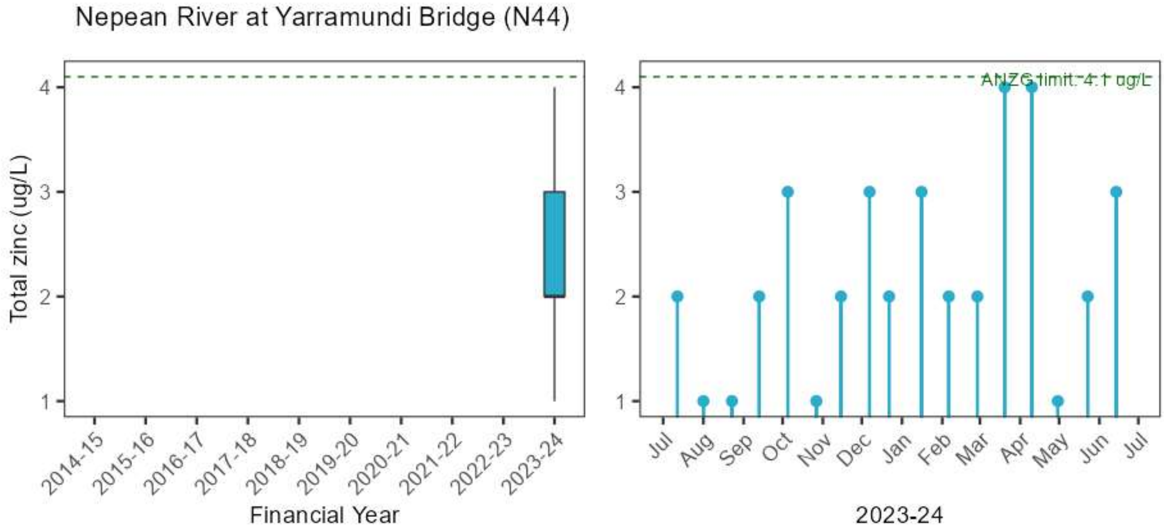


Nepean River at Yarramundi Bridge (N44)
Total copper (ug/L)
ANZG limit: 1.4 ug/L
Financial Year
2023-24

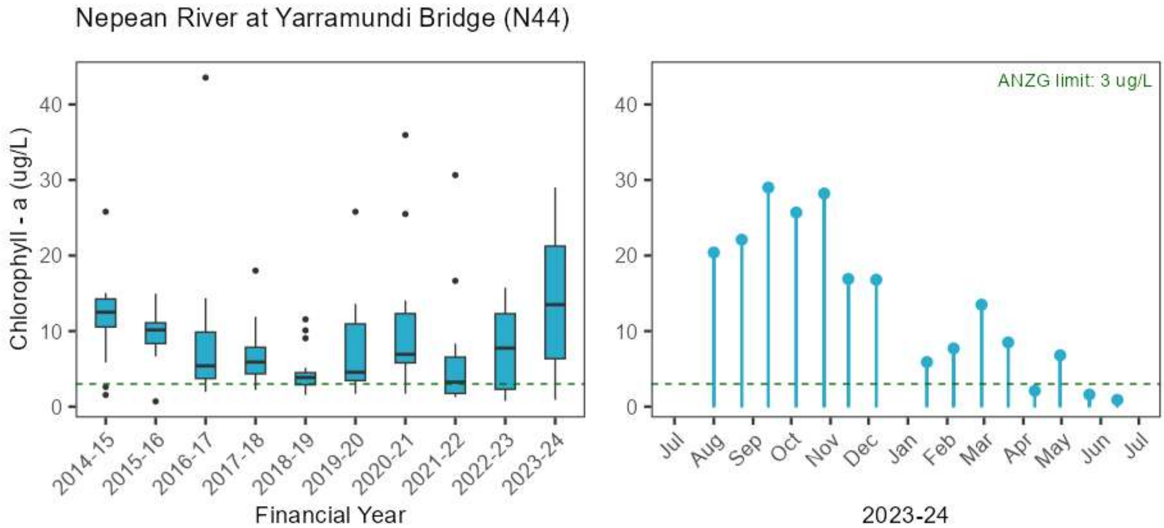

Nepean River at Yarramundi Bridge (N44)
Filterable nickel (ug/L)
2.0
1.5
1.0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 2 ug/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Nepean River at Yarramundi Bridge (N44)
Total nickel (ug/L)
9
6
3
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 11 ug/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Nepean River at Yarramundi Bridge (N44)
Filterable zinc (ug/L)
4
3
2
1
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24



Ecosystem receptor – Phytoplankton



C.1.2. Lower South Creek at Fitzroy bridge, (NS04A)

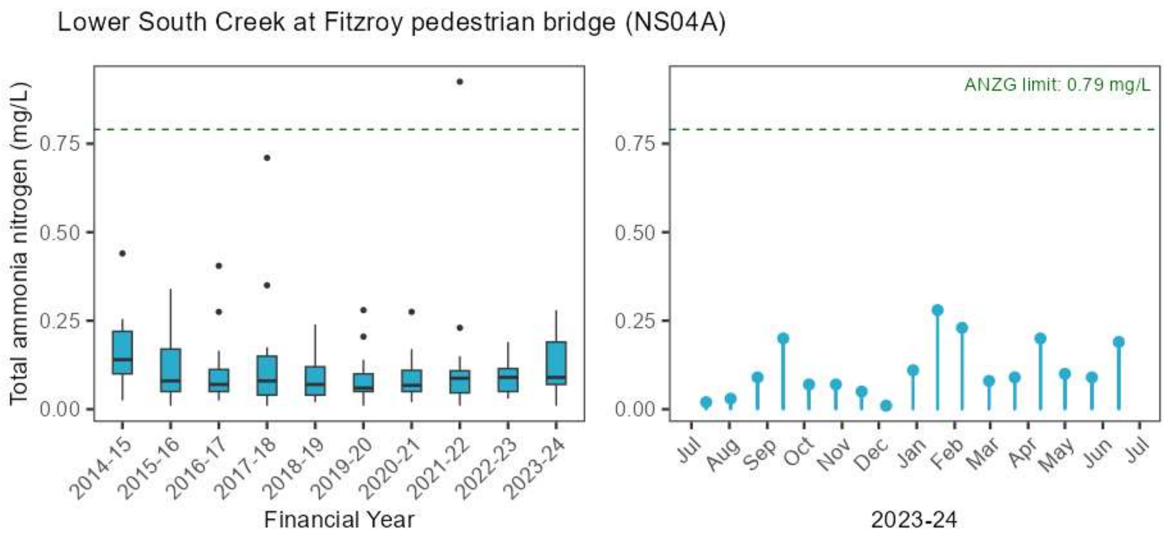
Stressors - Statistical analysis outcomes

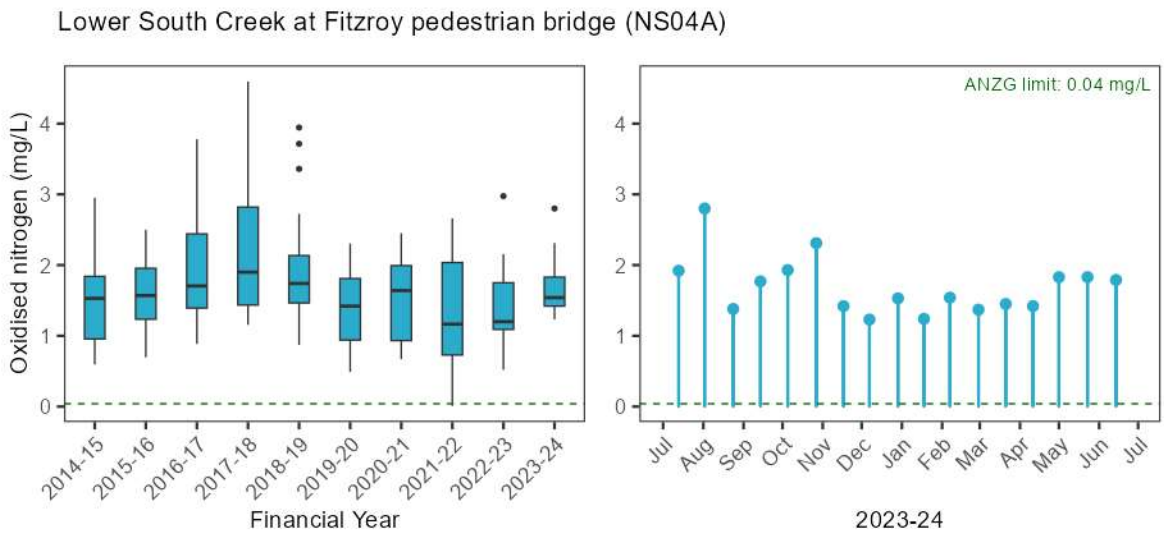
Table C-2 Current period vs previous period comparison contrast outcomes for NS04A

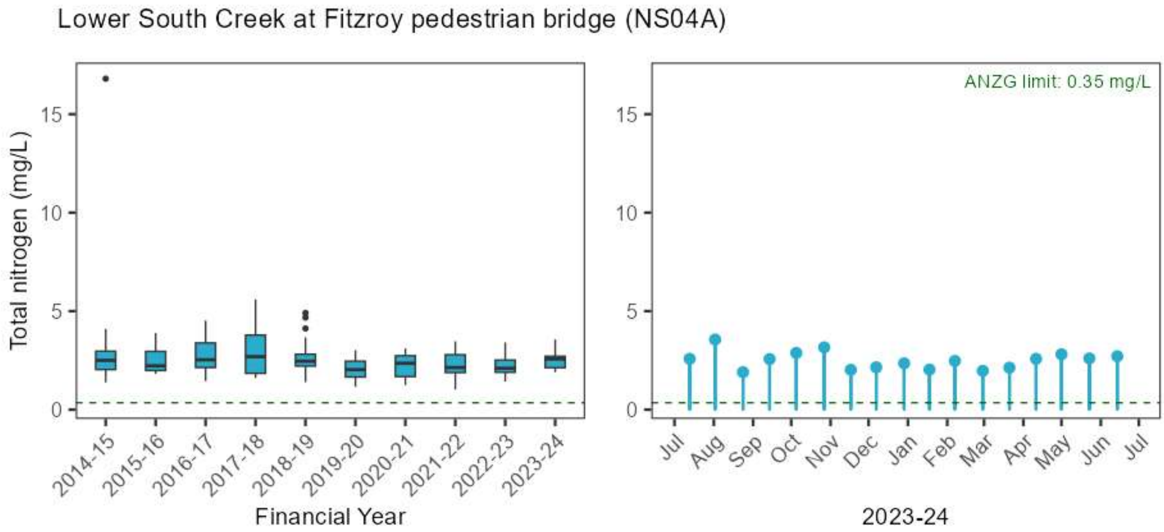
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.03	0.21	161	0.16	0.870
Oxidised nitrogen	1.16	0.17	161	1.02	0.307
Total nitrogen	1.05	0.09	161	0.53	0.596
Filterable total phosphorus	1.11	0.16	161	0.74	0.458
Total phosphorus	1.08	0.12	161	0.66	0.510
Conductivity	0.96	0.08	161	-0.49	0.628
Dissolved oxygen	1.12	0.07	160	1.73	0.086
Dissolved oxygen saturation	8.66	3.07	160	2.82	0.005
pH	0.04	0.04	160	0.91	0.362
Water temperature	1.06	0.07	161	0.86	0.391
Turbidity	0.99	0.13	161	-0.11	0.911
Chlorophyll - a	0.72	0.18	161	-1.31	0.194

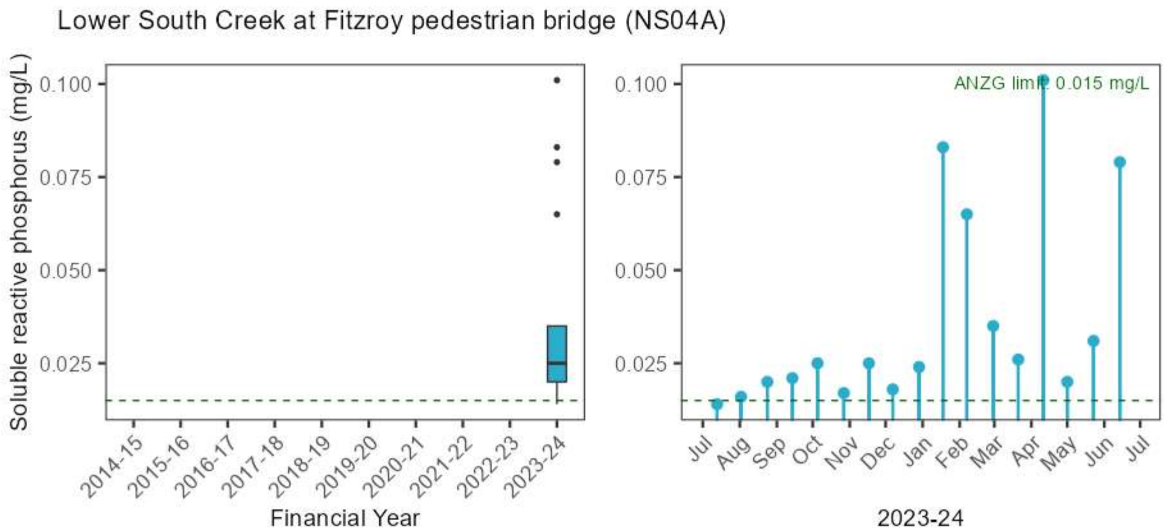
	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

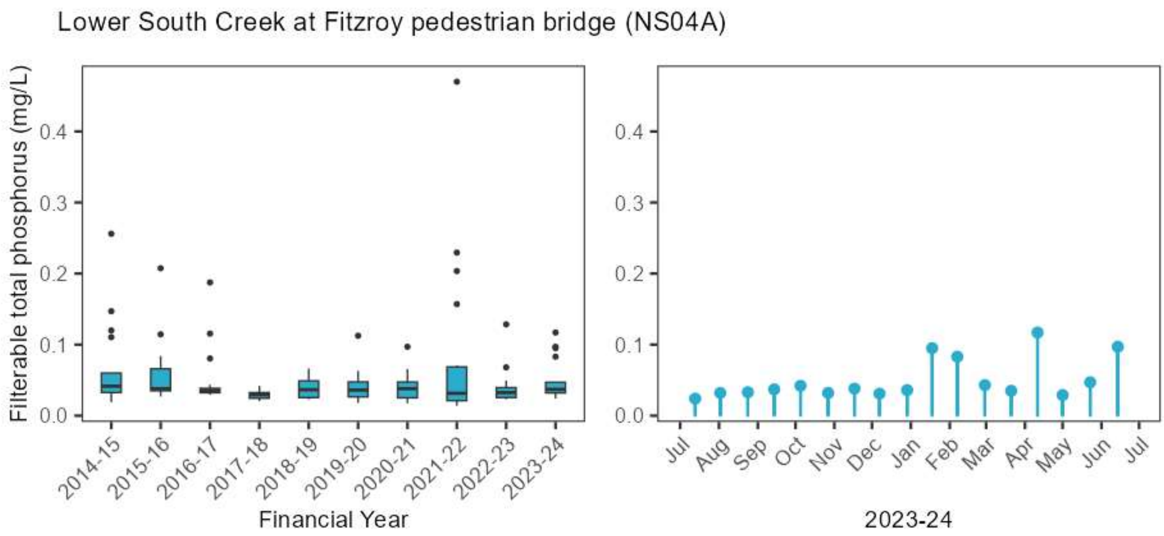
Stressors – Nutrients

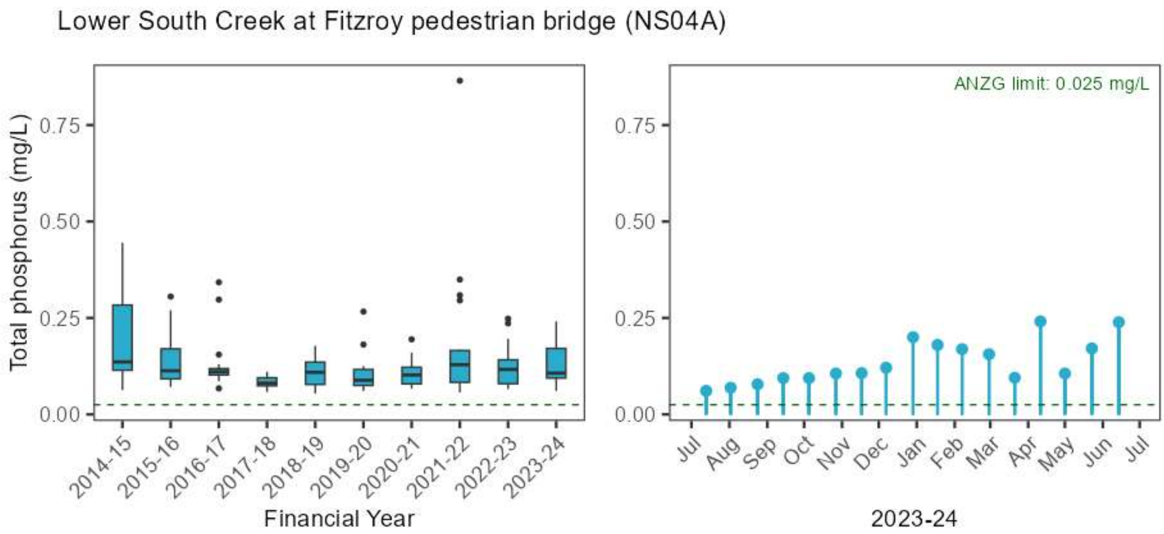



Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Oxidised nitrogen (mg/L)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
ANZG limit: 0.04 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

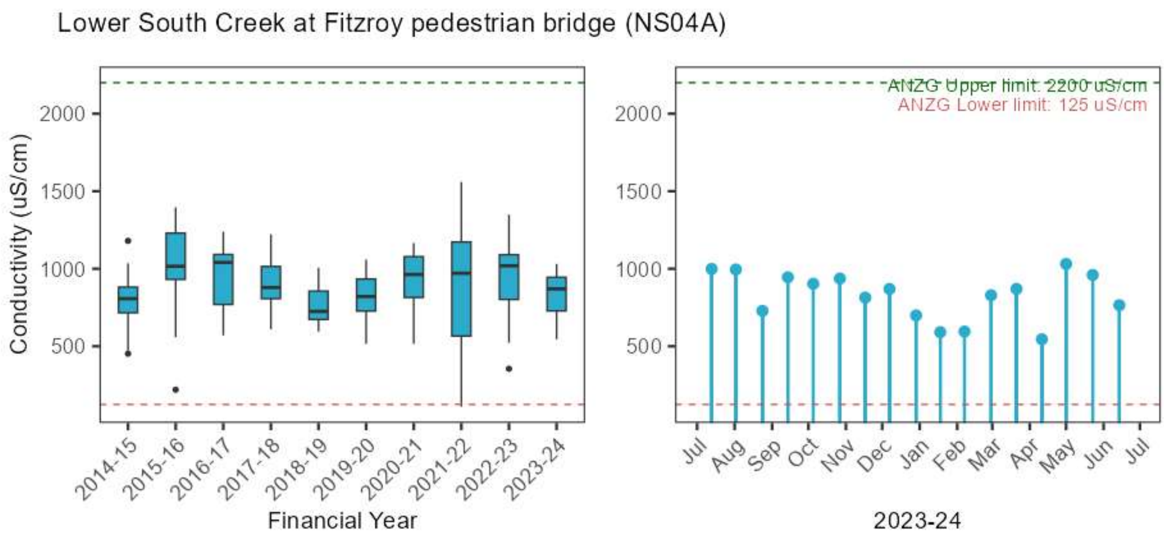

Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Total nitrogen (mg/L)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
ANZG limit: 0.35 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

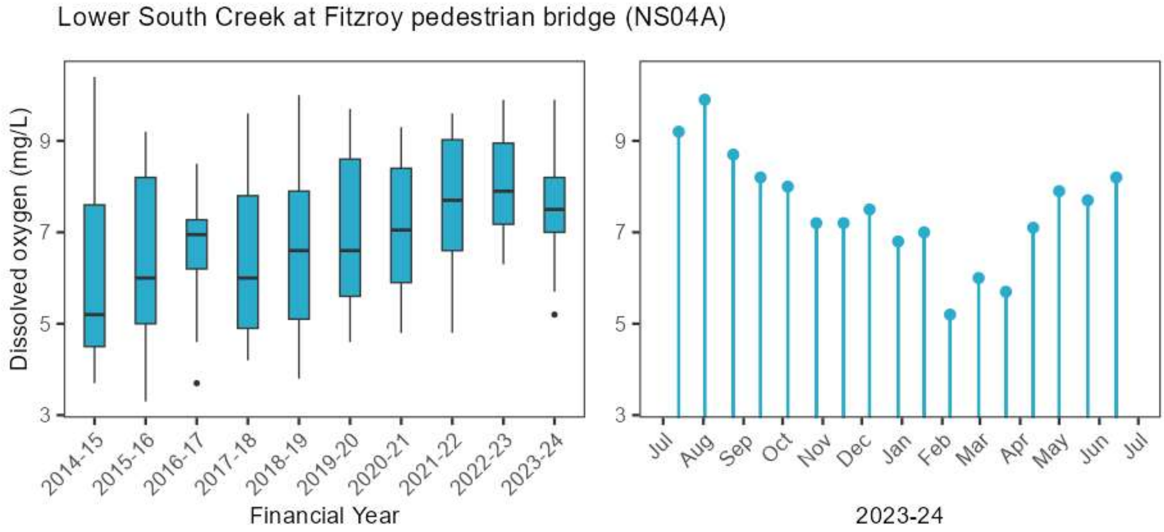

Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Soluble reactive phosphorus (mg/L)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
ANZG limit: 0.015 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

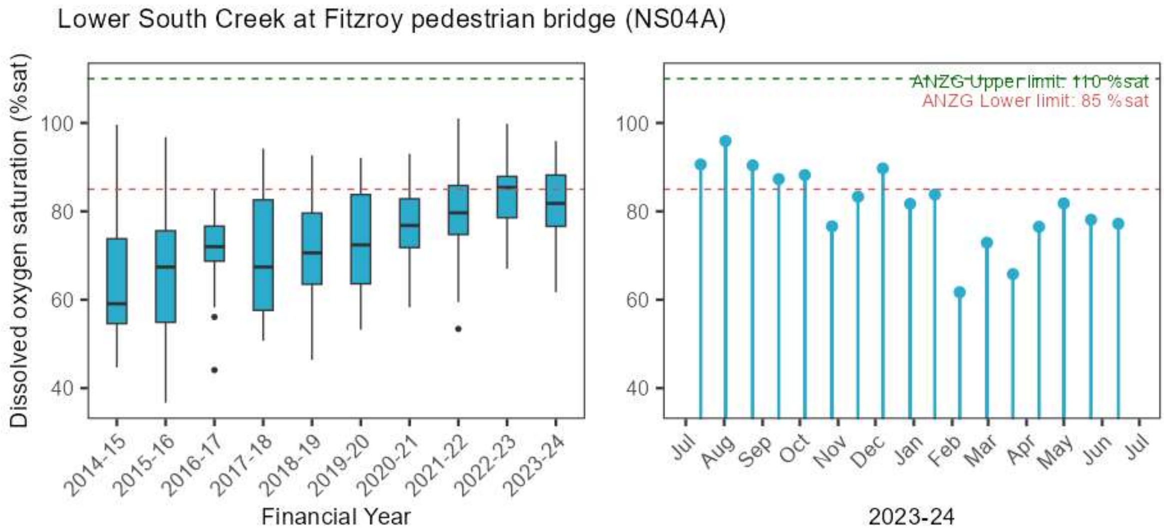


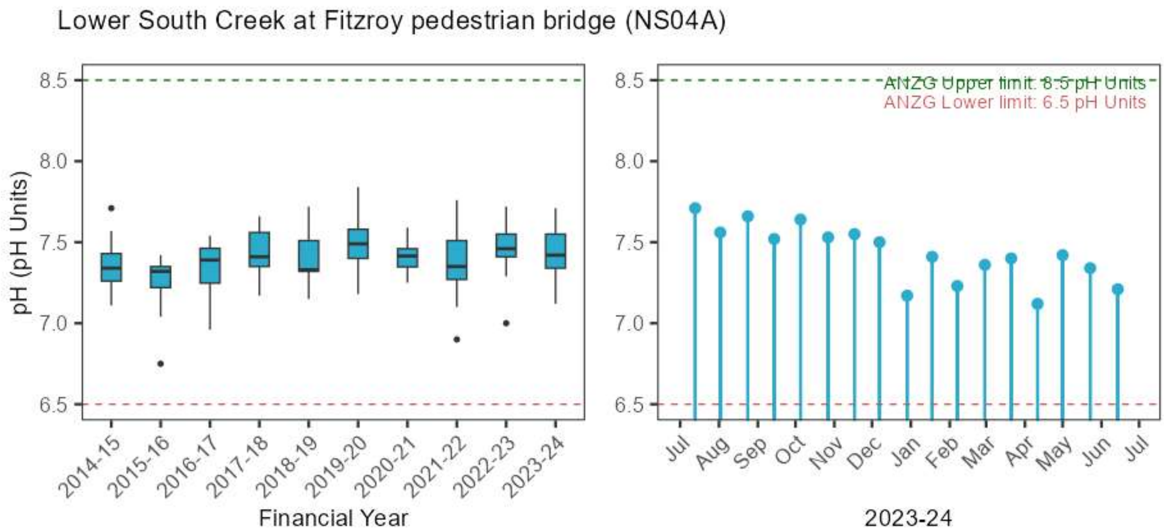


Stressors – Physico-chemical water quality

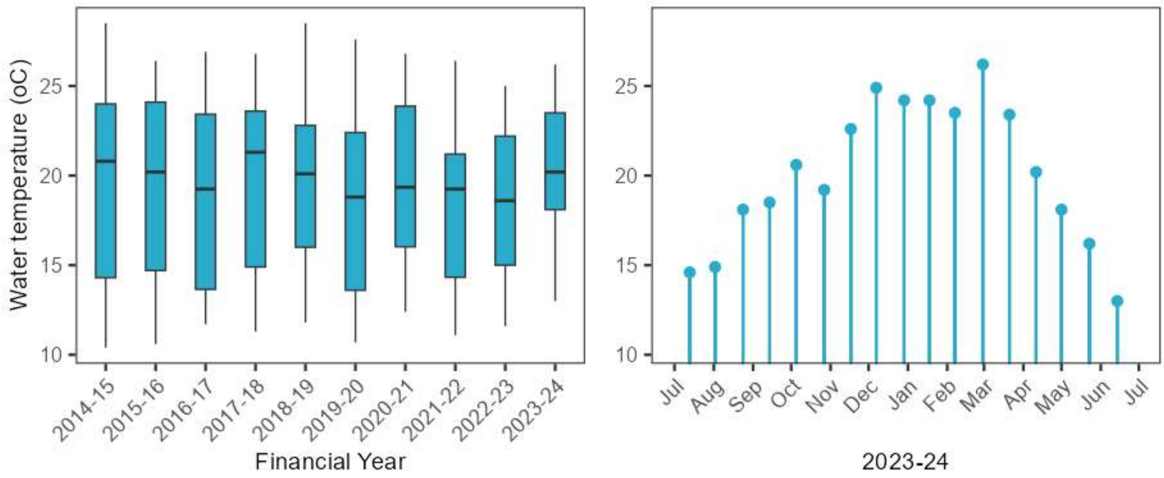



Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Dissolved oxygen (mg/L)
3
5
7
9
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24

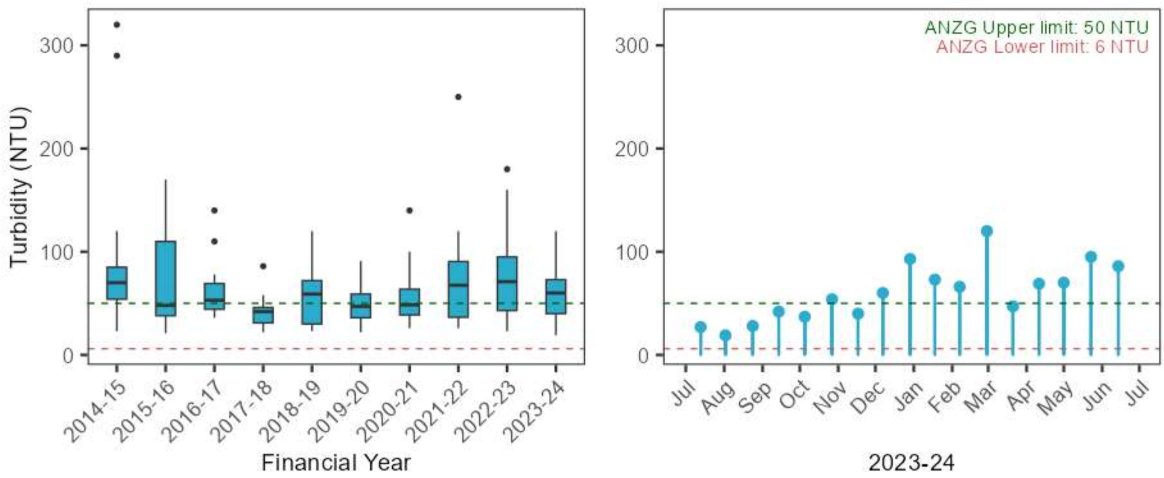

Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Dissolved oxygen saturation (%sat)
40
60
80
100
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG Upper limit: 110 %sat
ANZG Lower limit: 85 %sat
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24


Lower South Creek at Fitzroy pedestrian bridge (NS04A)
pH (pH Units)
6.5
7.0
7.5
8.0
8.5
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24

Lower South Creek at Fitzroy pedestrian bridge (NS04A)

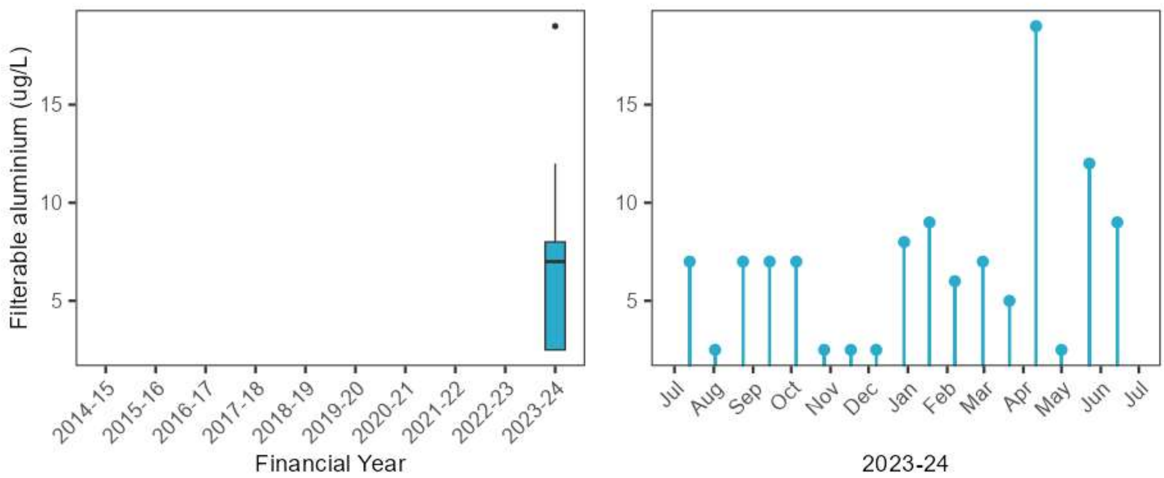


Lower South Creek at Fitzroy pedestrian bridge (NS04A)

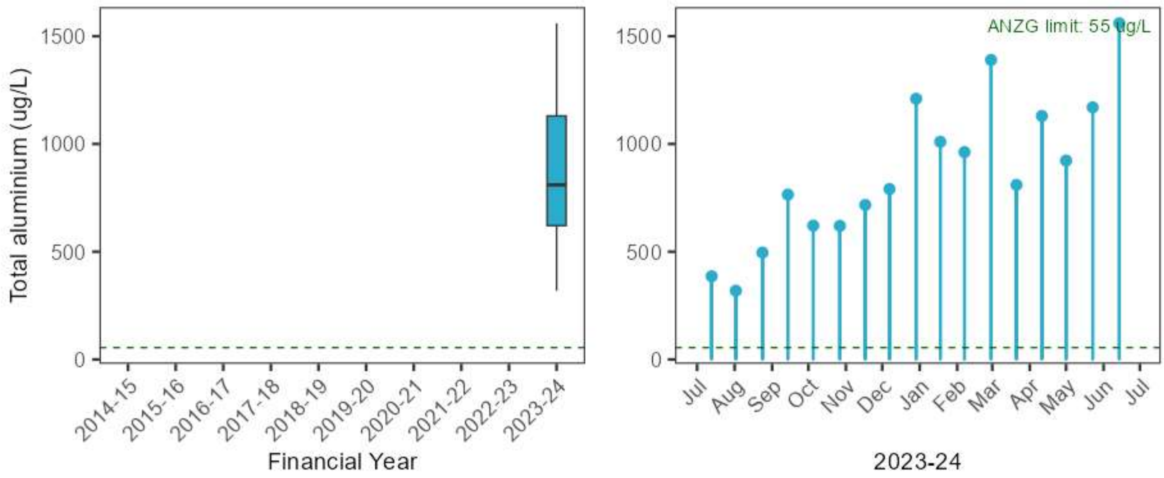


Stressors – Trace metals

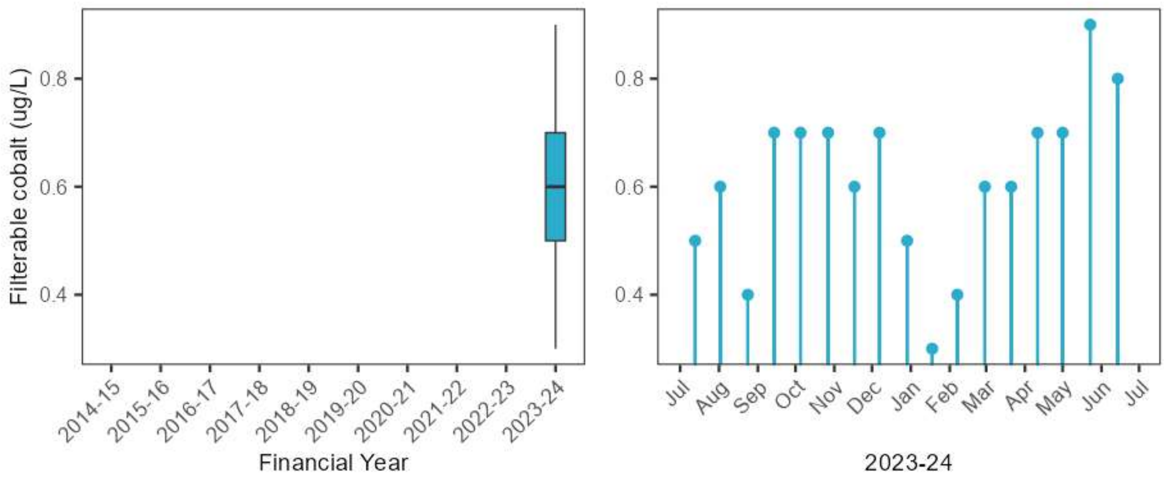
Lower South Creek at Fitzroy pedestrian bridge (NS04A)



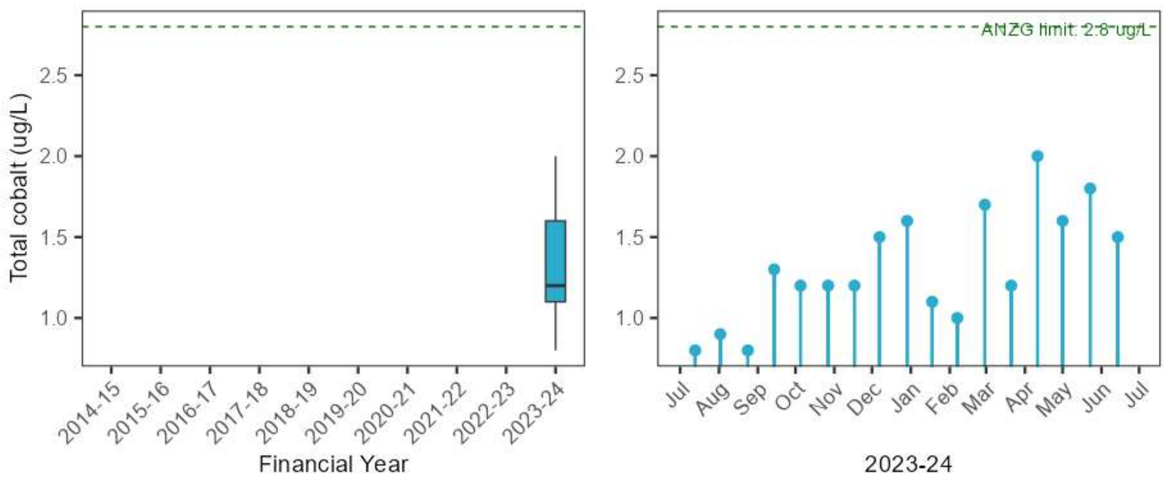
Lower South Creek at Fitzroy pedestrian bridge (NS04A)

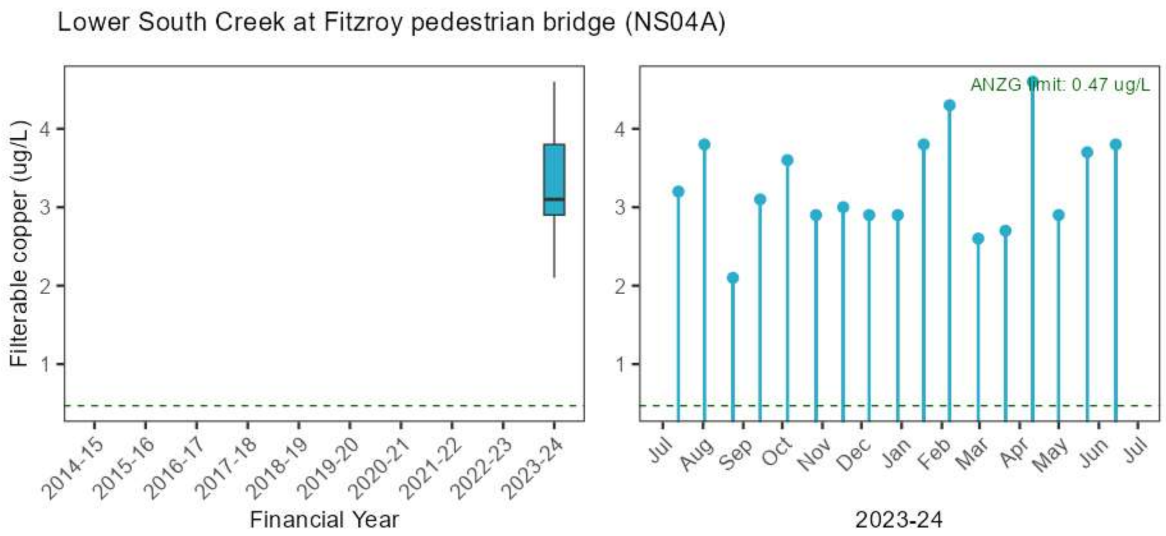


Lower South Creek at Fitzroy pedestrian bridge (NS04A)

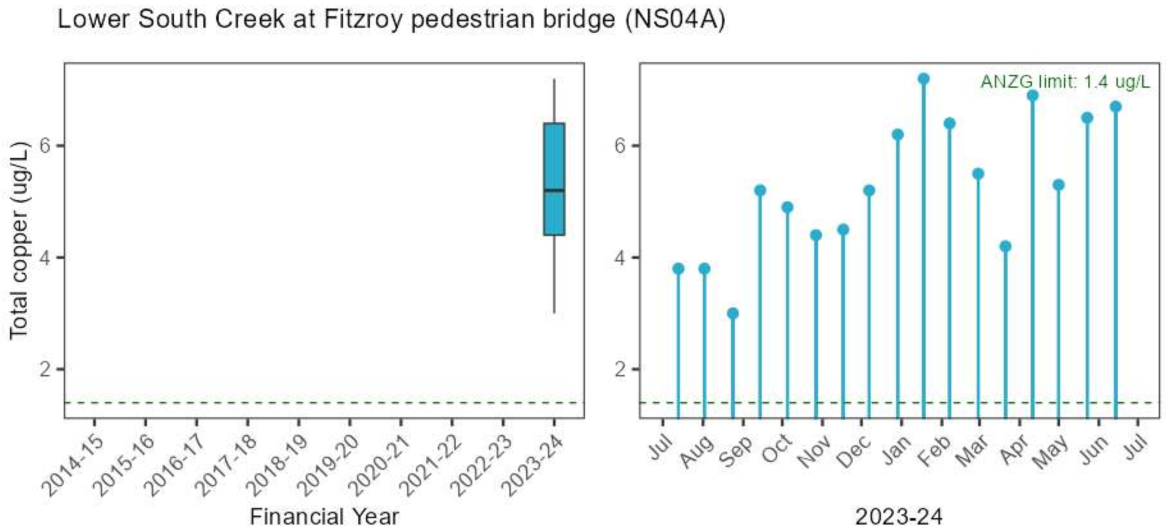


Lower South Creek at Fitzroy pedestrian bridge (NS04A)

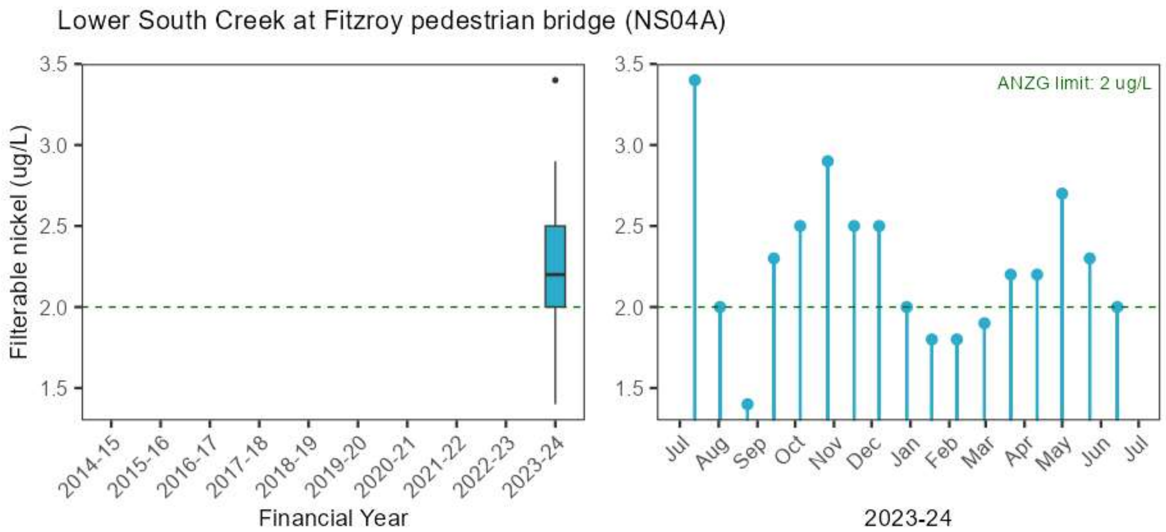




Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Filterable copper (ug/L)
ANZG limit: 0.47 ug/L
Financial Year
2023-24

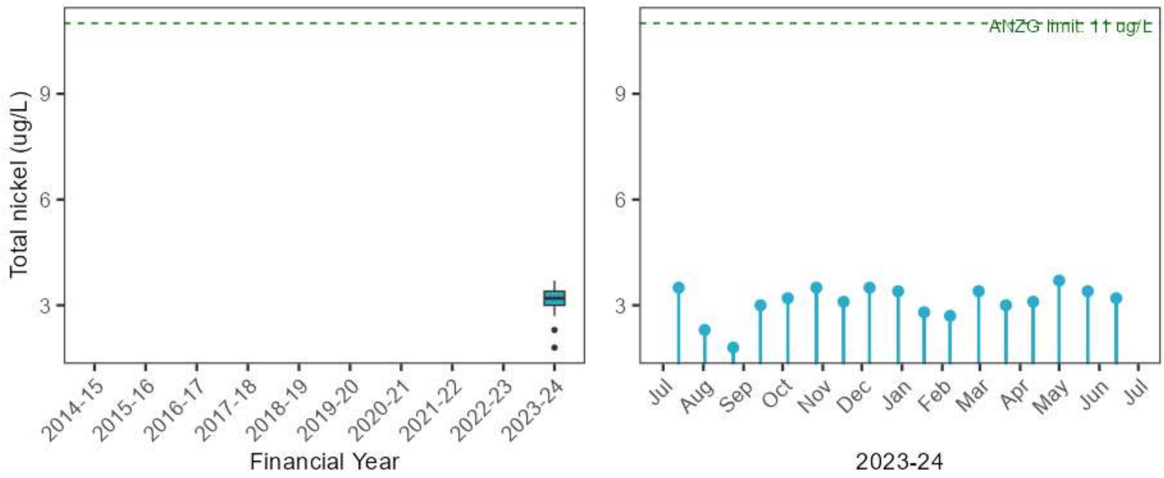


Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Total copper (ug/L)
ANZG limit: 1.4 ug/L
Financial Year
2023-24

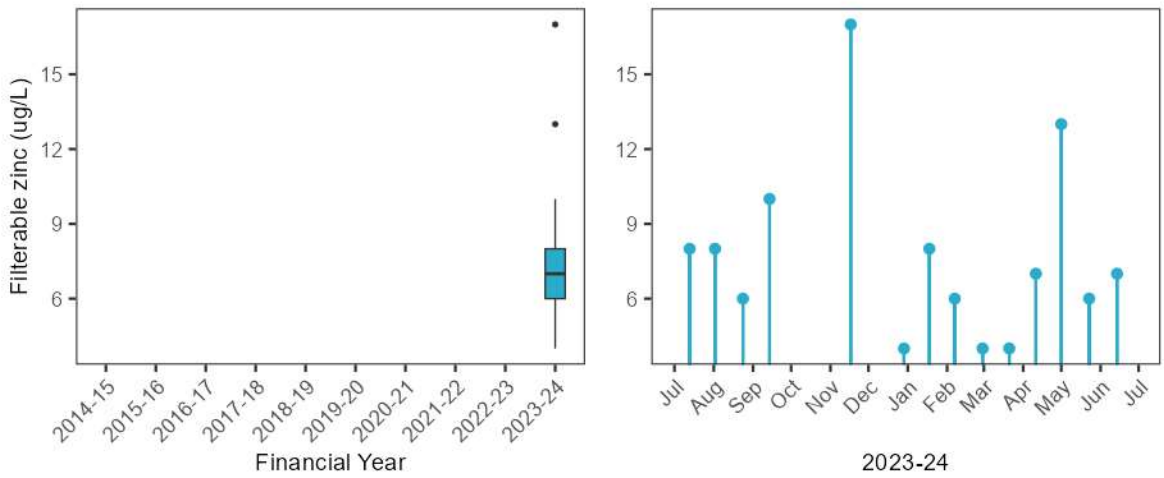


Lower South Creek at Fitzroy pedestrian bridge (NS04A)
Filterable nickel (ug/L)
ANZG limit: 2 ug/L
Financial Year
2023-24

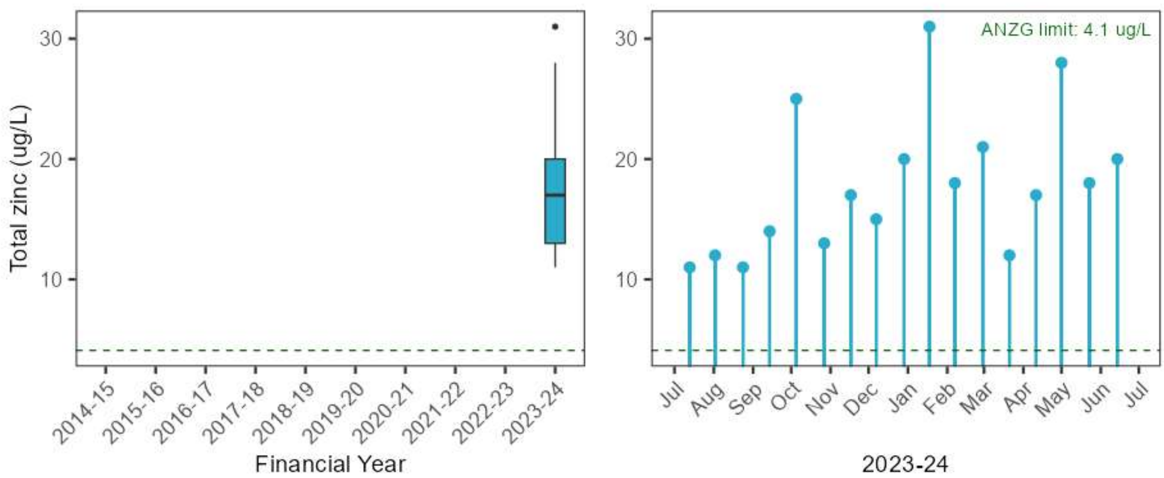
Lower South Creek at Fitzroy pedestrian bridge (NS04A)



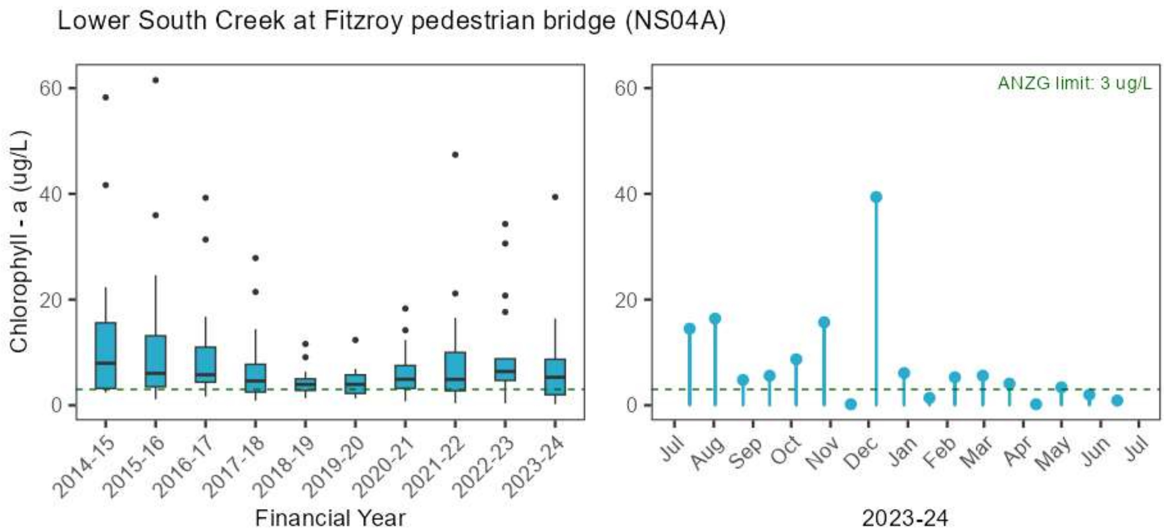
Lower South Creek at Fitzroy pedestrian bridge (NS04A)



Lower South Creek at Fitzroy pedestrian bridge (NS04A)



Ecosystem receptor – Phytoplankton



C.1.3. Hawkesbury River at Wilberforce (N35)

Stressors - Statistical analysis outcomes

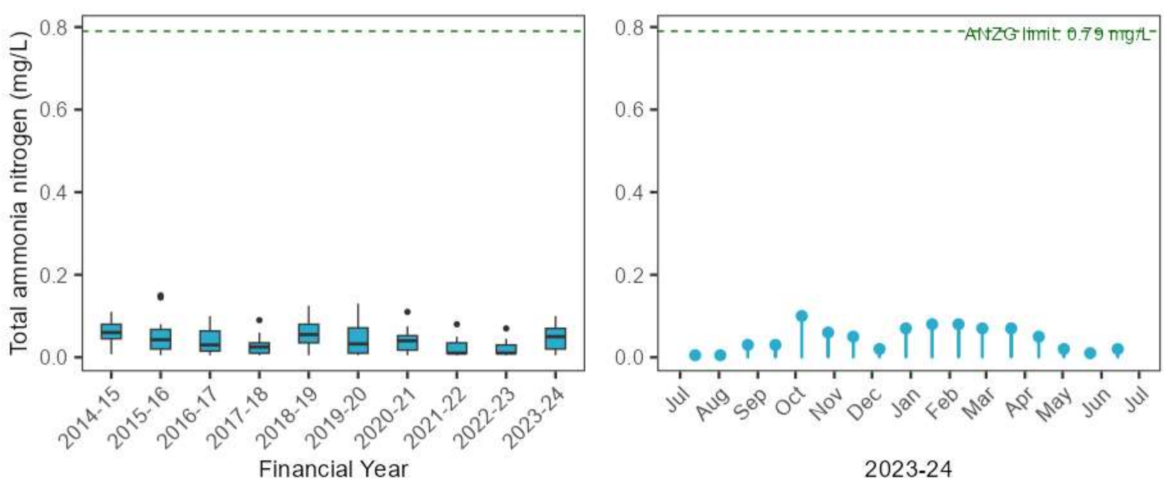
Table C-3 Current period vs previous period comparison contrast outcomes for N35

Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.22	0.29	159	0.83	0.408
Oxidised nitrogen	1.52	0.36	159	1.76	0.080
Total nitrogen	1.12	0.09	159	1.50	0.136
Filterable total phosphorus	0.88	0.13	159	-0.85	0.395
Total phosphorus	1.10	0.12	159	0.84	0.400
Conductivity	1.10	0.08	158	1.31	0.193
Dissolved oxygen	1.07	0.05	159	1.48	0.141
Dissolved oxygen saturation	5.60	2.74	159	2.04	0.043
pH	0.00	0.07	159	0.03	0.973
Water temperature	1.02	0.07	157	0.22	0.830
Turbidity	1.25	0.17	159	1.62	0.107
Chlorophyll - a	1.11	0.25	159	0.45	0.656

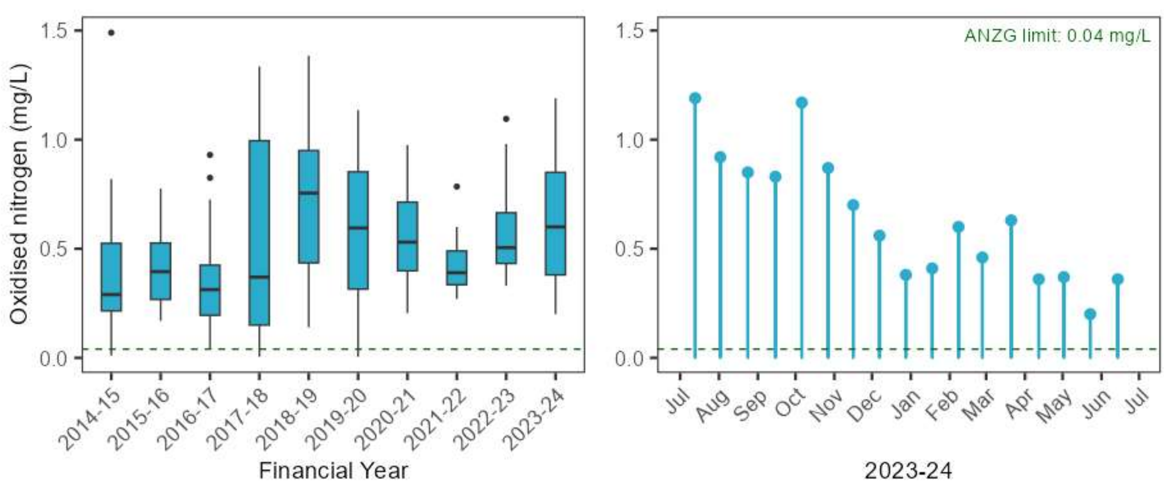
	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

Stressors – Nutrients

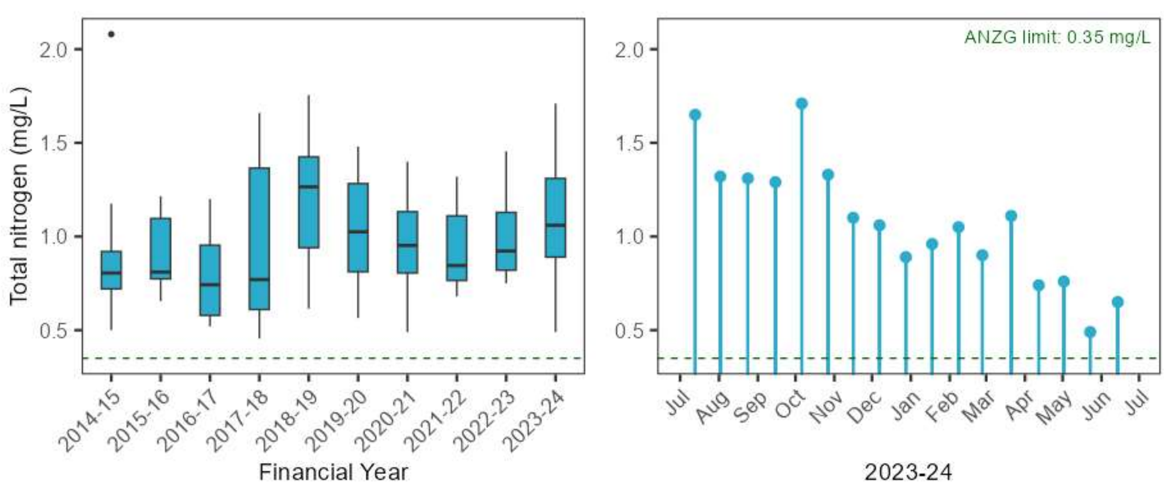
Hawkesbury River at Wilberforce (N35)

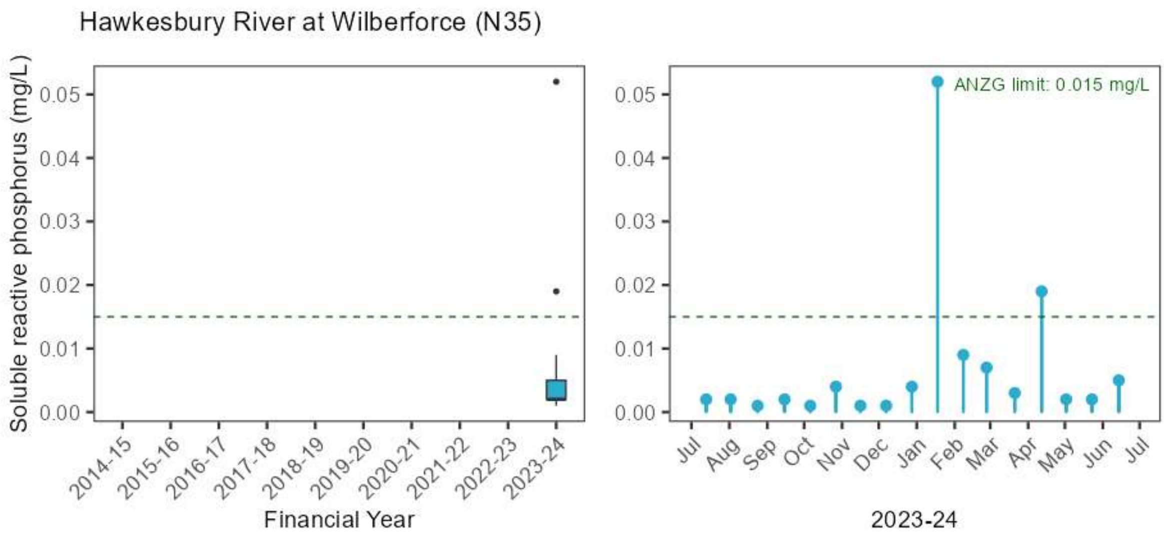


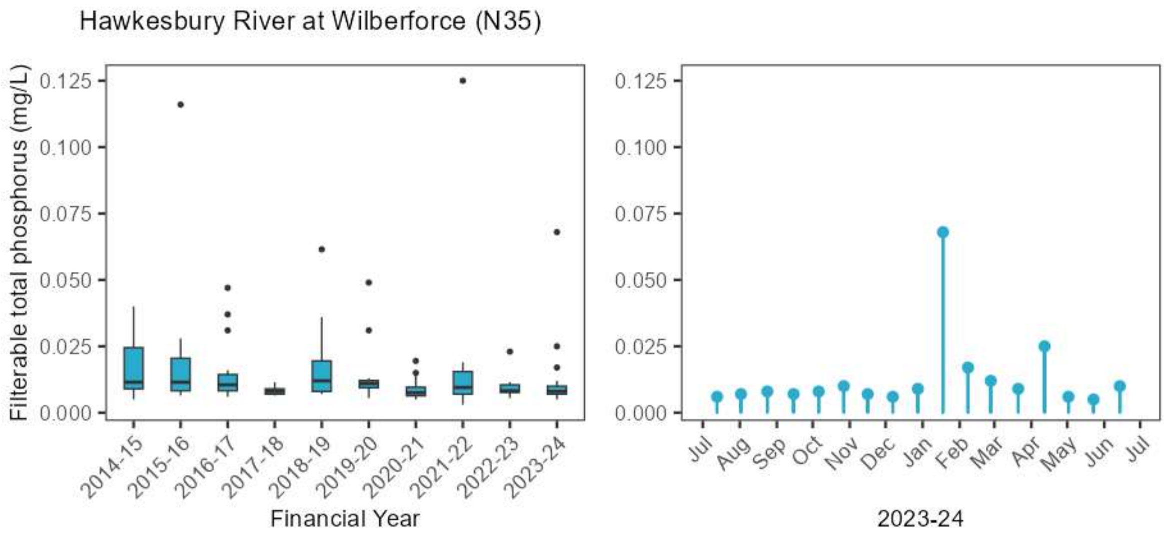
Hawkesbury River at Wilberforce (N35)

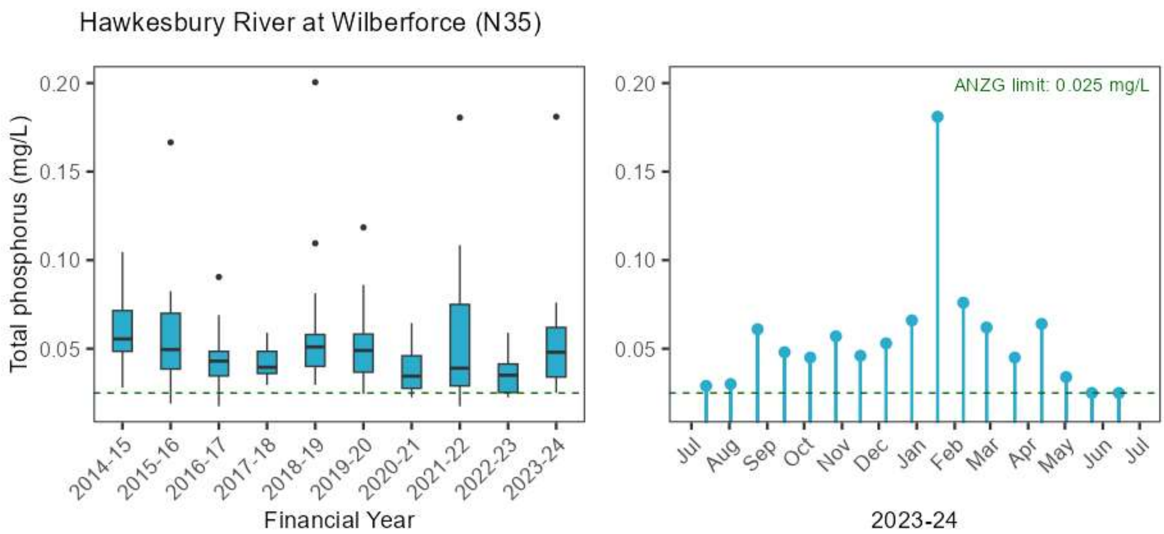


Hawkesbury River at Wilberforce (N35)

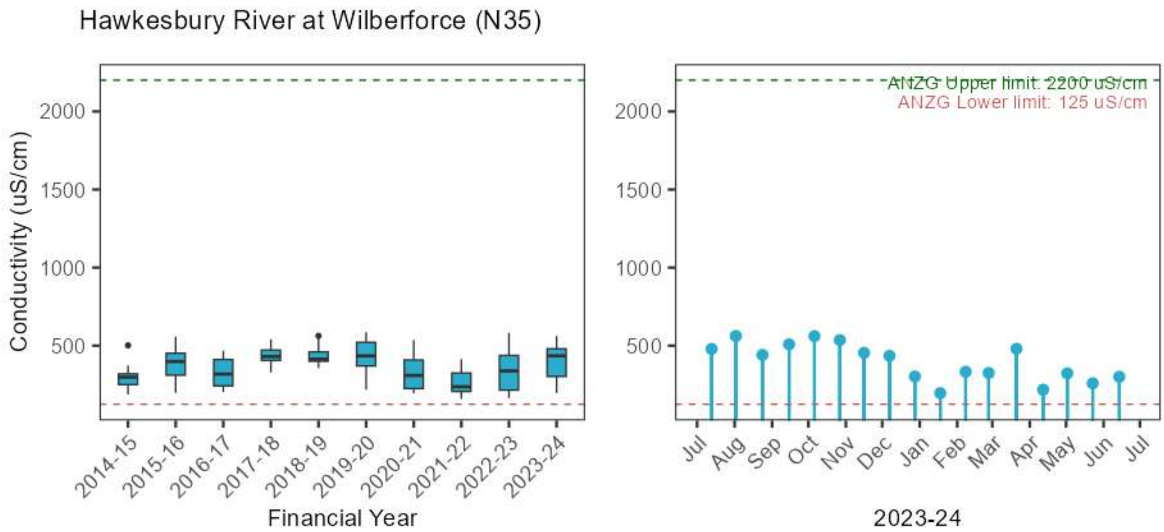


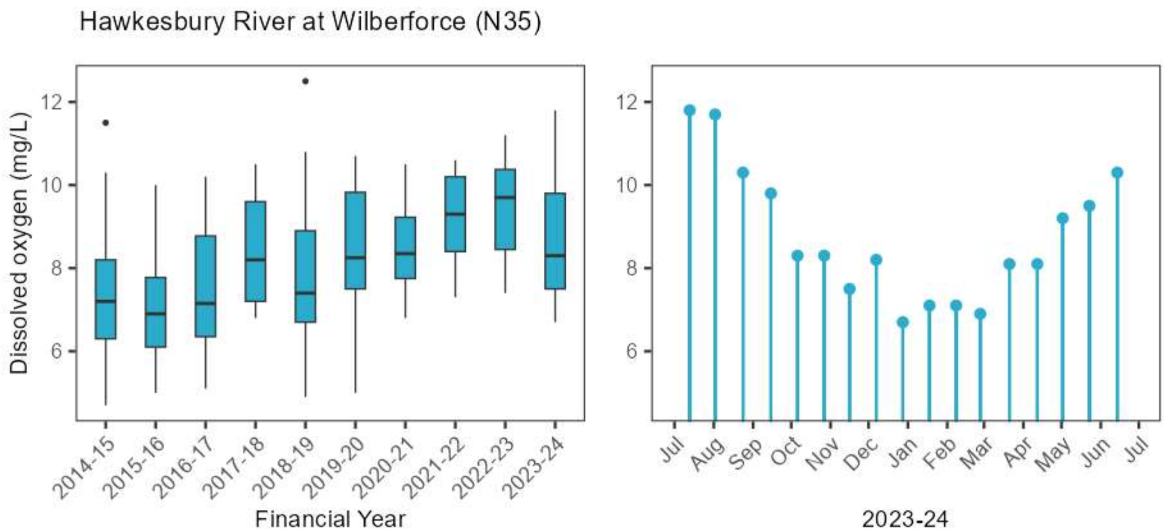

Hawkesbury River at Wilberforce (N35)
Soluble reactive phosphorus (mg/L)
Financial Year
ANZG limit: 0.015 mg/L
2023-24

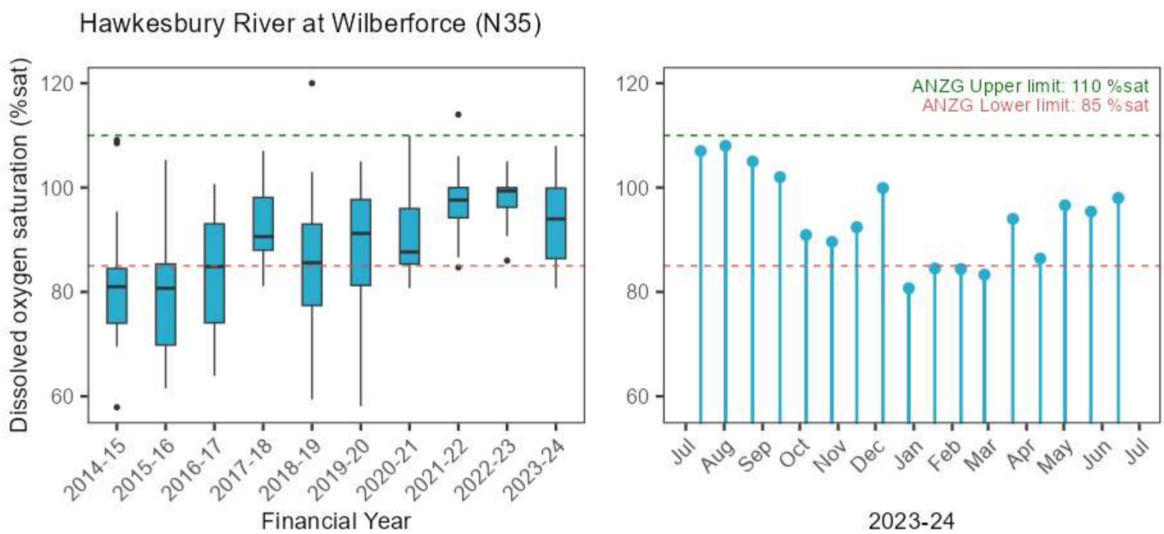

Hawkesbury River at Wilberforce (N35)
Filterable total phosphorus (mg/L)
Financial Year
2023-24

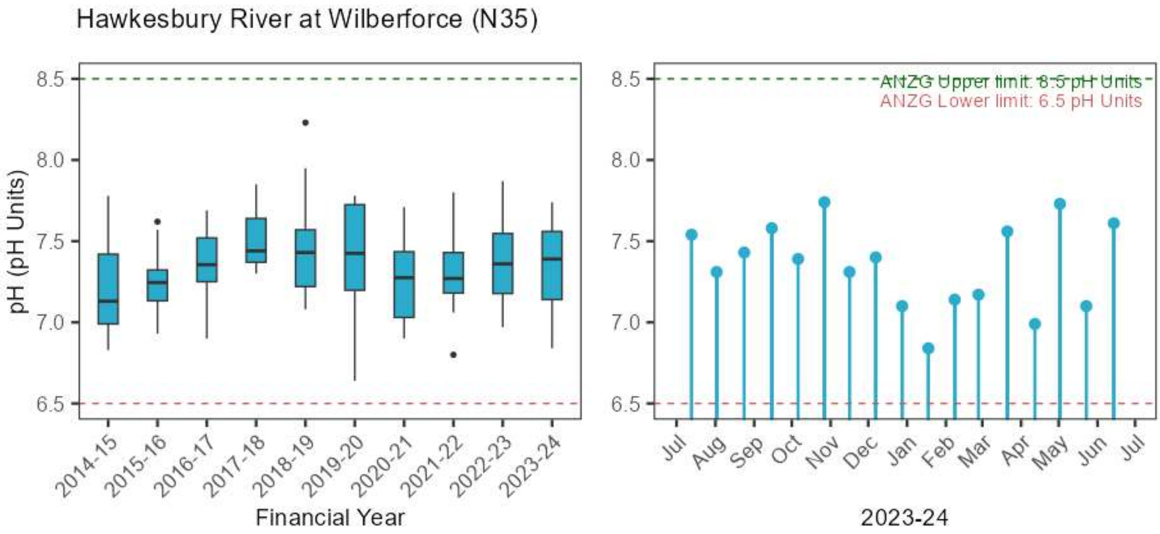

Hawkesbury River at Wilberforce (N35)
Total phosphorus (mg/L)
Financial Year
ANZG limit: 0.025 mg/L
2023-24

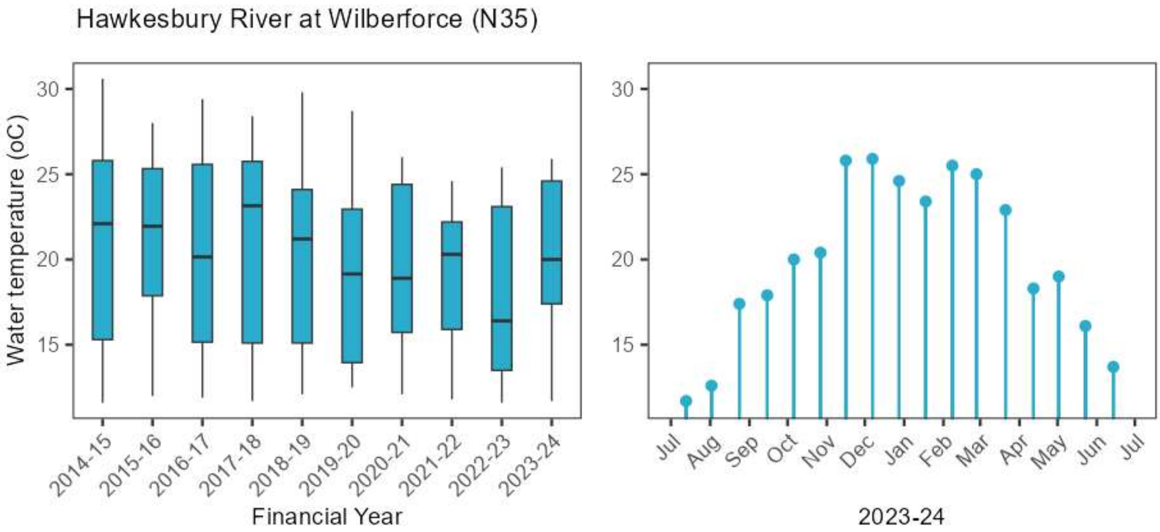
Stressors – Physico-chemical water quality

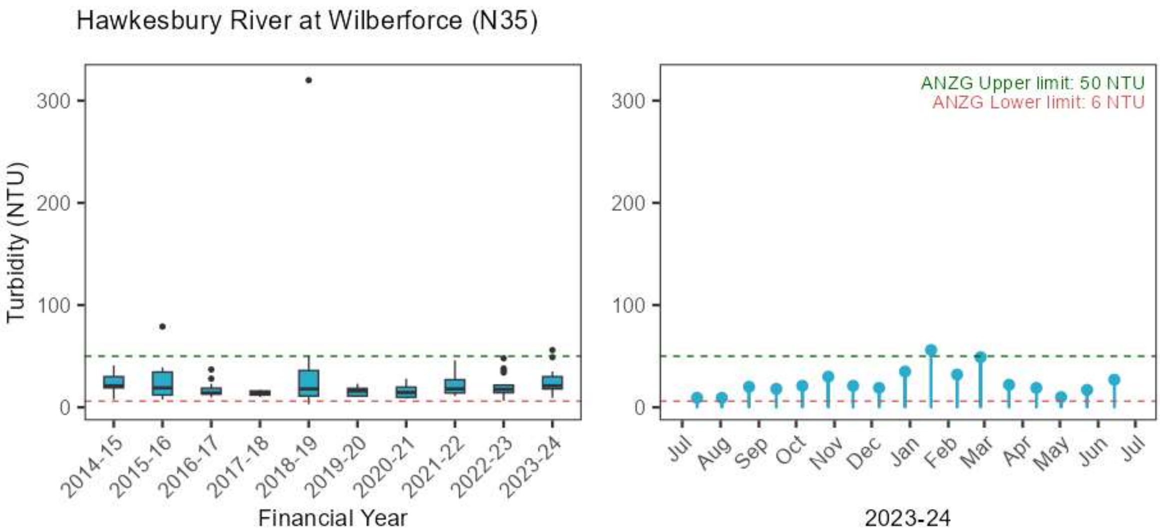




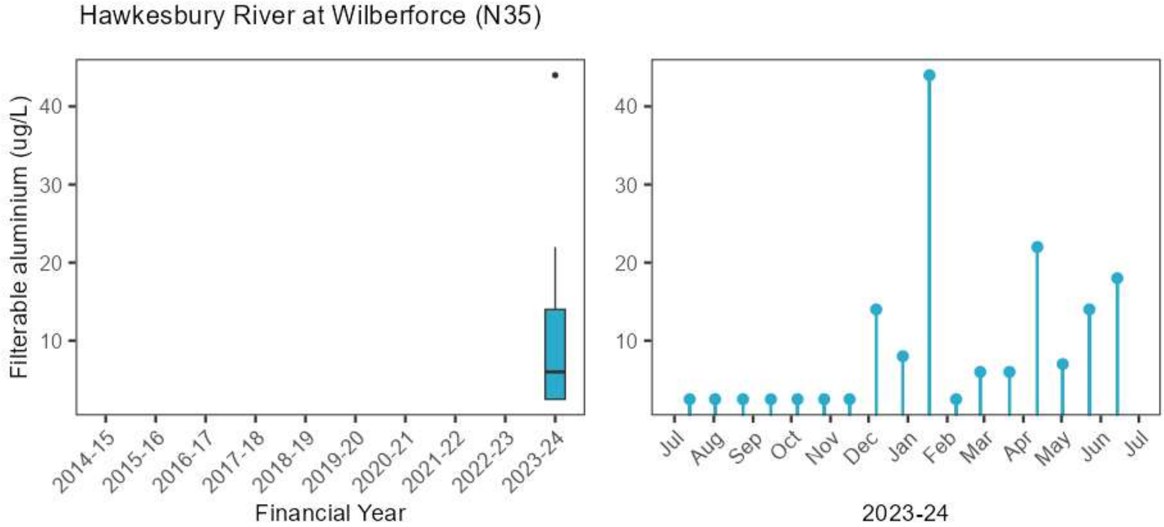


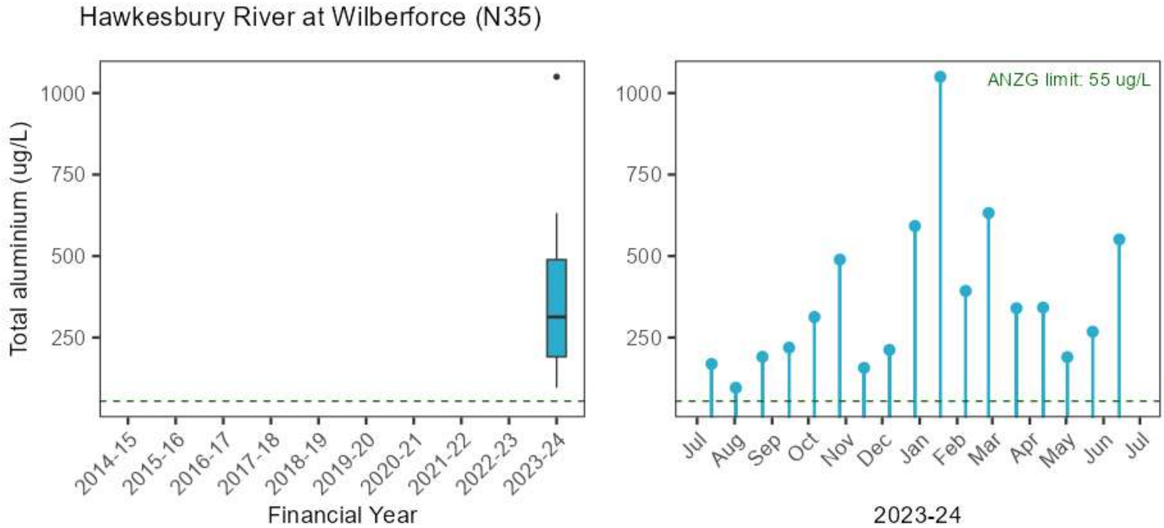

Hawkesbury River at Wilberforce (N35)
pH (pH Units)
Financial Year
2023-24
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units

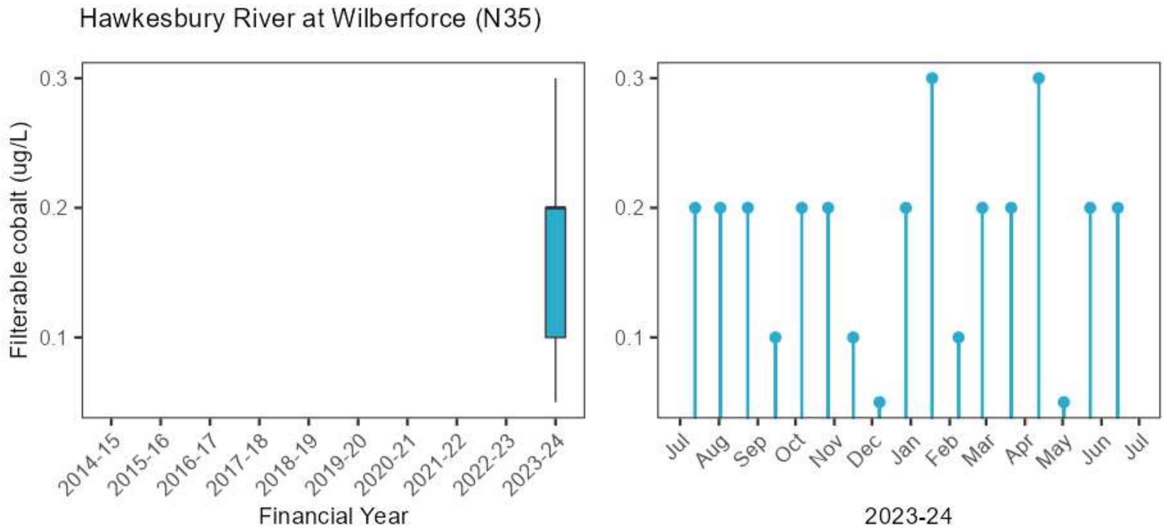

Hawkesbury River at Wilberforce (N35)
Water temperature (oC)
Financial Year
2023-24


Hawkesbury River at Wilberforce (N35)
Turbidity (NTU)
Financial Year
2023-24
ANZG Upper limit: 50 NTU
ANZG Lower limit: 6 NTU

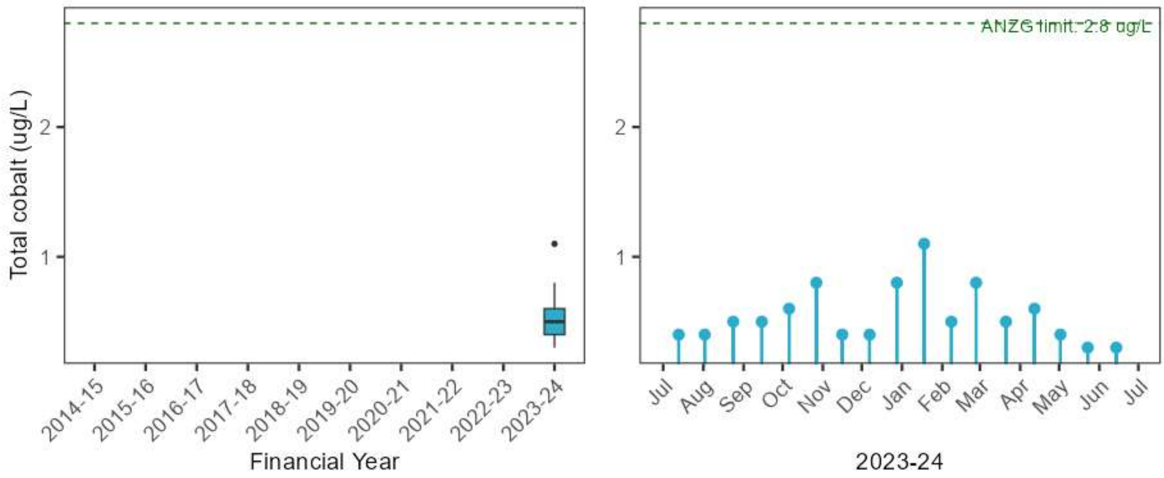
Stressors – Trace metals



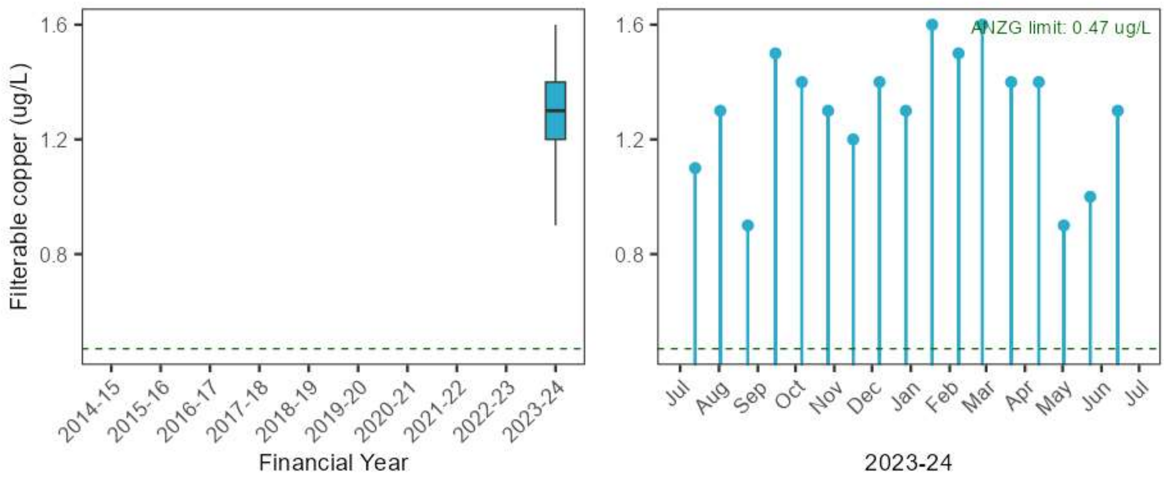




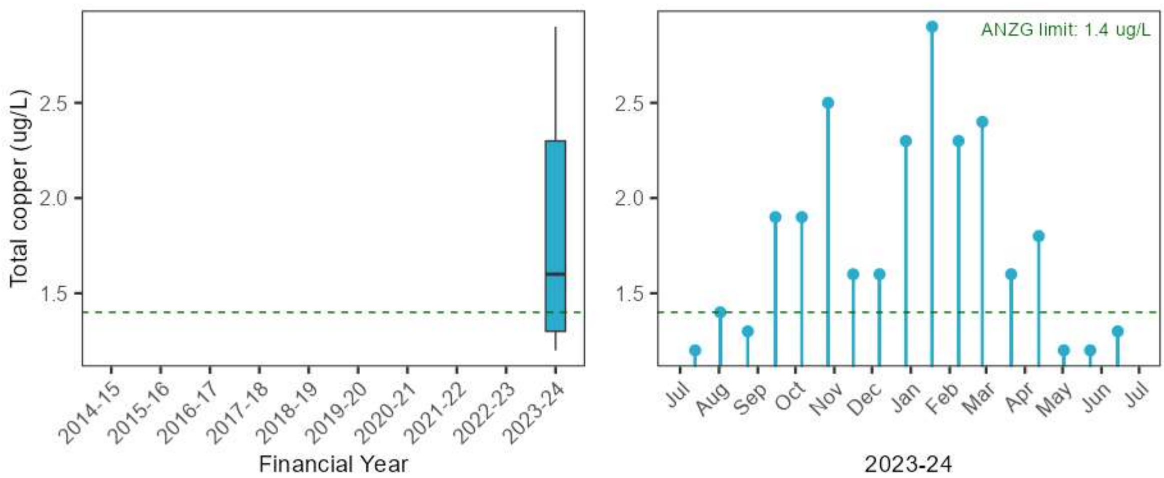
Hawkesbury River at Wilberforce (N35)



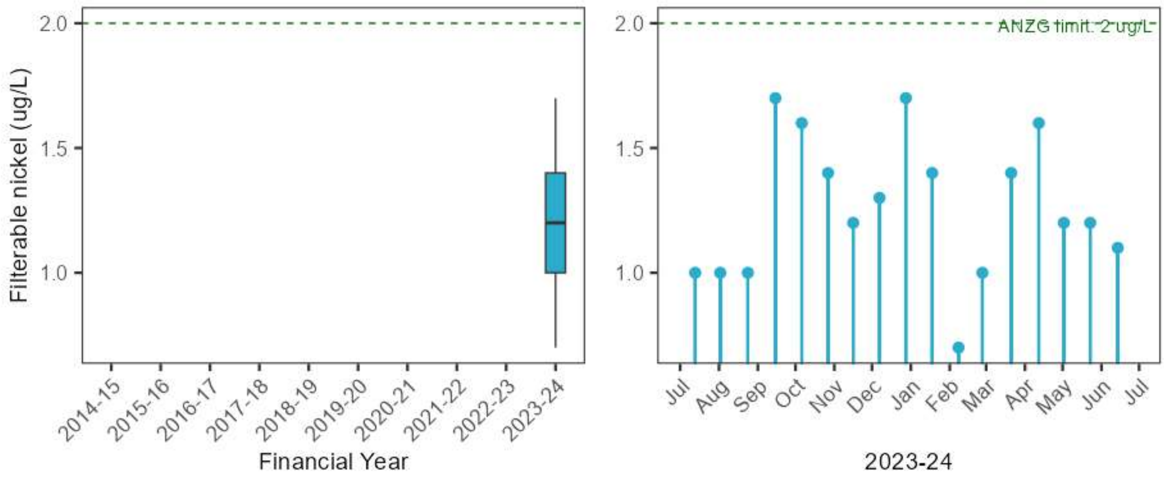
Hawkesbury River at Wilberforce (N35)



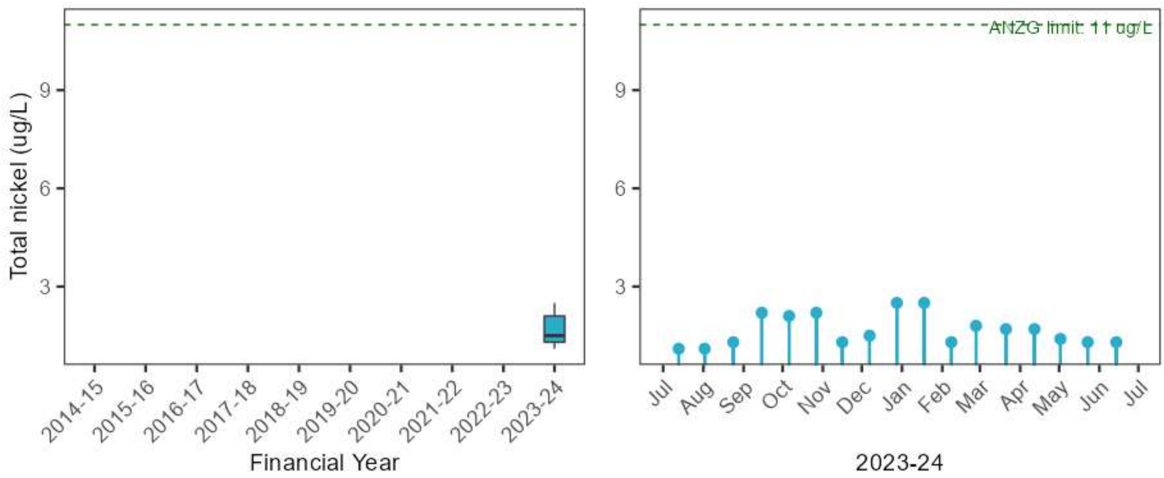
Hawkesbury River at Wilberforce (N35)



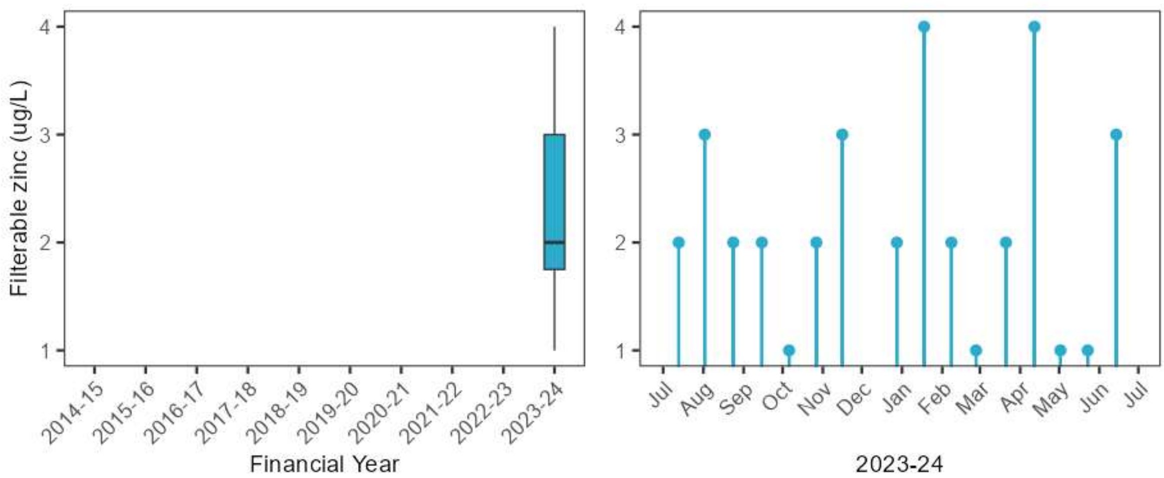
Hawkesbury River at Wilberforce (N35)

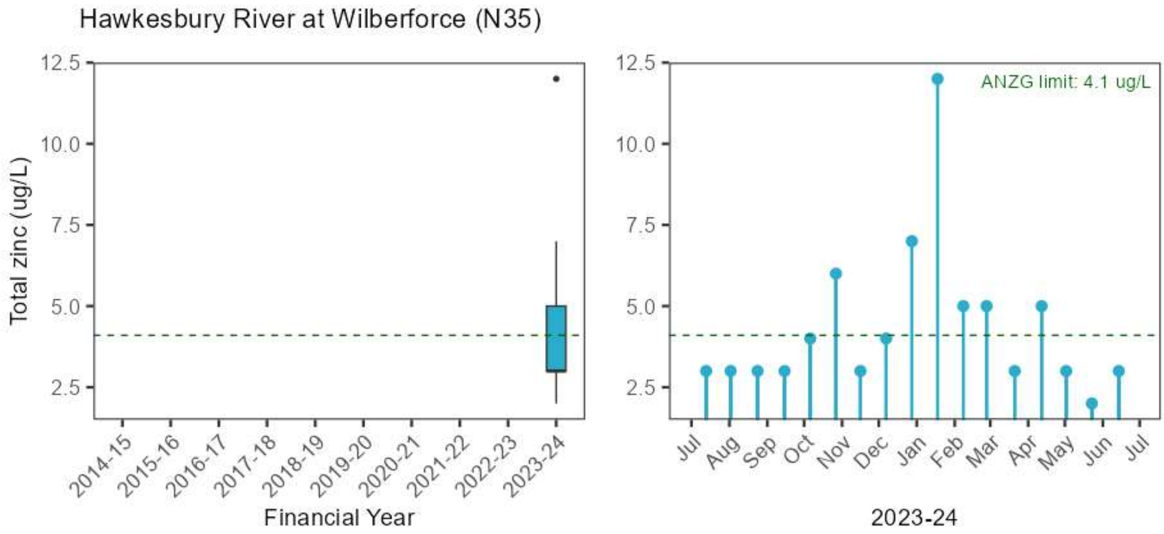


Hawkesbury River at Wilberforce (N35)

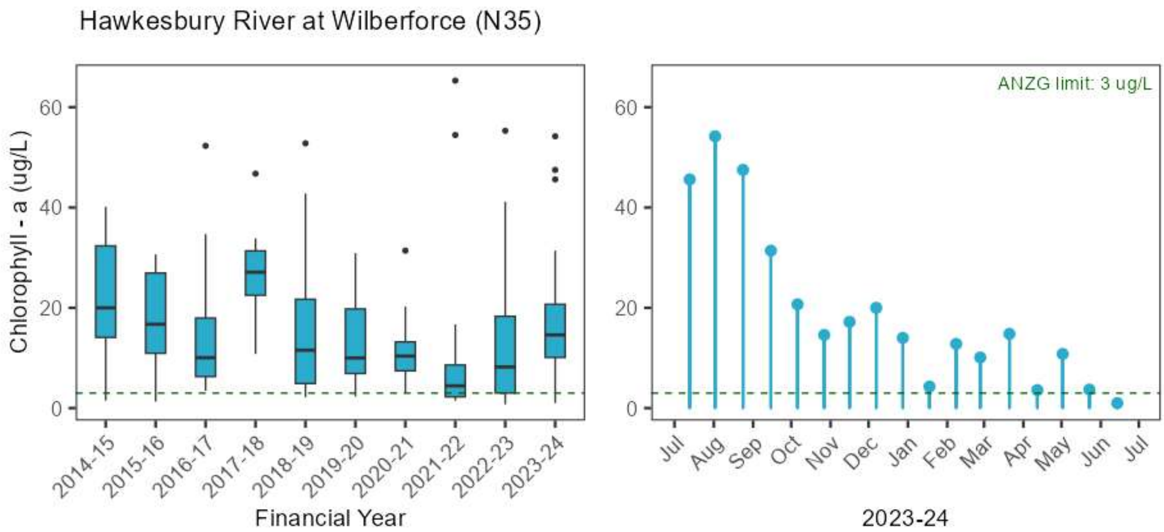


Hawkesbury River at Wilberforce (N35)





Ecosystem receptor – Phytoplankton



C.1.4. Lower Cattai Creek at Cattai Ridge Road (NC11A)

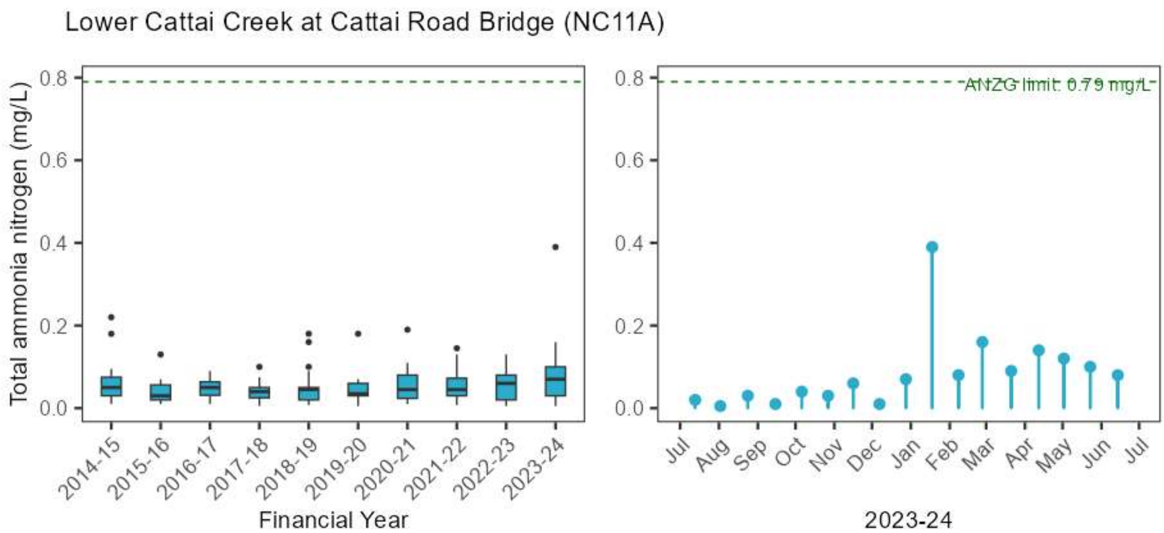
Stressors - Statistical analysis outcomes

Table C-4 Current period vs previous period comparison contrast outcomes for NC11A

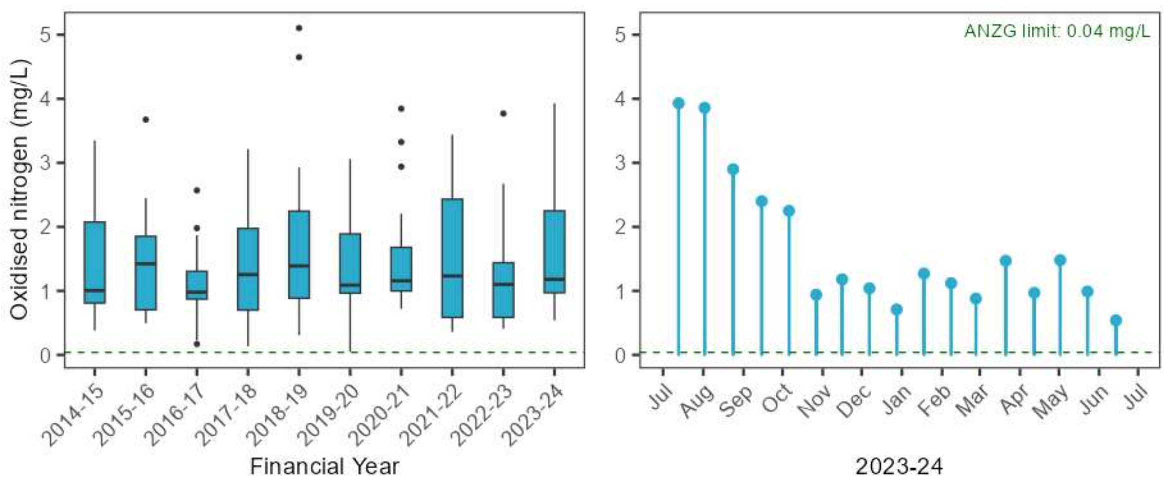
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.26	0.27	158	1.09	0.279
Oxidised nitrogen	1.19	0.22	158	0.98	0.329
Total nitrogen	1.11	0.13	158	0.92	0.359
Filterable total phosphorus	0.94	0.11	158	-0.56	0.579
Total phosphorus	1.01	0.10	158	0.13	0.894
Conductivity	0.99	0.08	158	-0.13	0.897
Dissolved oxygen	1.12	0.08	158	1.60	0.111
Dissolved oxygen saturation	6.53	3.49	158	1.87	0.063
pH	0.02	0.05	157	0.40	0.691
Water temperature	1.01	0.08	158	0.10	0.918
Turbidity	0.97	0.13	158	-0.25	0.804
Chlorophyll - a	1.08	0.28	158	0.30	0.766

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

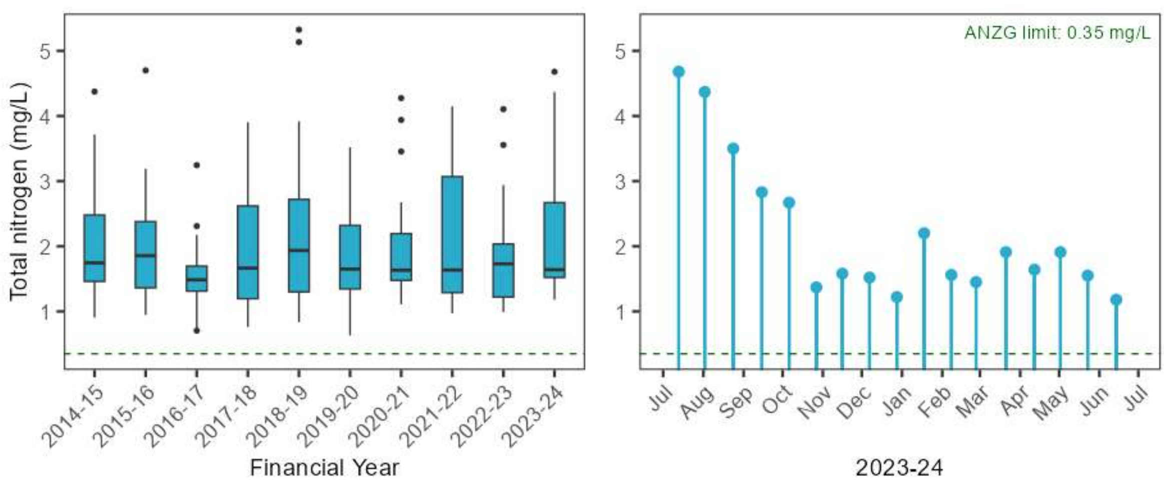
Stressors – Nutrients



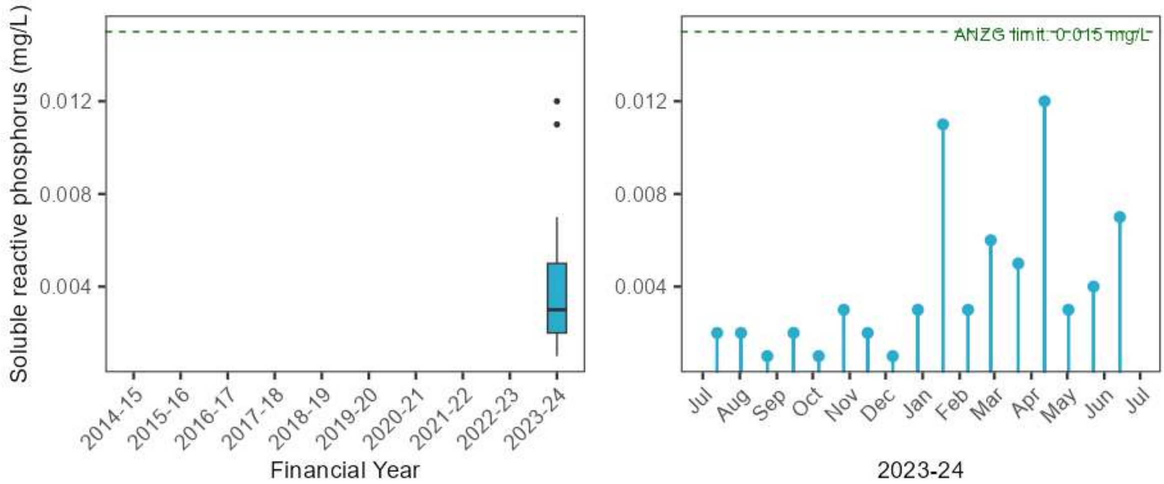
Lower Cattai Creek at Cattai Road Bridge (NC11A)



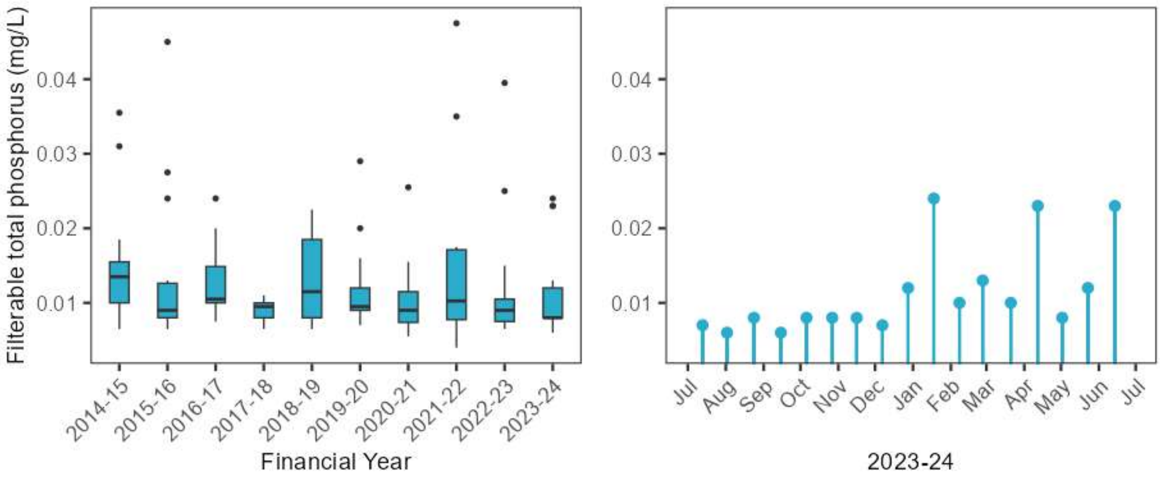
Lower Cattai Creek at Cattai Road Bridge (NC11A)



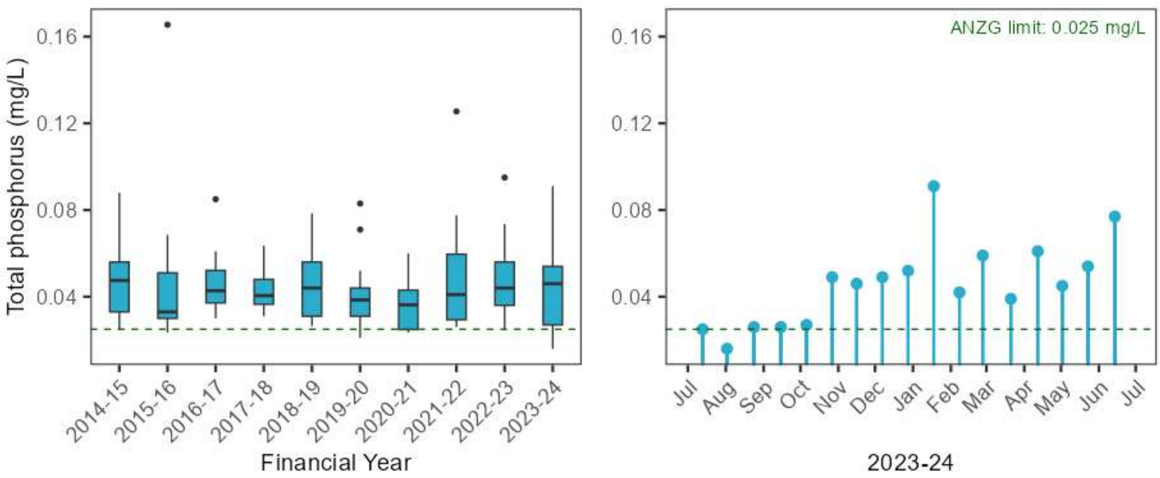
Lower Cattai Creek at Cattai Road Bridge (NC11A)



Lower Cattai Creek at Cattai Road Bridge (NC11A)

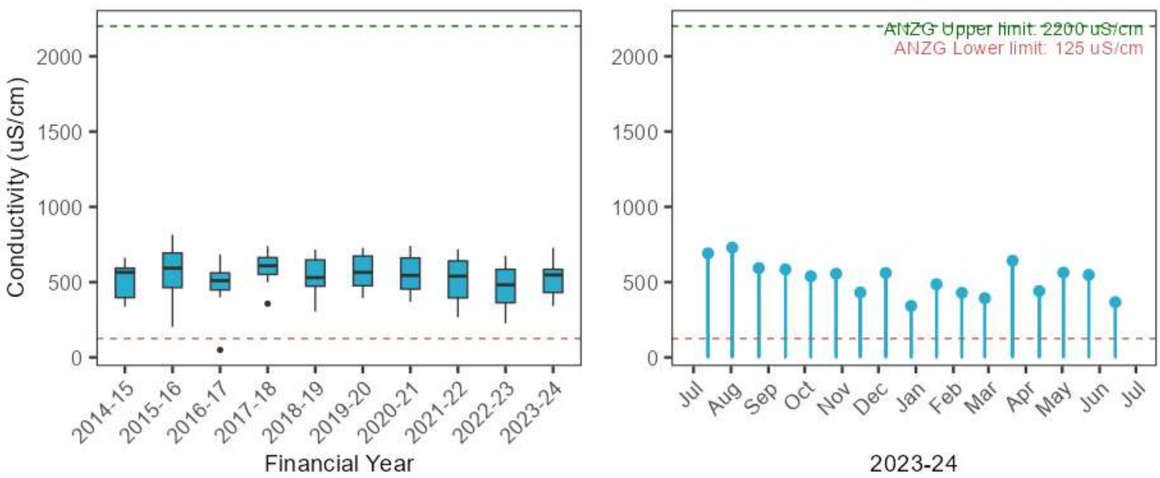


Lower Cattai Creek at Cattai Road Bridge (NC11A)

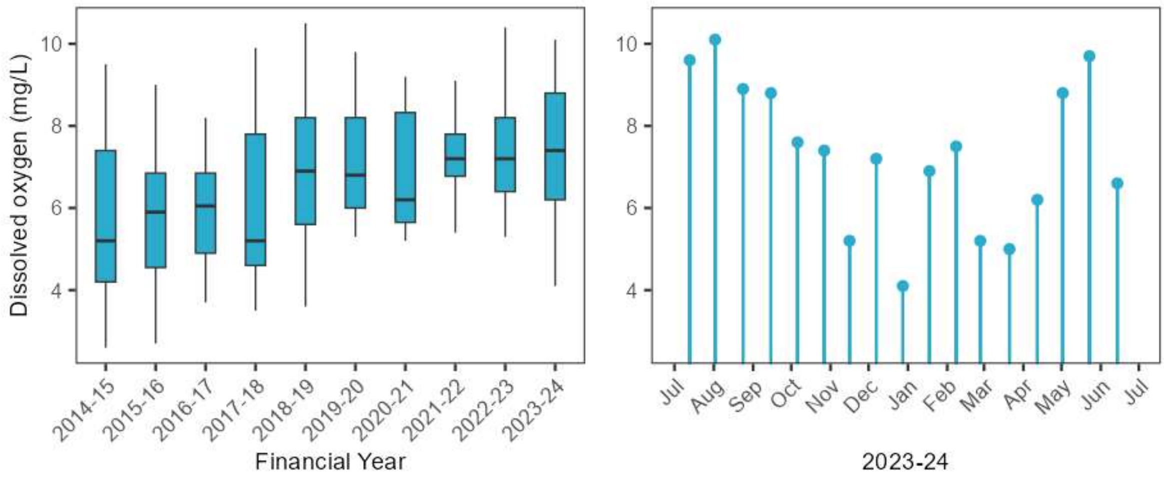


Stressors – Physico-chemical water quality

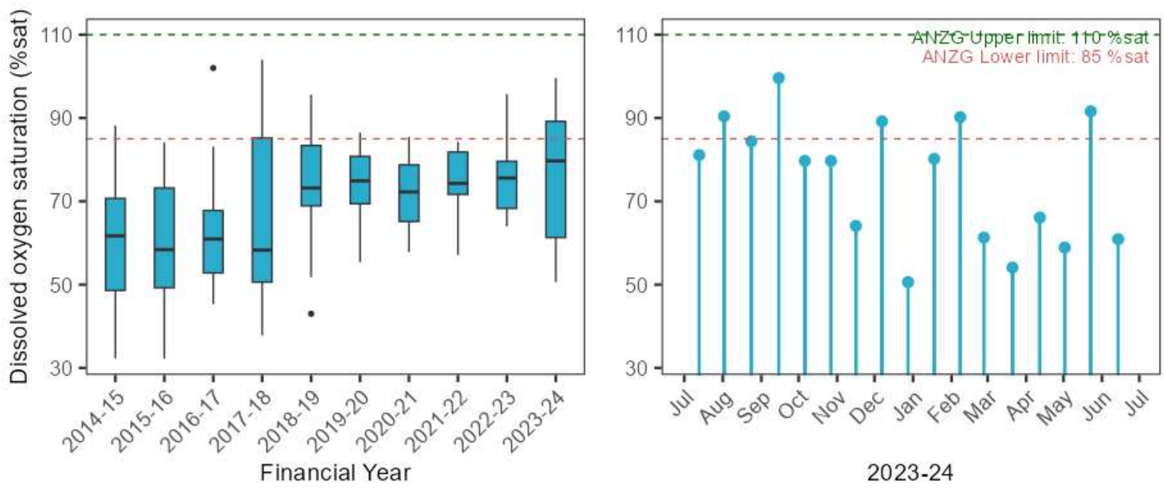
Lower Cattai Creek at Cattai Road Bridge (NC11A)



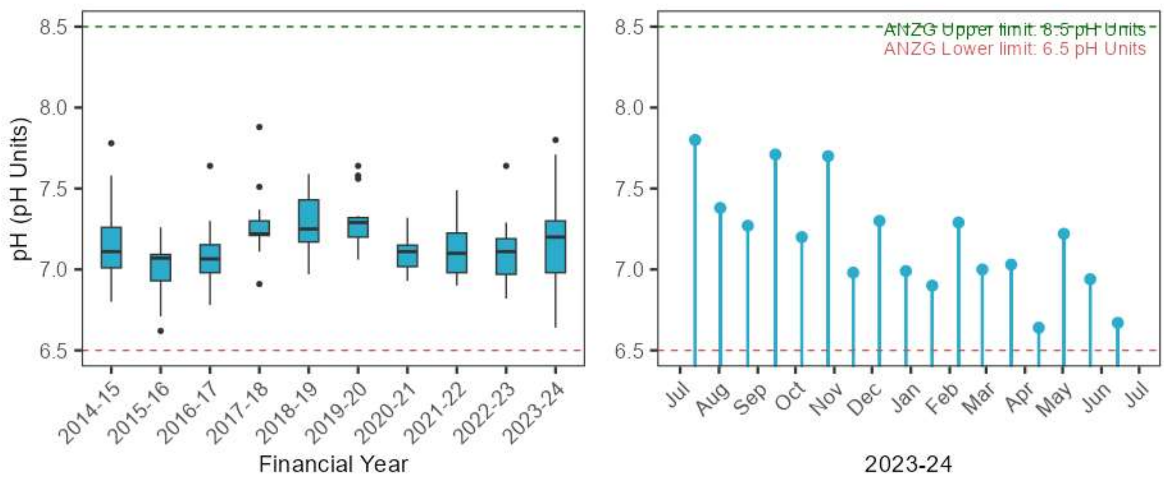
Lower Cattai Creek at Cattai Road Bridge (NC11A)



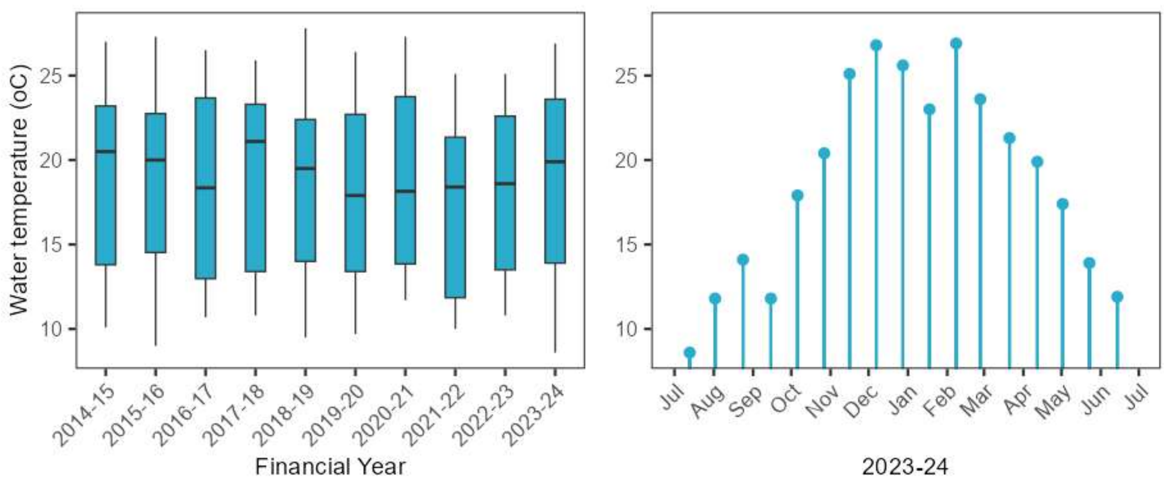
Lower Cattai Creek at Cattai Road Bridge (NC11A)



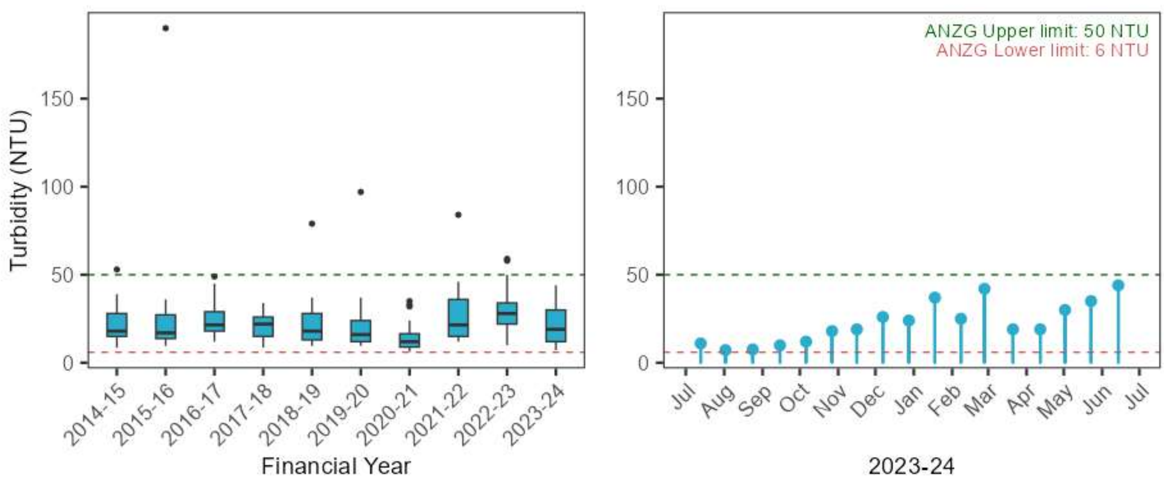
Lower Cattai Creek at Cattai Road Bridge (NC11A)



Lower Cattai Creek at Cattai Road Bridge (NC11A)

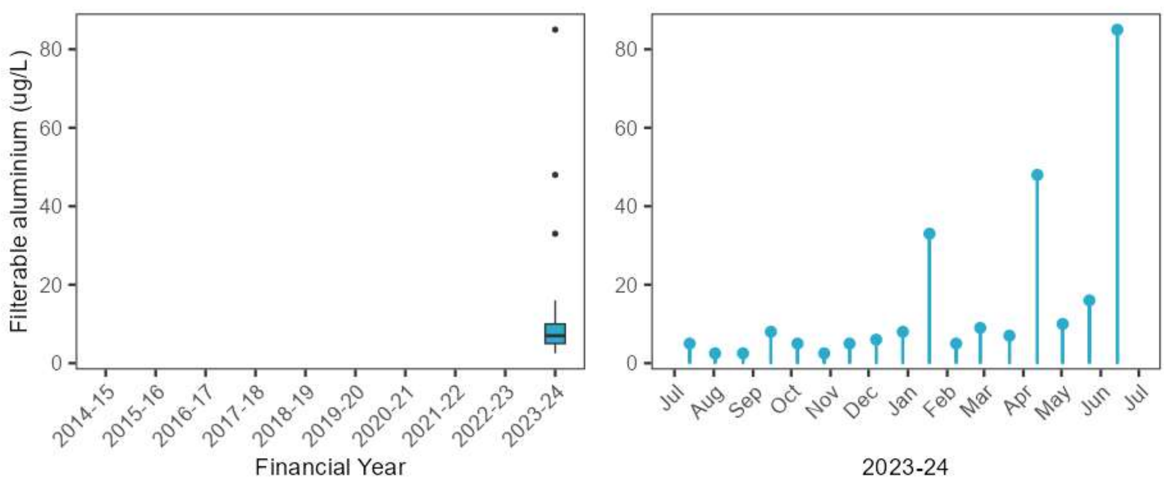


Lower Cattai Creek at Cattai Road Bridge (NC11A)

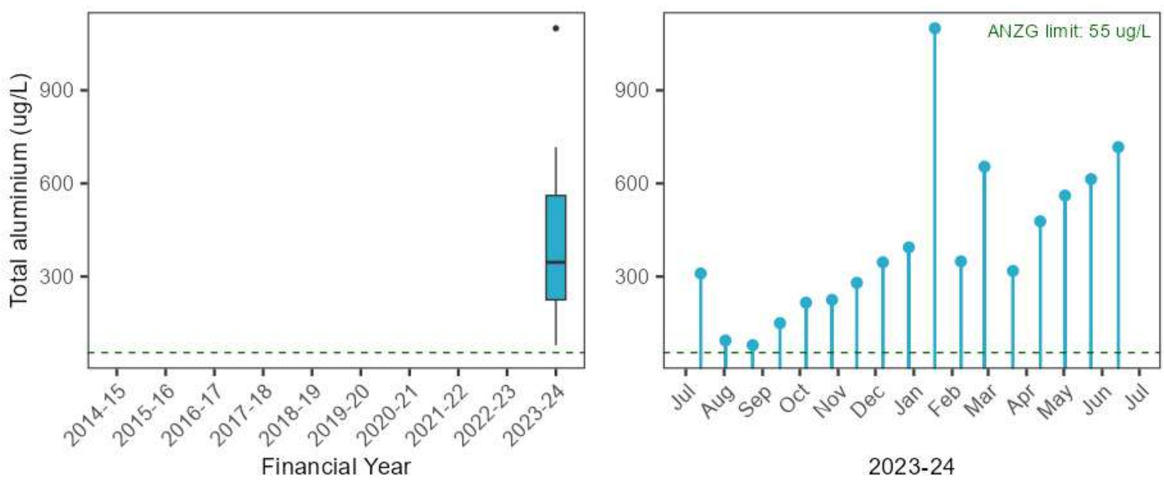


Stressors – Trace metals

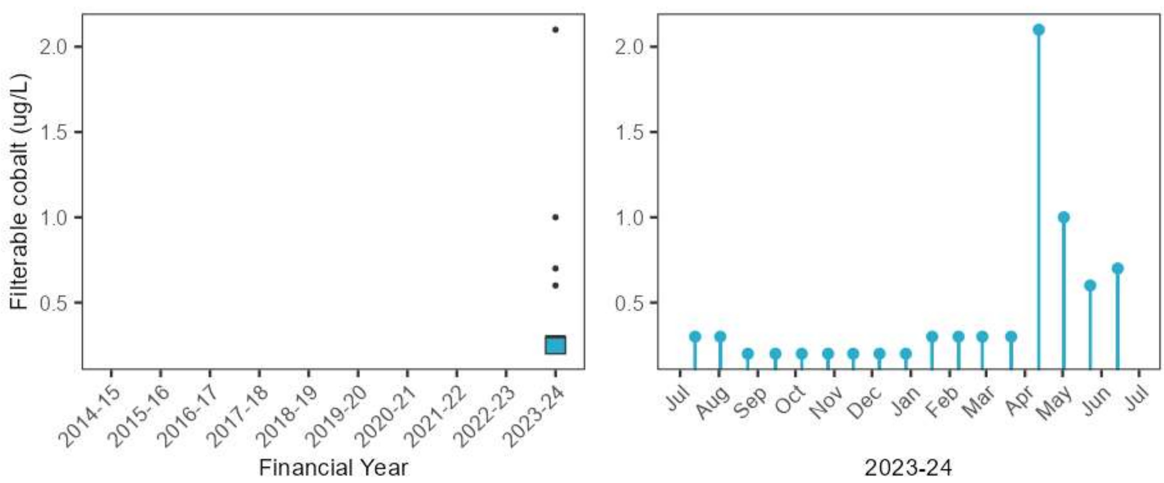
Lower Cattai Creek at Cattai Road Bridge (NC11A)



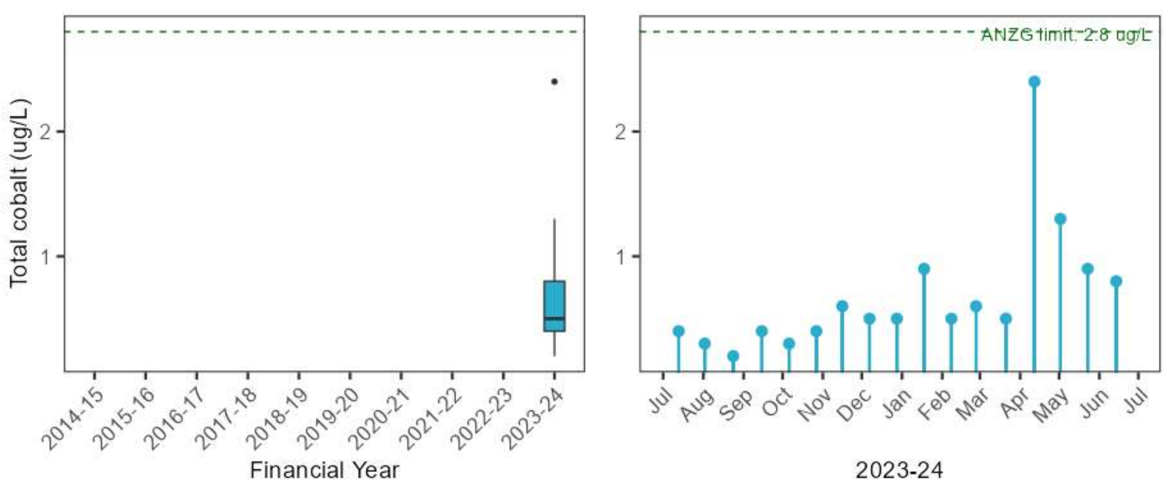
Lower Cattai Creek at Cattai Road Bridge (NC11A)



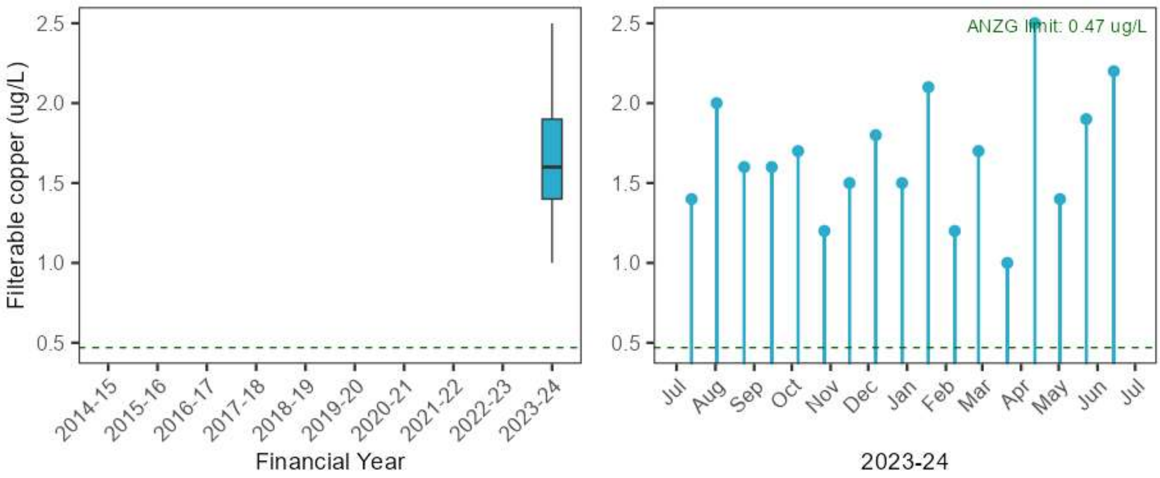
Lower Cattai Creek at Cattai Road Bridge (NC11A)



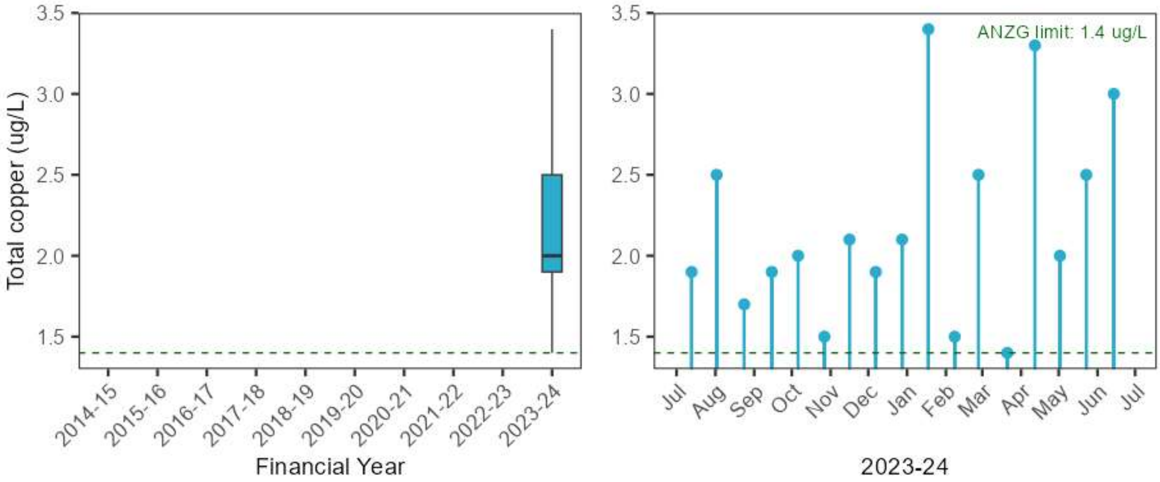
Lower Cattai Creek at Cattai Road Bridge (NC11A)



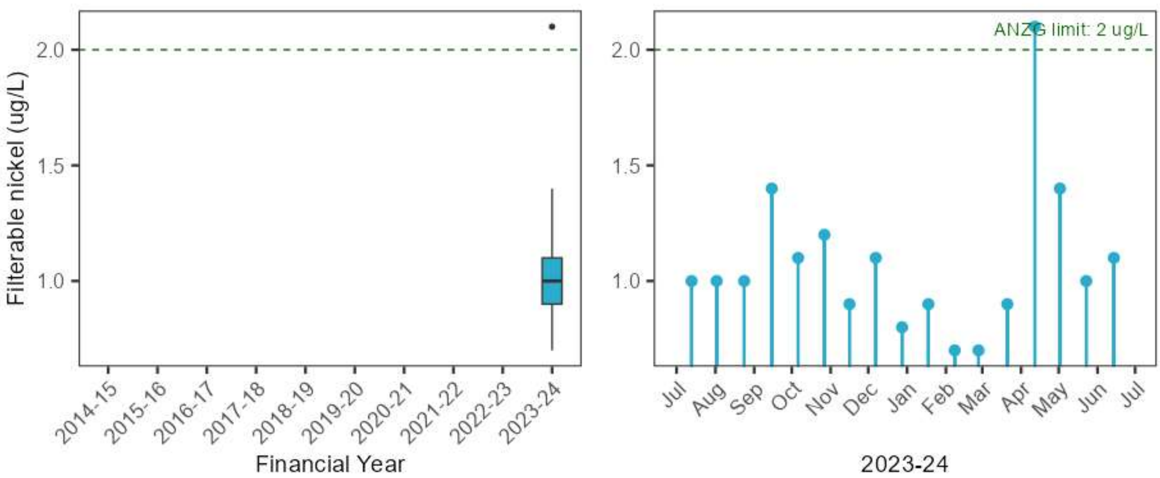
Lower Cattai Creek at Cattai Road Bridge (NC11A)

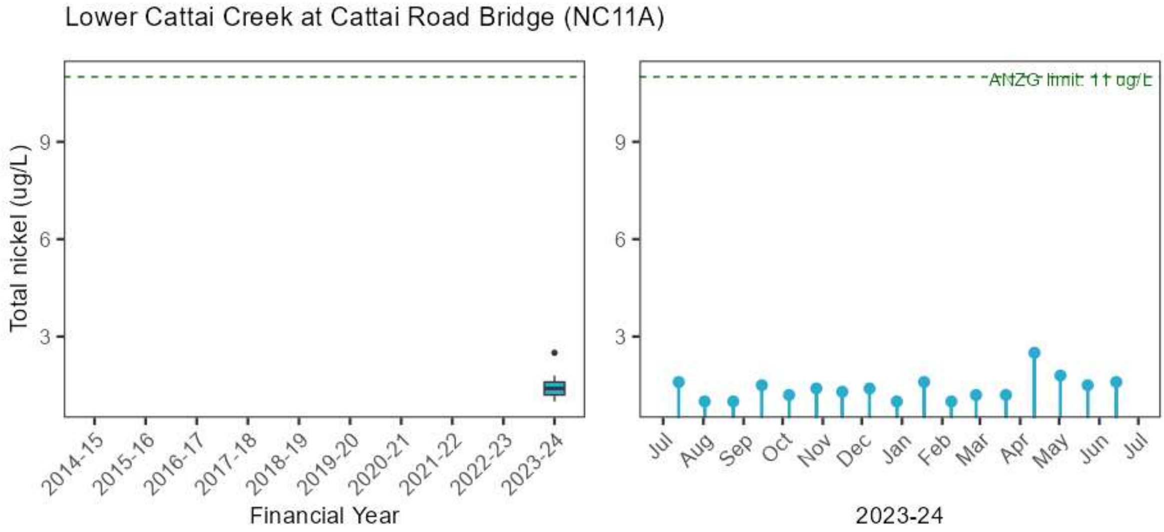


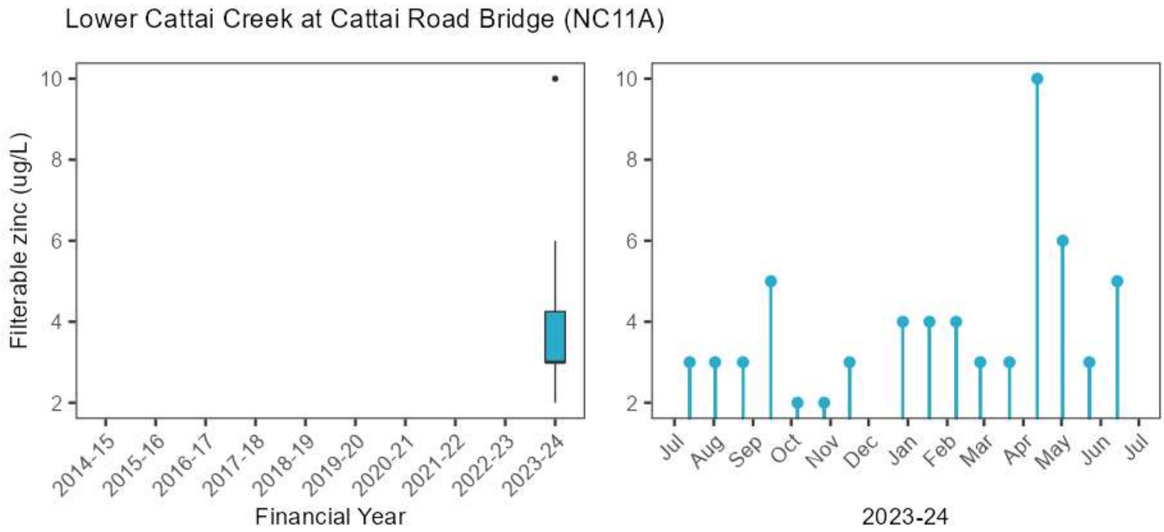
Lower Cattai Creek at Cattai Road Bridge (NC11A)

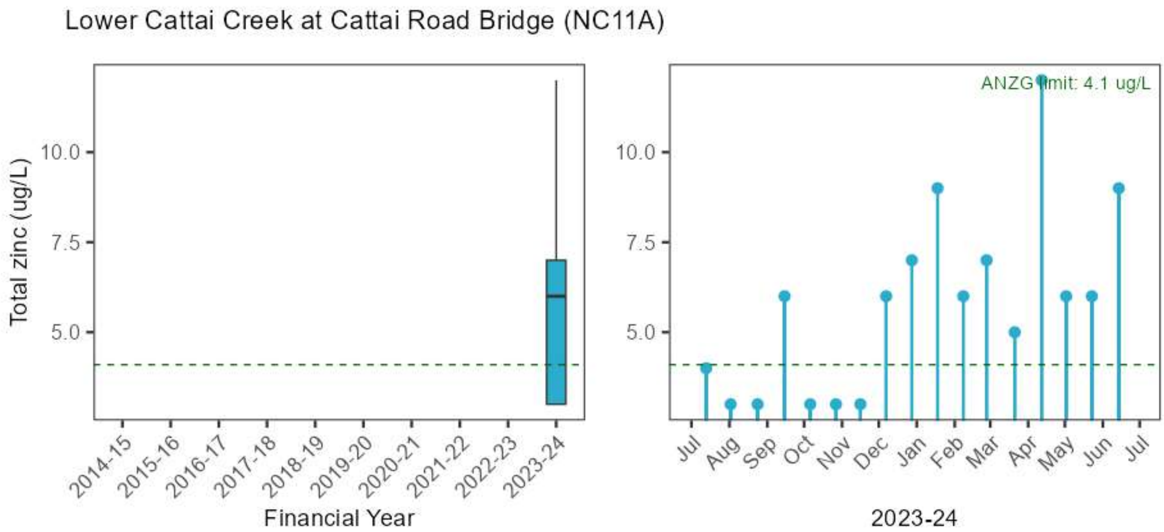


Lower Cattai Creek at Cattai Road Bridge (NC11A)

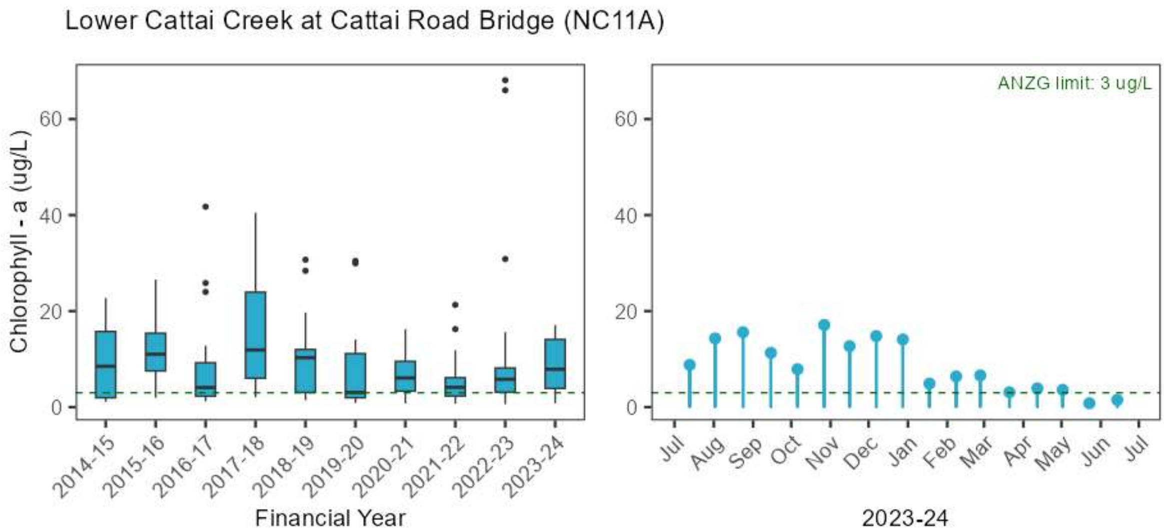



Lower Cattai Creek at Cattai Road Bridge (NC11A)
Total nickel (ug/L)
Financial Year
2023-24
ANZG limit: 11 ug/L


Lower Cattai Creek at Cattai Road Bridge (NC11A)
Filterable zinc (ug/L)
Financial Year
2023-24


Lower Cattai Creek at Cattai Road Bridge (NC11A)
Total zinc (ug/L)
Financial Year
2023-24
ANZG limit: 4.1 ug/L

Ecosystem receptor – Phytoplankton



C.1.5. Hawkesbury River off Cattai SRA (N3001)

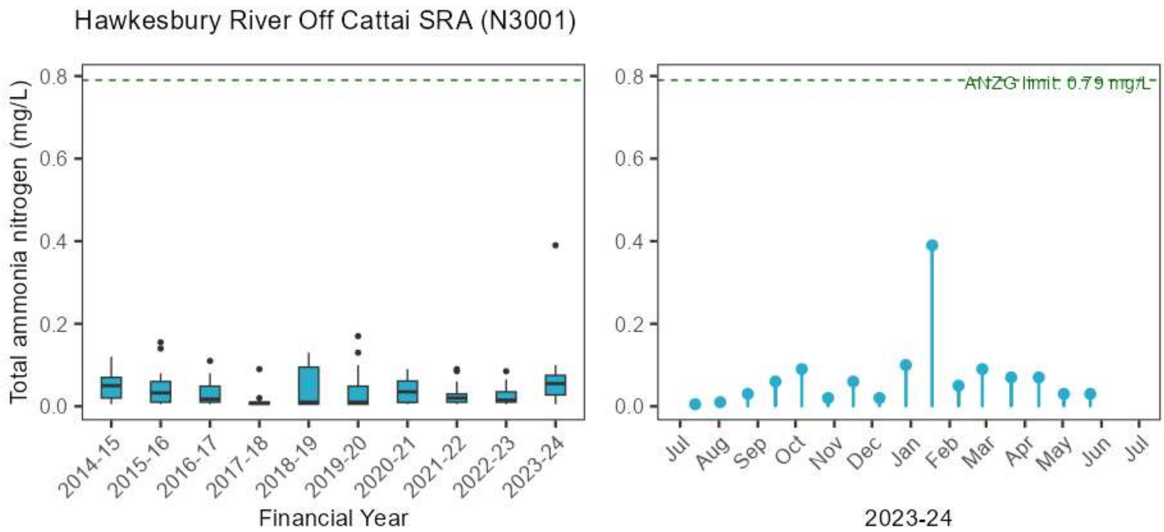
Stressors - Statistical analysis outcomes

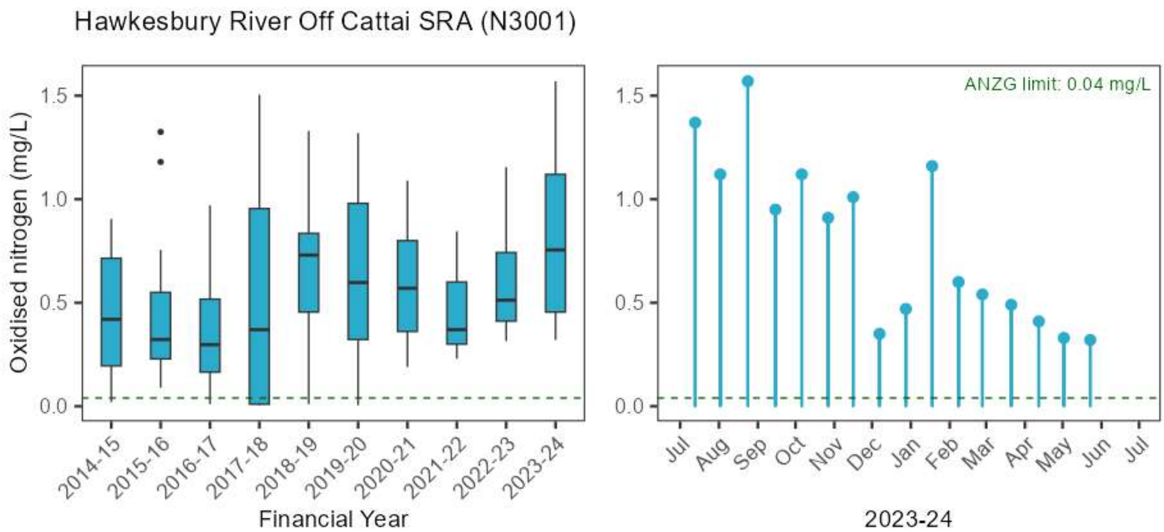
Table C-5 Current period vs previous period comparison contrast outcomes for N3001

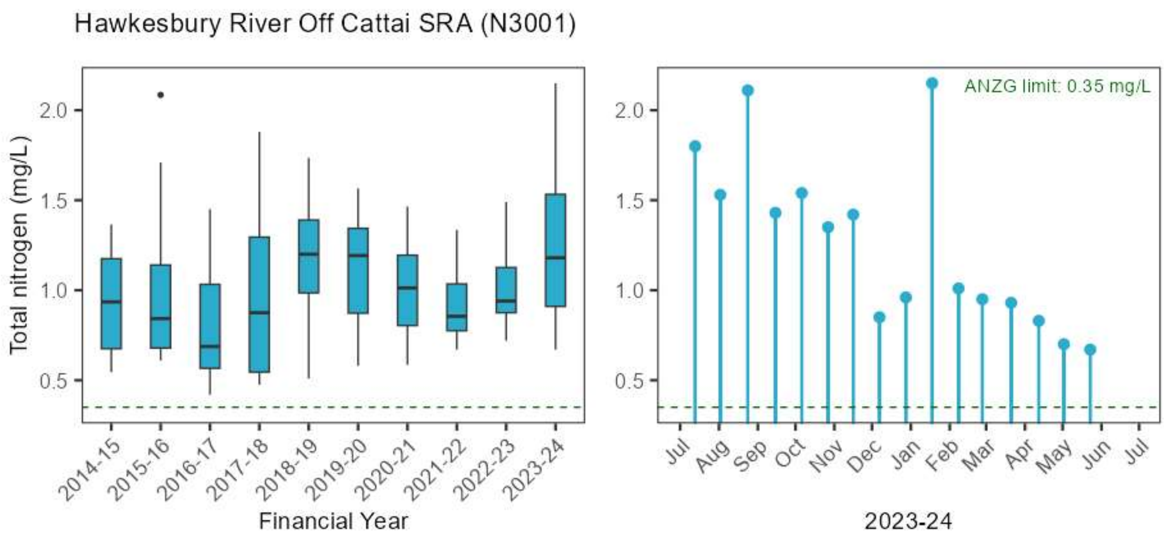
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	2.20	0.60	158	2.90	0.004
Oxidised nitrogen	1.99	0.62	158	2.21	0.028
Total nitrogen	1.26	0.11	158	2.67	0.008
Filterable total phosphorus	0.84	0.13	158	-1.09	0.278
Total phosphorus	1.12	0.12	158	0.99	0.322
Conductivity	1.21	0.09	157	2.60	0.010
Dissolved oxygen	0.99	0.06	158	-0.27	0.788
Dissolved oxygen saturation	-1.21	3.42	157	-0.36	0.723
pH	-0.11	0.09	158	-1.25	0.213
Water temperature	1.03	0.08	157	0.44	0.657
Turbidity	1.24	0.17	158	1.56	0.121
Chlorophyll - a	1.20	0.28	157	0.79	0.431

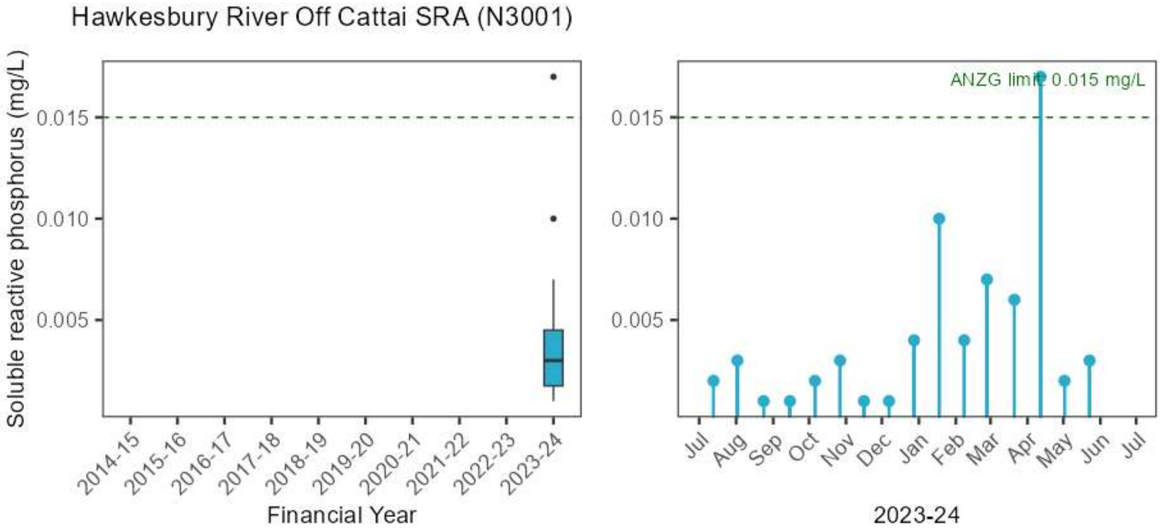
	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

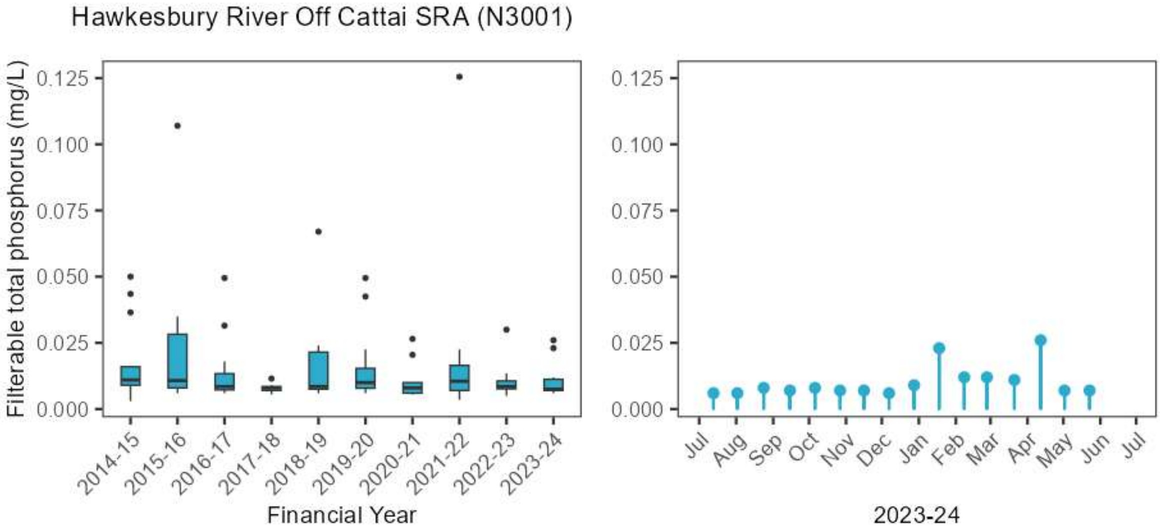
Stressors – Nutrients

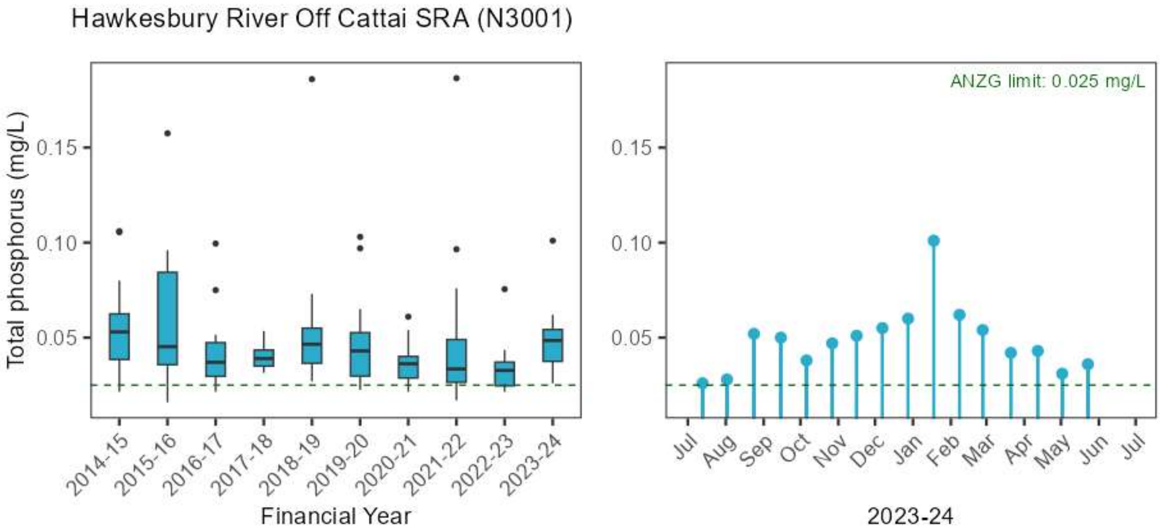




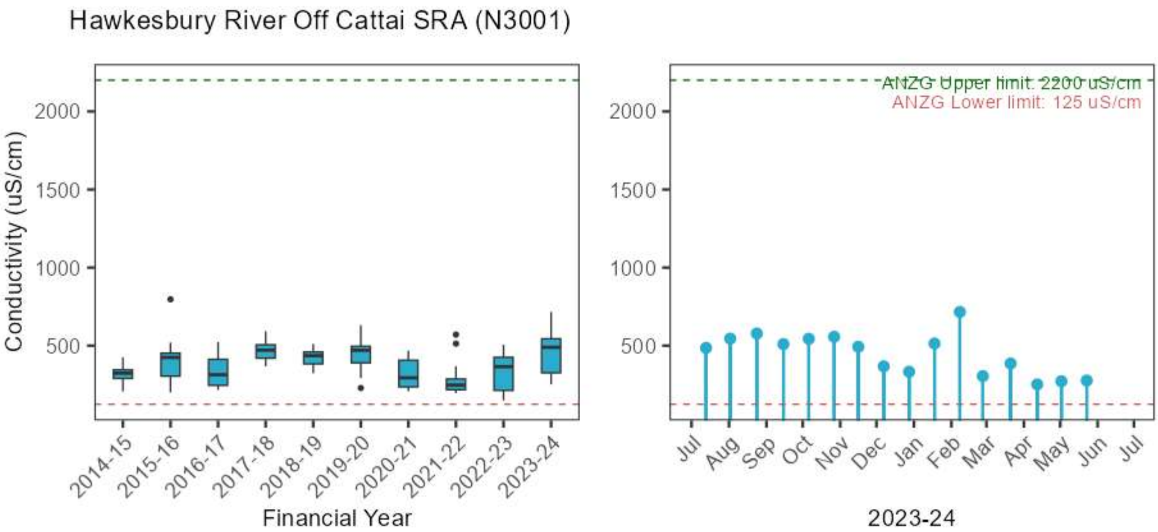


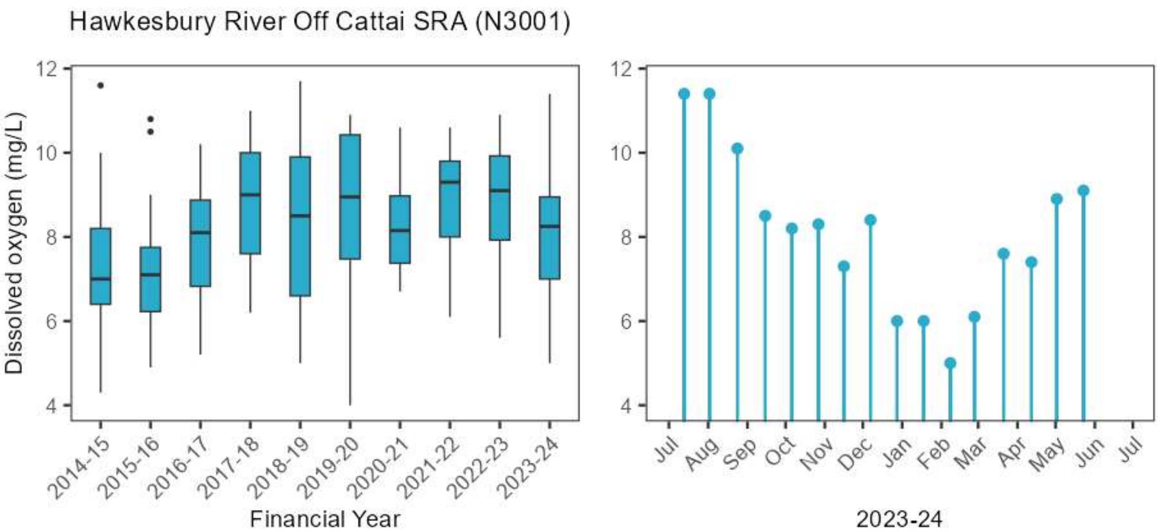

Hawkesbury River Off Cattai SRA (N3001)
Soluble reactive phosphorus (mg/L)
Financial Year
2023-24
ANZG limit: 0.015 mg/L

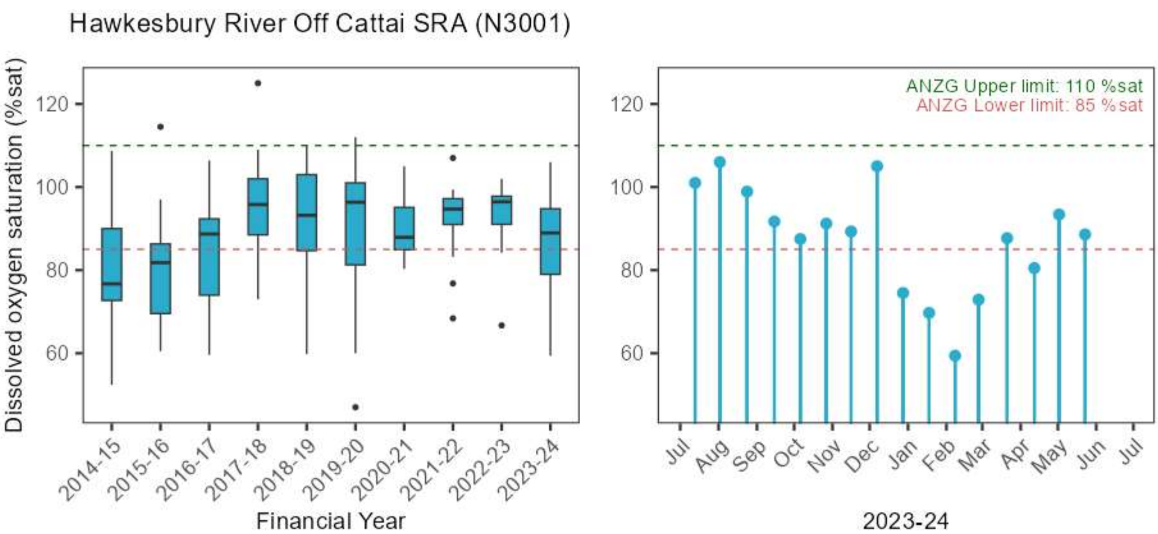

Hawkesbury River Off Cattai SRA (N3001)
Filterable total phosphorus (mg/L)
Financial Year
2023-24


Hawkesbury River Off Cattai SRA (N3001)
Total phosphorus (mg/L)
Financial Year
2023-24
ANZG limit: 0.025 mg/L

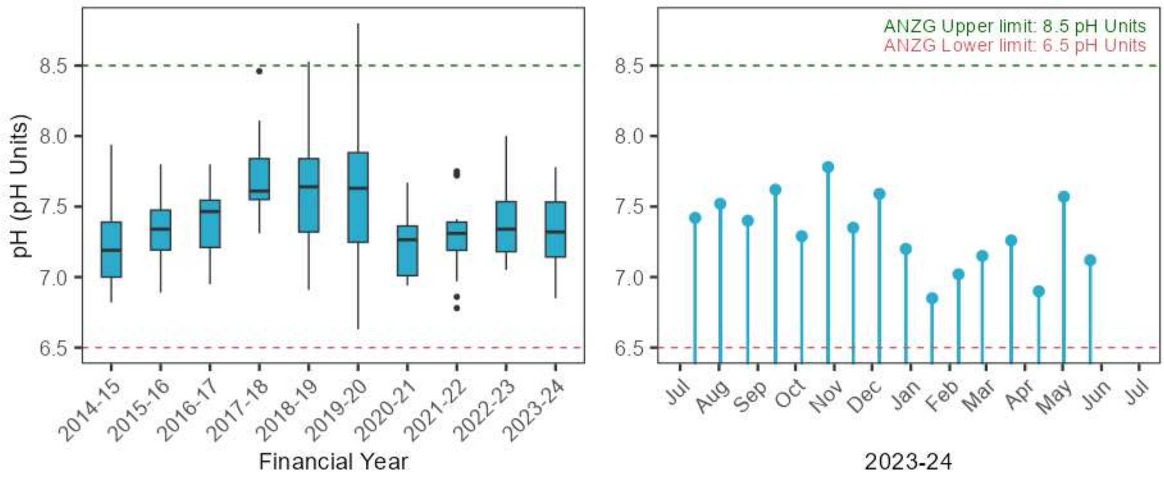
Stressors – Physico-chemical water quality



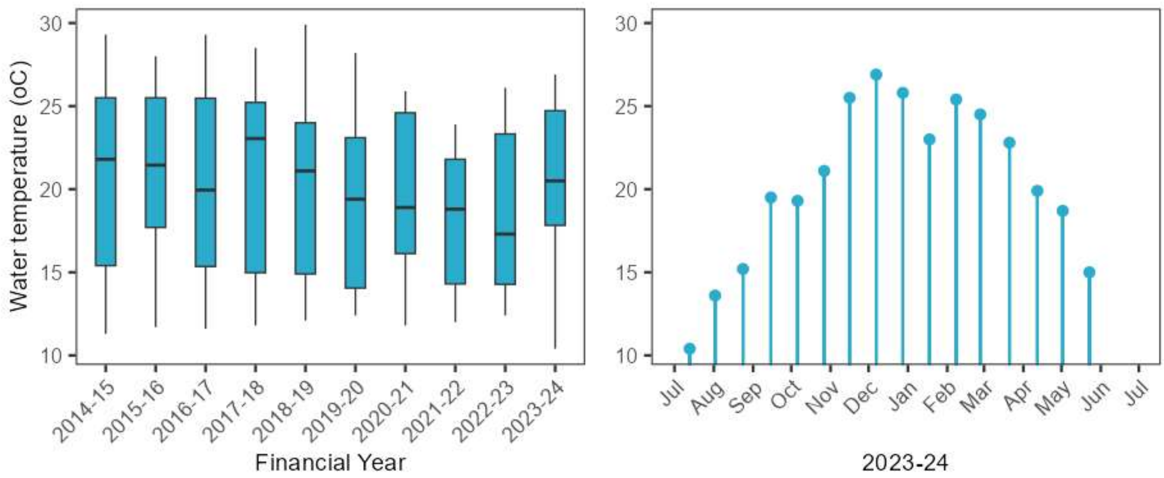




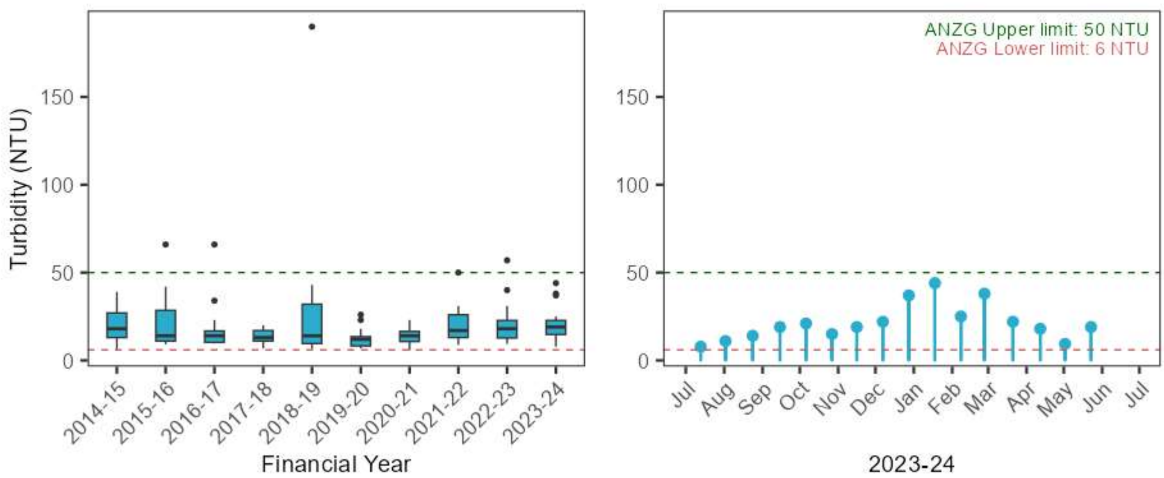
Hawkesbury River Off Cattai SRA (N3001)



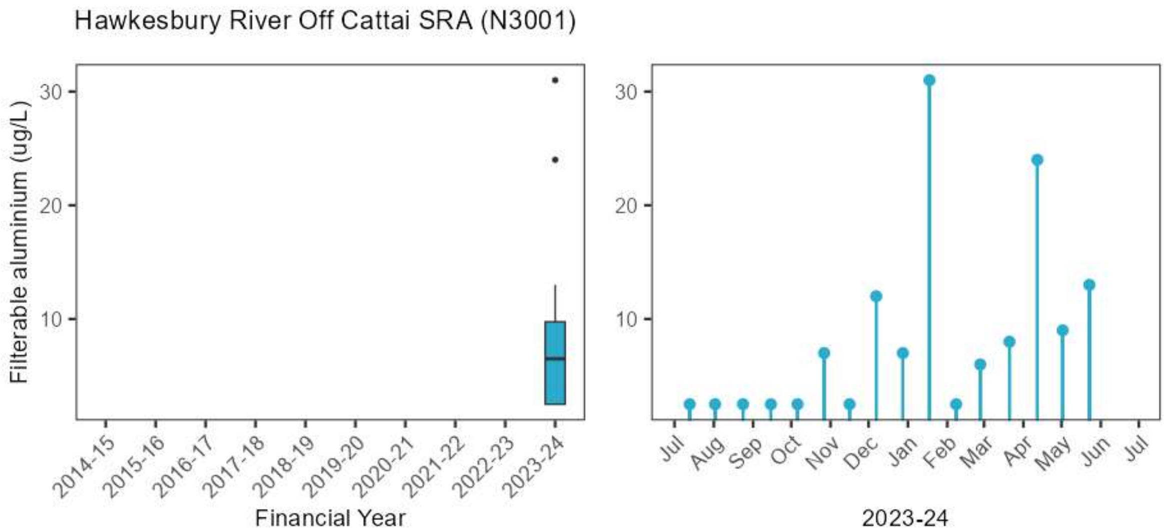
Hawkesbury River Off Cattai SRA (N3001)

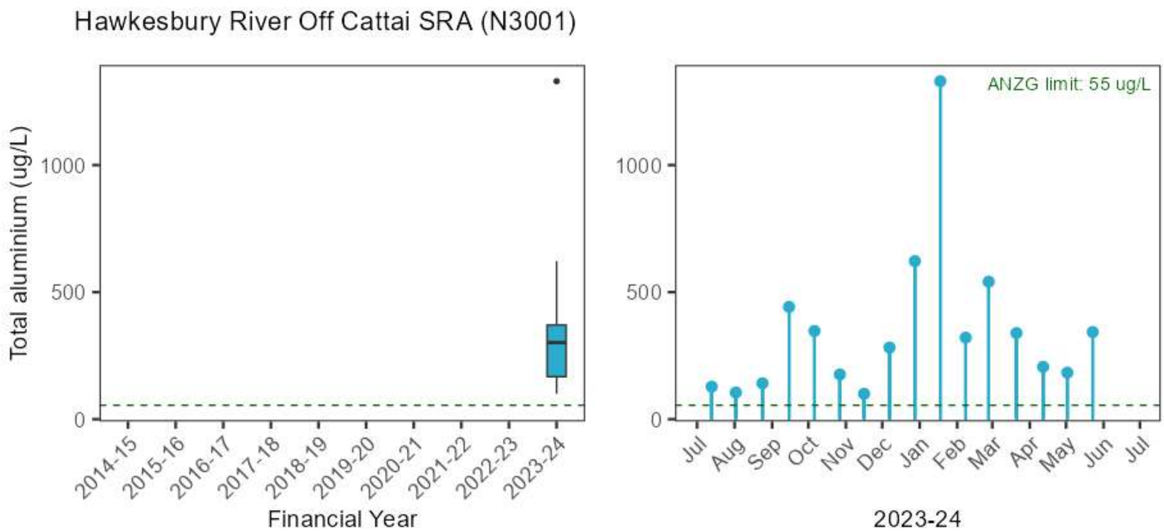


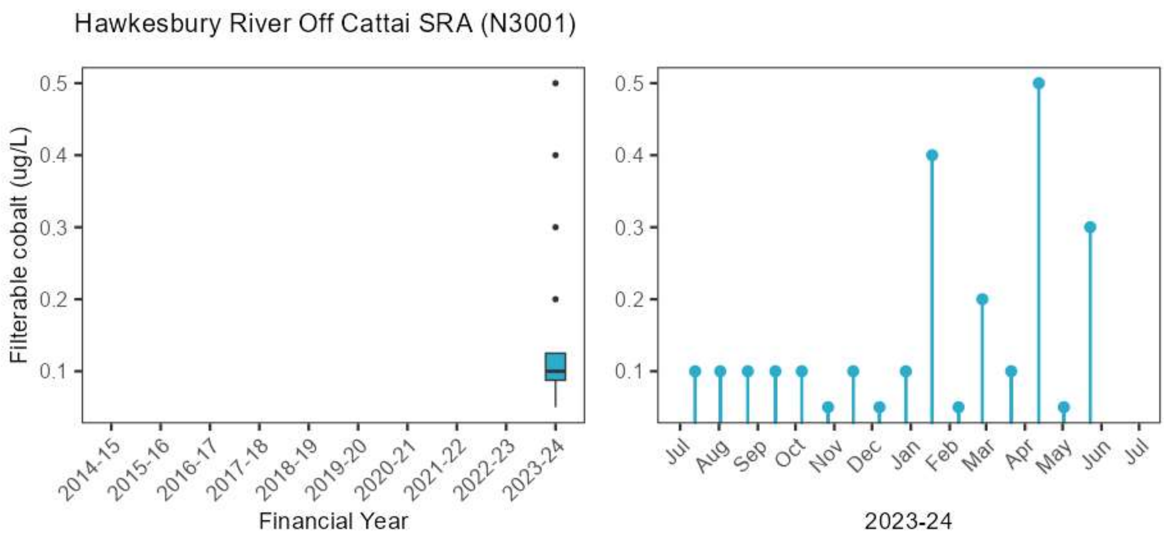
Hawkesbury River Off Cattai SRA (N3001)



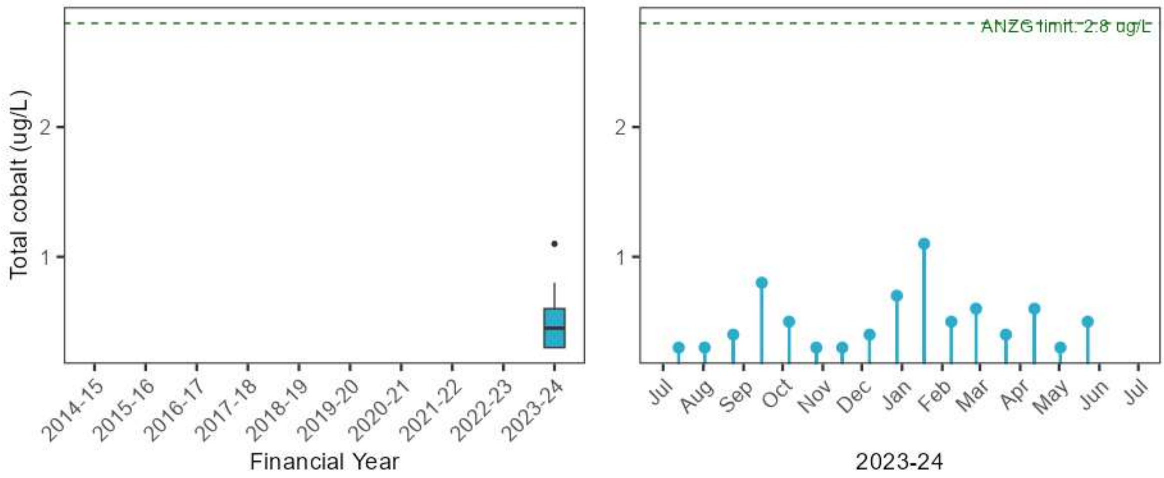
Stressors – Trace metals



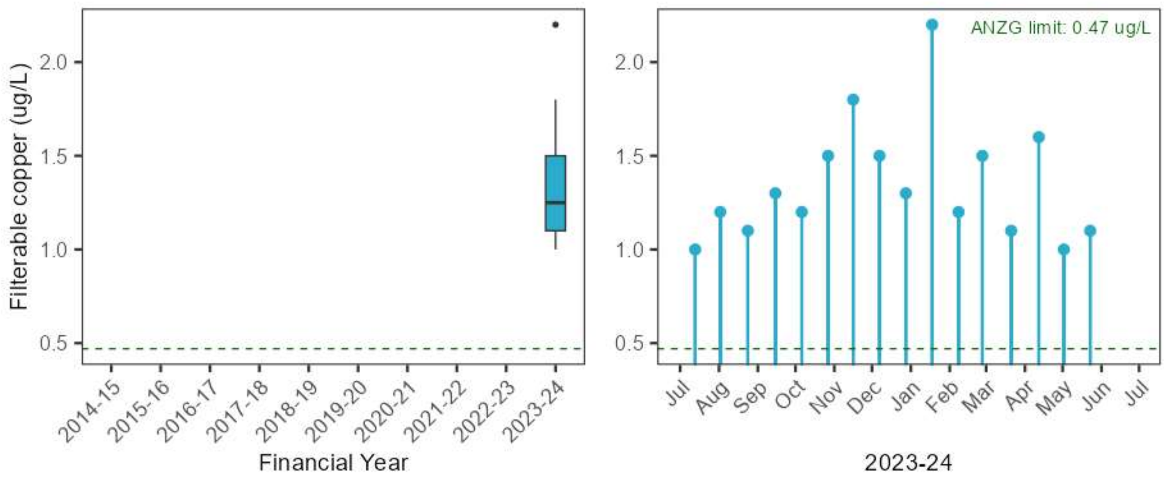




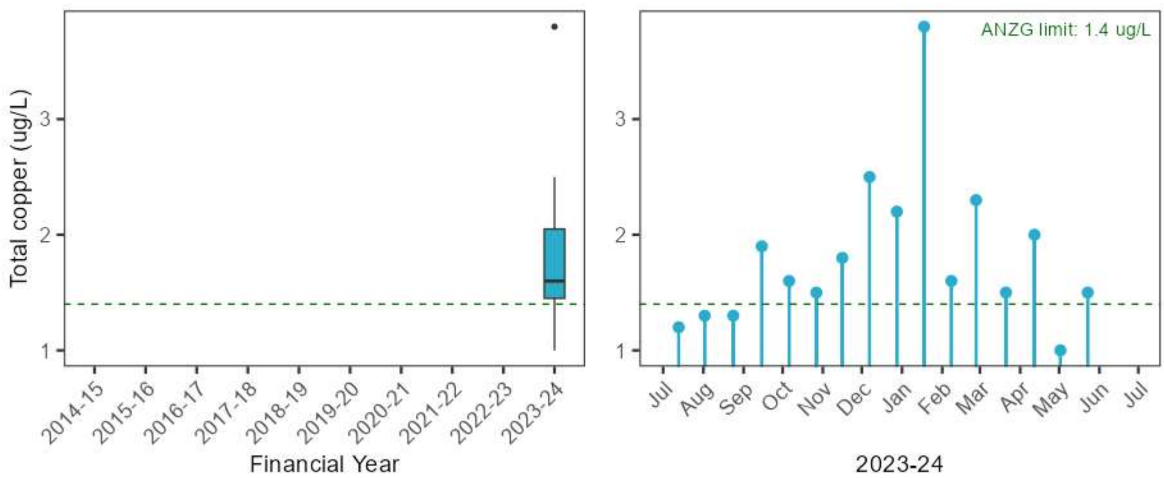
Hawkesbury River Off Cattai SRA (N3001)

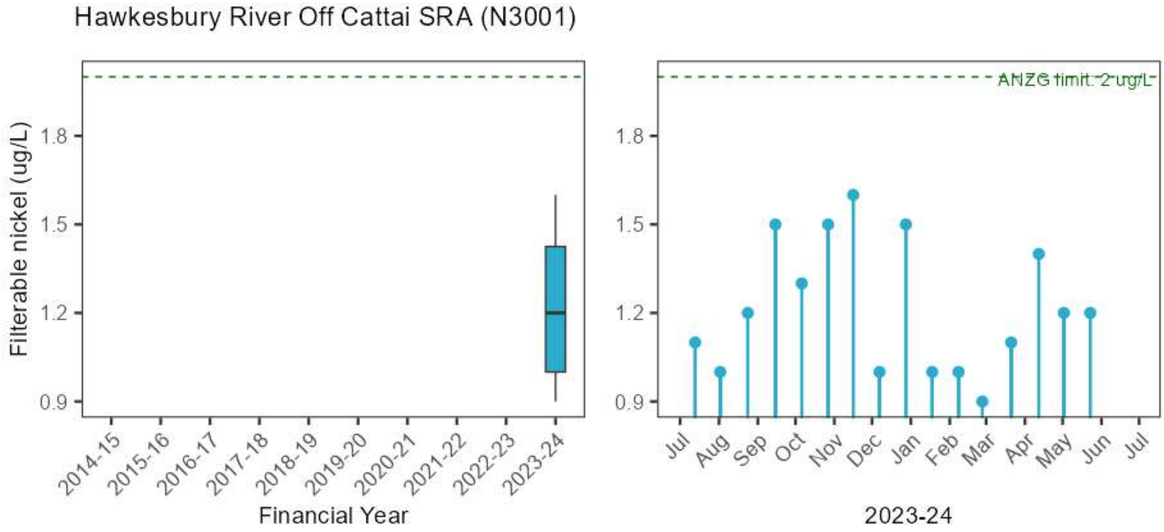


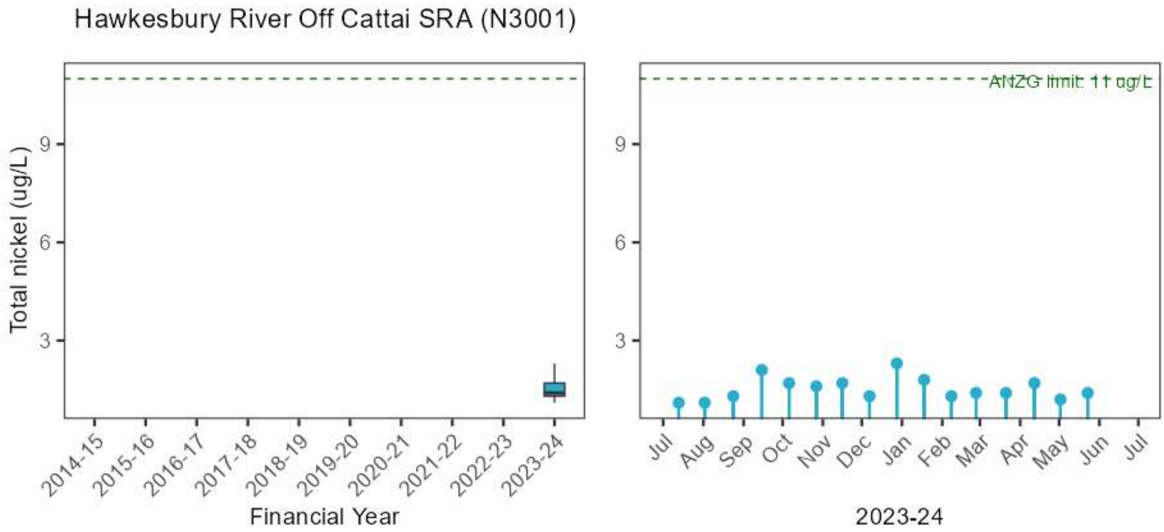
Hawkesbury River Off Cattai SRA (N3001)

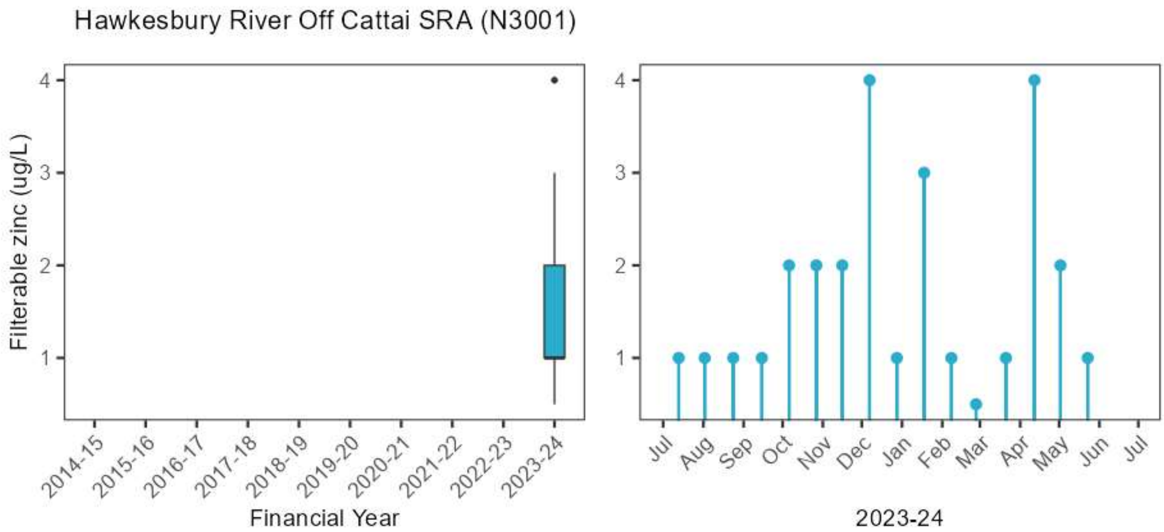


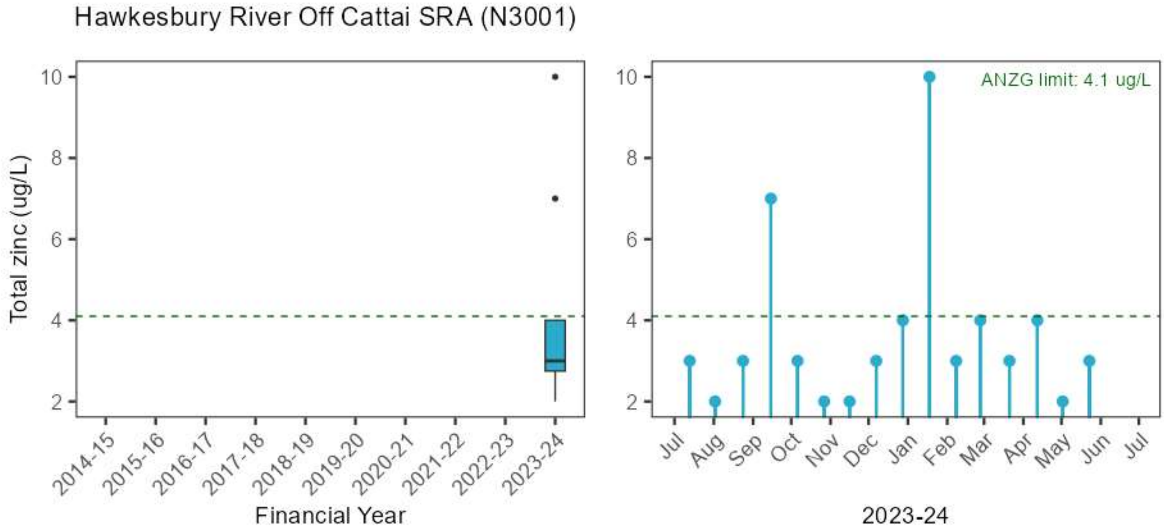
Hawkesbury River Off Cattai SRA (N3001)



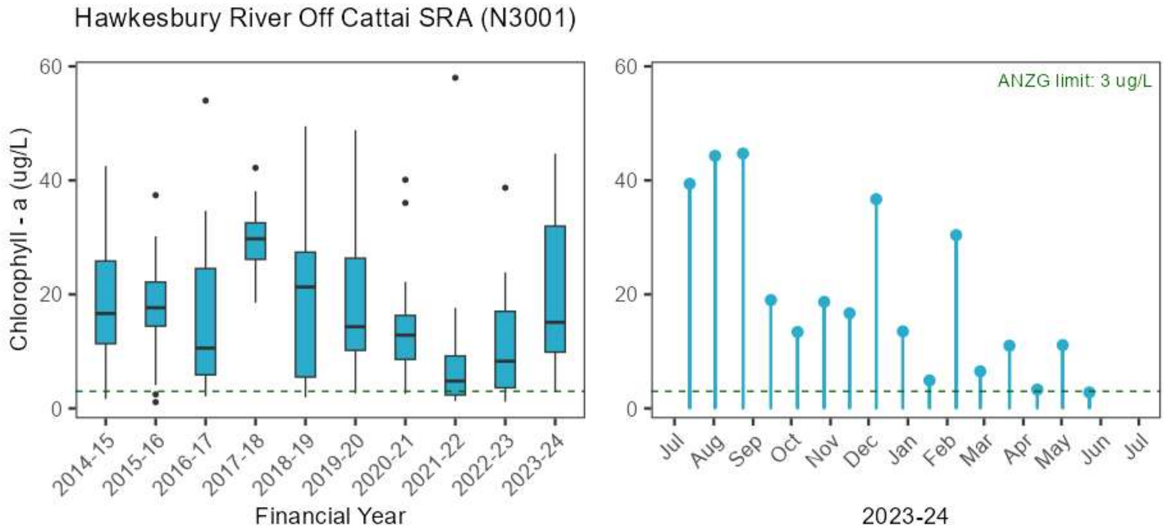

Hawkesbury River Off Cattai SRA (N3001)
Filterable nickel (ug/L)
1.8
1.5
1.2
0.9
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 2 ug/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Hawkesbury River Off Cattai SRA (N3001)
Total nickel (ug/L)
9
6
3
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 11 ug/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Hawkesbury River Off Cattai SRA (N3001)
Filterable zinc (ug/L)
4
3
2
1
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24



Ecosystem receptor – Phytoplankton



C.1.6. Hawkesbury River at Sackville Ferry (N26)

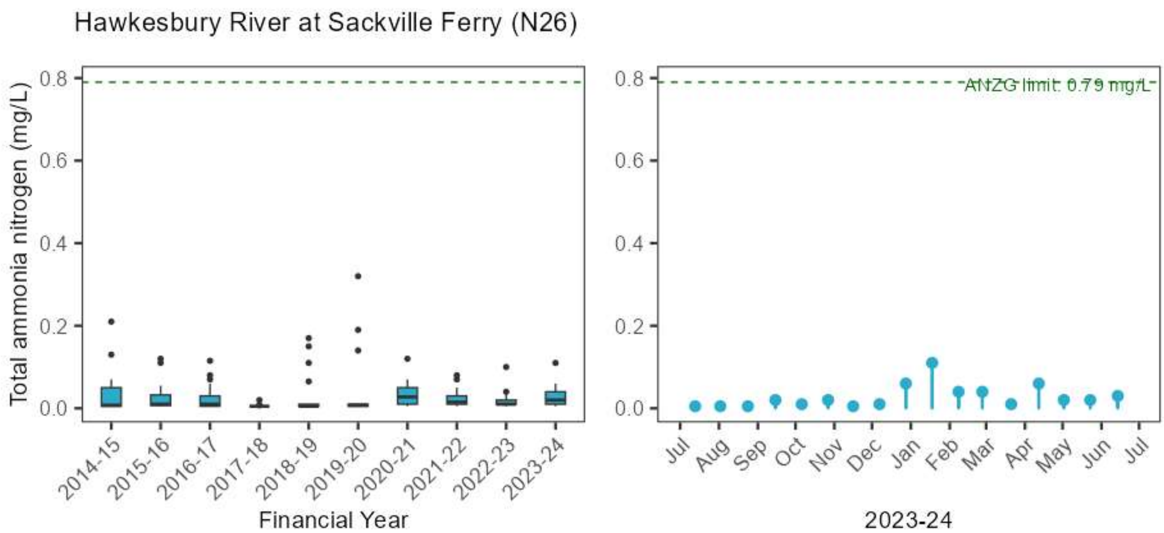
Stressors - Statistical analysis outcomes

Table C-6 Current period vs previous period comparison contrast outcomes for N26

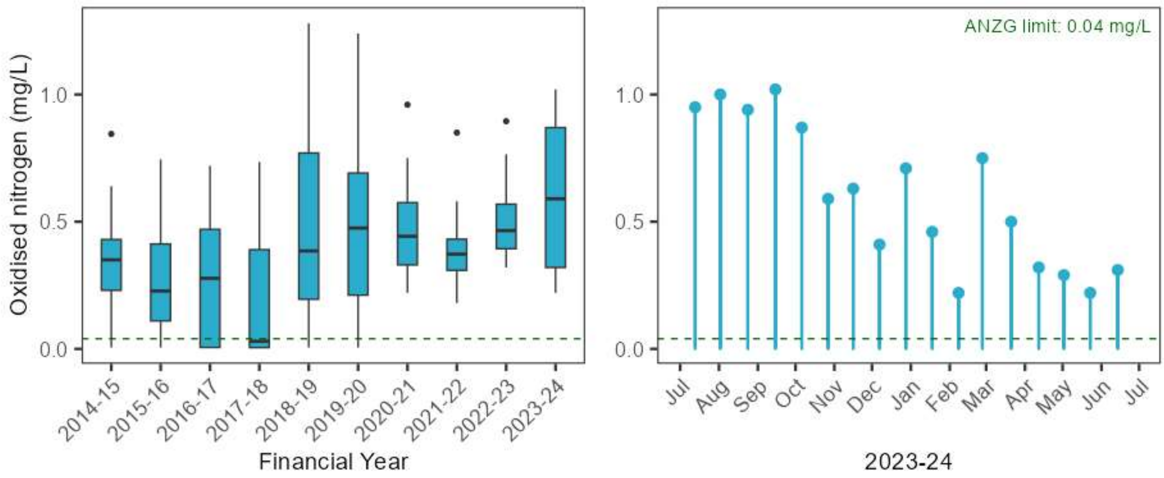
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.29	0.35	158	0.96	0.341
Oxidised nitrogen	2.74	1.03	158	2.68	0.008
Total nitrogen	1.21	0.10	158	2.34	0.020
Filterable total phosphorus	0.83	0.15	158	-1.03	0.305
Total phosphorus	1.05	0.13	158	0.40	0.689
Conductivity	1.15	0.08	157	1.97	0.050
Dissolved oxygen	1.05	0.06	158	0.89	0.373
Dissolved oxygen saturation	3.82	3.70	158	1.03	0.303
pH	-0.12	0.12	158	-0.95	0.345
Water temperature	1.03	0.07	157	0.42	0.673
Turbidity	1.31	0.22	158	1.66	0.099
Chlorophyll - a	1.07	0.23	158	0.31	0.757

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

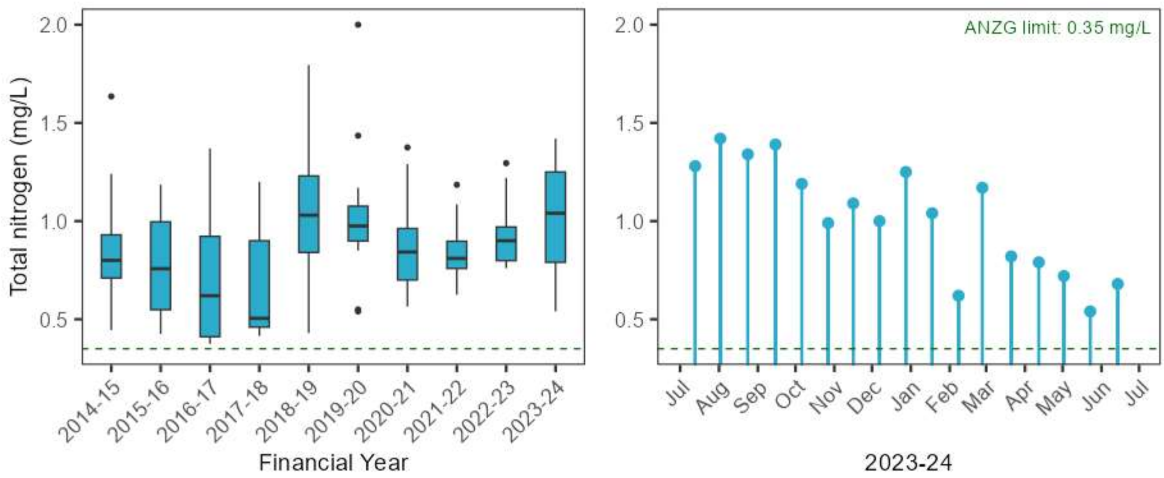
Stressors – Nutrients



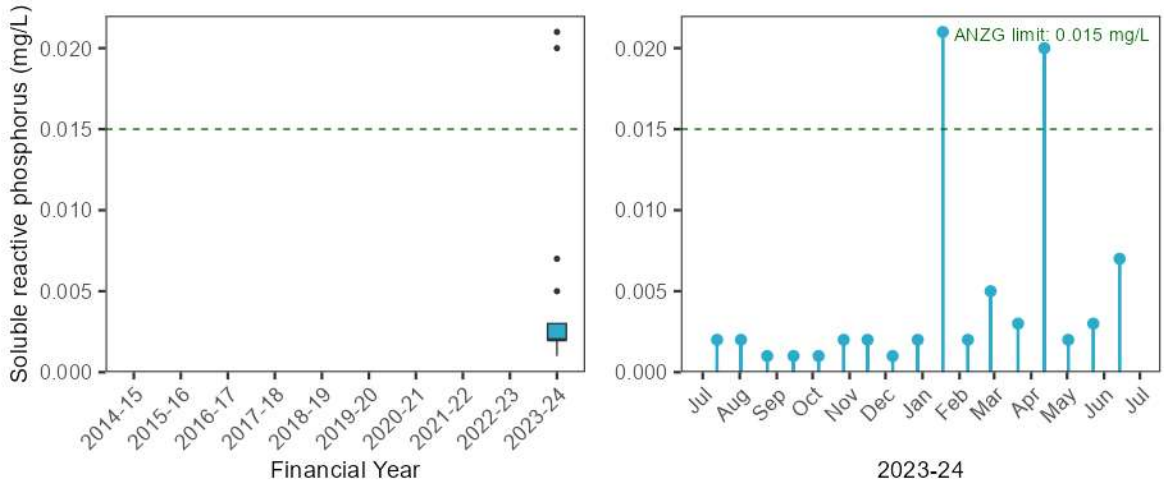
Hawkesbury River at Sackville Ferry (N26)

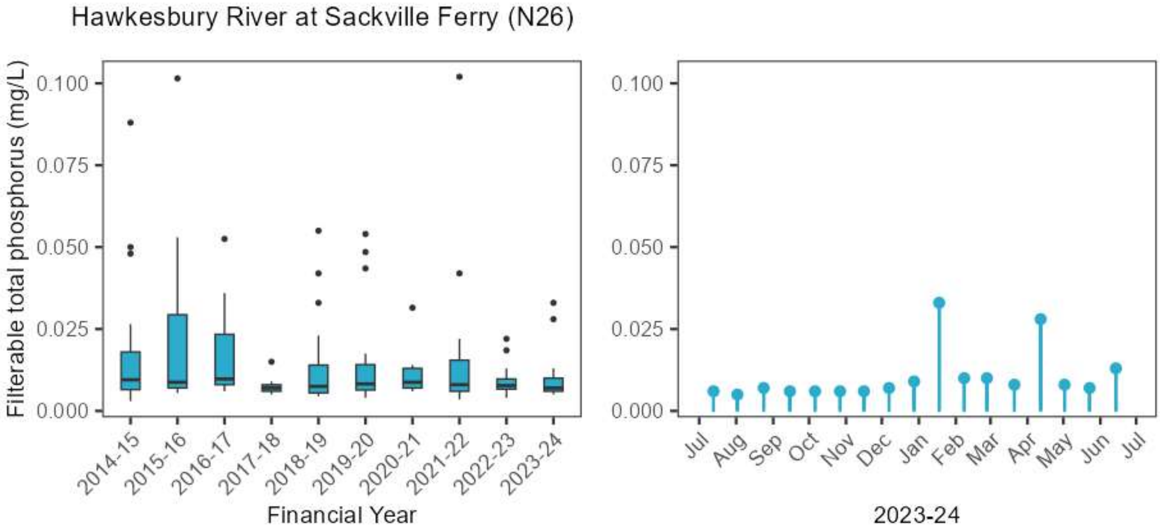


Hawkesbury River at Sackville Ferry (N26)

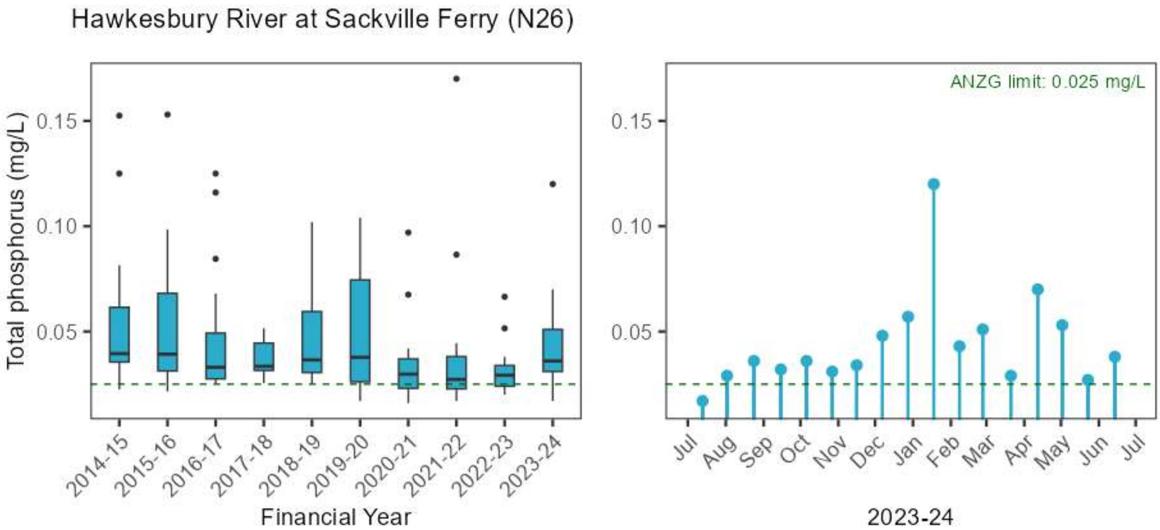


Hawkesbury River at Sackville Ferry (N26)



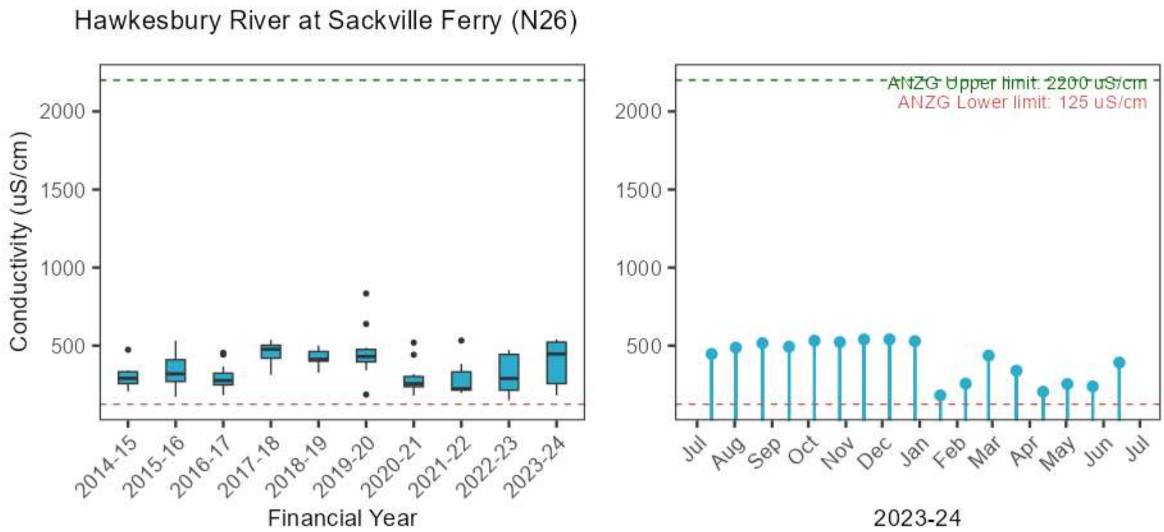


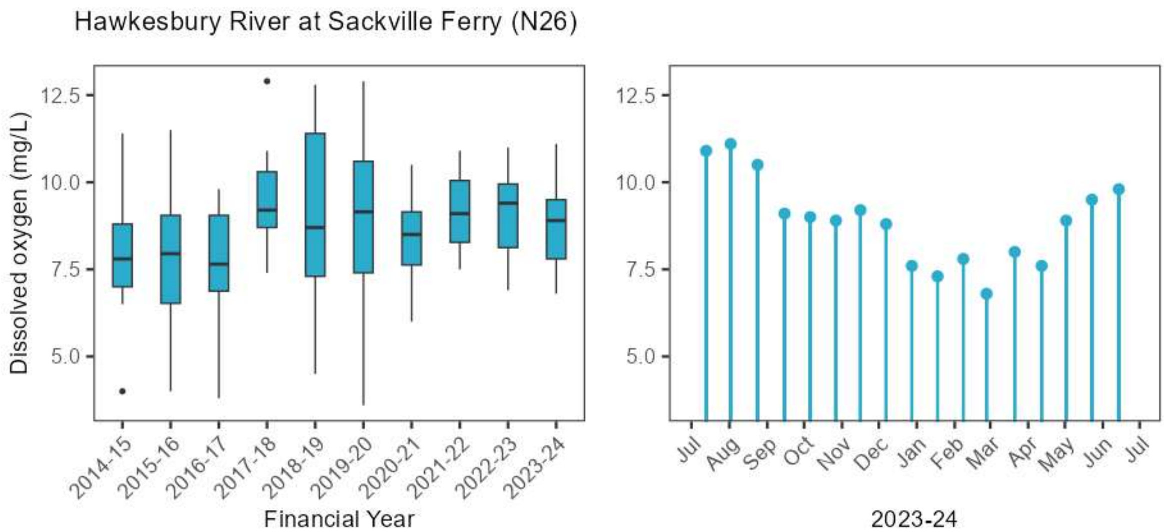
Hawkesbury River at Sackville Ferry (N26)
Filterable total phosphorus (mg/L)
0.100
0.075
0.050
0.025
0.000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

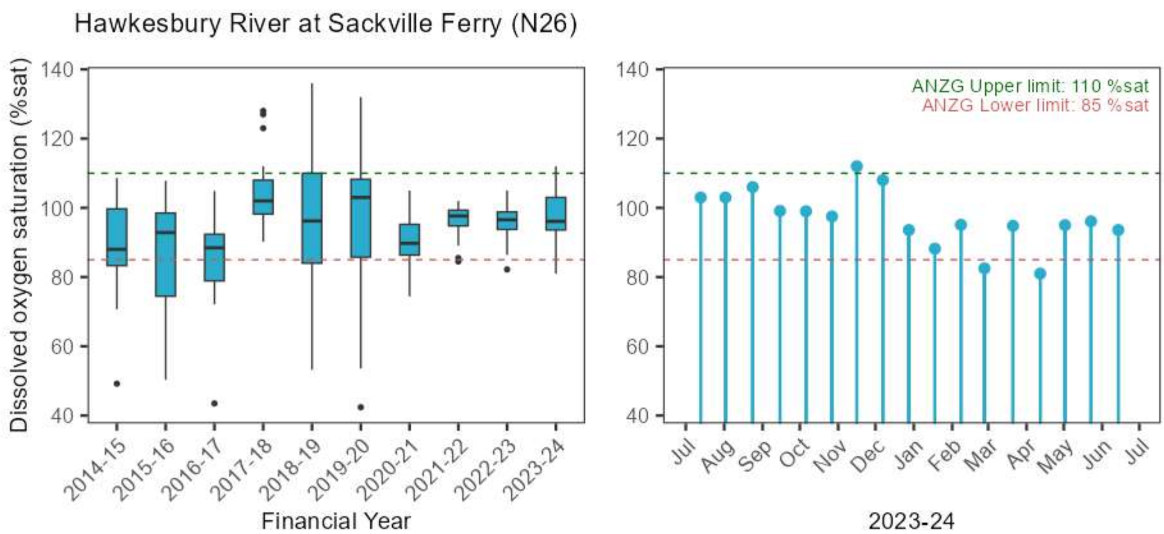


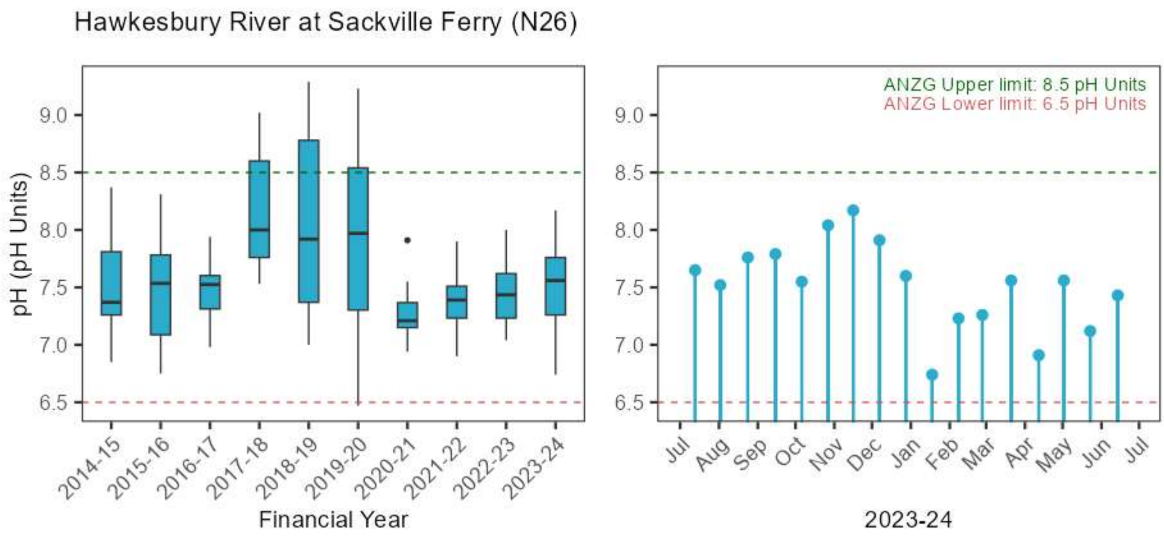
Hawkesbury River at Sackville Ferry (N26)
Total phosphorus (mg/L)
0.15
0.10
0.05
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.025 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

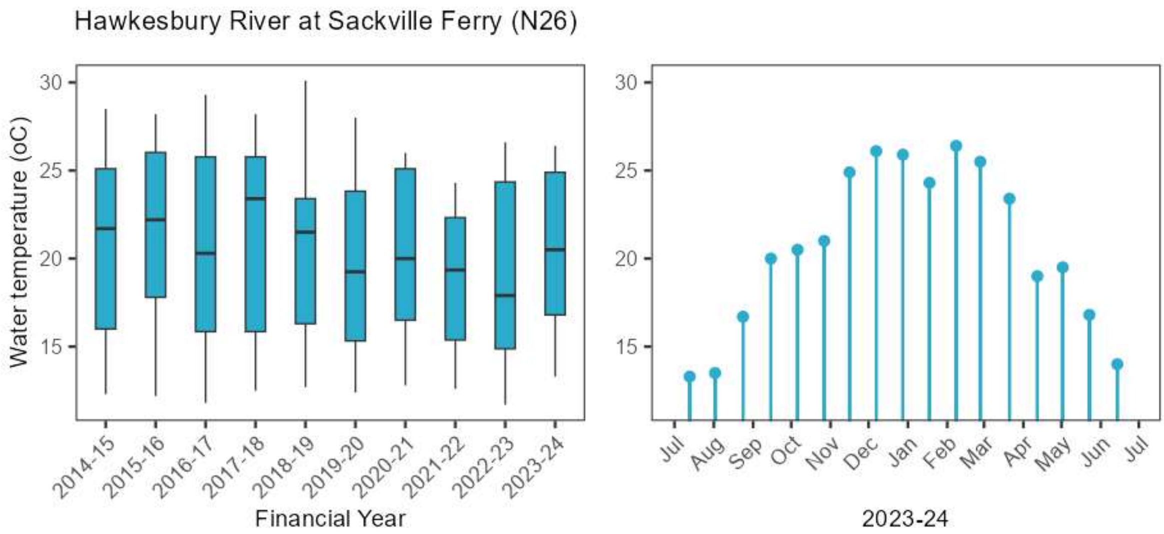
Stressors - Physico-chemical water quality

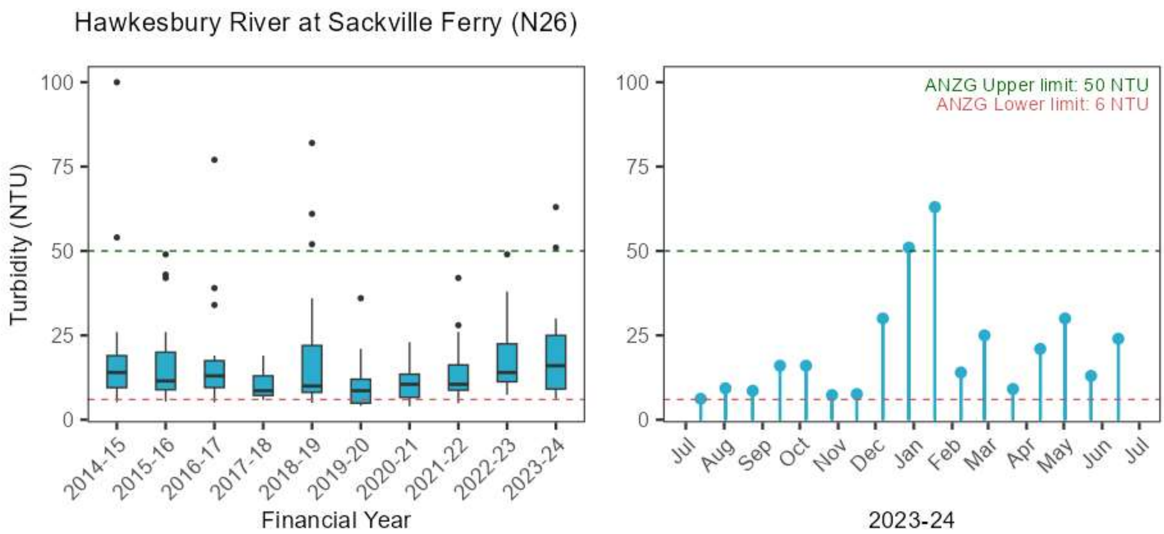




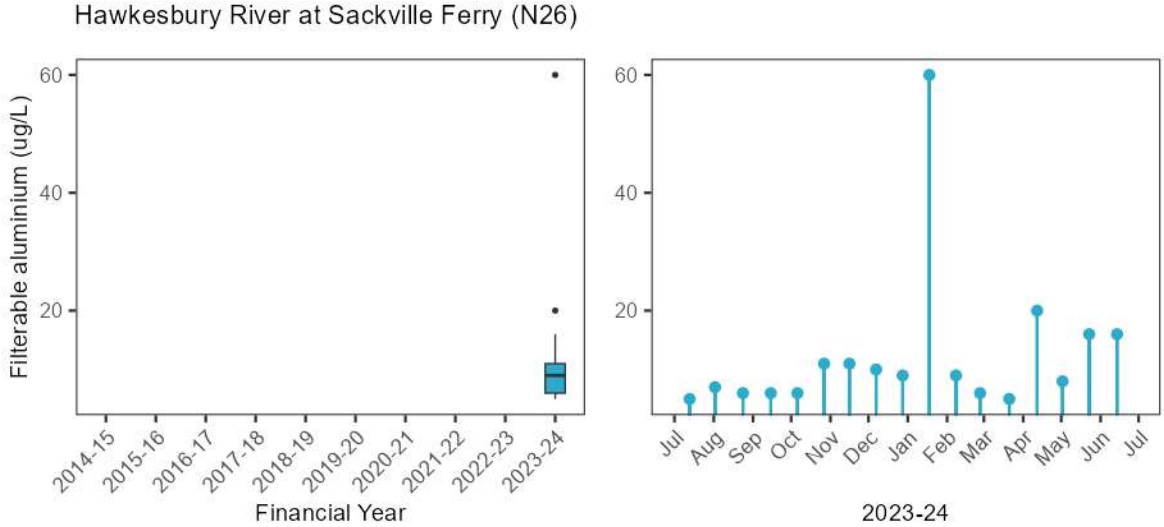


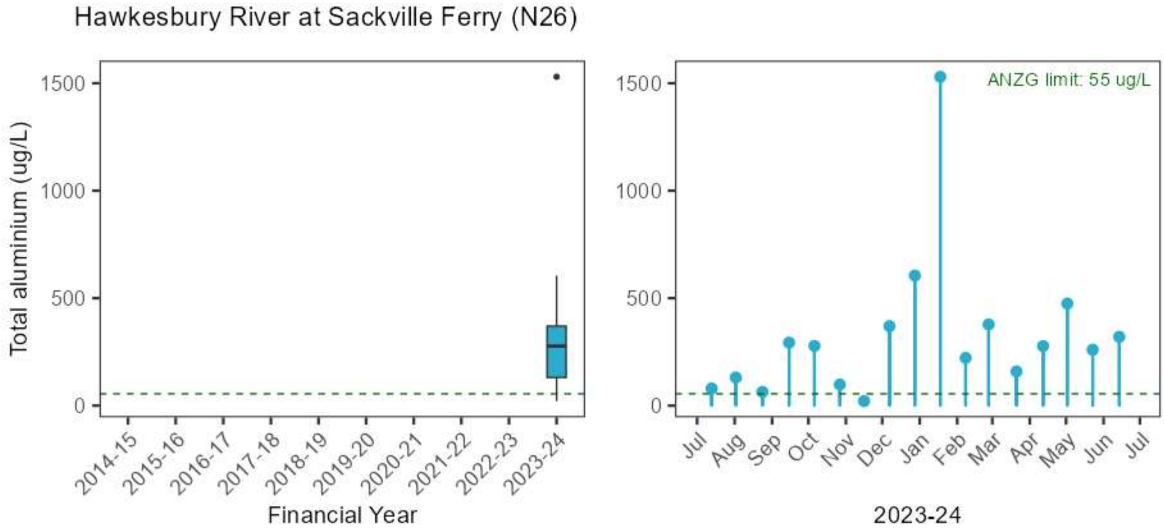

Hawkesbury River at Sackville Ferry (N26)
pH (pH Units)
Financial Year
2023-24
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units

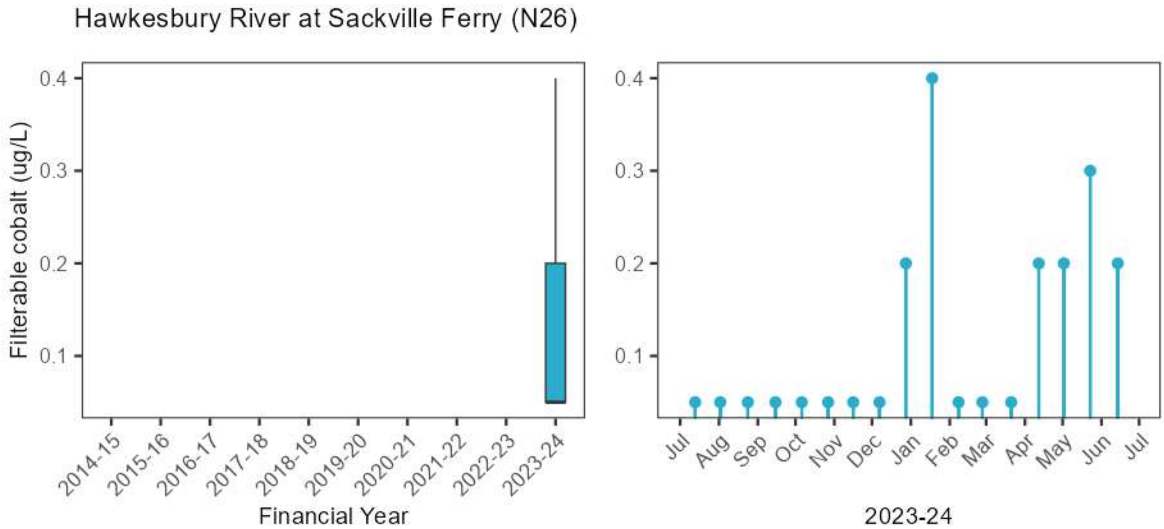

Hawkesbury River at Sackville Ferry (N26)
Water temperature (oC)
Financial Year
2023-24


Hawkesbury River at Sackville Ferry (N26)
Turbidity (NTU)
Financial Year
2023-24
ANZG Upper limit: 50 NTU
ANZG Lower limit: 6 NTU

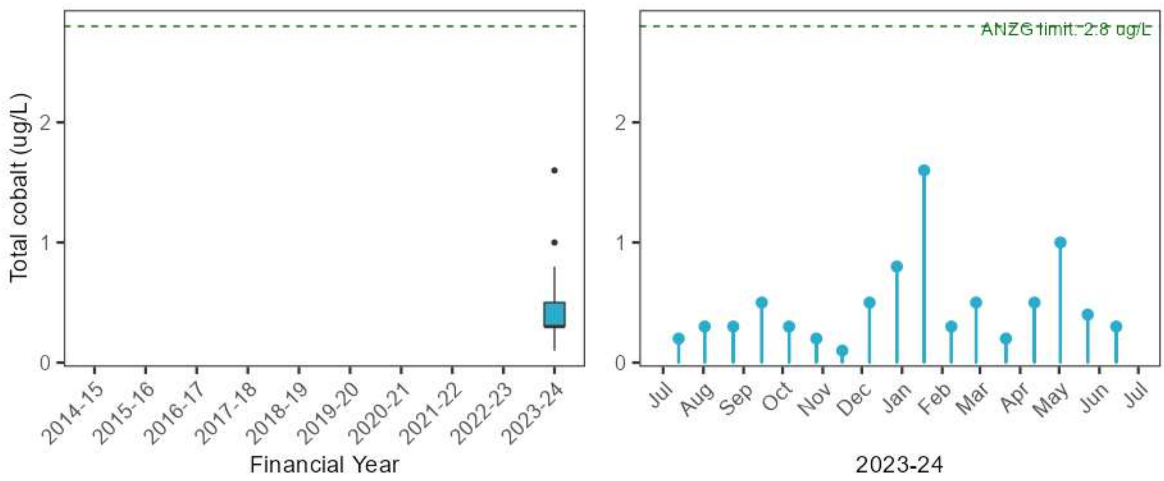
Stressors - Trace metals



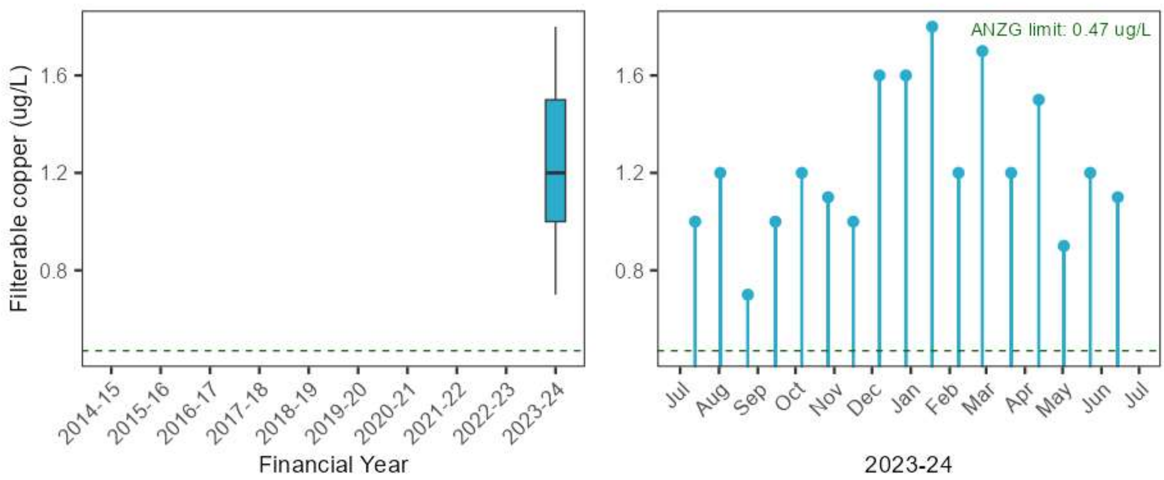




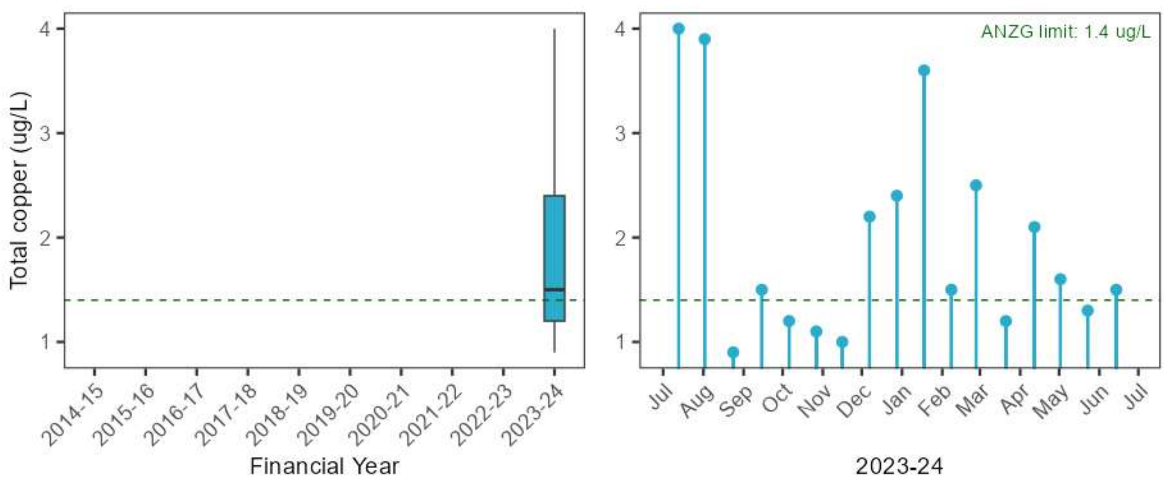
Hawkesbury River at Sackville Ferry (N26)

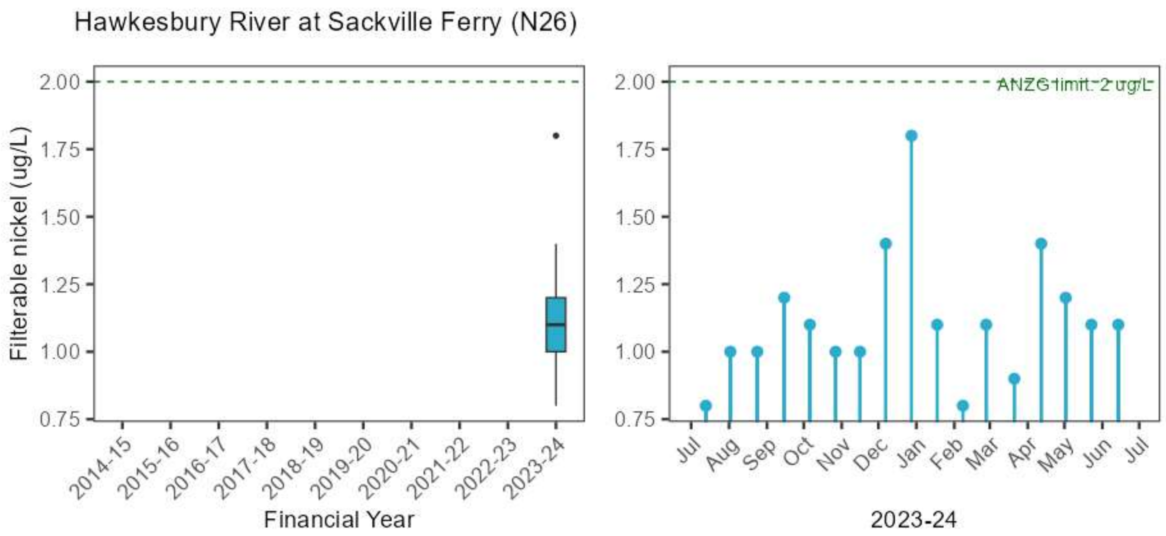


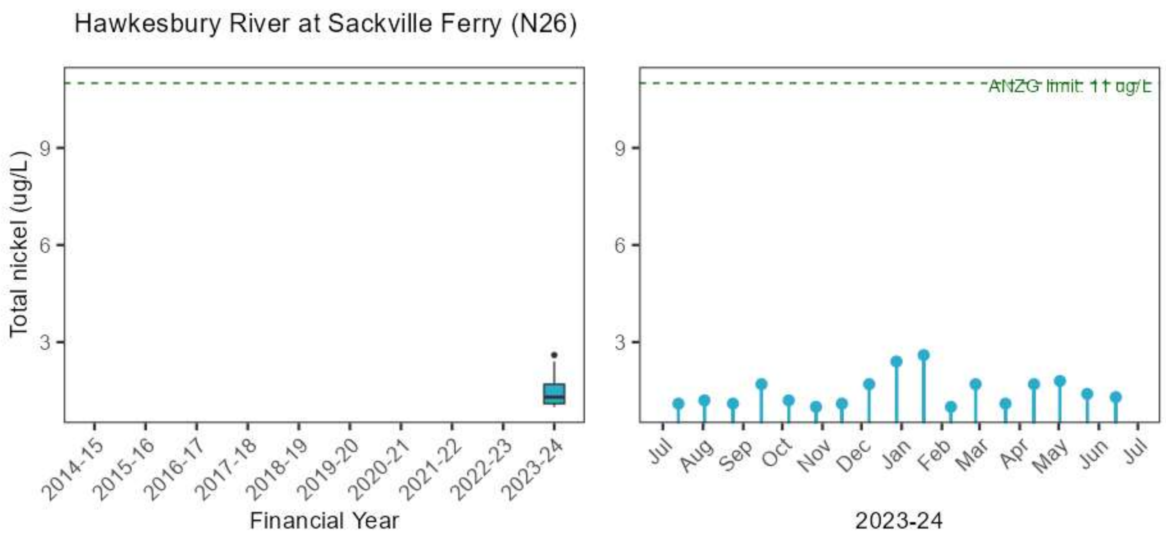
Hawkesbury River at Sackville Ferry (N26)

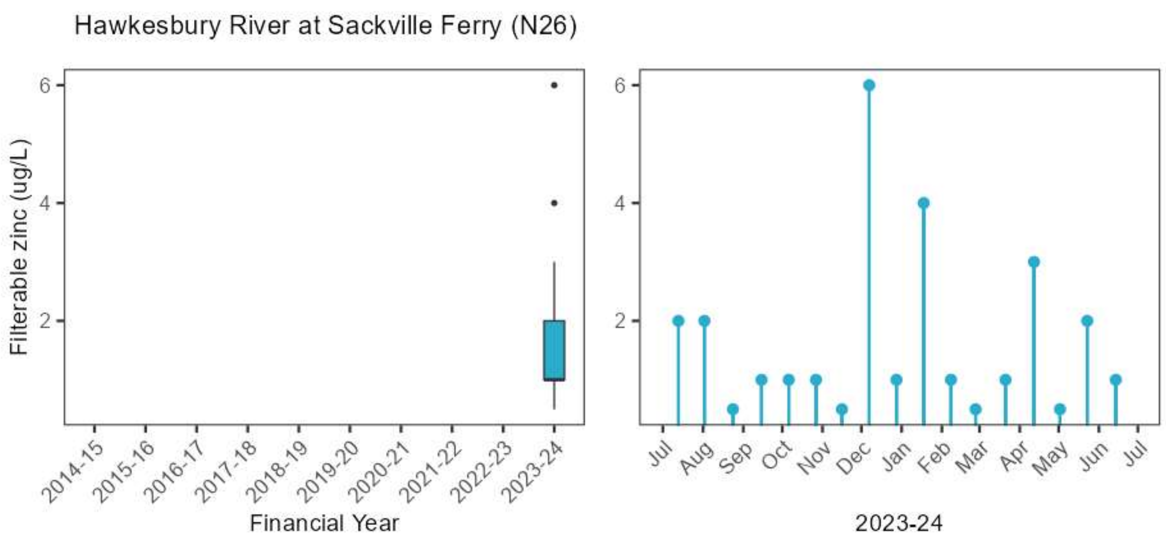


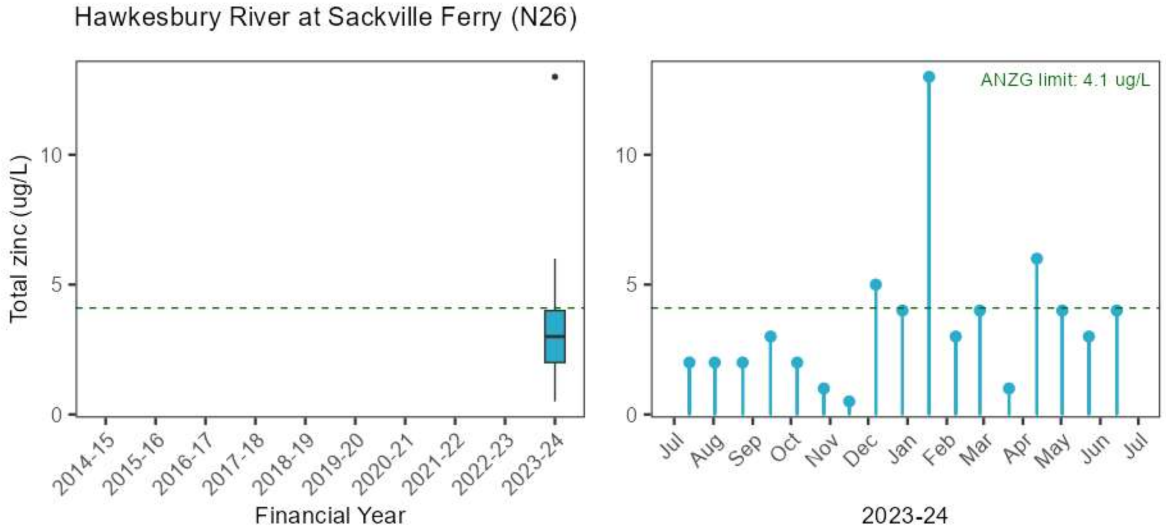
Hawkesbury River at Sackville Ferry (N26)



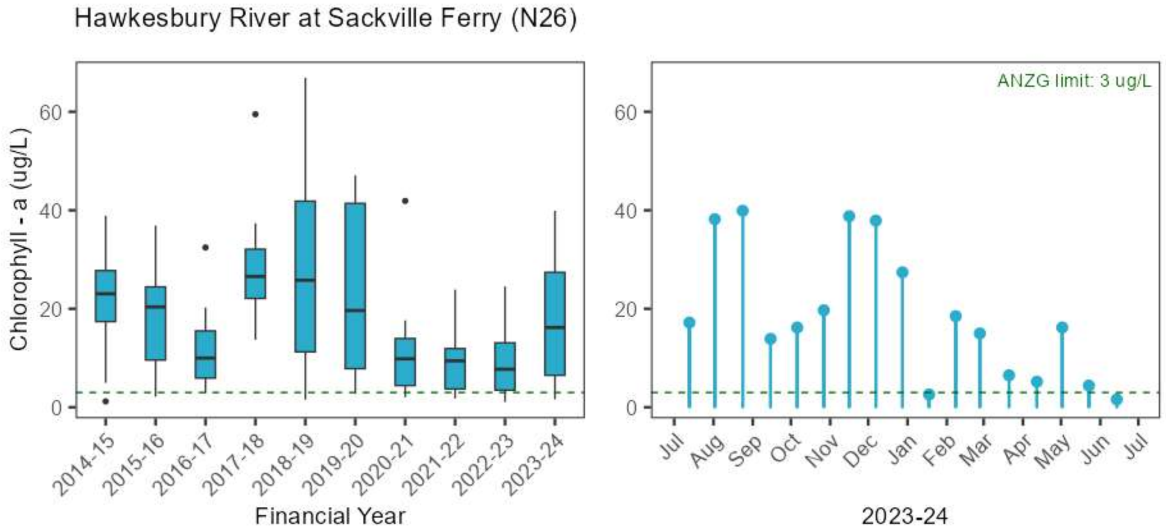

Hawkesbury River at Sackville Ferry (N26)
Filterable nickel (ug/L)
Financial Year
ANZG limit: 2 ug/L
2023-24


Hawkesbury River at Sackville Ferry (N26)
Total nickel (ug/L)
Financial Year
ANZG limit: 11 ug/L
2023-24


Hawkesbury River at Sackville Ferry (N26)
Filterable zinc (ug/L)
Financial Year
2023-24



Ecosystem receptor - Phytoplankton



C.1.7. Lower Colo River at Putty Road (N2202)

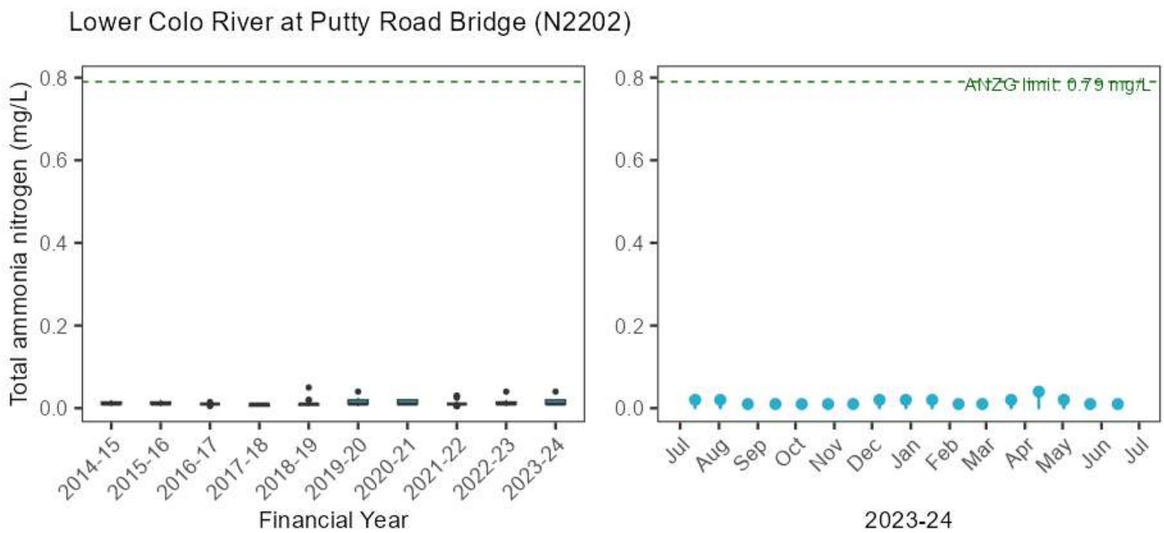
Stressors - Statistical analysis outcomes

Table C-7 Current period vs previous period comparison contrast outcomes for N2202

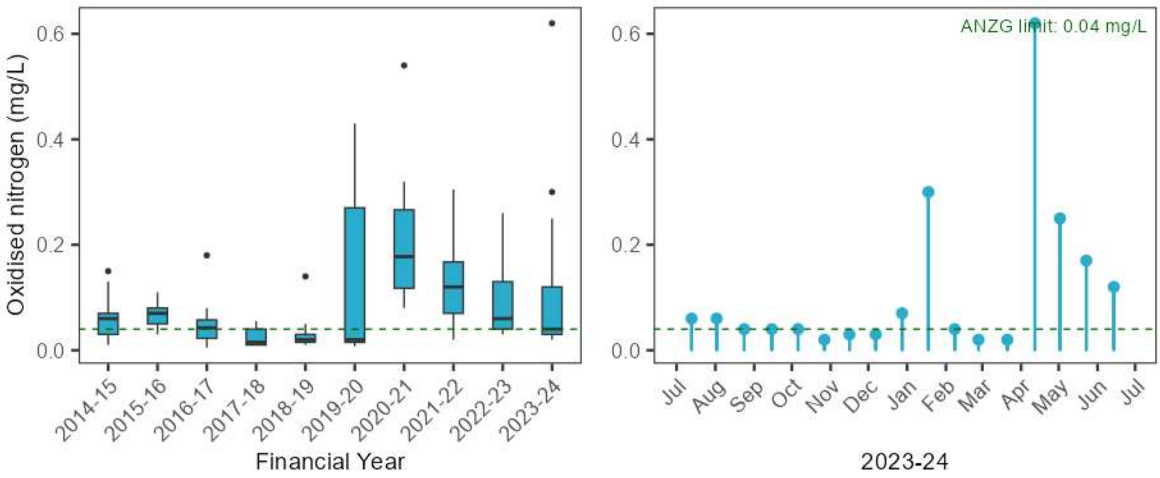
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.33	0.15	161	2.56	0.011
Oxidised nitrogen	1.22	0.26	161	0.94	0.348
Total nitrogen	0.96	0.11	161	-0.38	0.707
Filterable total phosphorus	0.83	0.09	161	-1.72	0.087
Total phosphorus	0.98	0.16	161	-0.13	0.894
Conductivity	1.24	0.11	161	2.32	0.022
Dissolved oxygen	1.02	0.04	161	0.37	0.712
Dissolved oxygen saturation	0.53	1.59	160	0.33	0.740
pH	0.06	0.08	160	0.72	0.472
Water temperature	1.01	0.09	160	0.11	0.913
Turbidity	1.30	0.30	161	1.14	0.256
Chlorophyll - a	0.61	0.15	161	-2.09	0.038

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

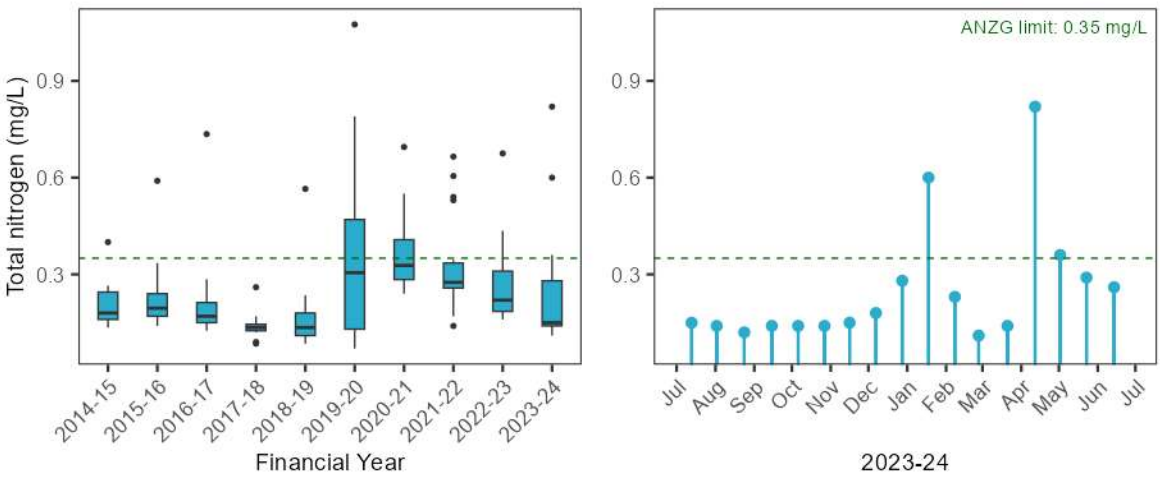
Stressors – Nutrients



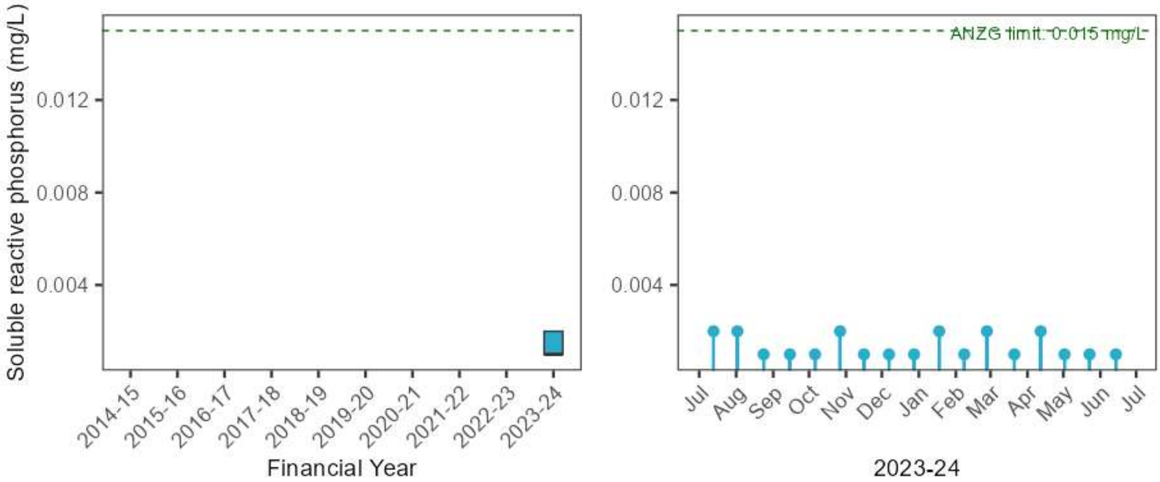
Lower Colo River at Putty Road Bridge (N2202)

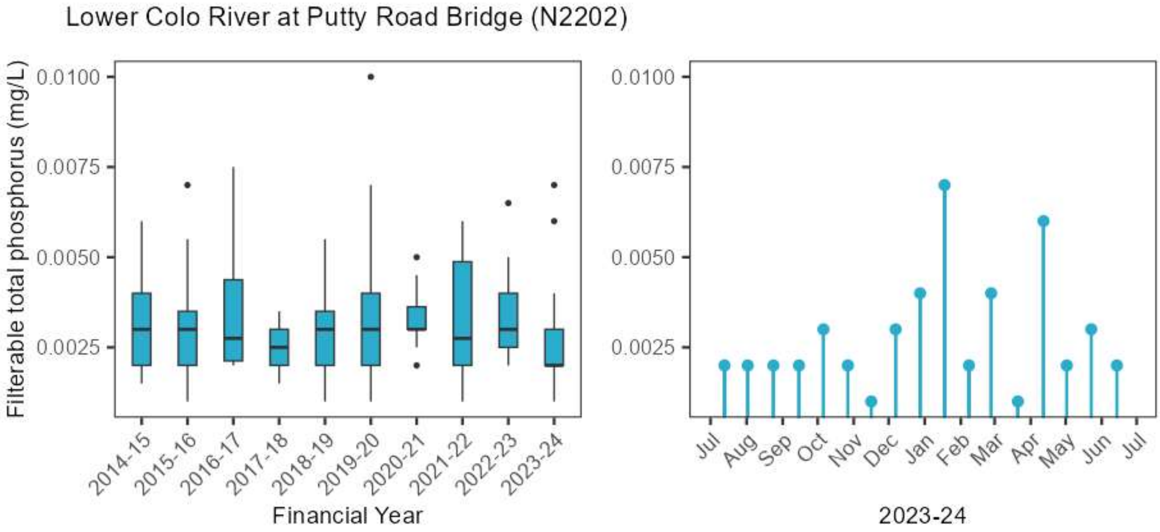


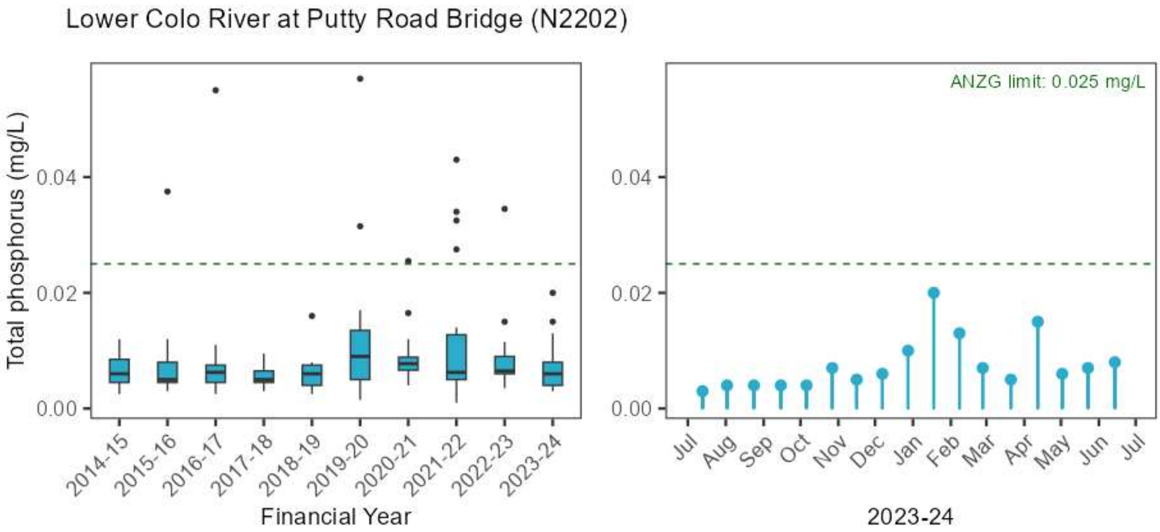
Lower Colo River at Putty Road Bridge (N2202)



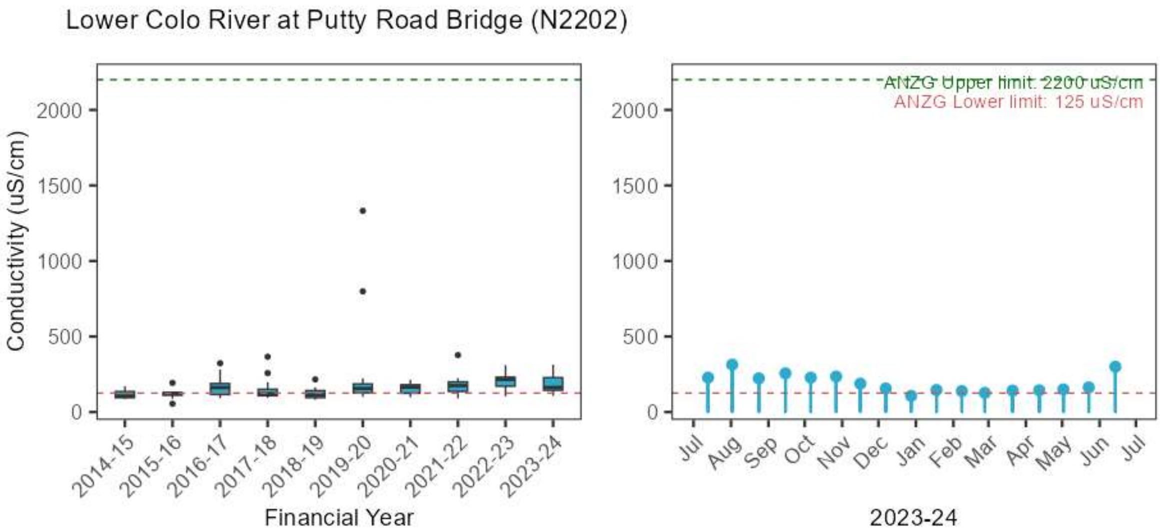
Lower Colo River at Putty Road Bridge (N2202)



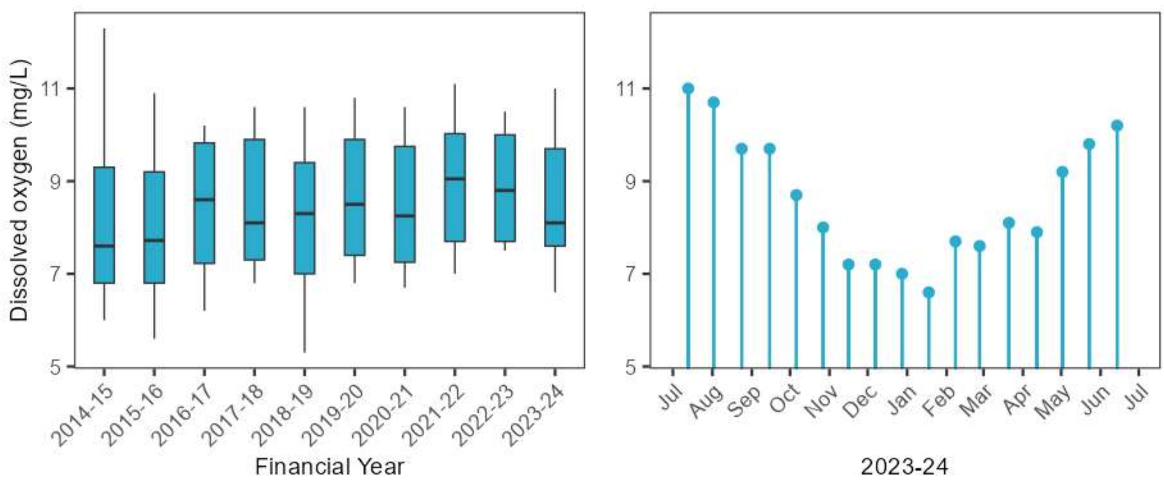




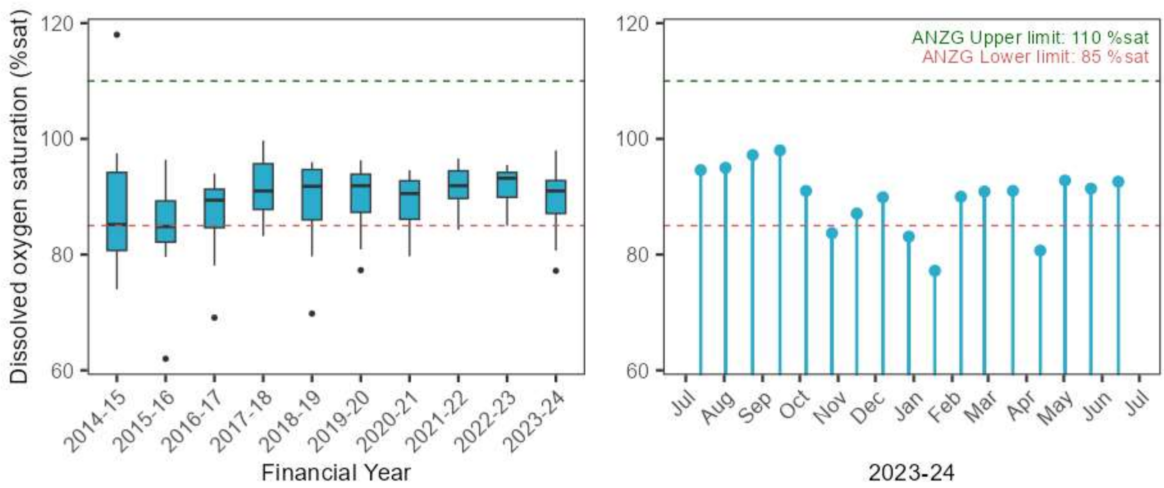
Stressors – Physico-chemical water quality



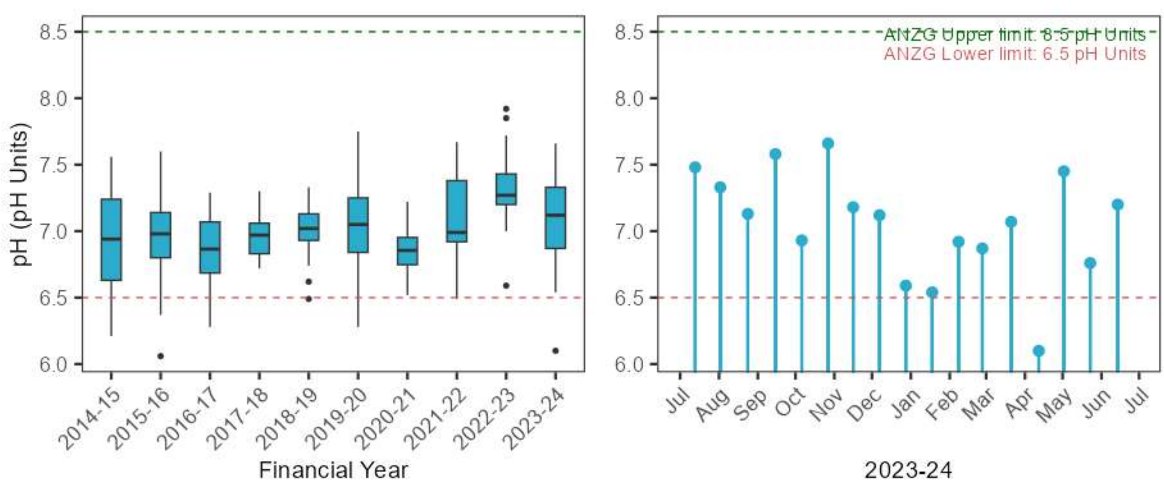
Lower Colo River at Putty Road Bridge (N2202)

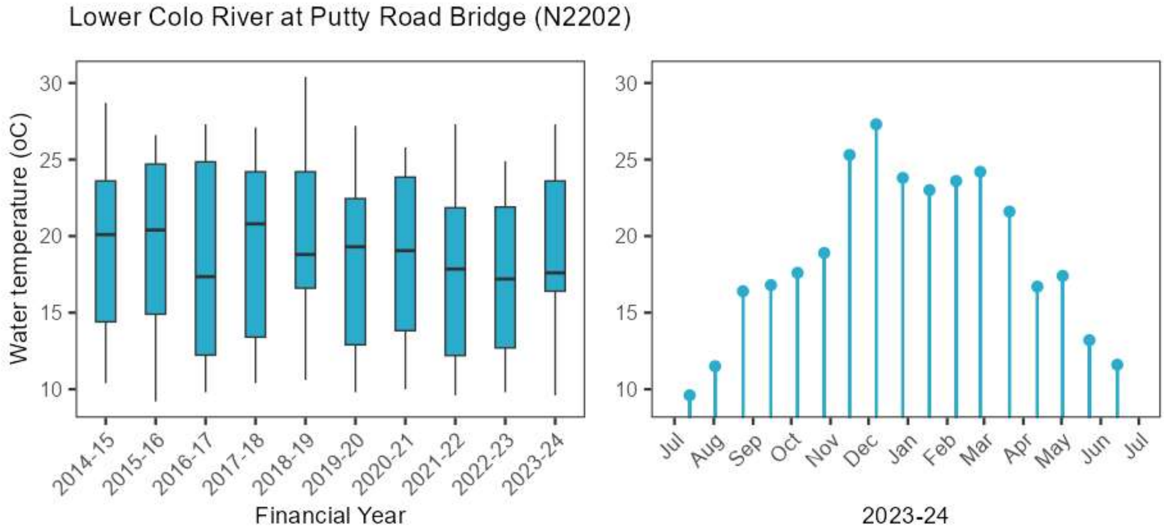


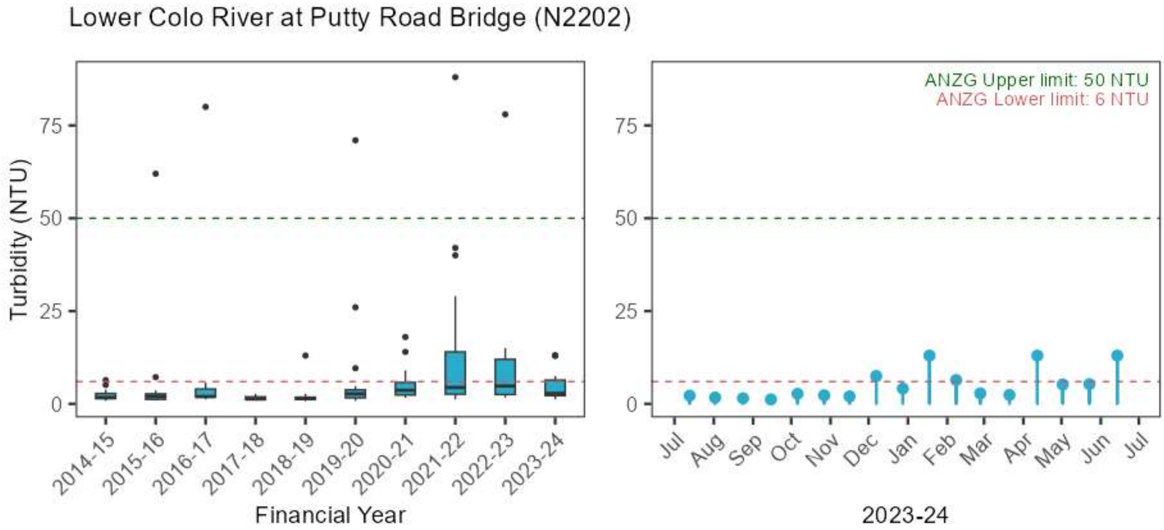
Lower Colo River at Putty Road Bridge (N2202)



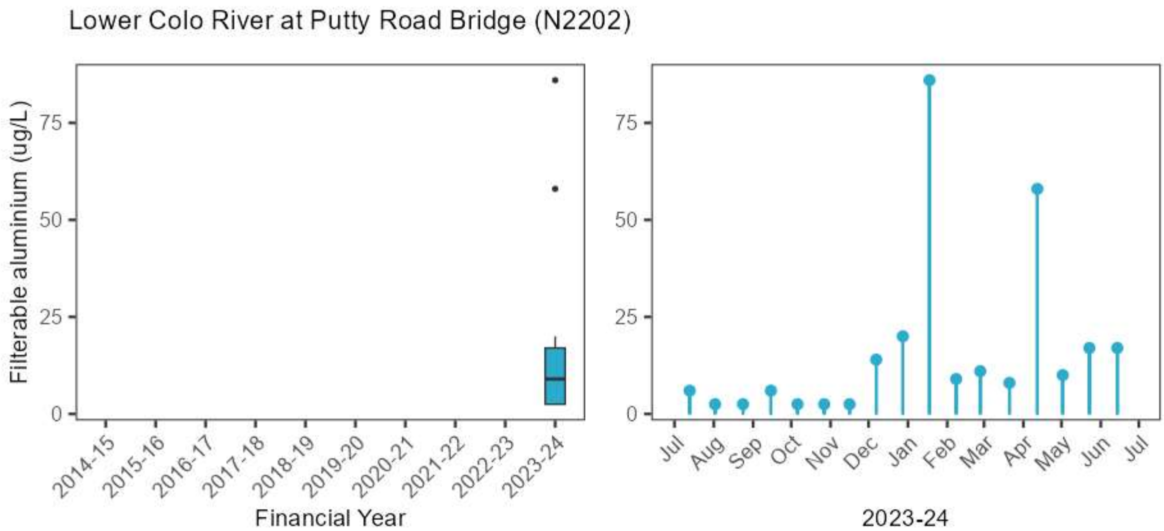
Lower Colo River at Putty Road Bridge (N2202)

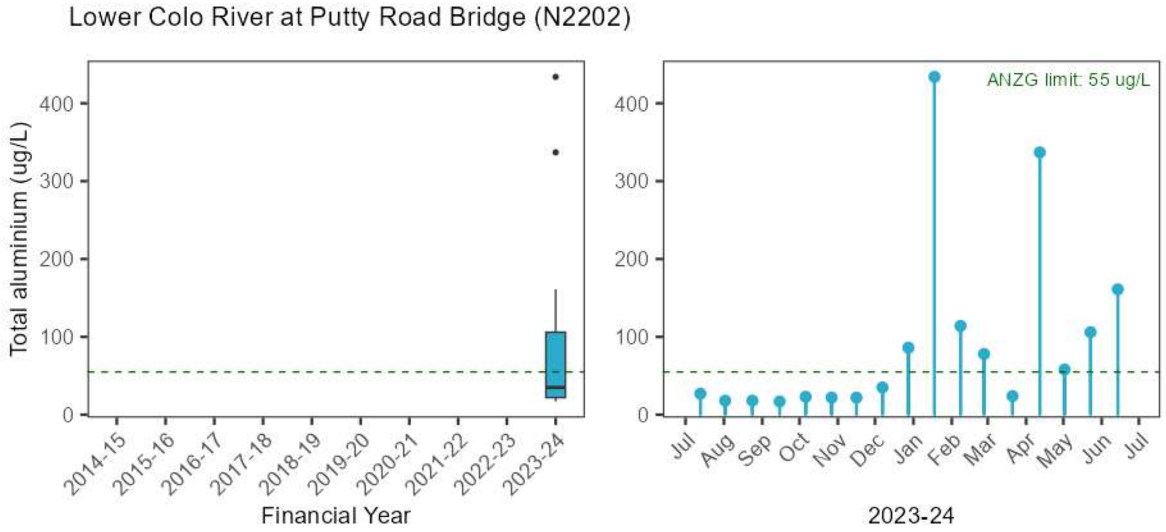




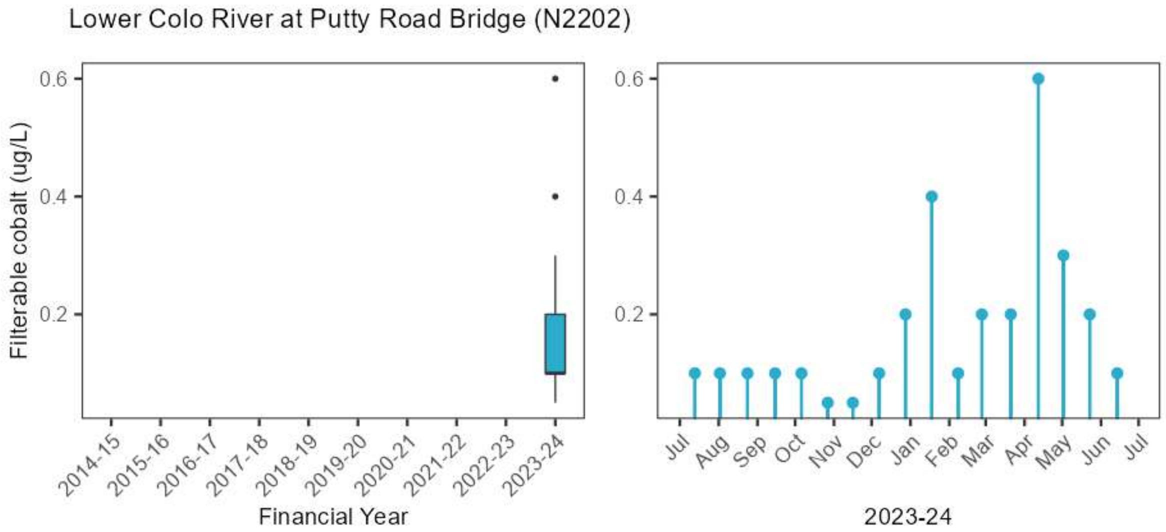


Stressors – Trace metals

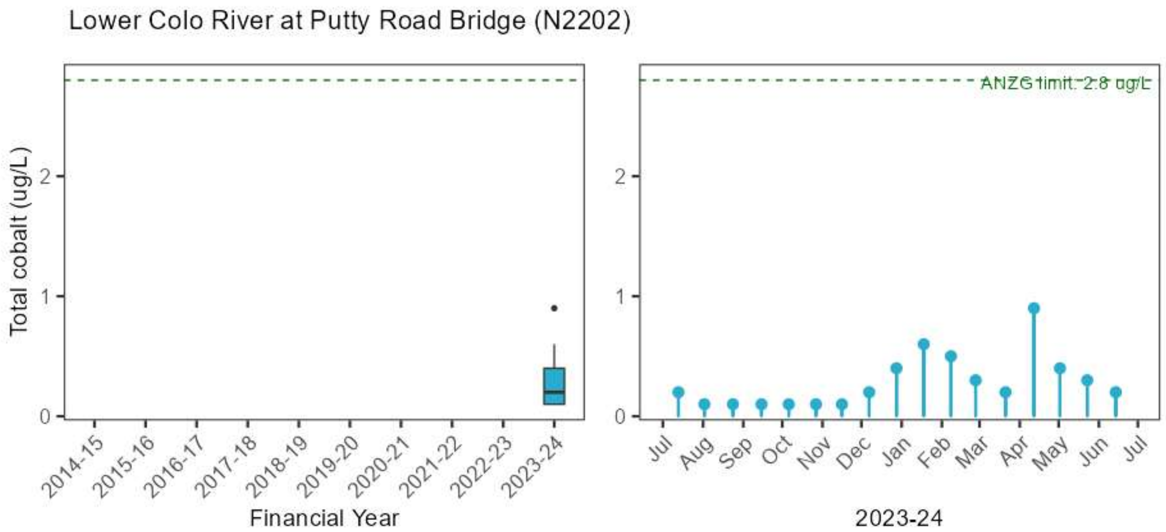




Lower Colo River at Putty Road Bridge (N2202)
Total aluminium (ug/L)
Financial Year
2023-24
ANZG limit: 55 ug/L

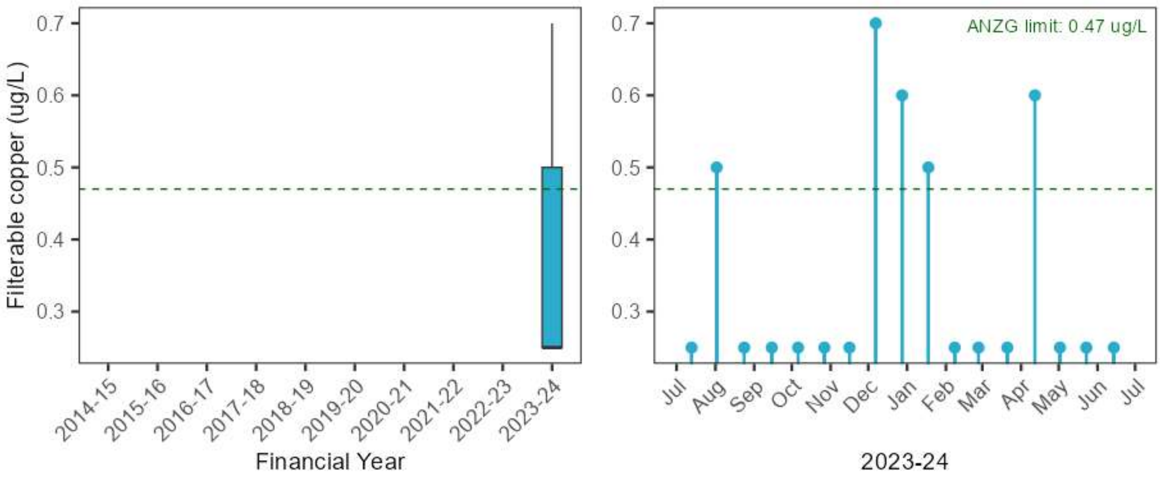


Lower Colo River at Putty Road Bridge (N2202)
Filterable cobalt (ug/L)
Financial Year
2023-24

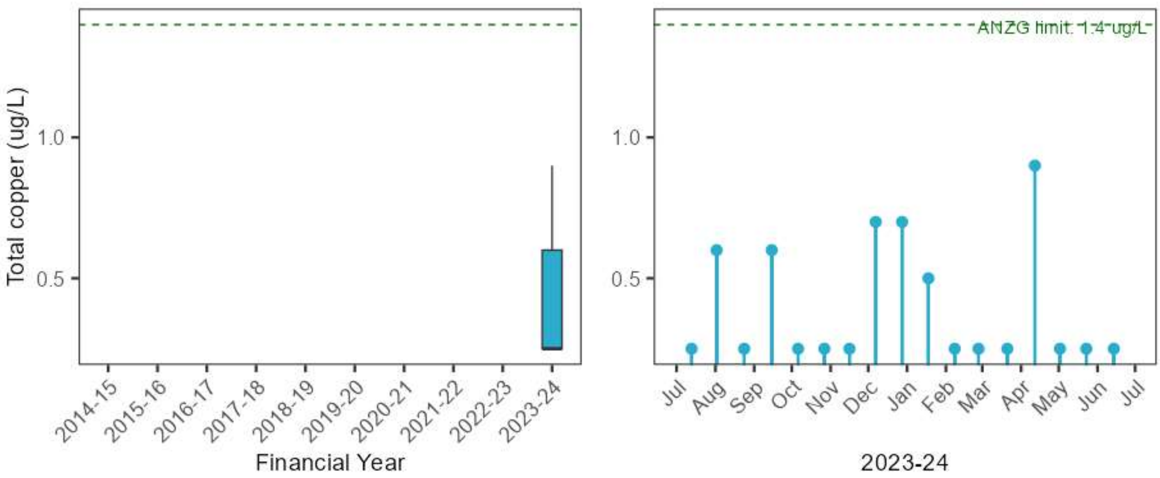


Lower Colo River at Putty Road Bridge (N2202)
Total cobalt (ug/L)
Financial Year
2023-24
ANZG limit: 2.8 ug/L

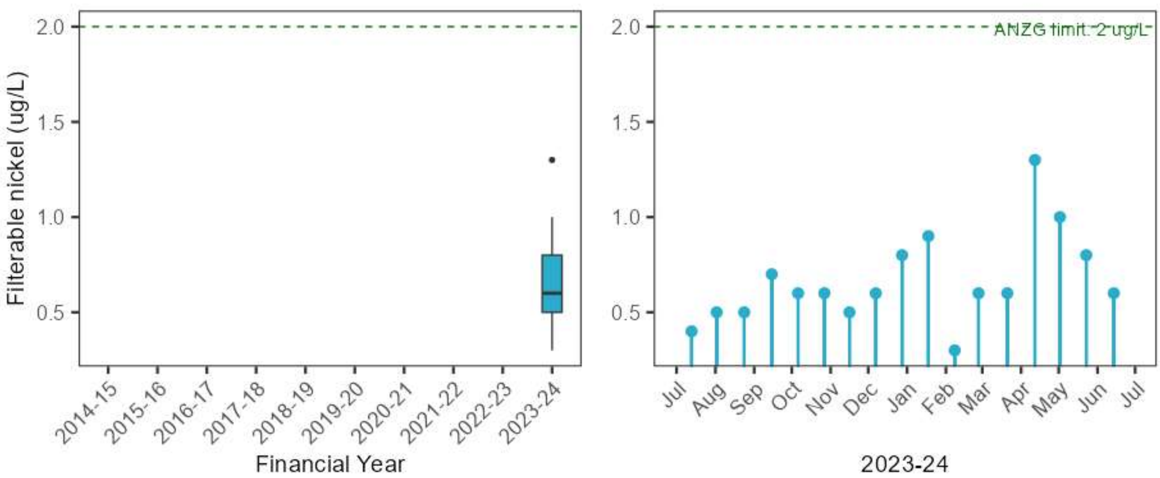
Lower Colo River at Putty Road Bridge (N2202)



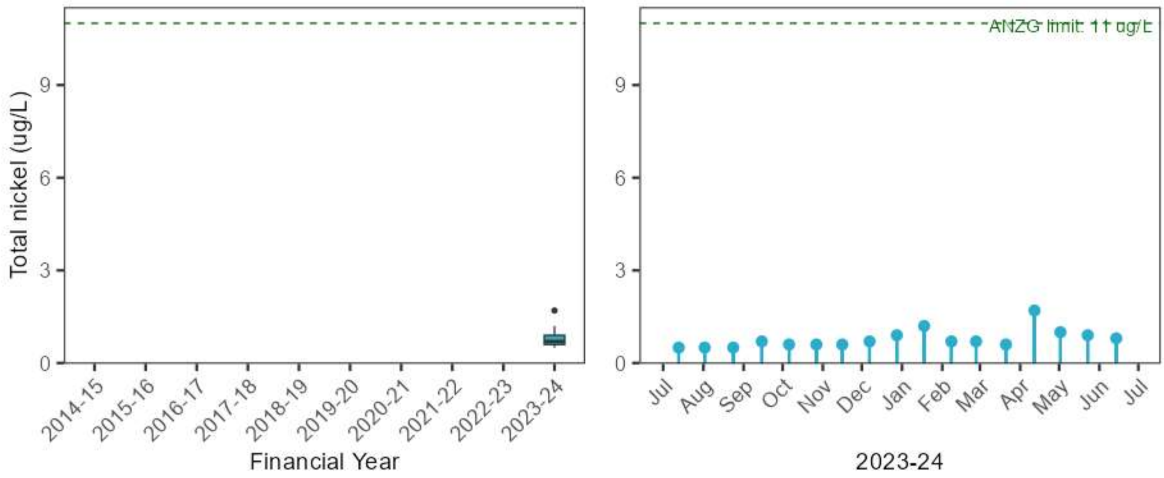
Lower Colo River at Putty Road Bridge (N2202)



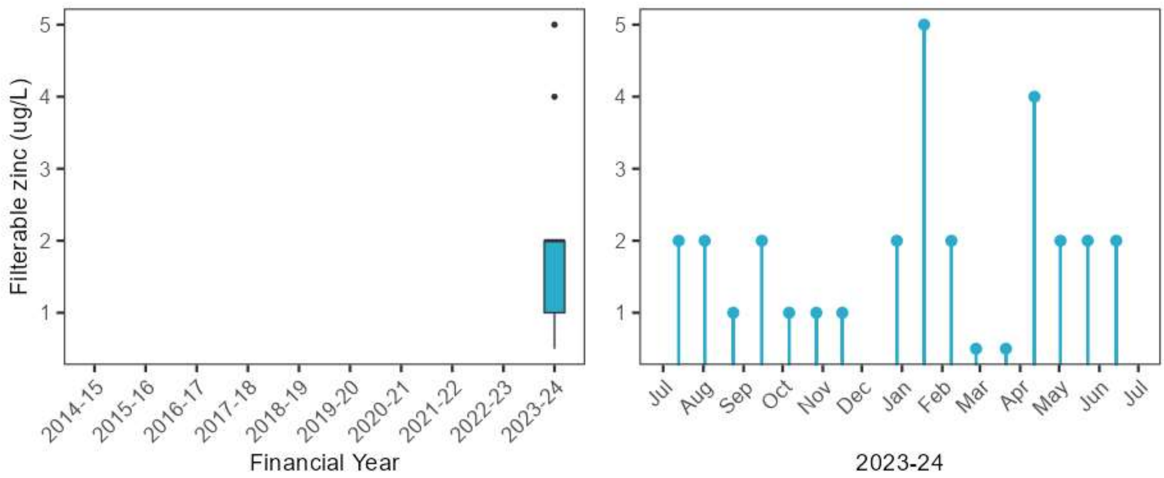
Lower Colo River at Putty Road Bridge (N2202)



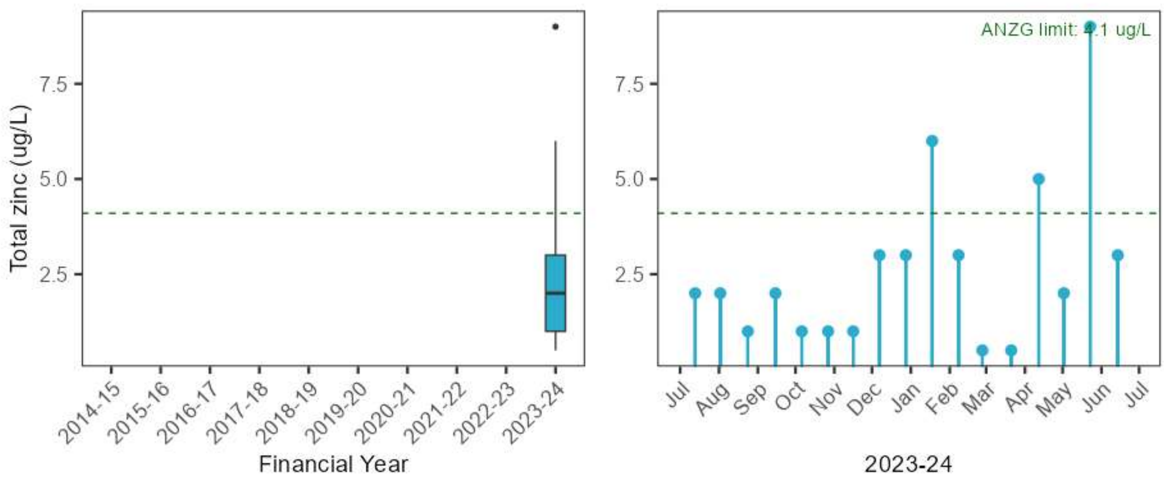
Lower Colo River at Putty Road Bridge (N2202)



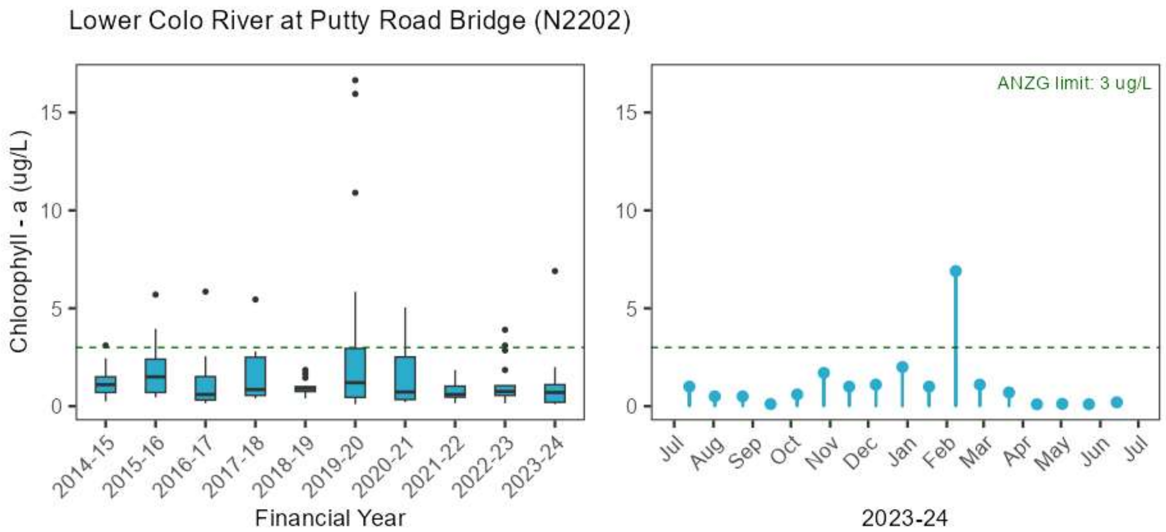
Lower Colo River at Putty Road Bridge (N2202)



Lower Colo River at Putty Road Bridge (N2202)



Ecosystem receptor – Phytoplankton



C.1.8. Hawkesbury River at Leets Vale (N18)

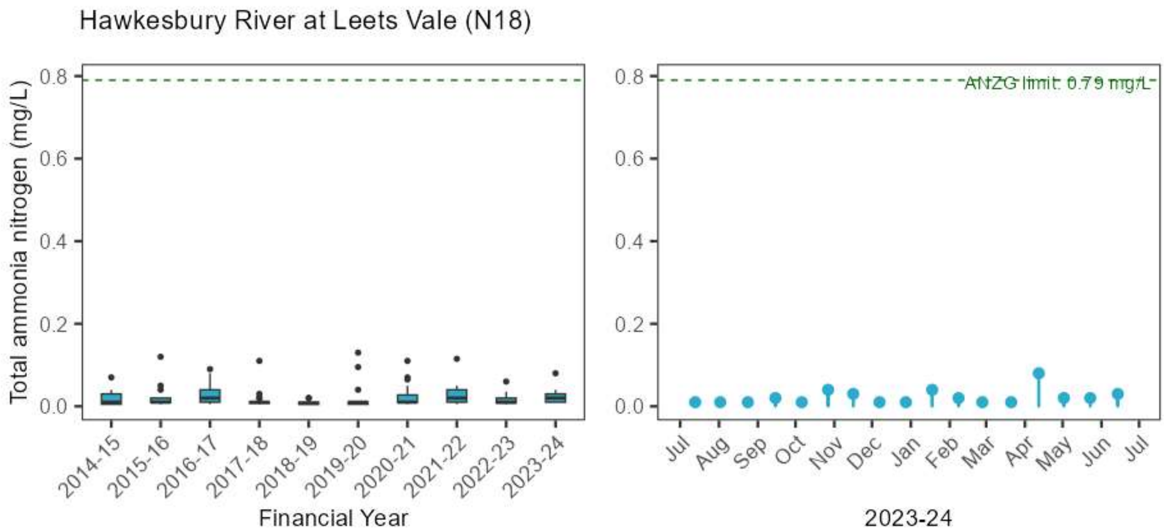
Stressors - Statistical analysis outcomes

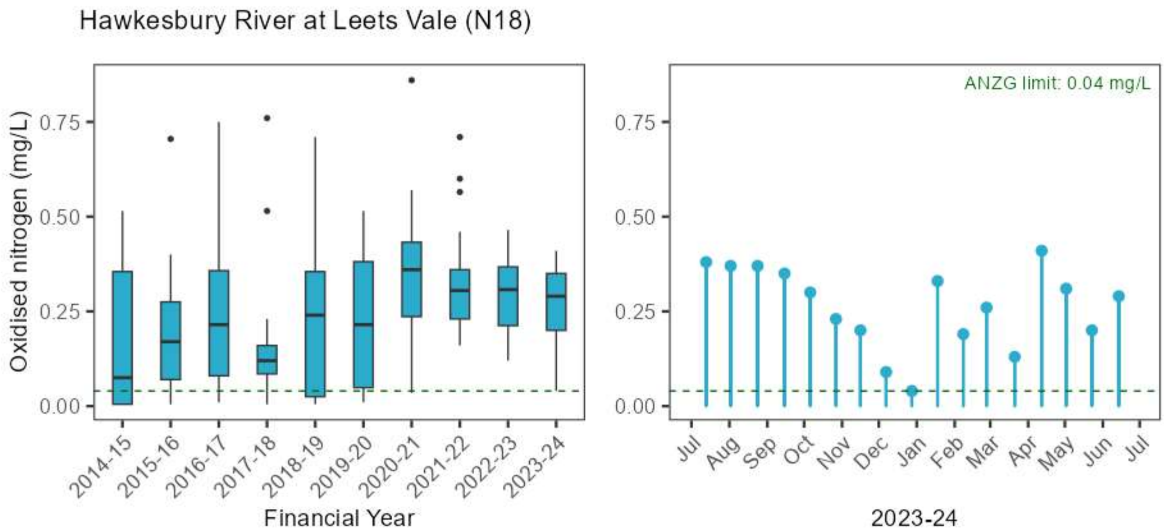
Table C-8 Current period vs previous period comparison contrast outcomes for N18

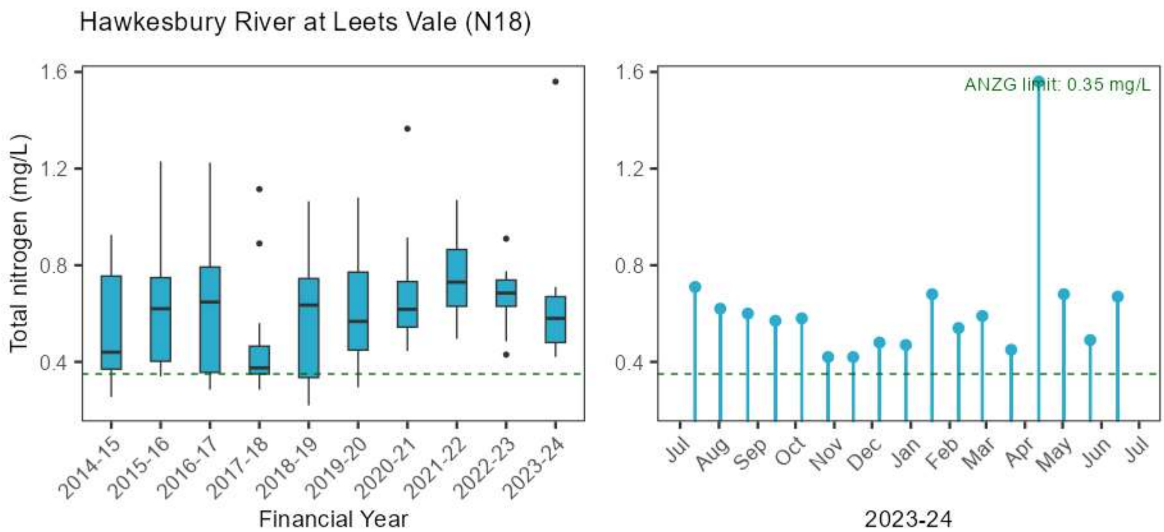
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.34	0.29	159	1.34	0.181
Oxidised nitrogen	1.59	0.49	159	1.50	0.136
Total nitrogen	1.02	0.10	159	0.25	0.803
Filterable total phosphorus	0.67	0.11	159	-2.48	0.014
Total phosphorus	0.71	0.09	159	-2.66	0.009
Conductivity	1.04	0.30	158	0.15	0.882
Dissolved oxygen	1.06	0.05	159	1.24	0.218
Dissolved oxygen saturation	4.80	2.78	159	1.73	0.086
pH	-0.05	0.09	159	-0.54	0.593
Water temperature	1.04	0.07	158	0.57	0.573
Turbidity	0.68	0.11	158	-2.35	0.020
Chlorophyll - a	0.98	0.23	159	-0.07	0.946

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

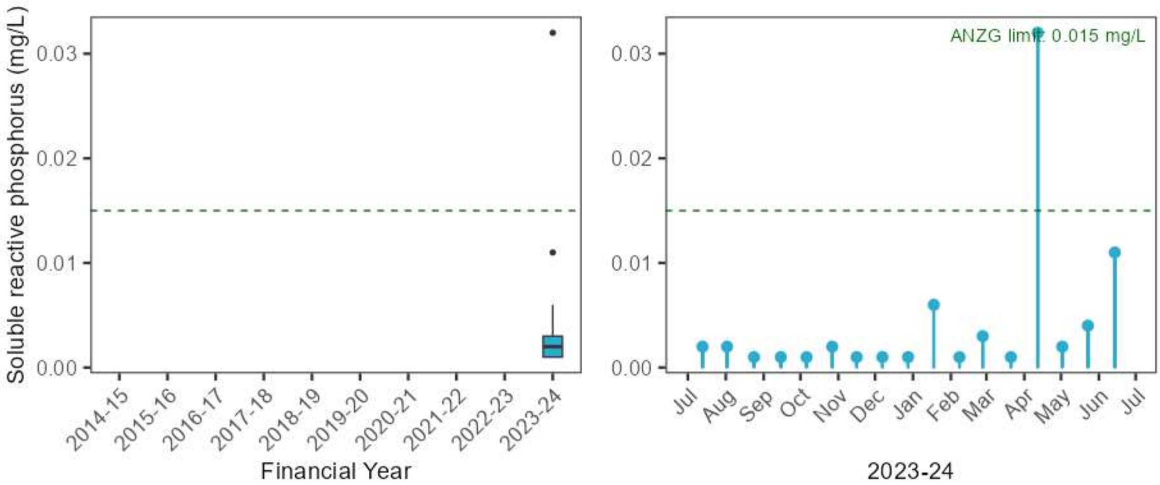
Stressors – Nutrients



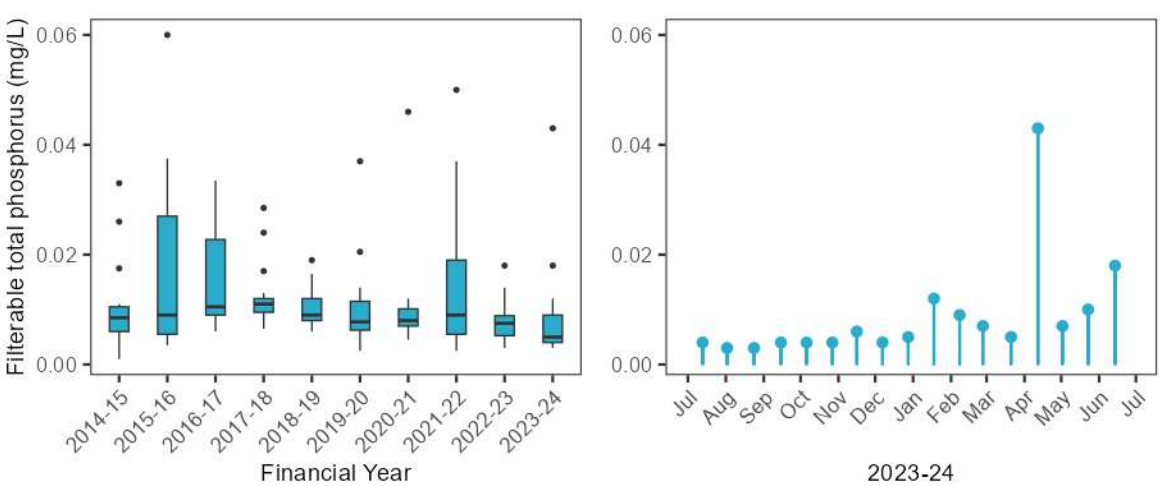




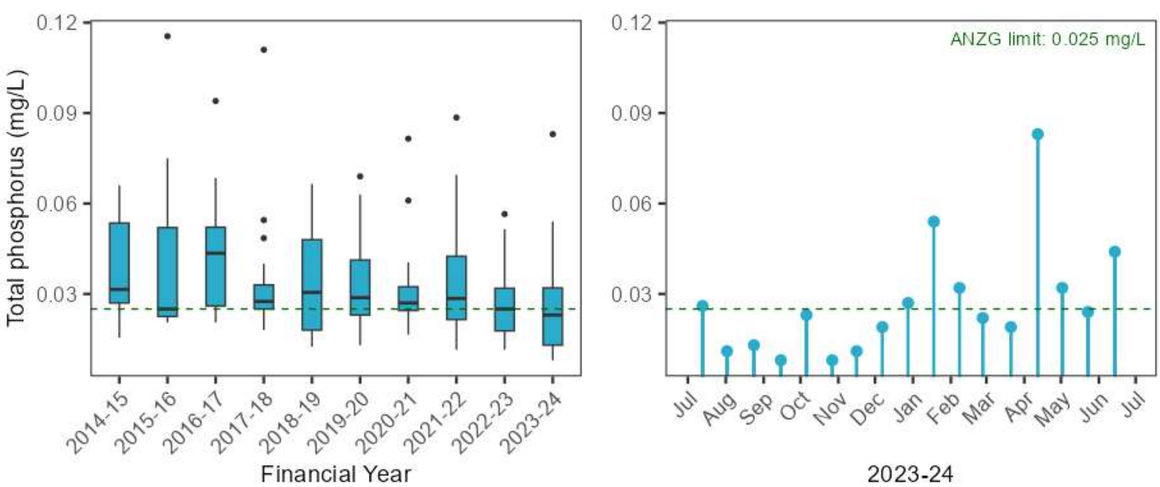
Hawkesbury River at Leets Vale (N18)



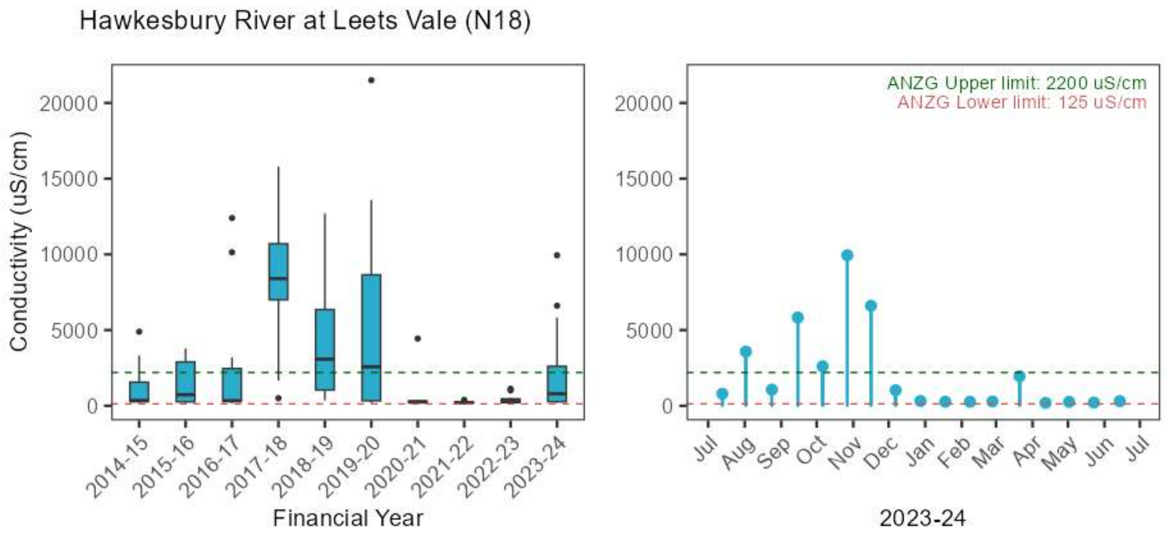
Hawkesbury River at Leets Vale (N18)

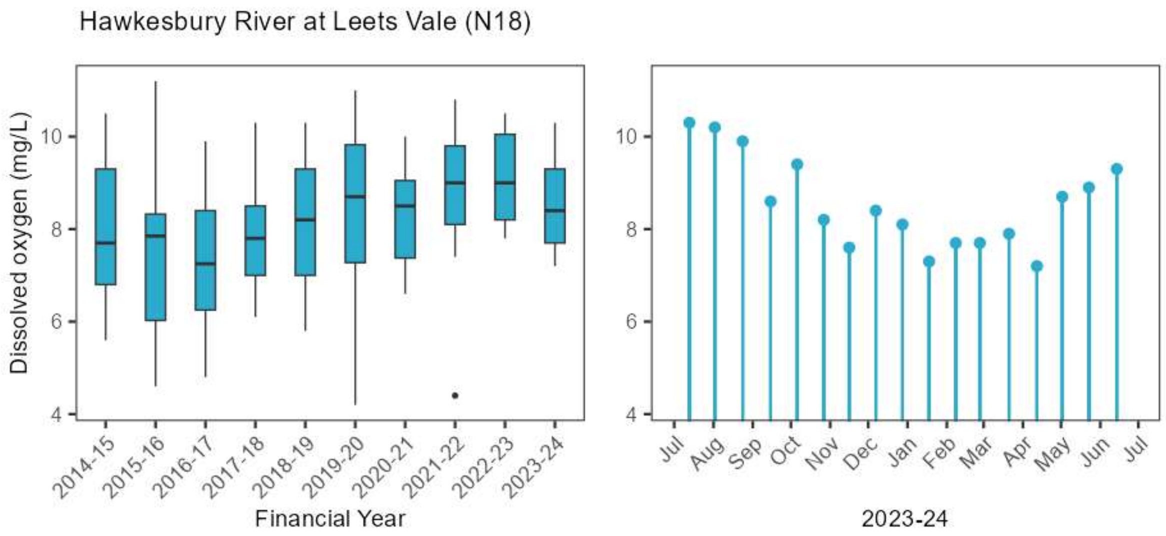


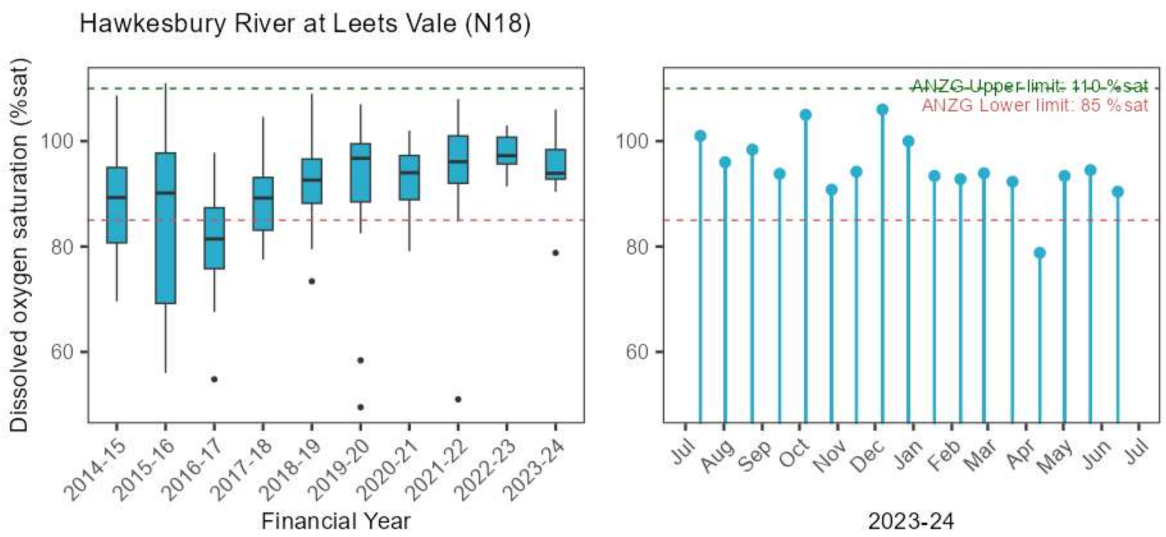
Hawkesbury River at Leets Vale (N18)

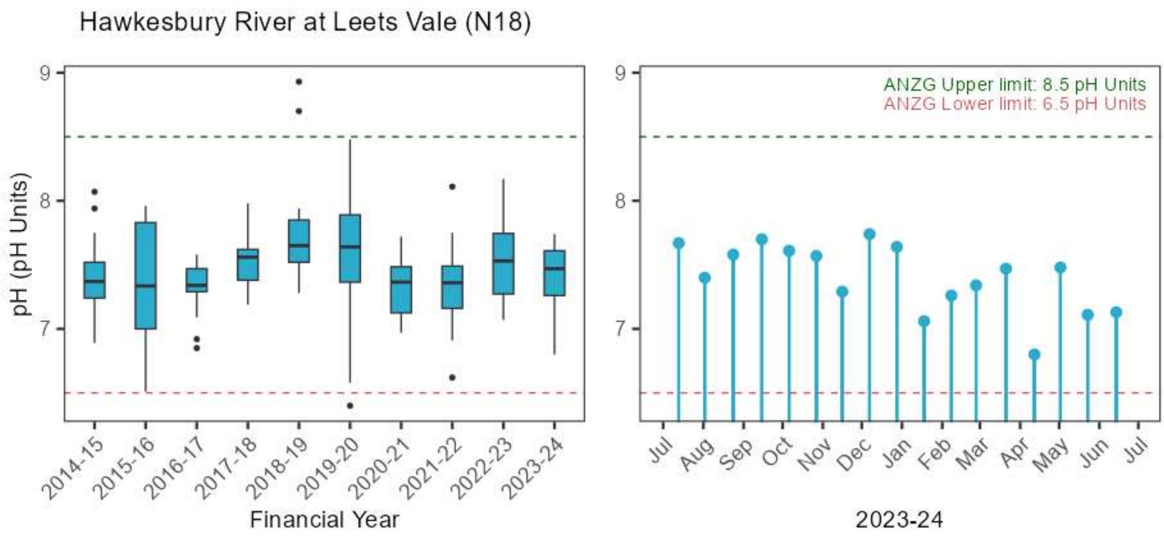


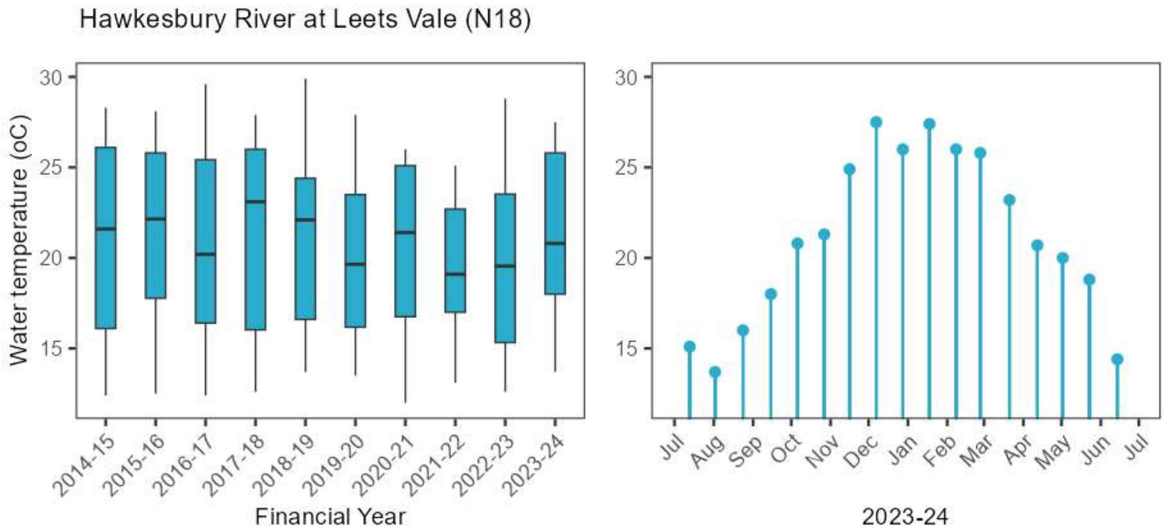
Stressors – Physico-chemical water quality

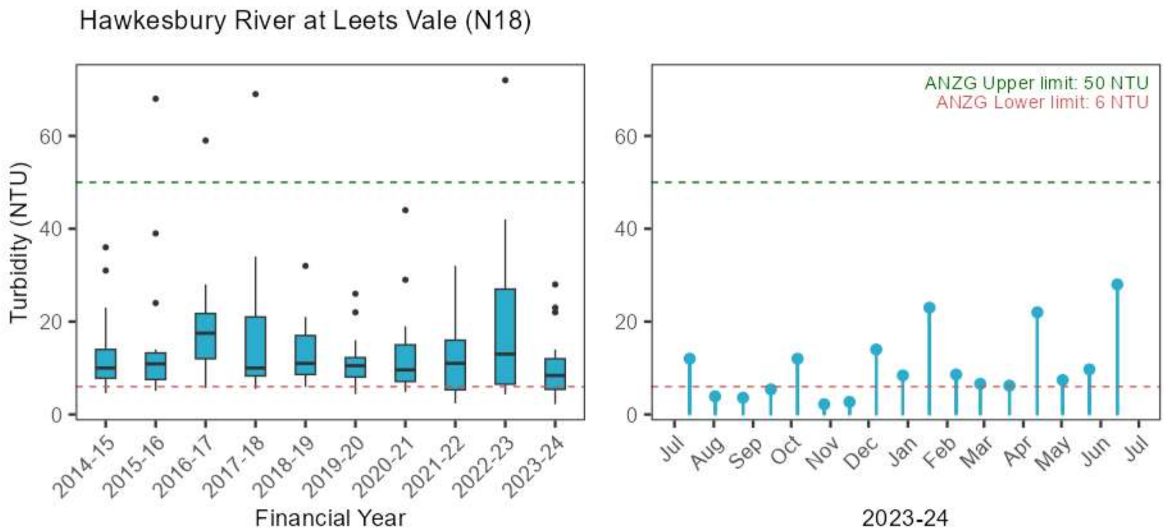




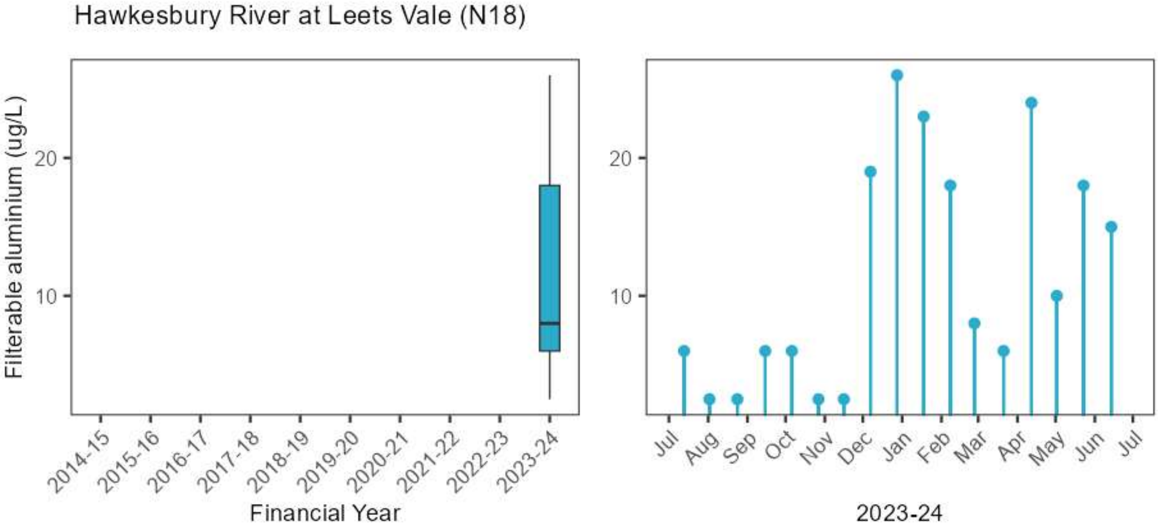


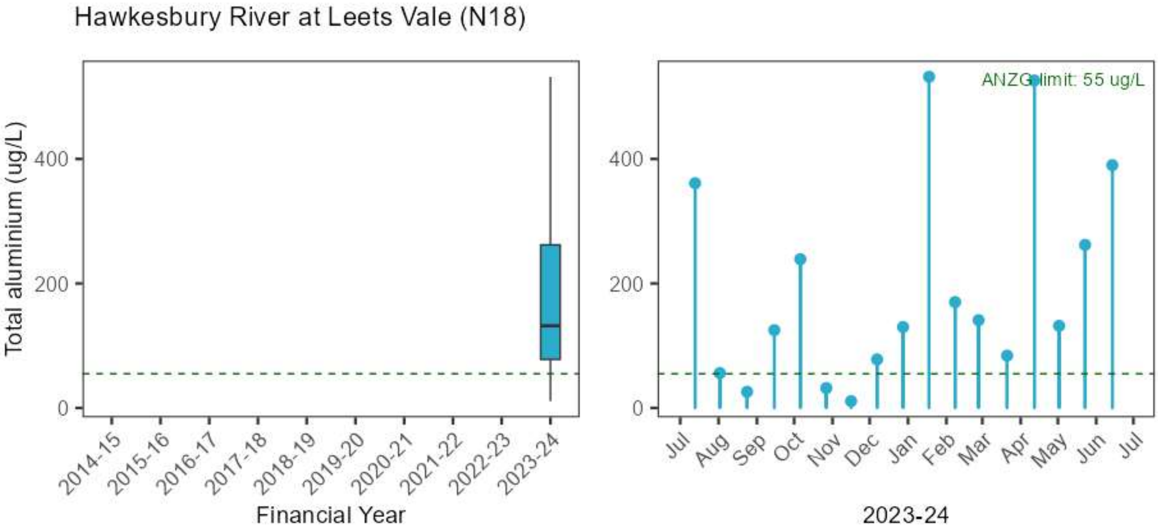

Hawkesbury River at Leets Vale (N18)
pH (pH Units)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24

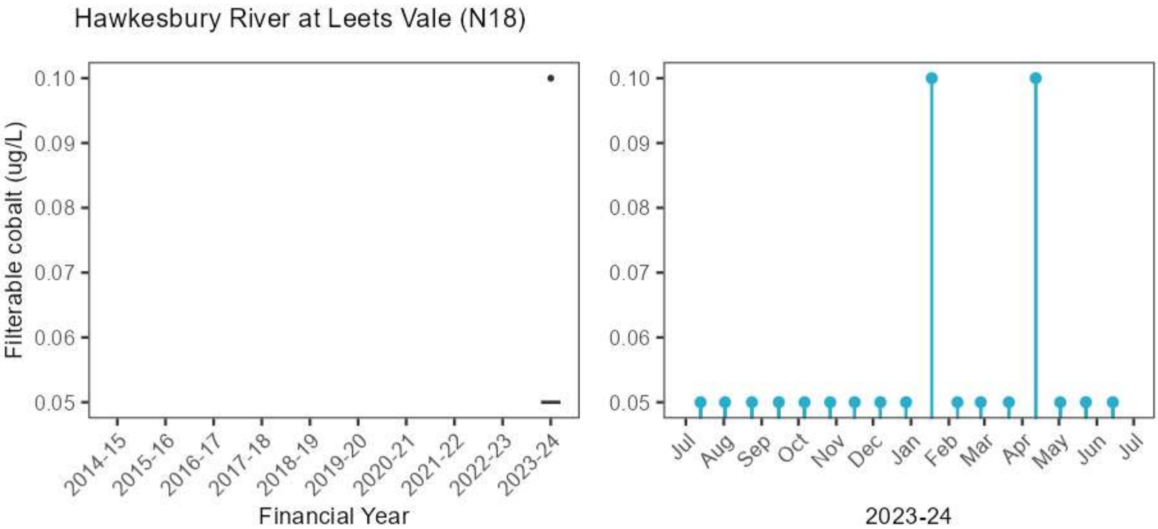

Hawkesbury River at Leets Vale (N18)
Water temperature (oC)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24


Hawkesbury River at Leets Vale (N18)
Turbidity (NTU)
Financial Year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
ANZG Upper limit: 50 NTU
ANZG Lower limit: 6 NTU
Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
2023-24

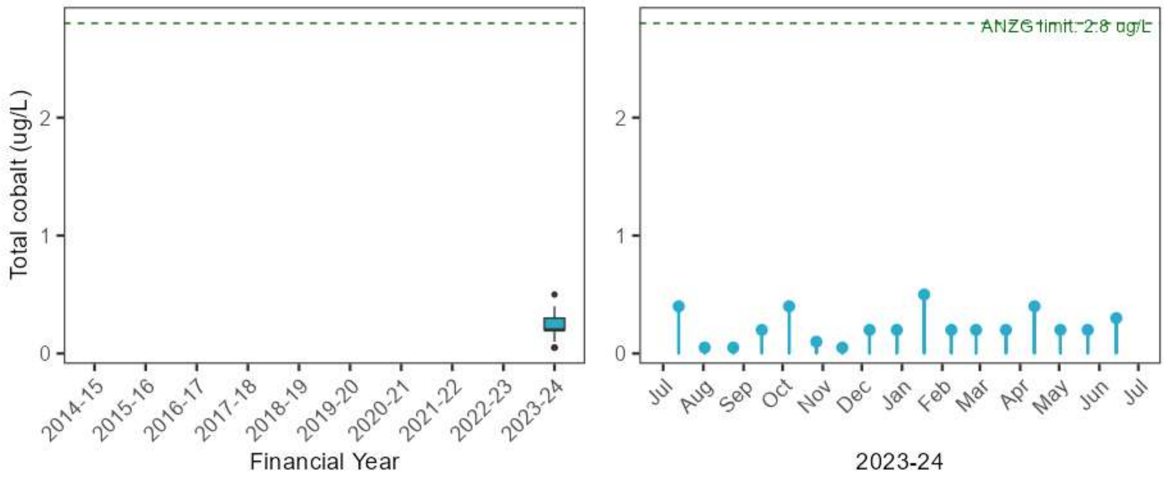
Stressors – Trace metals



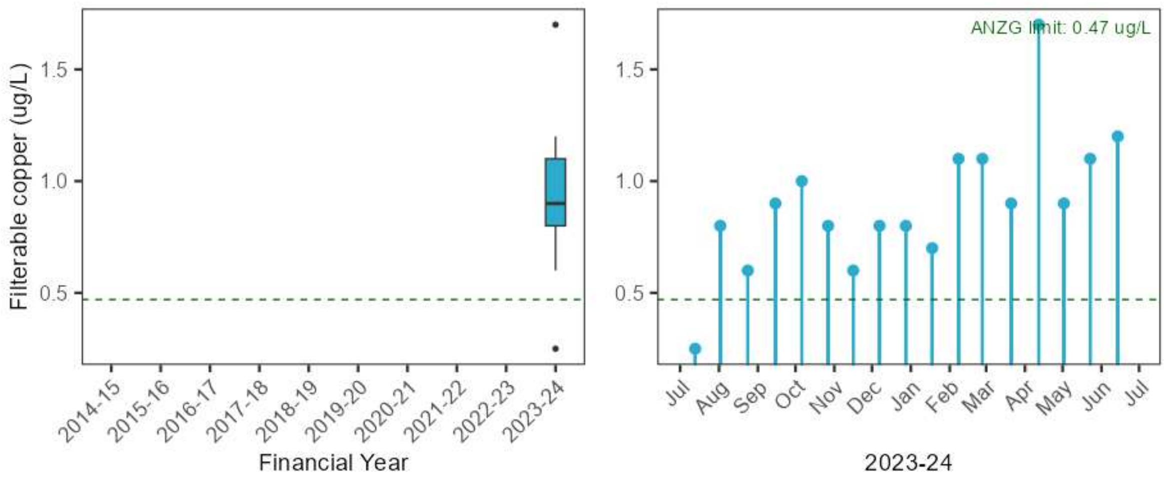




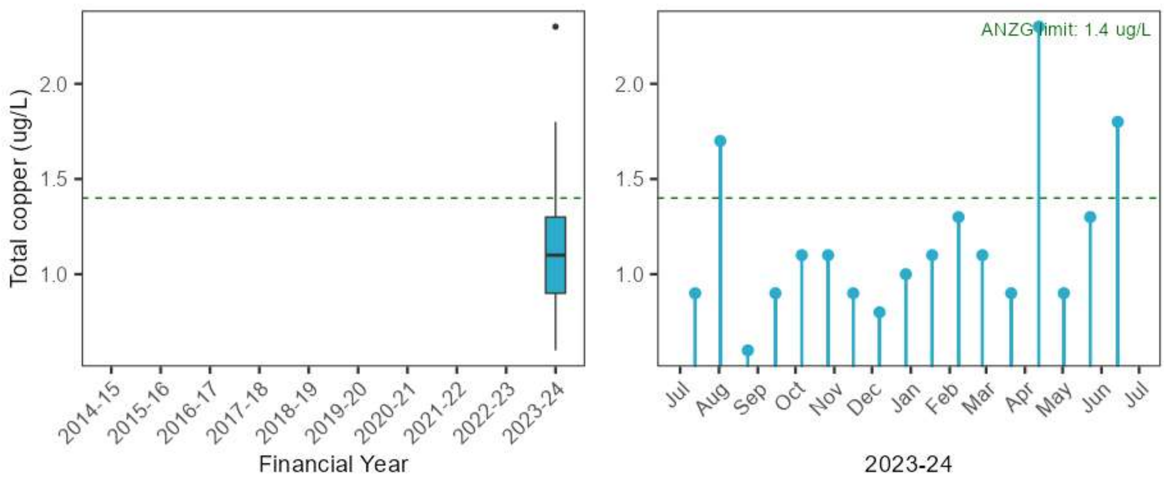
Hawkesbury River at Leets Vale (N18)



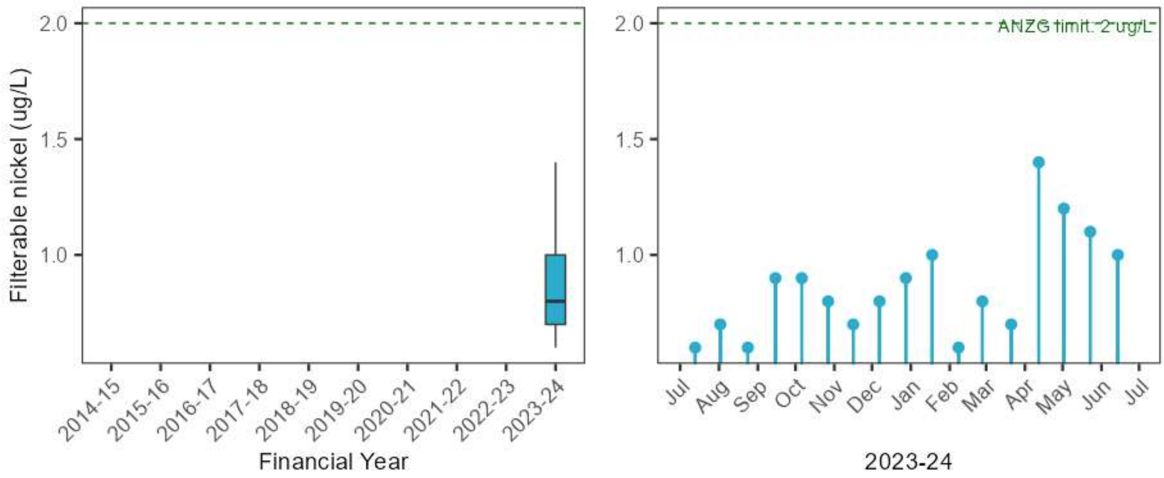
Hawkesbury River at Leets Vale (N18)



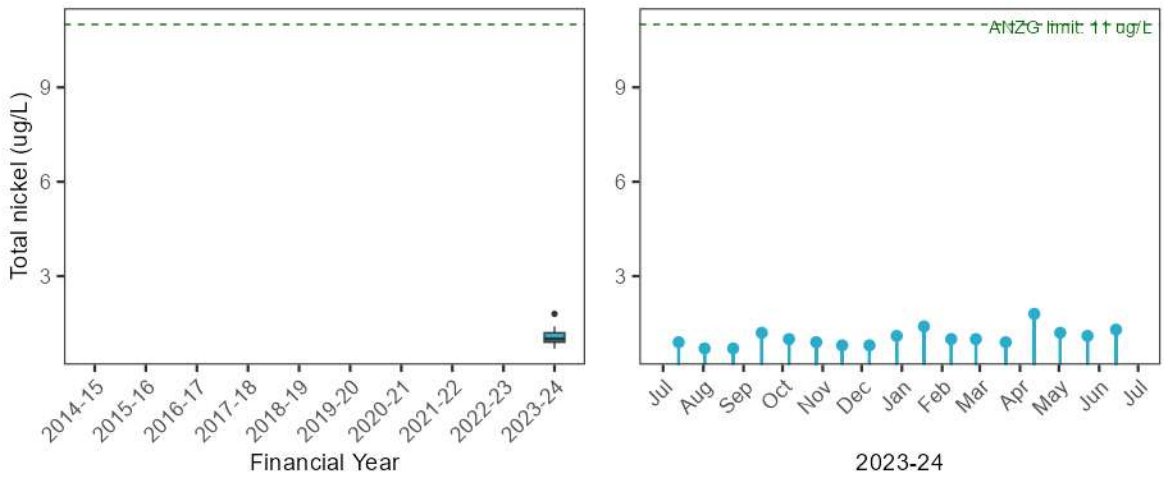
Hawkesbury River at Leets Vale (N18)



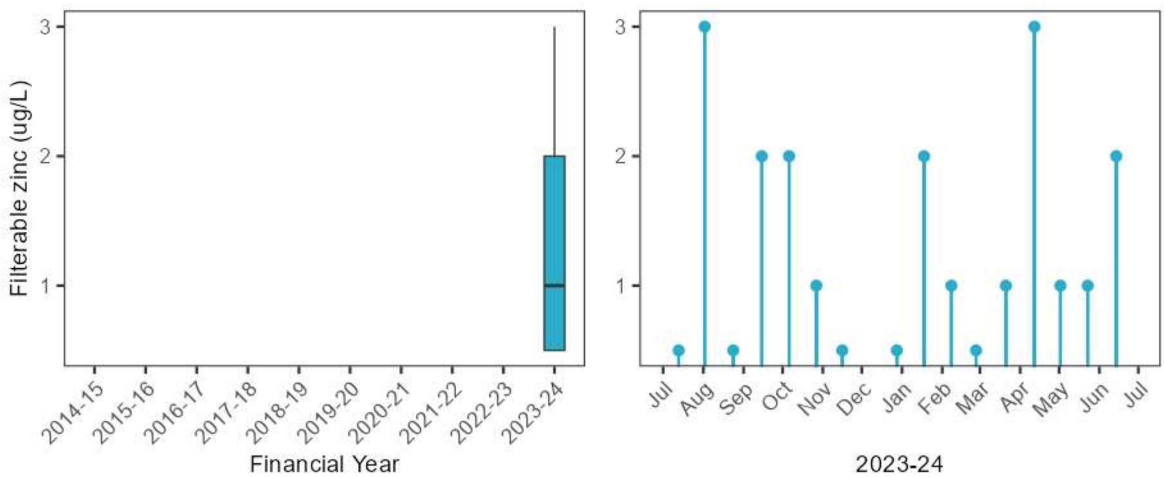
Hawkesbury River at Leets Vale (N18)

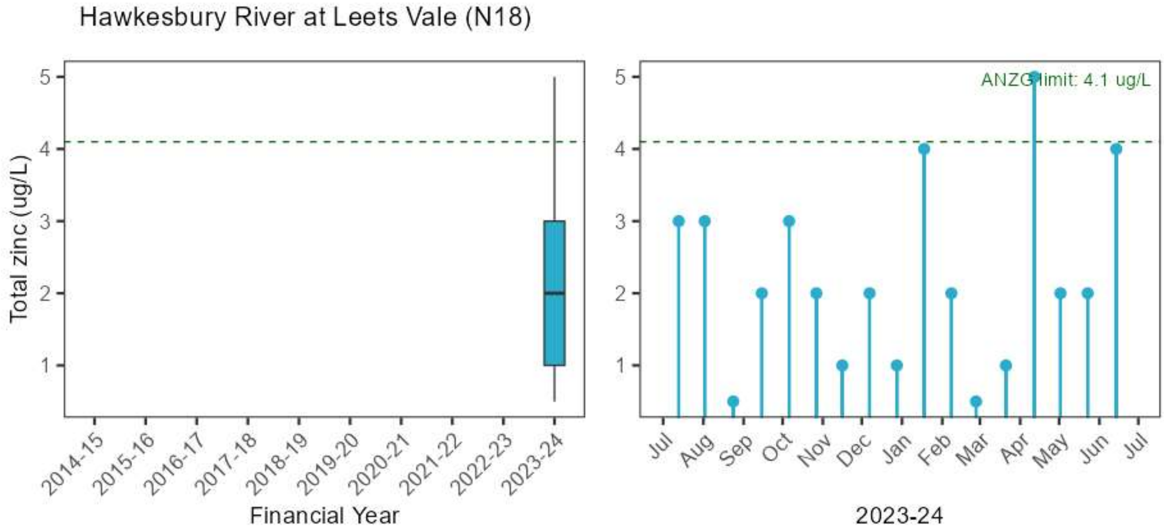


Hawkesbury River at Leets Vale (N18)

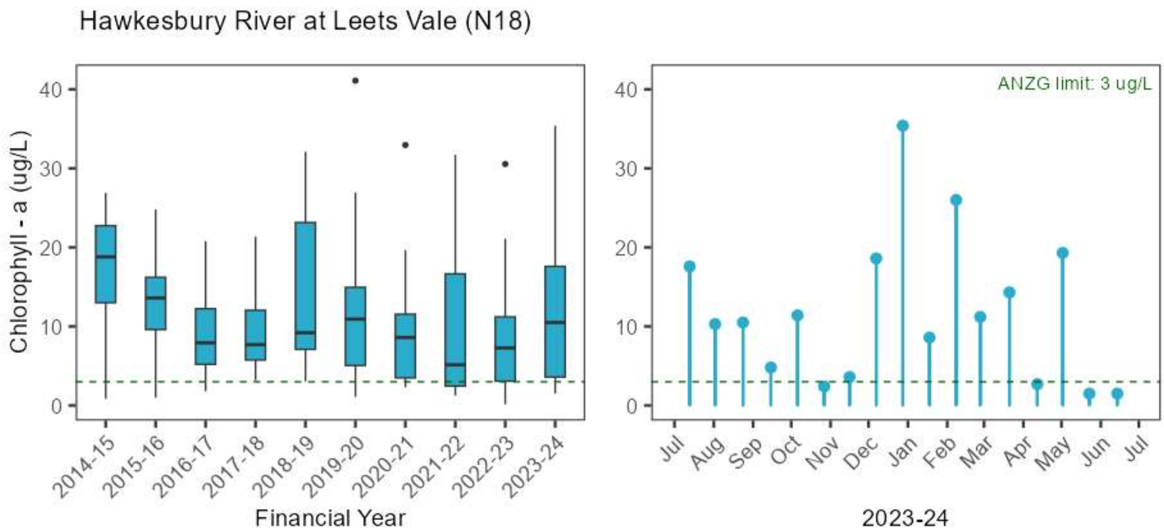


Hawkesbury River at Leets Vale (N18)





Ecosystem receptor – Phytoplankton



C.1.9. Berowra Creek at Calabash Bay (NB13)

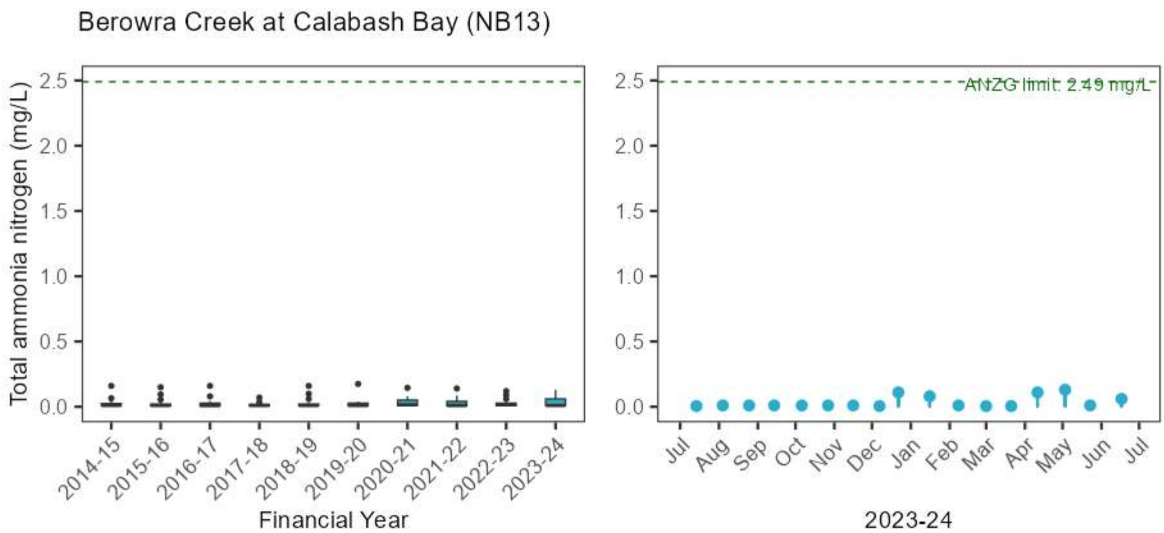
Stressors - Statistical analysis outcomes

Table C-9 Current period vs previous period comparison contrast outcomes for NB13

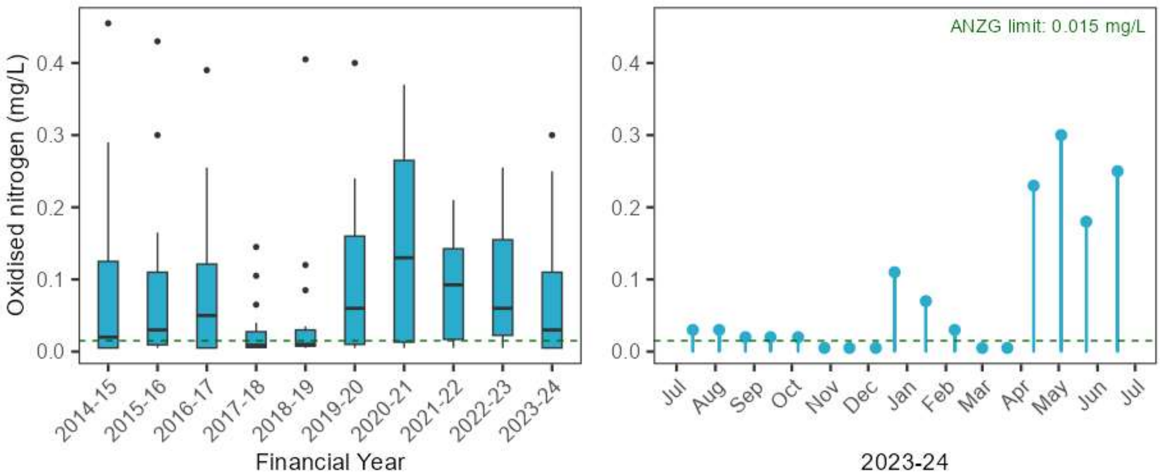
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.09	0.28	157	0.32	0.751
Oxidised nitrogen	0.88	0.33	157	-0.33	0.739
Total nitrogen	0.91	0.08	157	-1.14	0.257
Filterable total phosphorus	0.88	0.13	157	-0.90	0.368
Total phosphorus	0.86	0.12	157	-1.04	0.302
Conductivity	0.91	0.14	154	-0.66	0.512
Dissolved oxygen	0.98	0.05	155	-0.41	0.680
Dissolved oxygen saturation	-6.41	3.90	154	-1.64	0.102
pH	-0.19	0.08	155	-2.49	0.014
Water temperature	0.97	0.06	154	-0.51	0.609
Turbidity	0.96	0.17	157	-0.22	0.825
Chlorophyll - a	0.46	0.12	156	-2.96	0.004

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

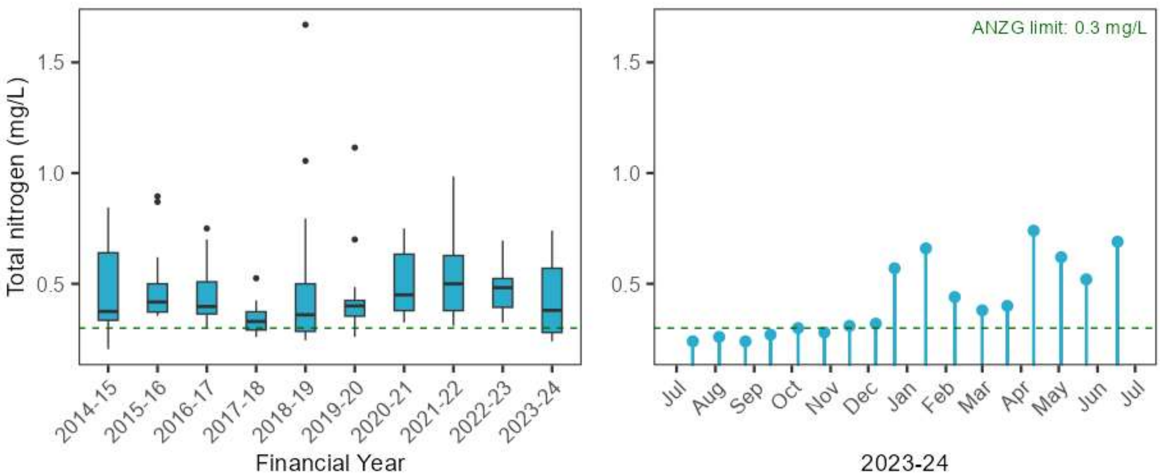
Stressors – Nutrients



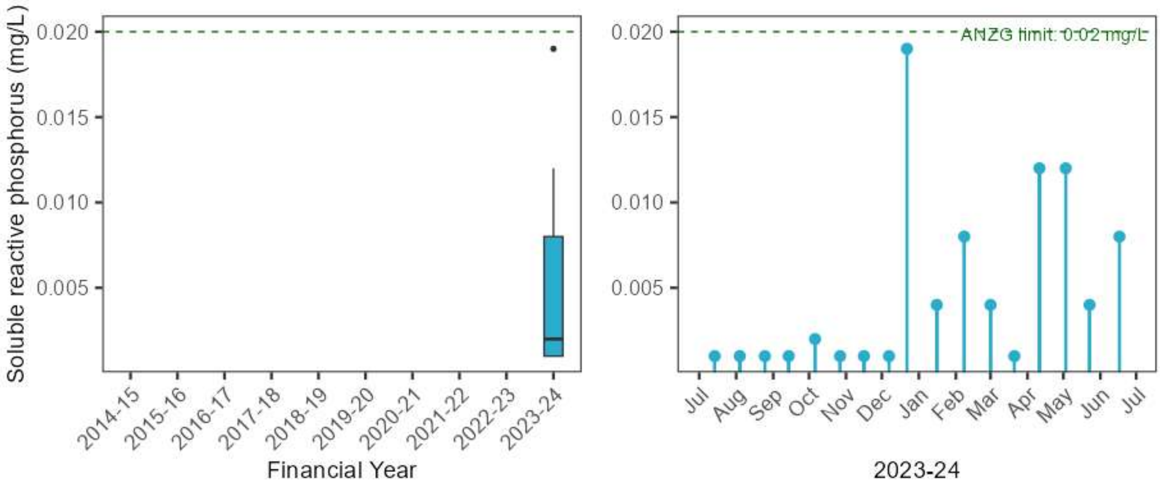
Berowra Creek at Calabash Bay (NB13)

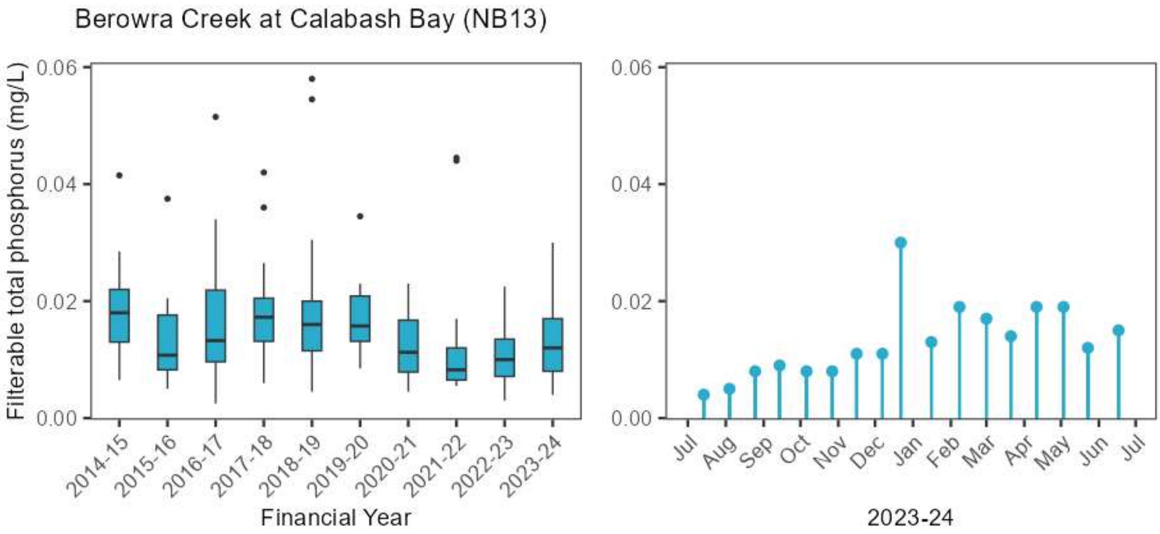


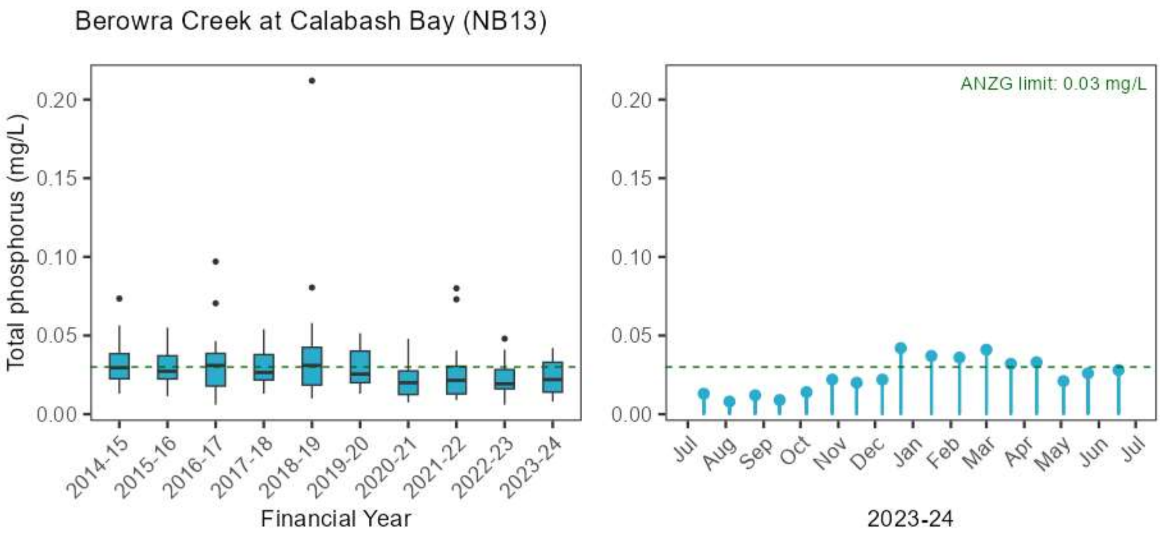
Berowra Creek at Calabash Bay (NB13)



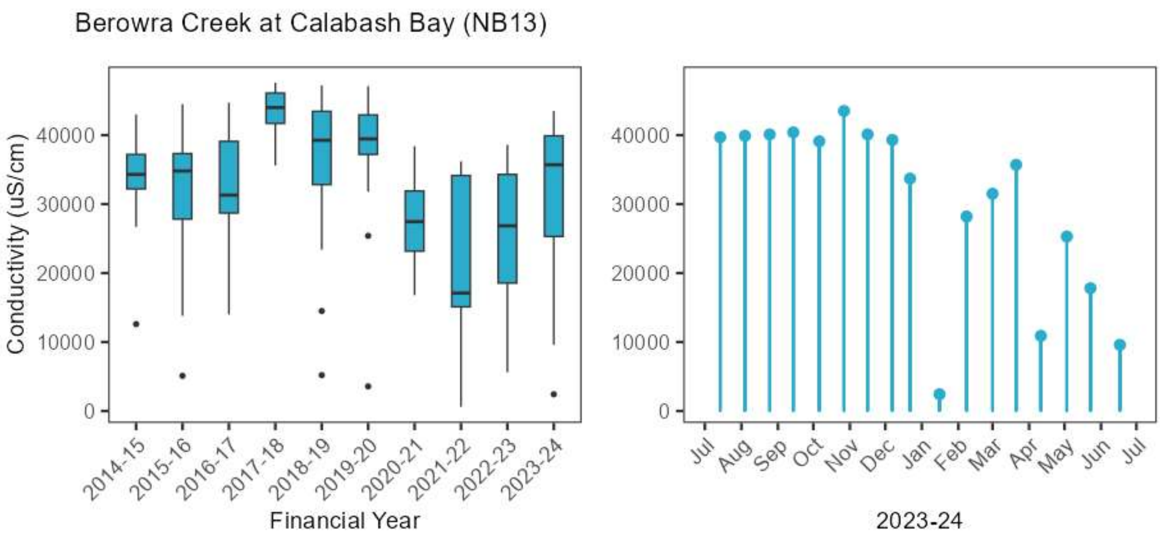
Berowra Creek at Calabash Bay (NB13)



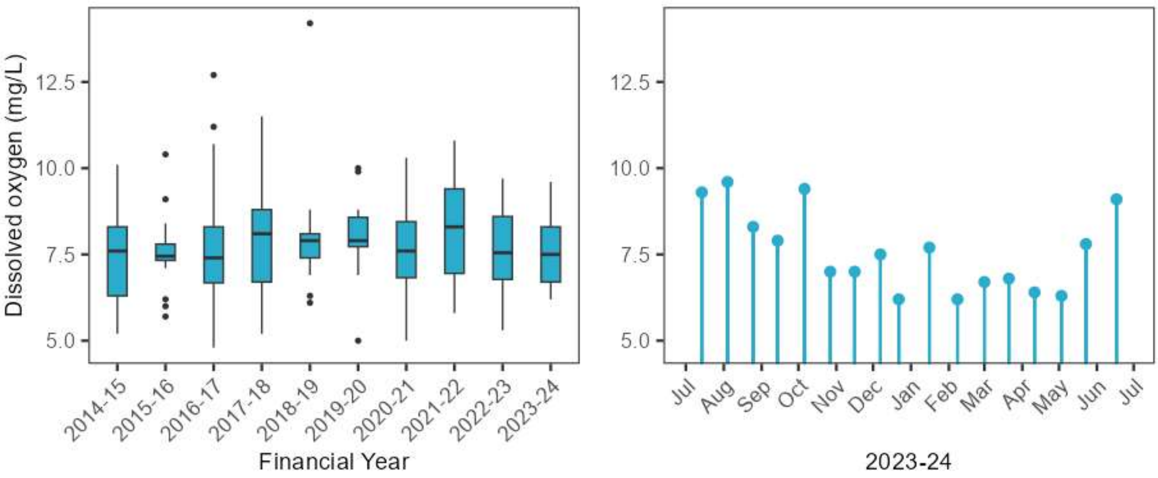




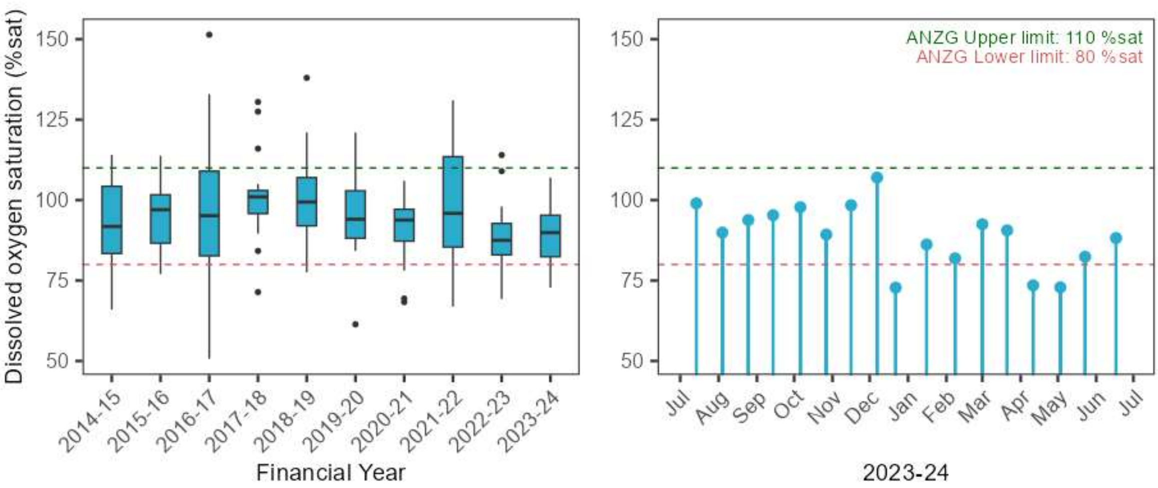
Stressors – Physico-chemical water quality



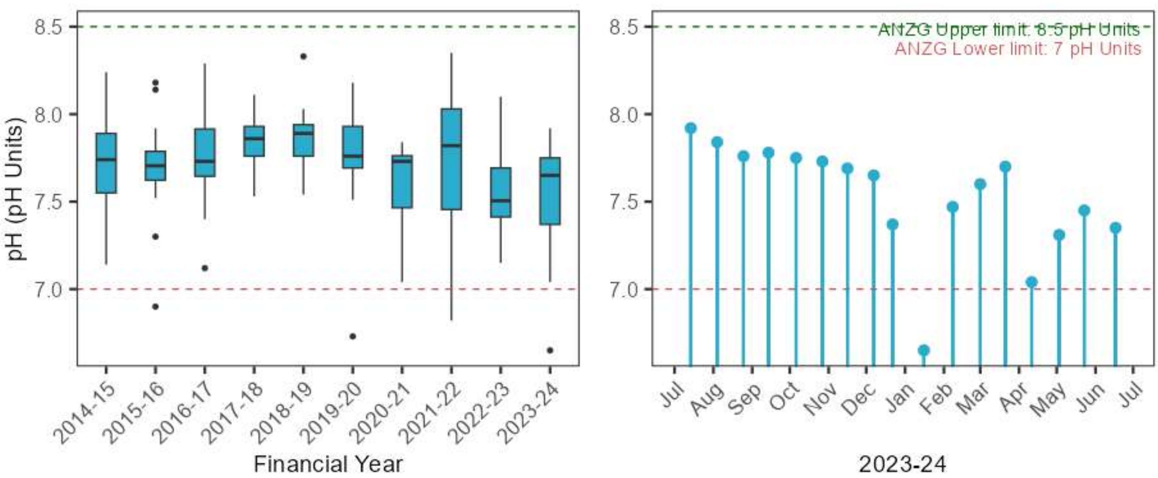
Berowra Creek at Calabash Bay (NB13)

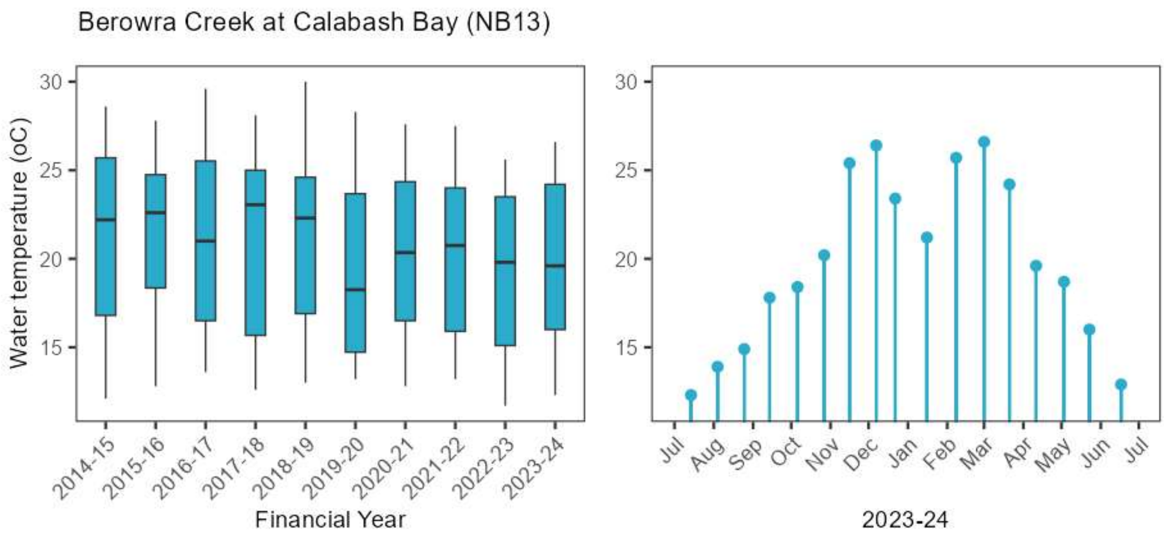


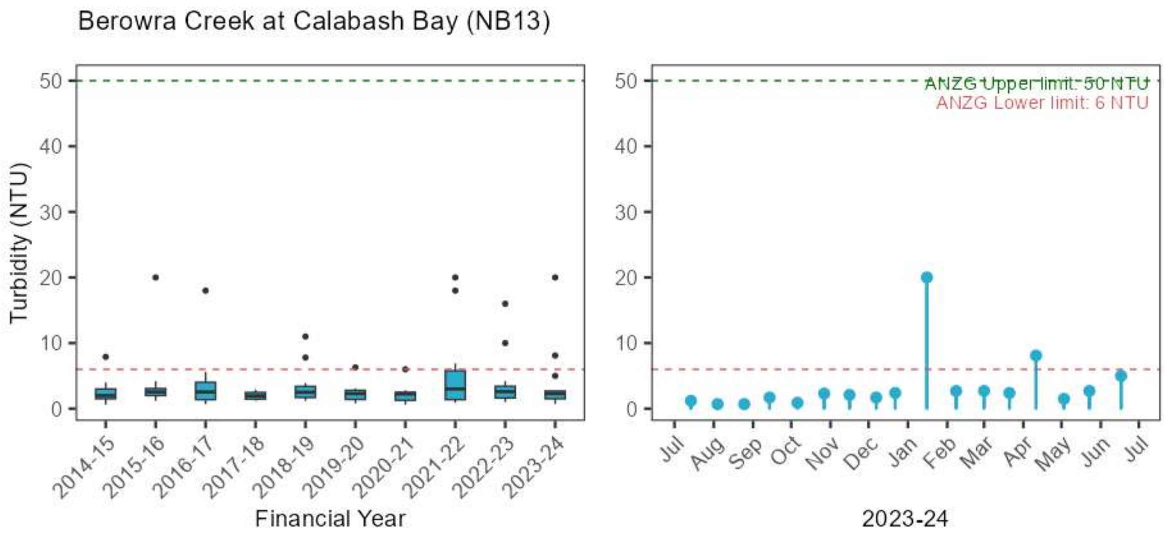
Berowra Creek at Calabash Bay (NB13)



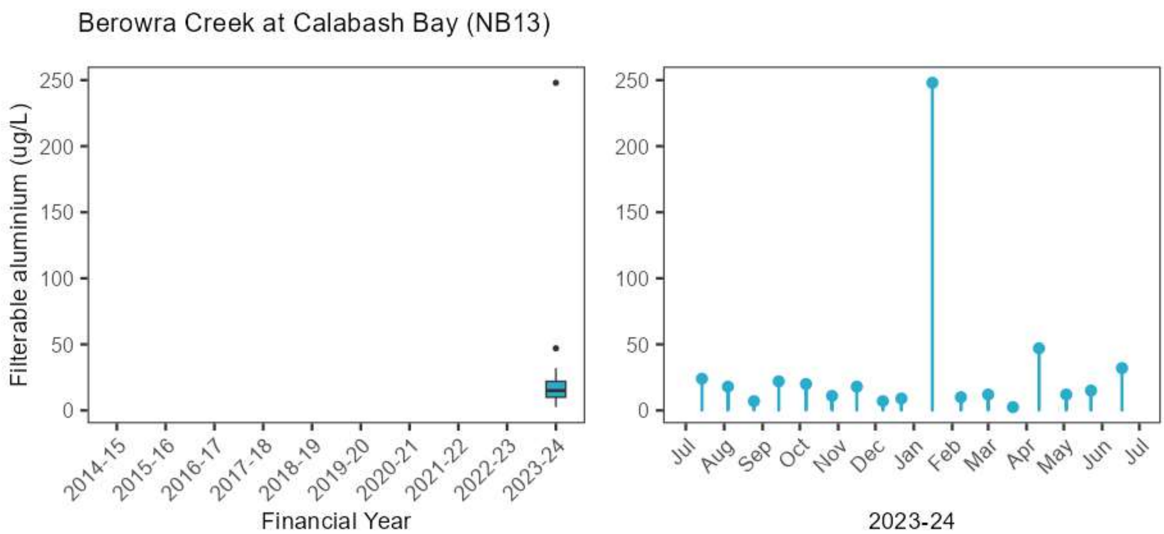
Berowra Creek at Calabash Bay (NB13)



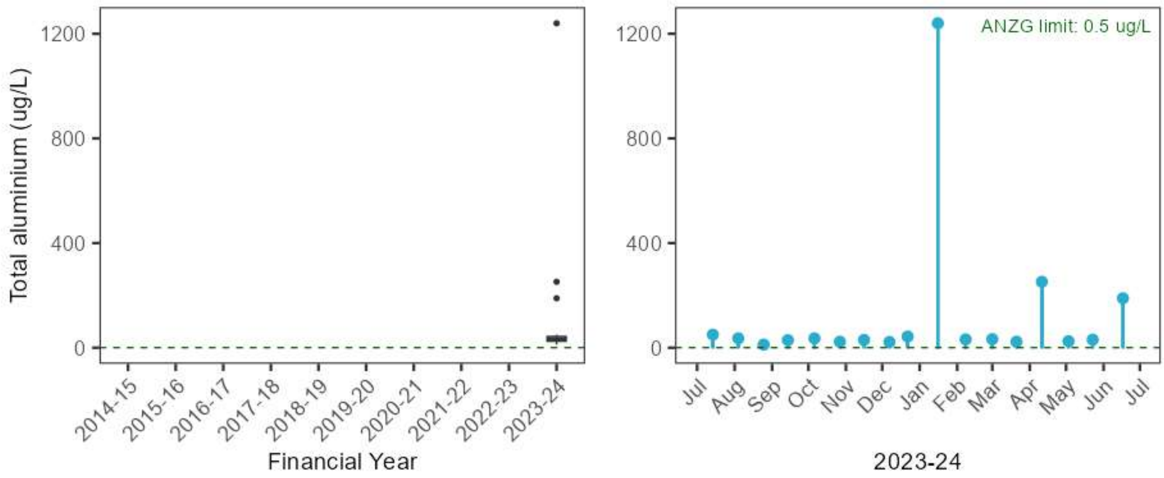




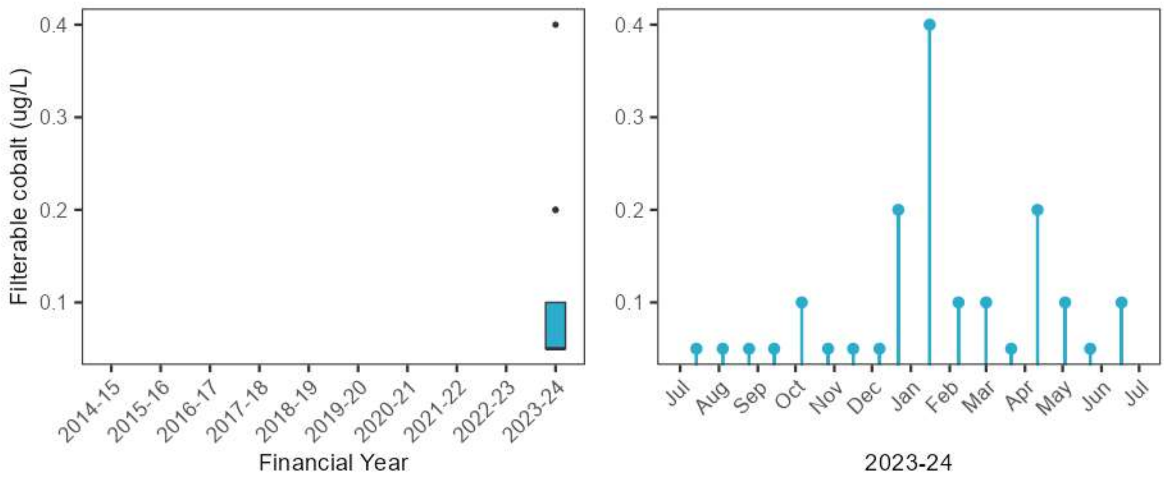
Stressors – Trace metals



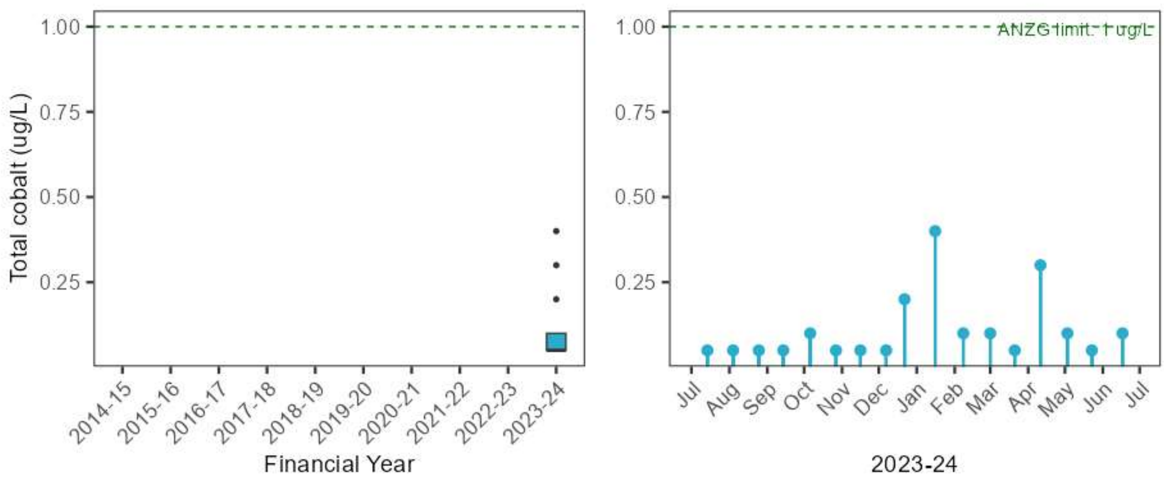
Berowra Creek at Calabash Bay (NB13)



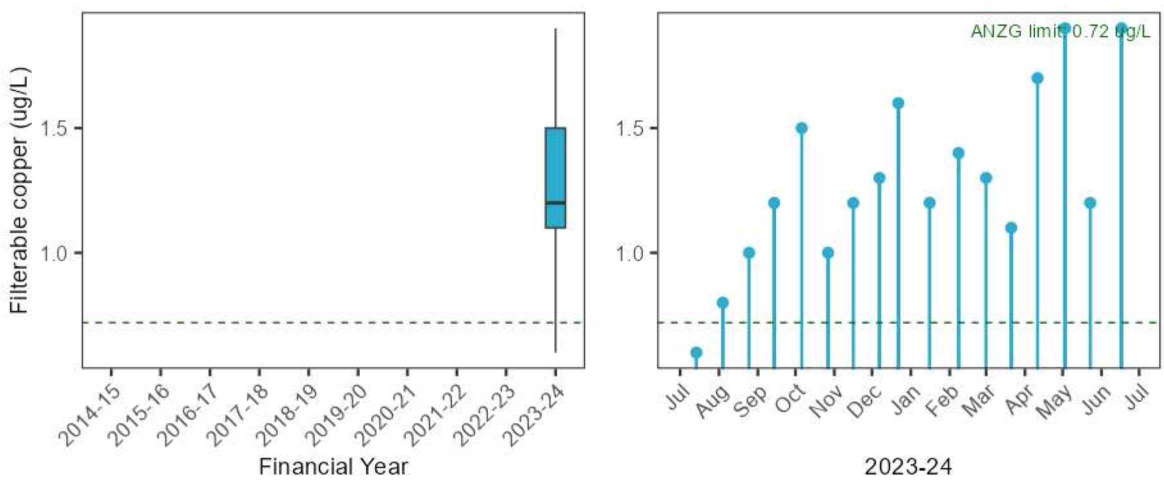
Berowra Creek at Calabash Bay (NB13)



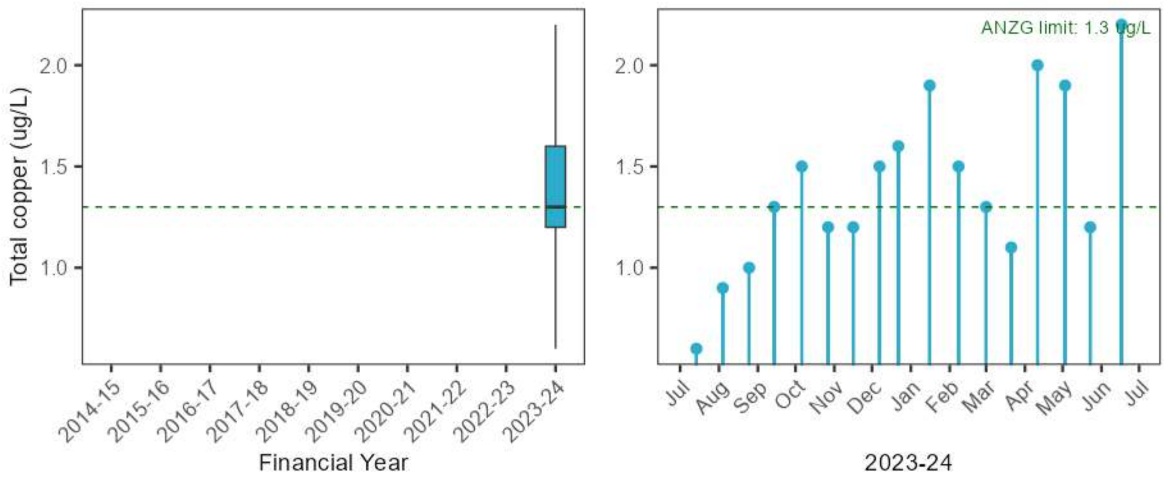
Berowra Creek at Calabash Bay (NB13)



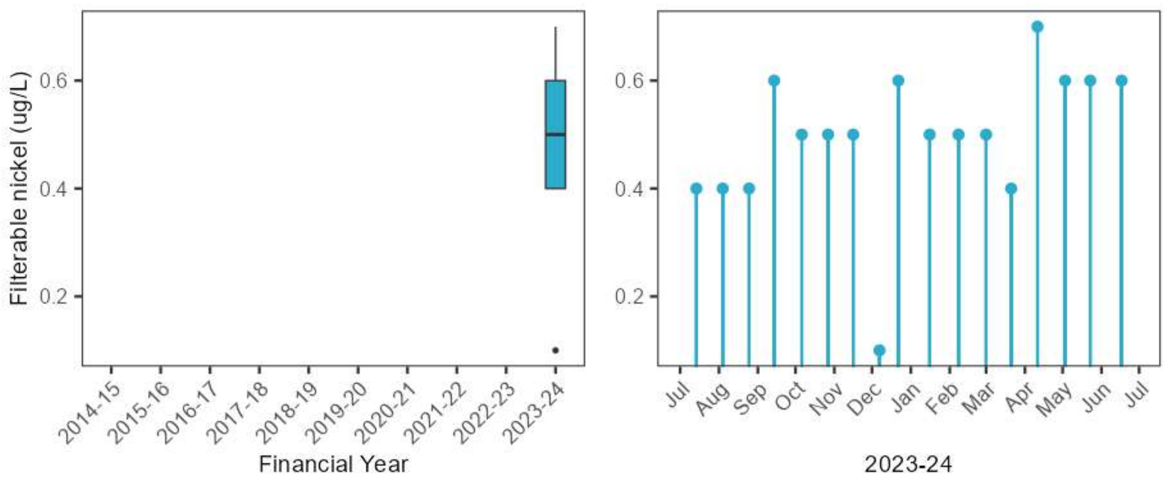
Berowra Creek at Calabash Bay (NB13)



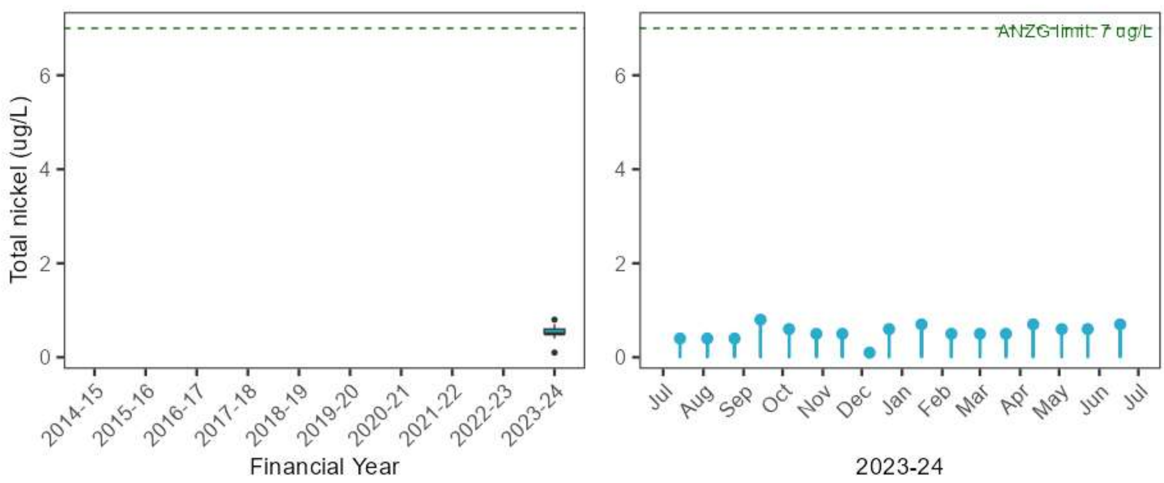
Berowra Creek at Calabash Bay (NB13)



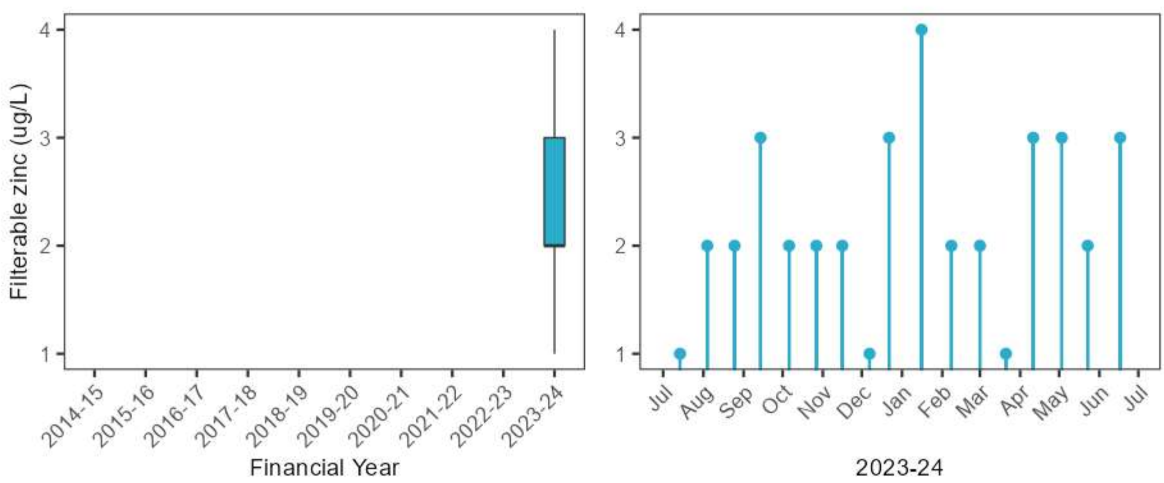
Berowra Creek at Calabash Bay (NB13)



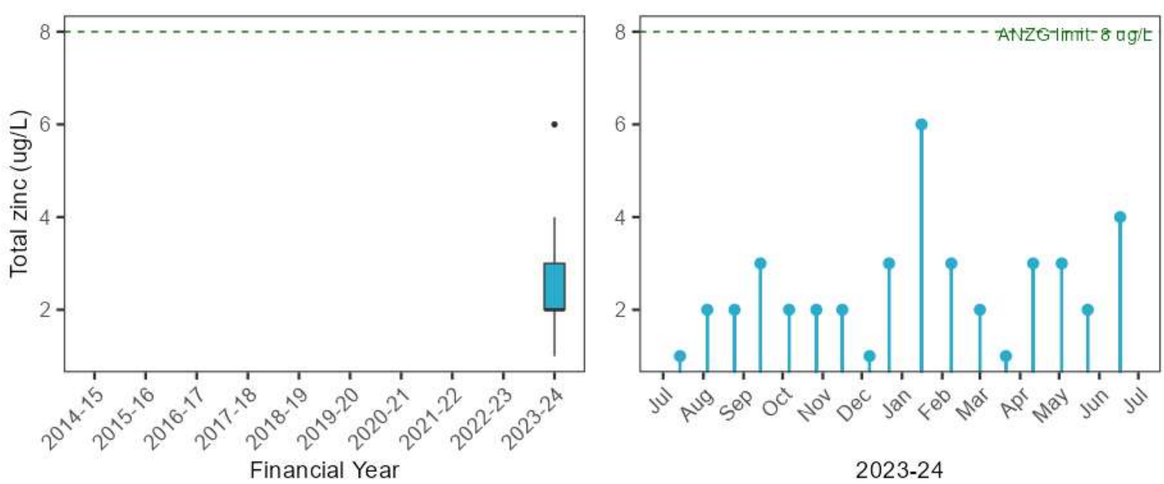
Berowra Creek at Calabash Bay (NB13)



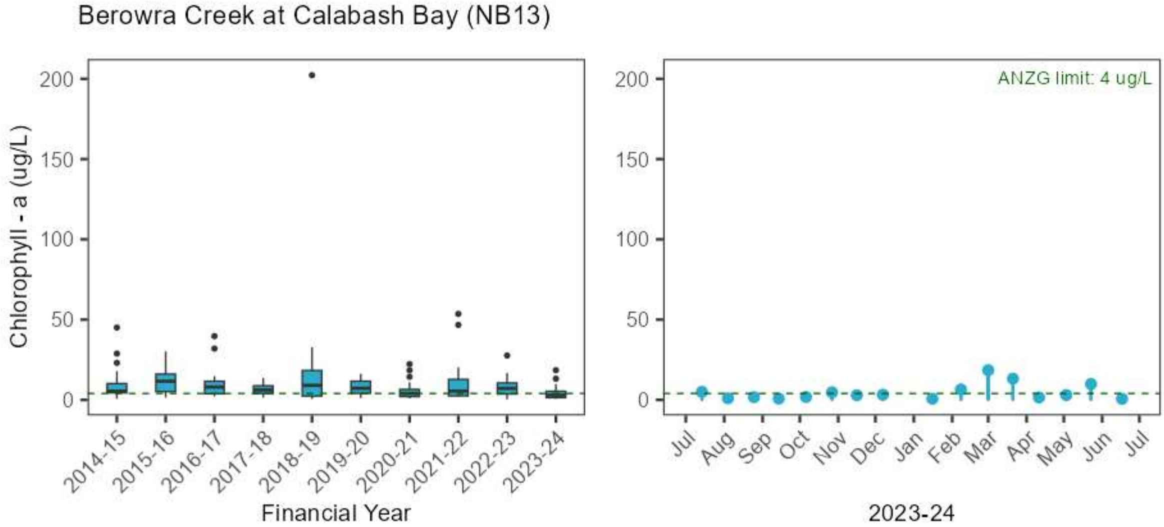
Berowra Creek at Calabash Bay (NB13)



Berowra Creek at Calabash Bay (NB13)



Ecosystem receptor – Phytoplankton



C.1.10. Berowra Creek Off Square Bay (NB11)

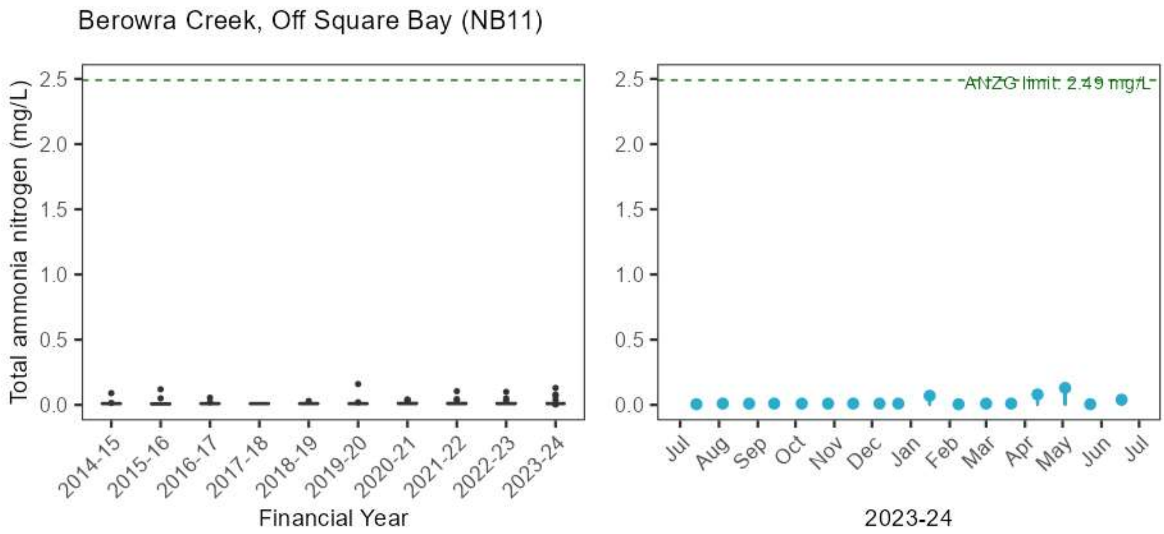
Stressors - Statistical analysis outcomes

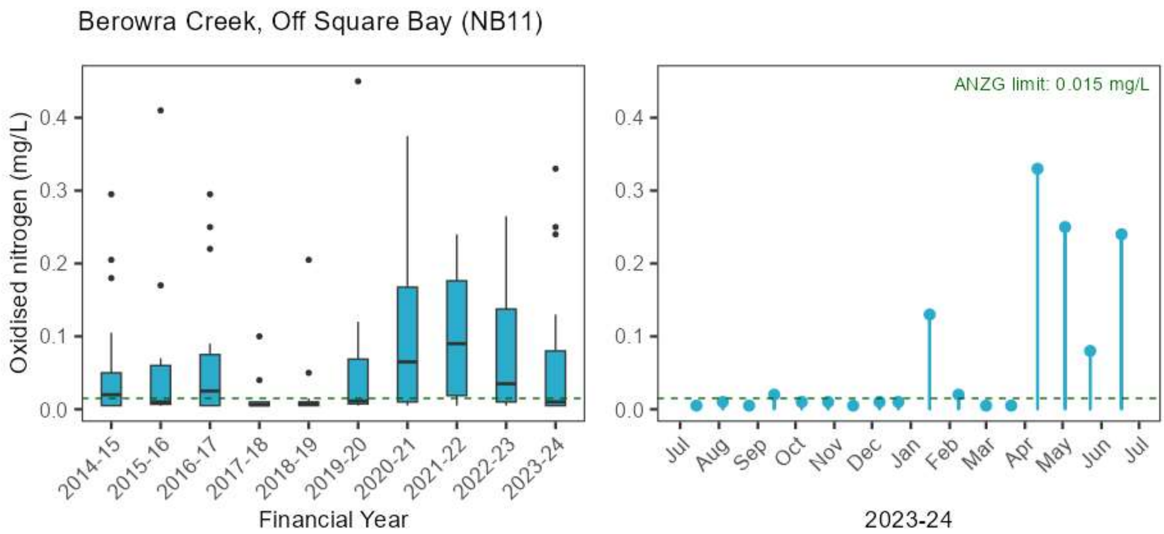
Table C-10 Current period vs previous period comparison contrast outcomes for NB11

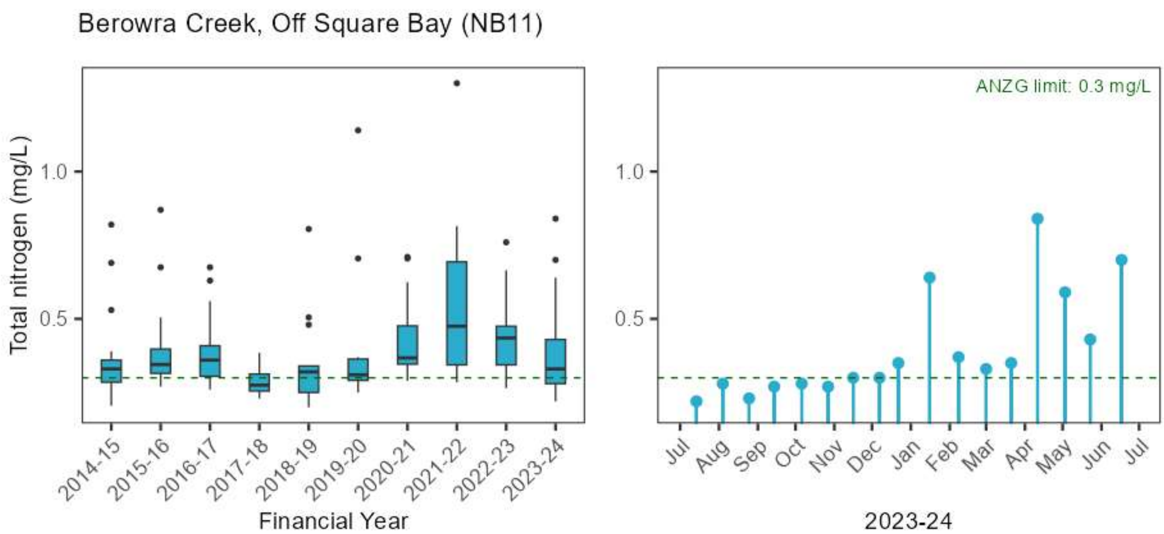
Analyte	Estimate	SE	DF	T ratio	P value
Total ammonia nitrogen	1.36	0.25	157	1.68	0.095
Oxidised nitrogen	0.90	0.32	157	-0.31	0.758
Total nitrogen	0.98	0.08	157	-0.26	0.798
Filterable total phosphorus	0.93	0.10	157	-0.66	0.512
Total phosphorus	1.01	0.11	157	0.10	0.918
Conductivity	0.93	0.12	155	-0.54	0.588
Dissolved oxygen	1.01	0.04	156	0.23	0.822
Dissolved oxygen saturation	-2.67	3.15	156	-0.85	0.398
pH	-0.11	0.07	156	-1.57	0.119
Water temperature	0.98	0.06	156	-0.25	0.806
Turbidity	1.09	0.16	157	0.63	0.533
Chlorophyll - a	0.86	0.17	156	-0.80	0.425

	not significant (p>0.05)		p <0.05 and >=0.01		p <0.01 and >=0.001		p <0.001

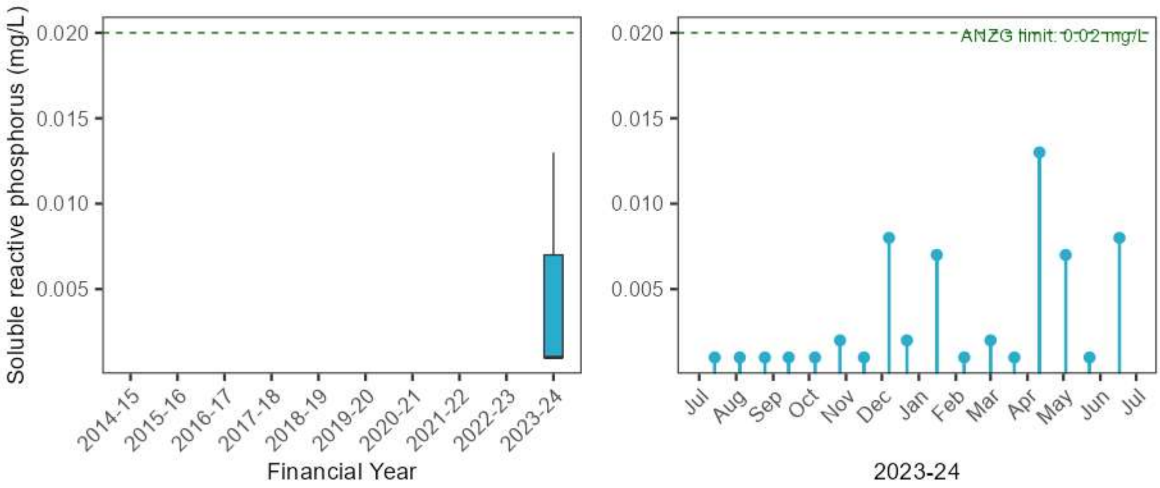
Stressors – Nutrients



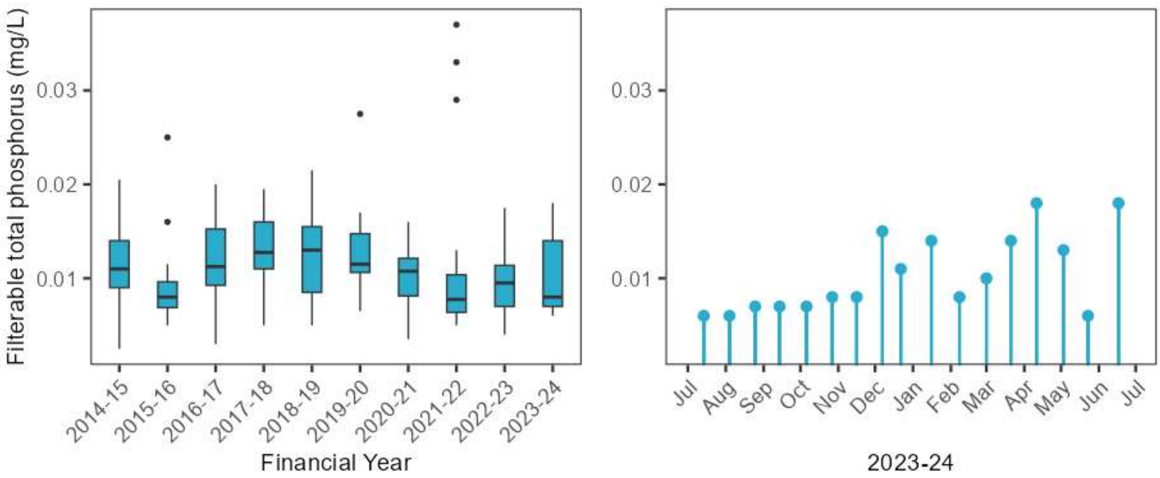




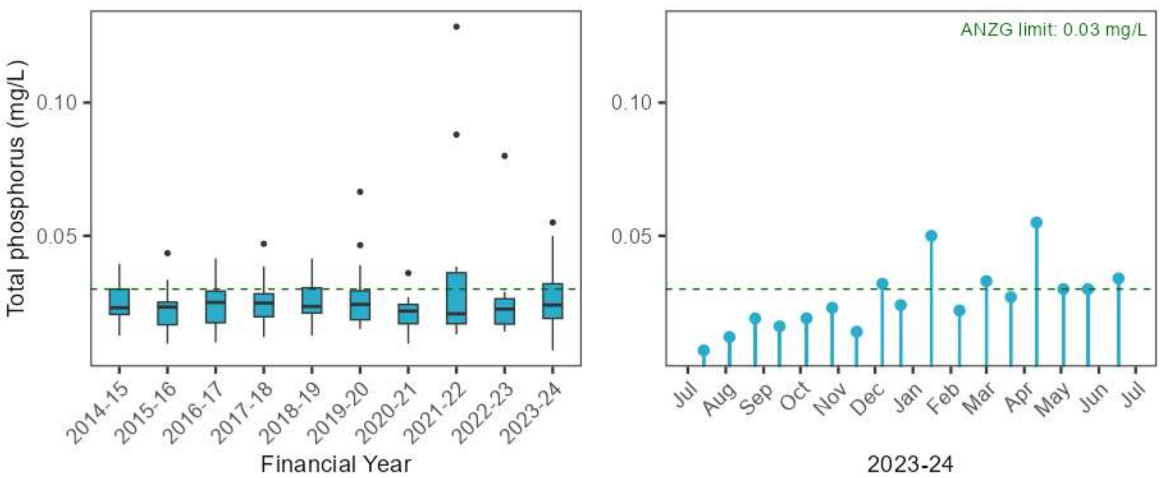
Berowra Creek, Off Square Bay (NB11)



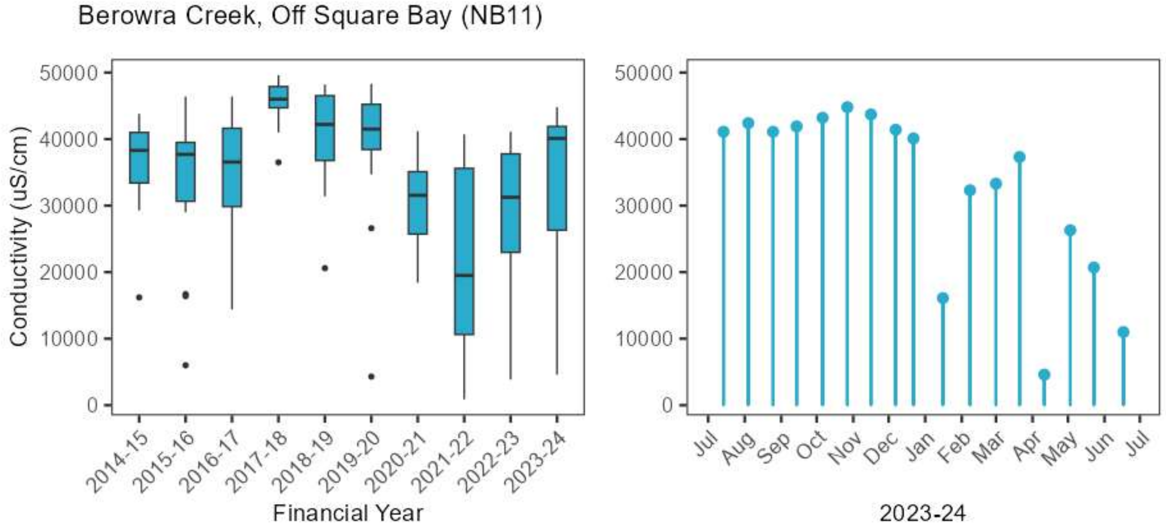
Berowra Creek, Off Square Bay (NB11)

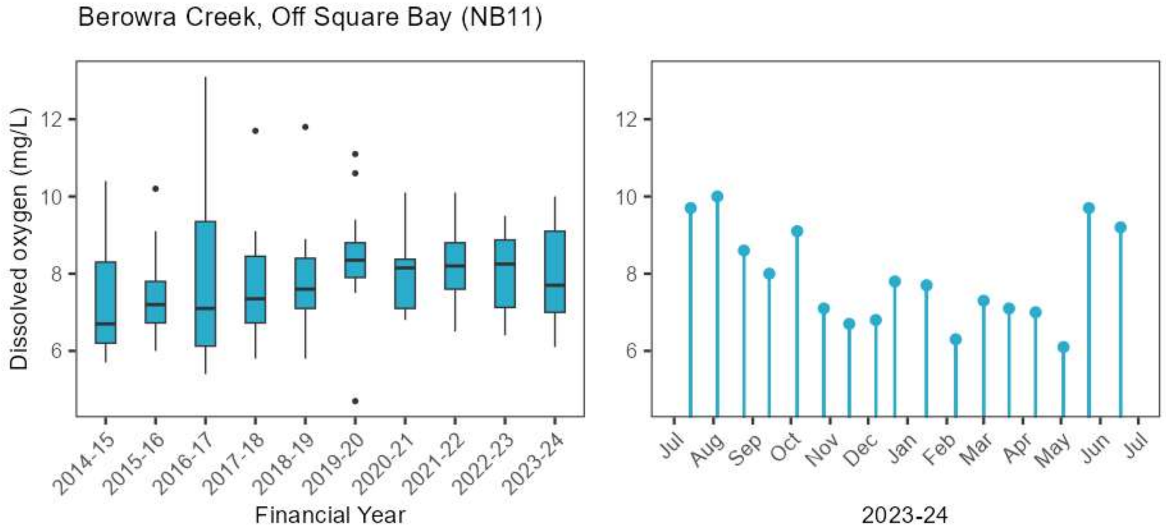


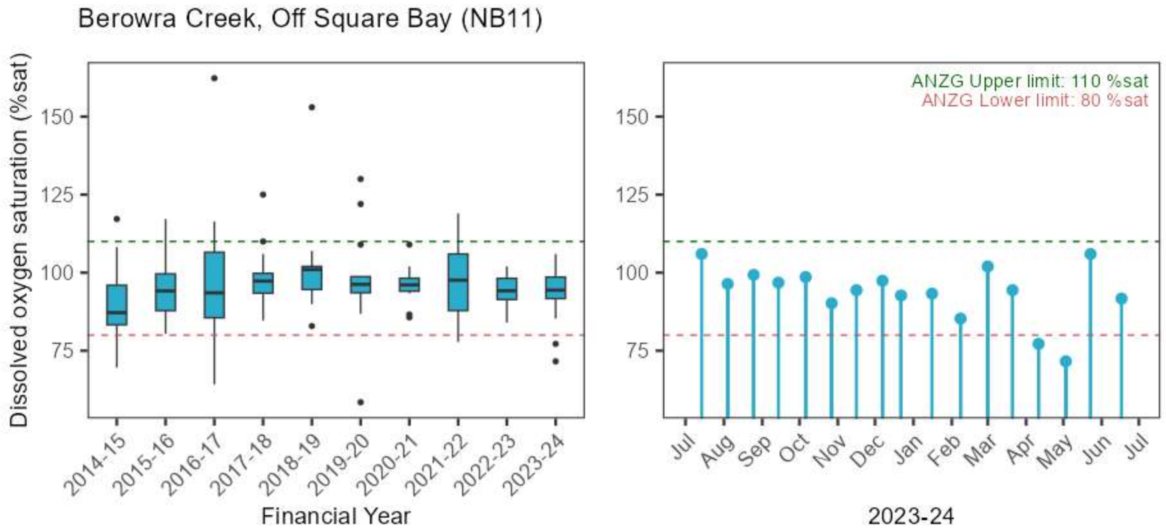
Berowra Creek, Off Square Bay (NB11)

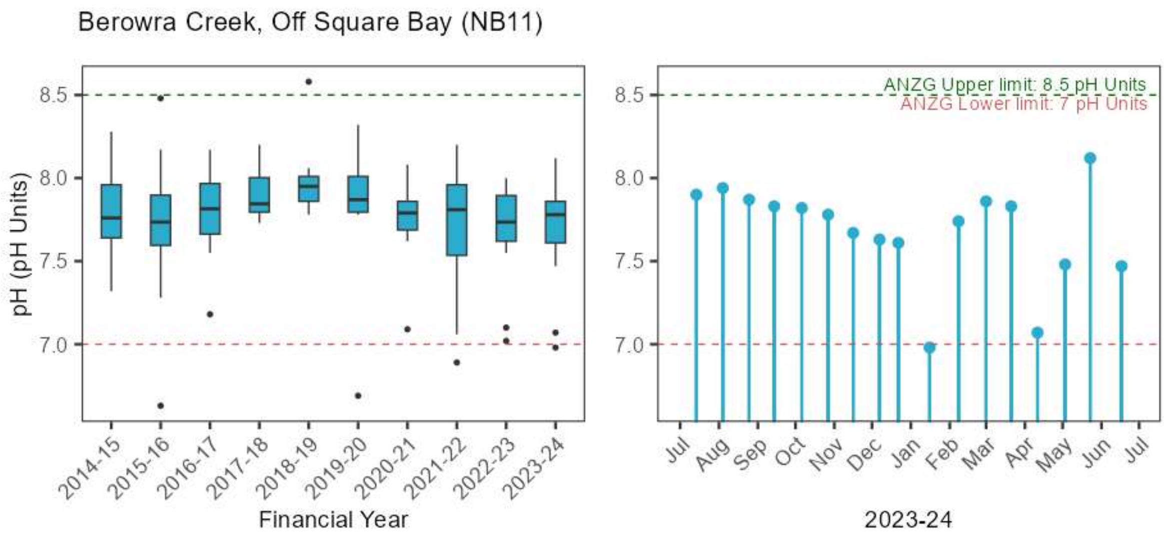


Stressors – Physico-chemical water quality

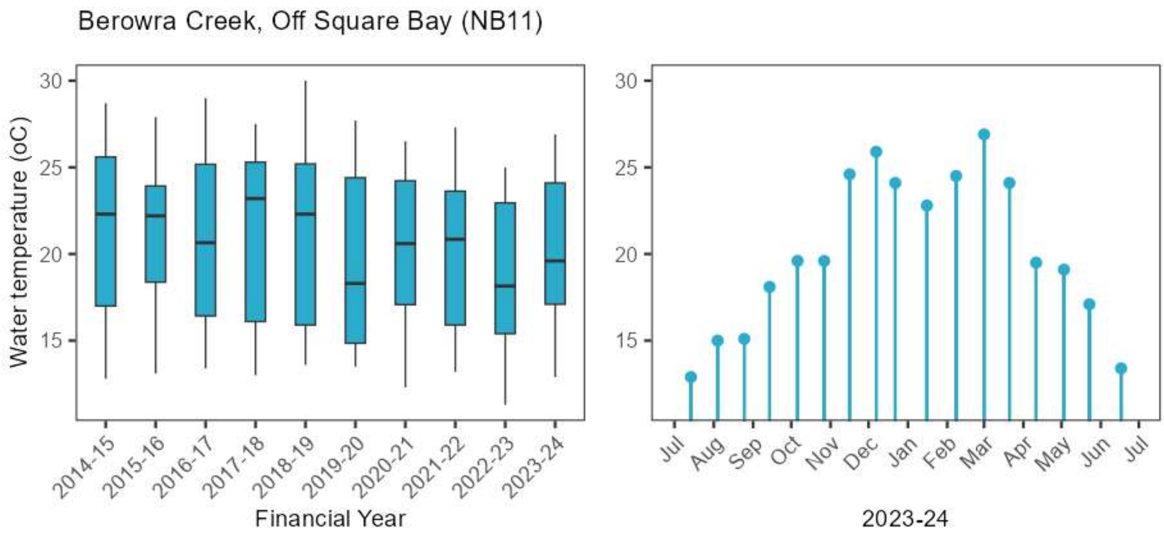




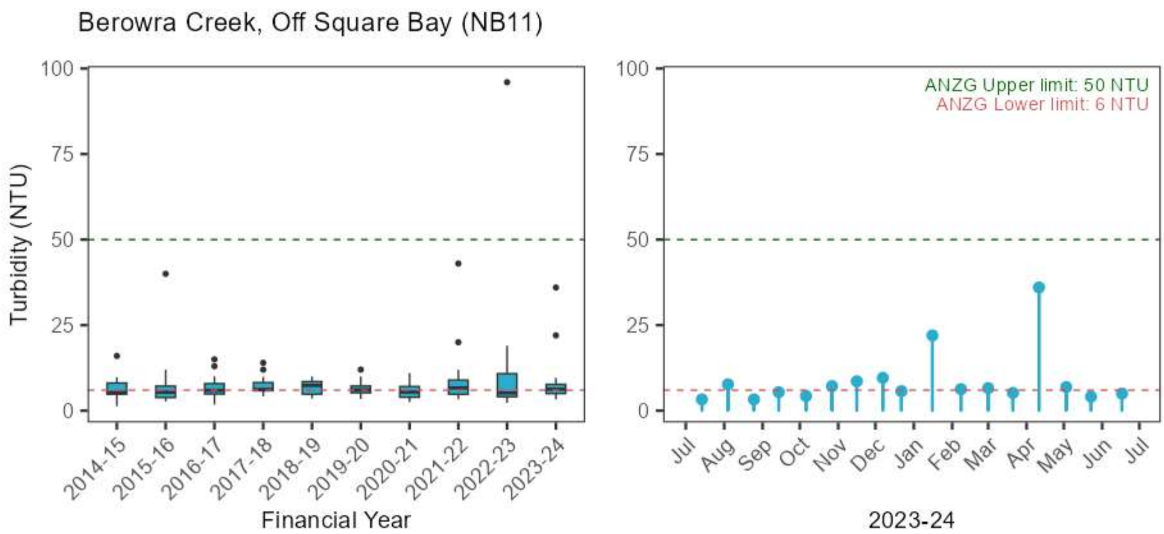




Berowra Creek, Off Square Bay (NB11)
pH (pH Units)
Financial Year
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 7 pH Units
2023-24

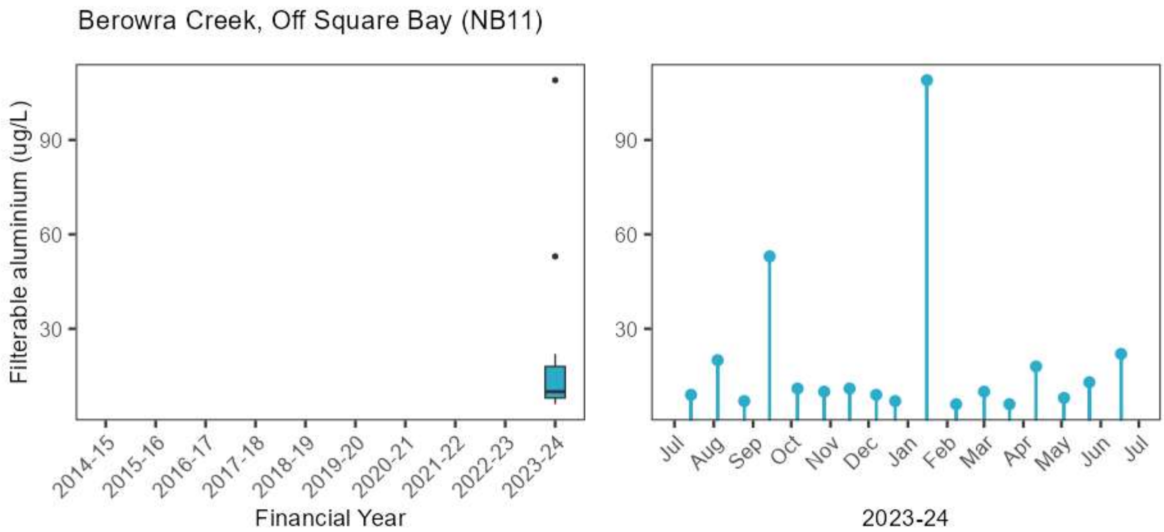


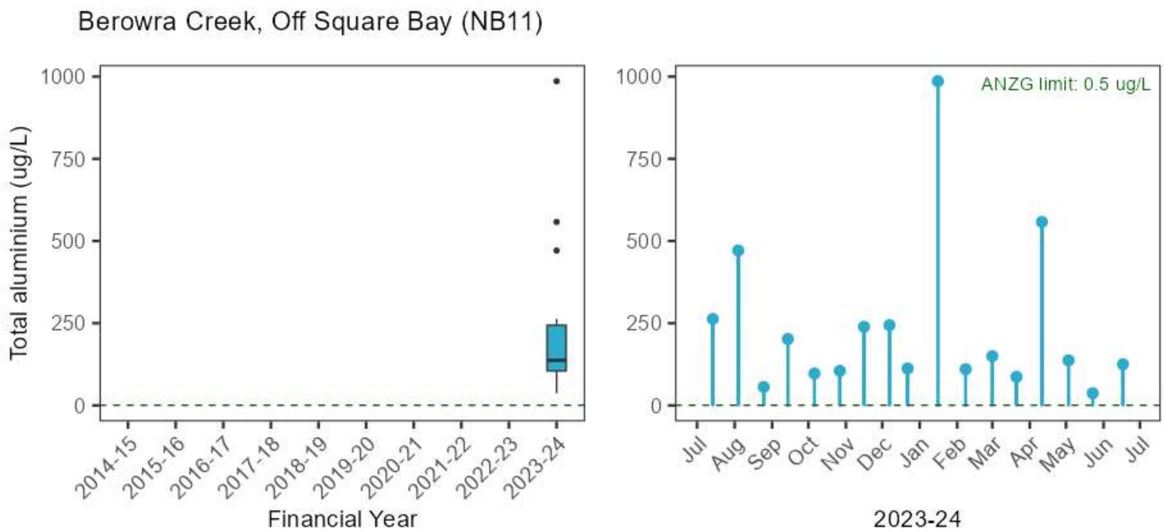
Berowra Creek, Off Square Bay (NB11)
Water temperature (oC)
Financial Year
2023-24

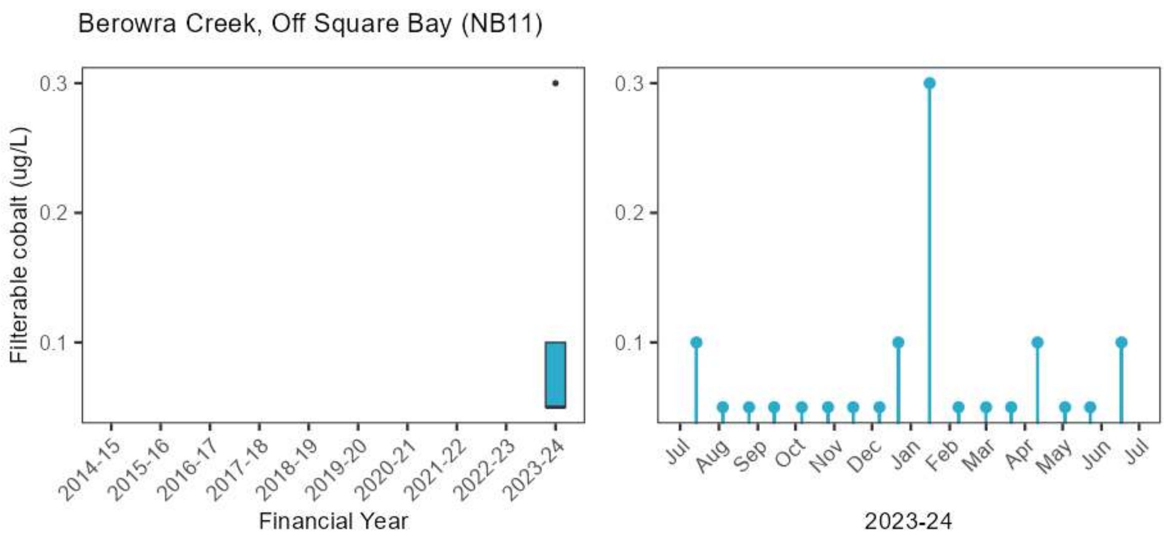


Berowra Creek, Off Square Bay (NB11)
Turbidity (NTU)
Financial Year
ANZG Upper limit: 50 NTU
ANZG Lower limit: 6 NTU
2023-24

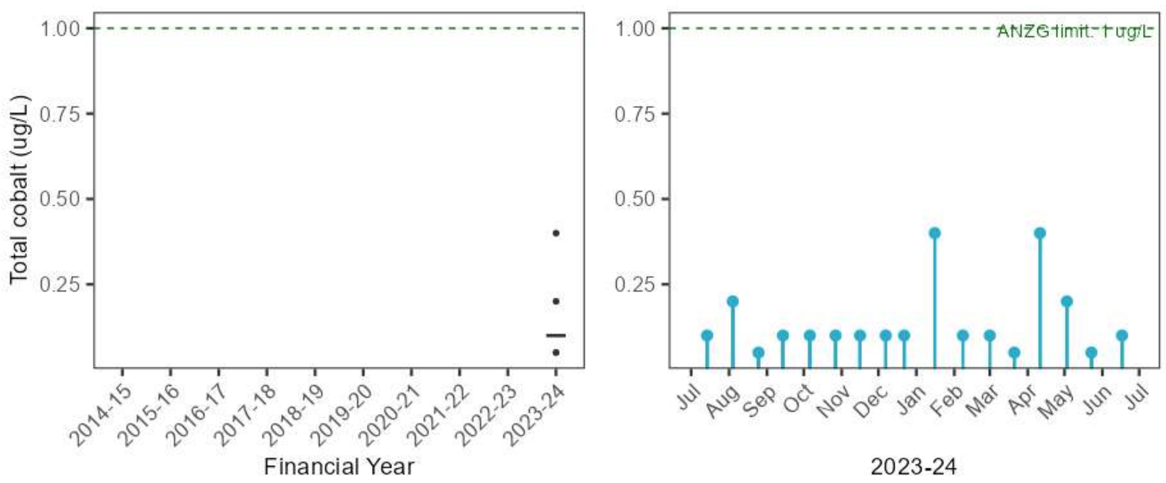
Stressors – Trace metals



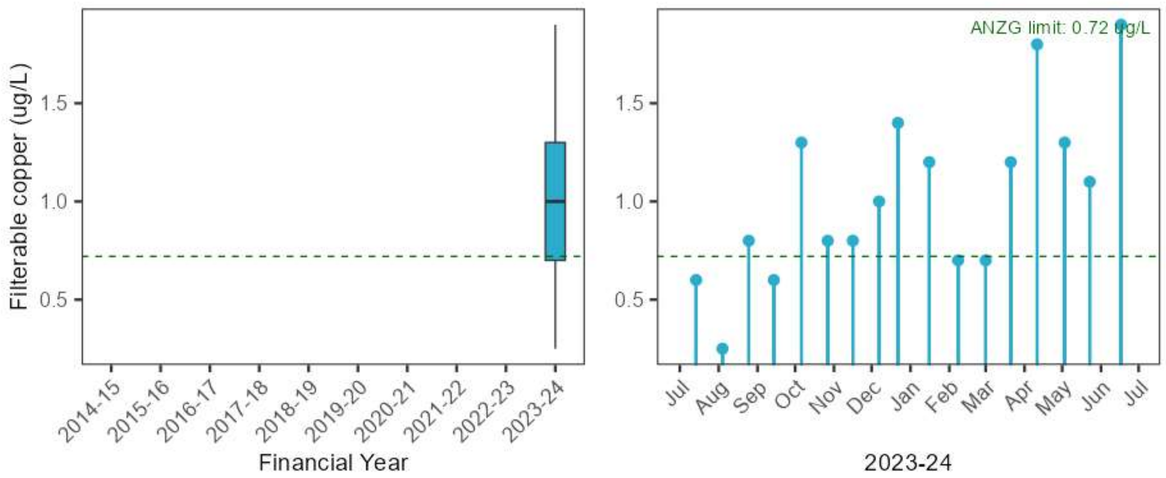




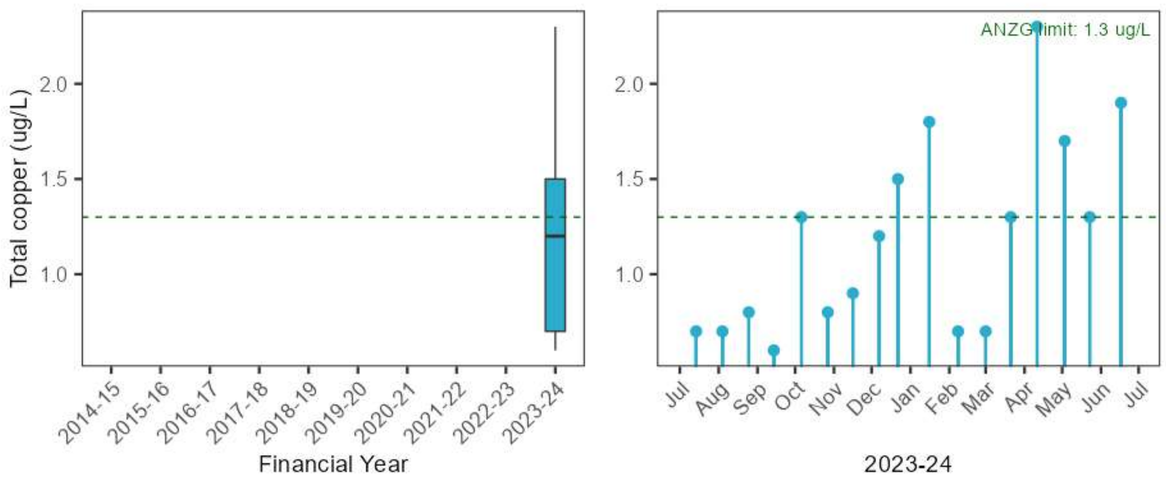
Berowra Creek, Off Square Bay (NB11)



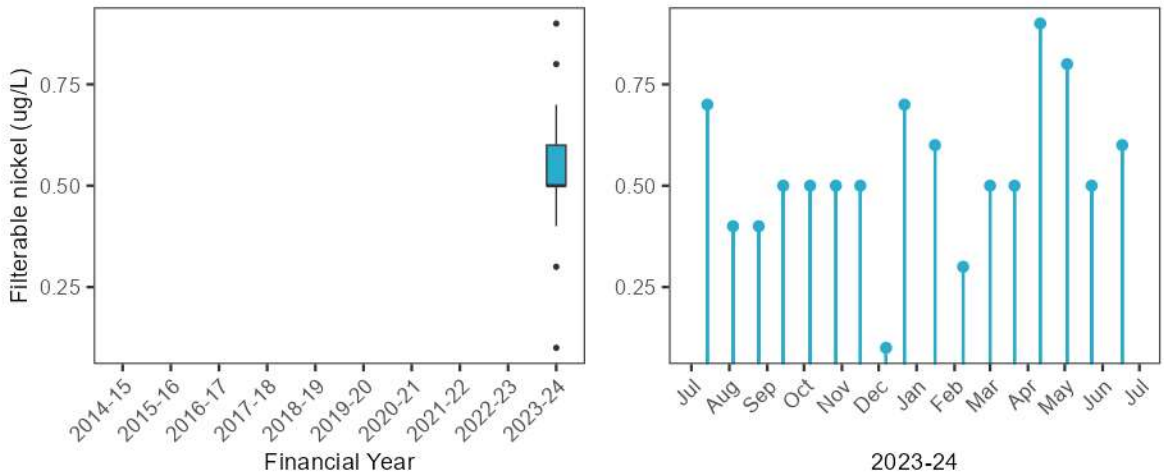
Berowra Creek, Off Square Bay (NB11)



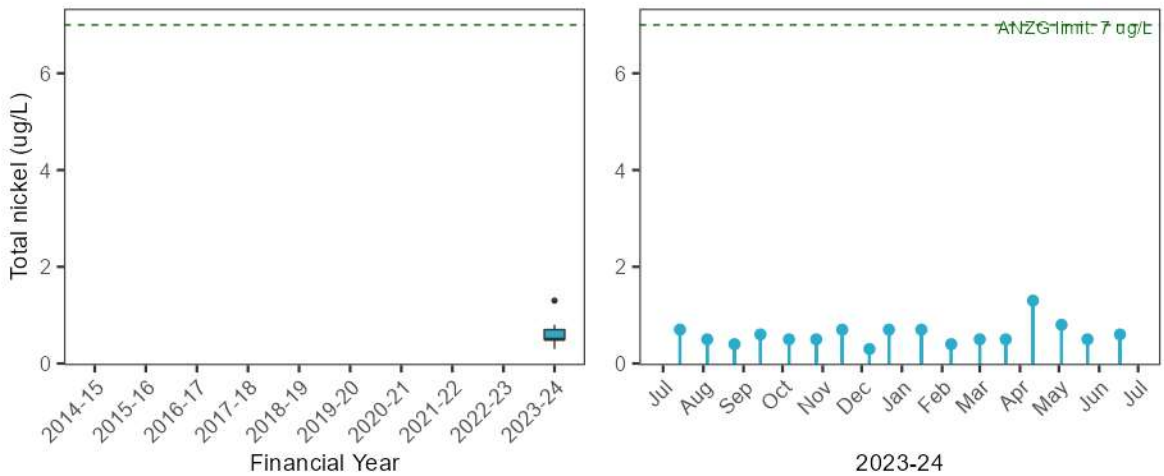
Berowra Creek, Off Square Bay (NB11)



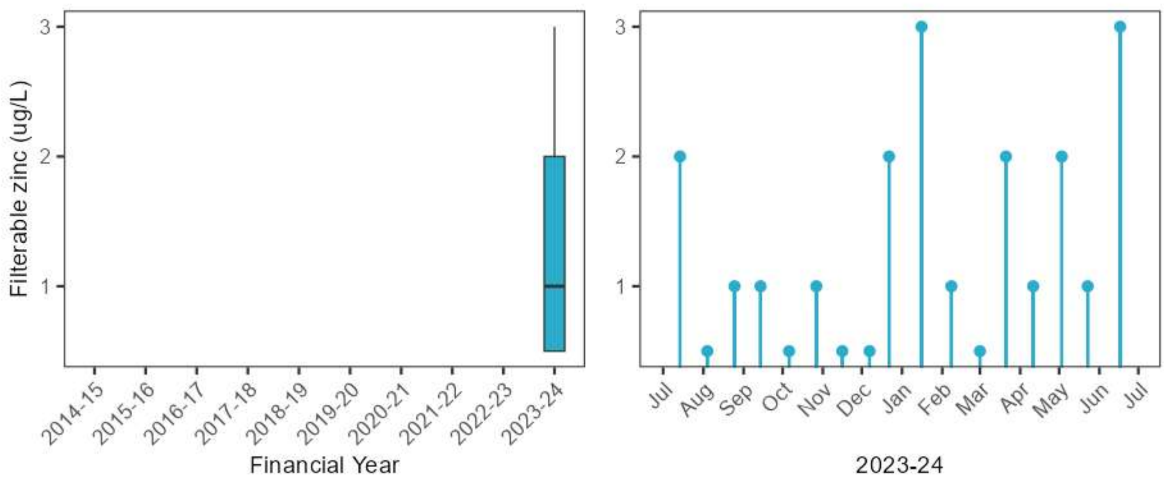
Berowra Creek, Off Square Bay (NB11)

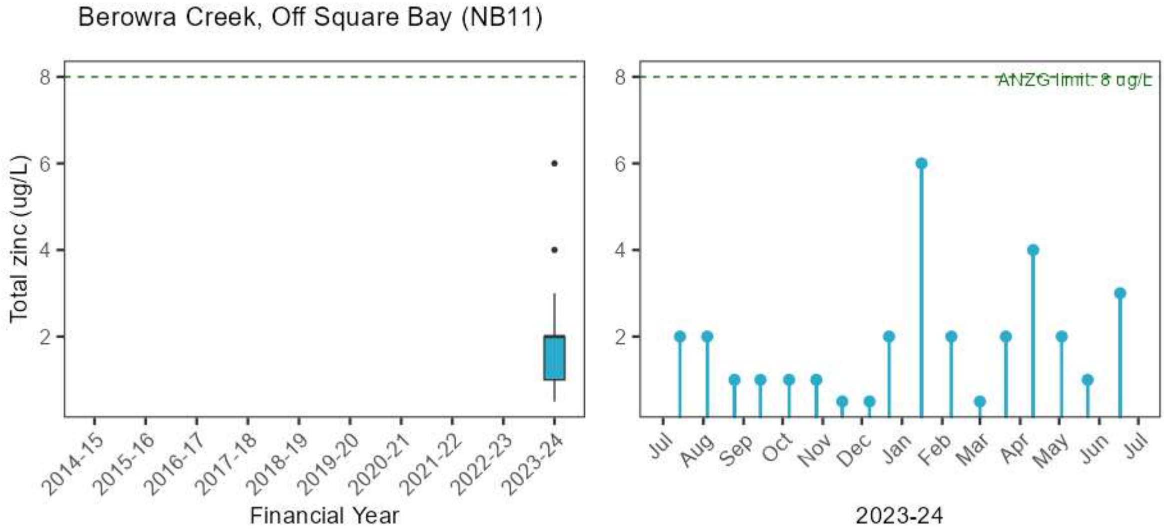


Berowra Creek, Off Square Bay (NB11)

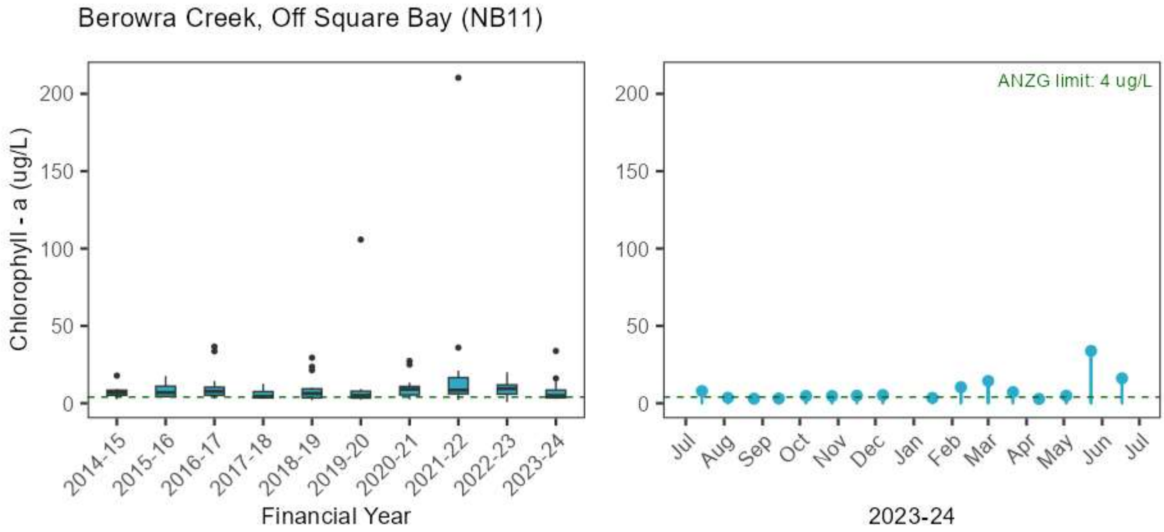


Berowra Creek, Off Square Bay (NB11)





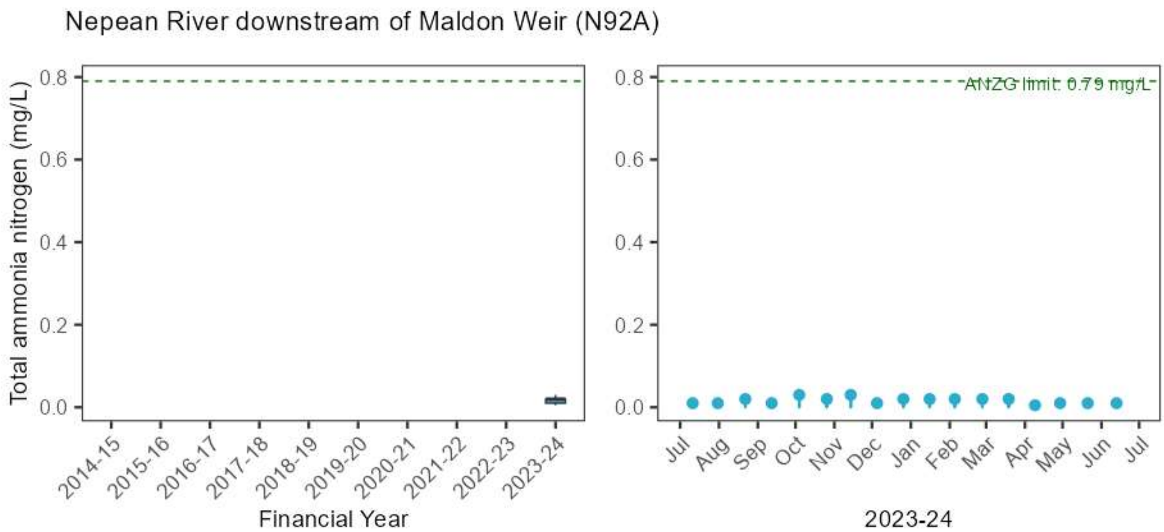
Ecosystem receptor – Phytoplankton

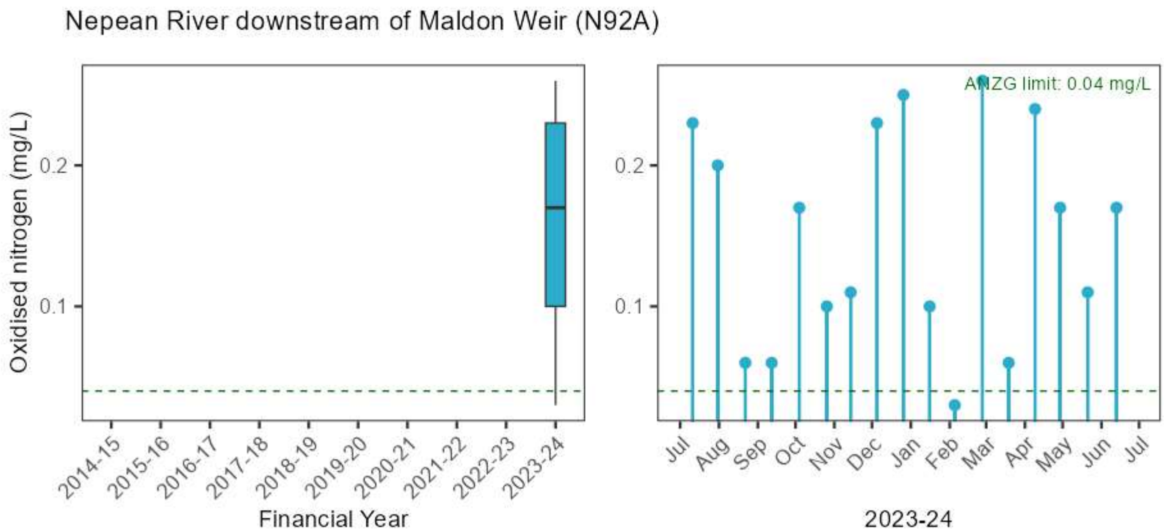


C.2. Water quality – Other HN River sites

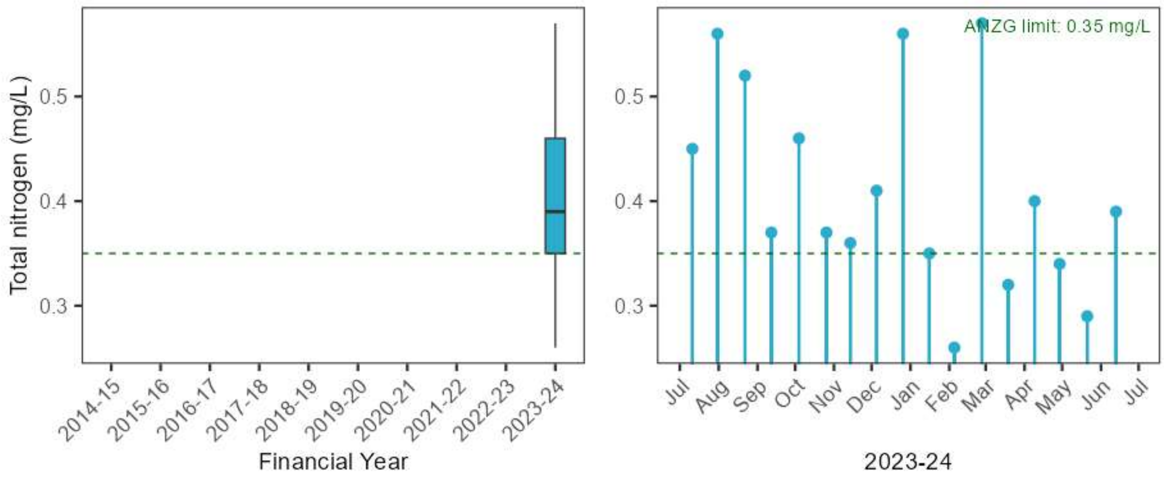
C.2.1. N92A Nepean River downstream of Maldon Weir

Stressors – Nutrients

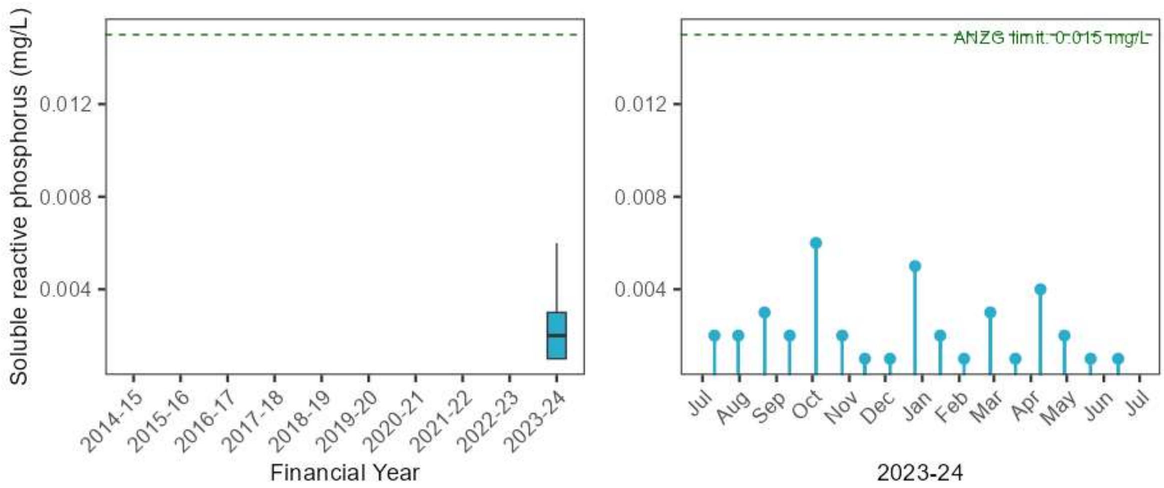




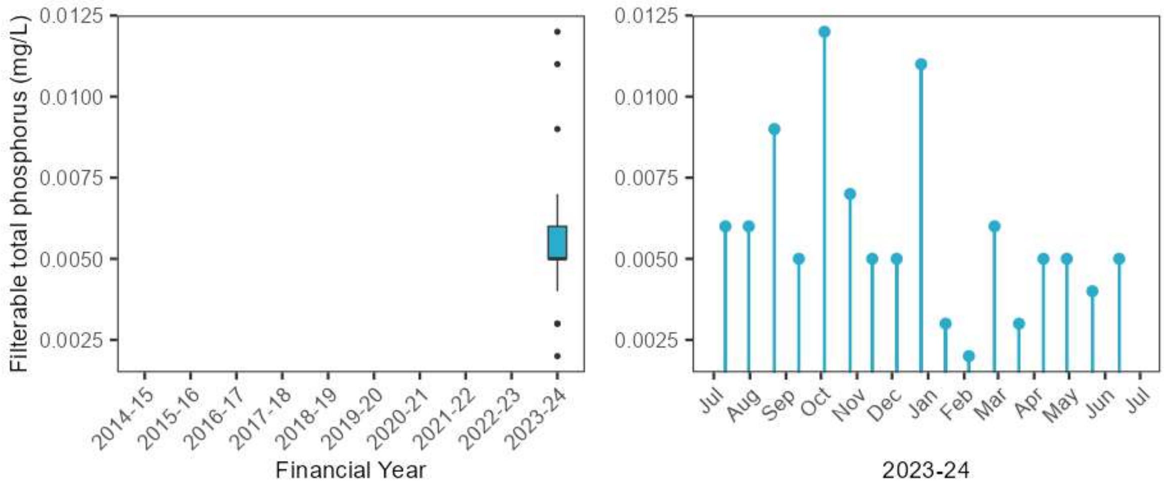
Nepean River downstream of Maldon Weir (N92A)

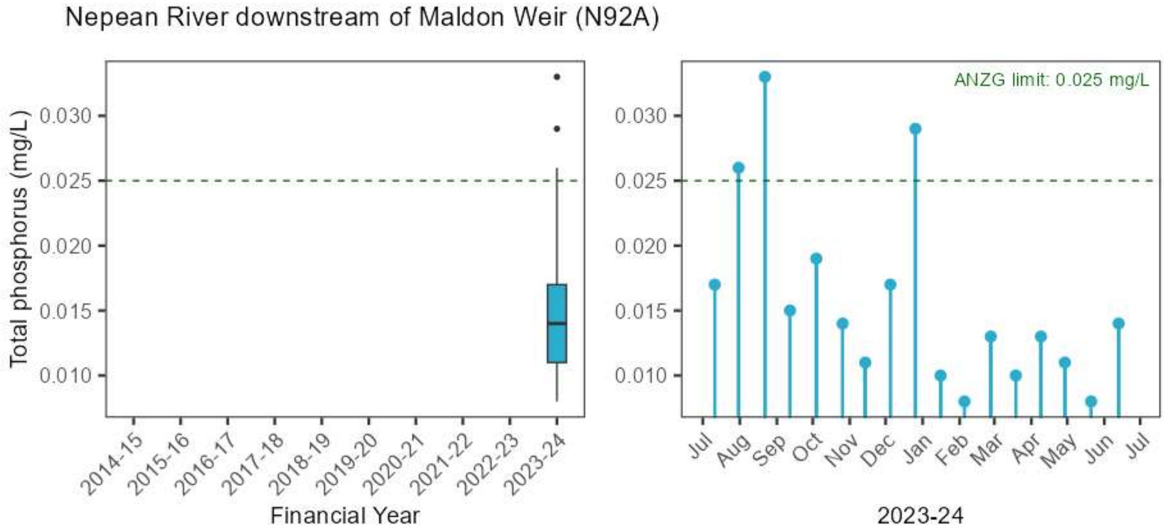


Nepean River downstream of Maldon Weir (N92A)

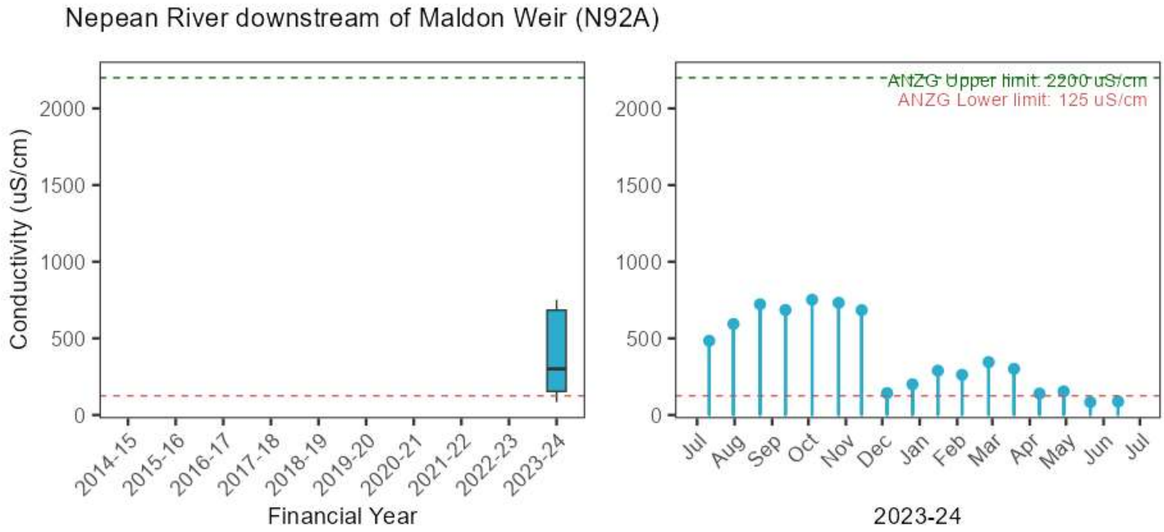


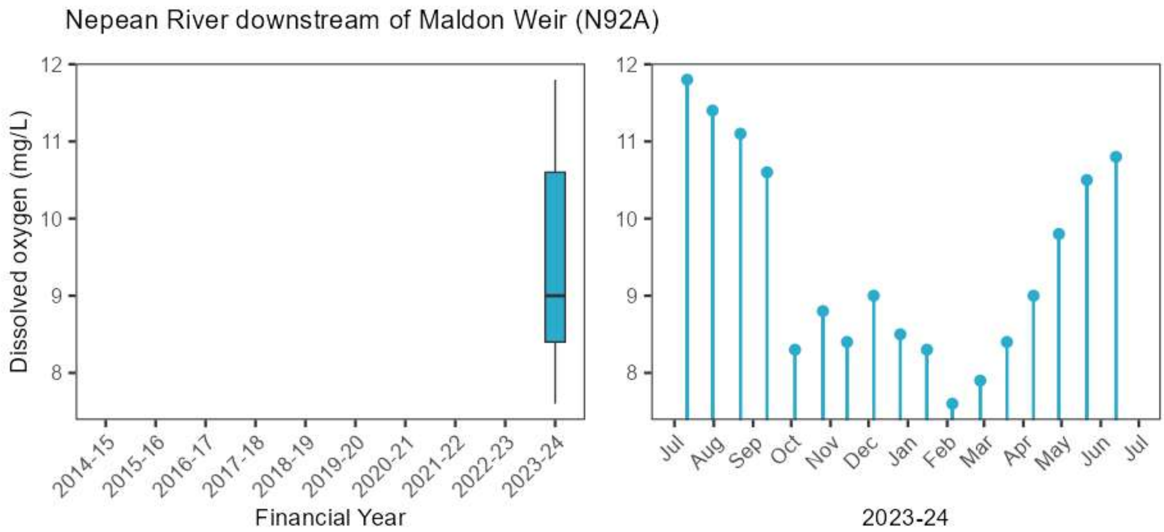
Nepean River downstream of Maldon Weir (N92A)

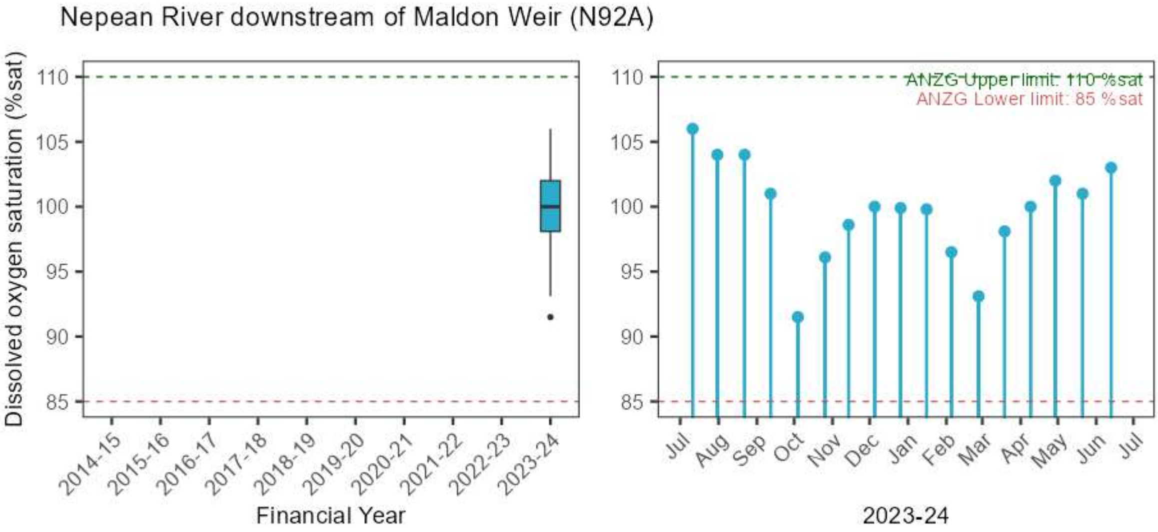


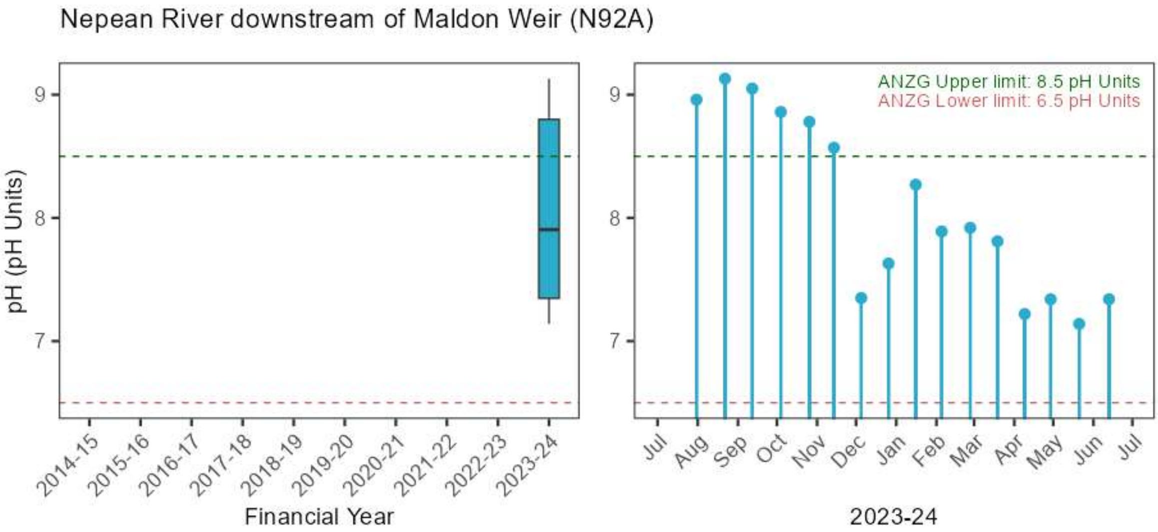


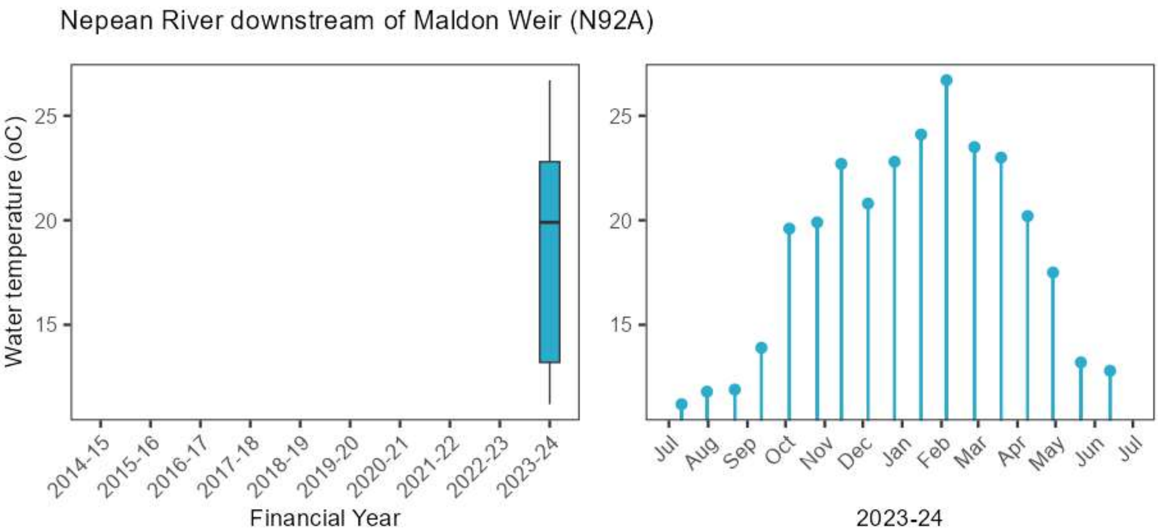
Stressors – Physico-chemical water quality

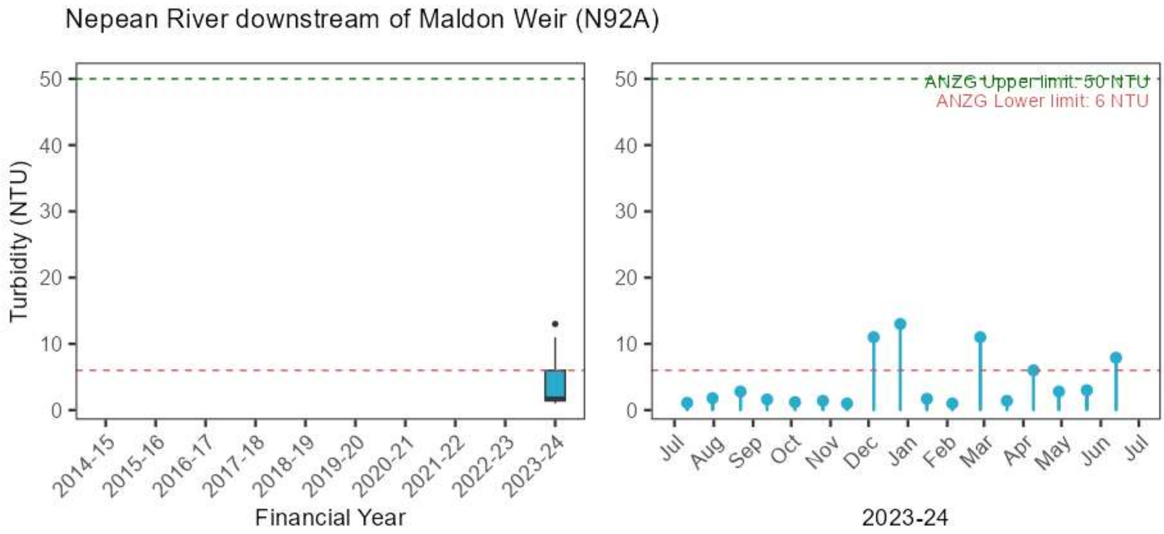




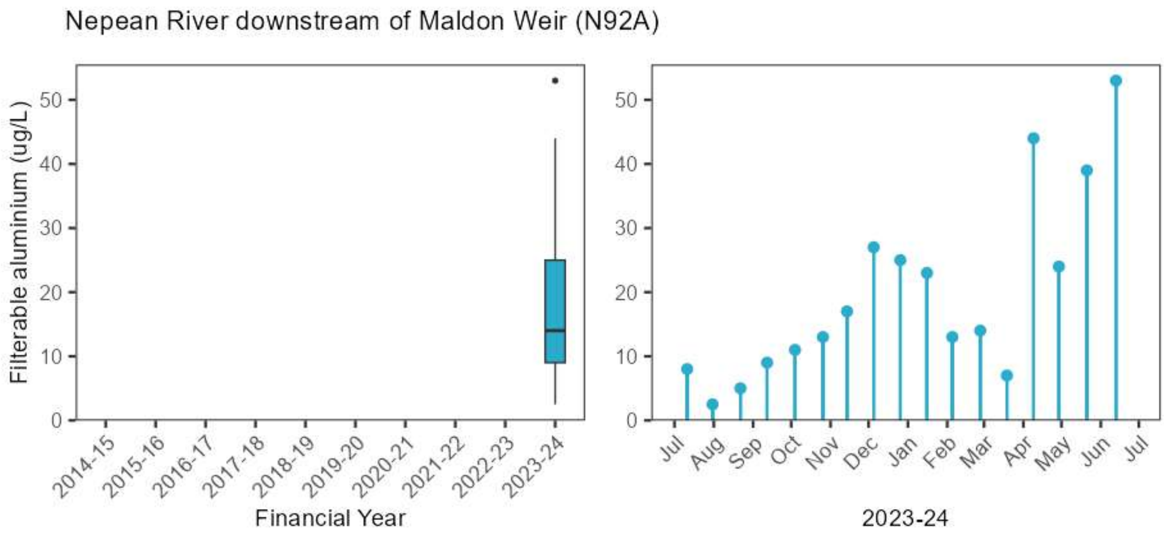

Nepean River downstream of Maldon Weir (N92A)
Dissolved oxygen saturation (%sat)
ANZG Upper limit: 110 %sat
ANZG Lower limit: 85 %sat
Financial Year
2023-24

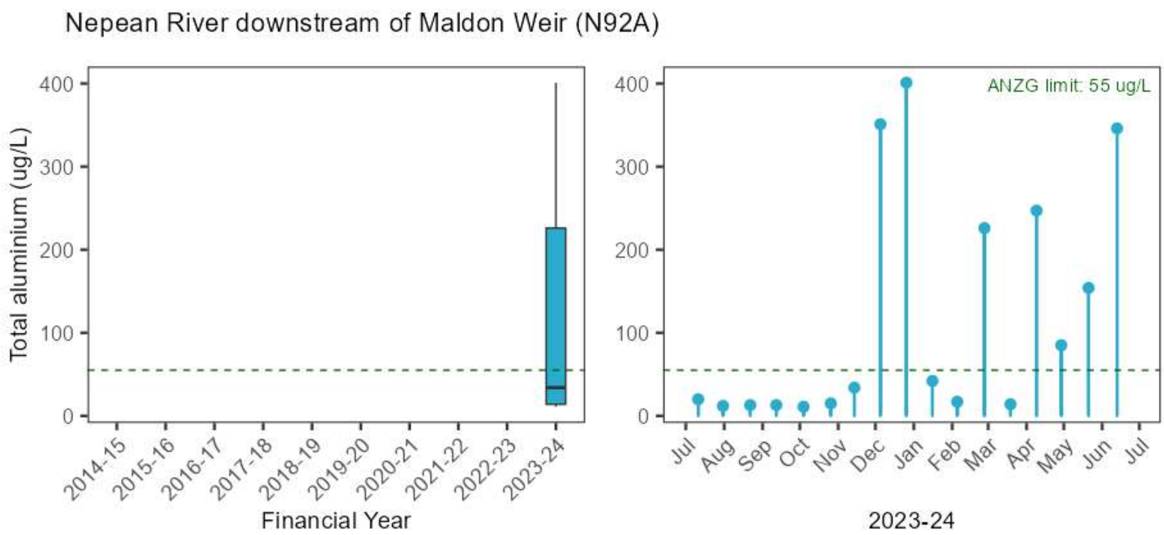

Nepean River downstream of Maldon Weir (N92A)
pH (pH Units)
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units
Financial Year
2023-24


Nepean River downstream of Maldon Weir (N92A)
Water temperature (oC)
Financial Year
2023-24

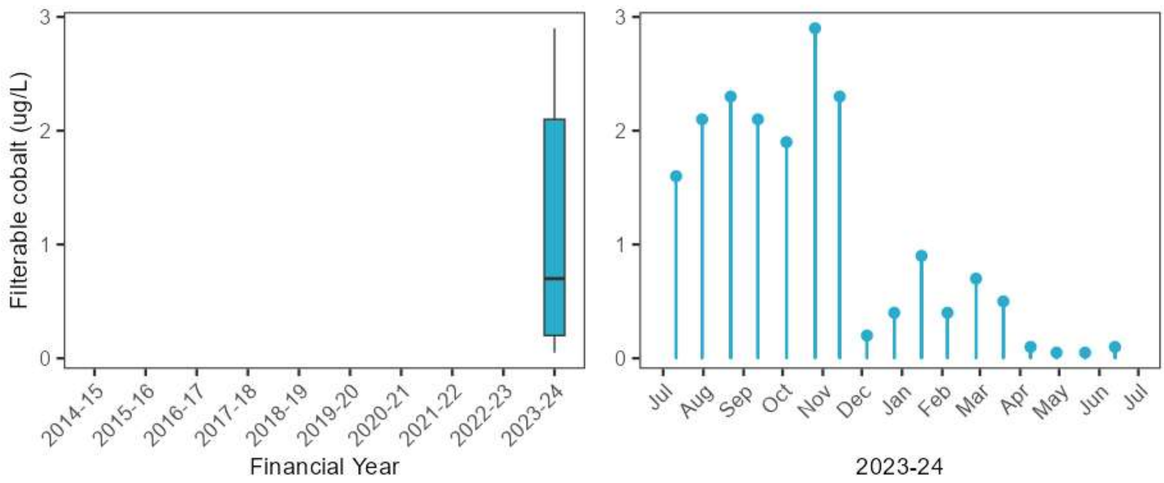


Stressors – Trace metals

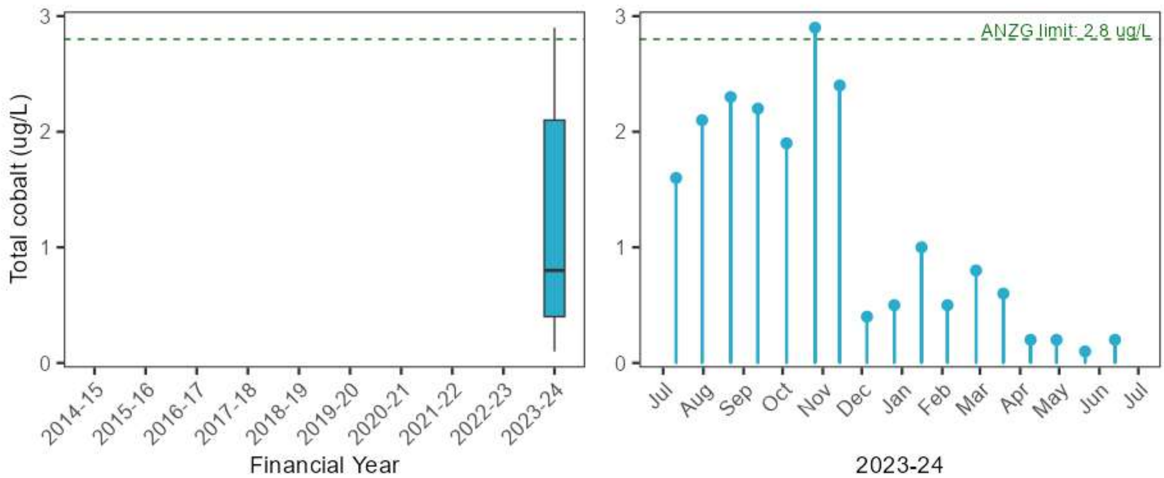




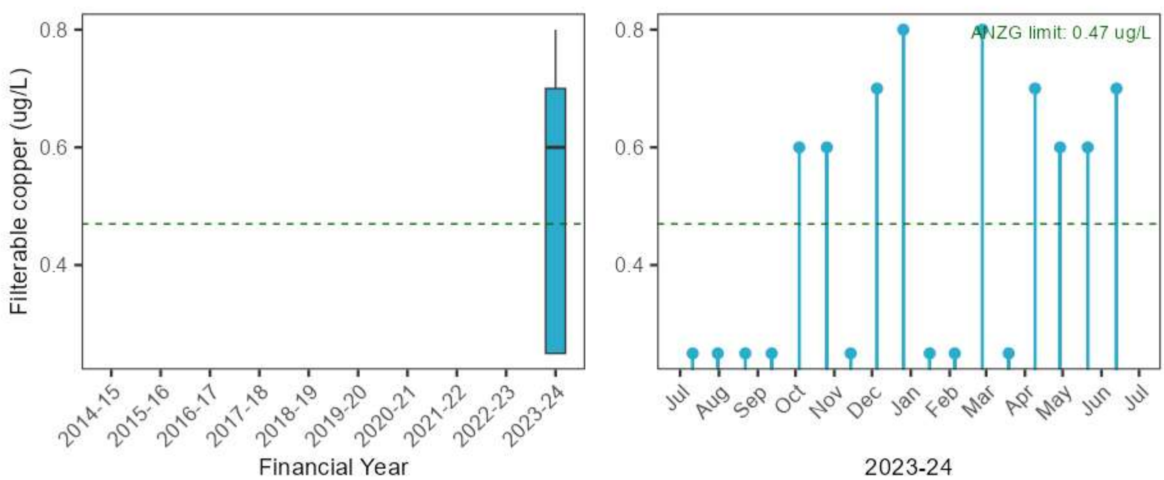
Nepean River downstream of Maldon Weir (N92A)



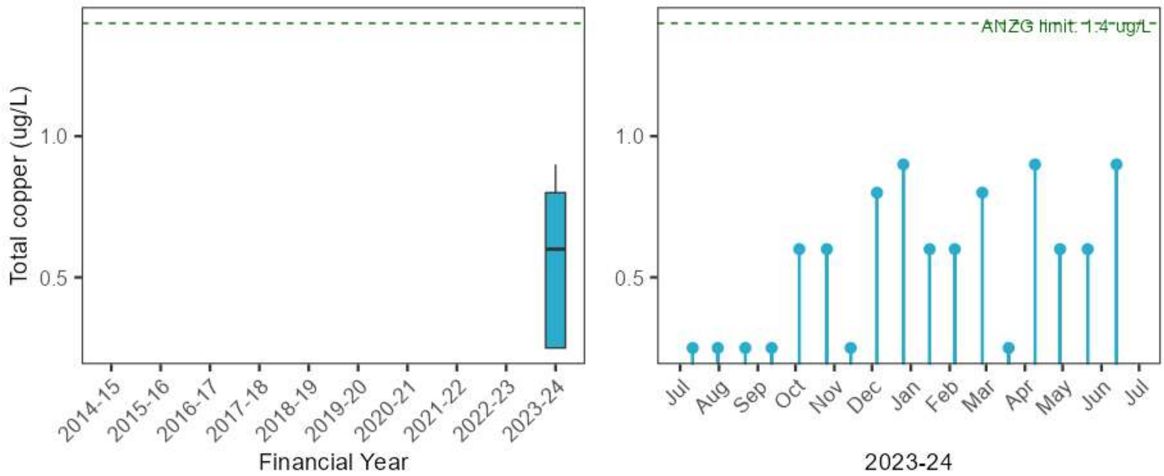
Nepean River downstream of Maldon Weir (N92A)



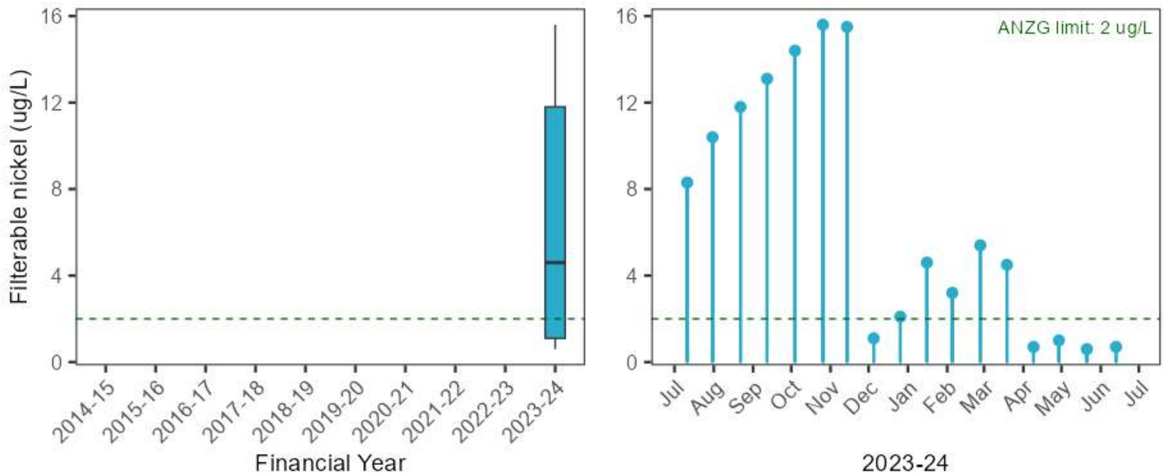
Nepean River downstream of Maldon Weir (N92A)



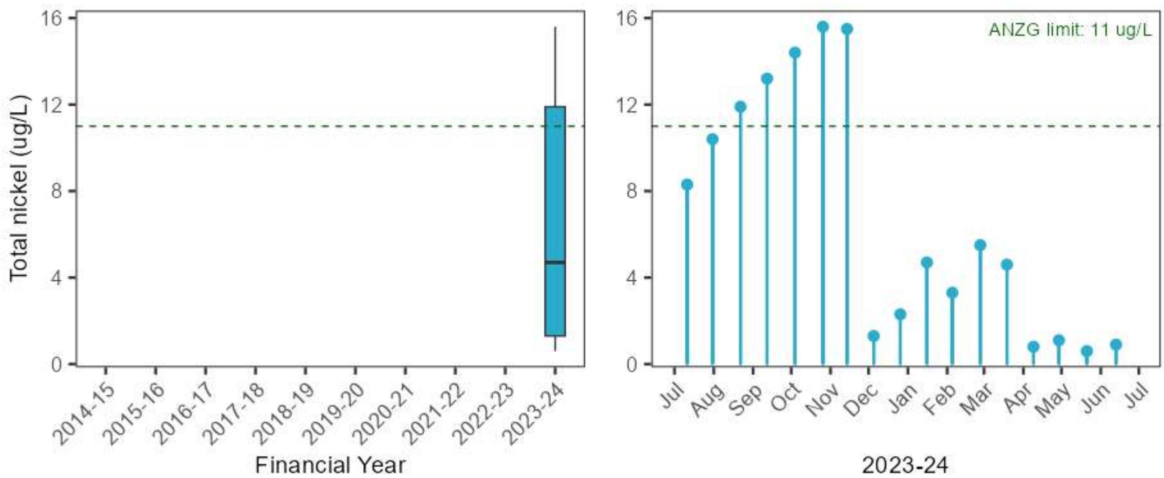
Nepean River downstream of Maldon Weir (N92A)



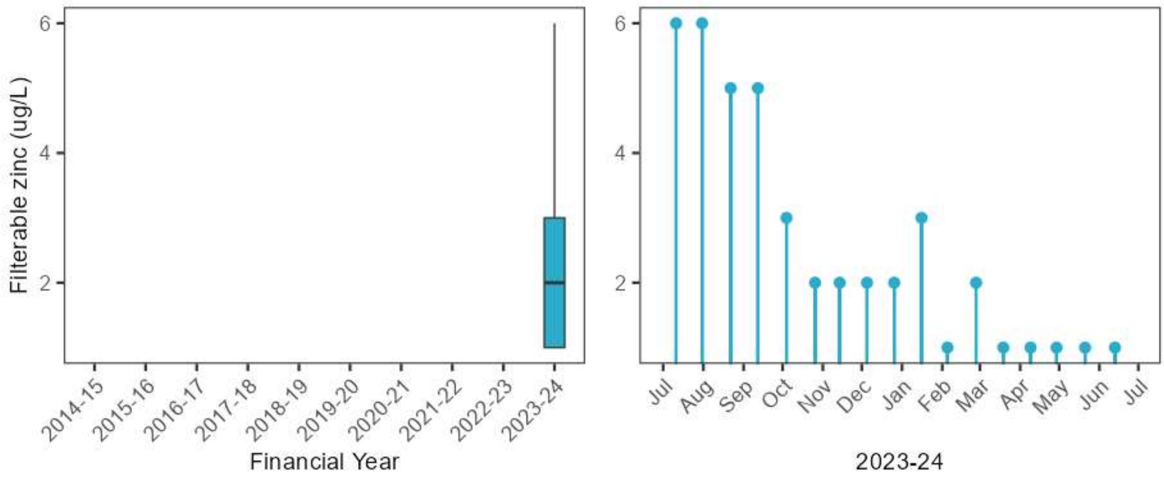
Nepean River downstream of Maldon Weir (N92A)



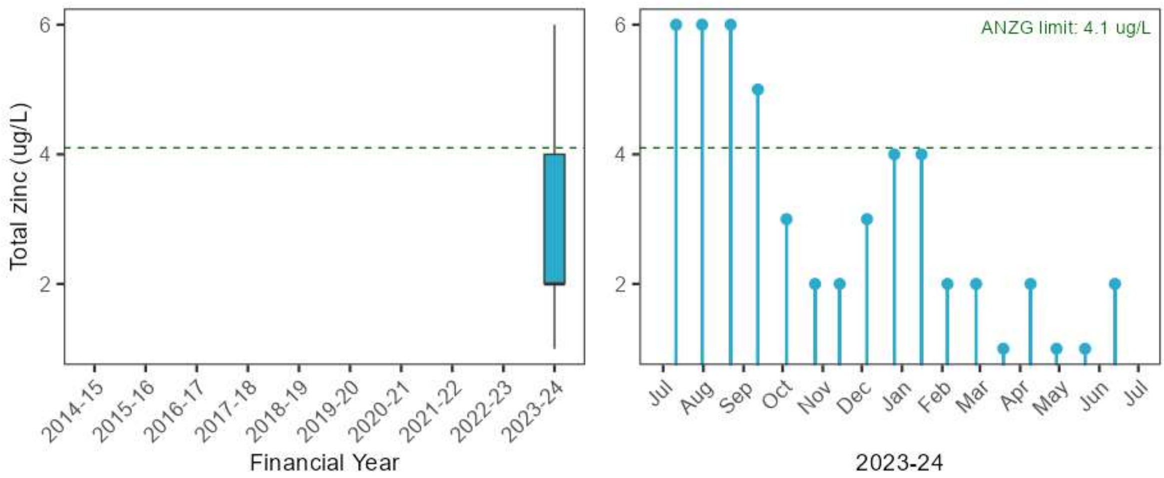
Nepean River downstream of Maldon Weir (N92A)



Nepean River downstream of Maldon Weir (N92A)

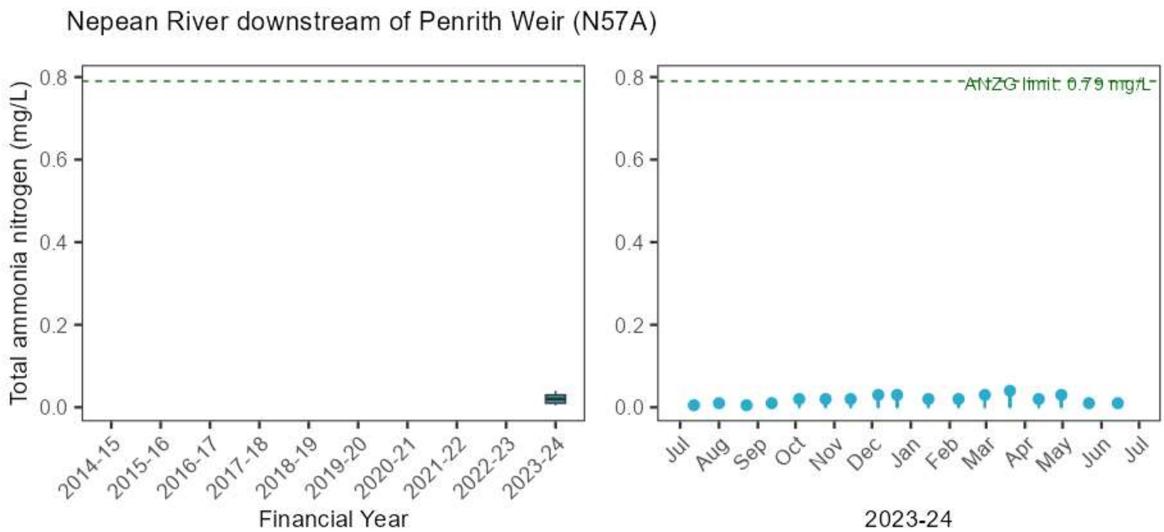


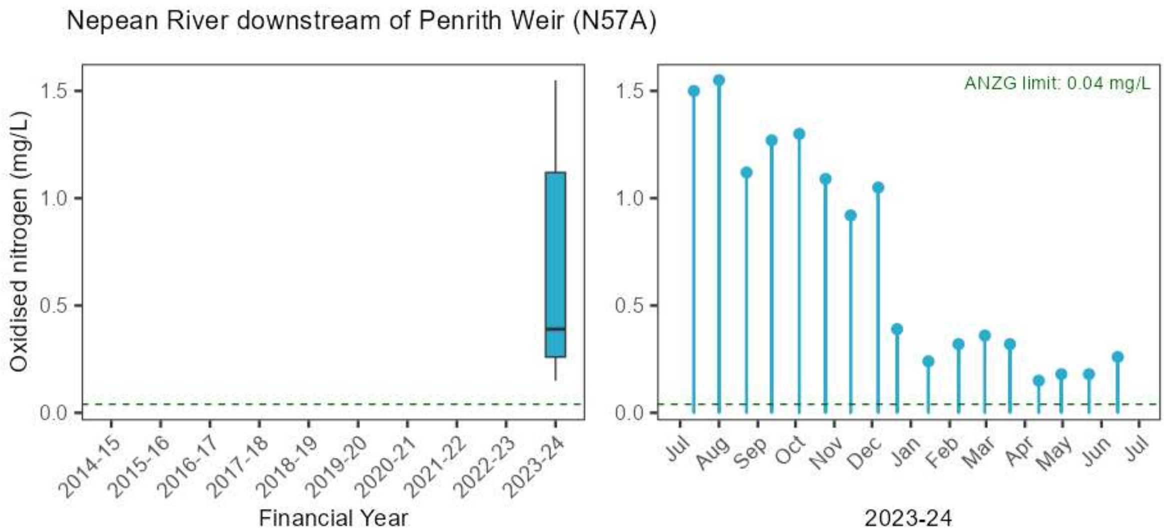
Nepean River downstream of Maldon Weir (N92A)

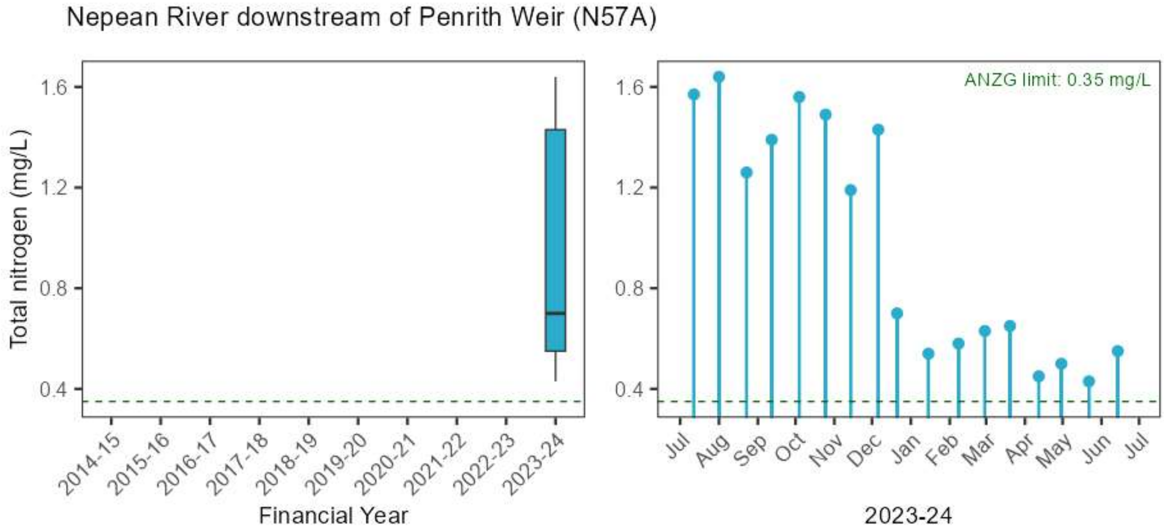


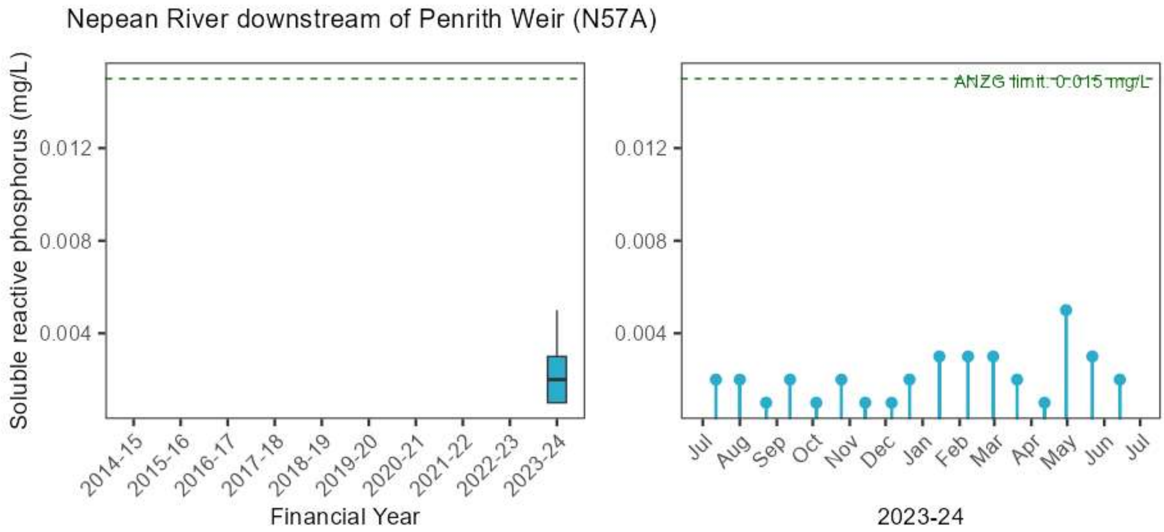
C.2.2. N57A Nepean River downstream of Penrith Weir

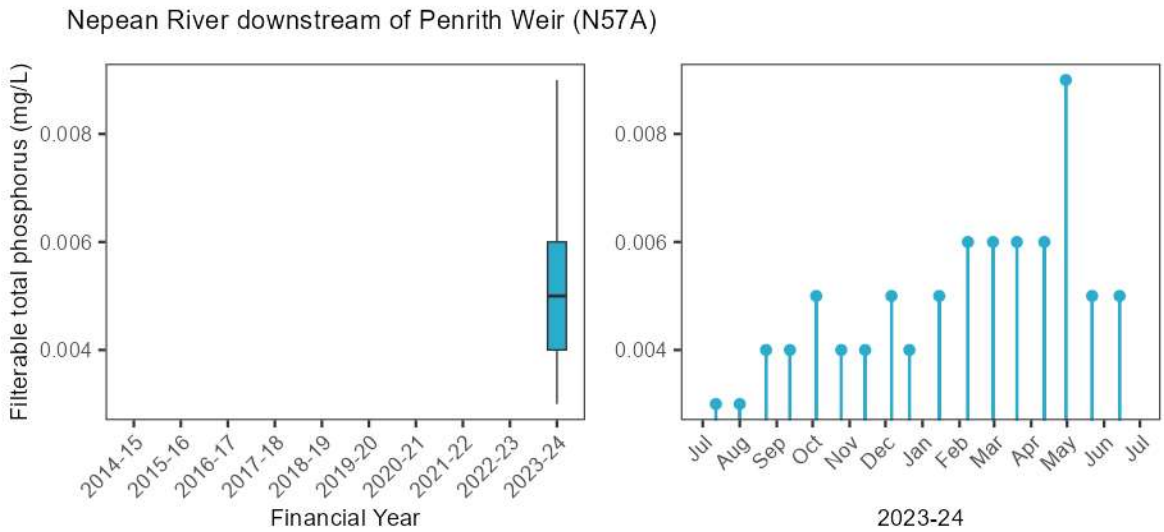
Stressors – nutrients

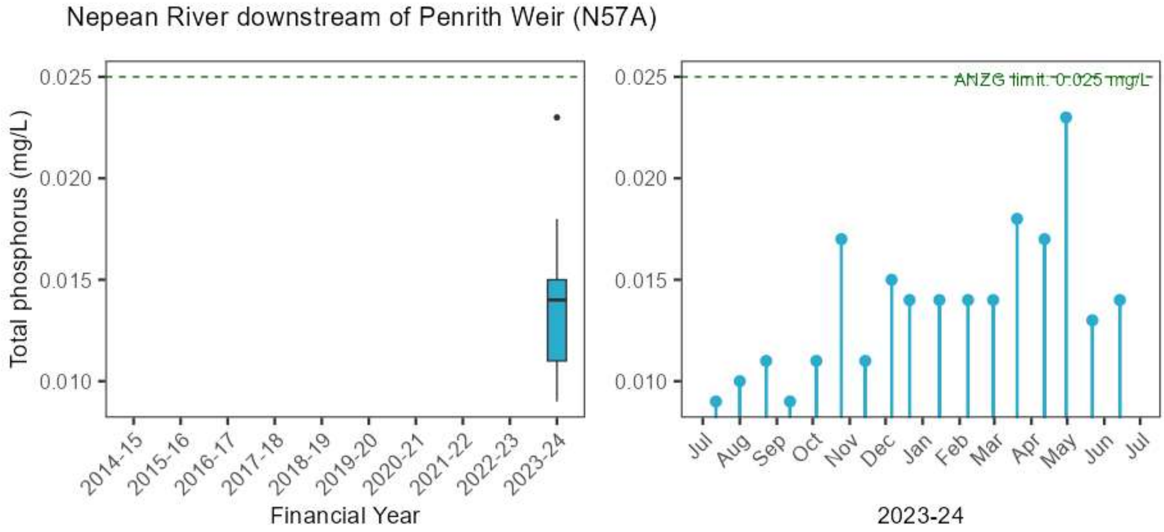




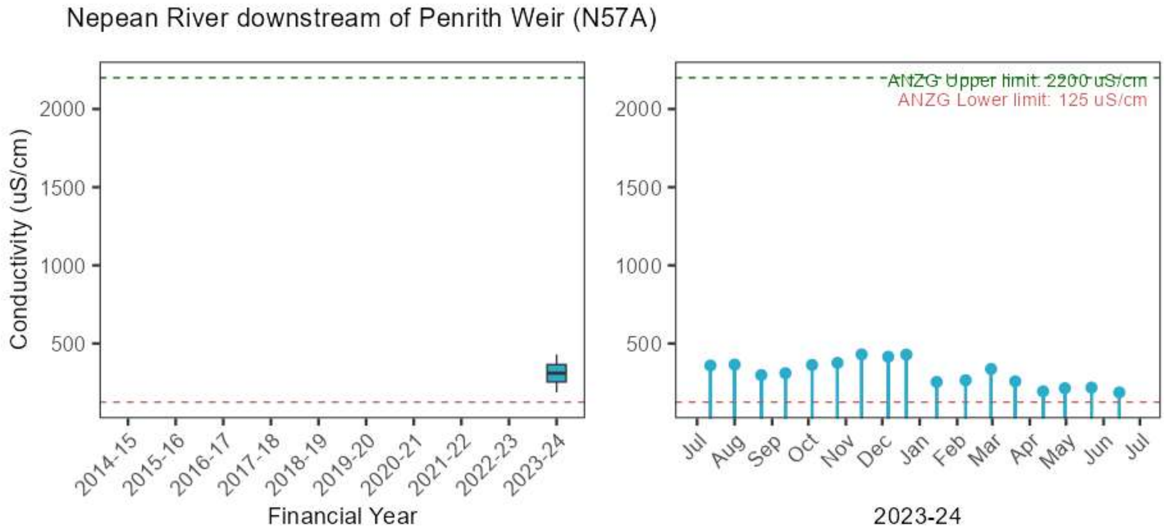

Nepean River downstream of Penrith Weir (N57A)
Total nitrogen (mg/L)
1.6
1.2
0.8
0.4
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.35 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

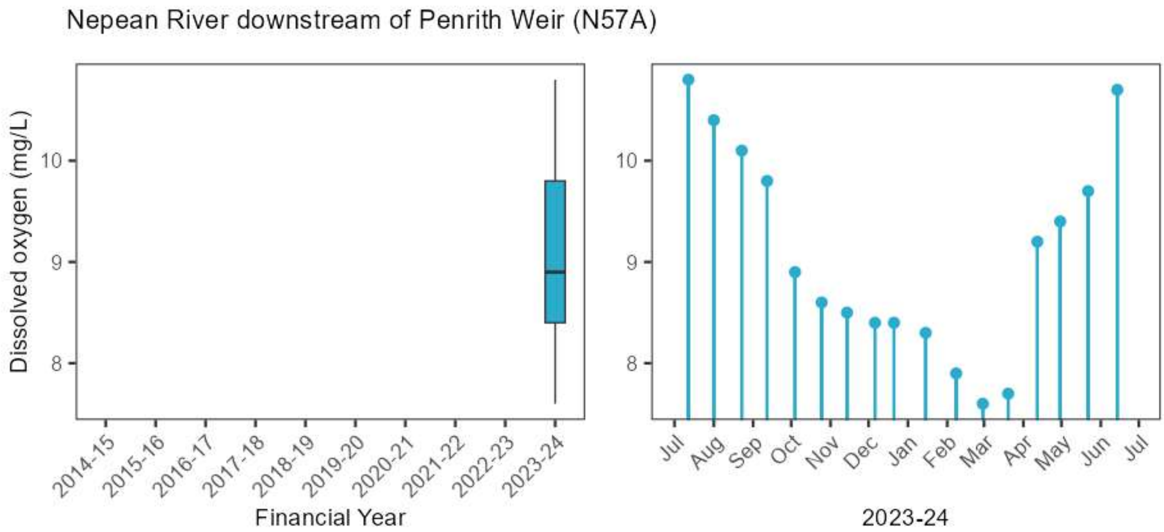

Nepean River downstream of Penrith Weir (N57A)
Soluble reactive phosphorus (mg/L)
0.012
0.008
0.004
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.015 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Nepean River downstream of Penrith Weir (N57A)
Filterable total phosphorus (mg/L)
0.008
0.006
0.004
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

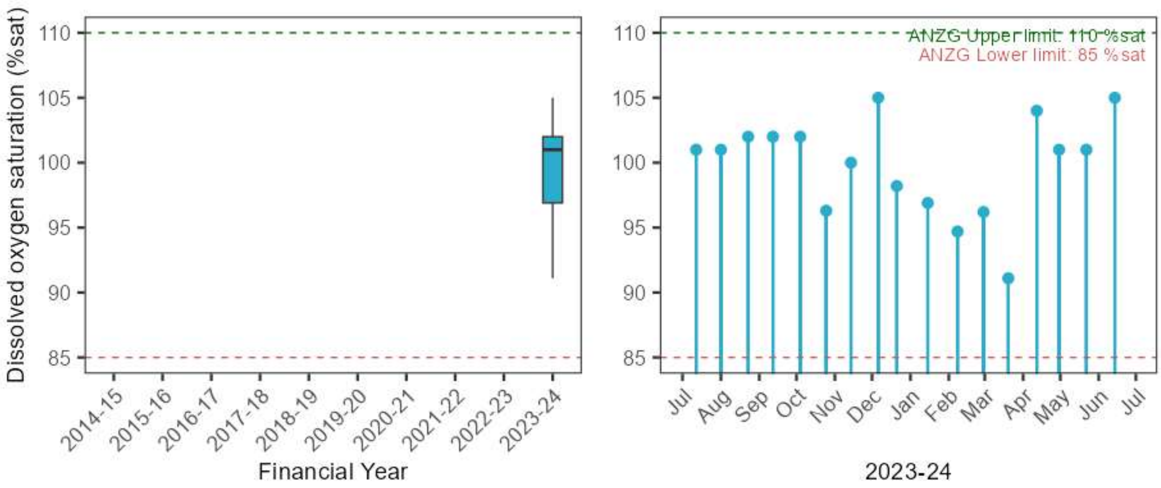


Stressors – Physico-chemical water quality

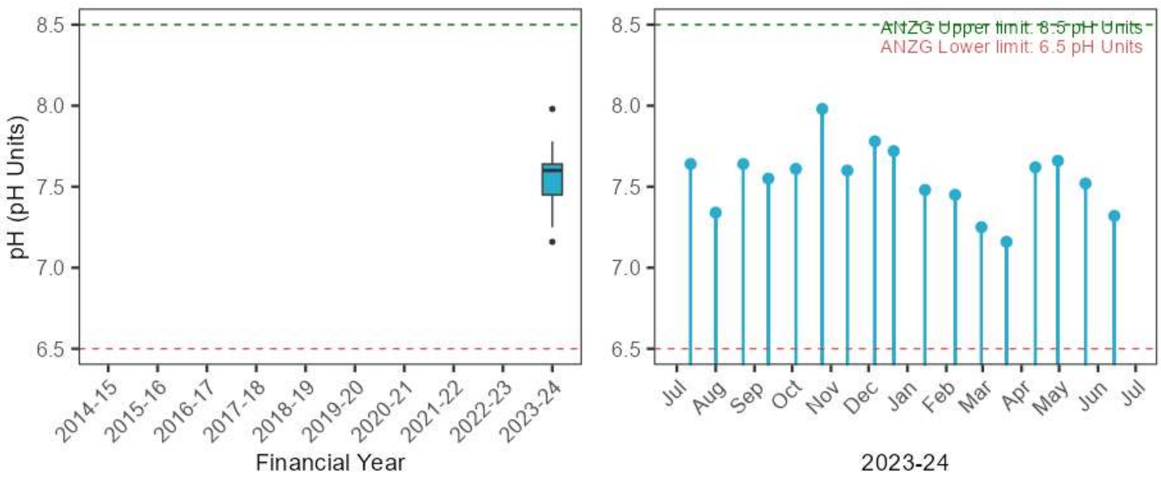




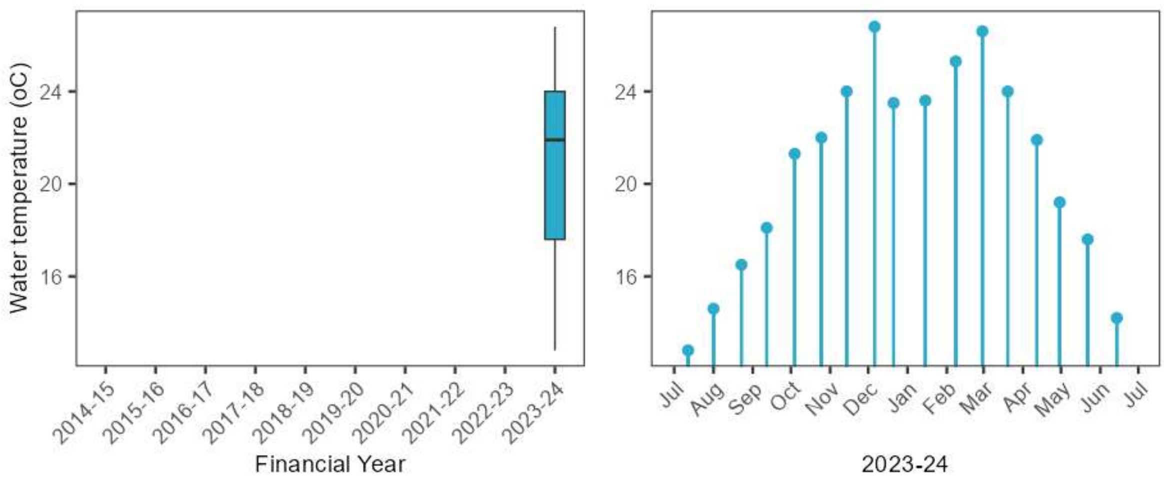
Nepean River downstream of Penrith Weir (N57A)

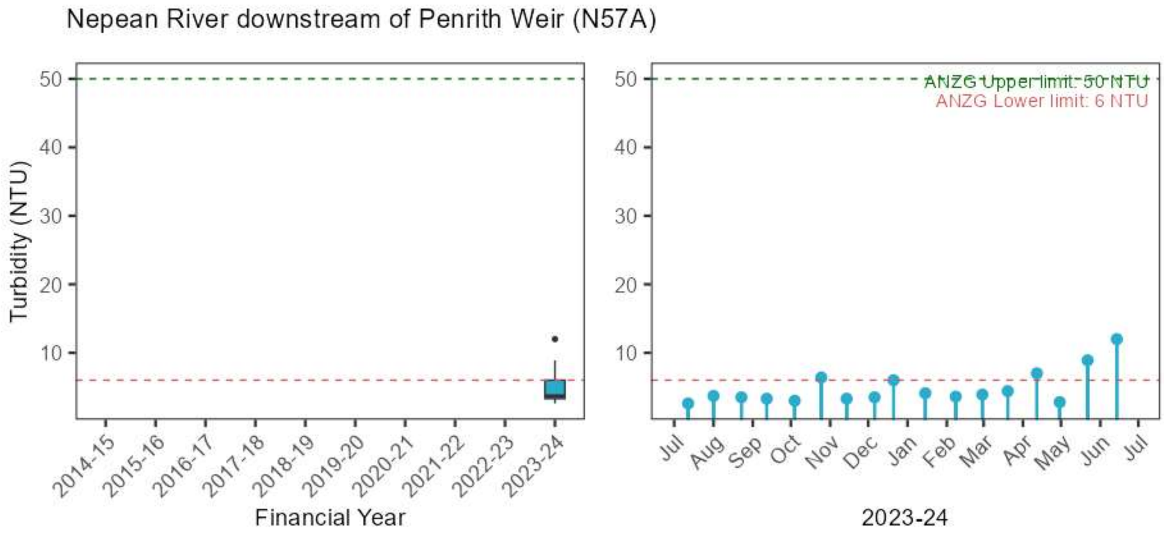


Nepean River downstream of Penrith Weir (N57A)

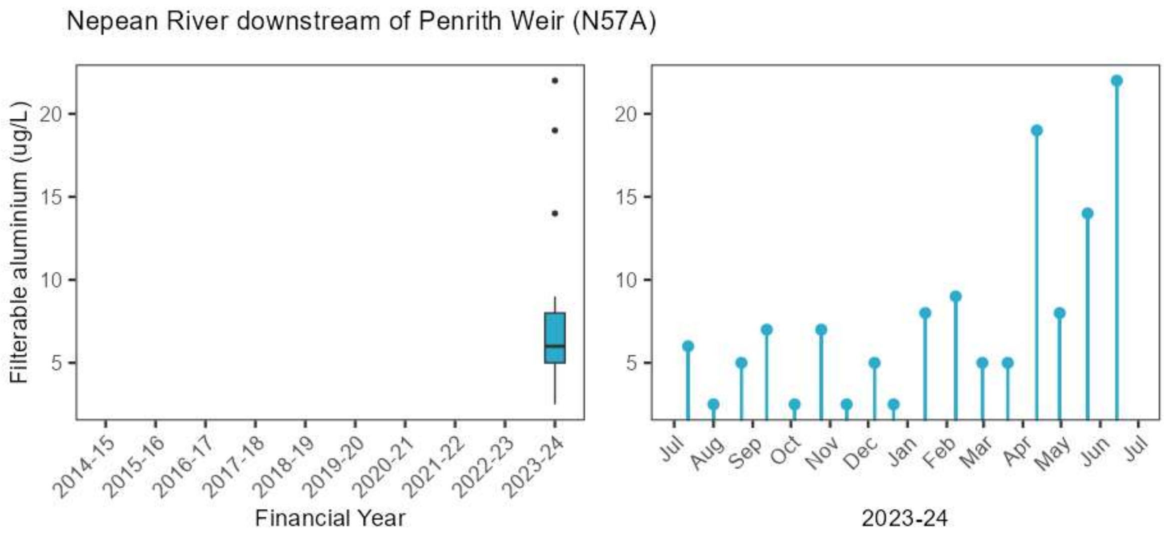


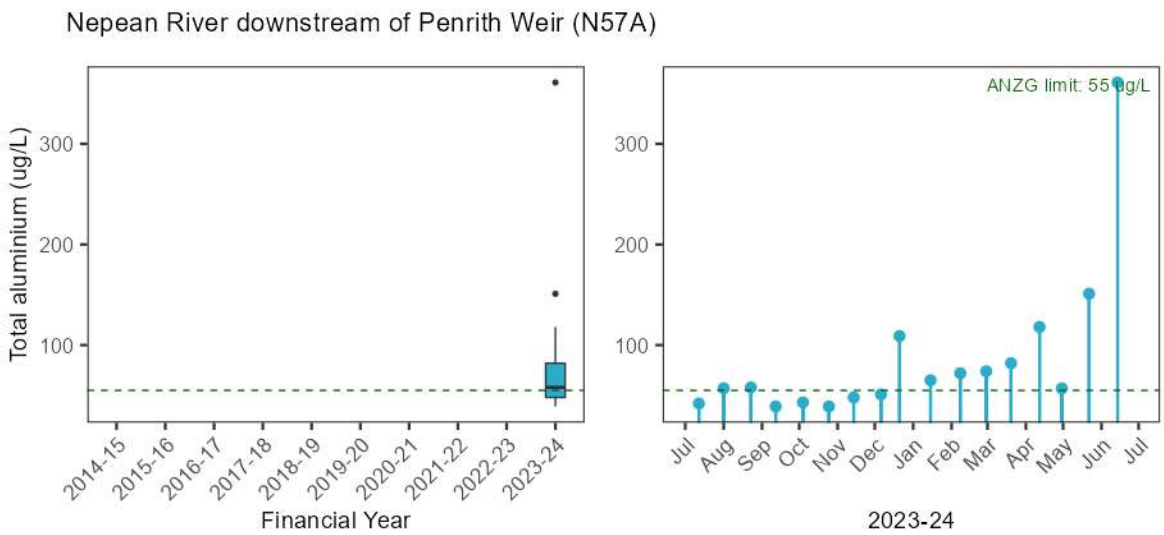
Nepean River downstream of Penrith Weir (N57A)



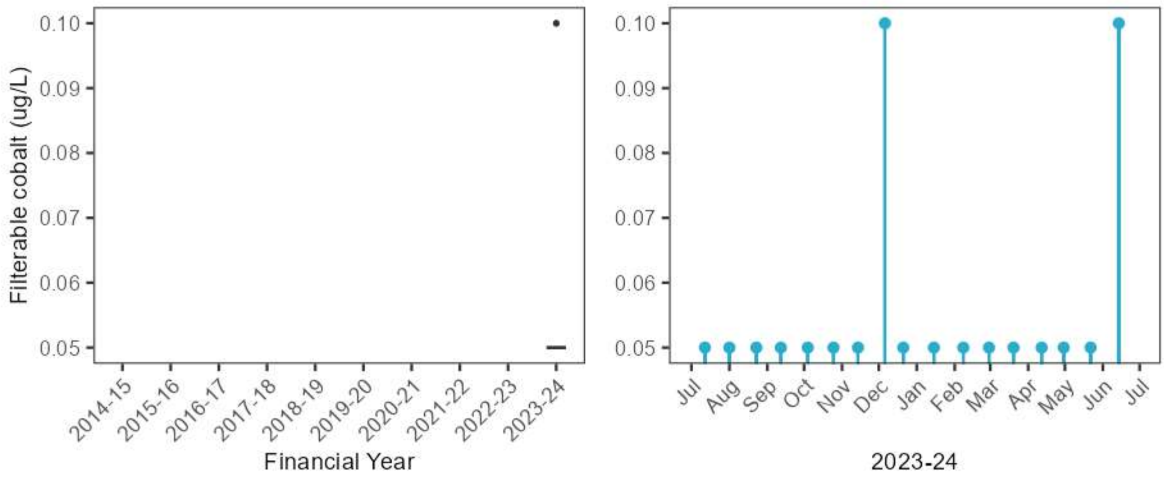


Stressors – Trace metals

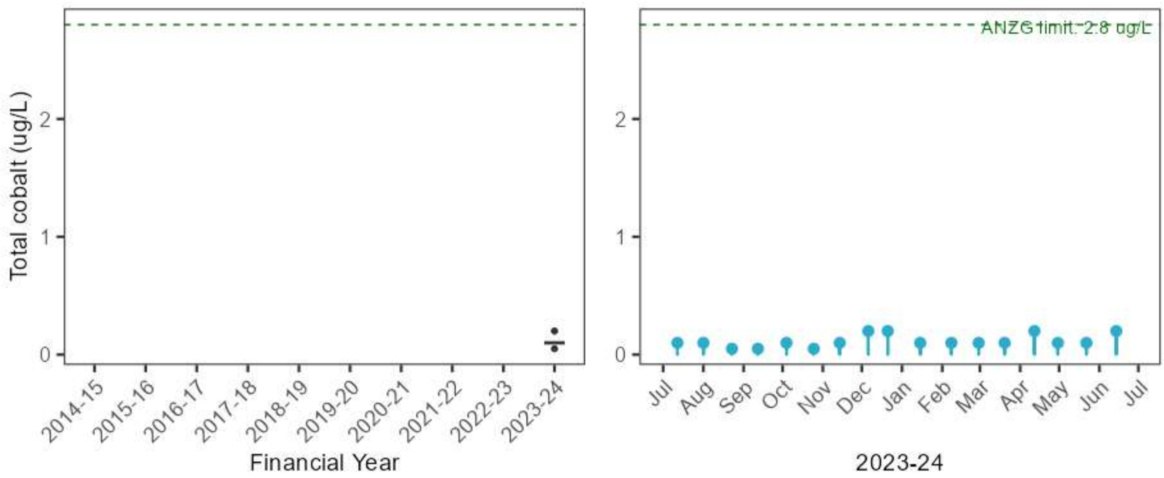




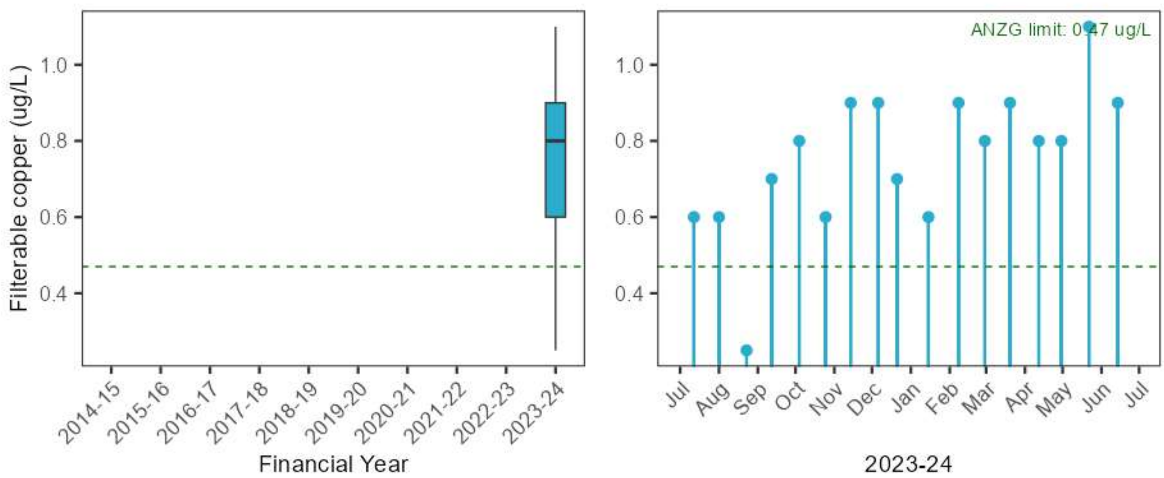
Nepean River downstream of Penrith Weir (N57A)



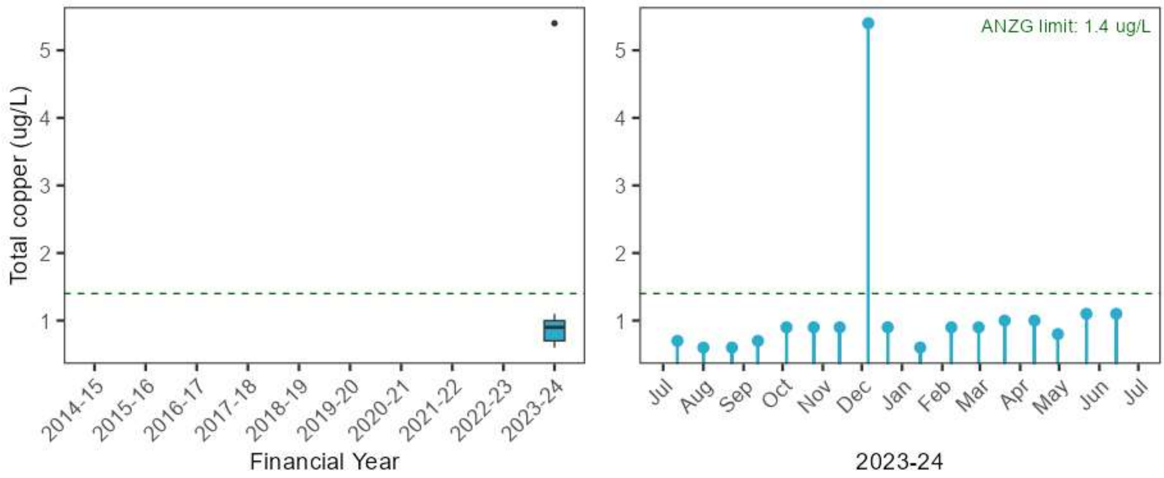
Nepean River downstream of Penrith Weir (N57A)



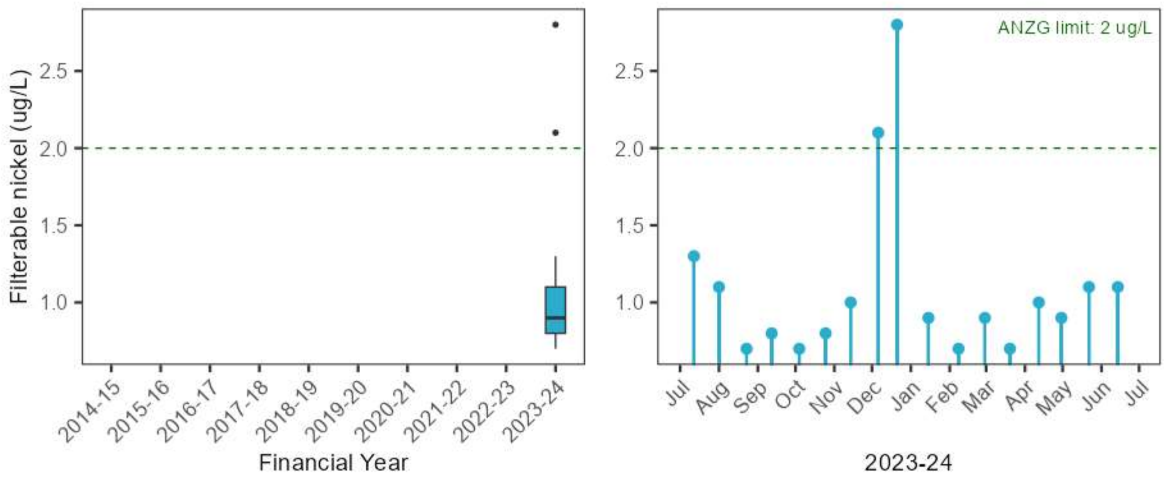
Nepean River downstream of Penrith Weir (N57A)



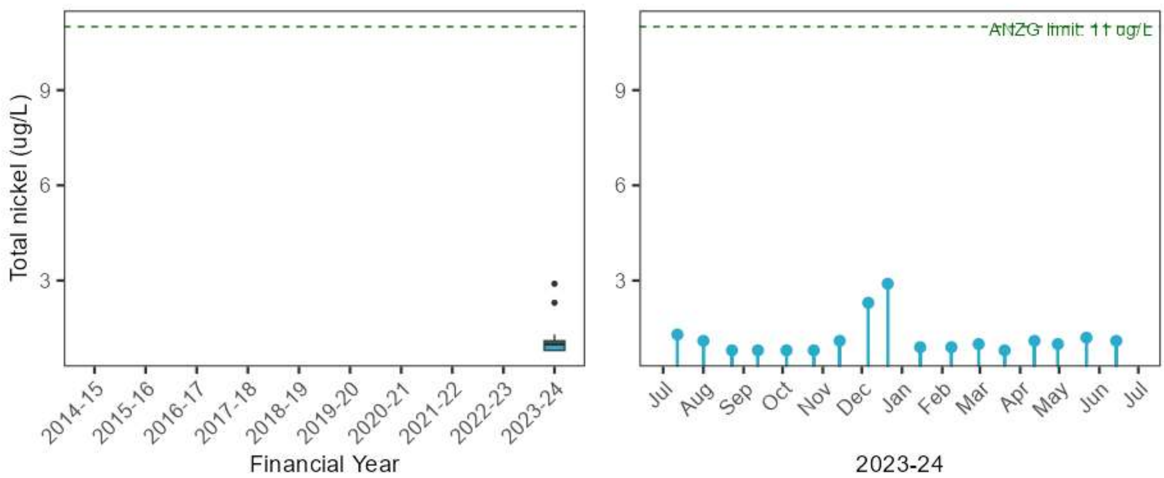
Nepean River downstream of Penrith Weir (N57A)



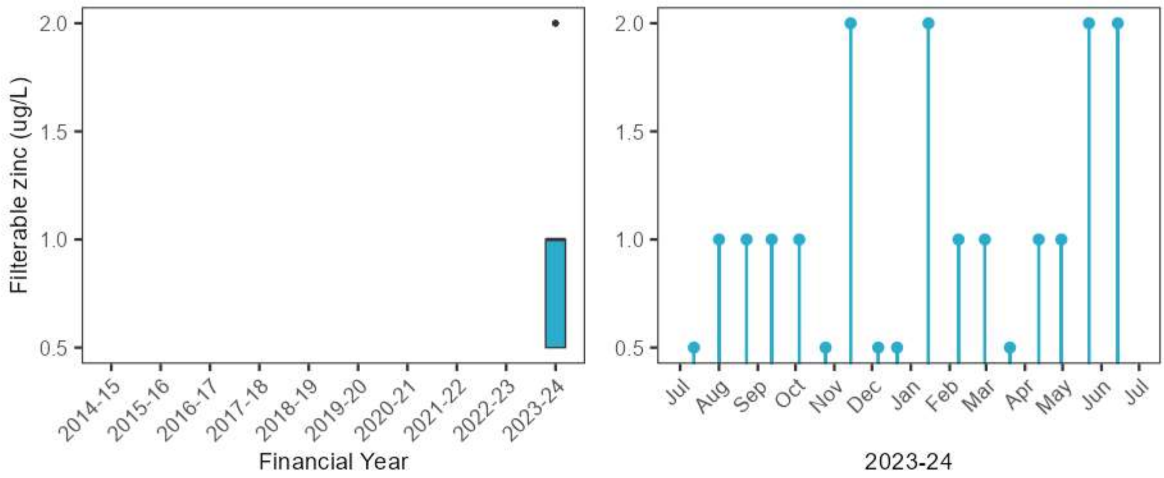
Nepean River downstream of Penrith Weir (N57A)



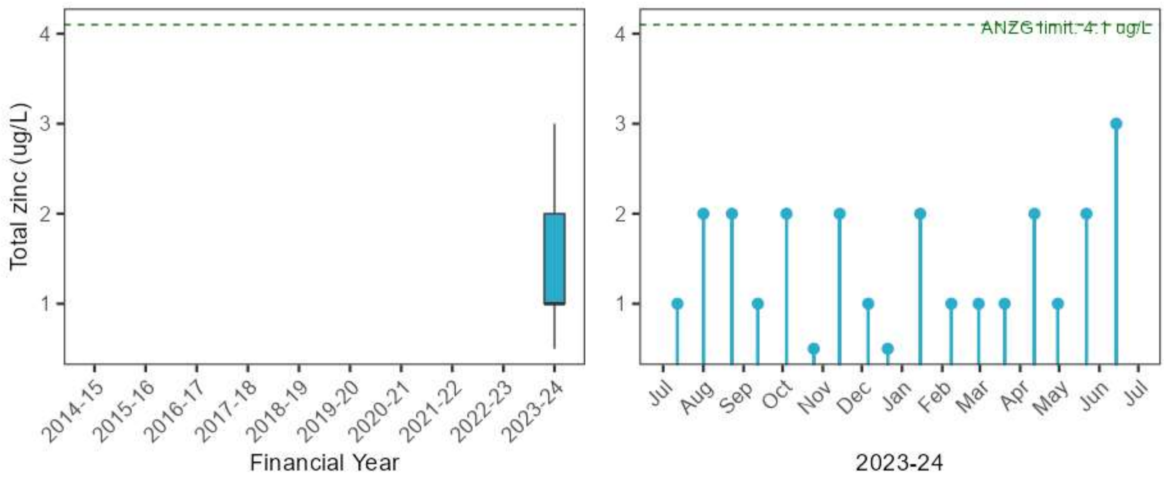
Nepean River downstream of Penrith Weir (N57A)



Nepean River downstream of Penrith Weir (N57A)



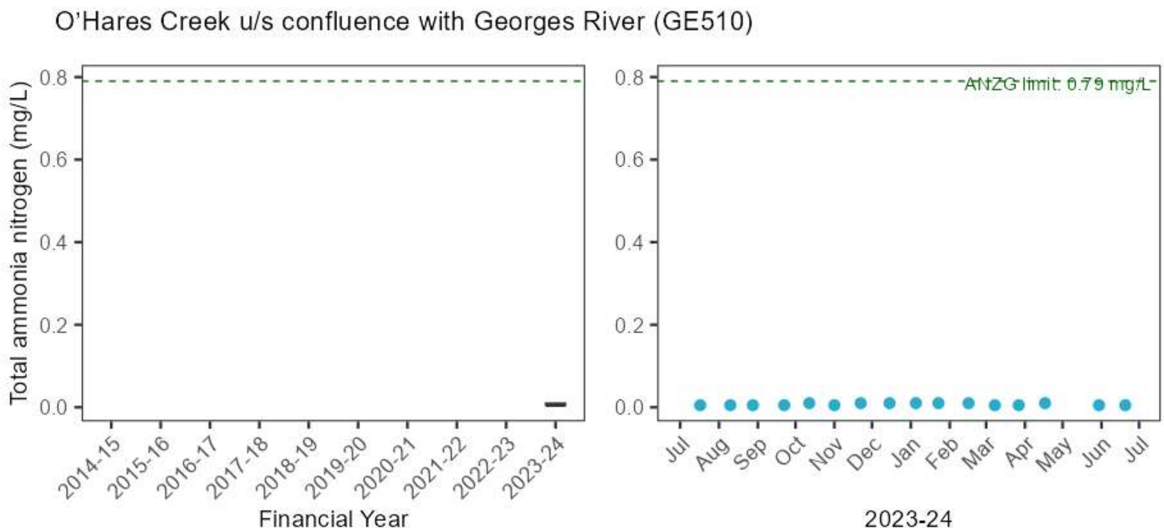
Nepean River downstream of Penrith Weir (N57A)

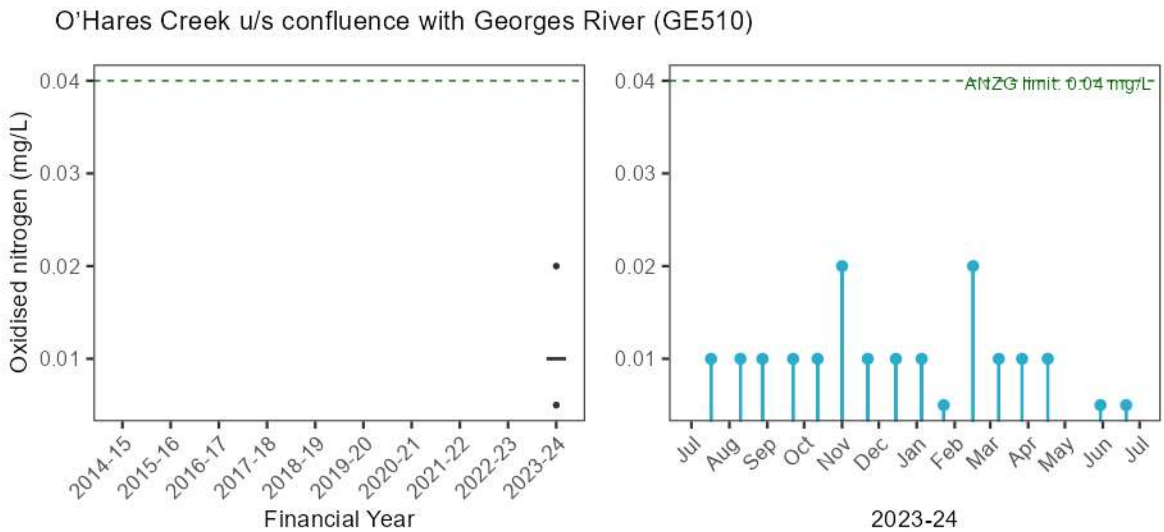


C.3. Water quality – freshwater reference sites

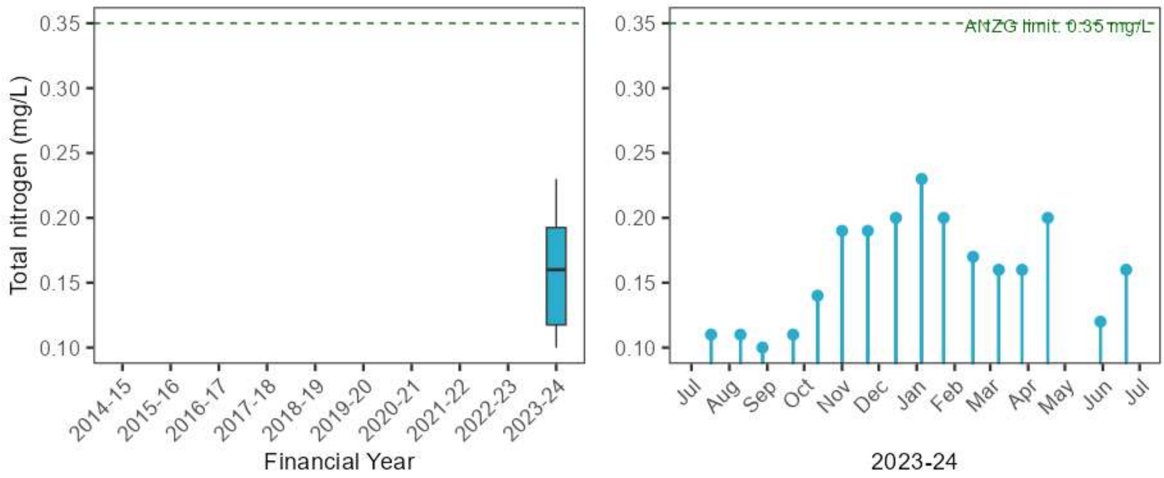
C.3.1. GE510 O'Hares Creek u/s confluence with Georges River

Stressors – Nutrients

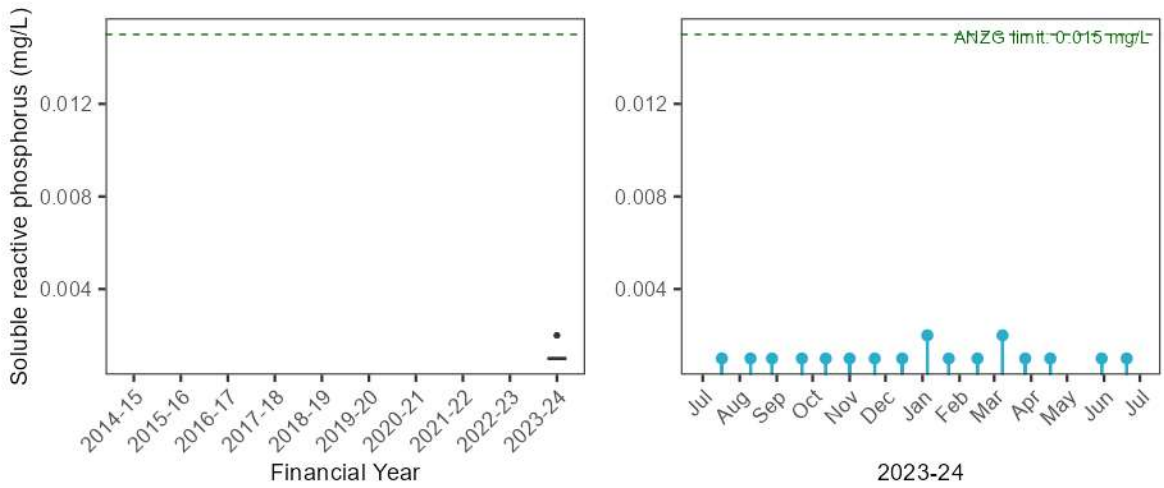




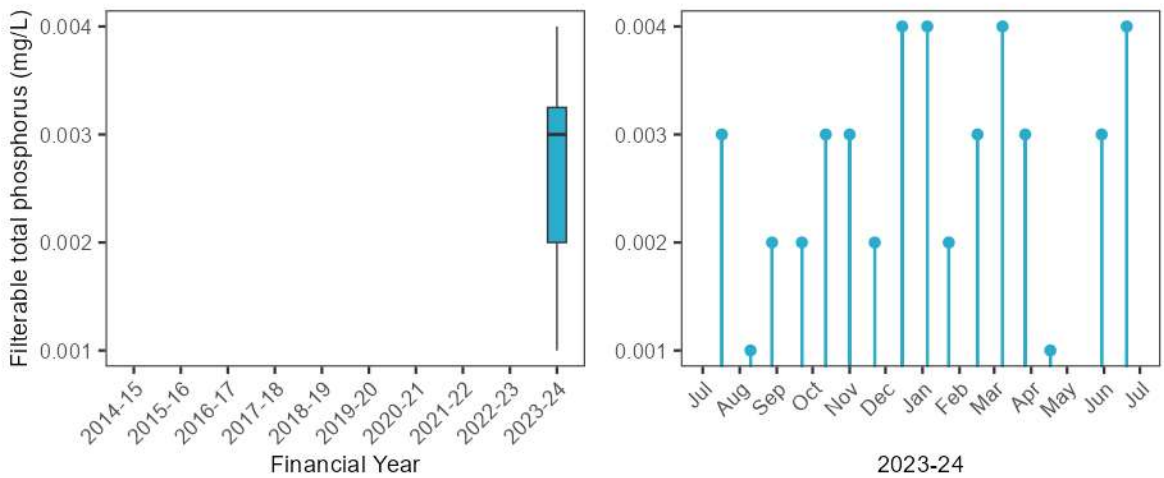
O'Hares Creek u/s confluence with Georges River (GE510)

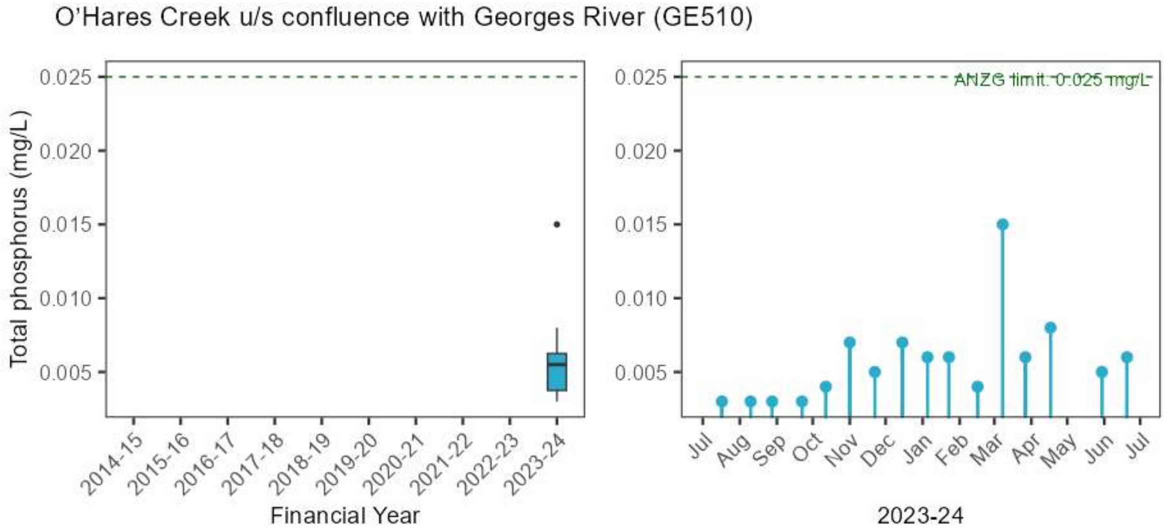


O'Hares Creek u/s confluence with Georges River (GE510)

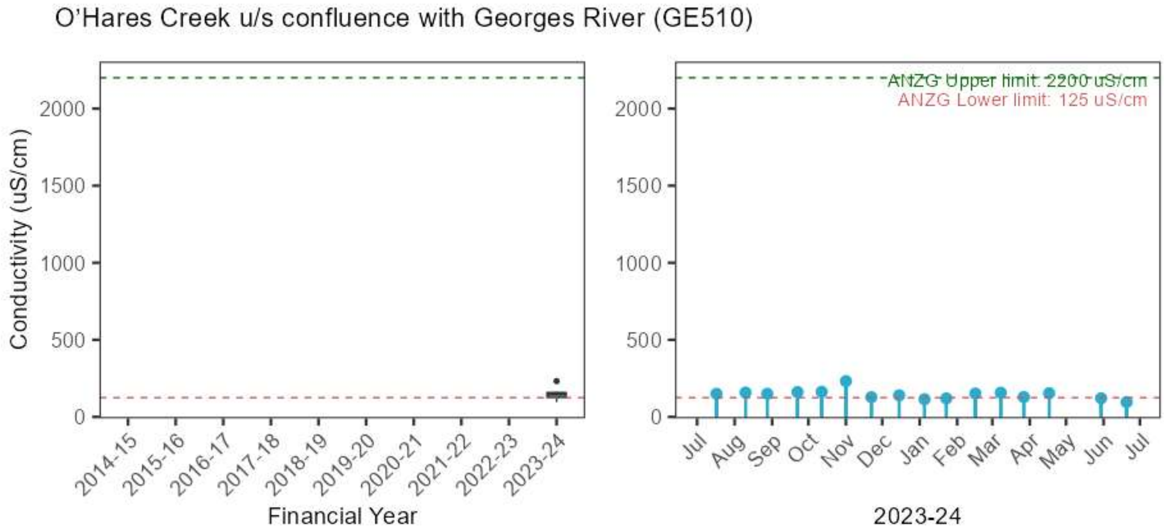


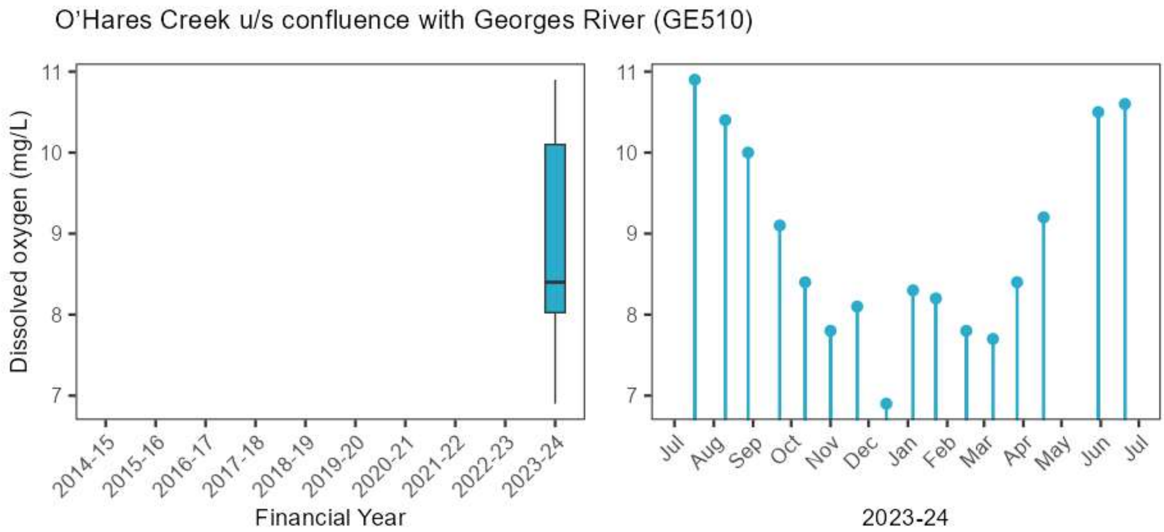
O'Hares Creek u/s confluence with Georges River (GE510)



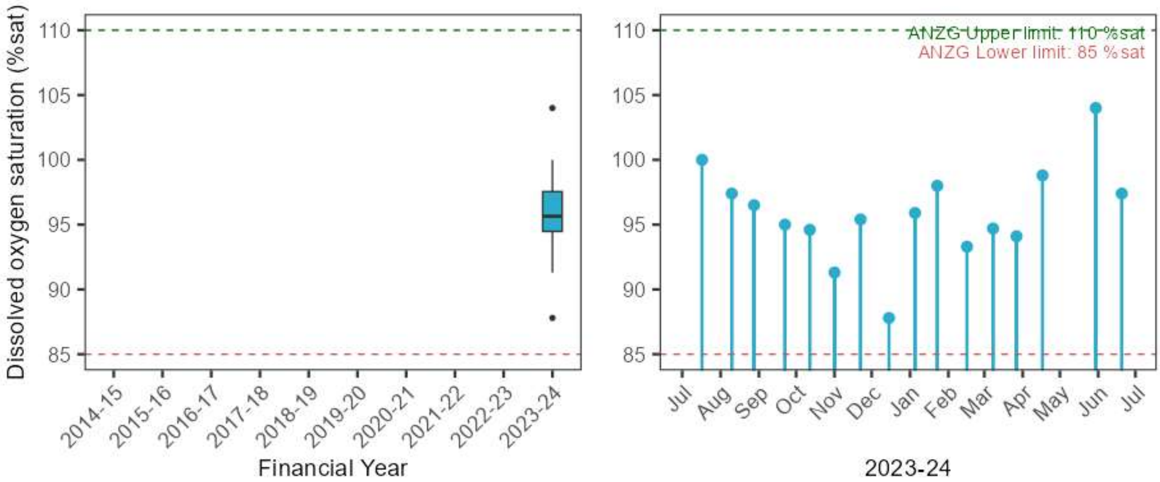


Stressors – Physico-chemical water quality

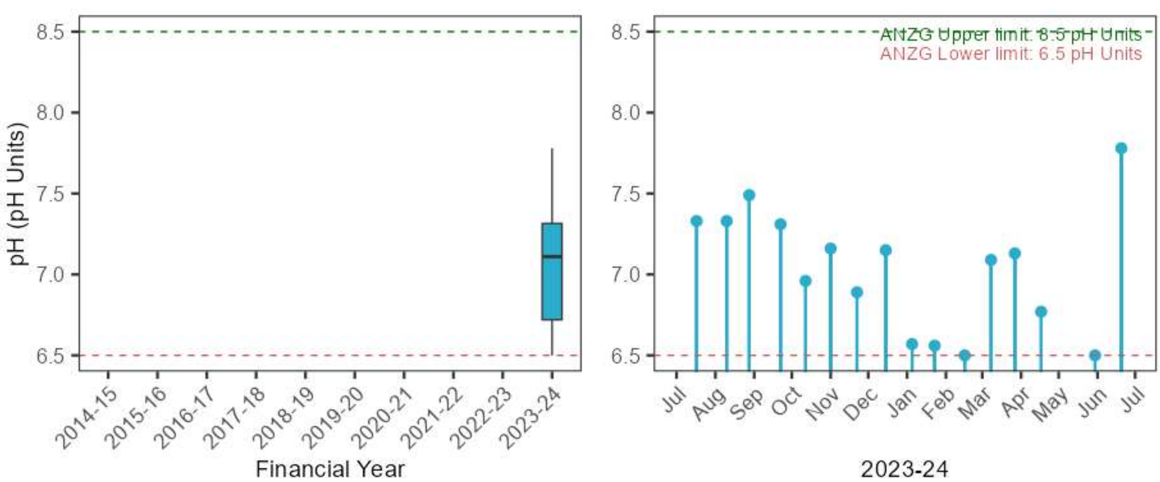




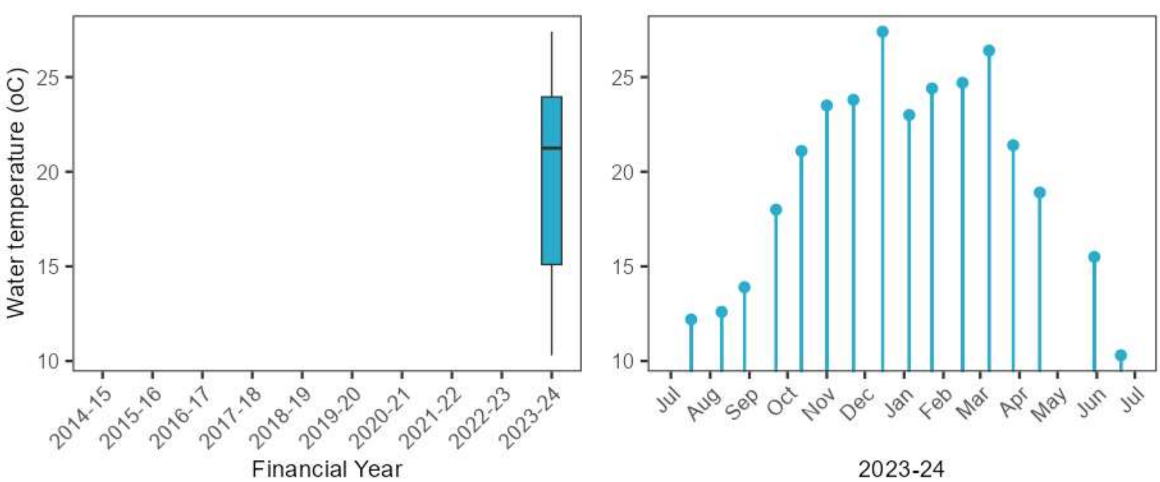
O'Hares Creek u/s confluence with Georges River (GE510)

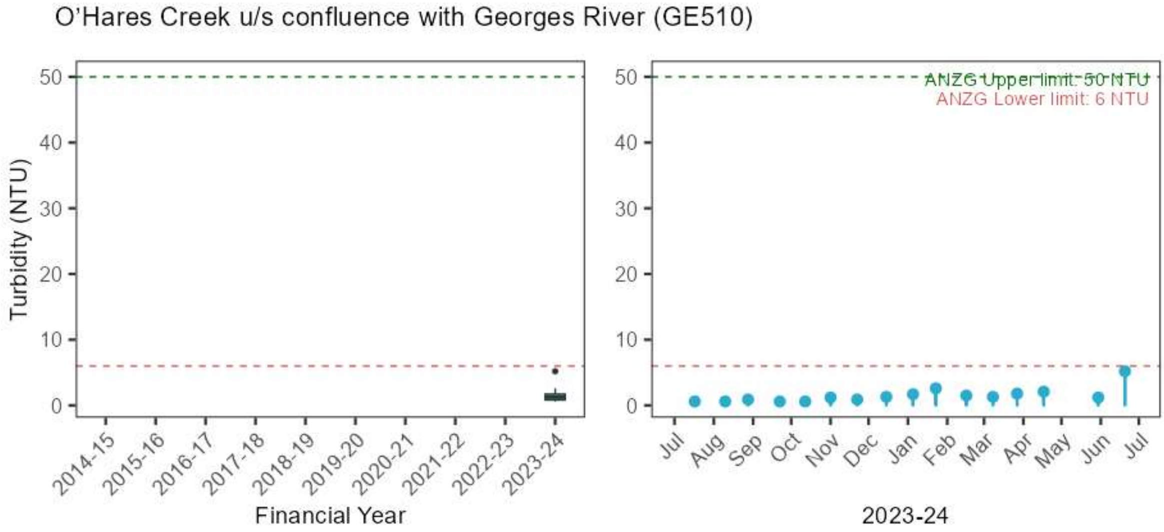


O'Hares Creek u/s confluence with Georges River (GE510)

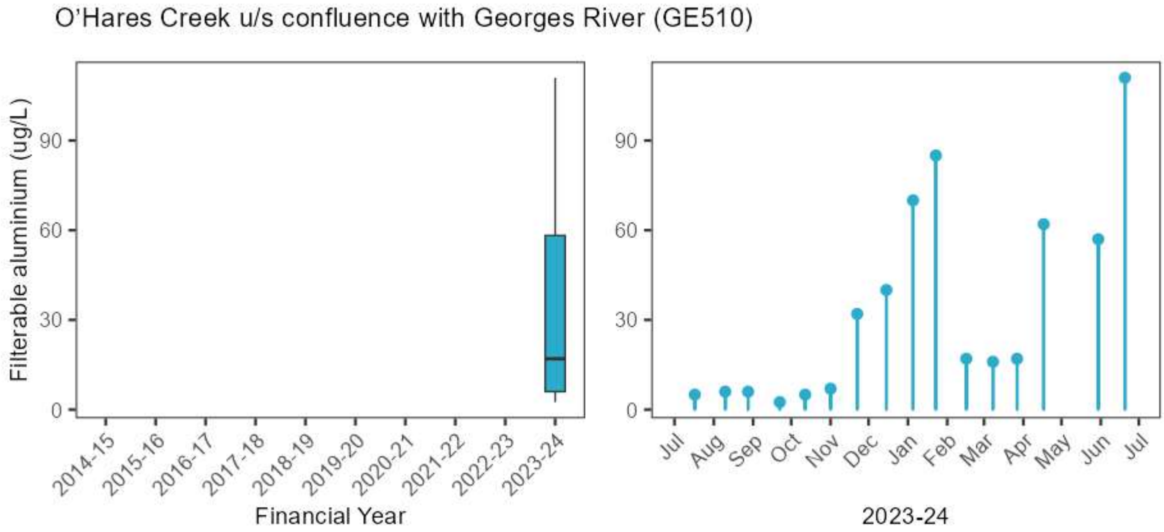


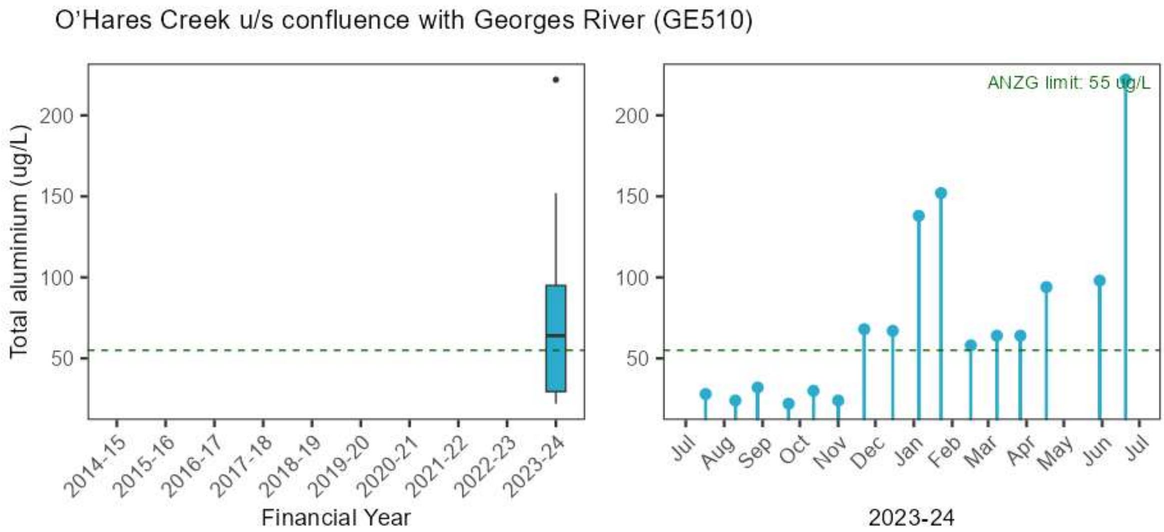
O'Hares Creek u/s confluence with Georges River (GE510)



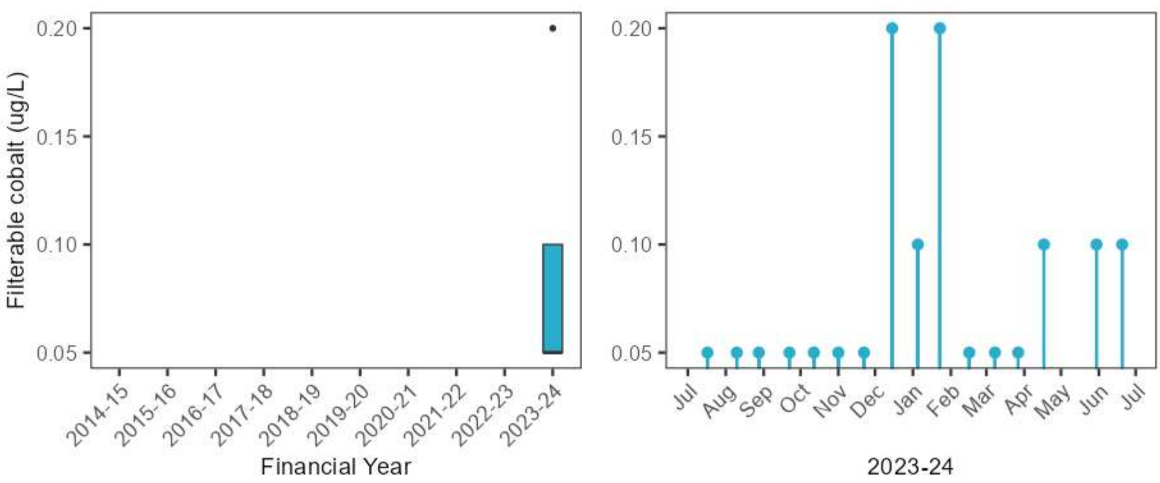


Stressors – Trace metals

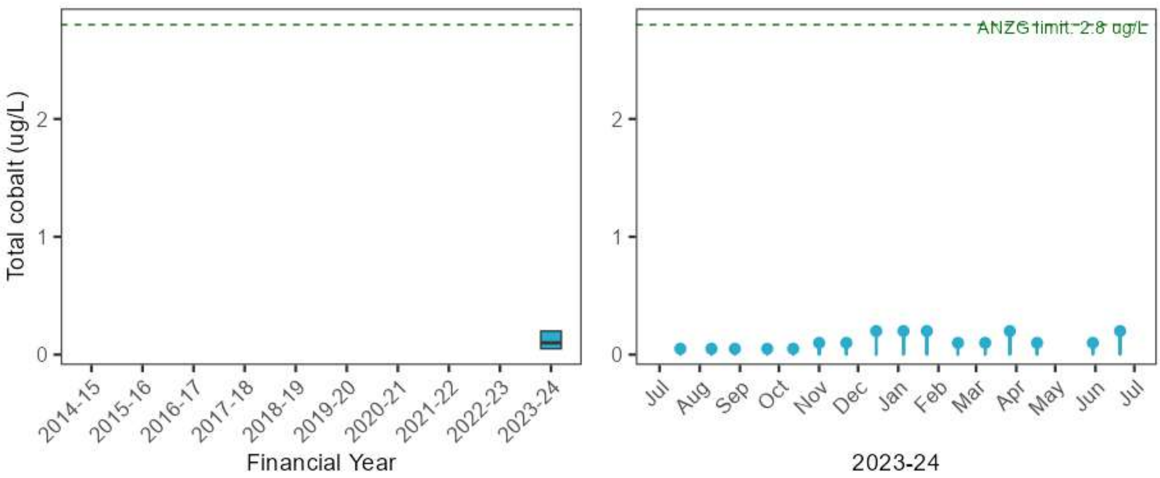




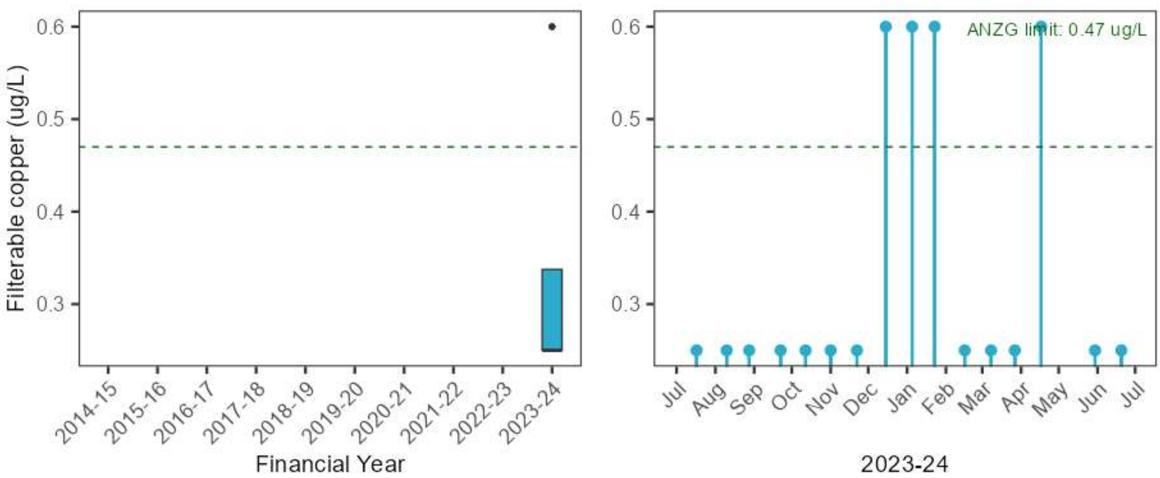
O'Hares Creek u/s confluence with Georges River (GE510)



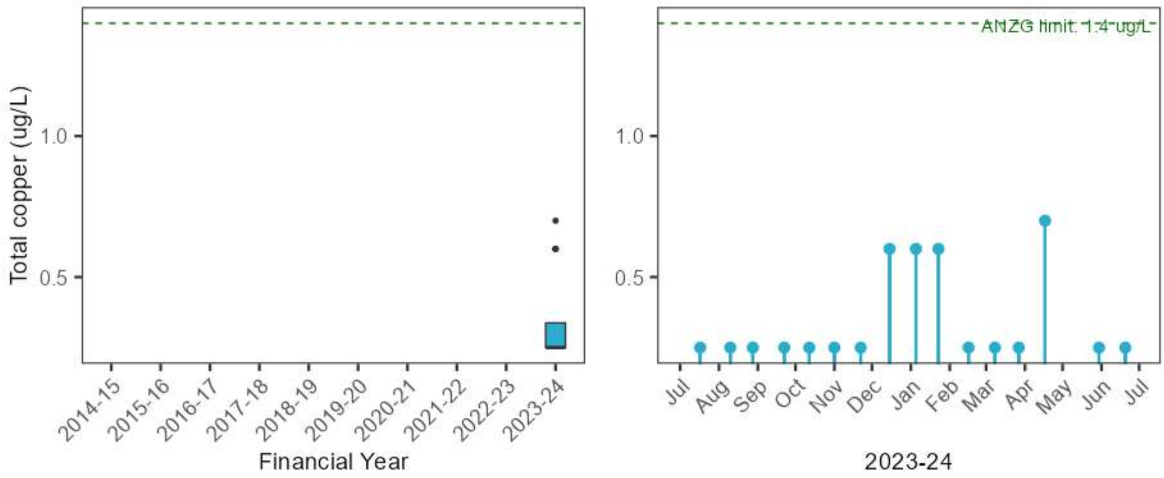
O'Hares Creek u/s confluence with Georges River (GE510)



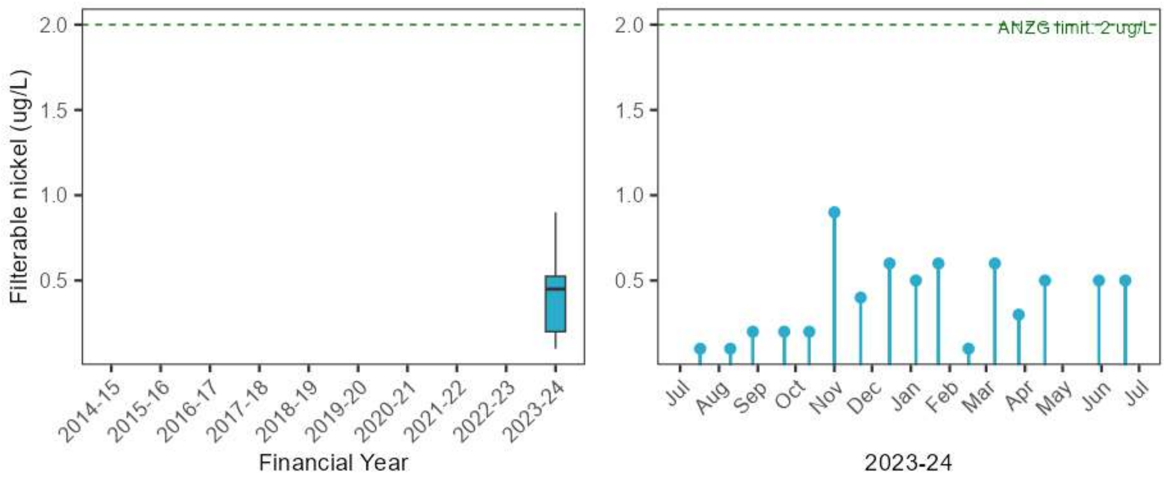
O'Hares Creek u/s confluence with Georges River (GE510)



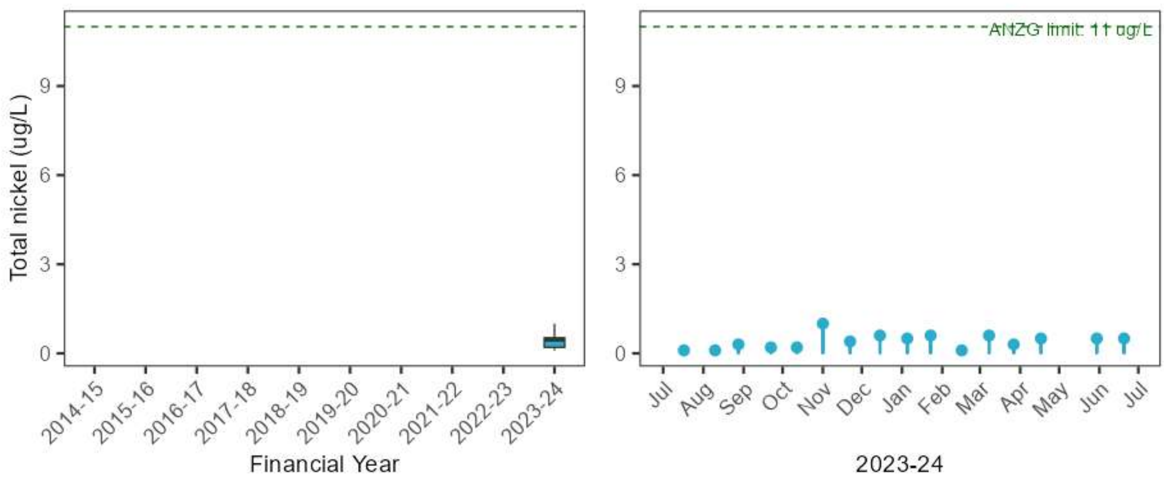
O’Hares Creek u/s confluence with Georges River (GE510)



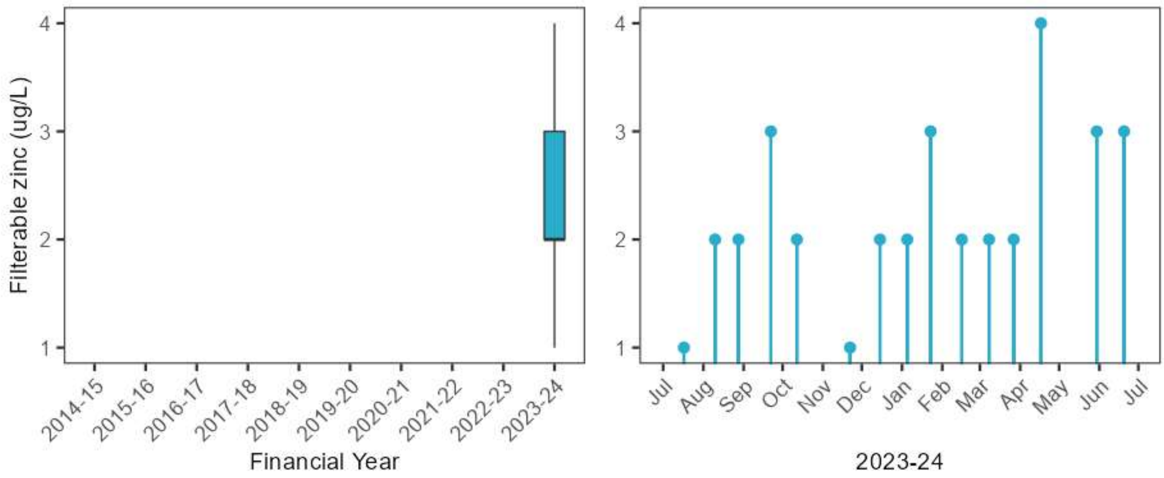
O’Hares Creek u/s confluence with Georges River (GE510)



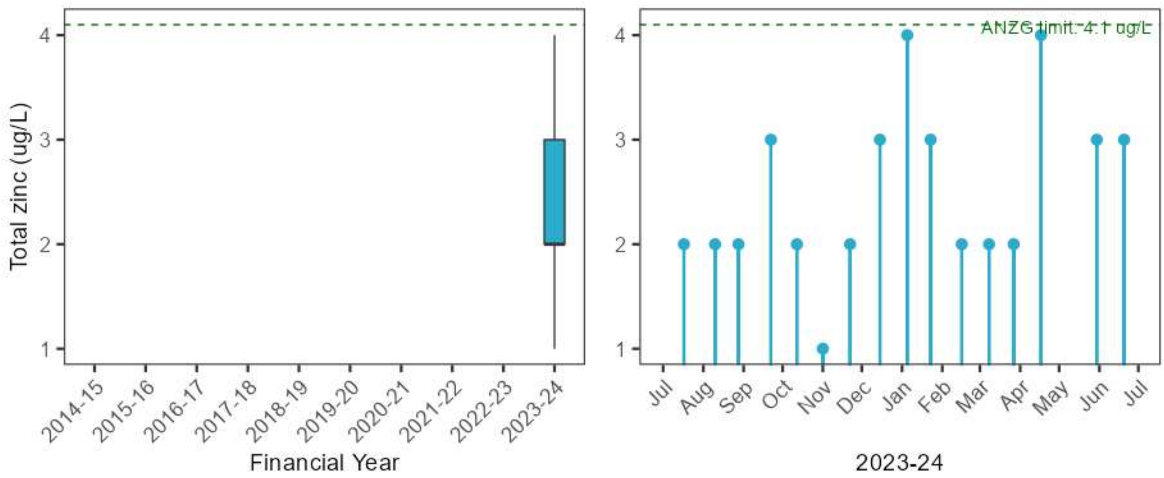
O’Hares Creek u/s confluence with Georges River (GE510)



O'Hares Creek u/s confluence with Georges River (GE510)

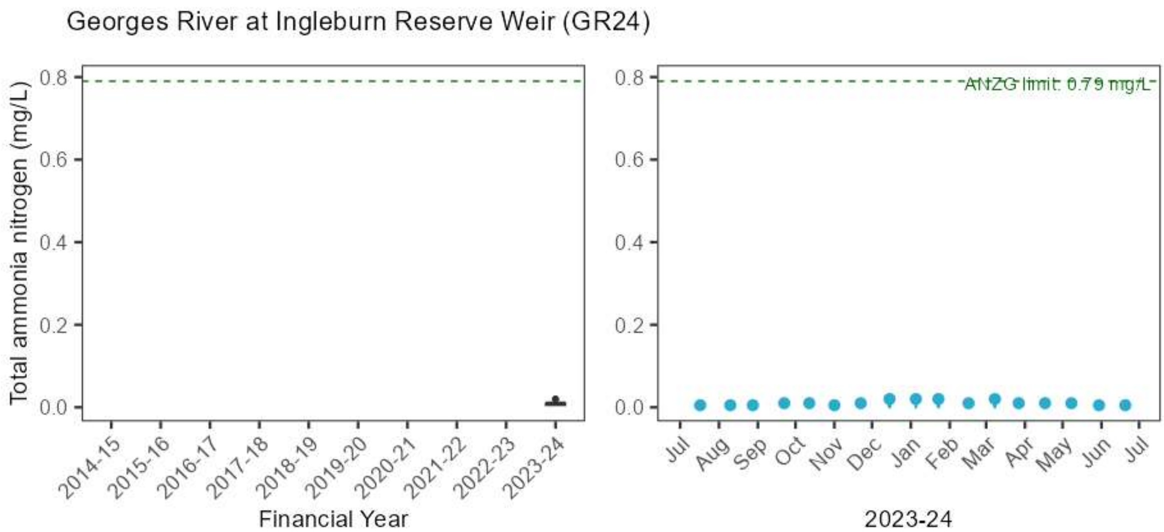


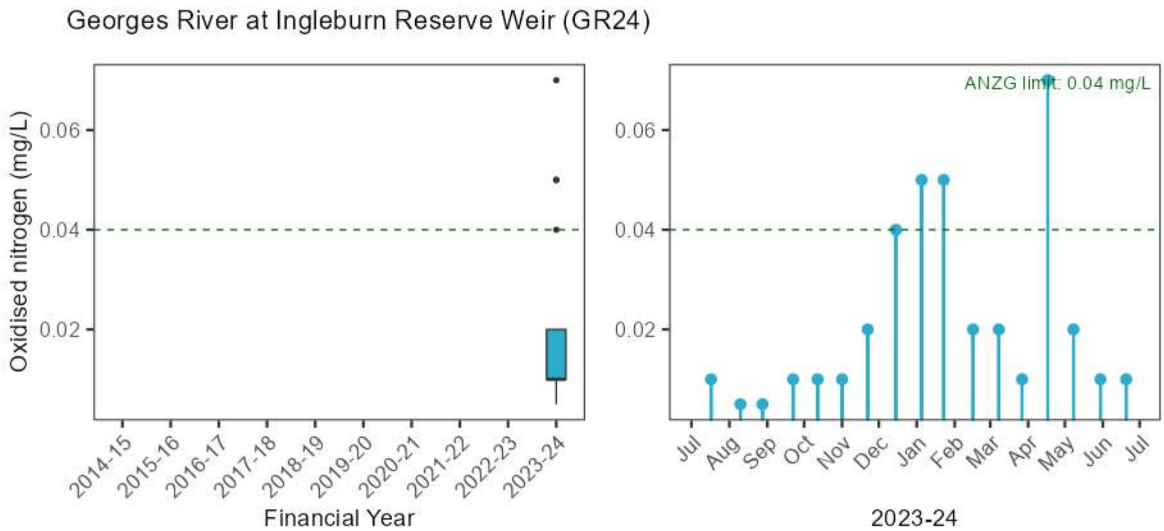
O'Hares Creek u/s confluence with Georges River (GE510)

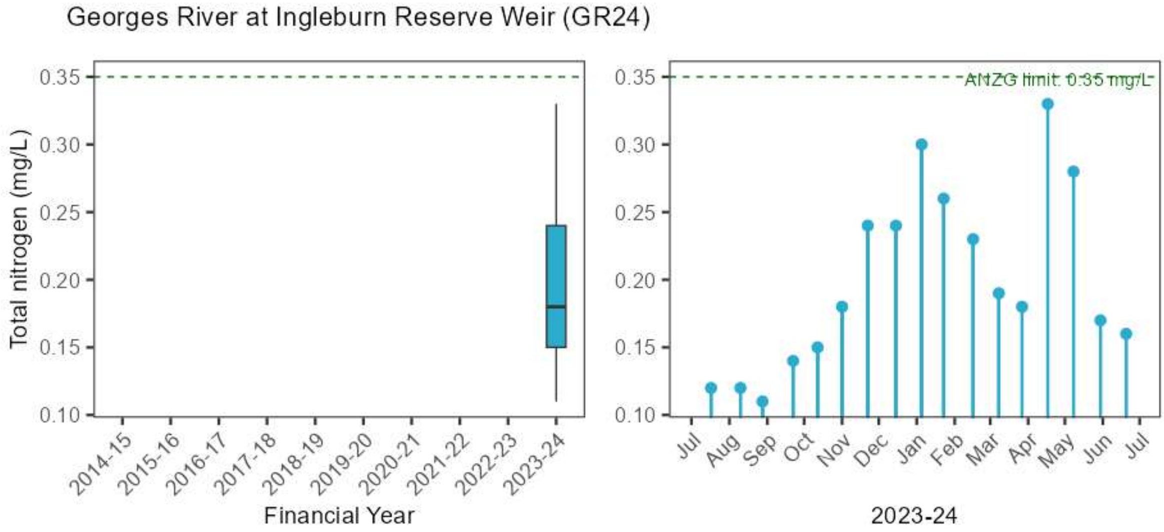


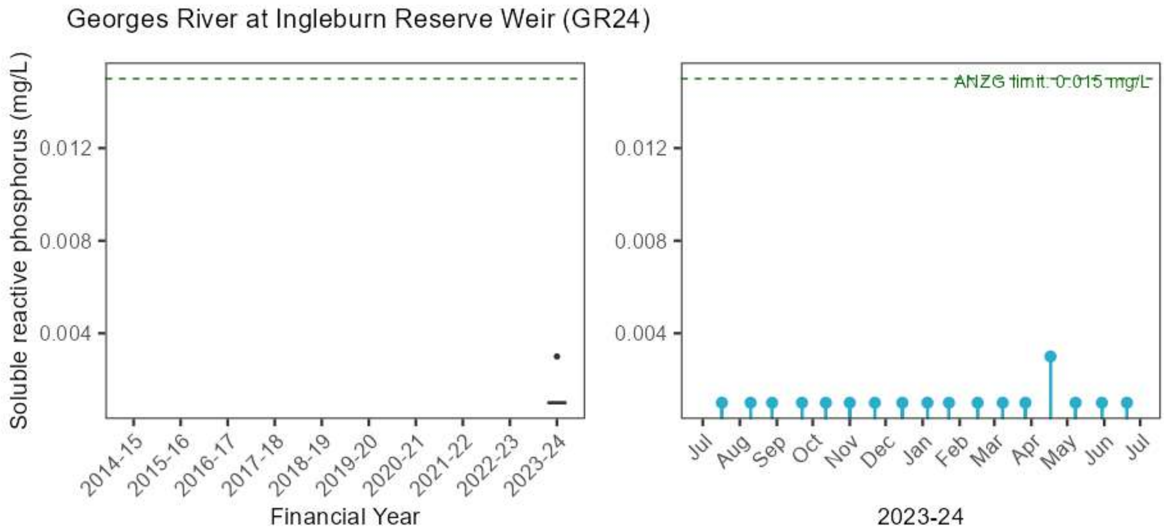
C.3.2. GR24 Georges River at Ingleburn Reserve Weir

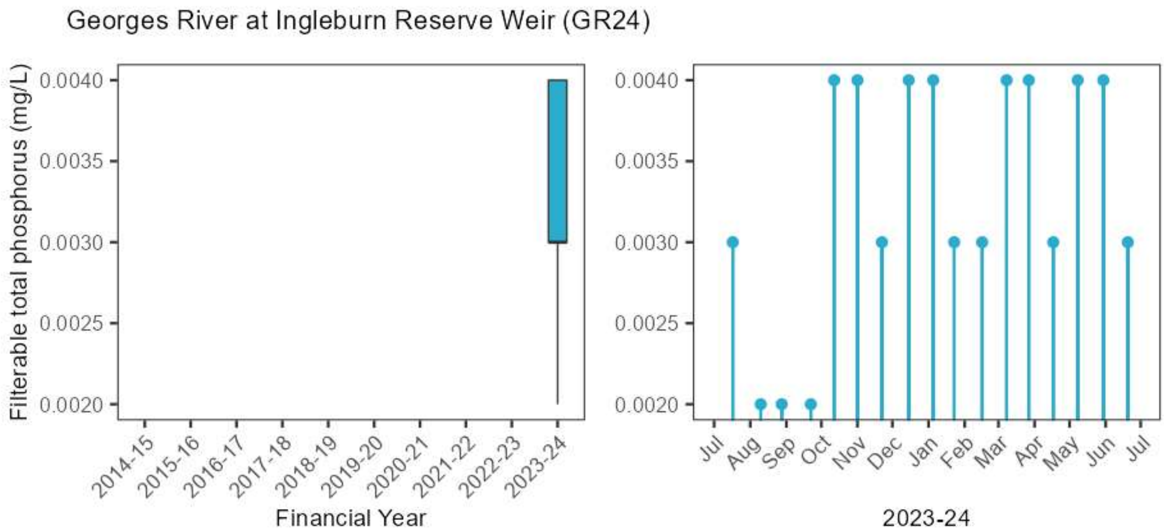
Stressors – Nutrients

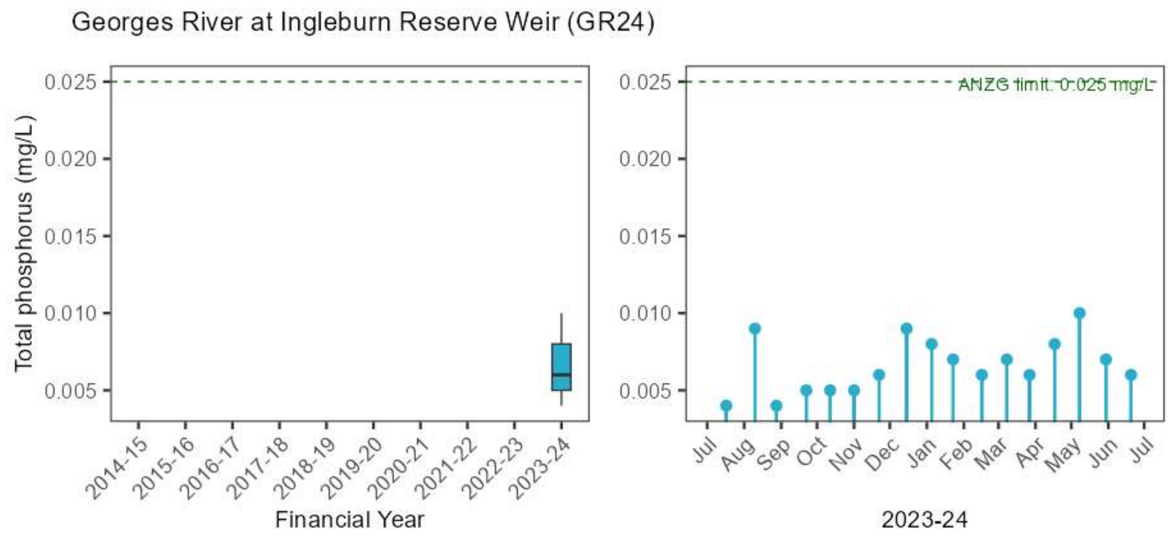




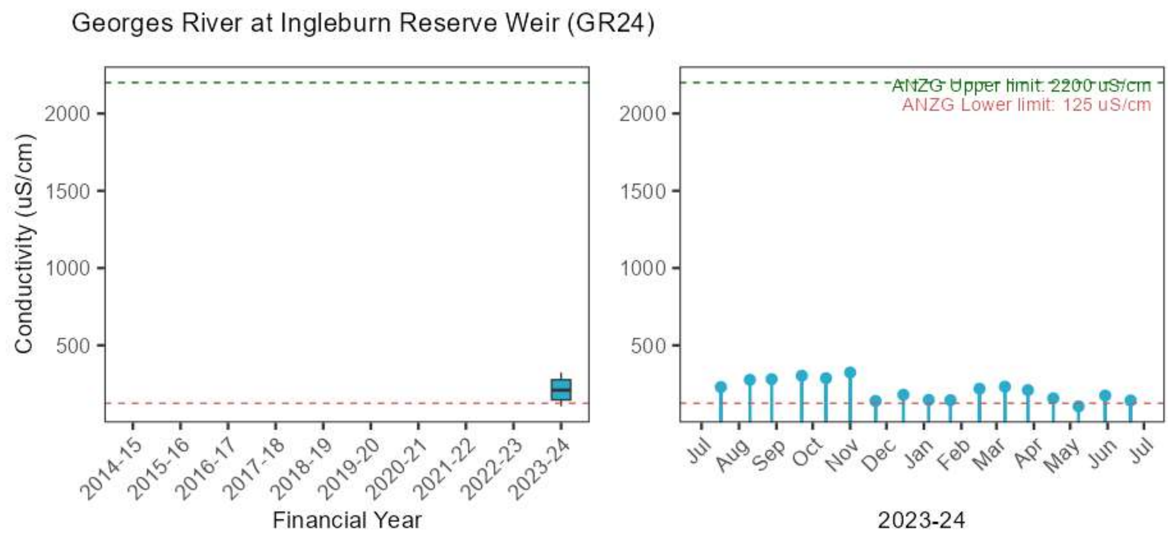

Georges River at Ingleburn Reserve Weir (GR24)
Total nitrogen (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.35 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

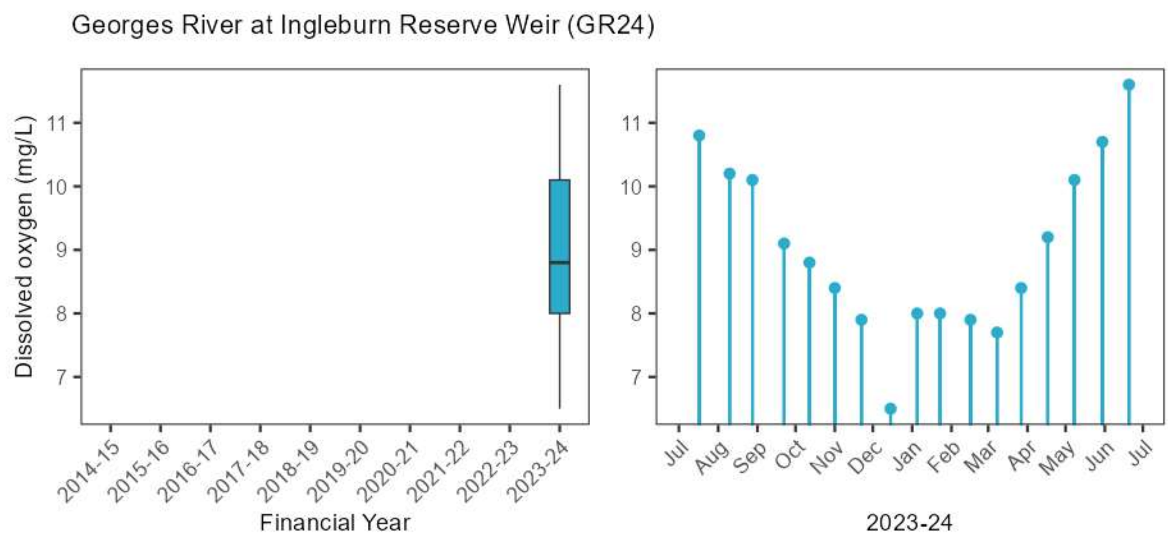

Georges River at Ingleburn Reserve Weir (GR24)
Soluble reactive phosphorus (mg/L)
0.012
0.008
0.004
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.015 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Georges River at Ingleburn Reserve Weir (GR24)
Filterable total phosphorus (mg/L)
0.0040
0.0035
0.0030
0.0025
0.0020
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

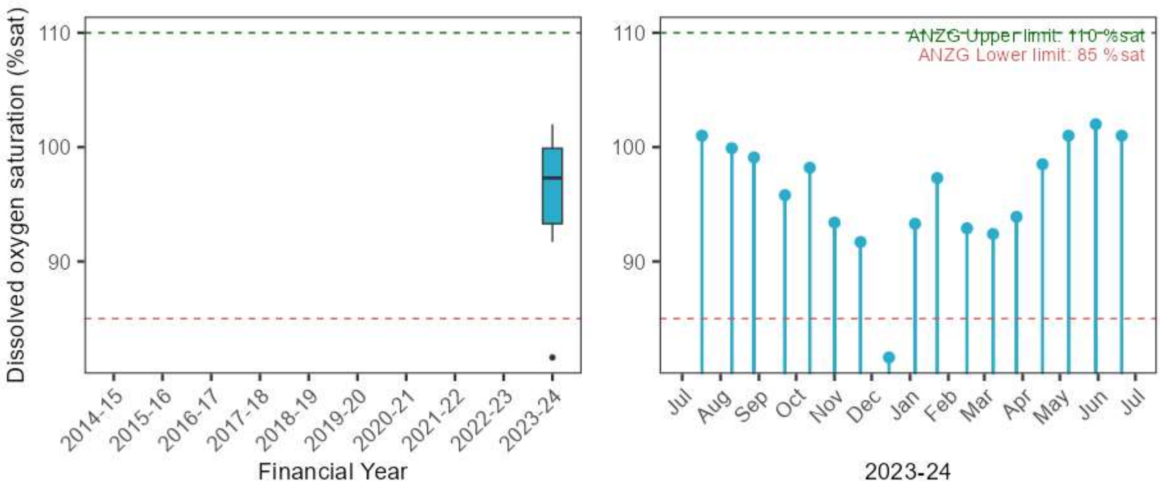


Stressors – Physico-chemical water quality

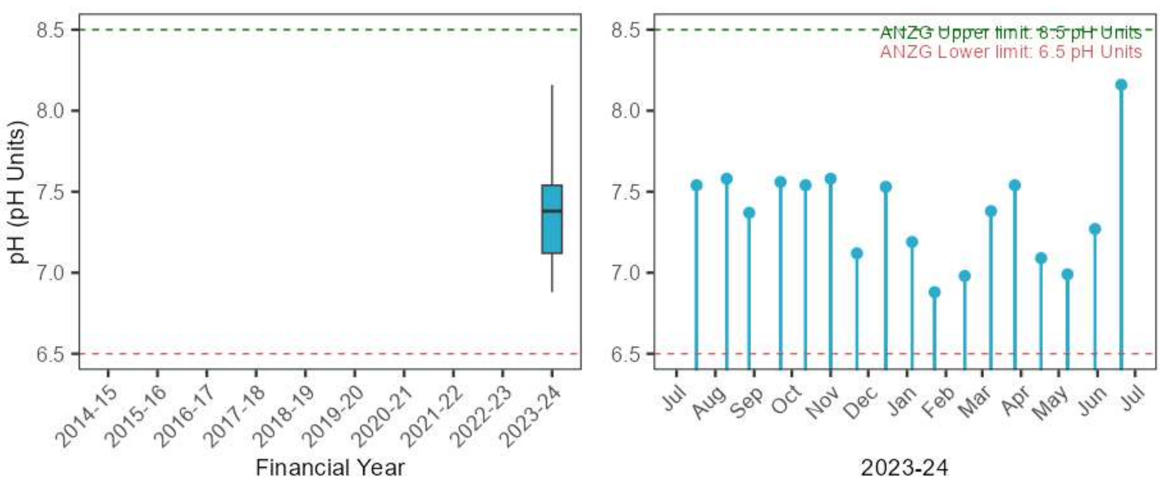




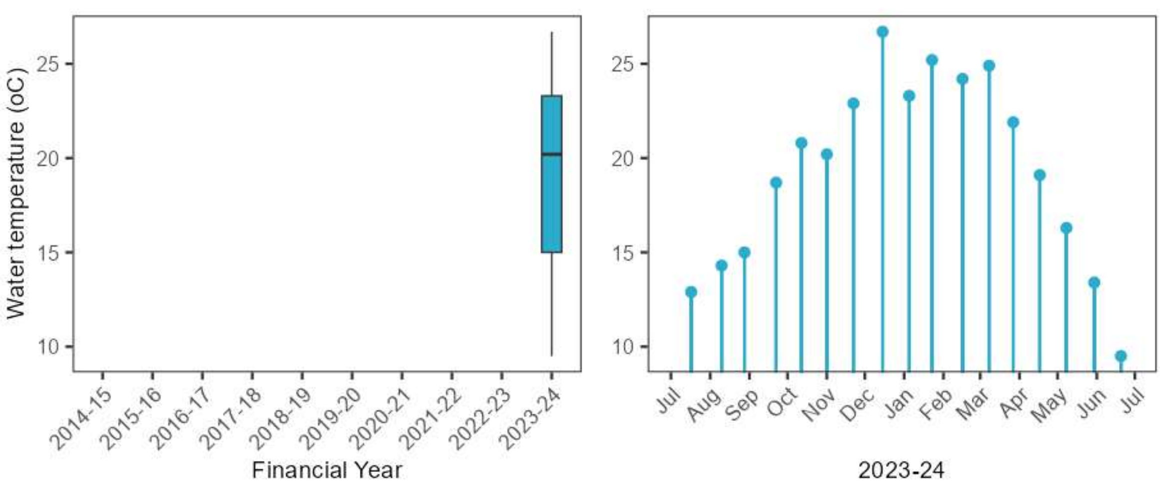
Georges River at Ingleburn Reserve Weir (GR24)

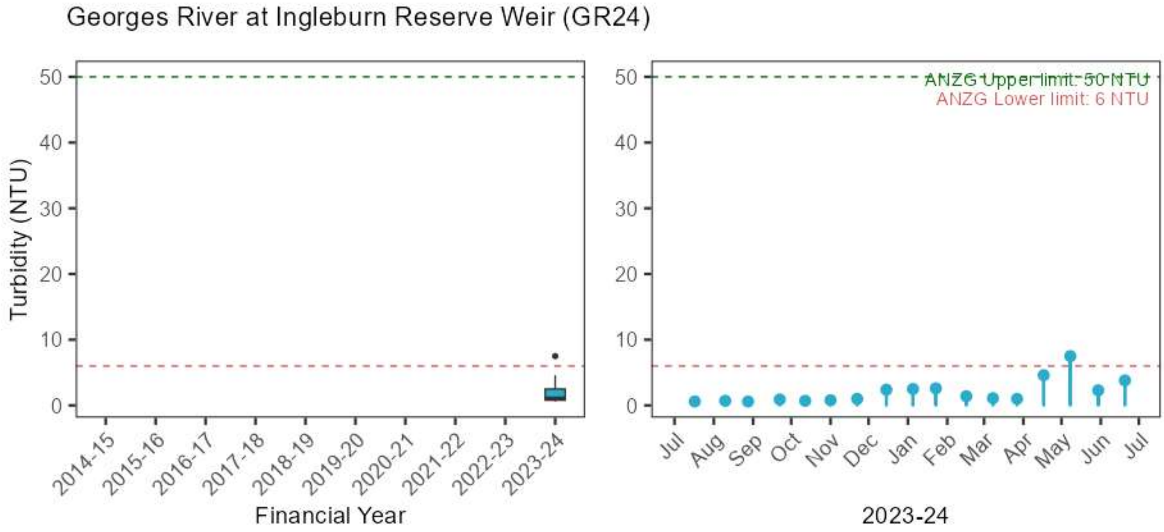


Georges River at Ingleburn Reserve Weir (GR24)

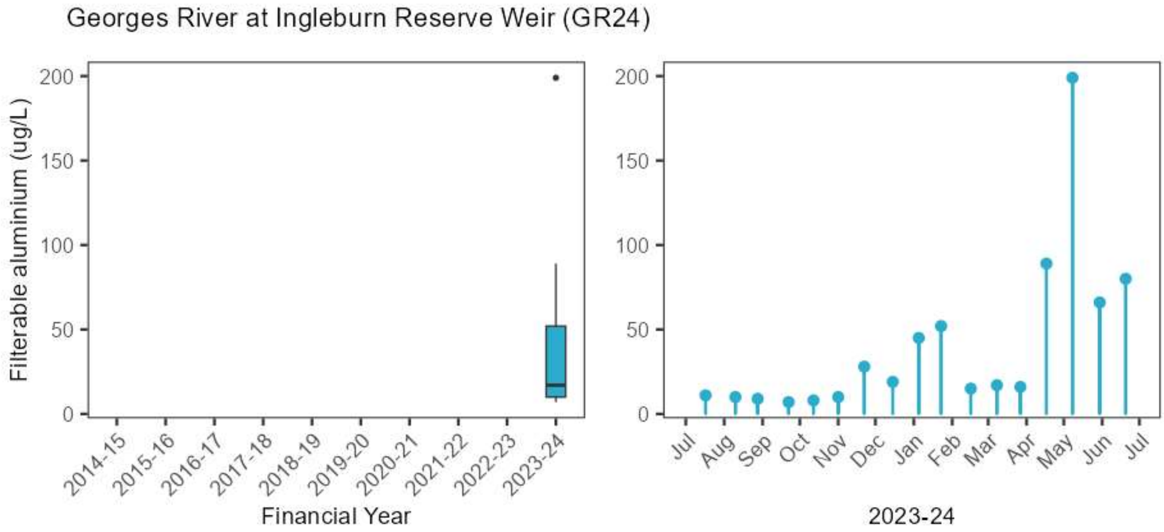


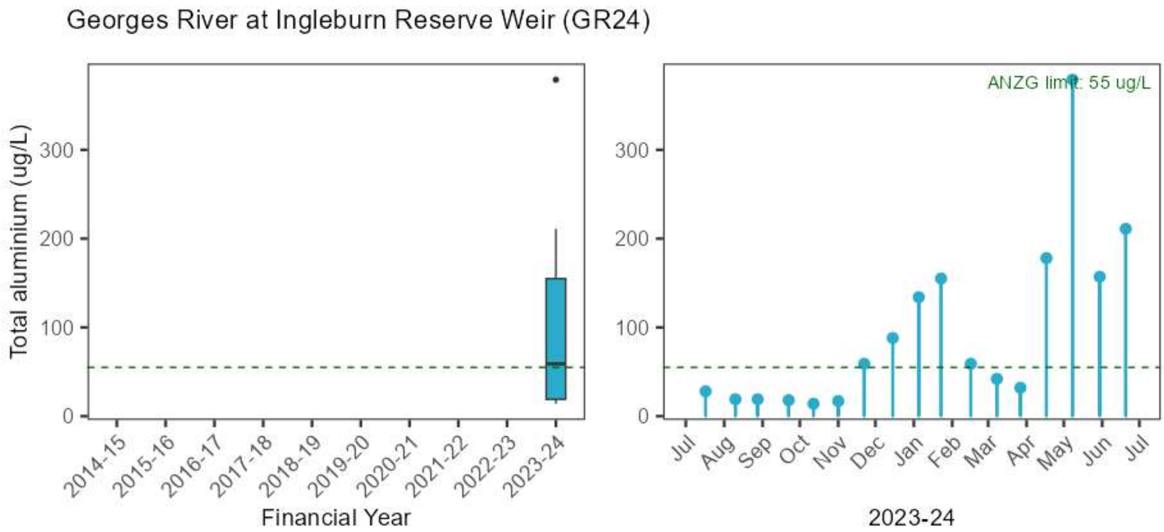
Georges River at Ingleburn Reserve Weir (GR24)



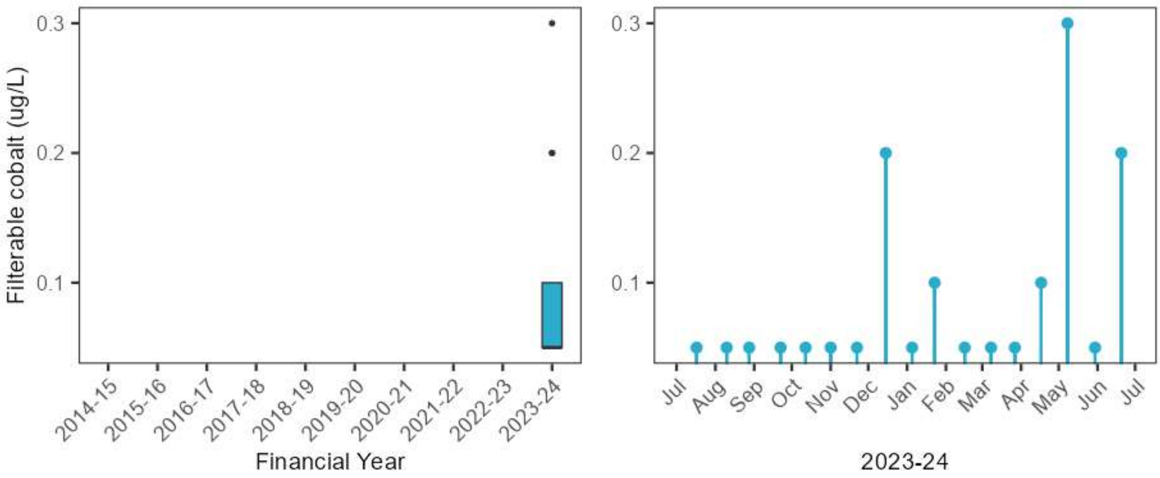


Stressors – Trace metals

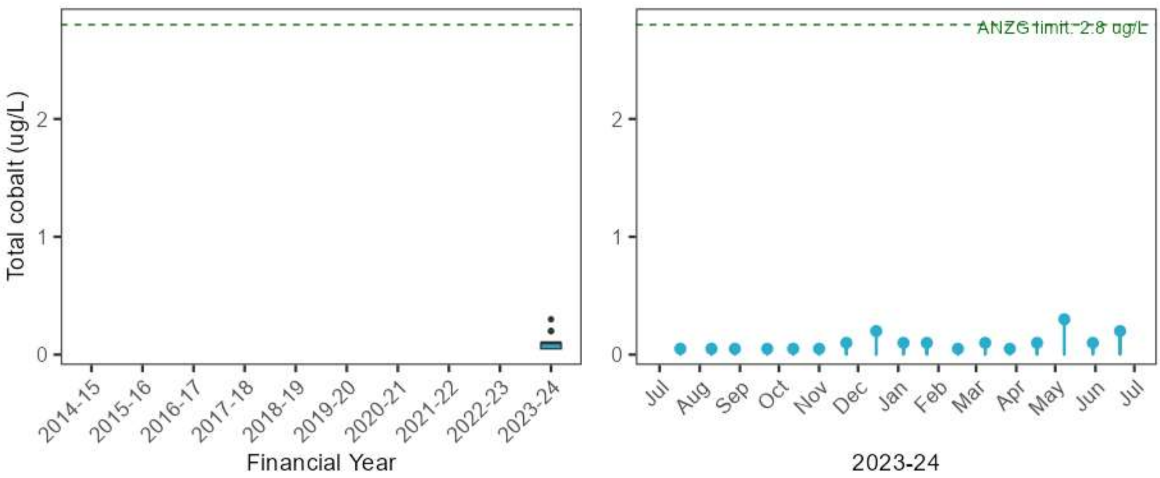




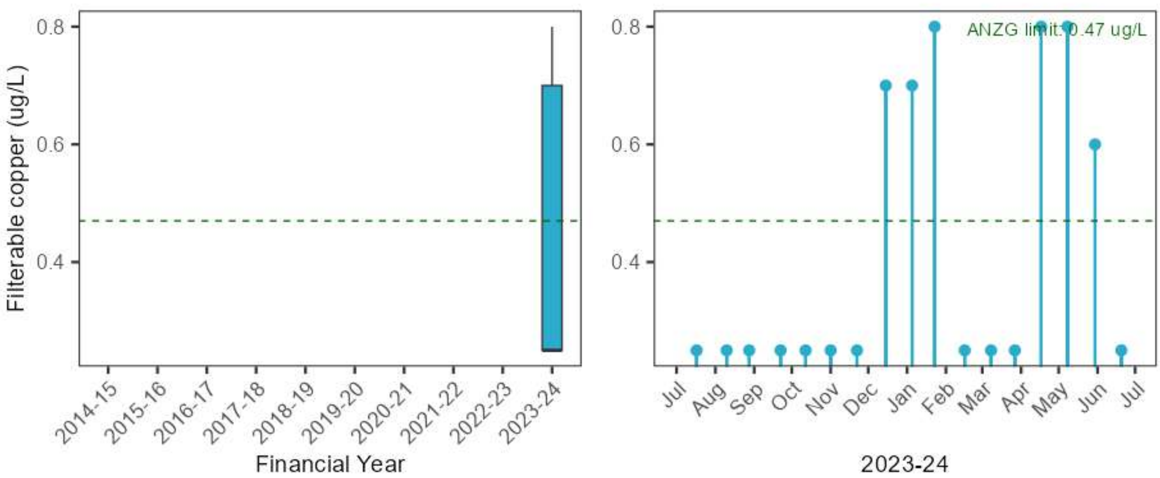
Georges River at Ingleburn Reserve Weir (GR24)



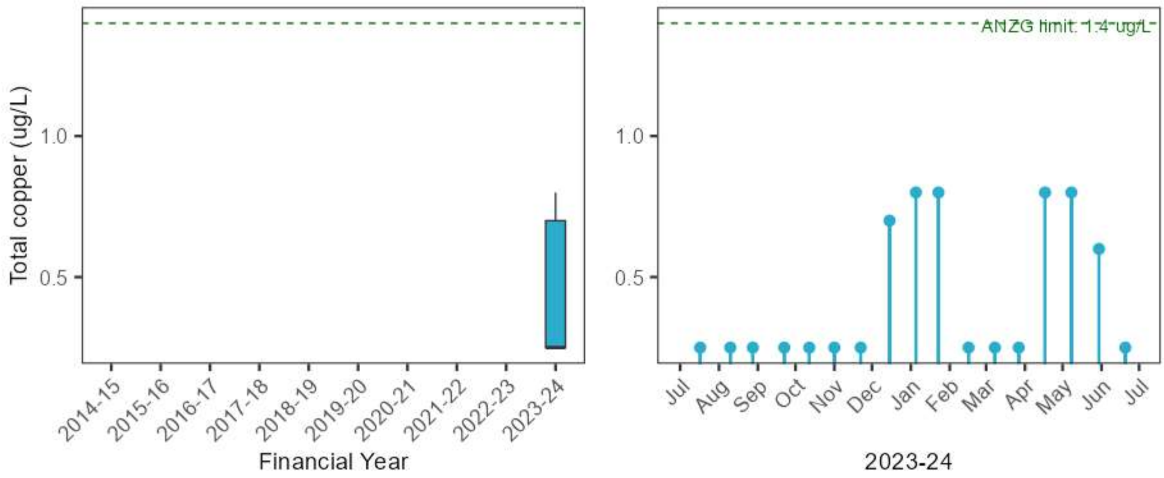
Georges River at Ingleburn Reserve Weir (GR24)



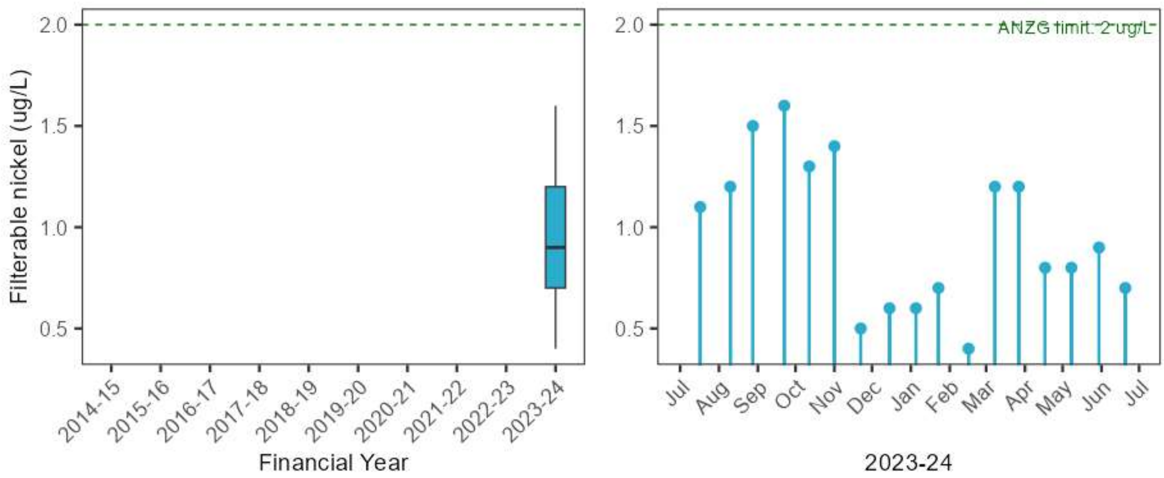
Georges River at Ingleburn Reserve Weir (GR24)



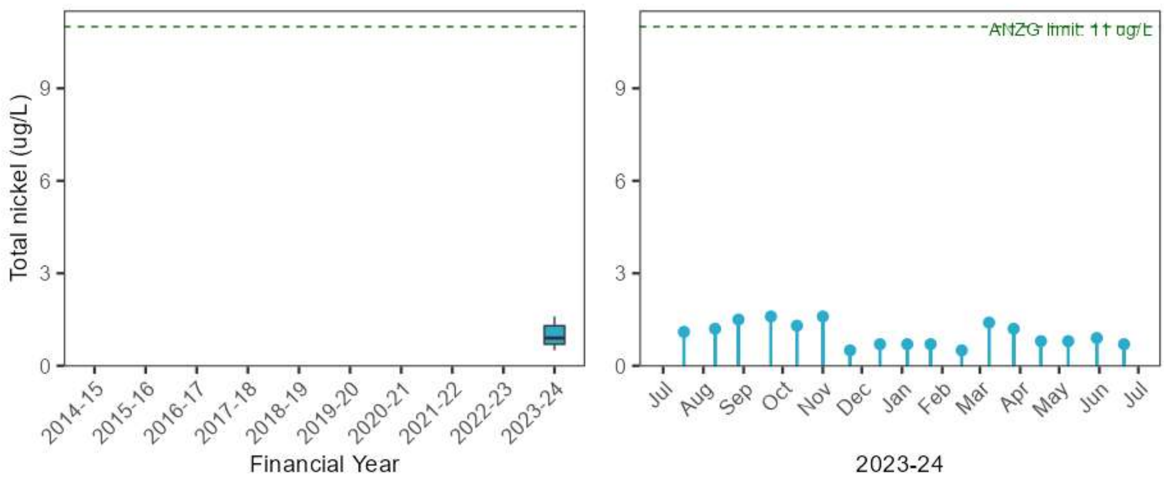
Georges River at Ingleburn Reserve Weir (GR24)

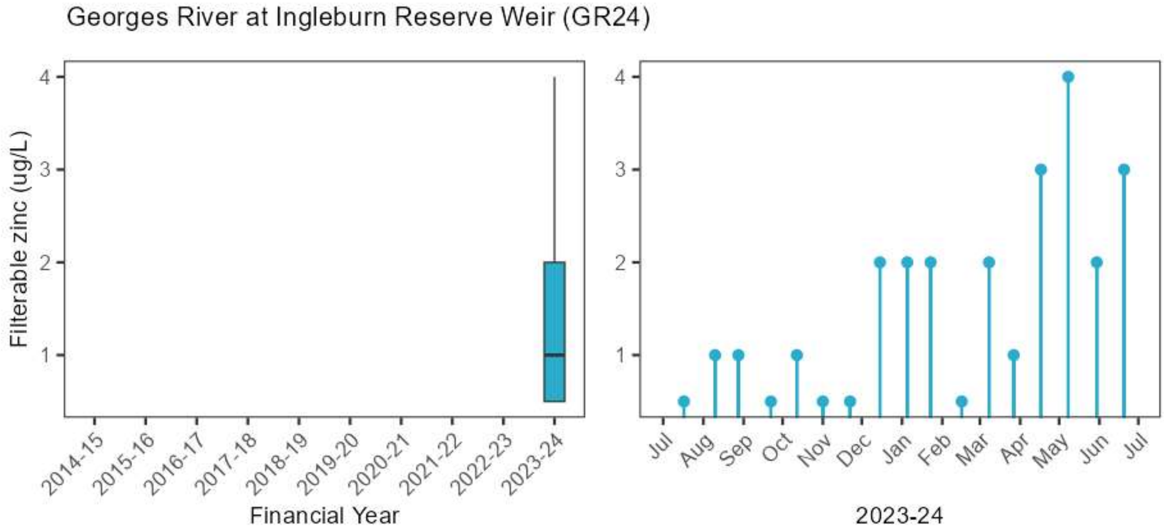


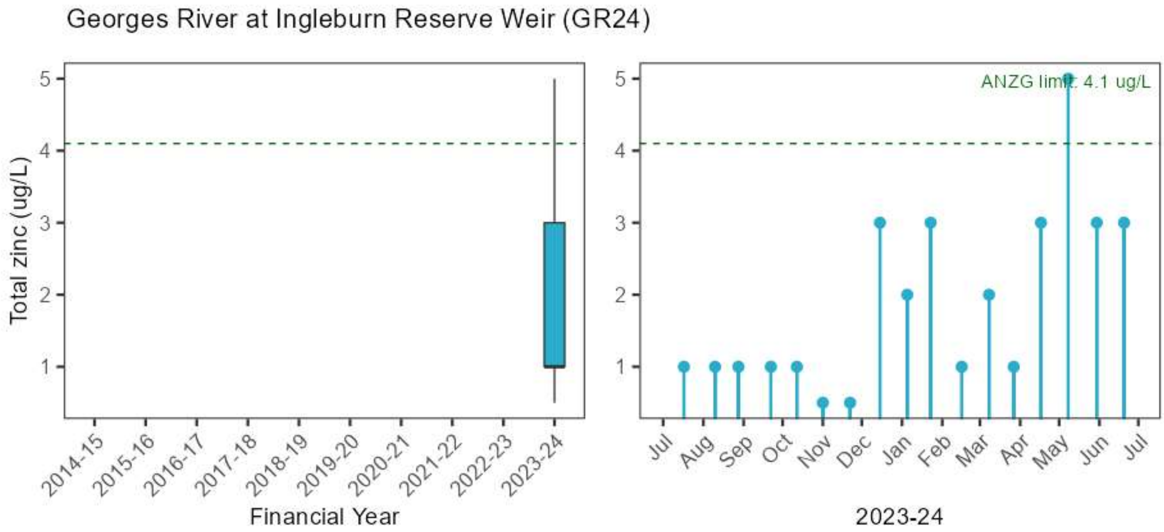
Georges River at Ingleburn Reserve Weir (GR24)



Georges River at Ingleburn Reserve Weir (GR24)

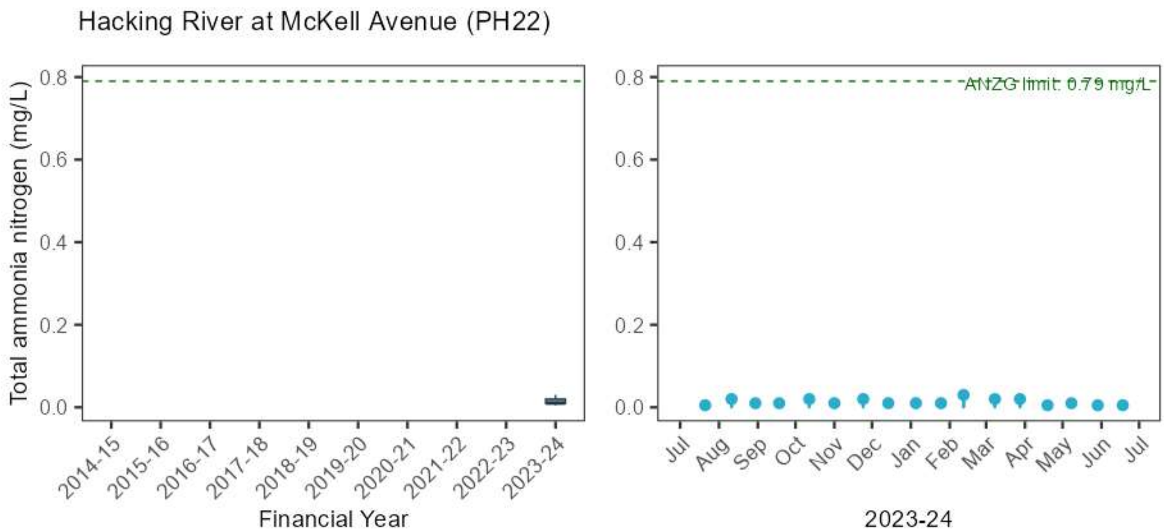


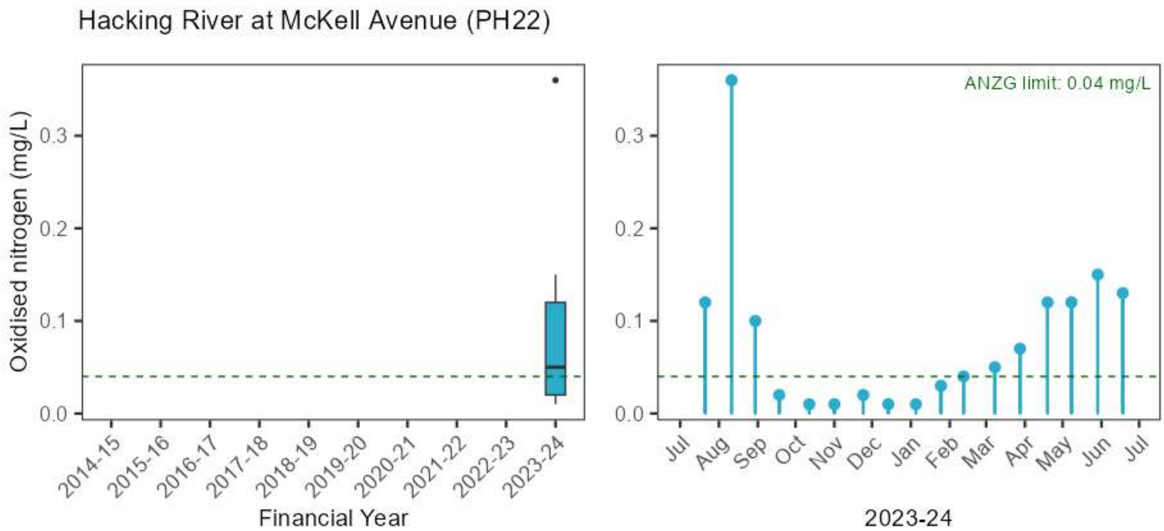

Georges River at Ingleburn Reserve Weir (GR24)
Filterable zinc (ug/L)
Financial Year
2023-24
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul

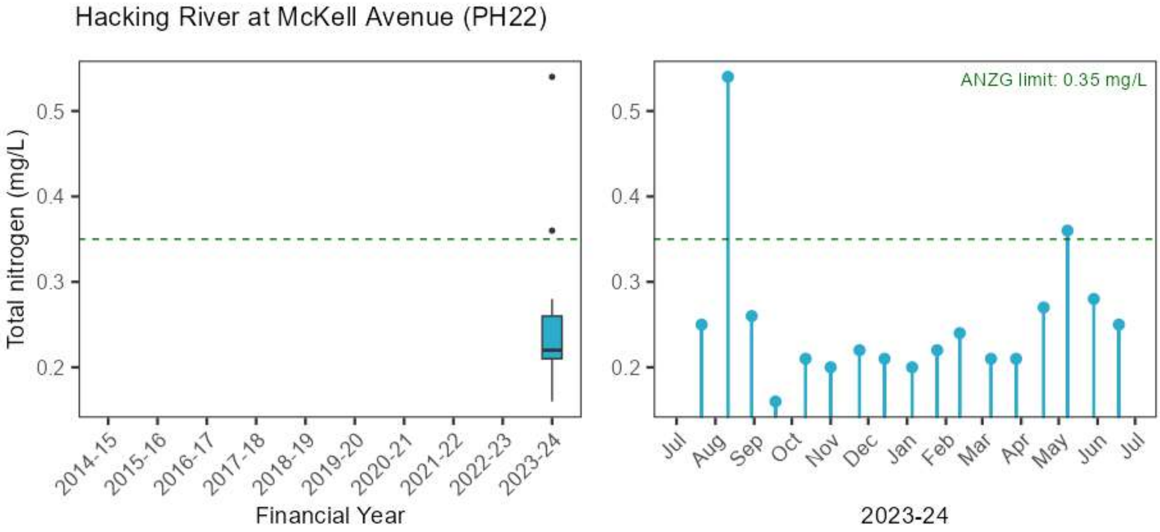

Georges River at Ingleburn Reserve Weir (GR24)
Total zinc (ug/L)
ANZG limit: 4.1 ug/L
Financial Year
2023-24
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul

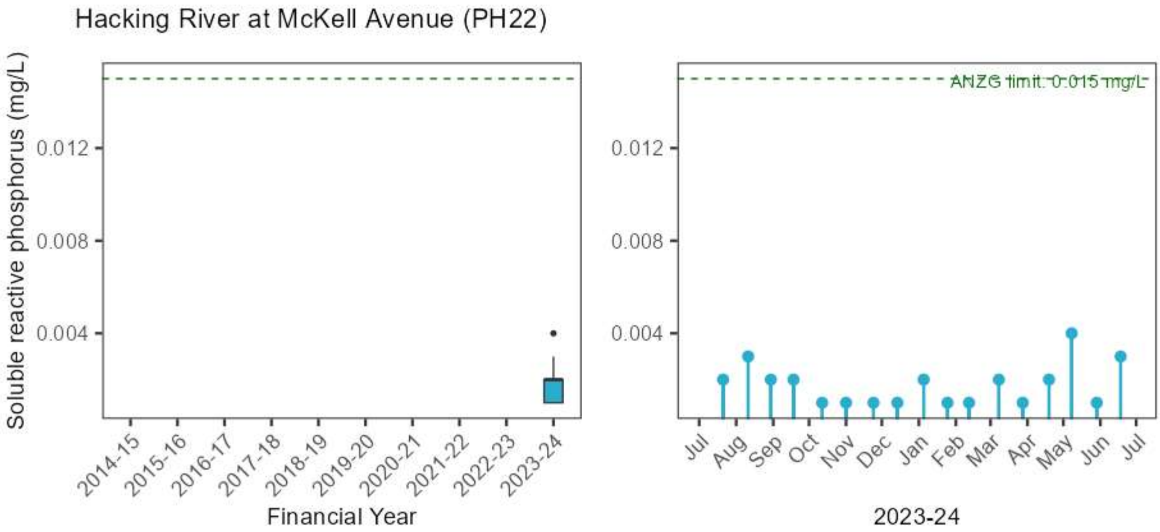
C.3.3. PH22 Hacking River at McKell Avenue

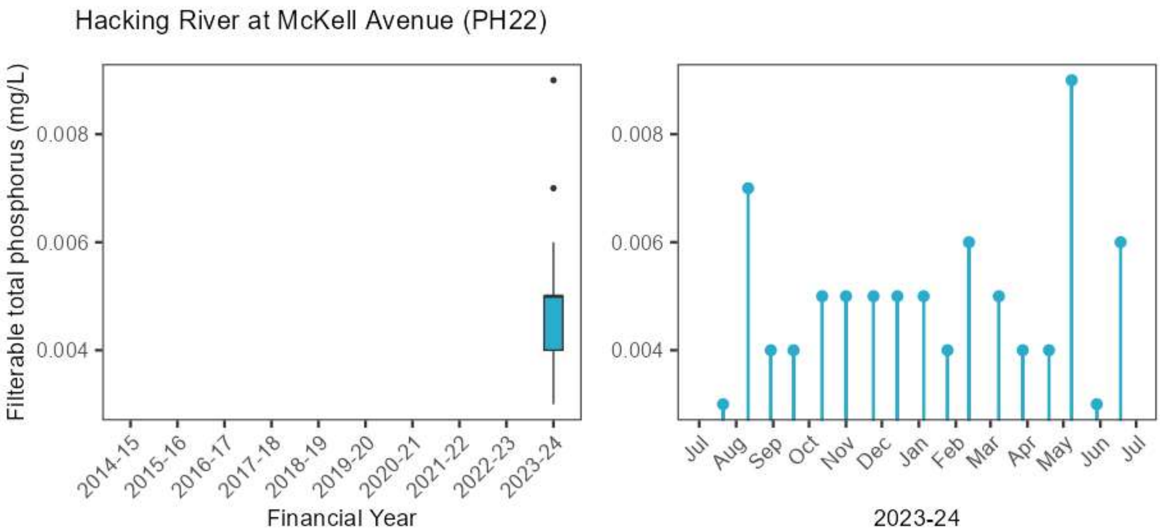
Stressors – Nutrients

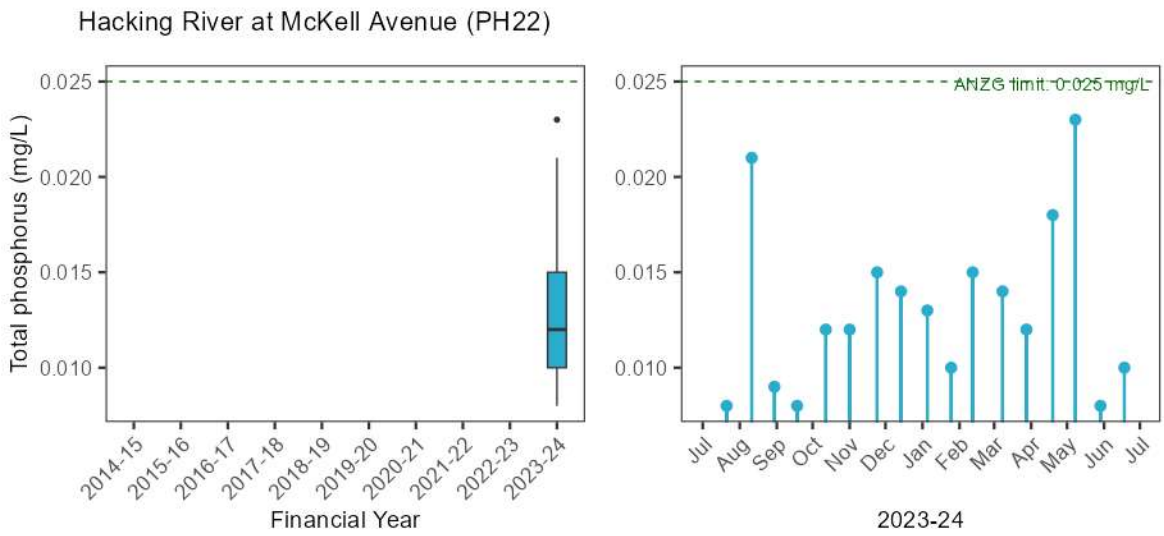




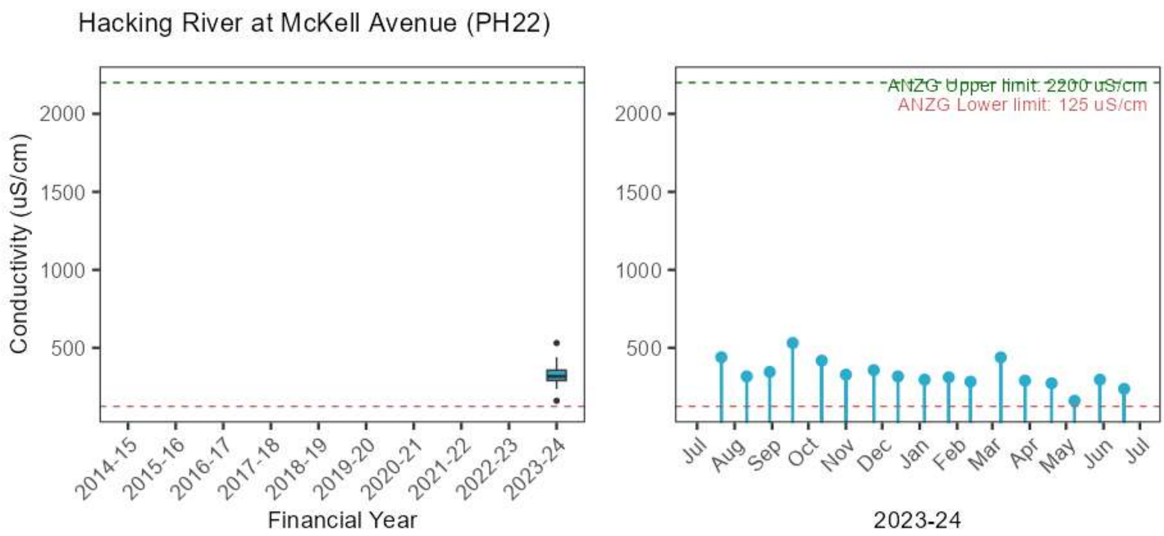

Hacking River at McKell Avenue (PH22)
ANZG limit: 0.35 mg/L
Total nitrogen (mg/L)
Financial Year
2023-24

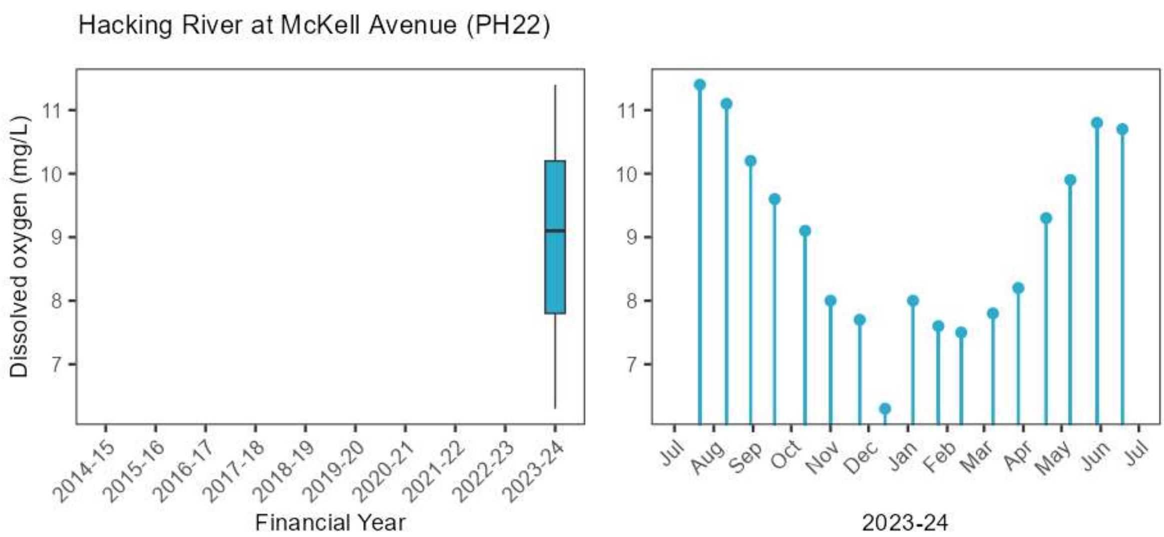

Hacking River at McKell Avenue (PH22)
ANZG limit: 0.015 mg/L
Soluble reactive phosphorus (mg/L)
Financial Year
2023-24

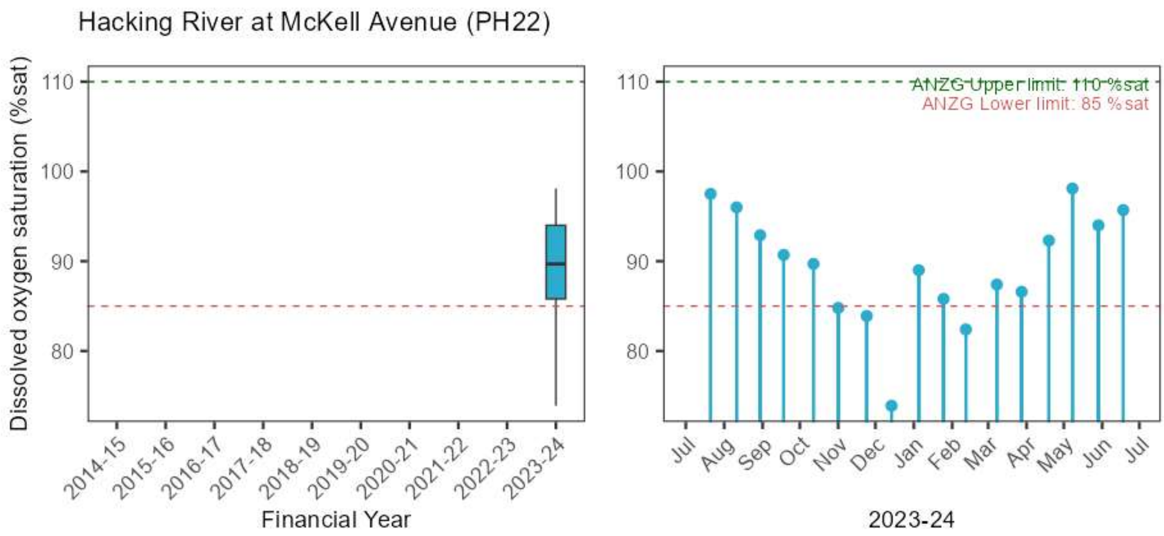

Hacking River at McKell Avenue (PH22)
Filterable total phosphorus (mg/L)
Financial Year
2023-24

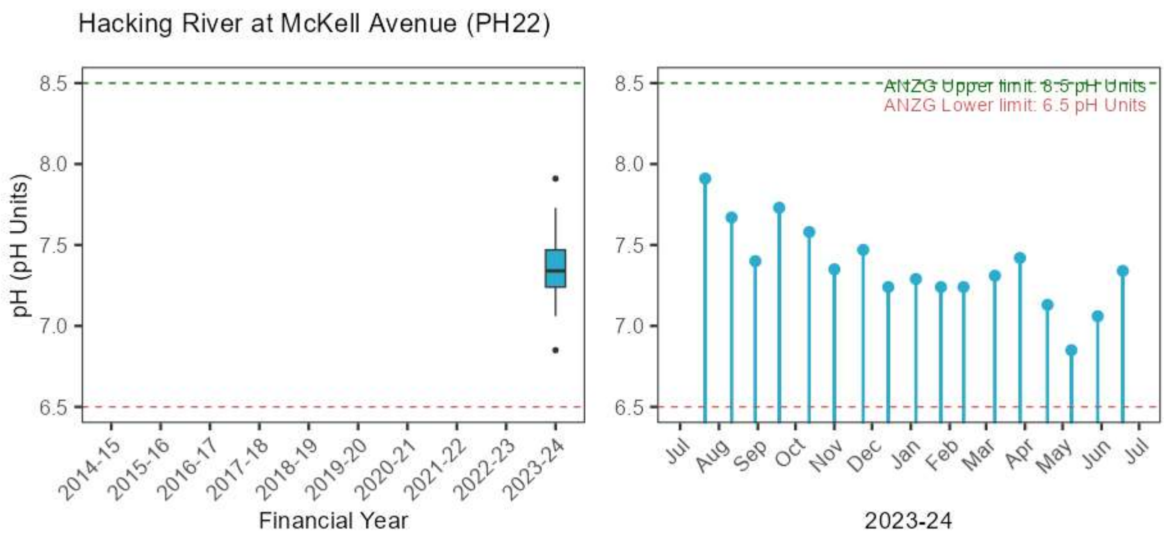


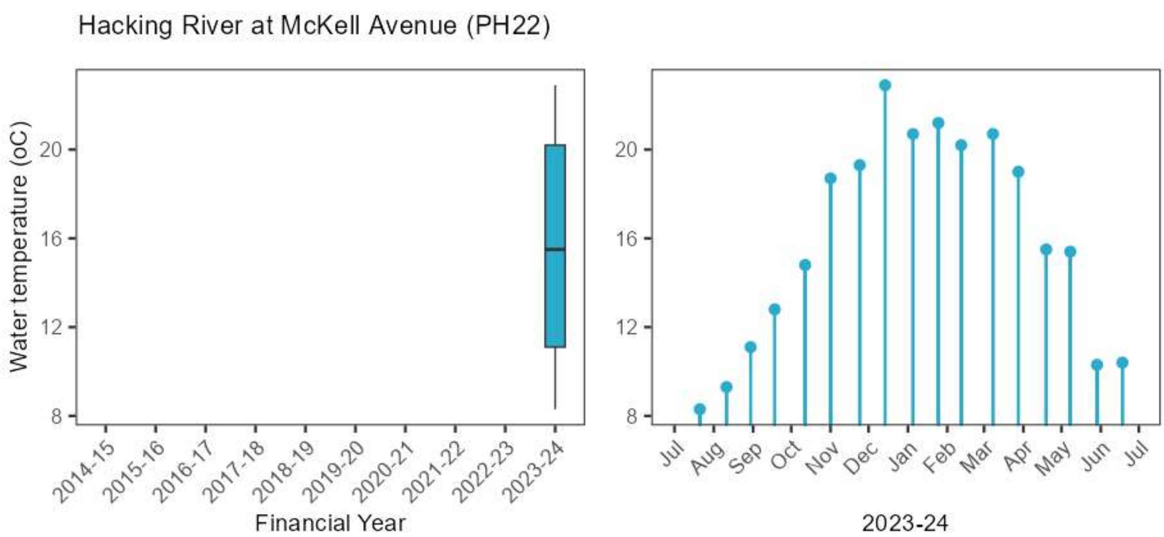
Stressors – Physico-chemical water quality



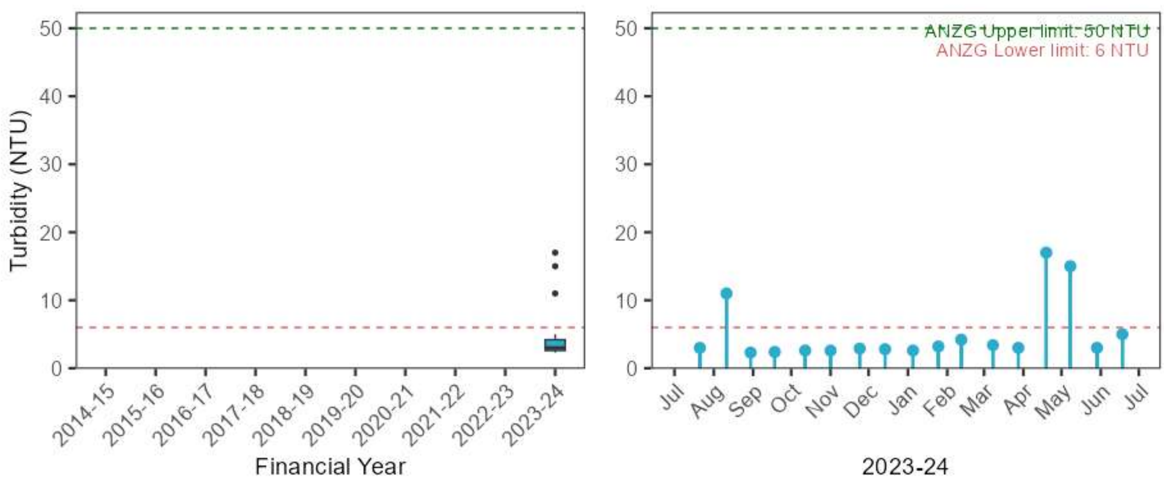



Hacking River at McKell Avenue (PH22)
Dissolved oxygen saturation (%sat)
Financial Year
2023-24
ANZG Upper limit: 110 %sat
ANZG Lower limit: 85 %sat


Hacking River at McKell Avenue (PH22)
pH (pH Units)
Financial Year
2023-24
ANZG Upper limit: 8.5 pH Units
ANZG Lower limit: 6.5 pH Units

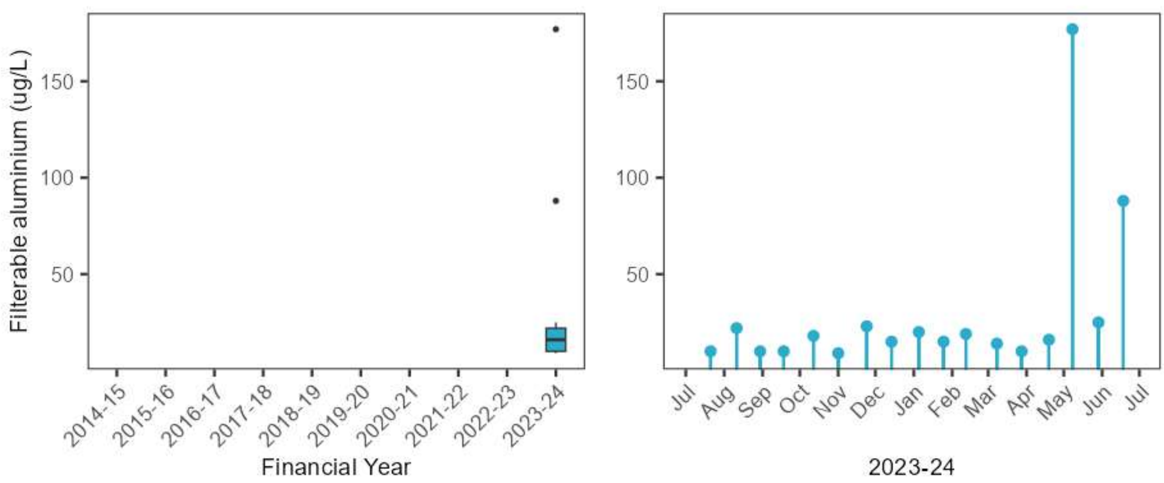

Hacking River at McKell Avenue (PH22)
Water temperature (oC)
Financial Year
2023-24

Hacking River at McKell Avenue (PH22)

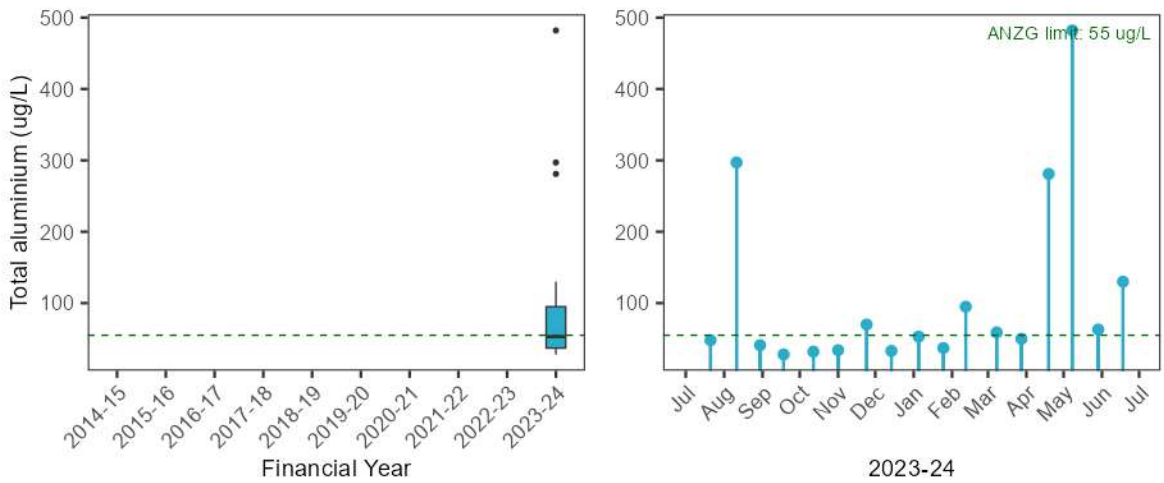


Stressors – Trace metals

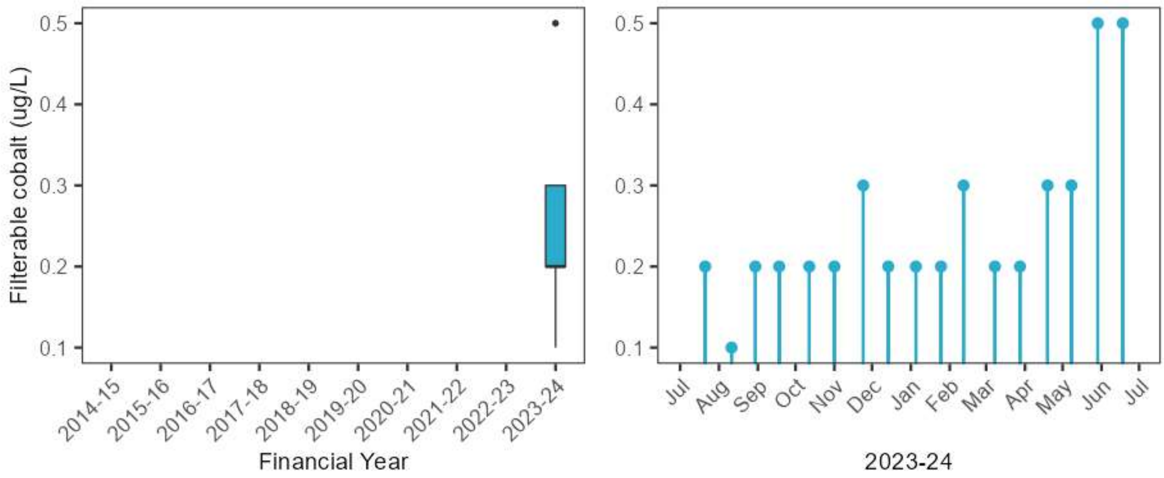
Hacking River at McKell Avenue (PH22)



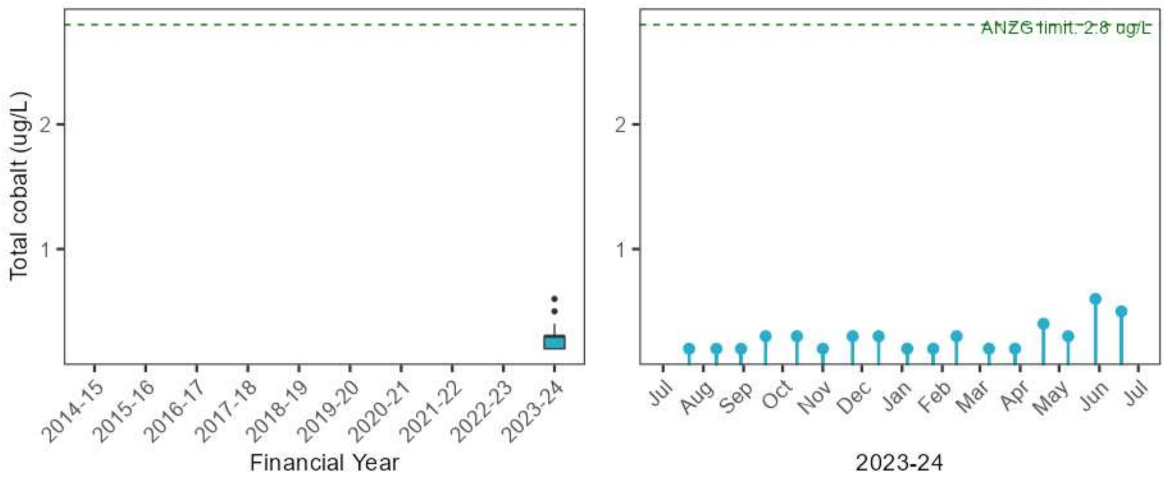
Hacking River at McKell Avenue (PH22)



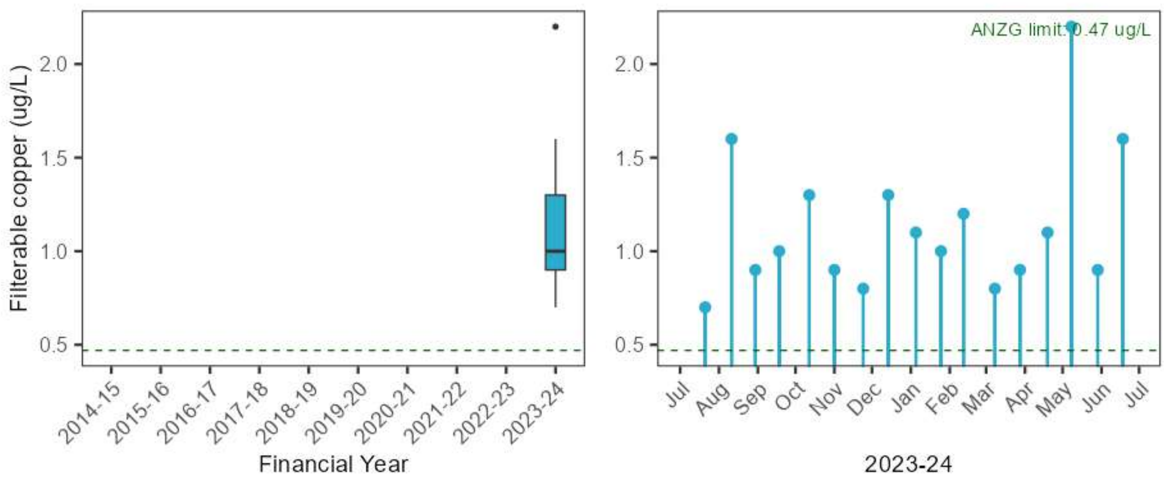
Hacking River at McKell Avenue (PH22)



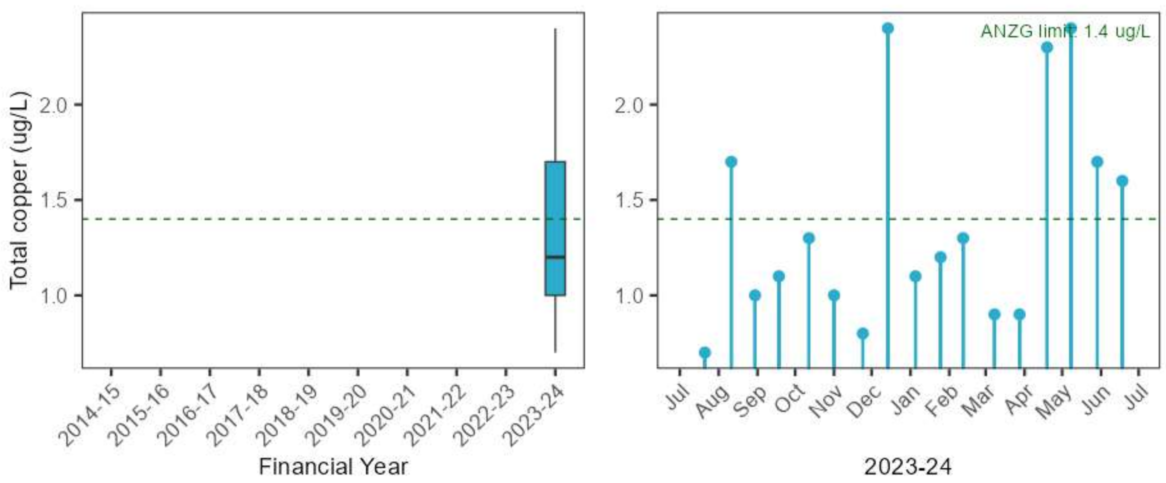
Hacking River at McKell Avenue (PH22)



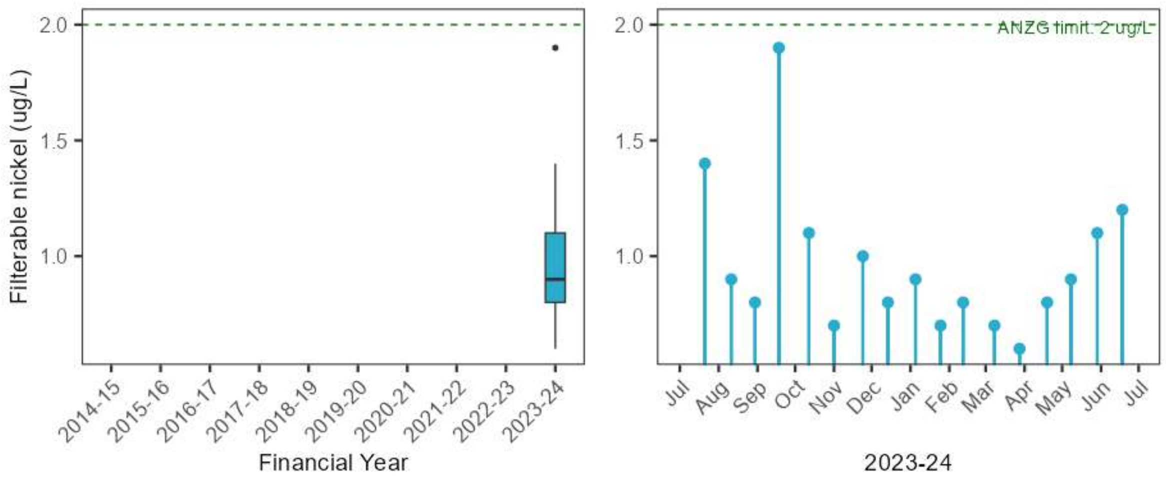
Hacking River at McKell Avenue (PH22)



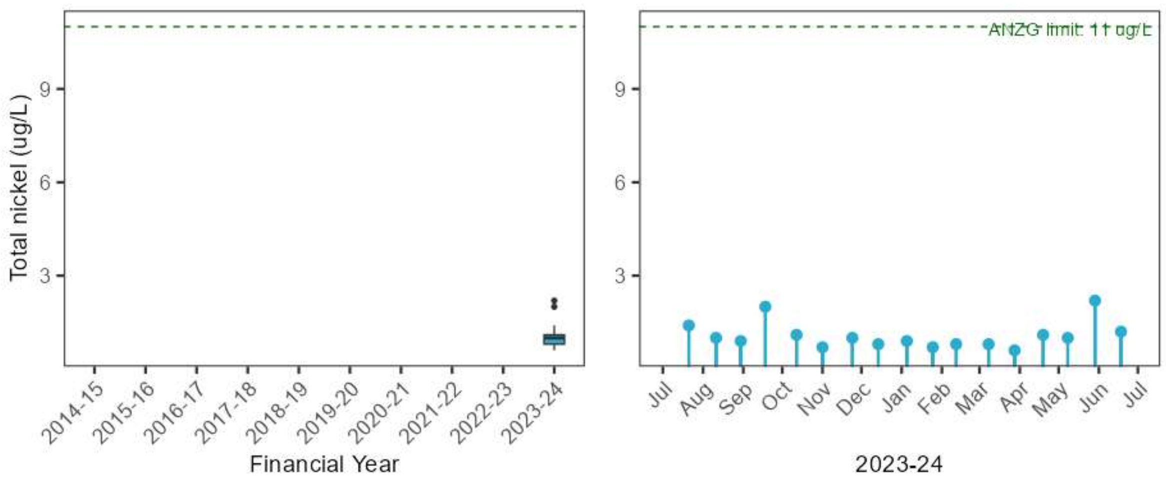
Hacking River at McKell Avenue (PH22)

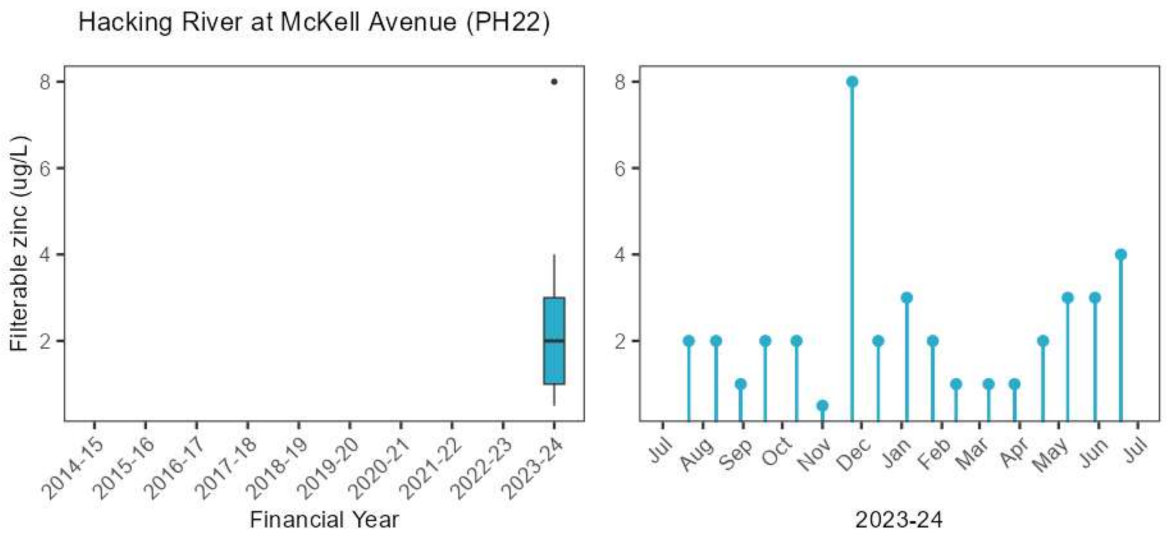


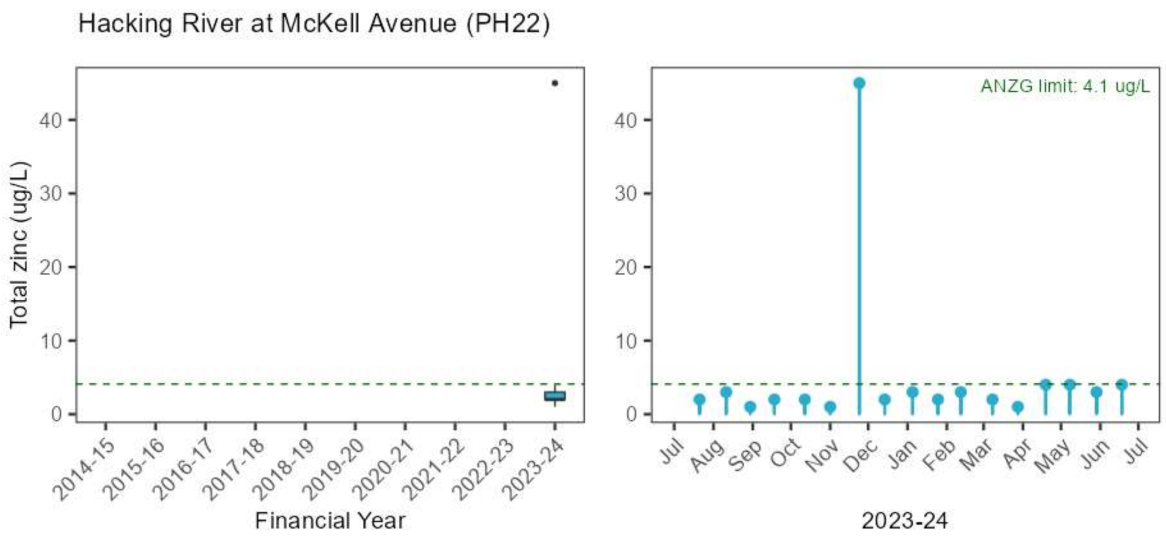
Hacking River at McKell Avenue (PH22)



Hacking River at McKell Avenue (PH22)

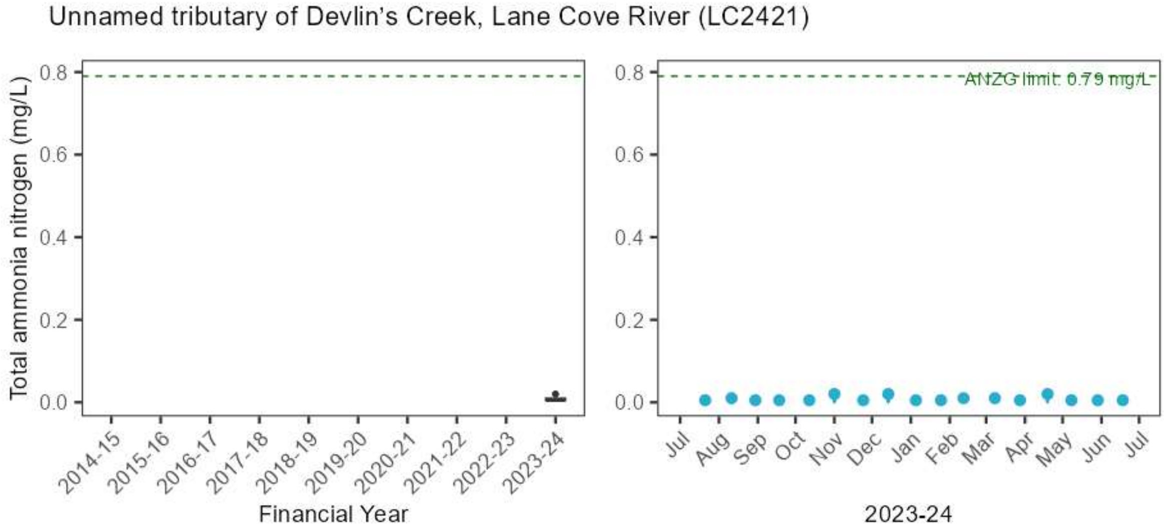


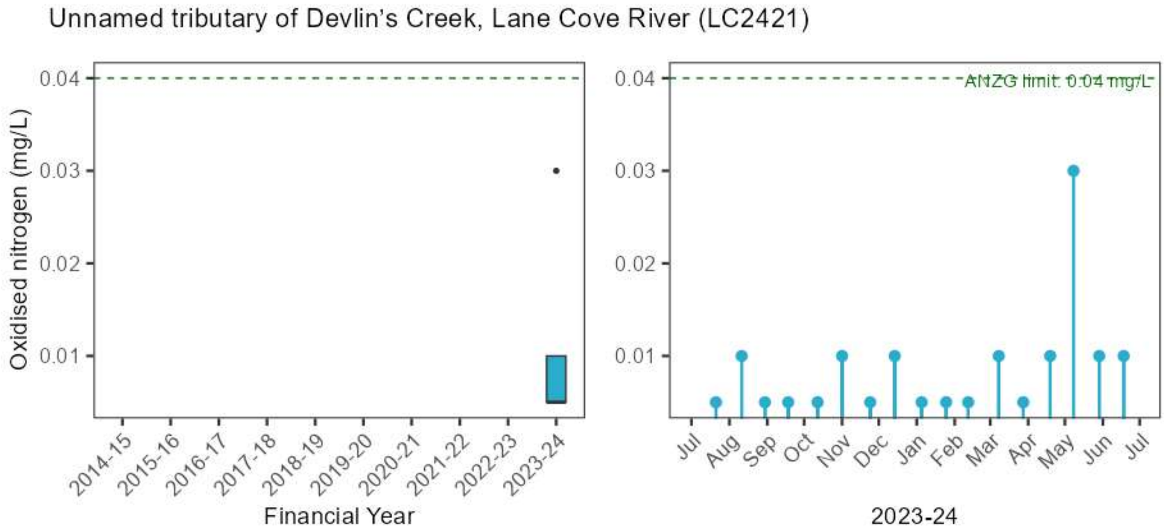

Hacking River at McKell Avenue (PH22)
Filterable zinc (ug/L)
8
6
4
2
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Hacking River at McKell Avenue (PH22)
Total zinc (ug/L)
40
30
20
10
0
ANZG limit: 4.1 ug/L
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

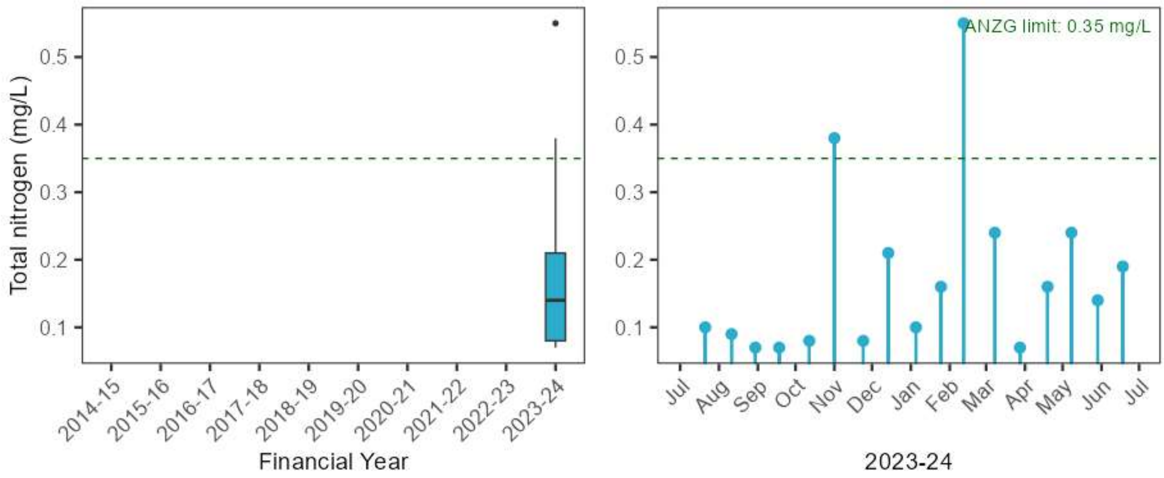
C.3.4. LC2421 Unnamed tributary of Devlin's Creek, Lane Cove River

Stressors – Nutrients

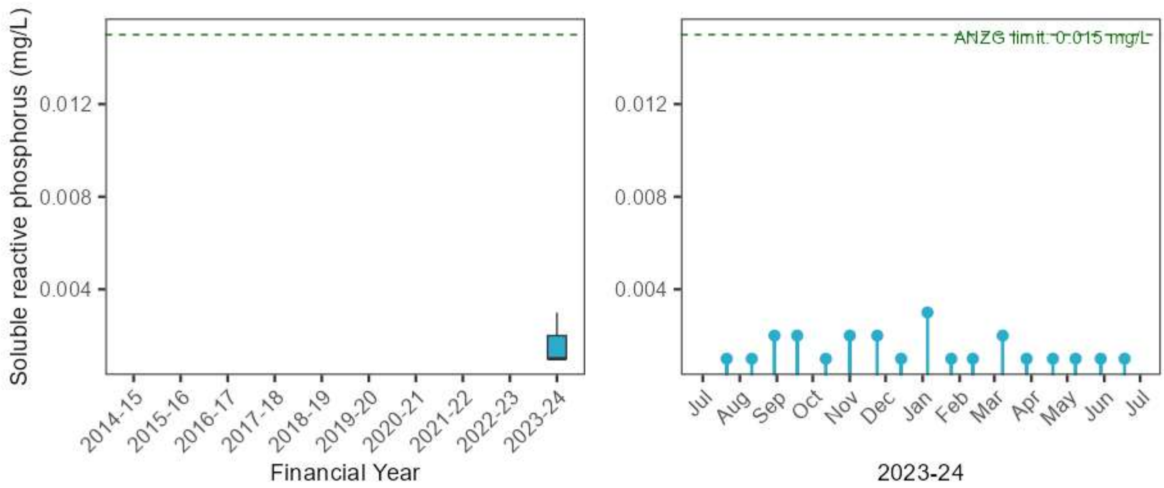




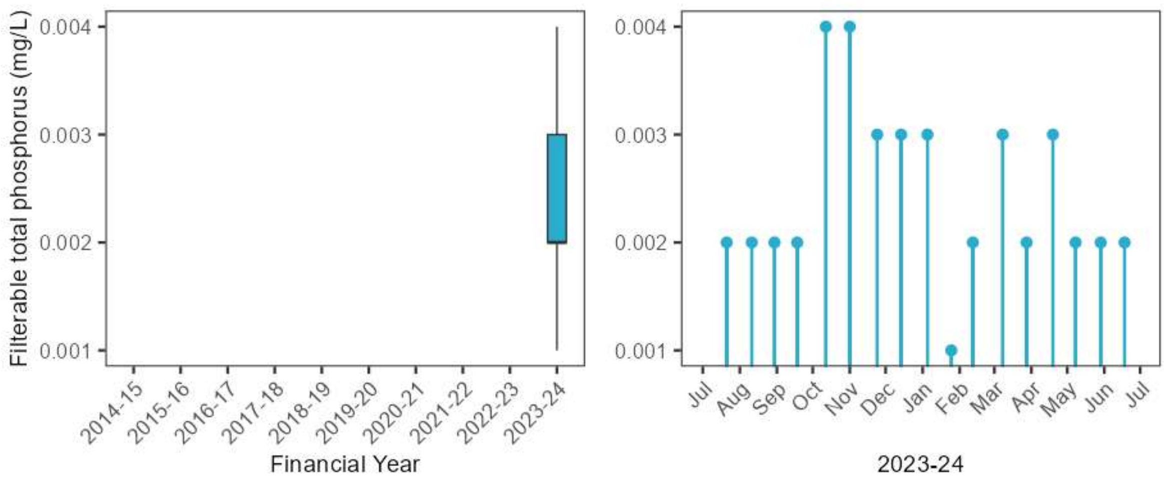
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)

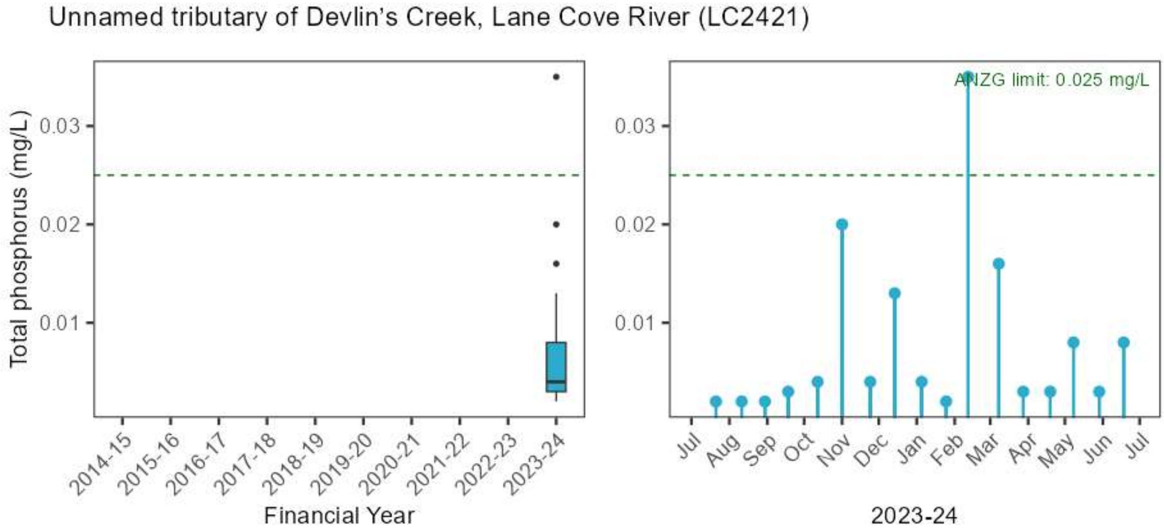


Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)

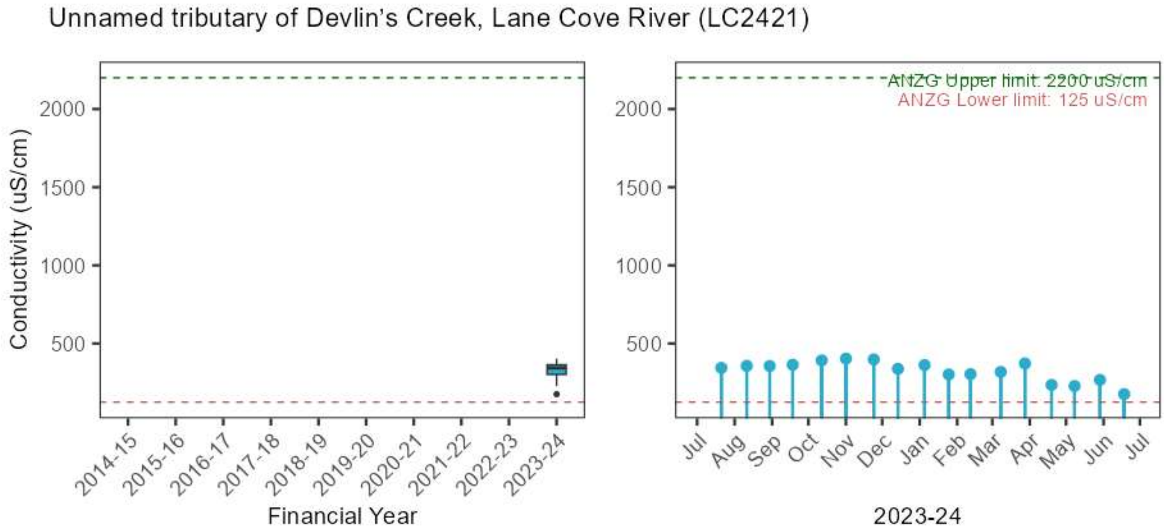


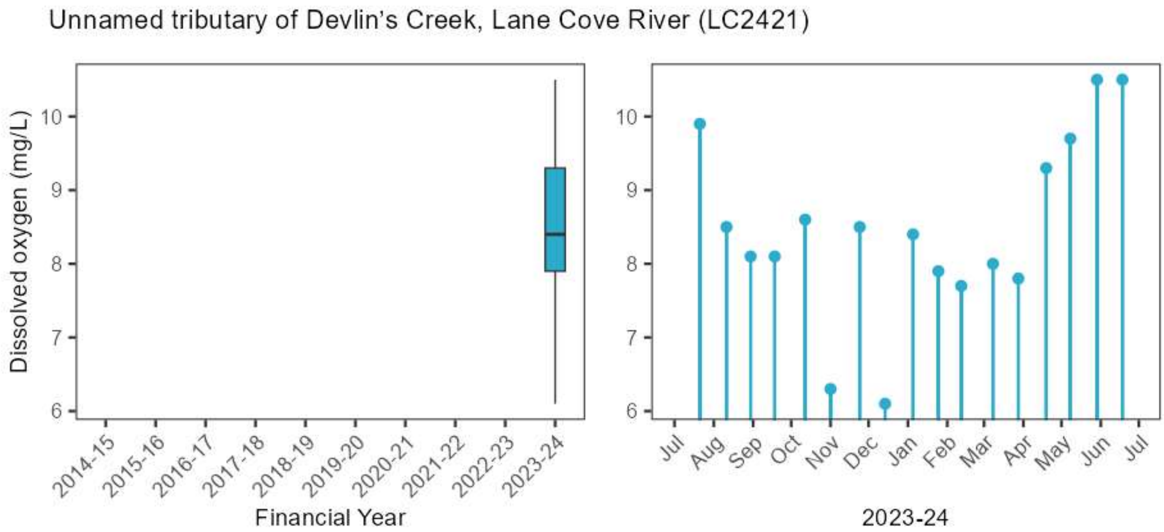
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



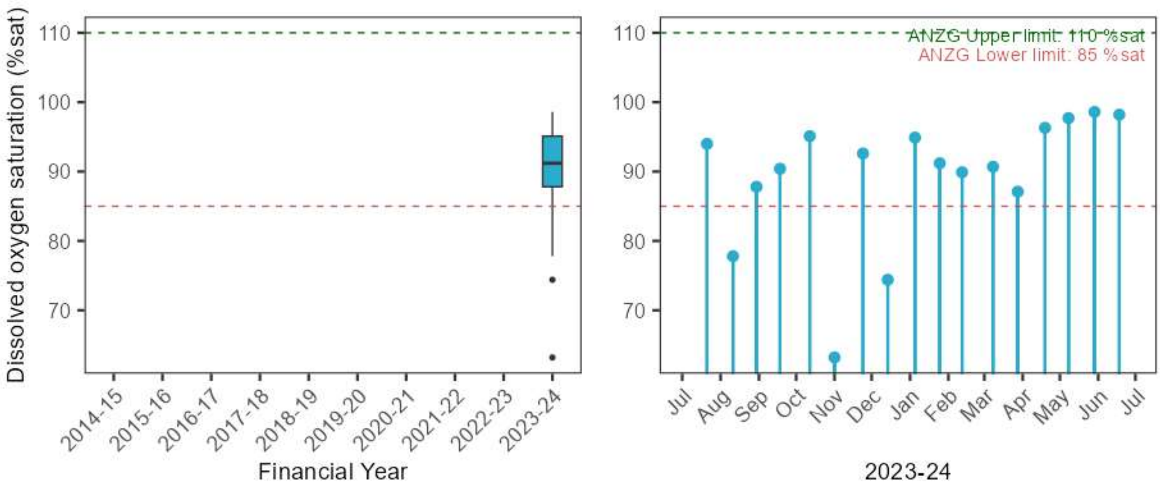


Stressors – Physico-chemical water quality

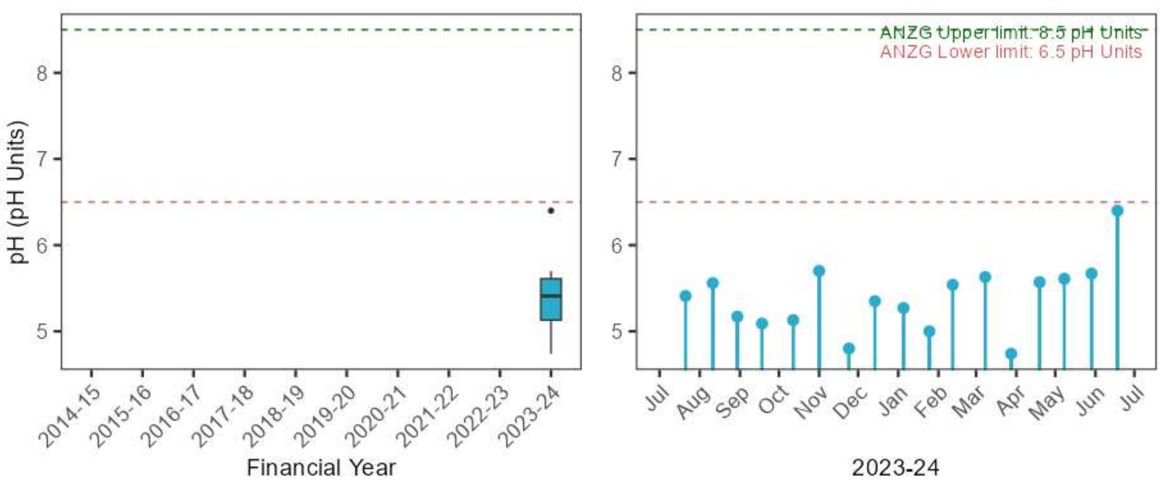




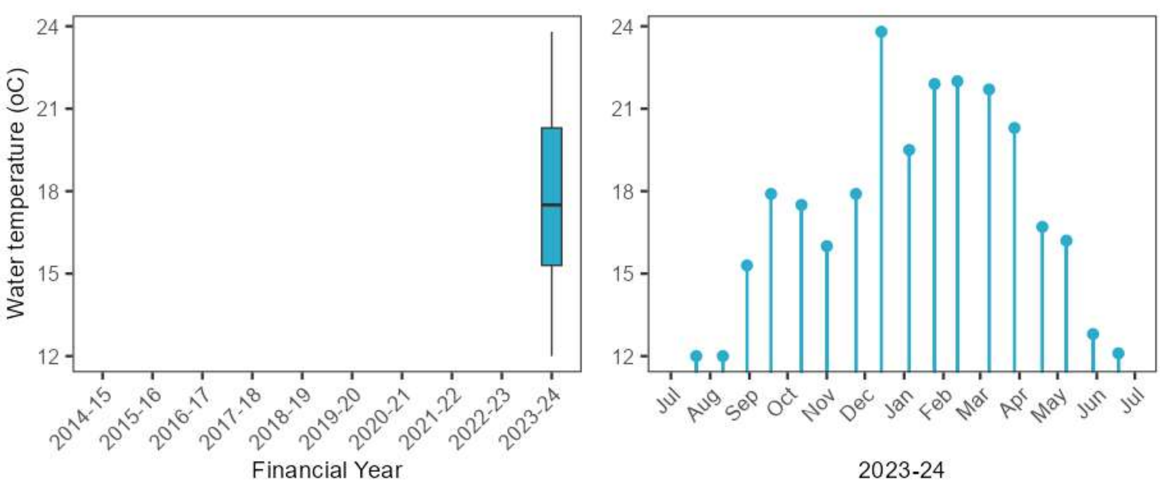
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)

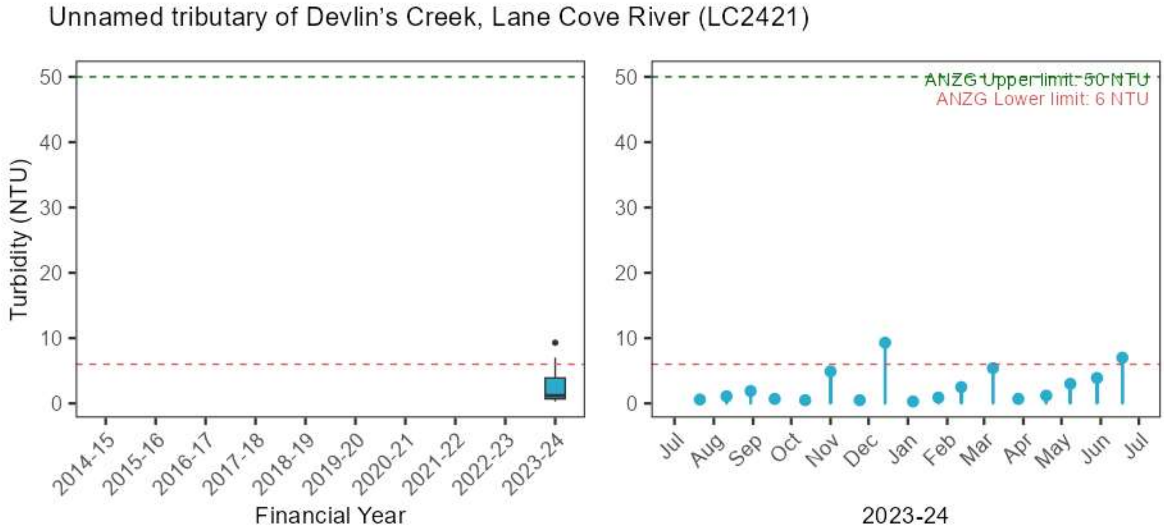


Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)

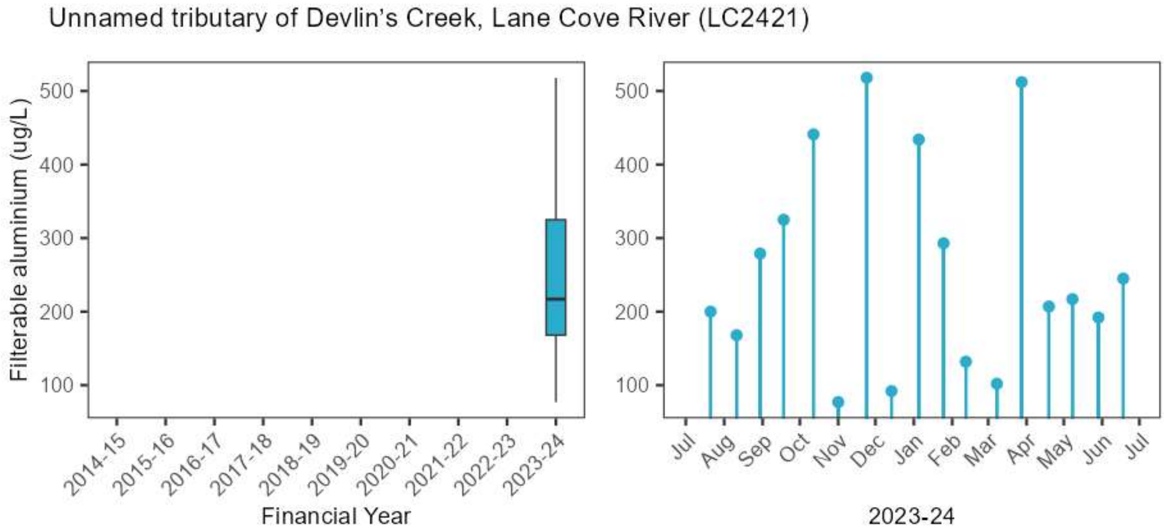


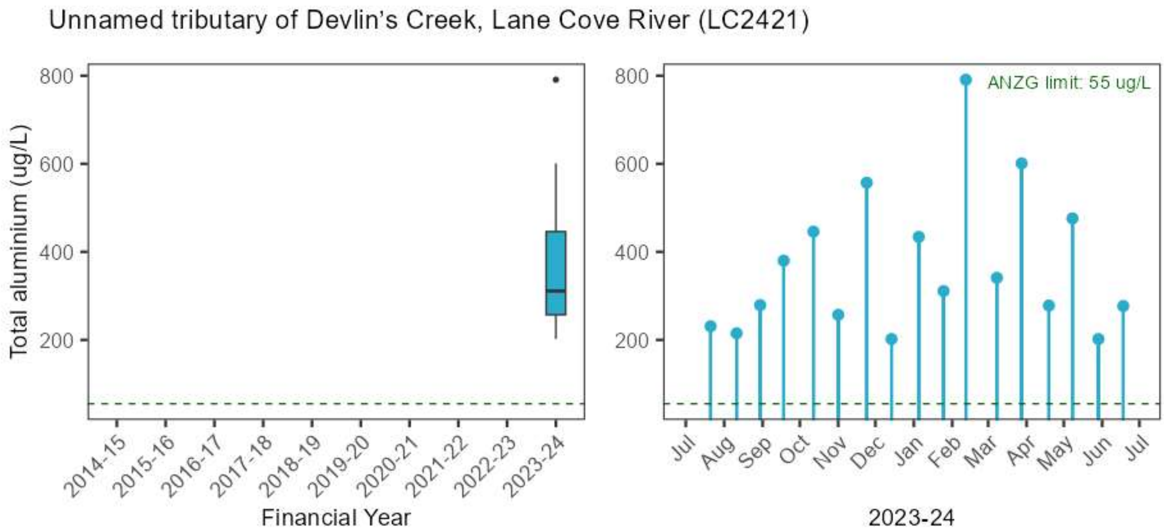
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



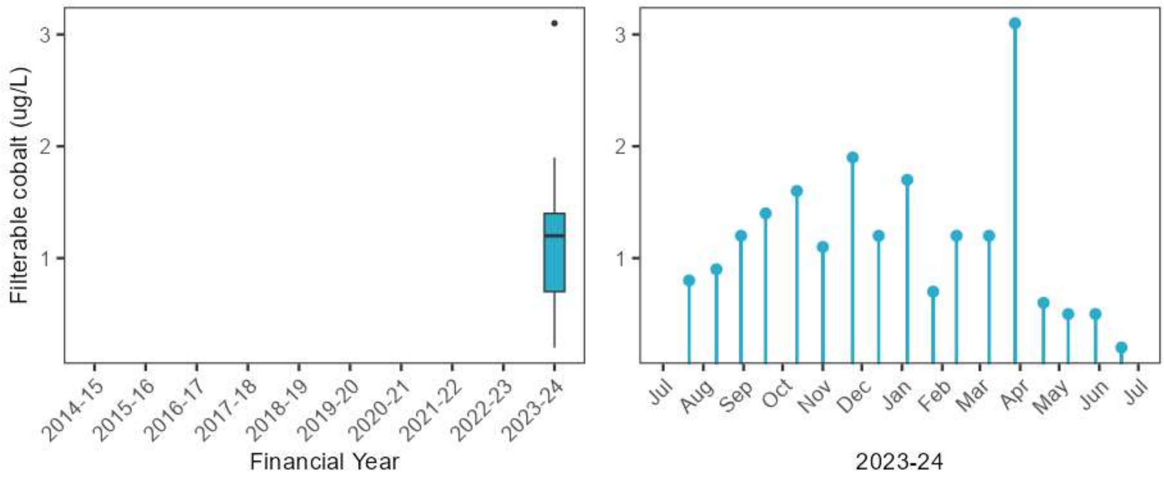


Stressors – Trace metals

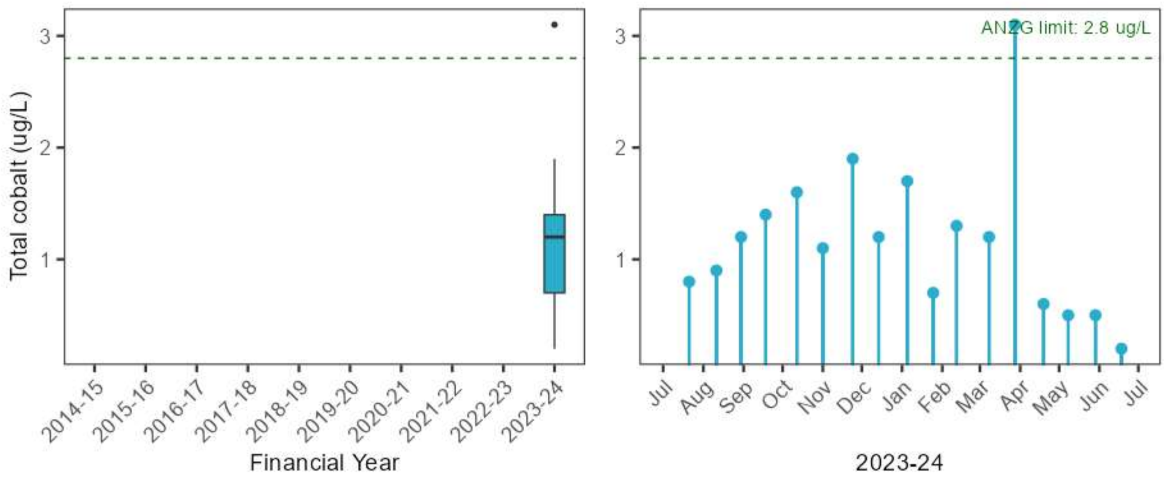




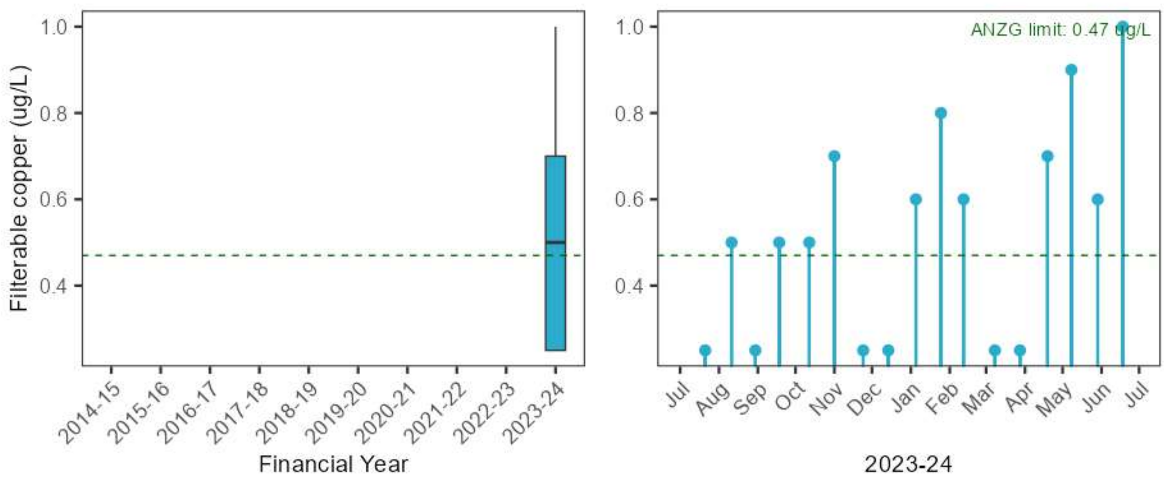
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



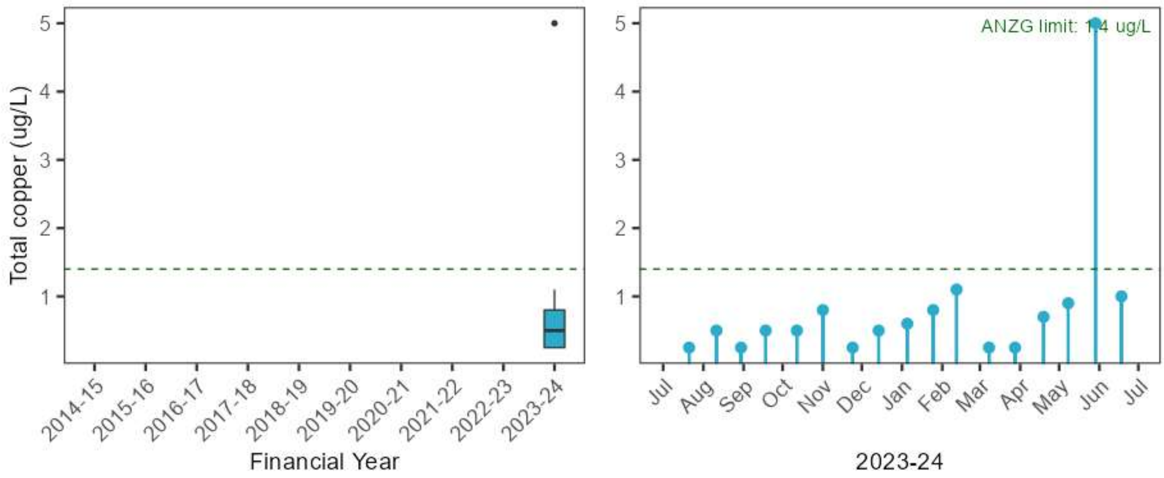
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



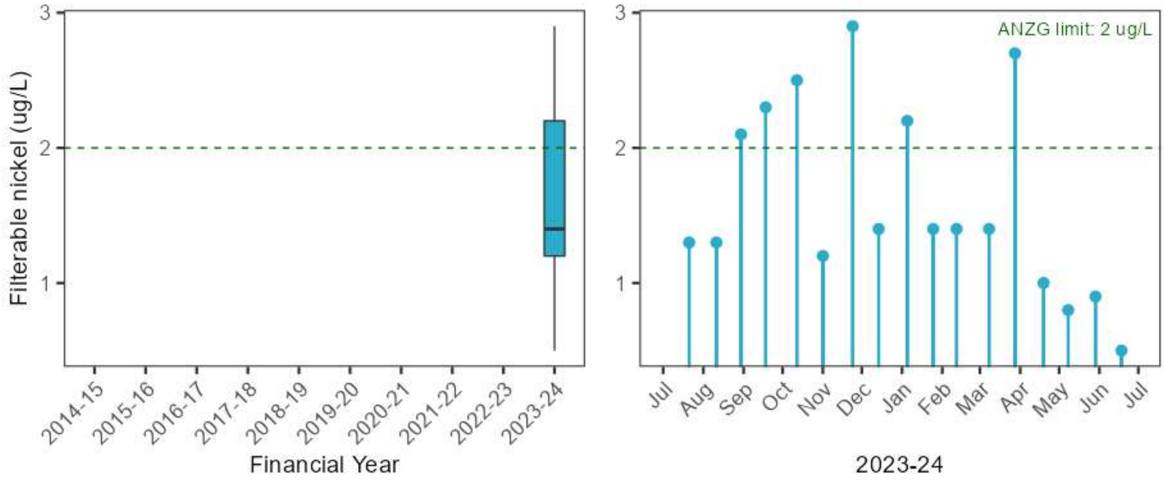
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



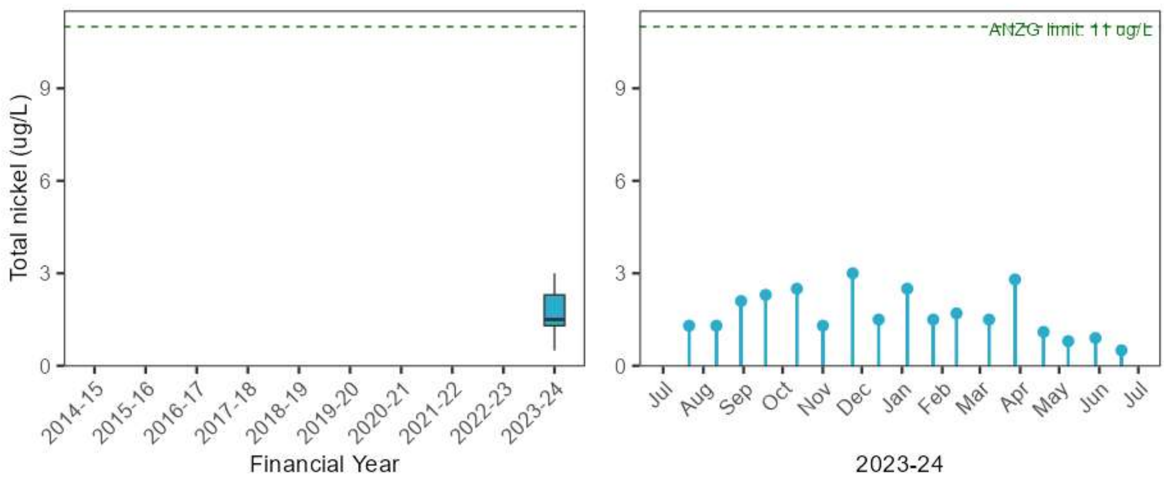
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



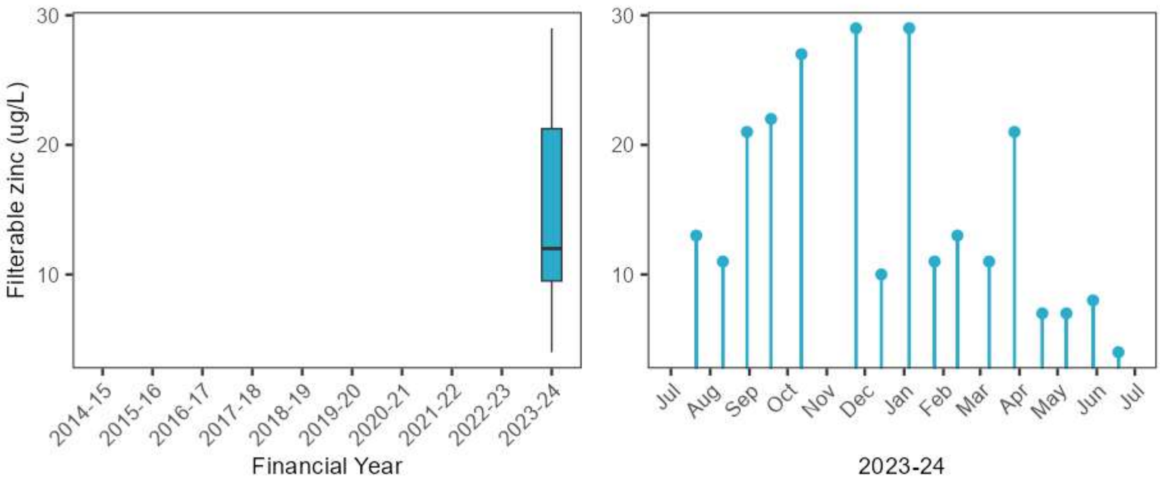
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



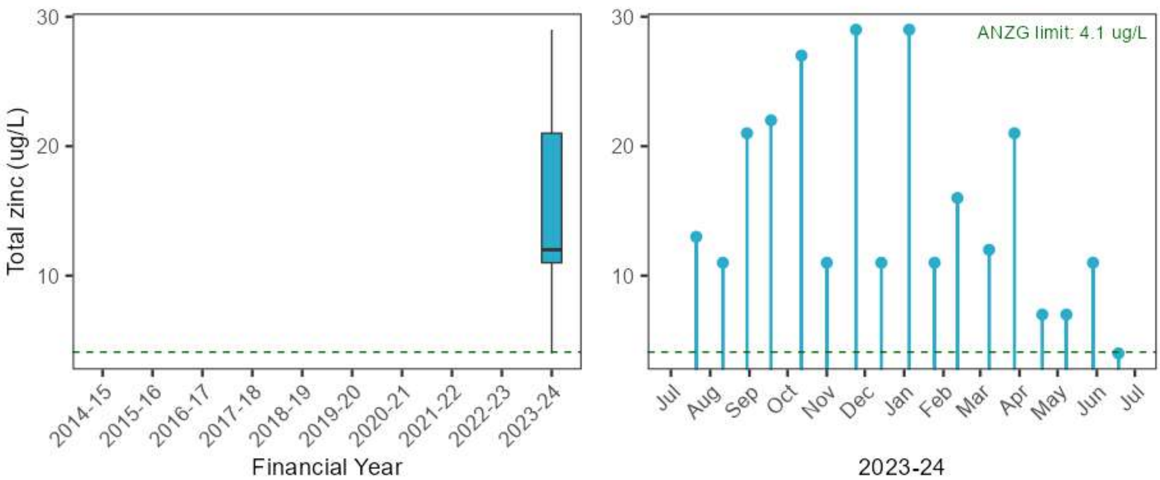
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)

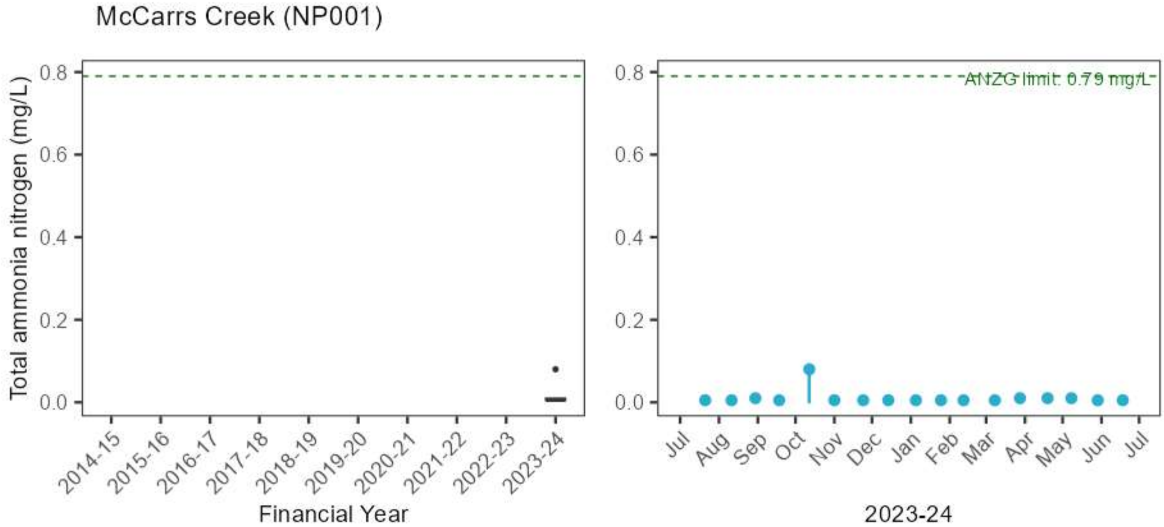


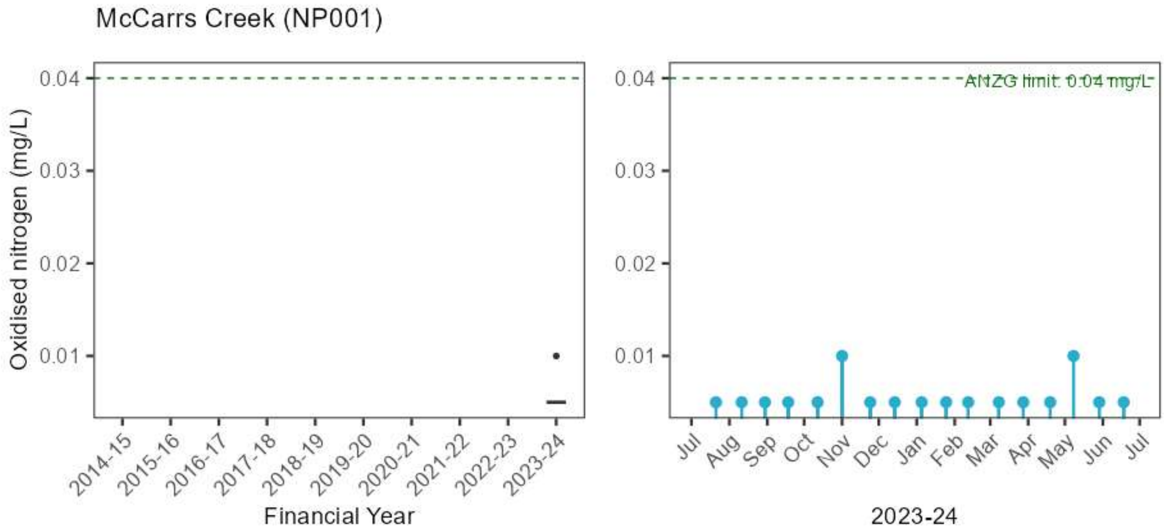
Unnamed tributary of Devlin's Creek, Lane Cove River (LC2421)



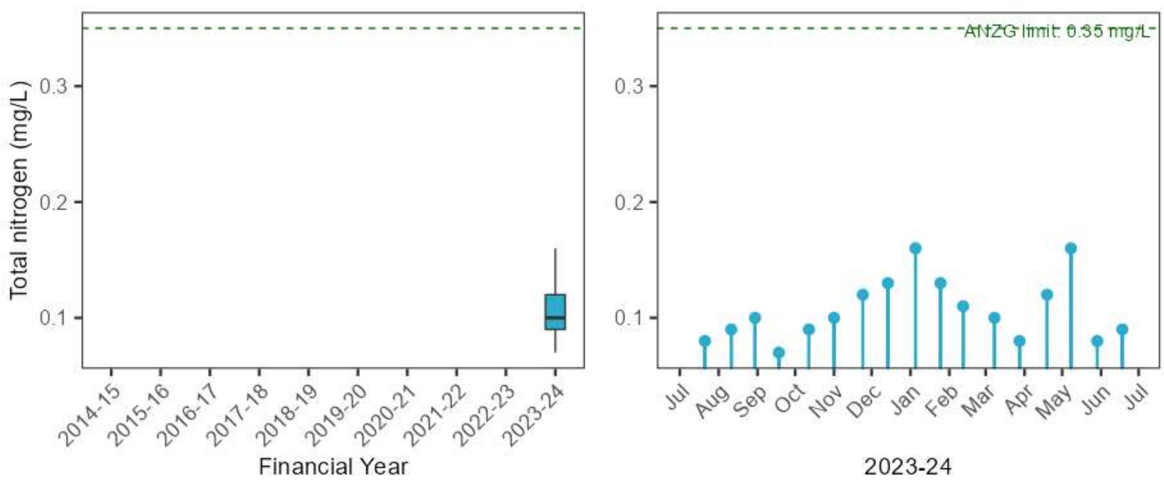
C.3.5. NP001 McCarrs Creek

Stressors – Nutrients

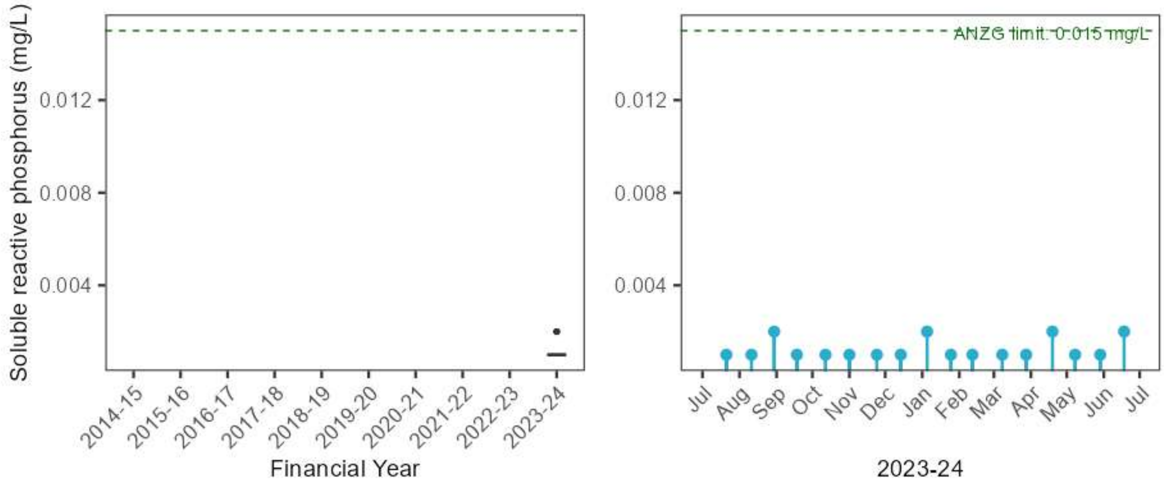




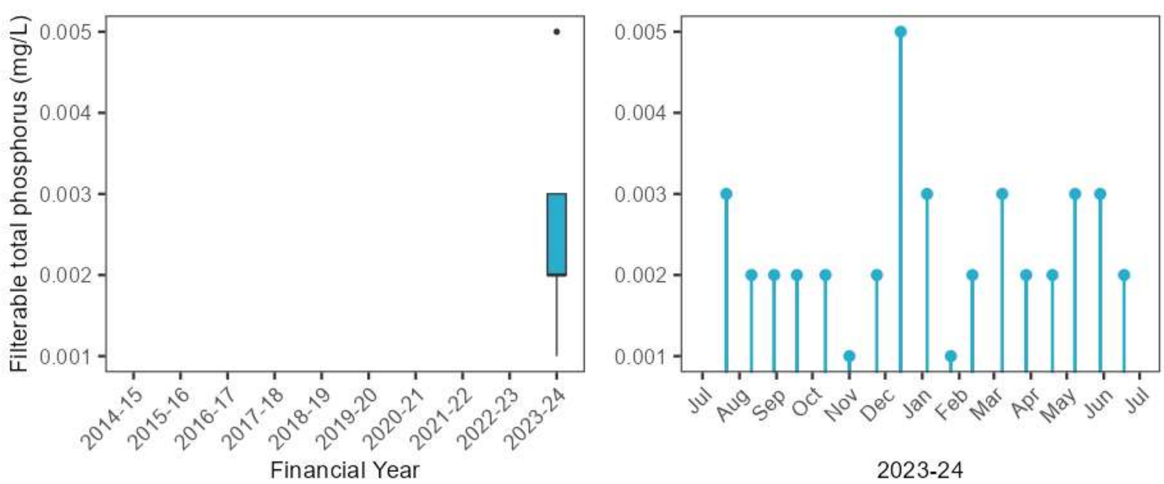
McCarrs Creek (NP001)

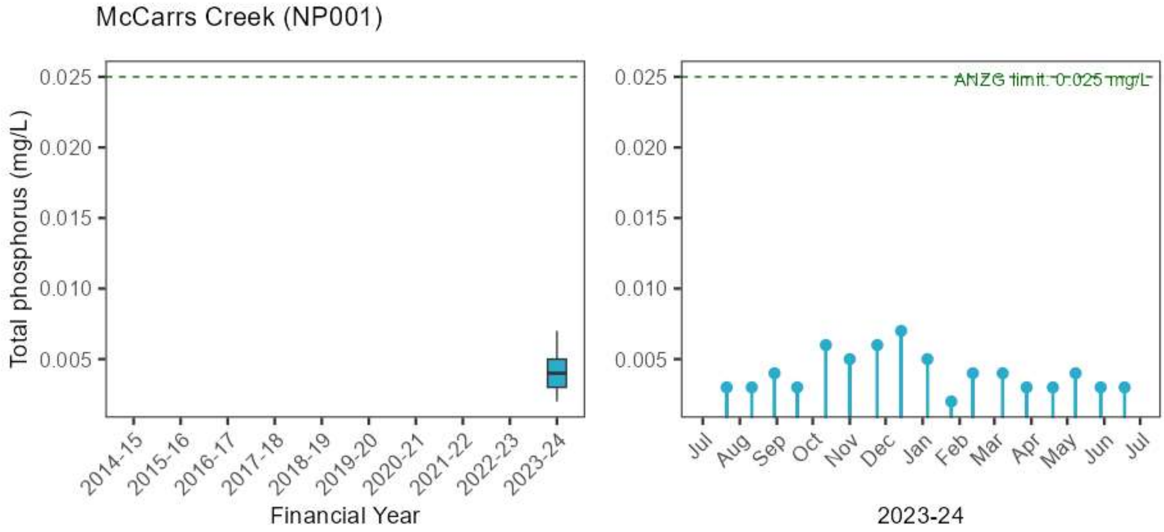


McCarrs Creek (NP001)

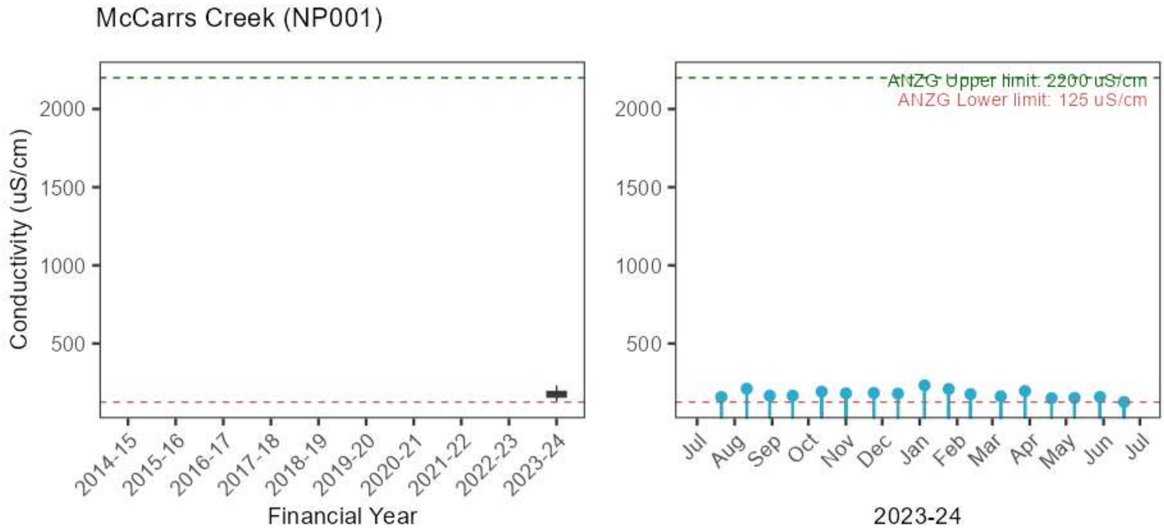


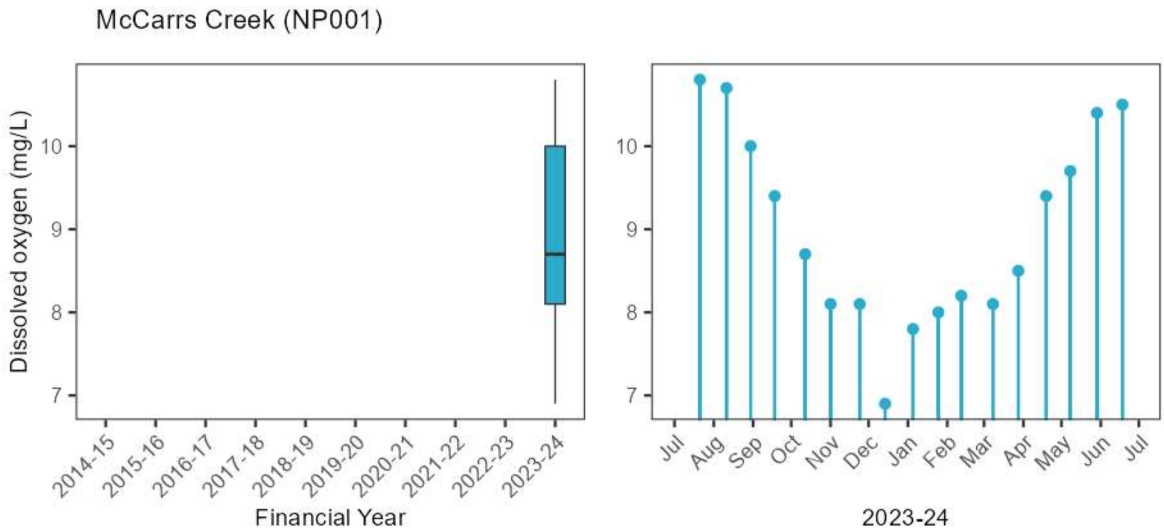
McCarrs Creek (NP001)



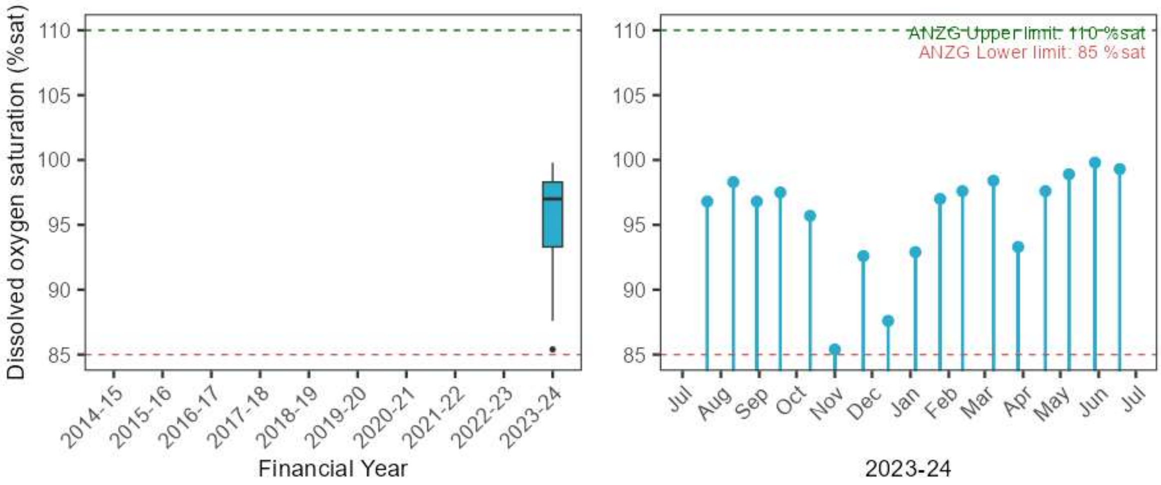


Stressors – Physico-chemical water quality

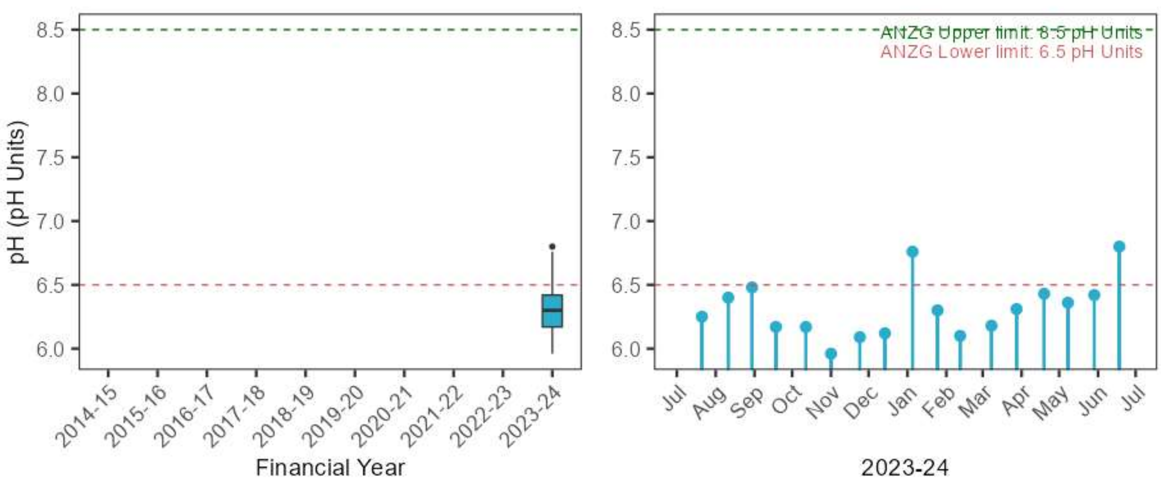




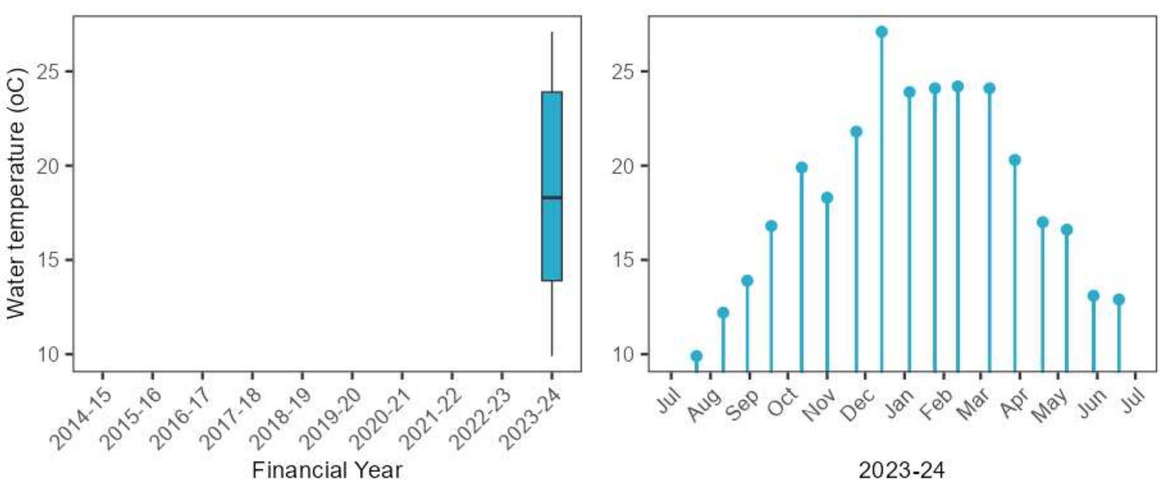
McCarrs Creek (NP001)

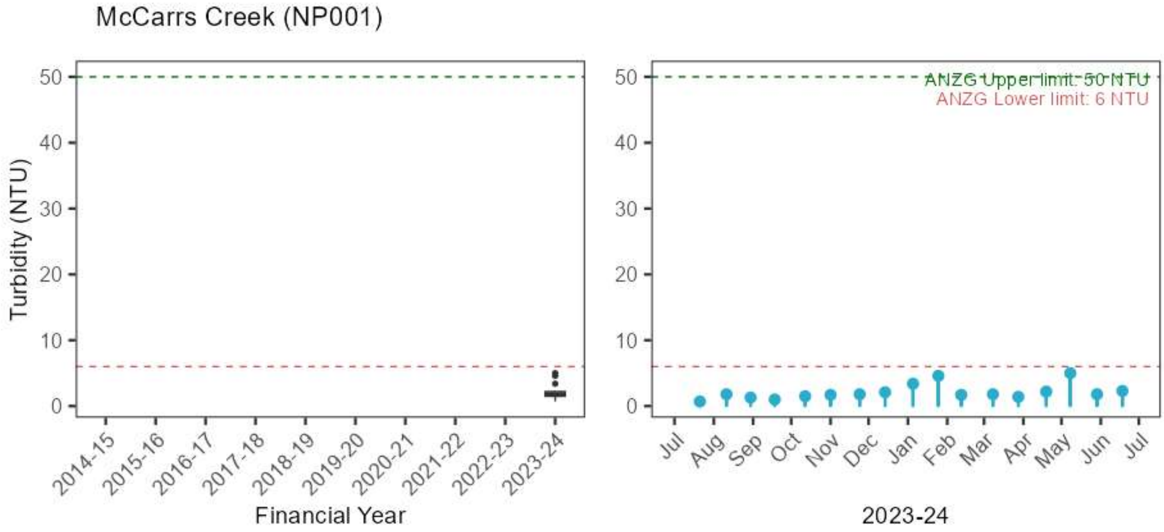


McCarrs Creek (NP001)

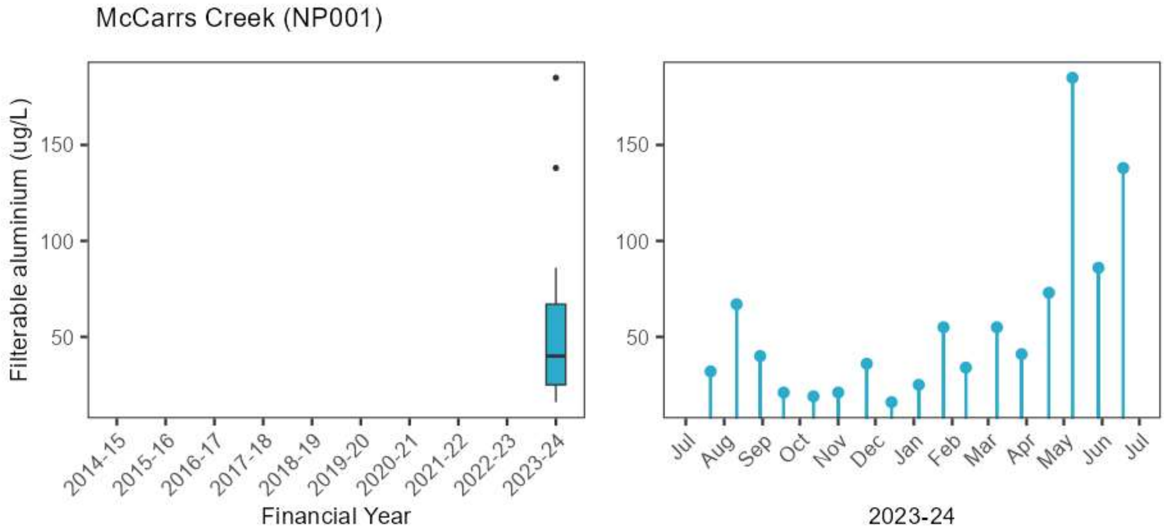


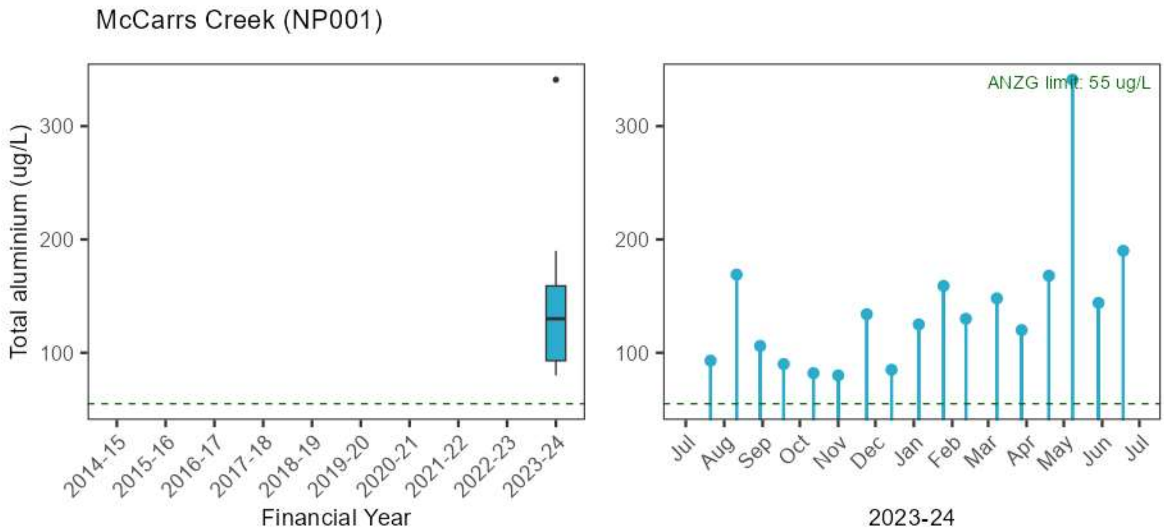
McCarrs Creek (NP001)



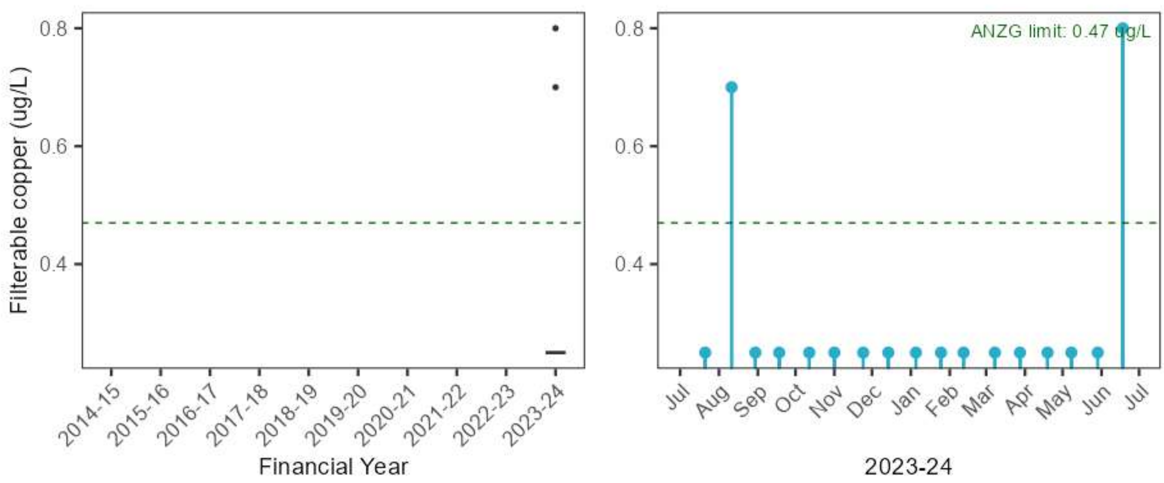


Stressors – Trace metals

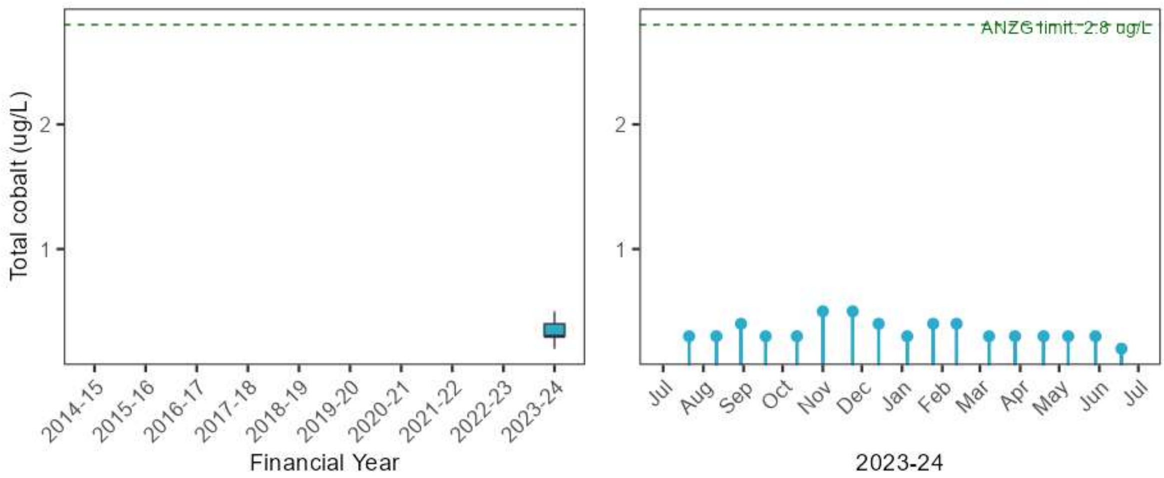




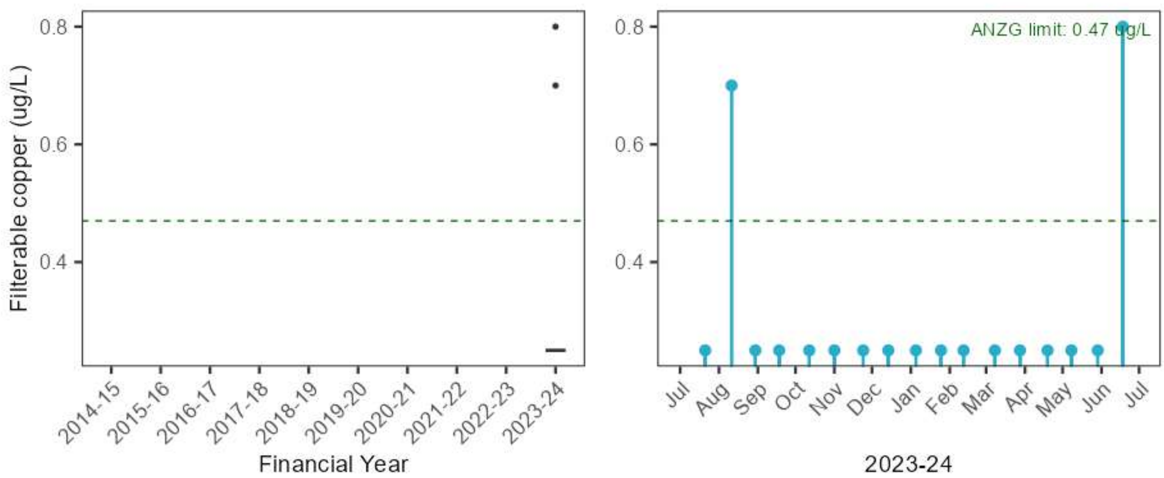
McCarrs Creek (NP001)



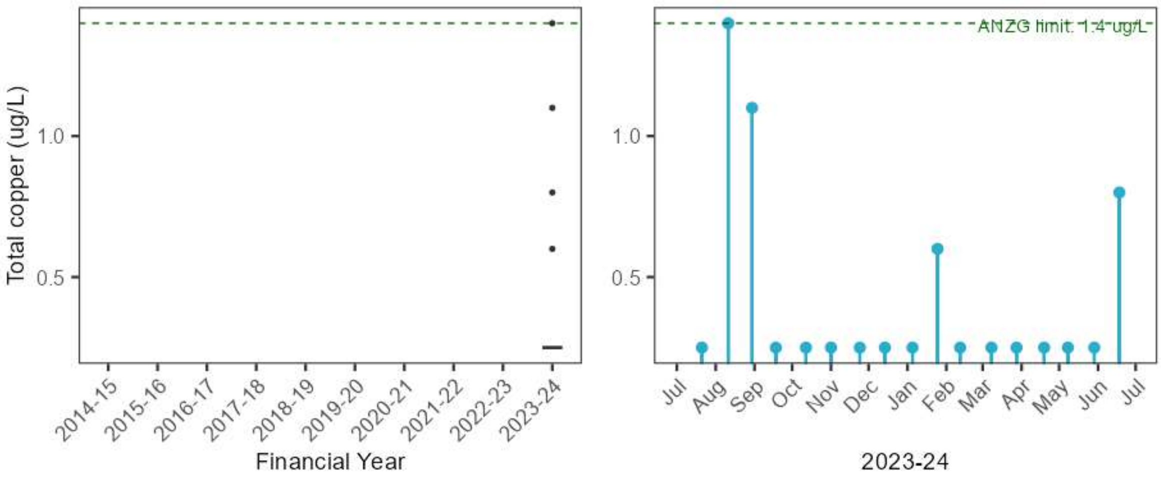
McCarrs Creek (NP001)



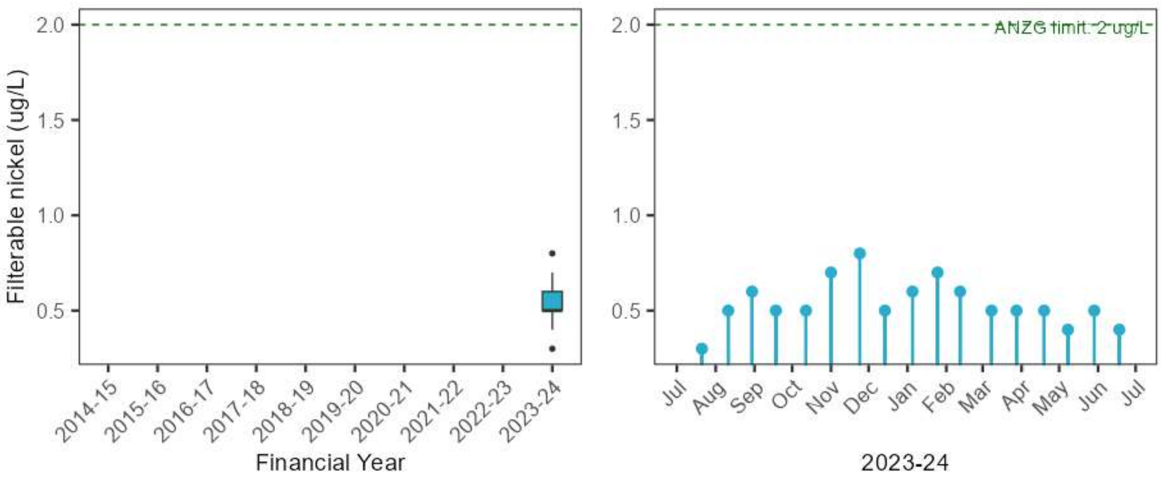
McCarrs Creek (NP001)



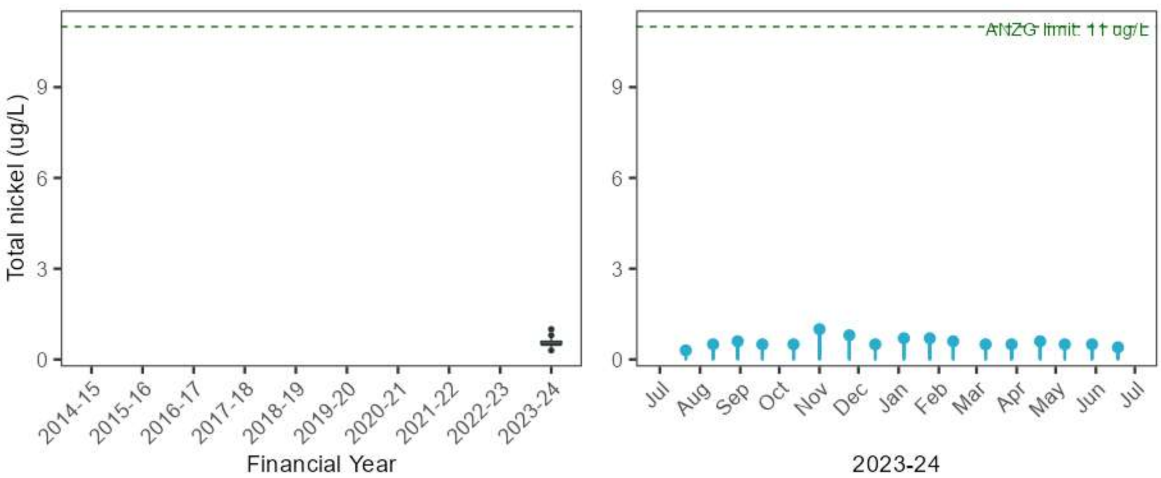
McCarrs Creek (NP001)



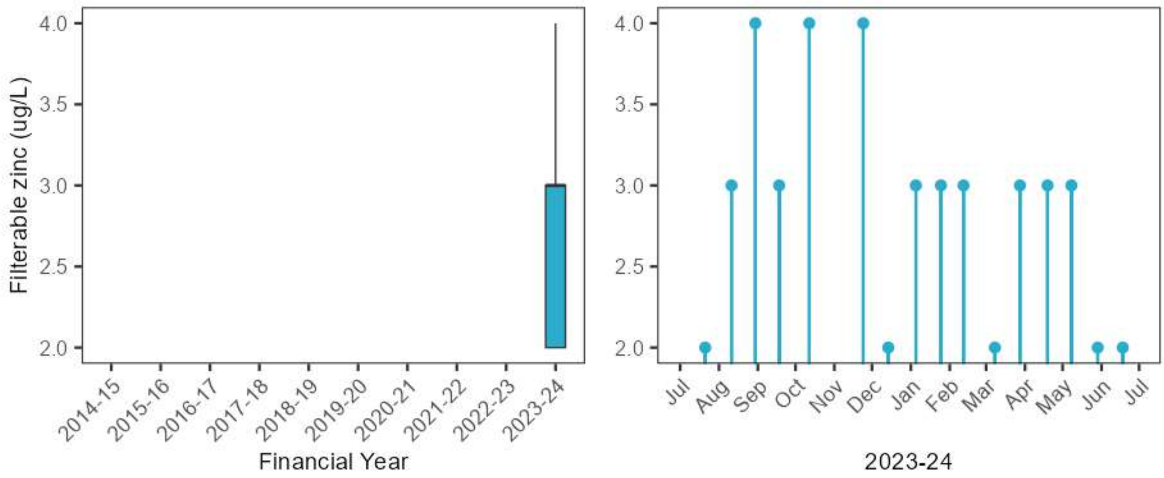
McCarrs Creek (NP001)



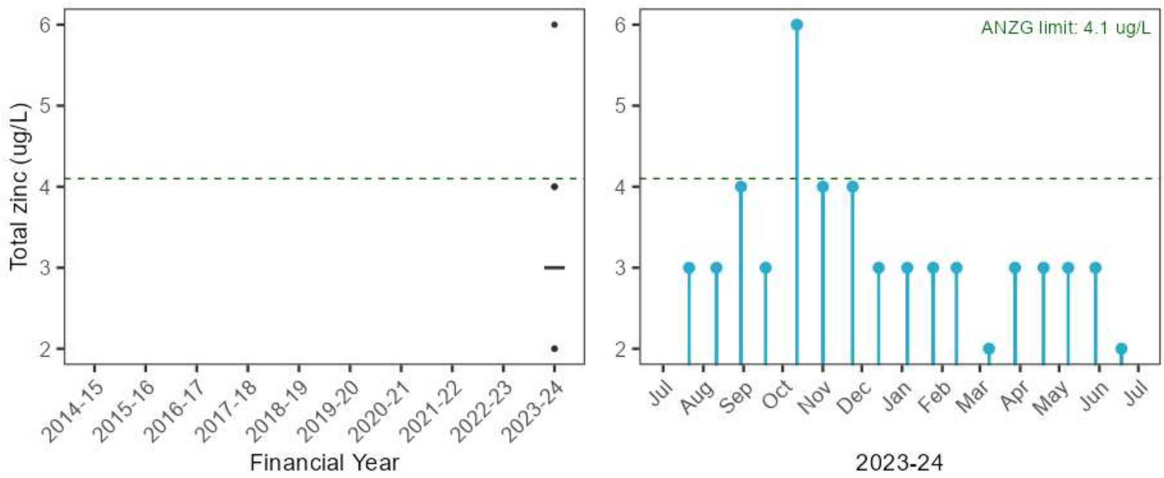
McCarrs Creek (NP001)



McCarrs Creek (NP001)

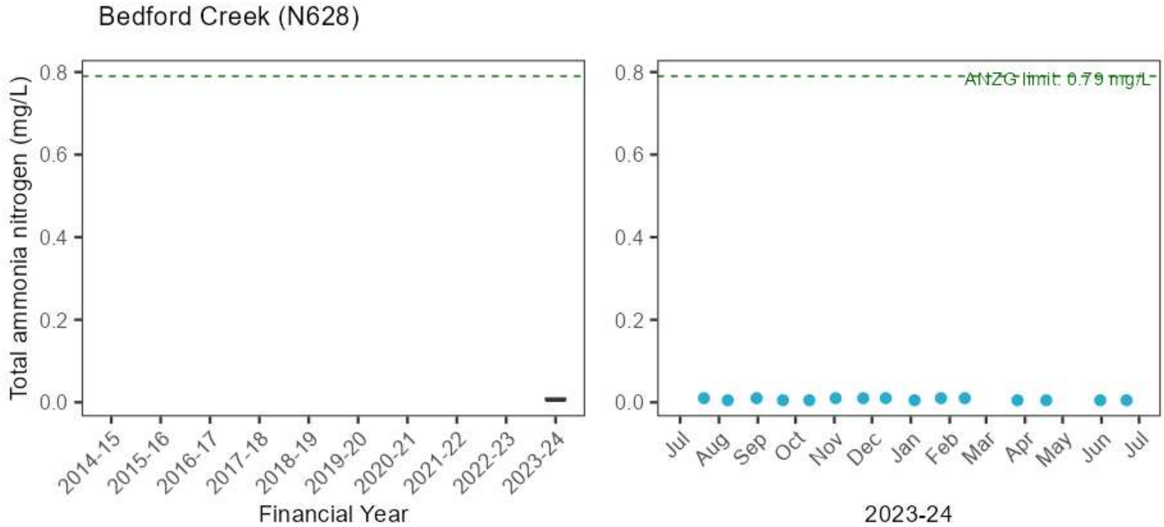


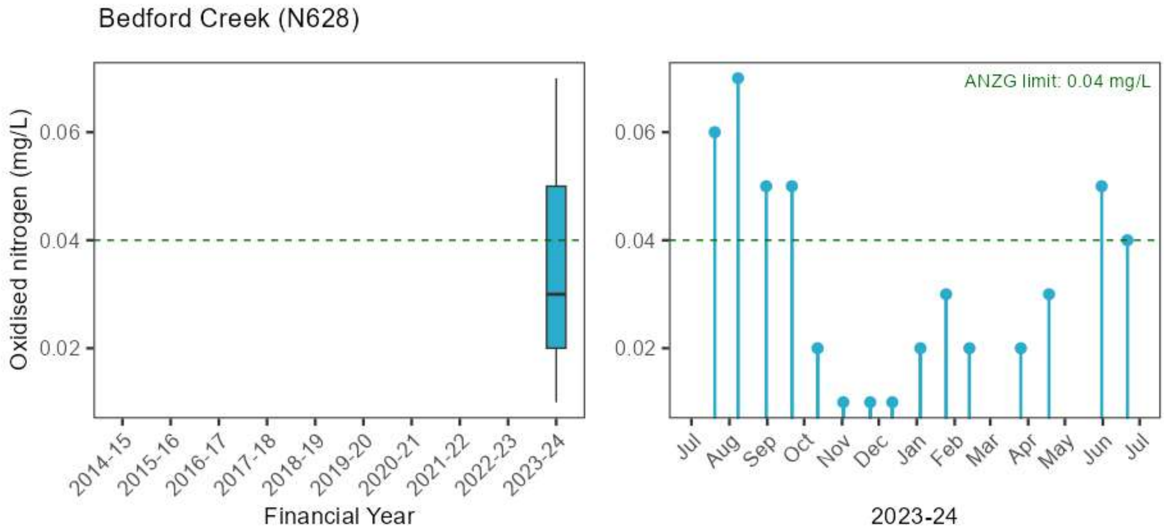
McCarrs Creek (NP001)



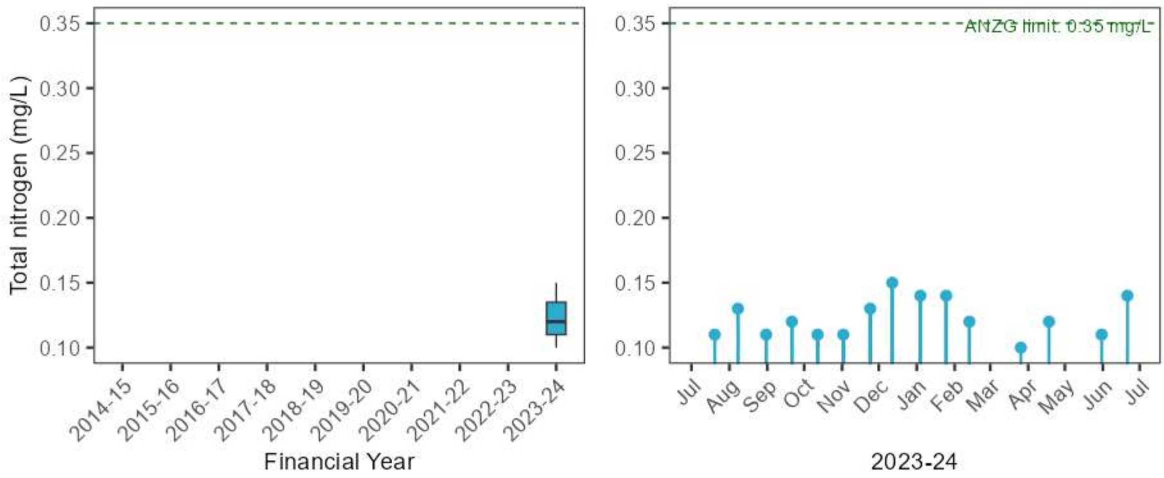
C.3.6. N628 Bedford Creek

Stressors – Nutrients

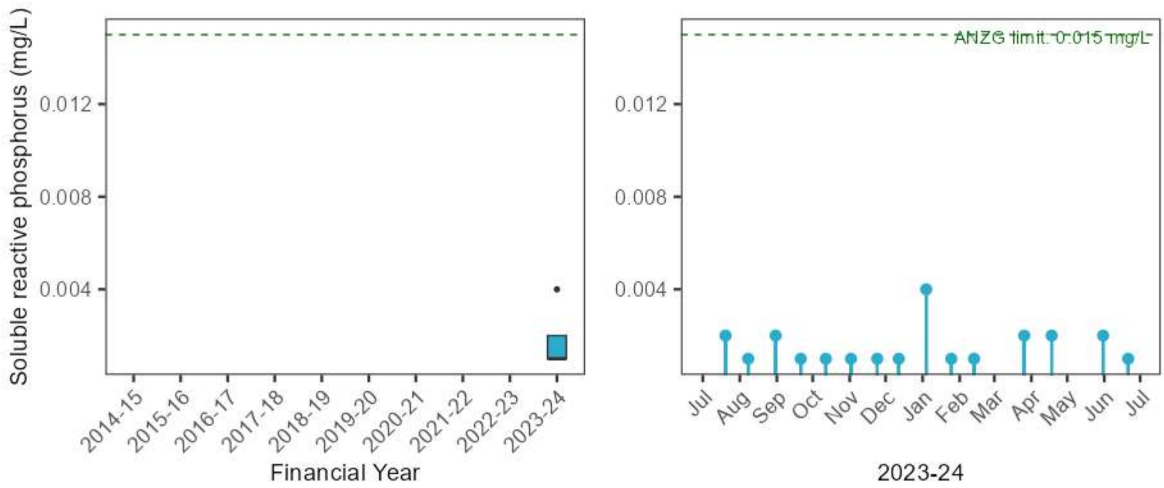




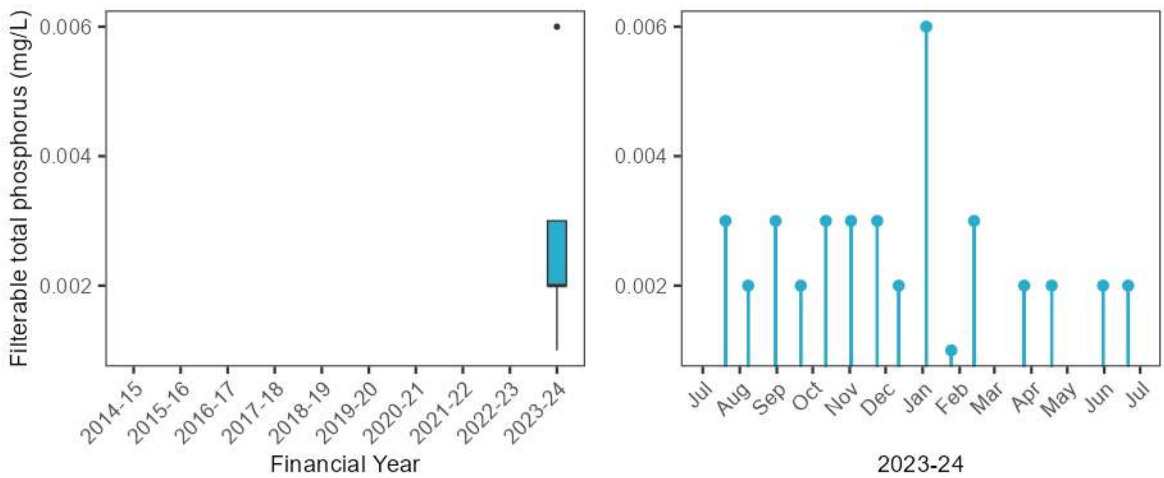
Bedford Creek (N628)

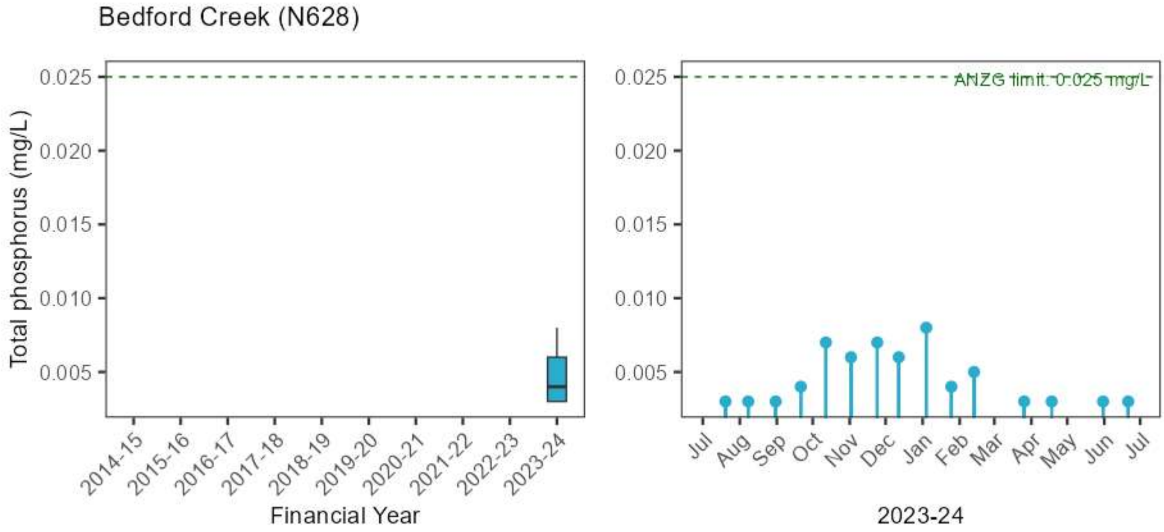


Bedford Creek (N628)

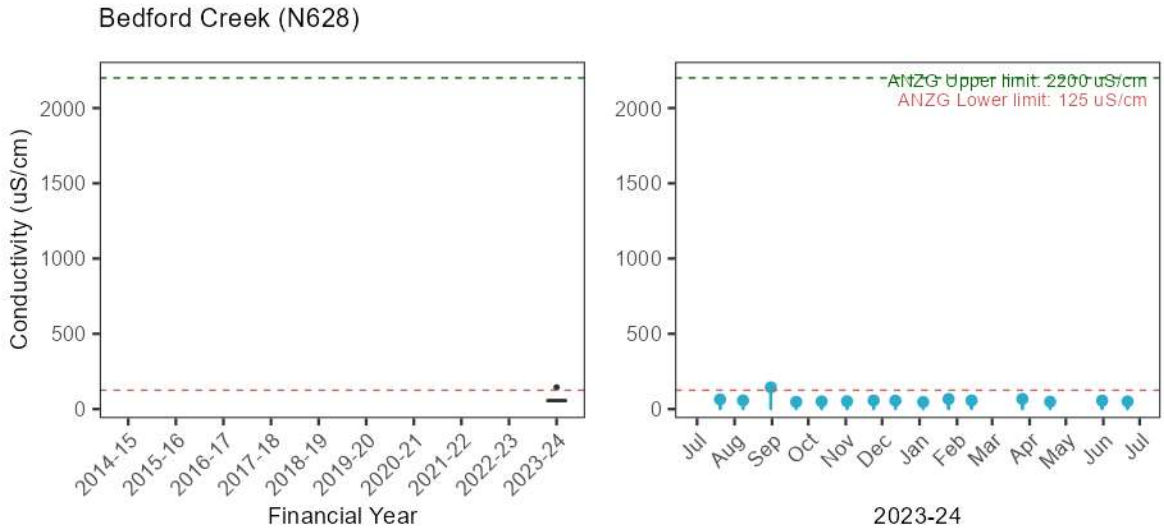


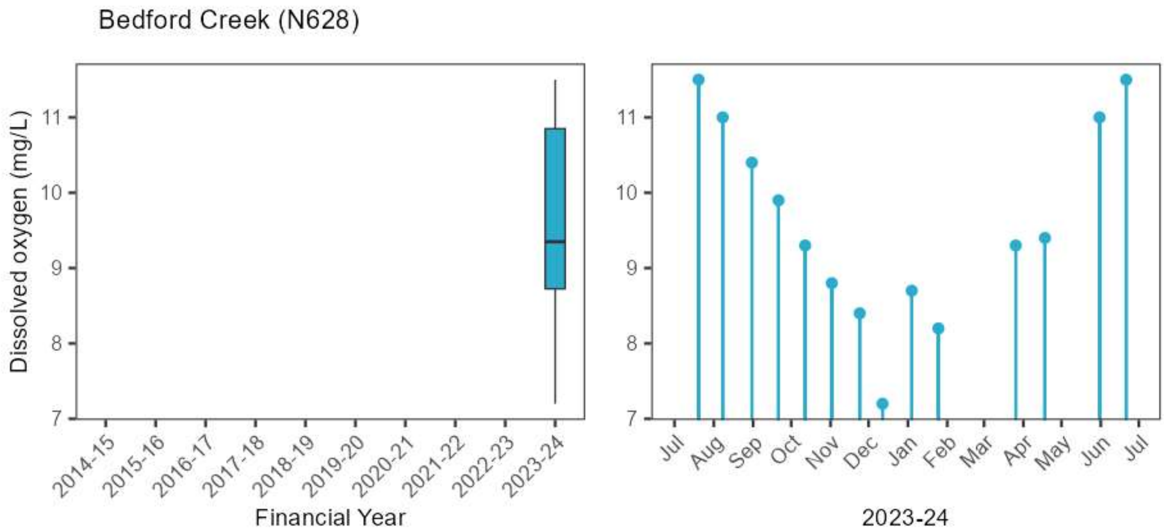
Bedford Creek (N628)



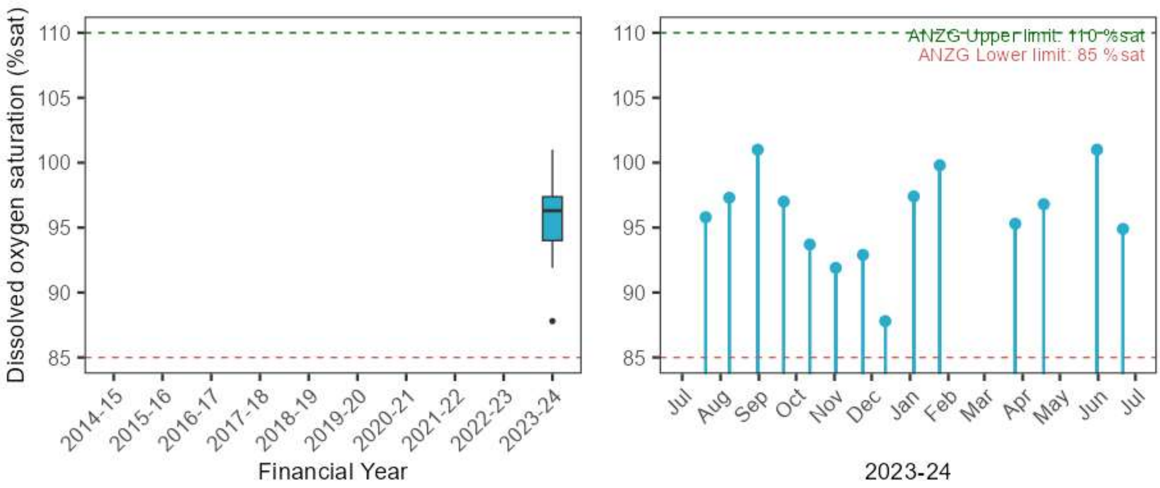


Stressors – Physico-chemical water quality

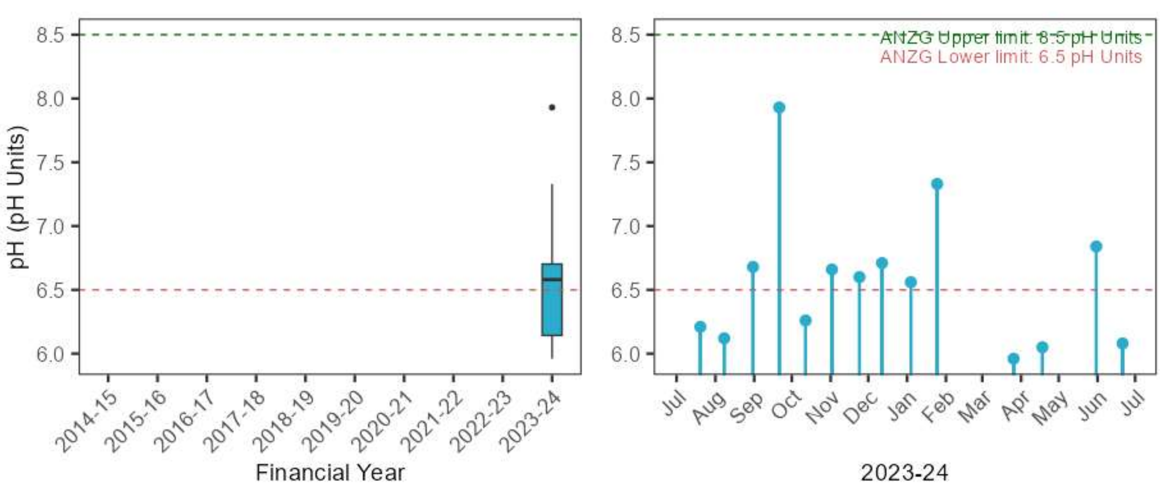




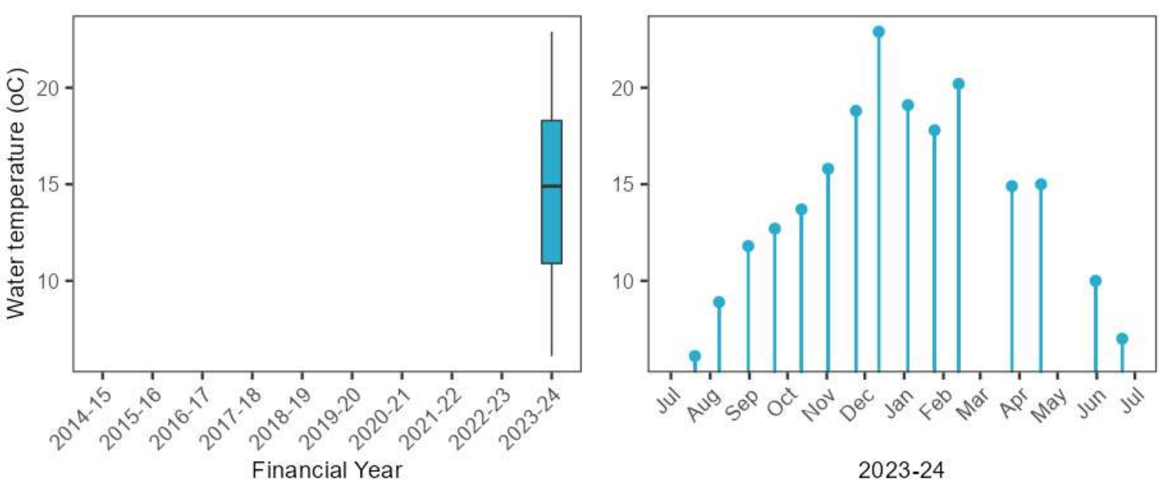
Bedford Creek (N628)

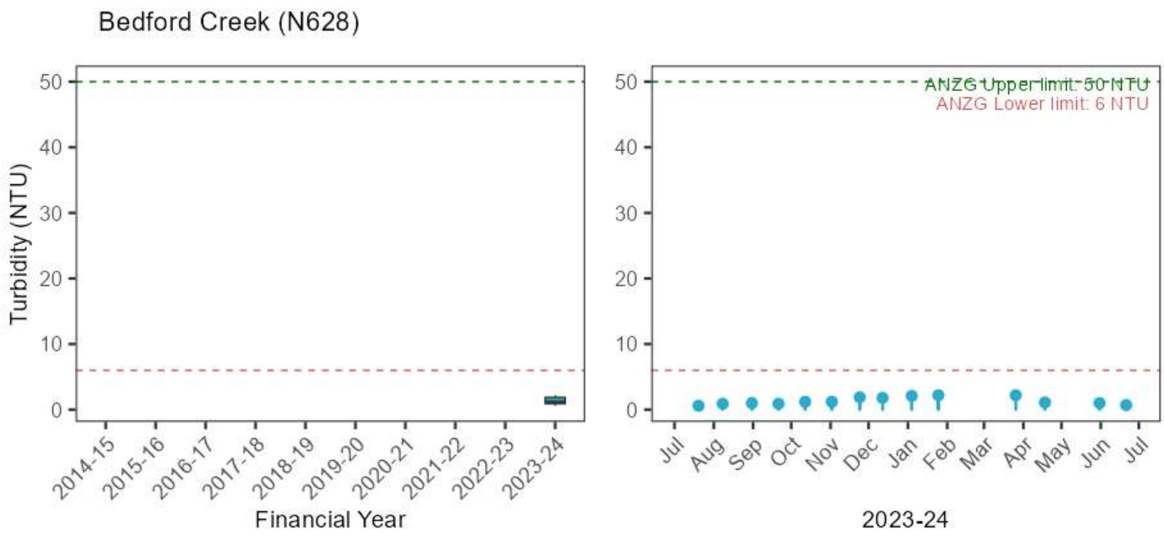


Bedford Creek (N628)

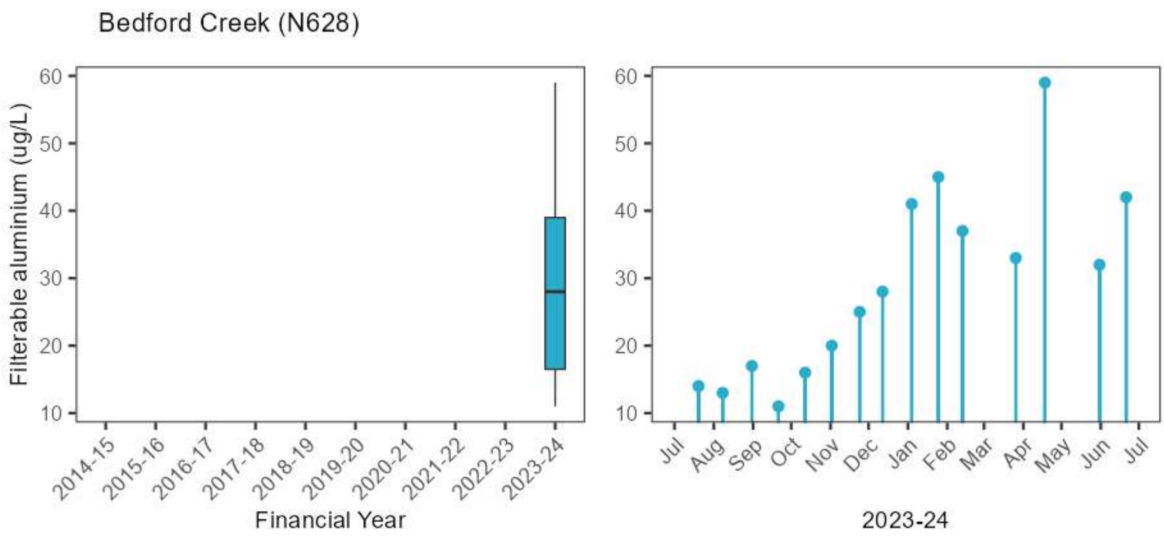


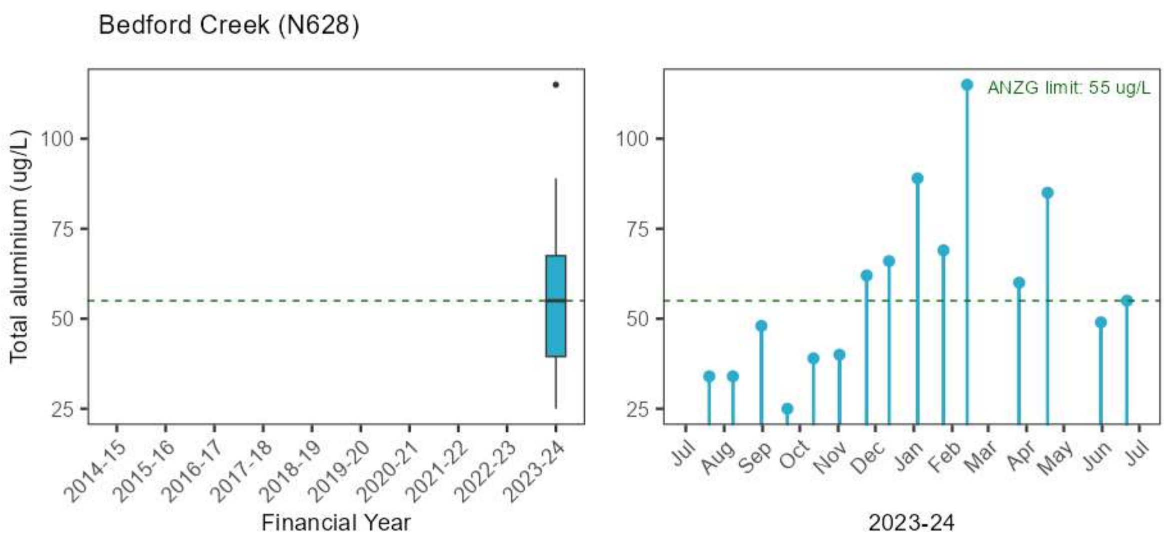
Bedford Creek (N628)



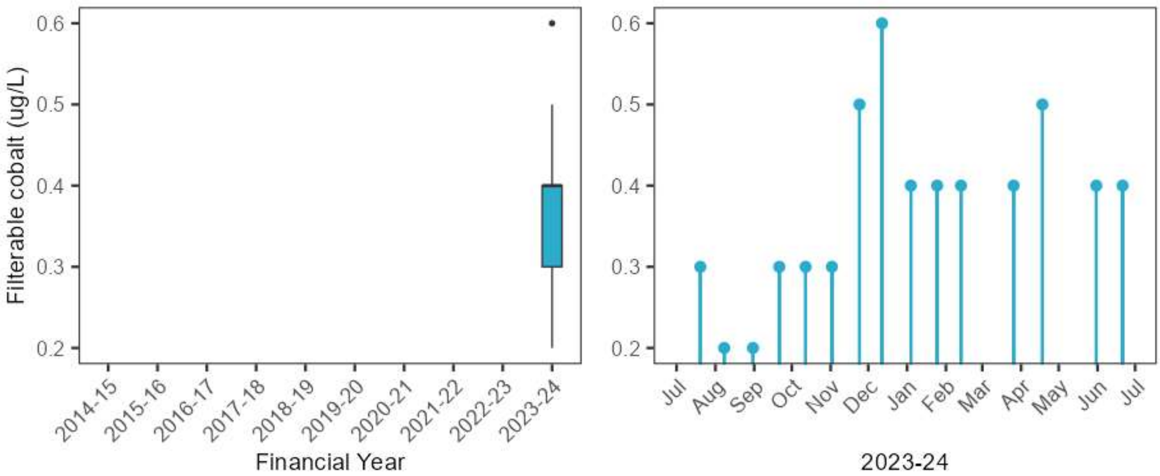


Stressors – Trace metals

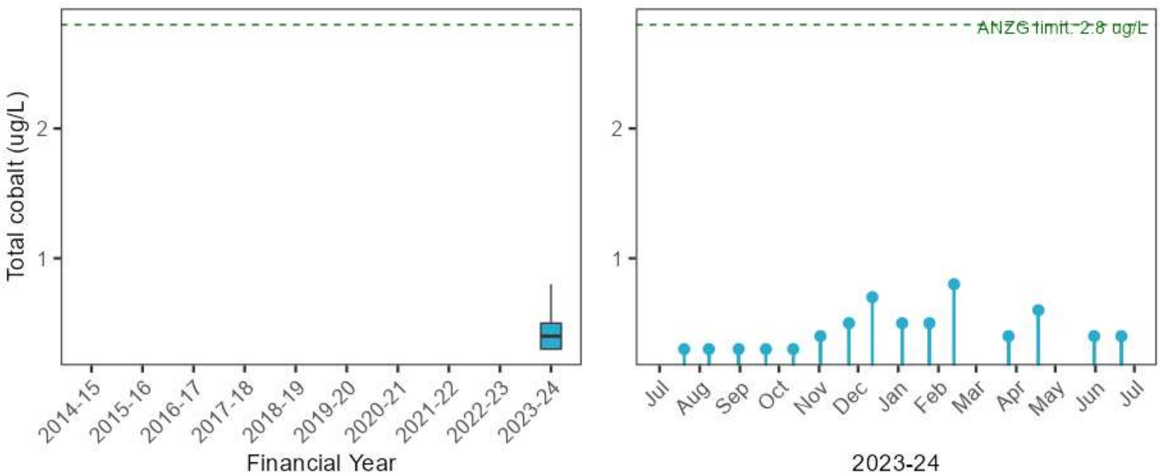




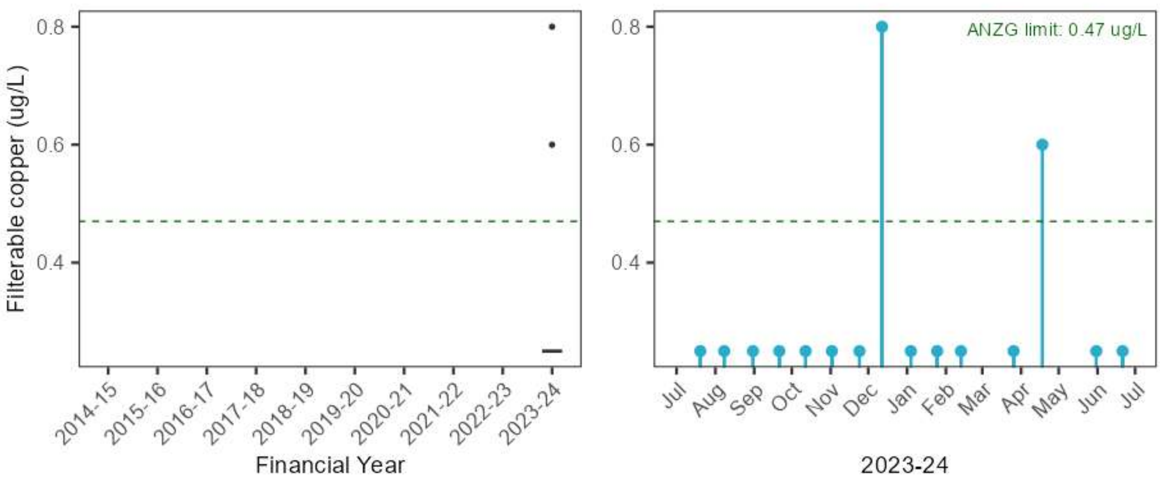
Bedford Creek (N628)



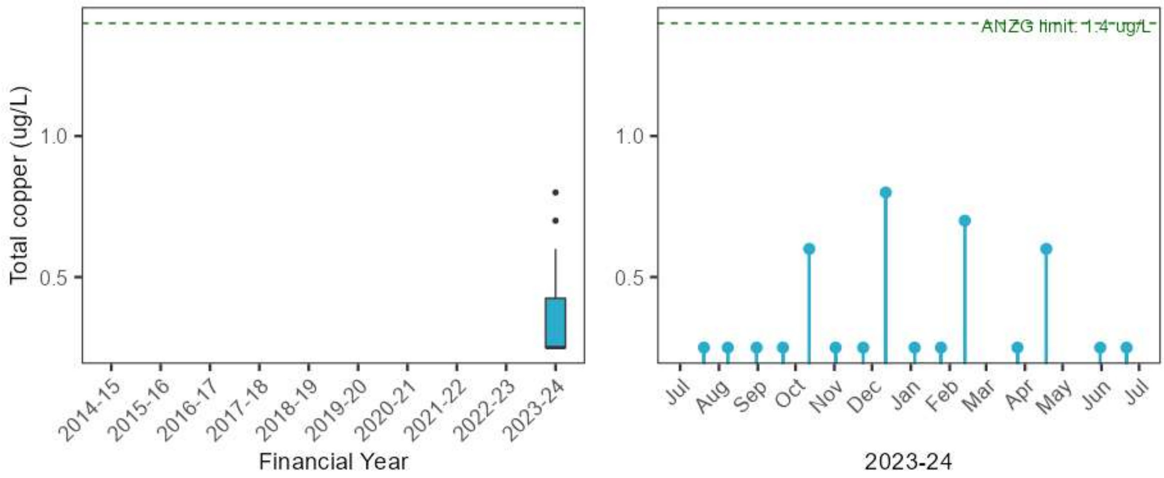
Bedford Creek (N628)



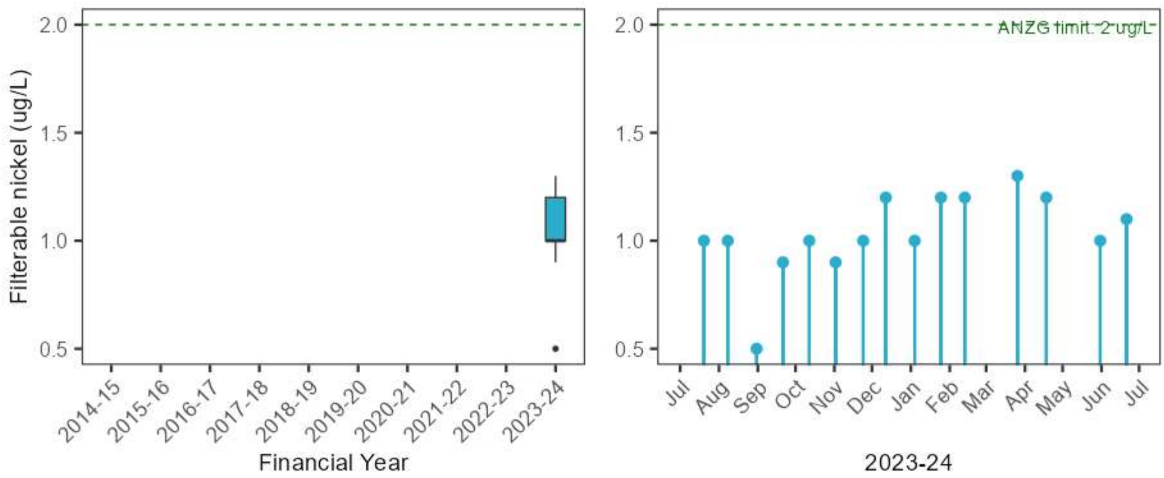
Bedford Creek (N628)



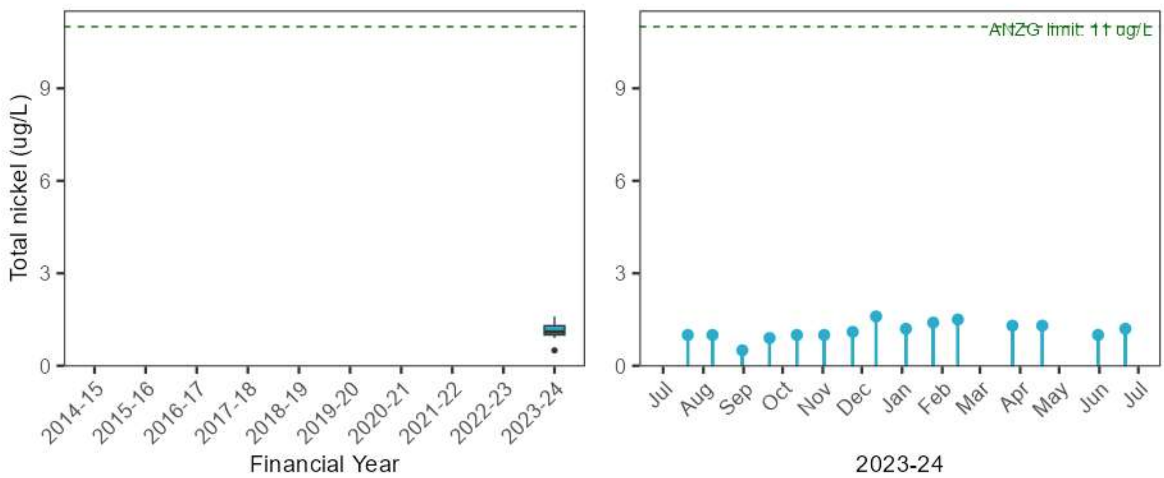
Bedford Creek (N628)



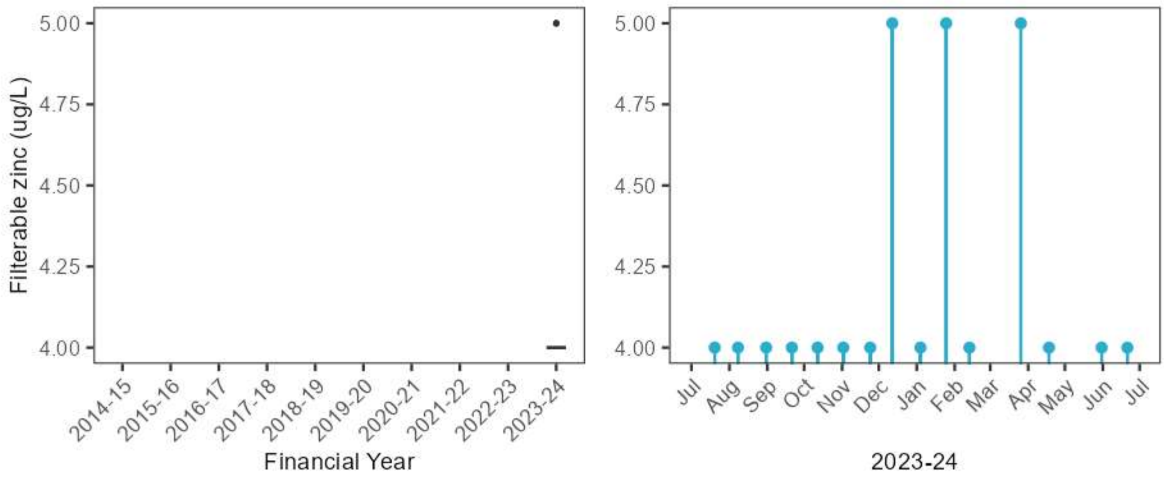
Bedford Creek (N628)



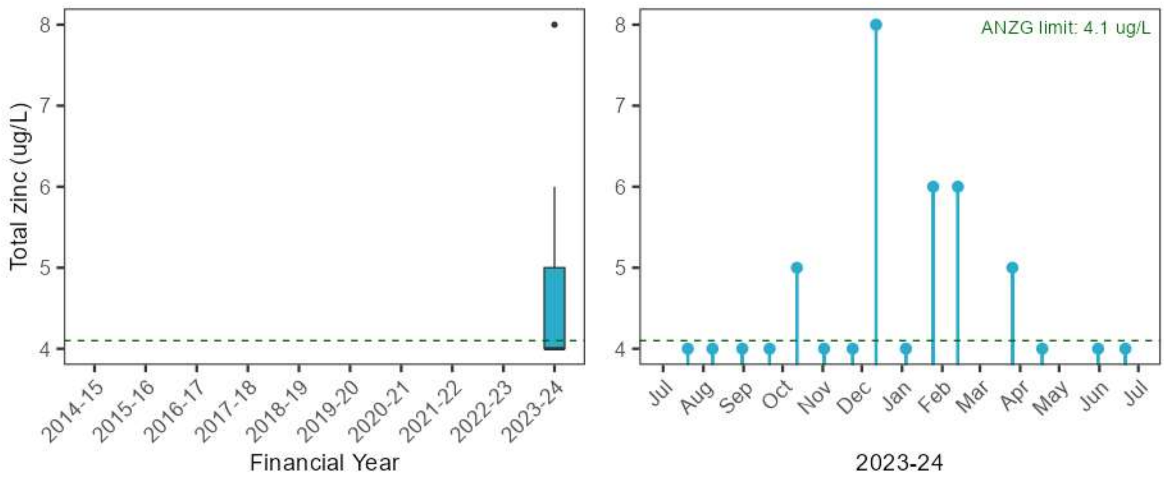
Bedford Creek (N628)



Bedford Creek (N628)

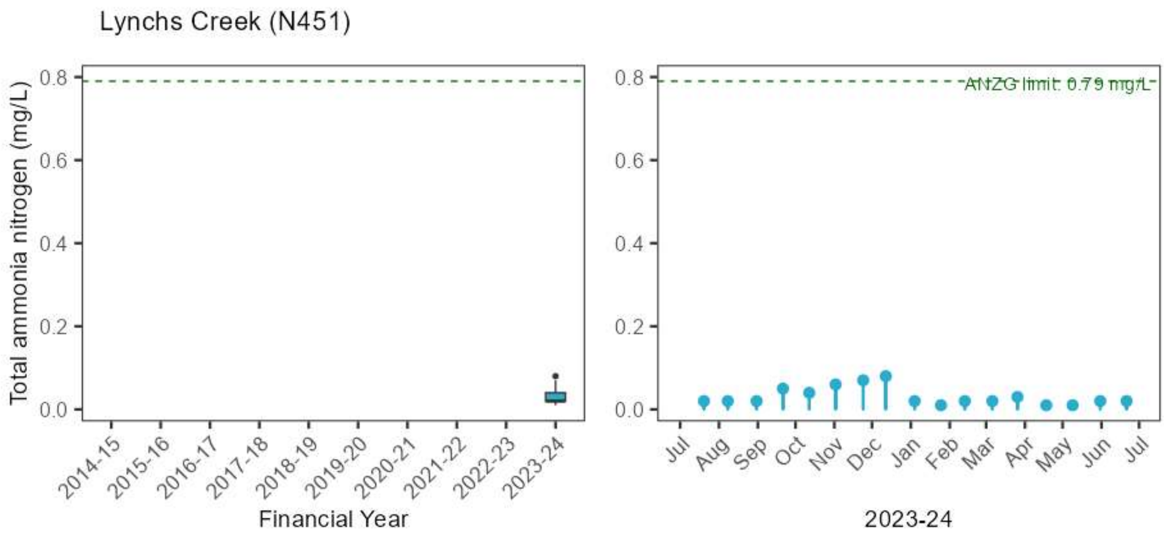


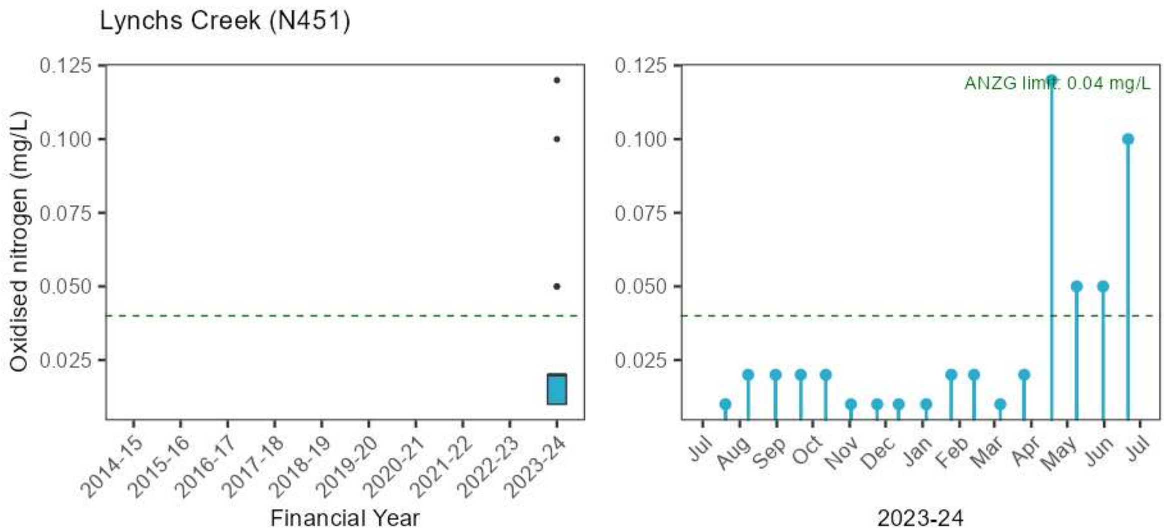
Bedford Creek (N628)

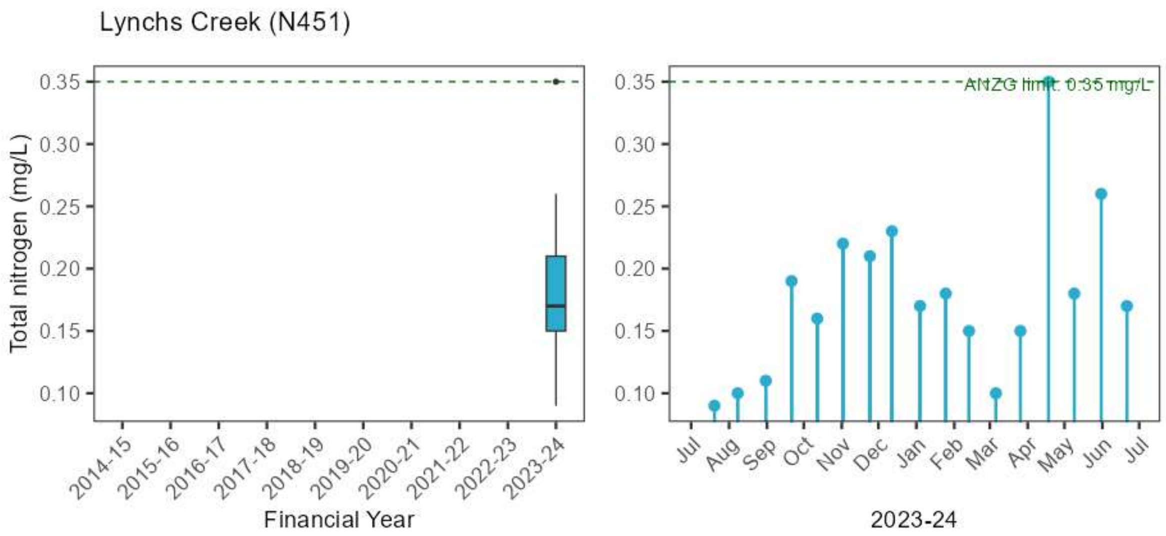


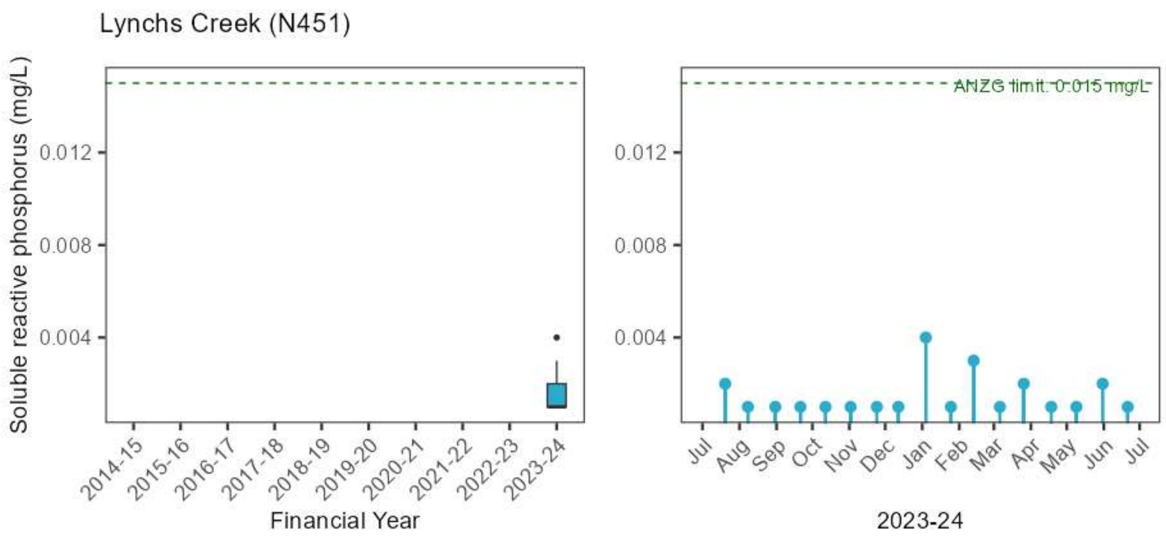
C.3.7. N451 Lynchs Creek

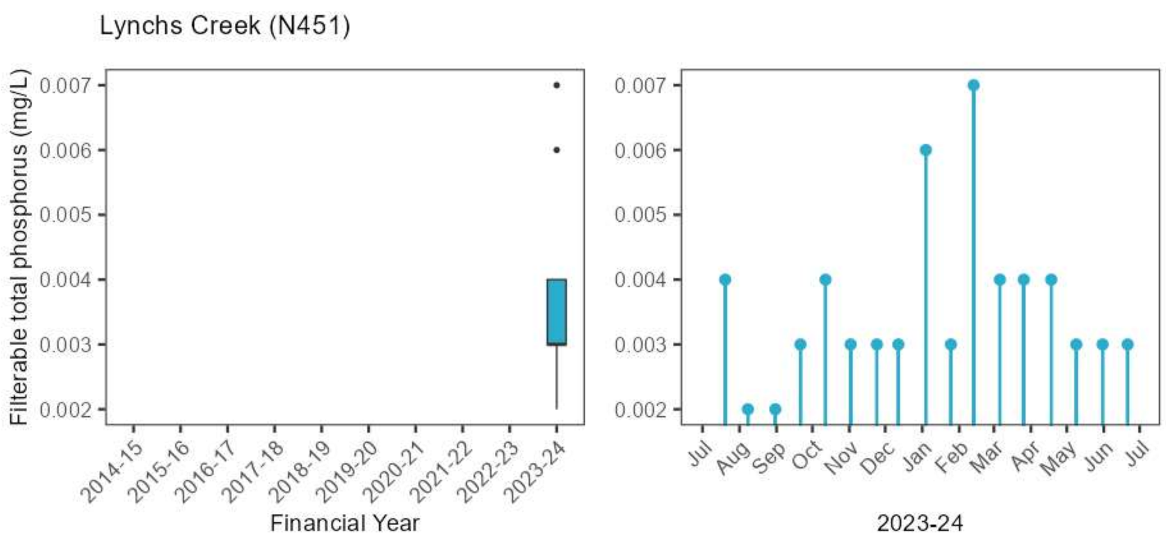
Stressors – Nutrients

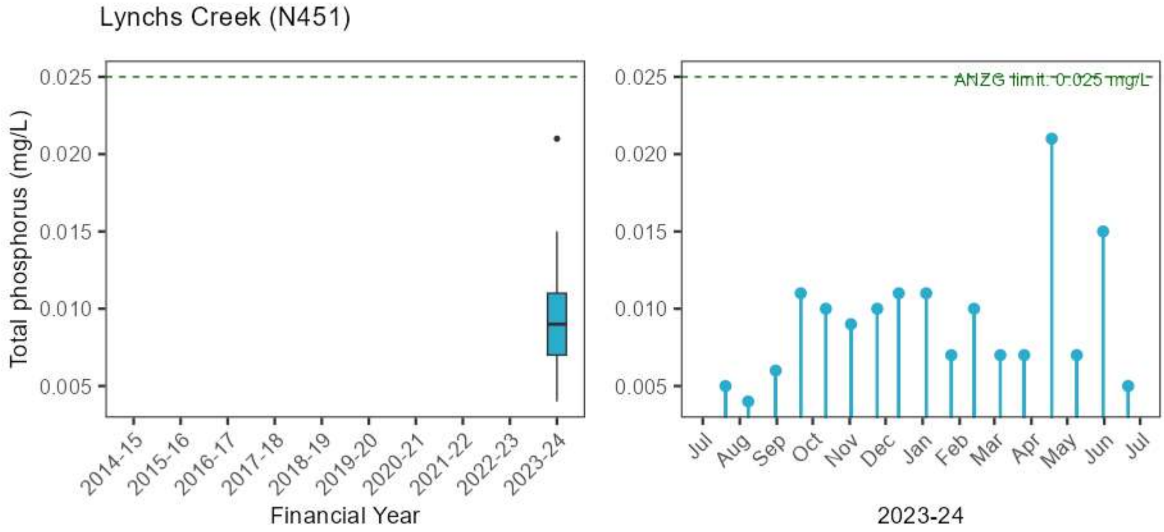




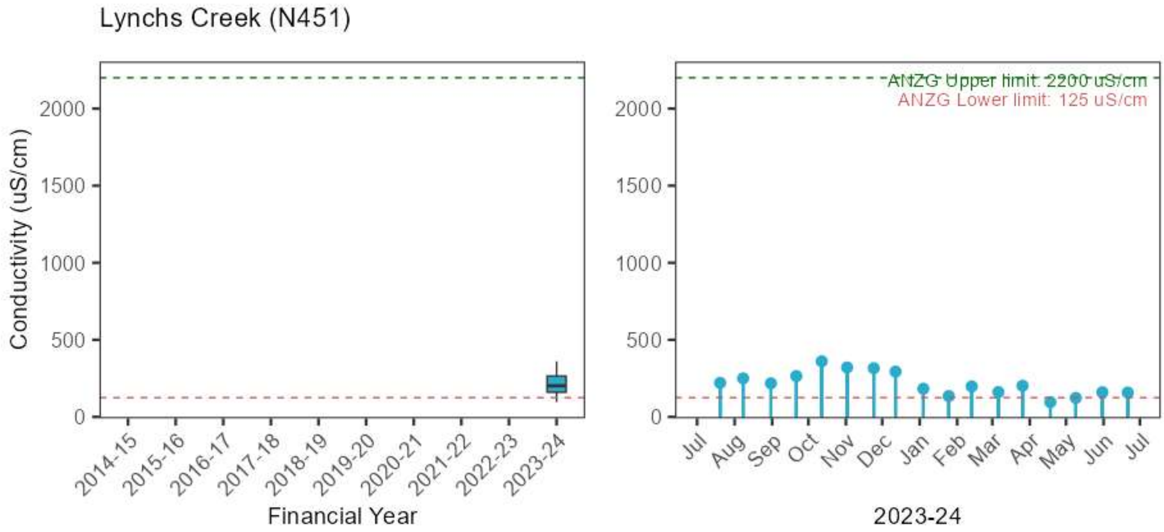

Lynchs Creek (N451)
Total nitrogen (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.35 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

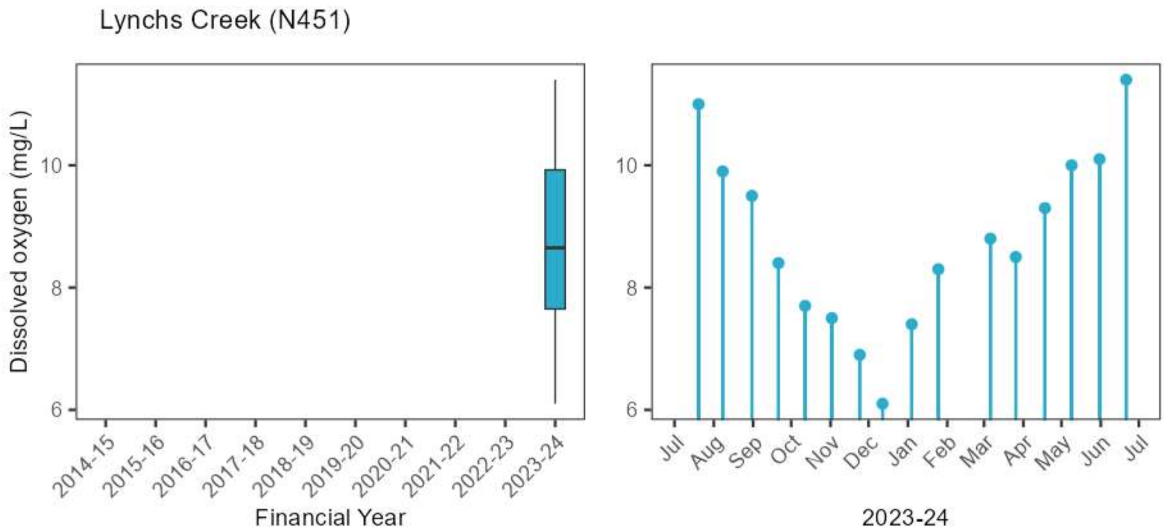

Lynchs Creek (N451)
Soluble reactive phosphorus (mg/L)
0.012
0.008
0.004
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
ANZG limit: 0.015 mg/L
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24


Lynchs Creek (N451)
Filterable total phosphorus (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2023-24

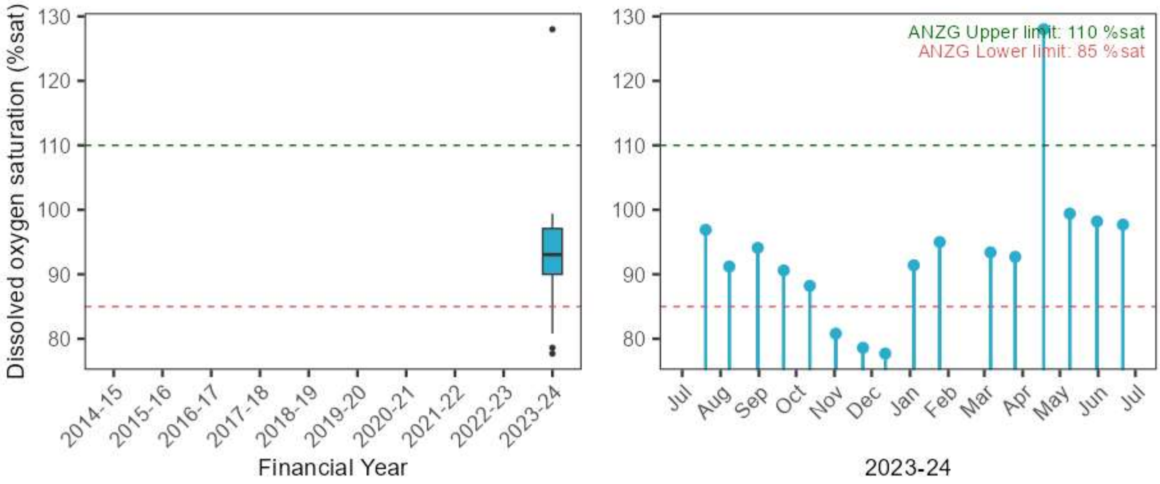


Stressors – Physico-chemical water quality

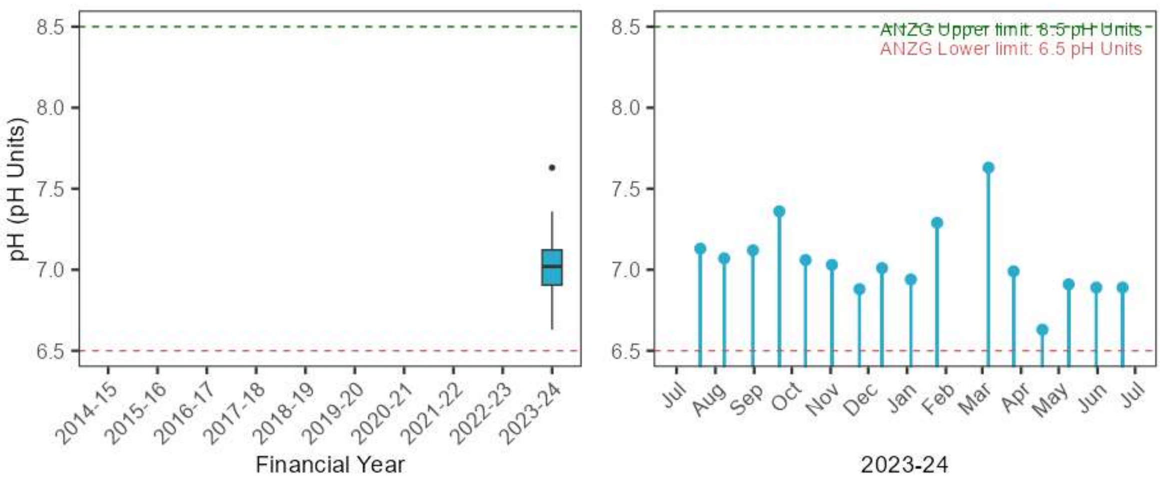




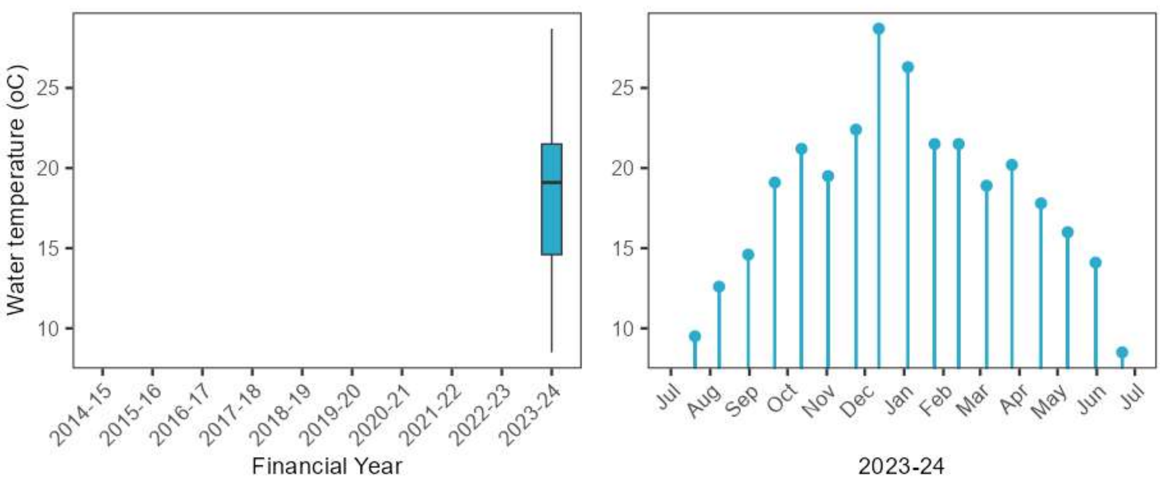
Lynchs Creek (N451)

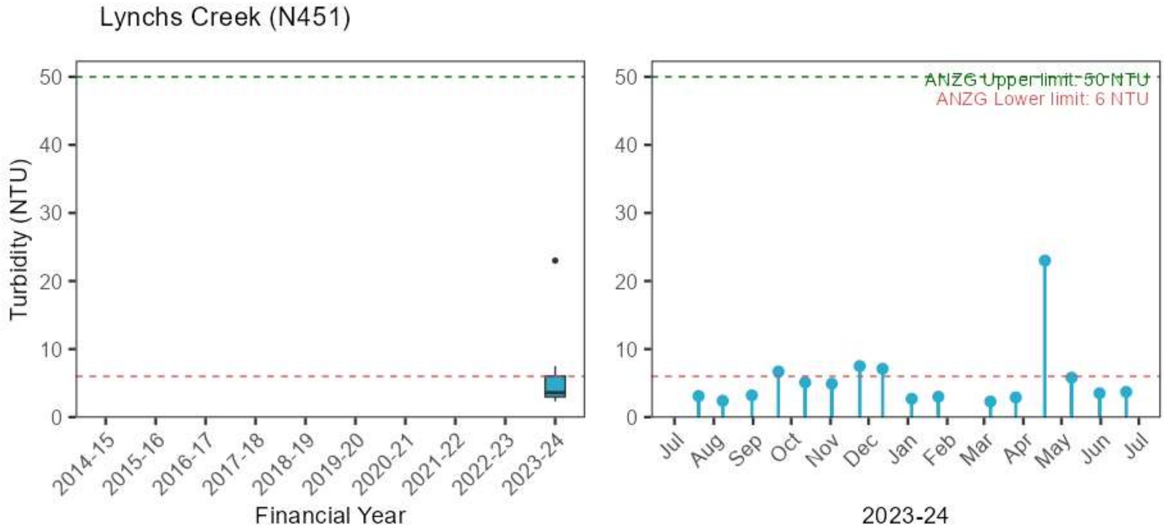


Lynchs Creek (N451)

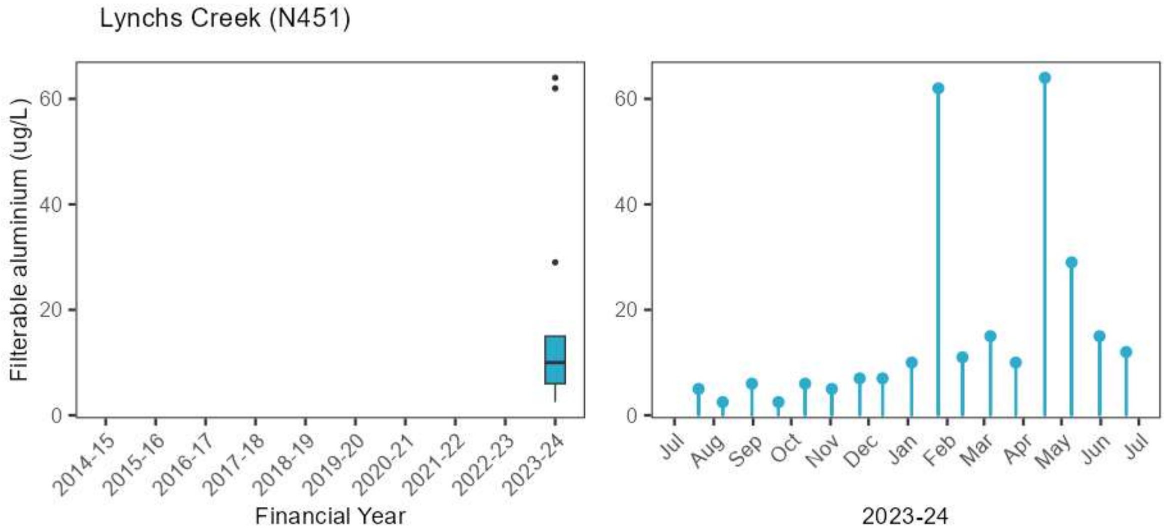


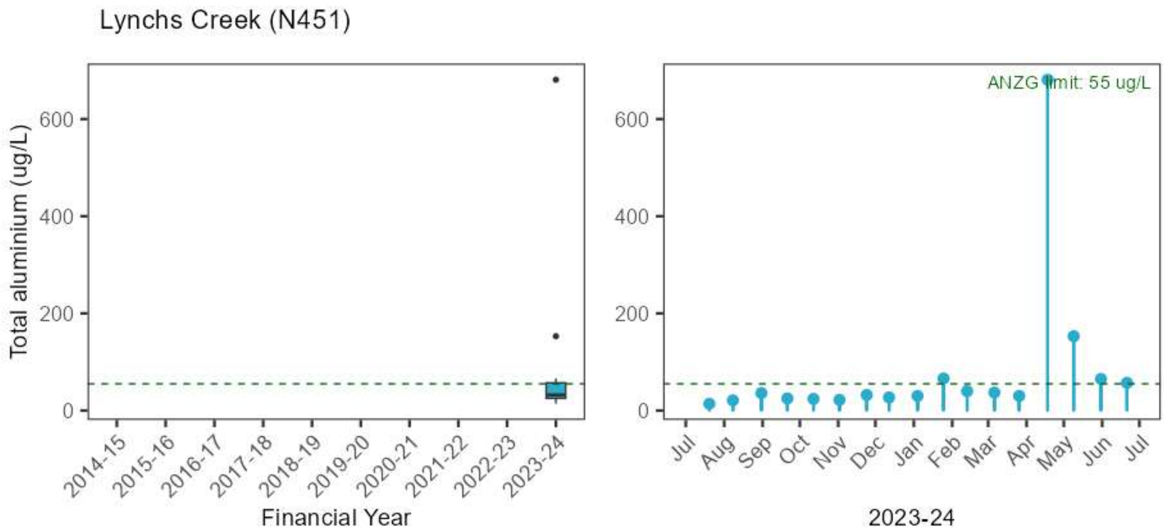
Lynchs Creek (N451)

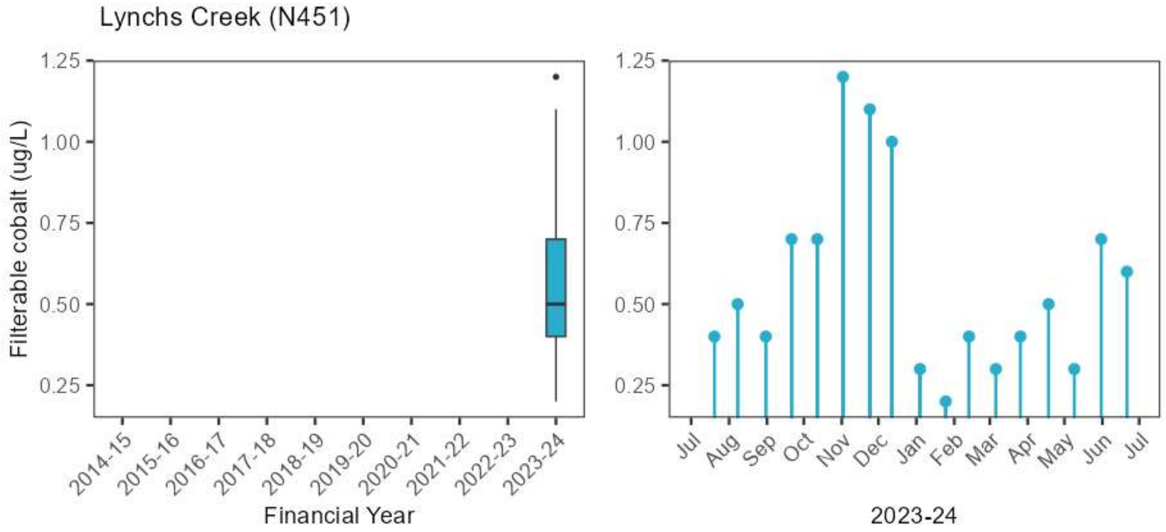


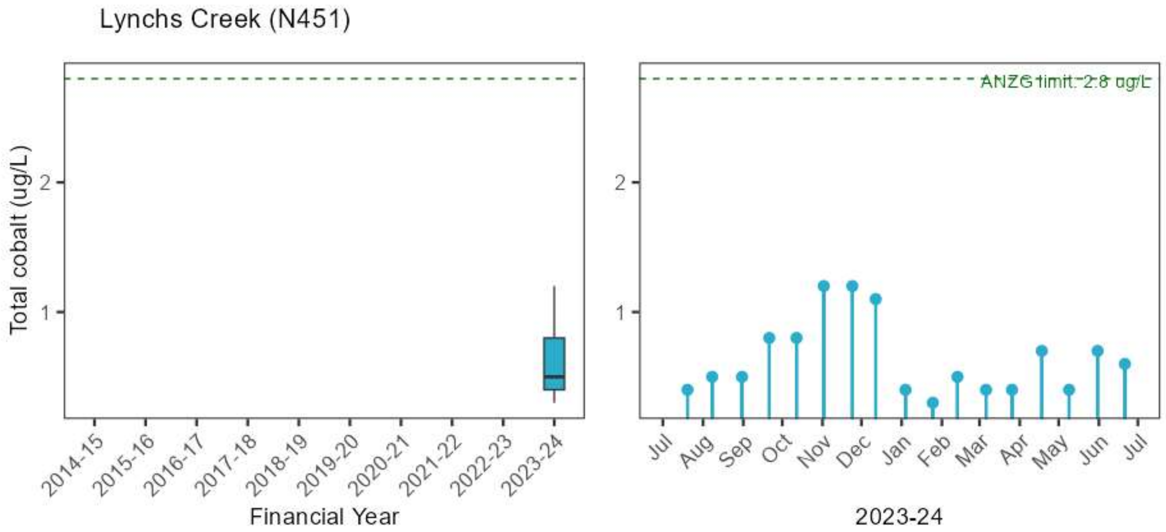


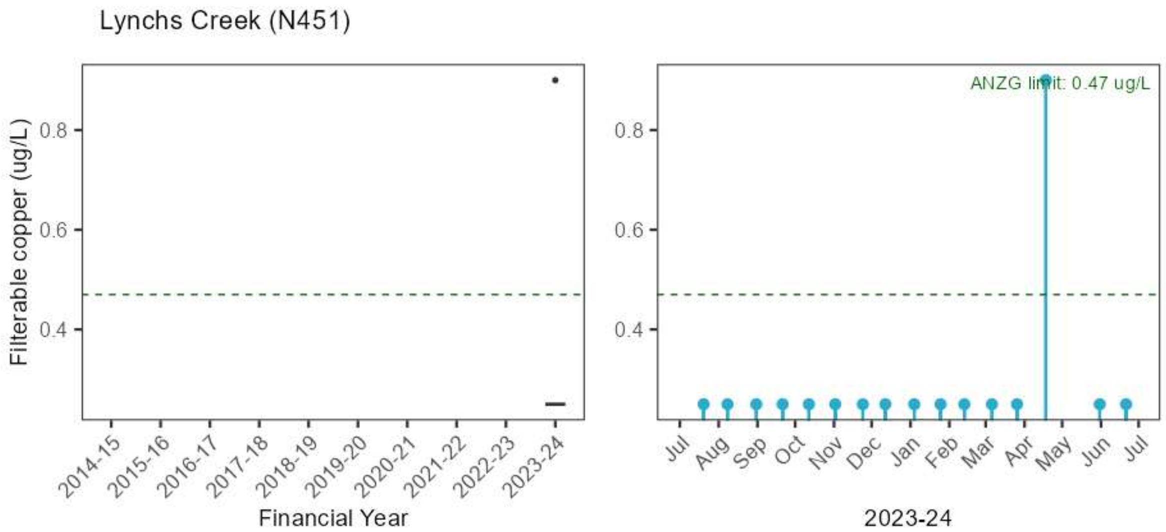
Stressors – Trace metals



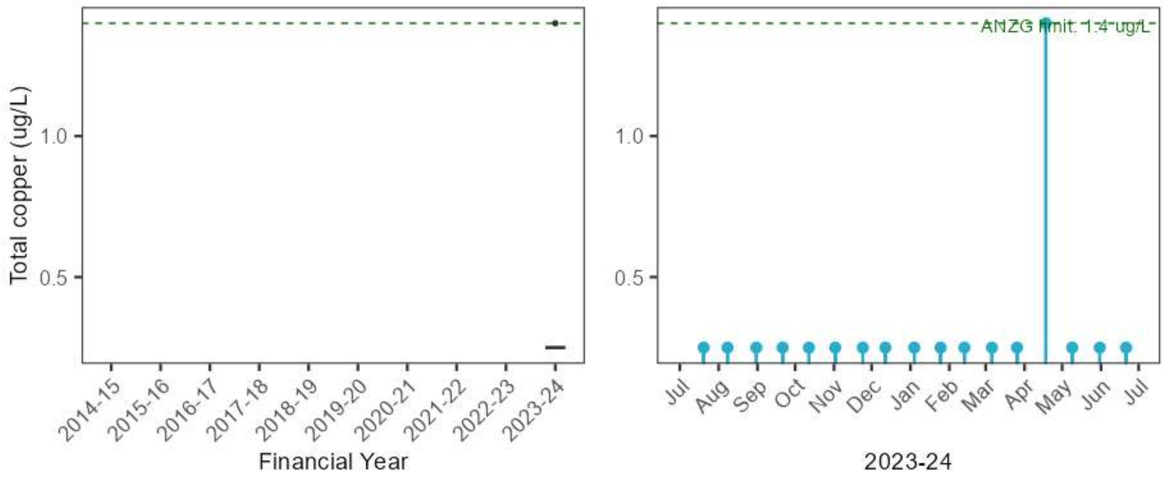



Lynchs Creek (N451)
Filterable cobalt (ug/L)
Financial Year
2023-24

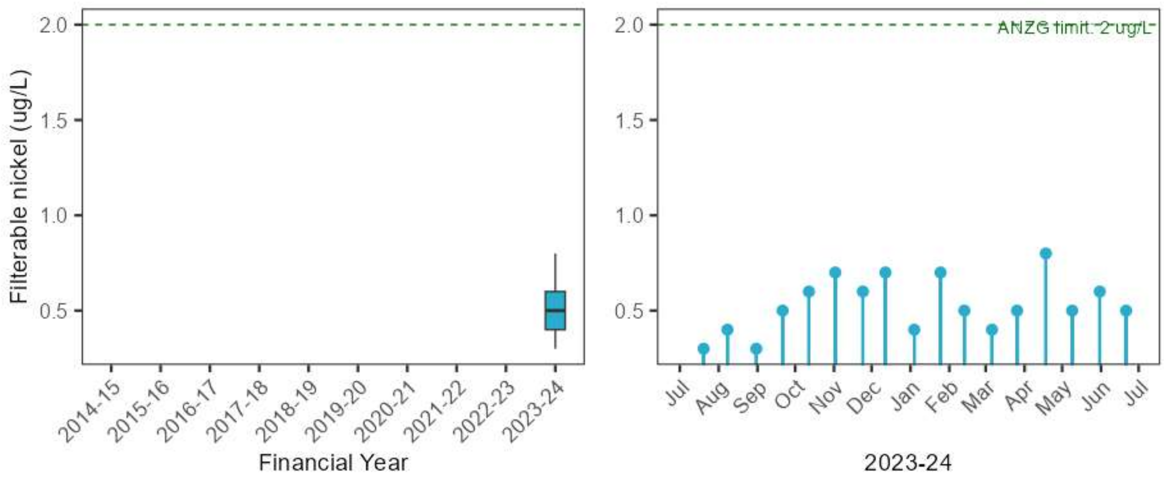

Lynchs Creek (N451)
Total cobalt (ug/L)
ANZG limit: 2.8 ug/L
Financial Year
2023-24


Lynchs Creek (N451)
Filterable copper (ug/L)
ANZG limit: 0.47 ug/L
Financial Year
2023-24

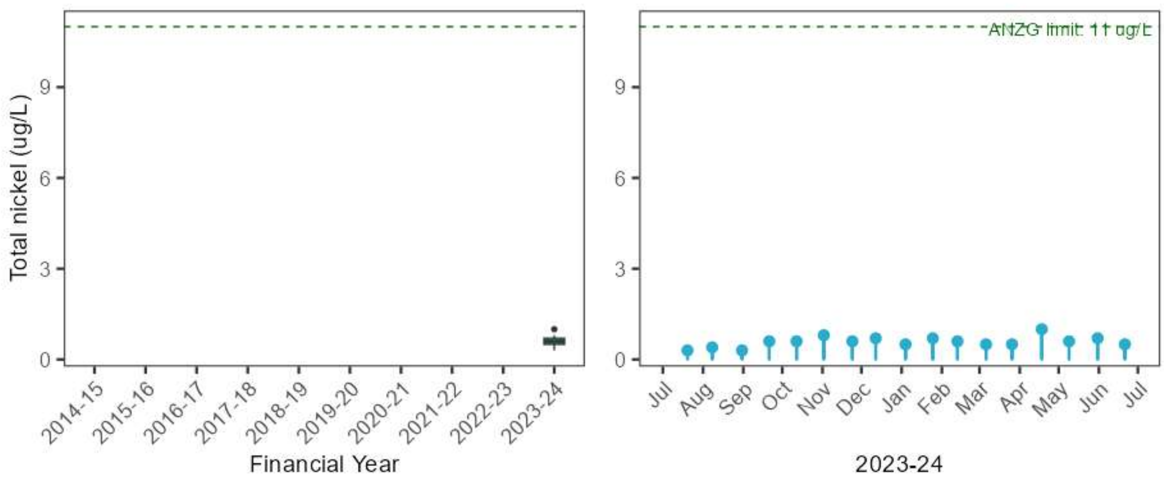
Lynchs Creek (N451)

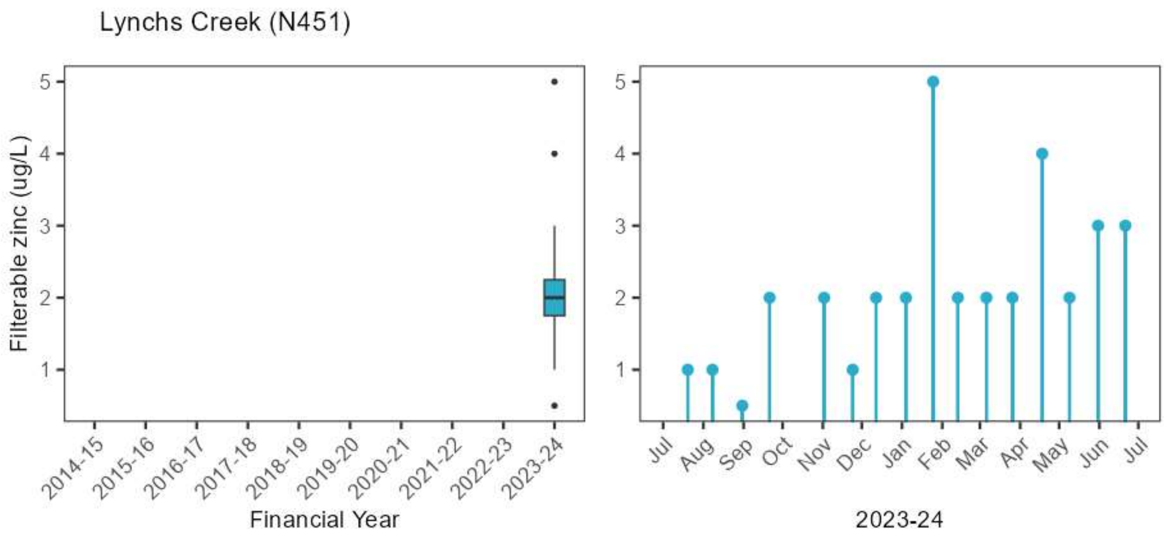


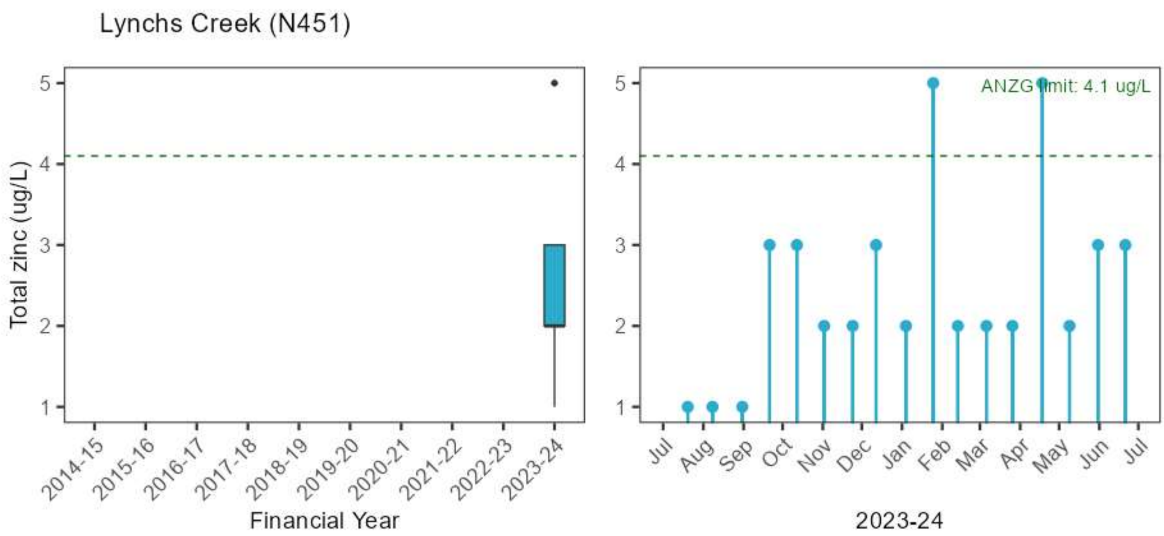
Lynchs Creek (N451)



Lynchs Creek (N451)







C.4. Freshwater reference sites – Ecosystem health

Seven sites are monitored for the macroinvertebrate indicator in freshwater streams to assess the general ambient condition of freshwater sites in the other major rivers flowing into the estuaries of the Sydney region. These waterways may be impacted by wastewater overflows and stormwater. Among these, four are control sites located upstream of any likely impact from urban areas. The control sites include Lynch's Creek (N451) a tributary of Hawkesbury-Nepean River, Hacking River at McKell Avenue in Royal National Park (PH22), the upper Georges River system at O'Hares Creek (GE510) and Georges River at Ingleburn Reserve (GR24). The remaining three sites are reference sites, which can also be used in future re-calibration of SIGNAL-SG – an unnamed tributary of Devlin's Creek (LC2421), McCarrs Creek (NP001) and Bedford Creek (N628).

Results from 2023-24 indicate stream health for all of the four control sites (N451, PH22, GE510 and GR24) was typical of natural water quality in bushland areas that do not receive urban stormwater runoff or sewer overflows (Figure C-1 and Figure C-2).

Results from these test sites represent the ambient condition of the combined impact of urban stormwater runoff and sewer overflows. These two influences cannot be teased apart.

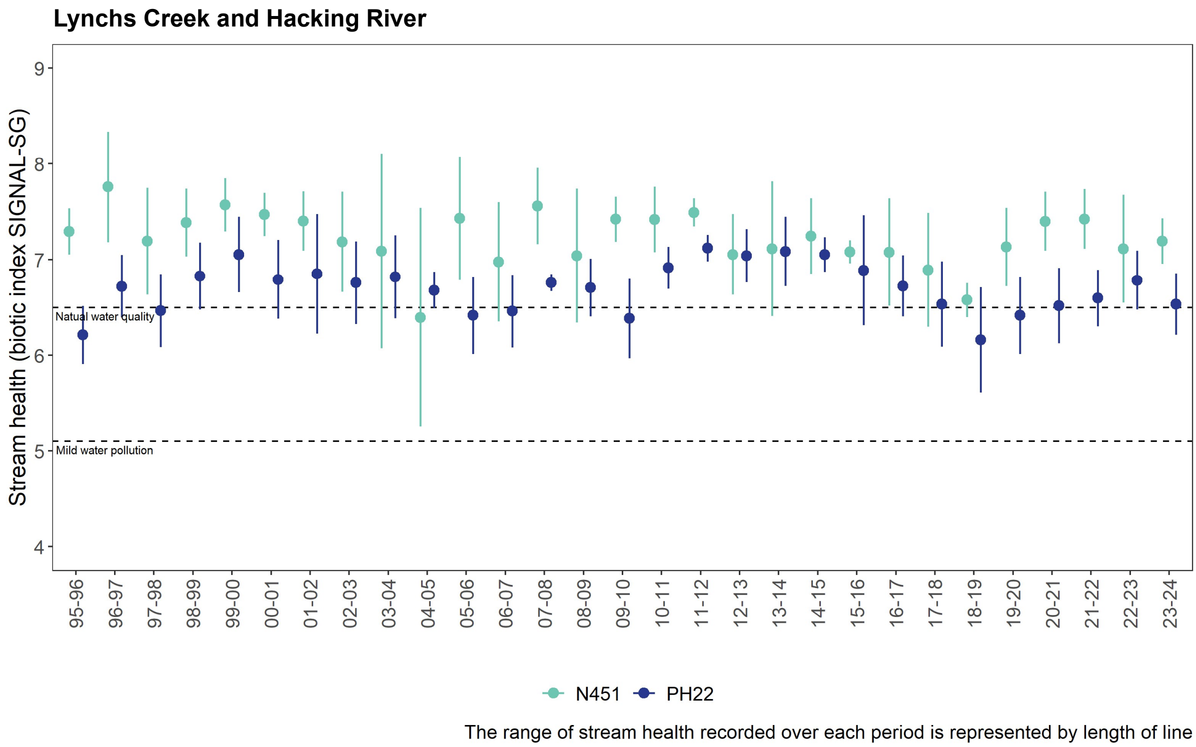


Figure C-1 Stream health of control sites in Lynchs Creek and Hacking River

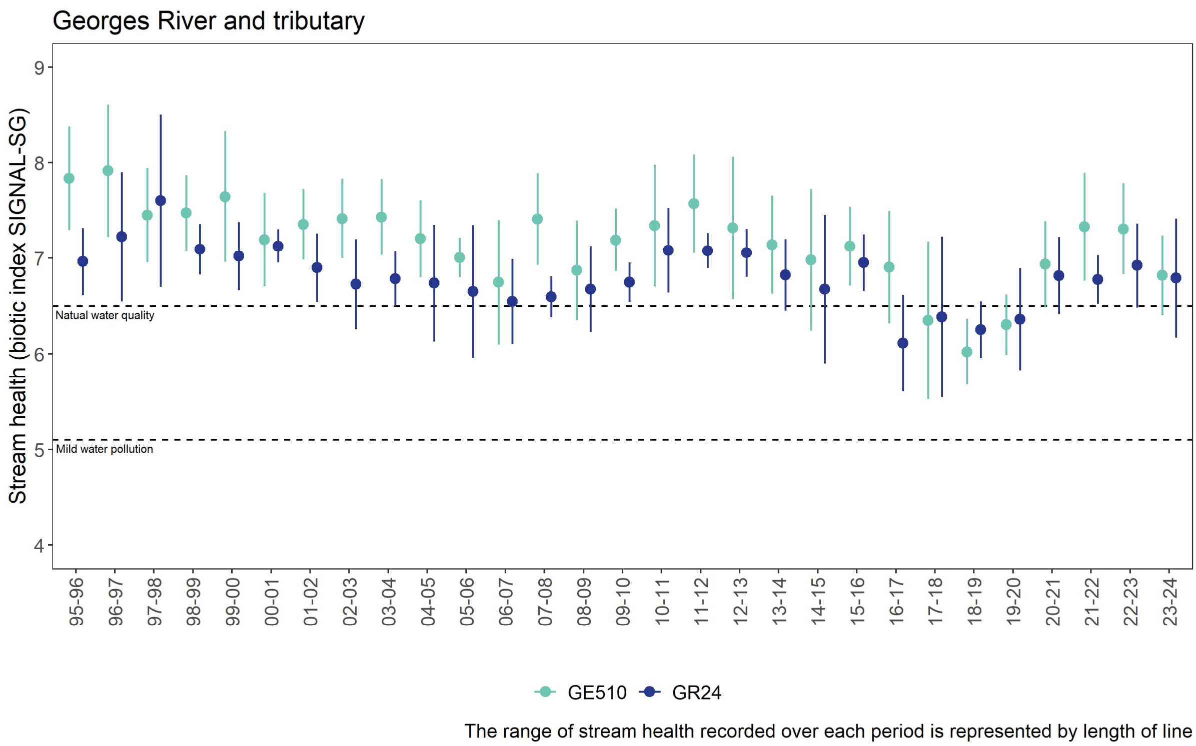


Figure C-2 Stream health of control sites in the upper Georges River system

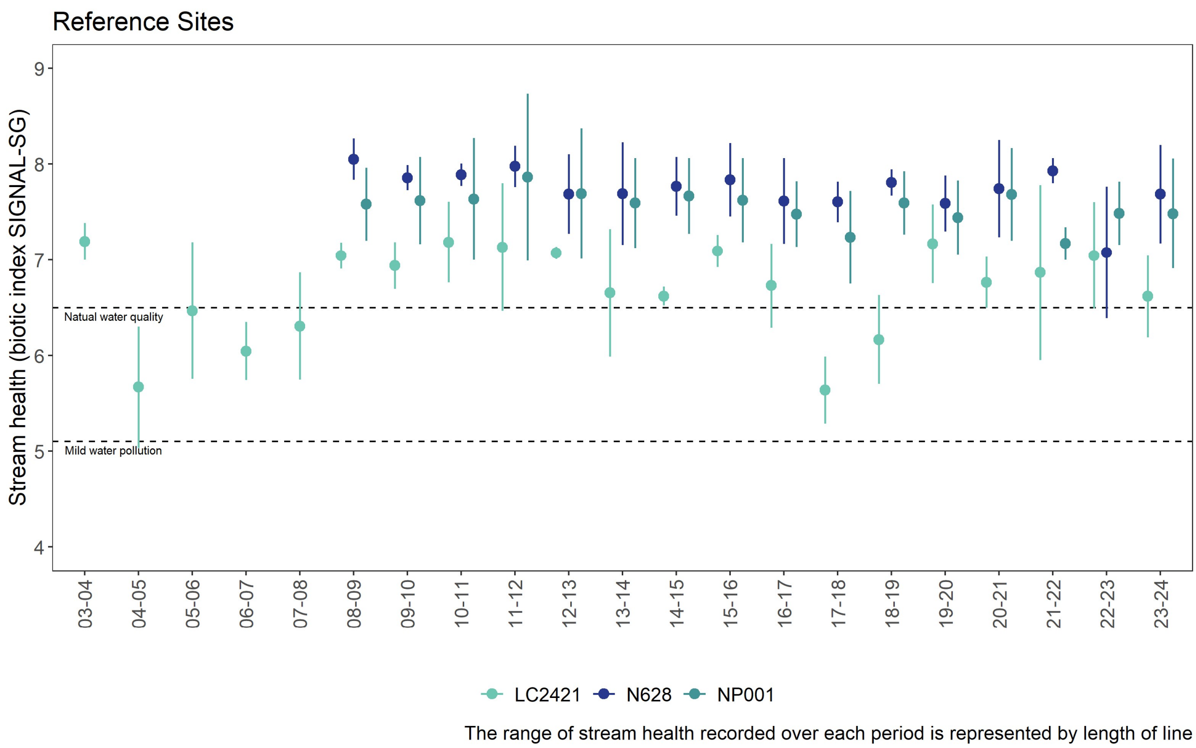


Figure C-3 Stream health of other freshwater reference sites

D. Nearshore marine environment

This Appendix includes graphical presentation of all monitoring data for the Nearshore Marine catchment.

The Water Resource Recovery Facilities (WRRFs) that are discharging into this catchment are ordered from North (Warriewood) to South (Bombo).

Under each WRRF (D-1 to D-6), the results are presented following the **Pressure, Stressor** and **Ecosystem Receptor (P-S-ER)** causal pathway elements.

For the Pressure, trend plots are included on wastewater quantity (discharge and inflow), quality, toxicity and discharge loads. Trends plots on other supplementary data are also included to improve our understanding on:

- weather condition i.e. catchment specific rainfall condition for each WRRF
- wastewater reuse/ recycling volume of the relevant WRRF.

Wastewater quality and load plots are included in the following four sub-groups, and then within each sub-group, analytes presented in alphabetical order:

- nutrients
- major conventional analytes
- trace metals
- other chemicals and organics (including pesticides)

Tests conducted on wastewater are specified in the EPL issued by the NSW EPA for each WRRF (D-7). Data for all these measured analytes that have EPL concentration and load limits are included. Summary statistics are included as electronic appendices sent to the EPA.

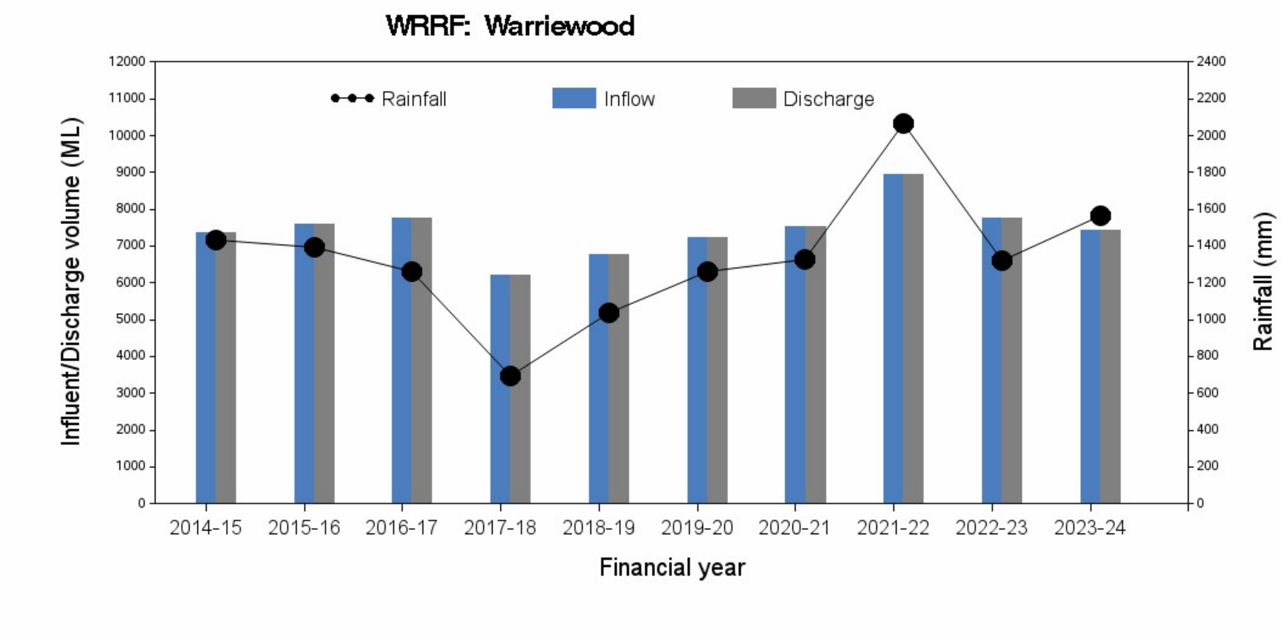
No **Stressor** data for the Nearshore environment are collected yet. A pilot is being planned with new monitoring methods at 10 intertidal sites in 2024-25.

Ecosystem Receptor data (macroalgae and invertebrates) are only available for the three Shellharbour sites. Data summaries, plots, statistical analyses outcomes, including detailed commentaries are included in Appendix D-5.5.

D.1. Warriewood WRRF

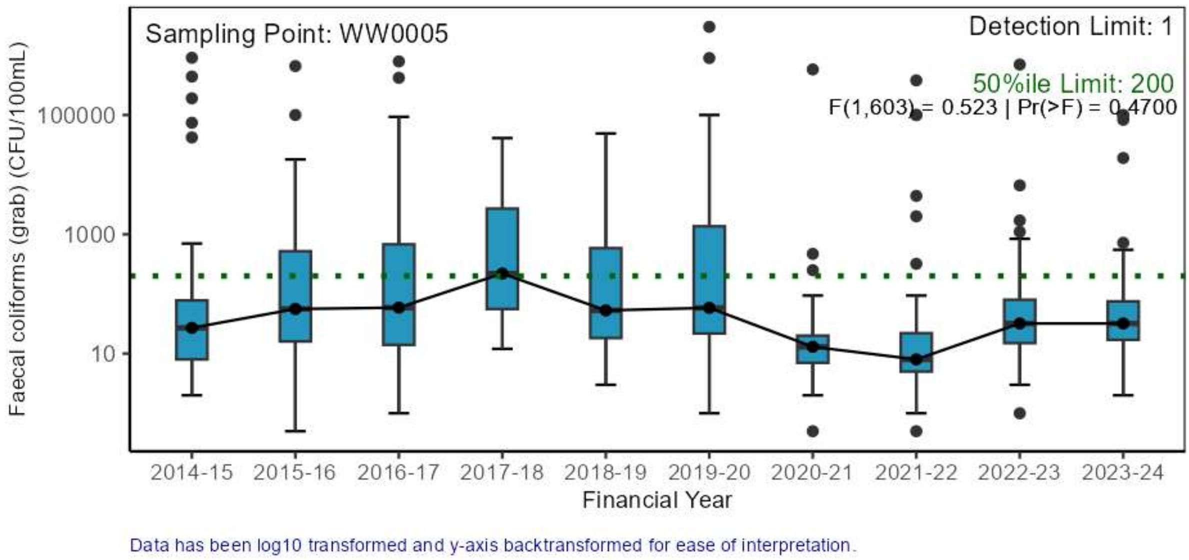
D.1.1. Pressure – Wastewater quantity

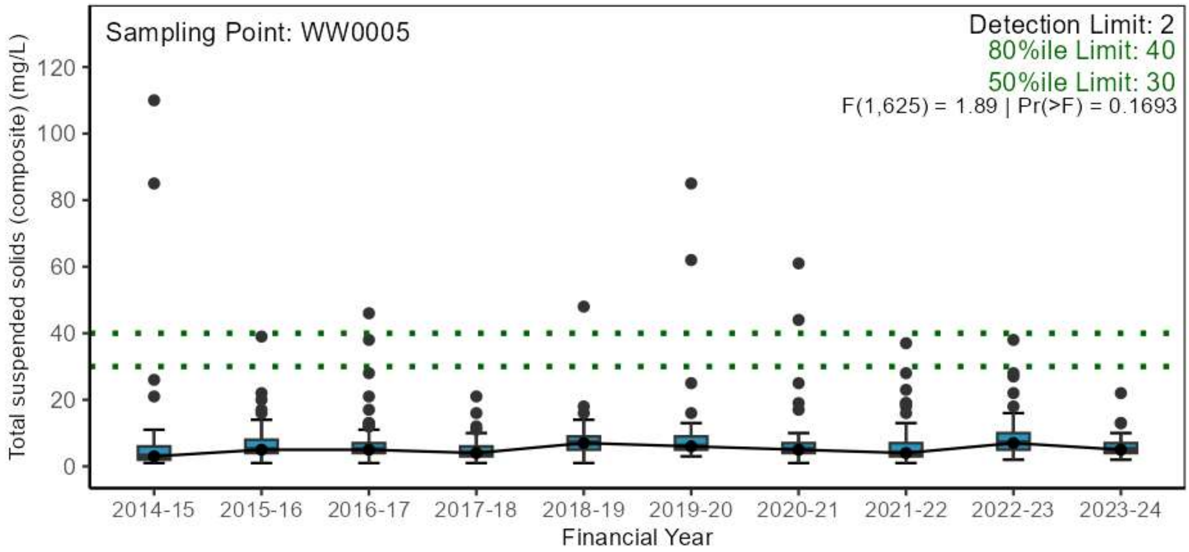
Inflow/ Discharge volume and rainfall



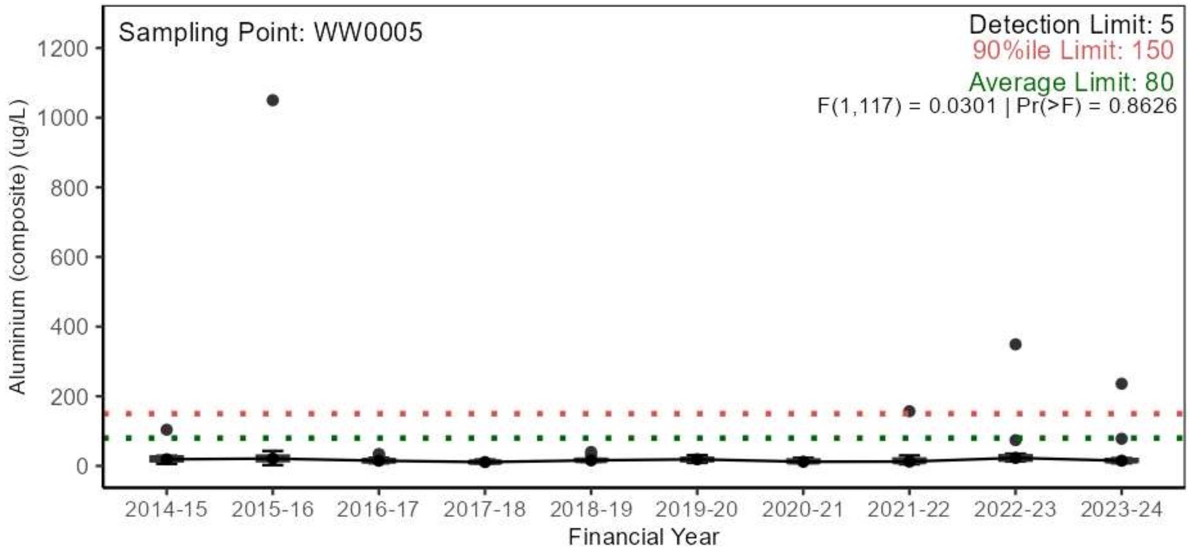
D.1.2. Pressure – Wastewater quality

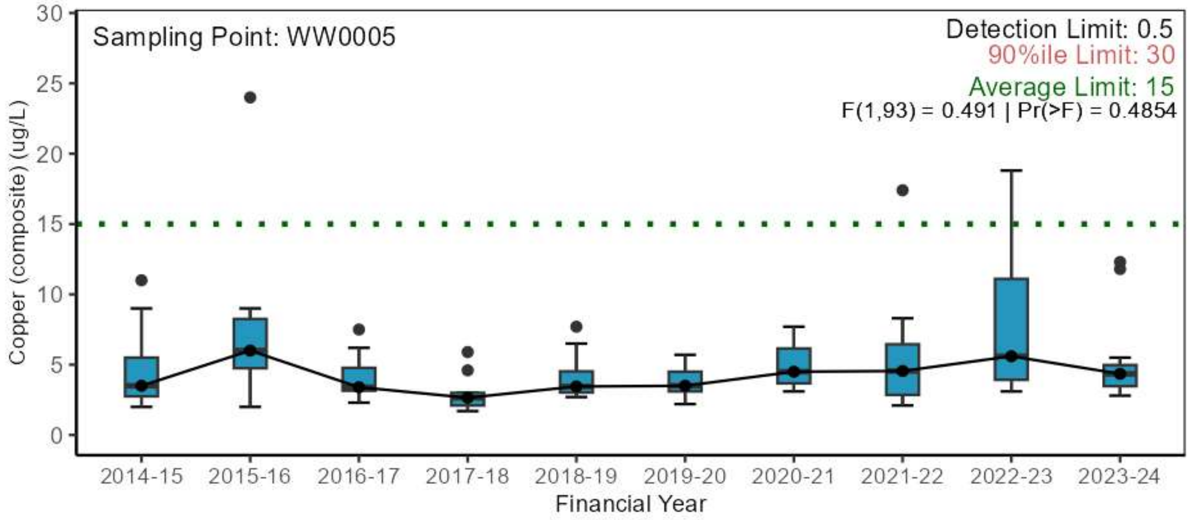
Major conventional analytes



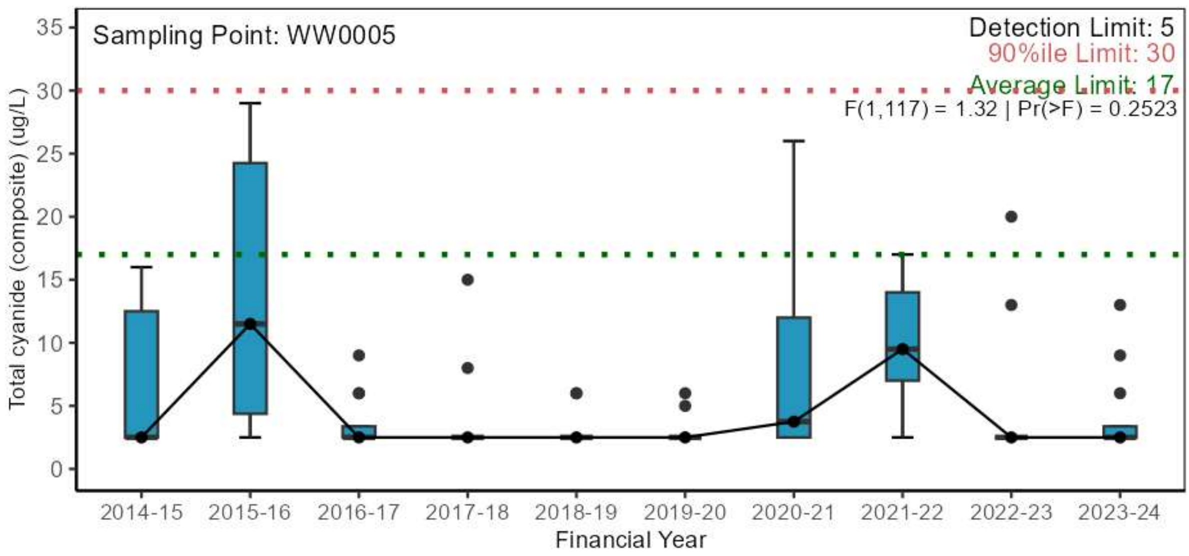


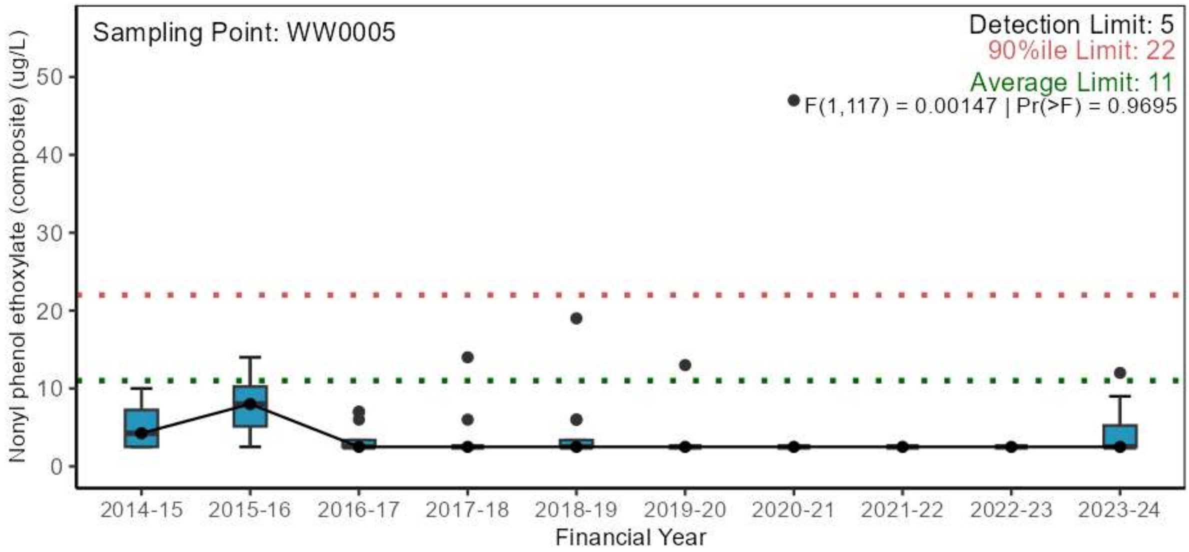
Trace metals





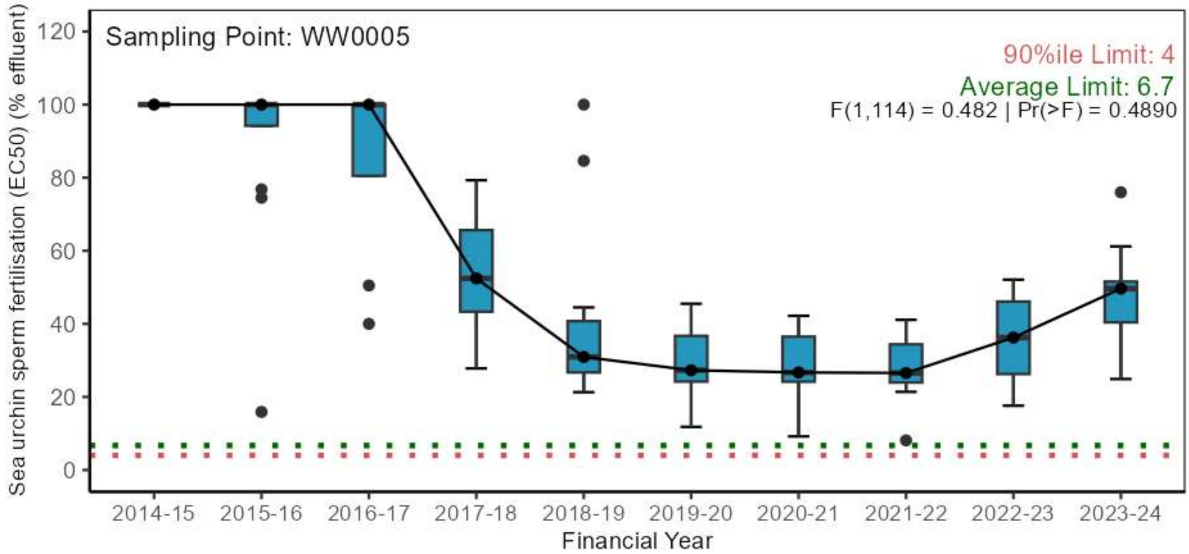
Statistical test excludes data prior to 2016-17 due to method detection limit change.





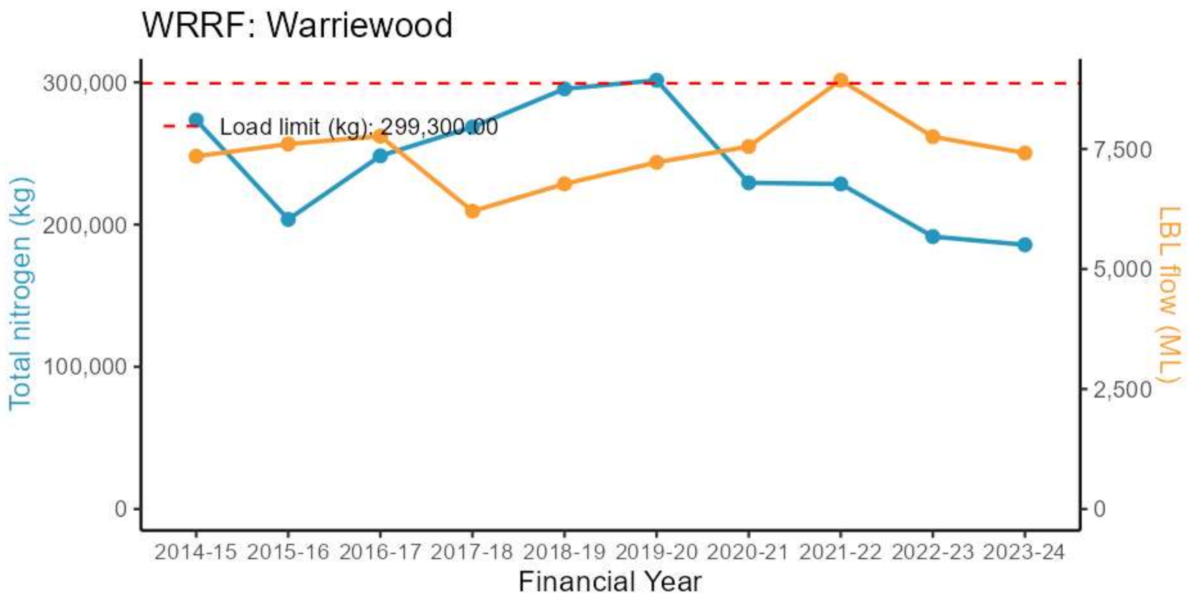
Other chemicals and organics (including pesticides)

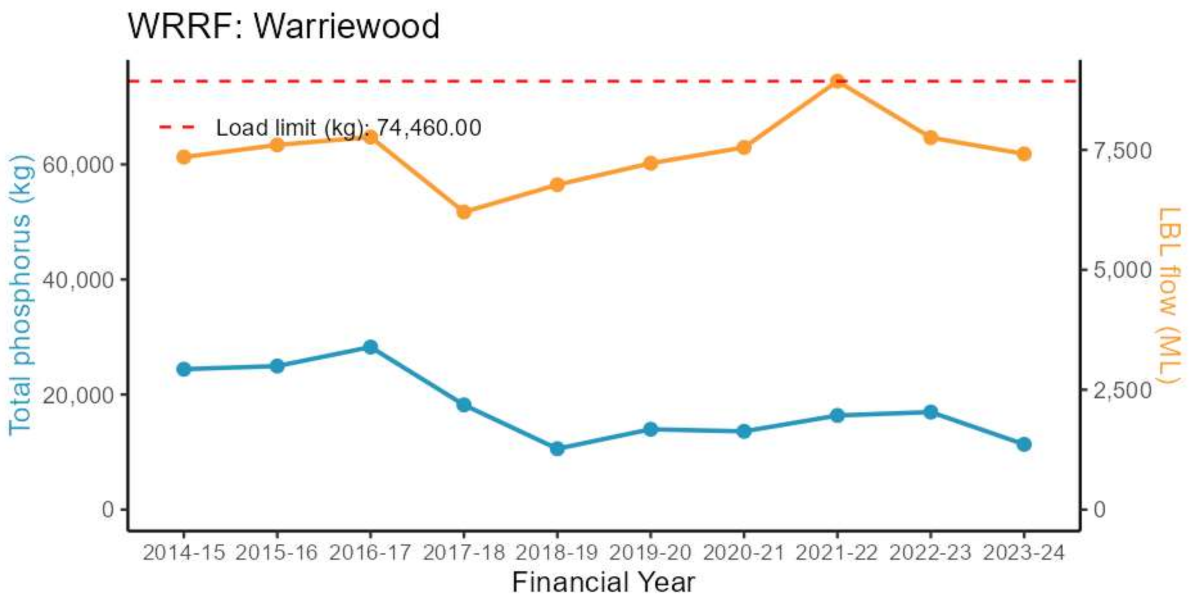
D.1.3. Pressure – Wastewater toxicity



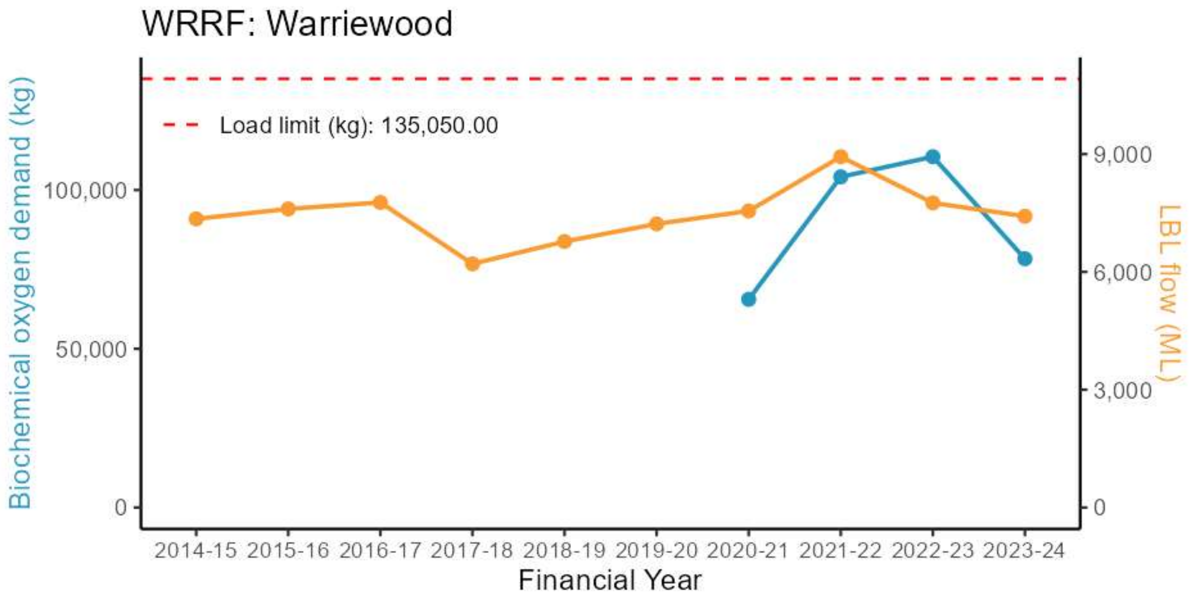
D.1.4. Pressure – Wastewater discharge load

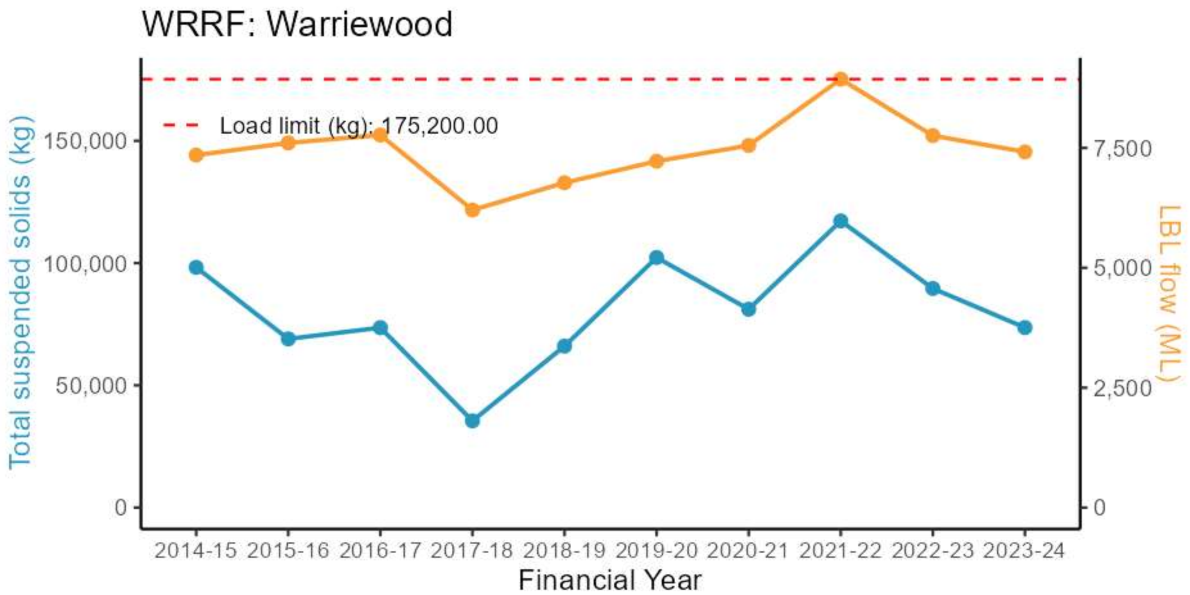
Nutrients


WRRF: Warriewood
Load limit (kg): 299,300.00
Total nitrogen (kg)
LBL flow (ML)
Financial Year
300,000
200,000
100,000
0
7,500
5,000
2,500
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24


WRRF: Warriewood
Load limit (kg): 74,460.00
Total phosphorus (kg)
LBL flow (ML)
Financial Year
60,000
40,000
20,000
0
7,500
5,000
2,500
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24

Major conventional analytes

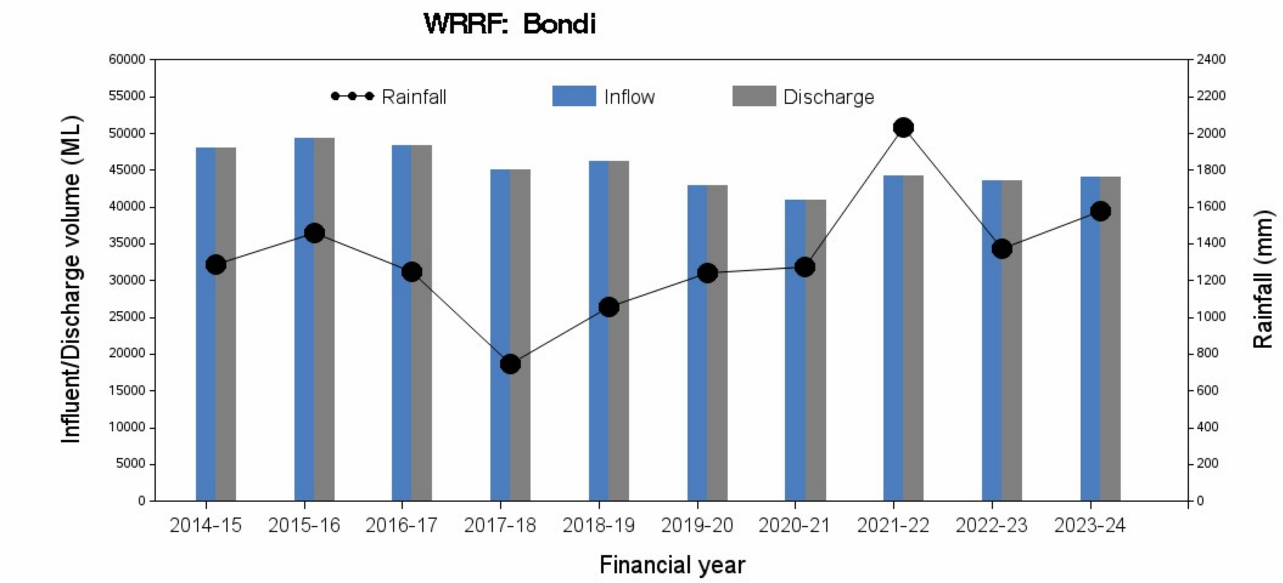


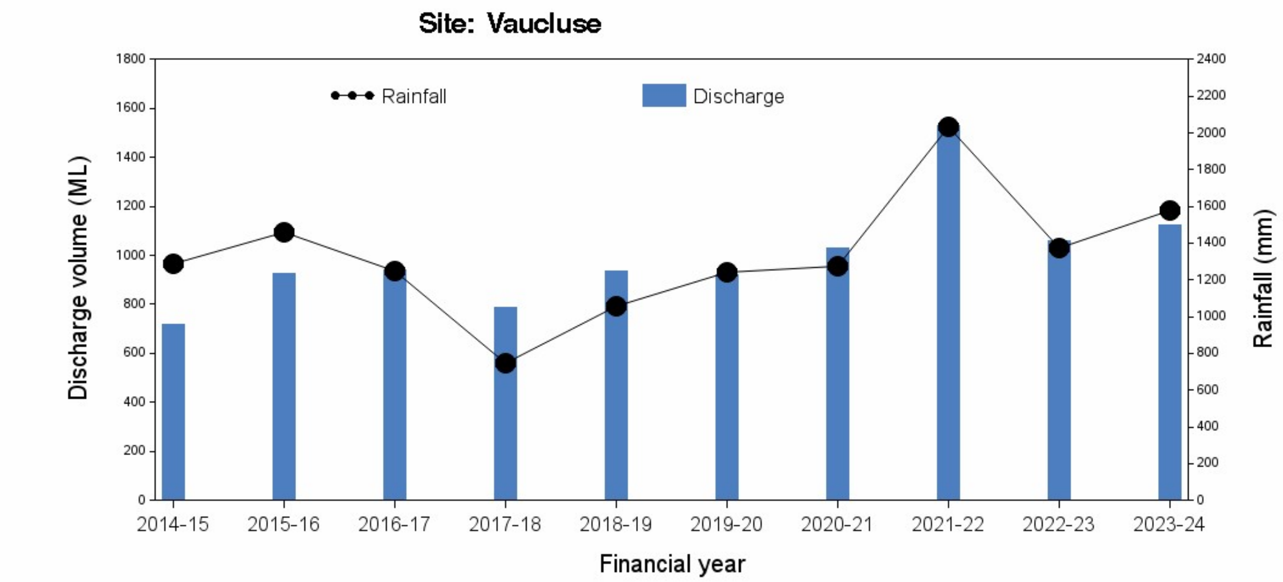


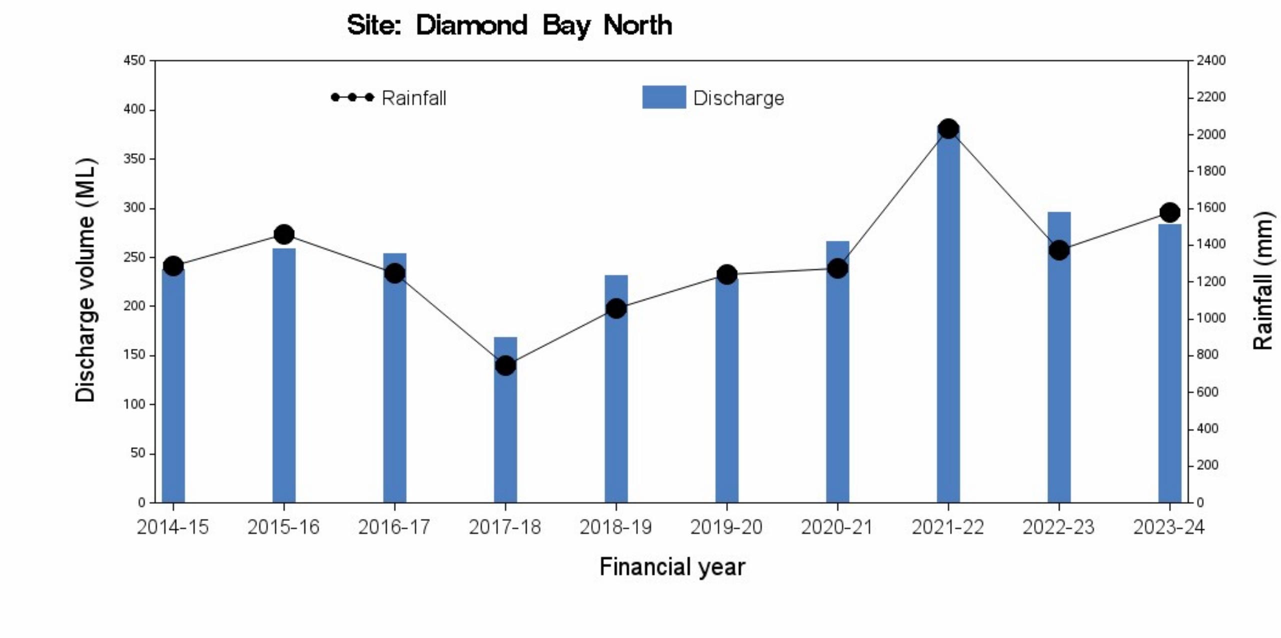
D.2. Bondi WRRF (Nearshore discharges, Vaucluse and Diamond Bay)

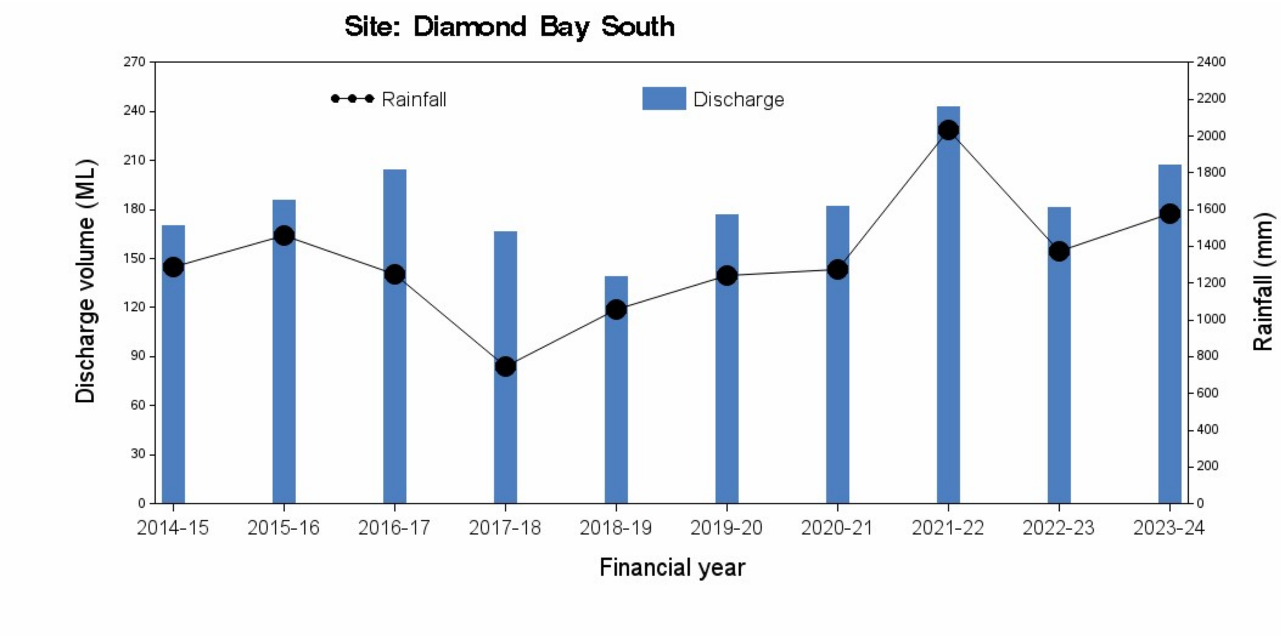
D.2.1. Pressure – Wastewater quantity

Inflow/ Discharge volume and rainfall





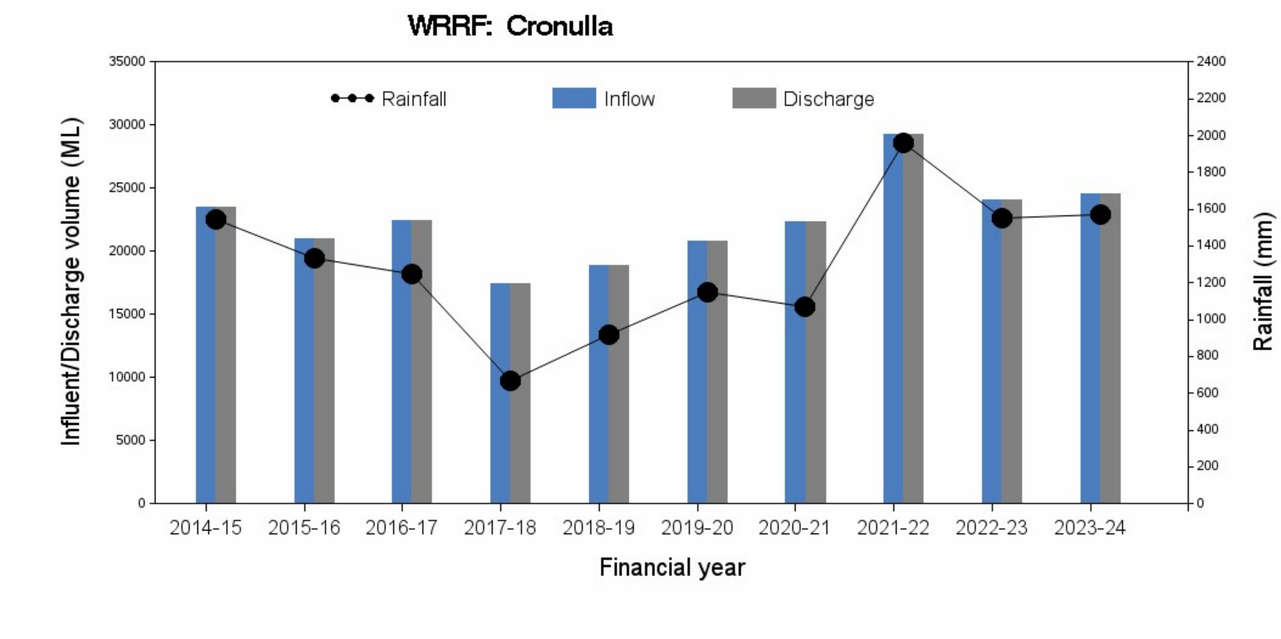

Site: Diamond Bay North
Rainfall
Discharge
Discharge volume (ML)
Rainfall (mm)
Financial year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24


Site: Diamond Bay South
Rainfall
Discharge
Discharge volume (ML)
Rainfall (mm)
Financial year
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24

D.3. Cronulla WRRF

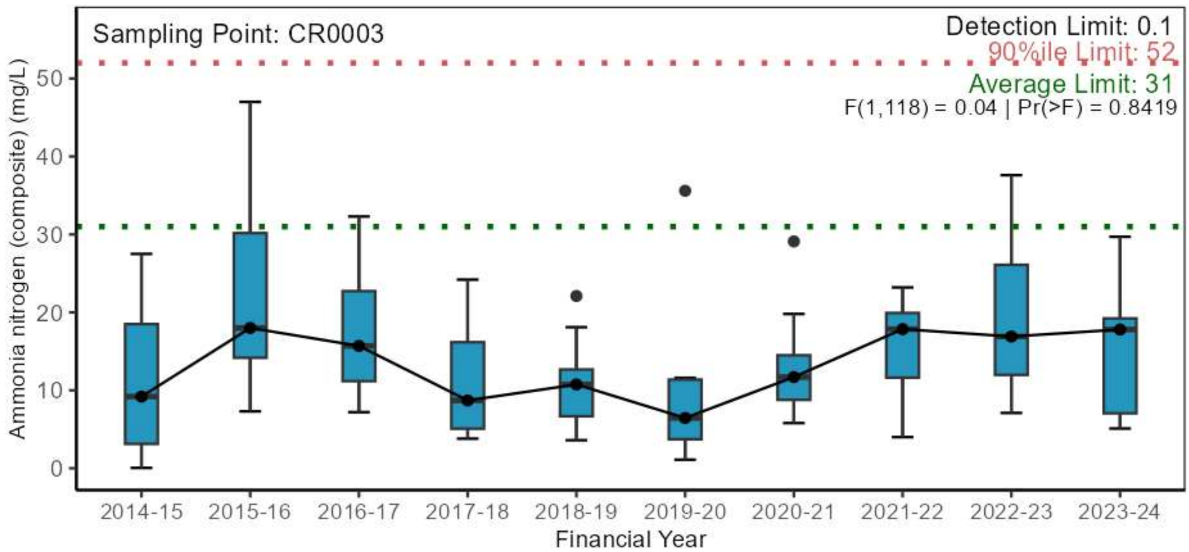
D.3.1. Pressure – Wastewater quantity

Inflow/ Discharge volume and rainfall

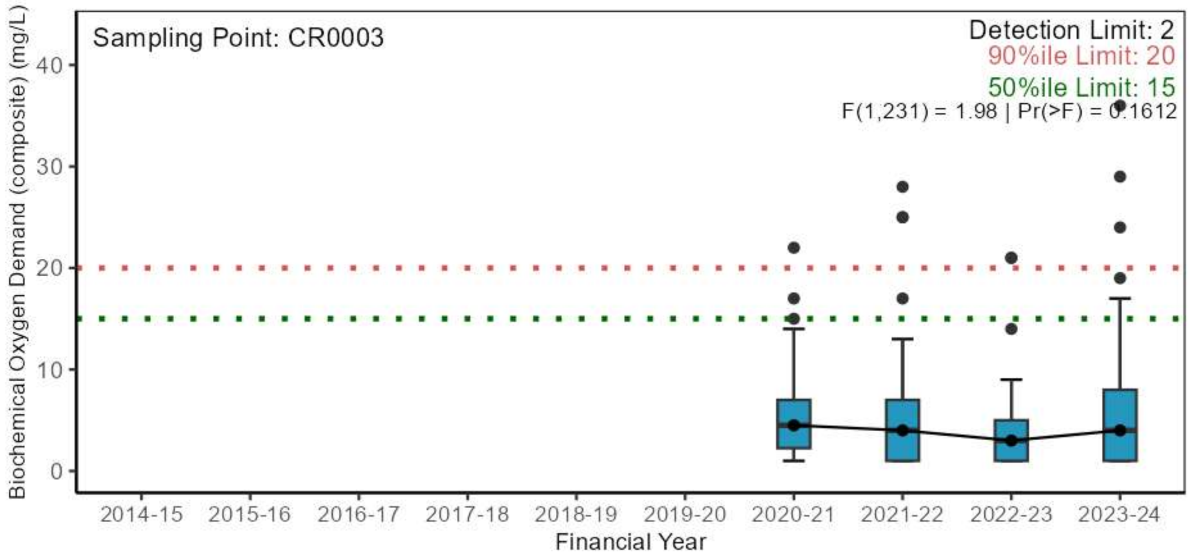


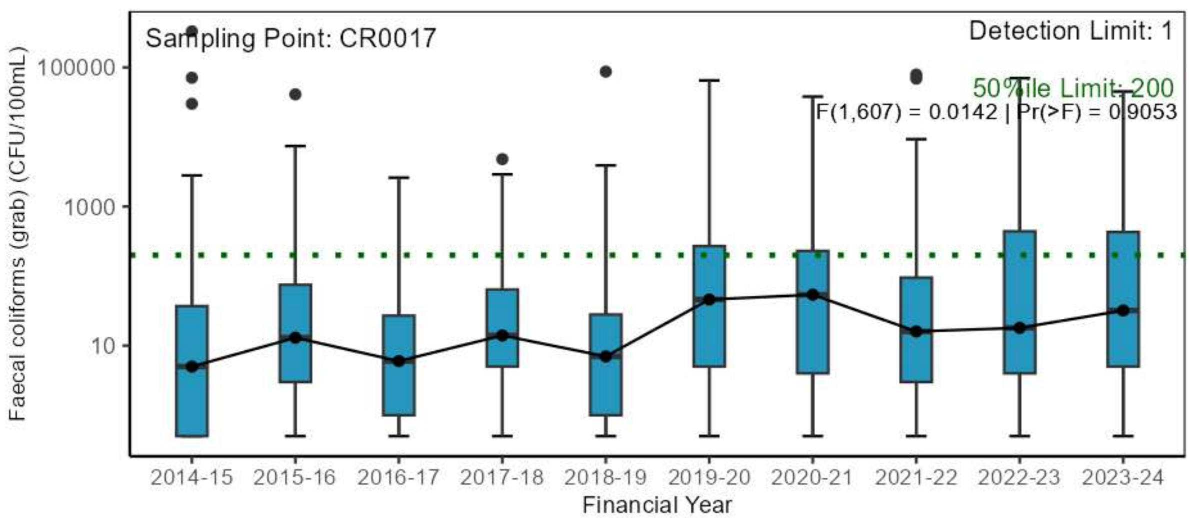
D.3.2. Pressure – Wastewater quality

Nutrients

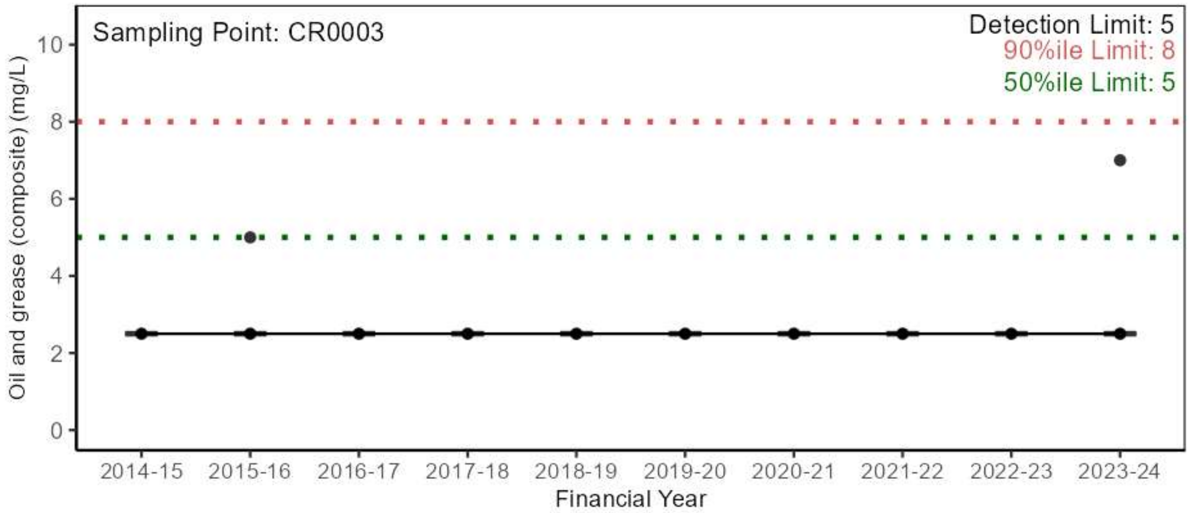


Major conventional analytes

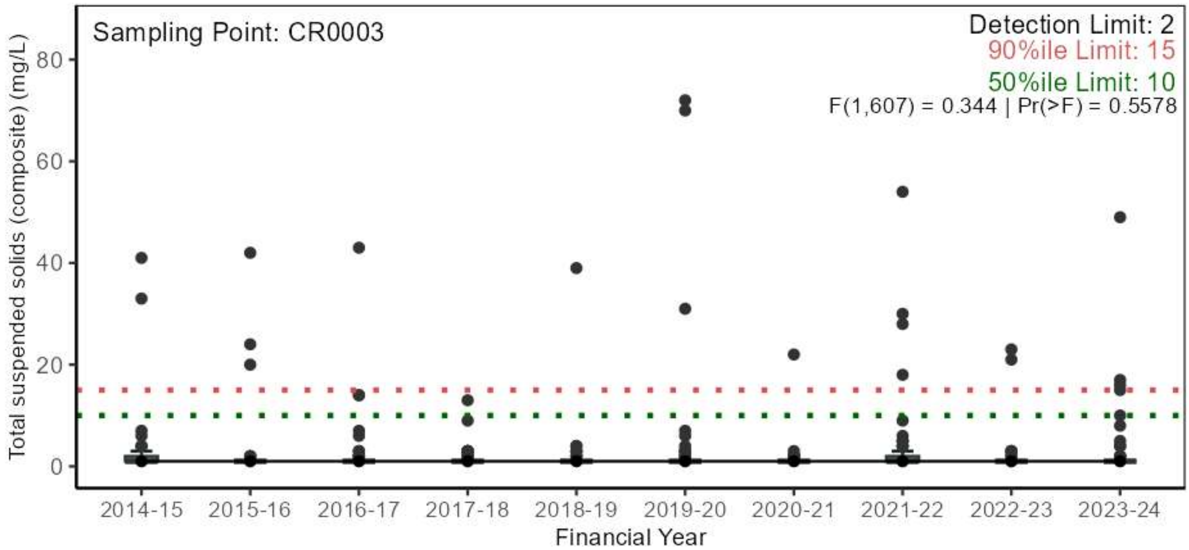




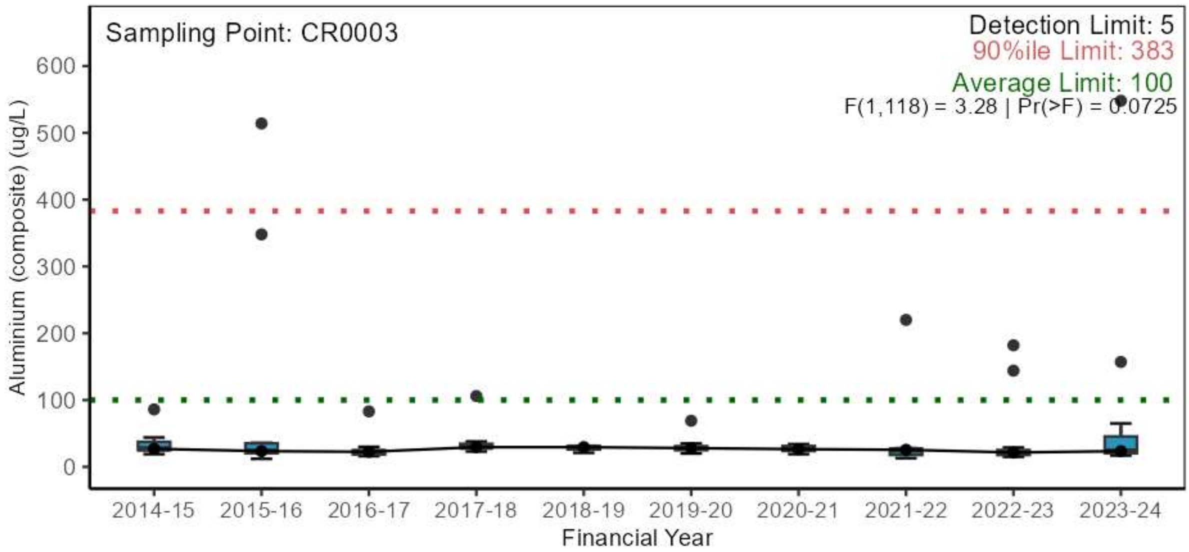
Data has been log10 transformed and y-axis backtransformed for ease of interpretation.

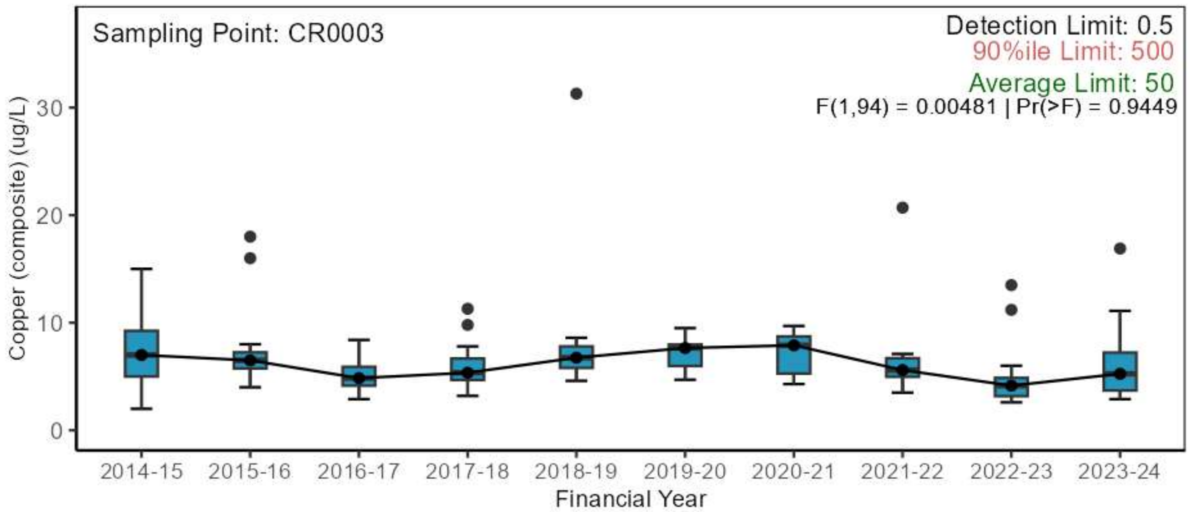


Statistical test not conducted as >90% of results were below detection limits.

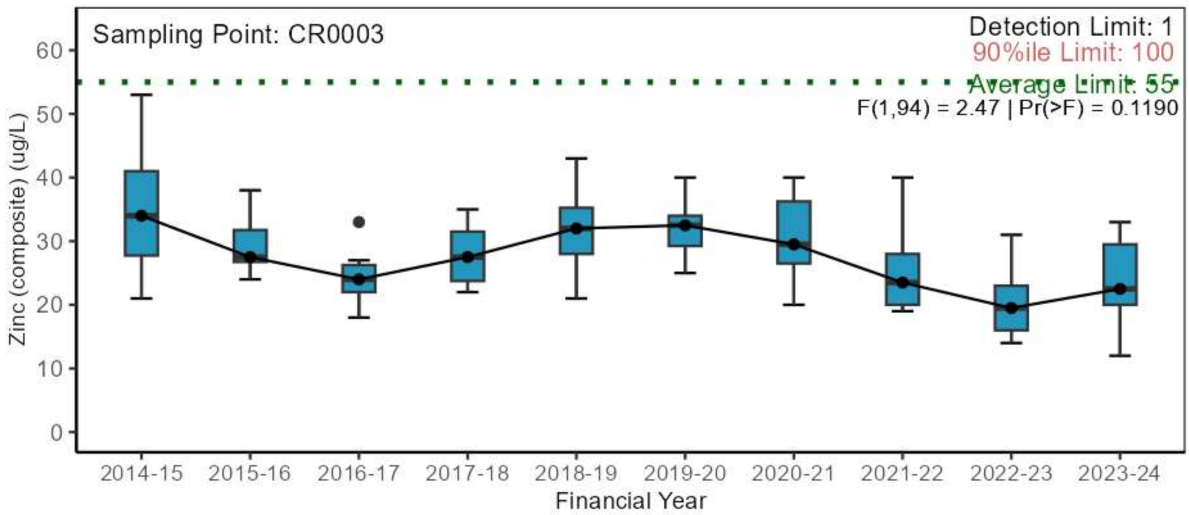


Trace metals



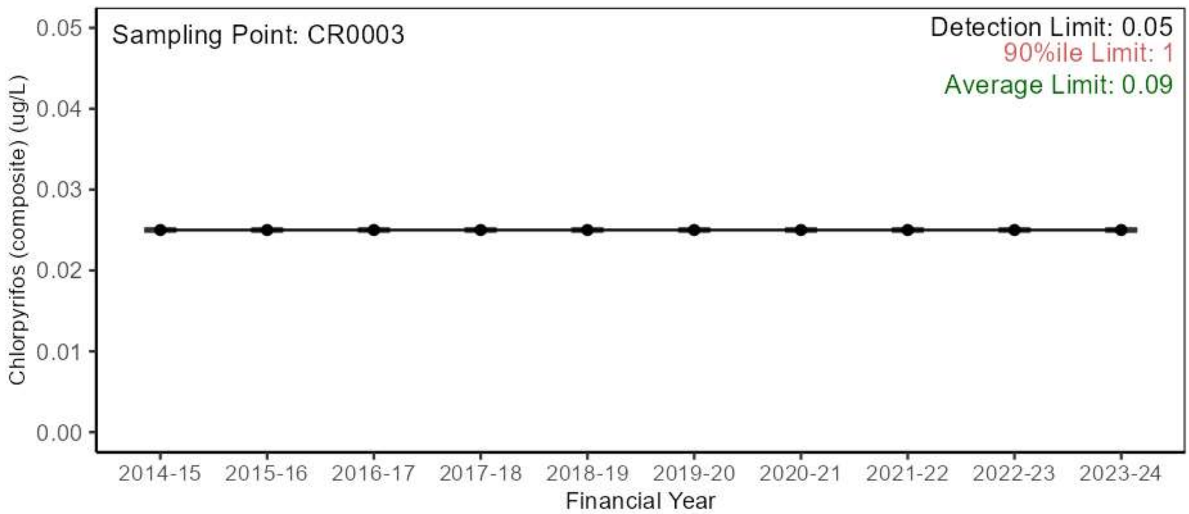


Statistical test excludes data prior to 2016-17 due to method detection limit change.

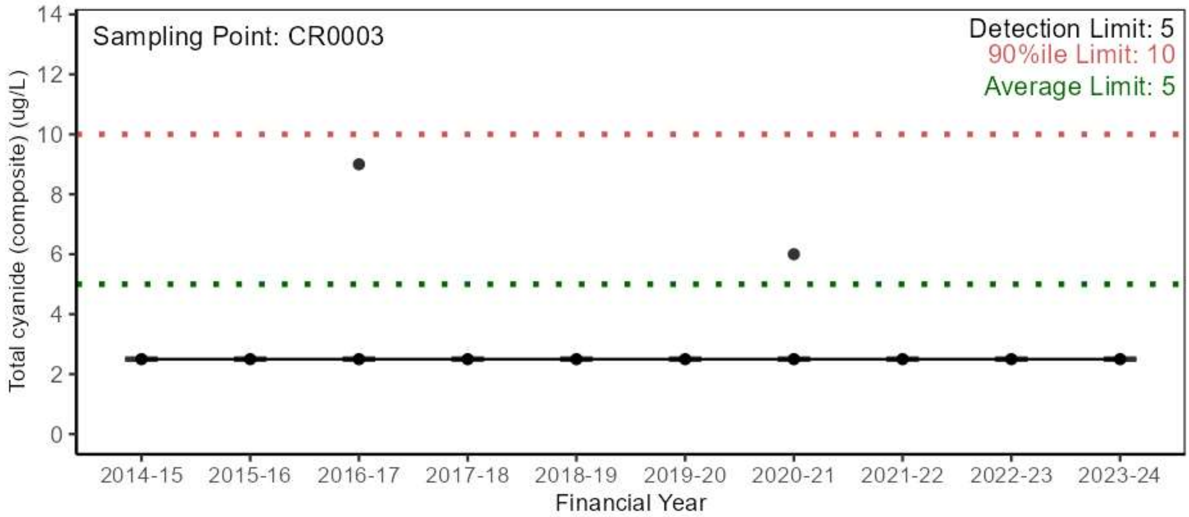


Statistical test excludes data prior to 2016-17 due to method detection limit change.

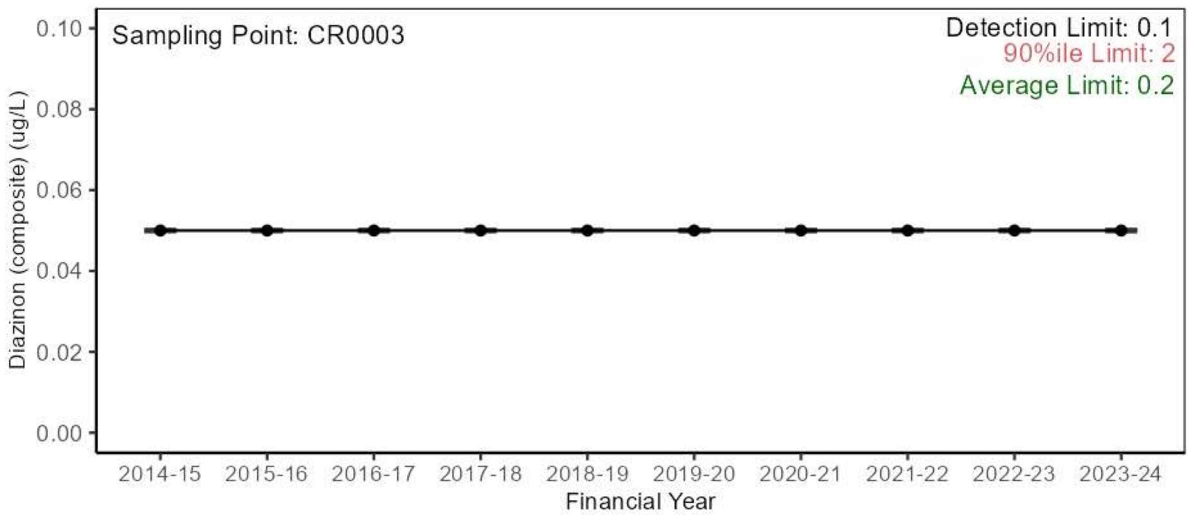
Other chemicals and organics (including pesticides)



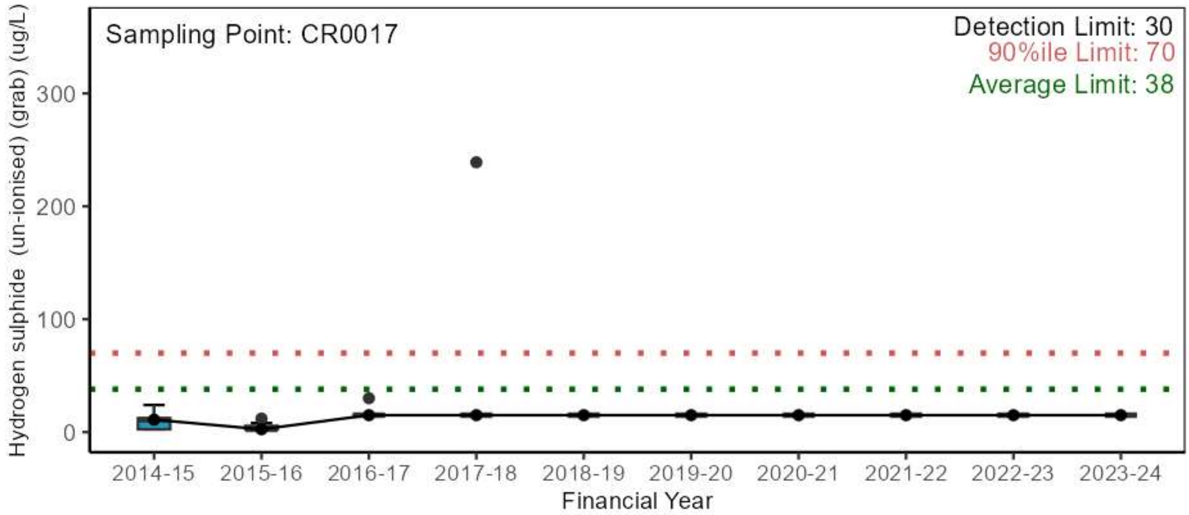
Statistical test not conducted as >90% of results were below detection limits.



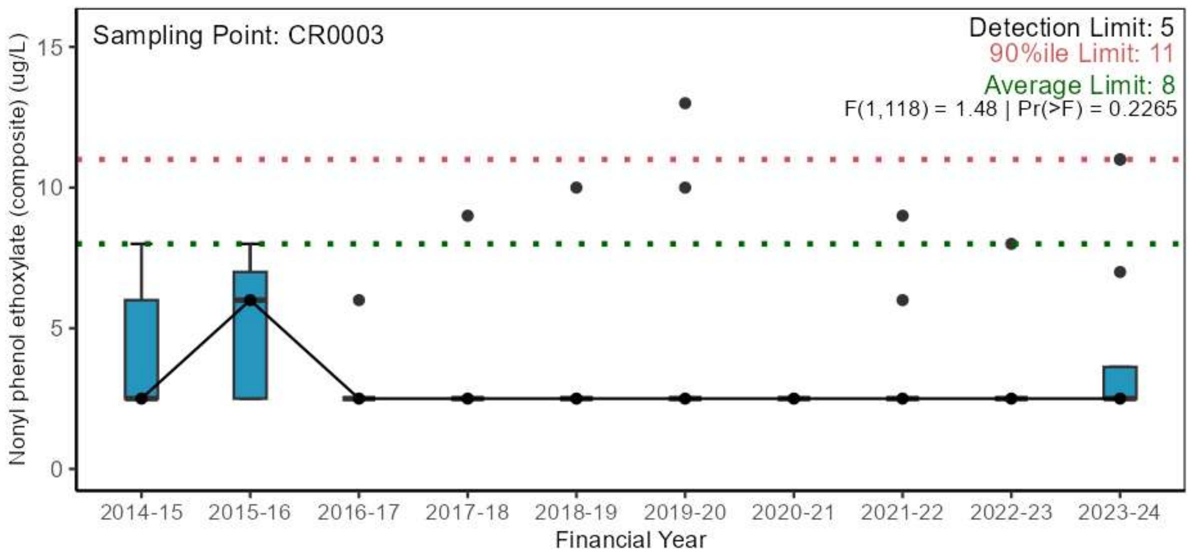
Statistical test not conducted as >90% of results were below detection limits.



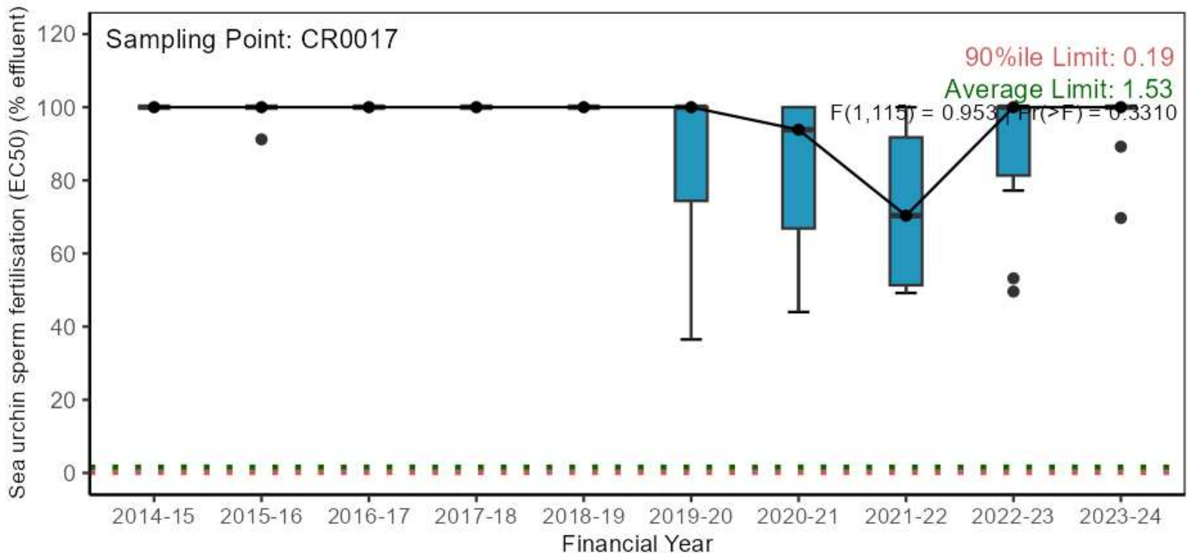
Statistical test not conducted as >90% of results were below detection limits.



Statistical test not conducted as >90% of results were below detection limits.

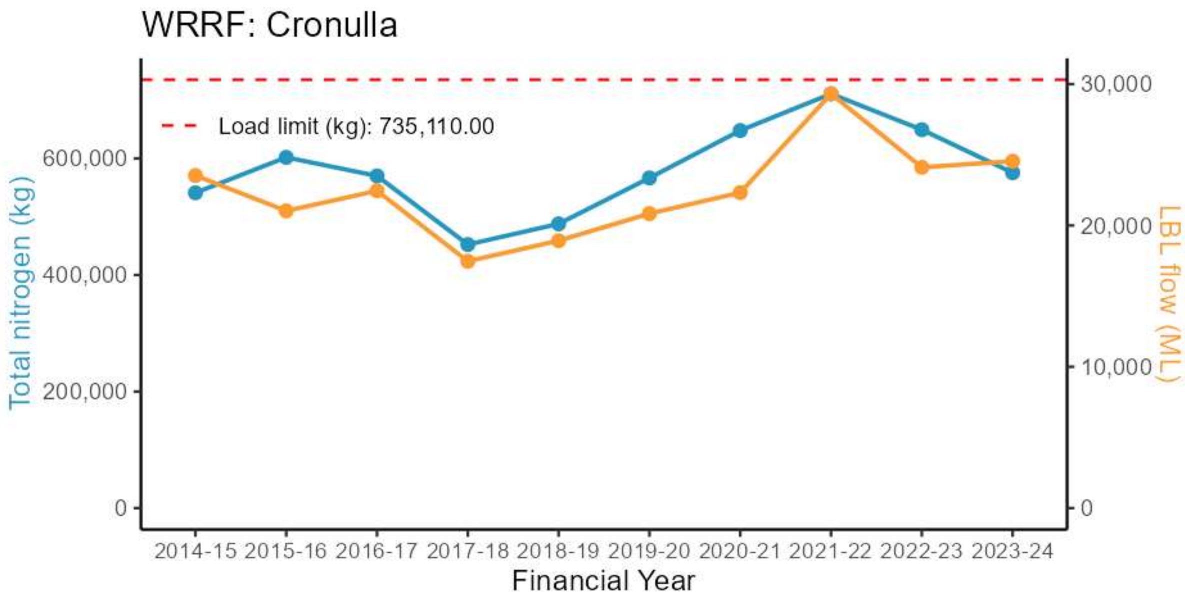


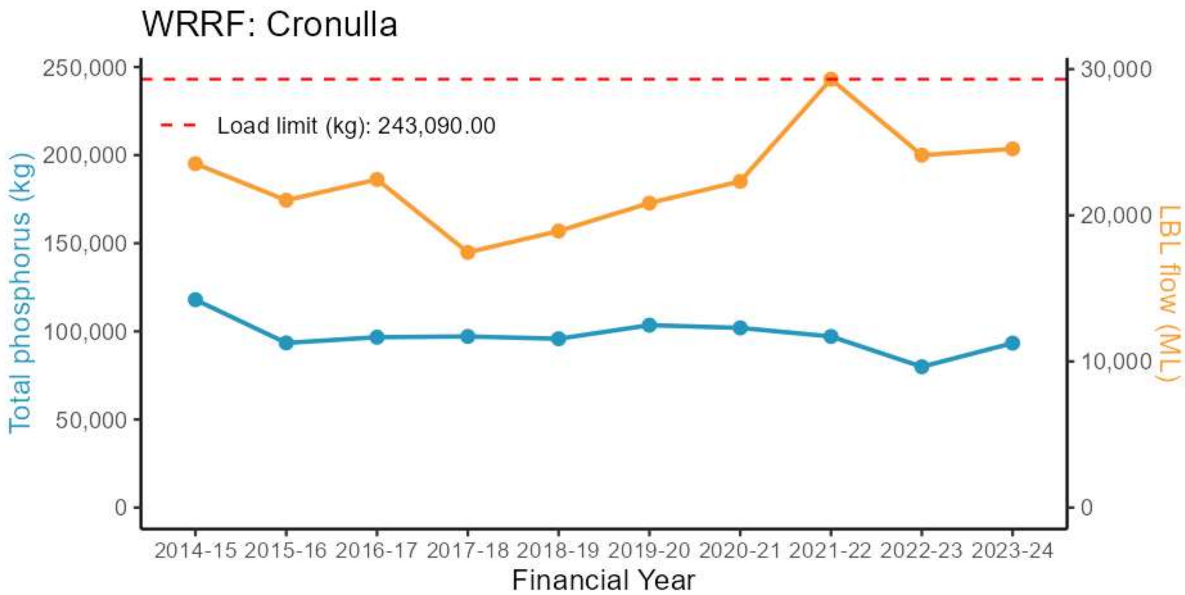
D.3.3. Pressure – Wastewater toxicity



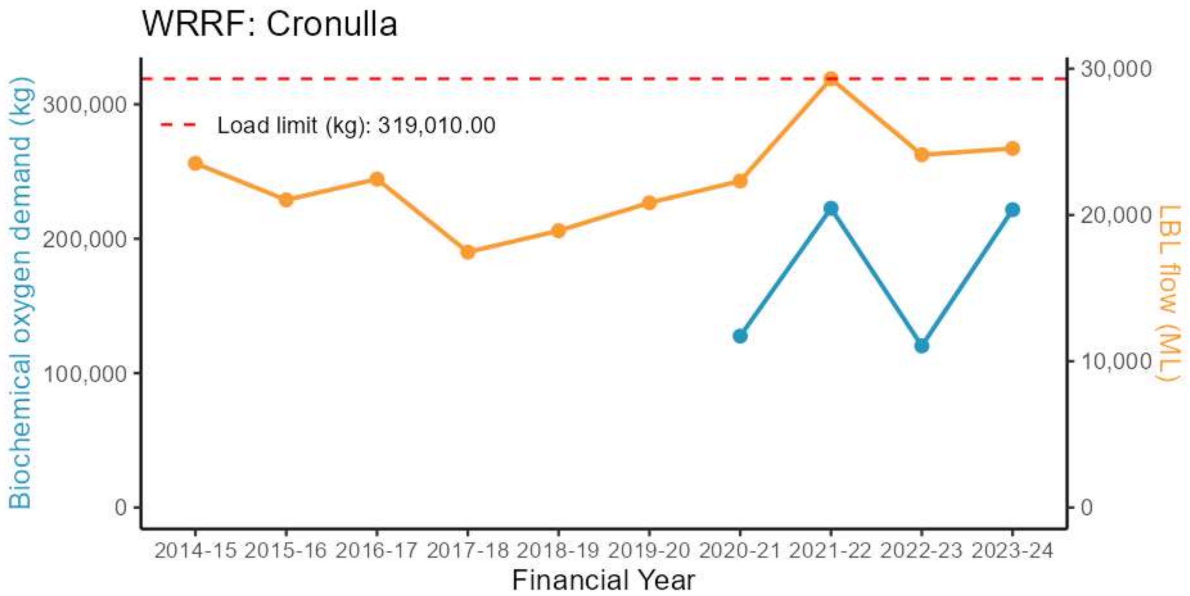
D.3.4. Pressure – Wastewater discharge load

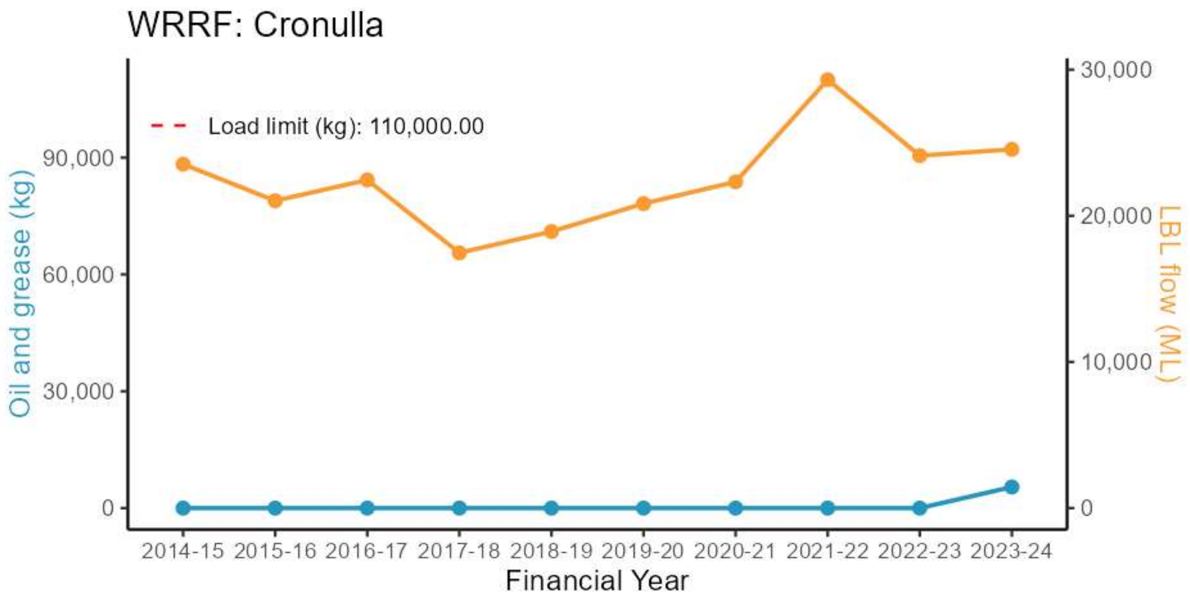
Nutrients

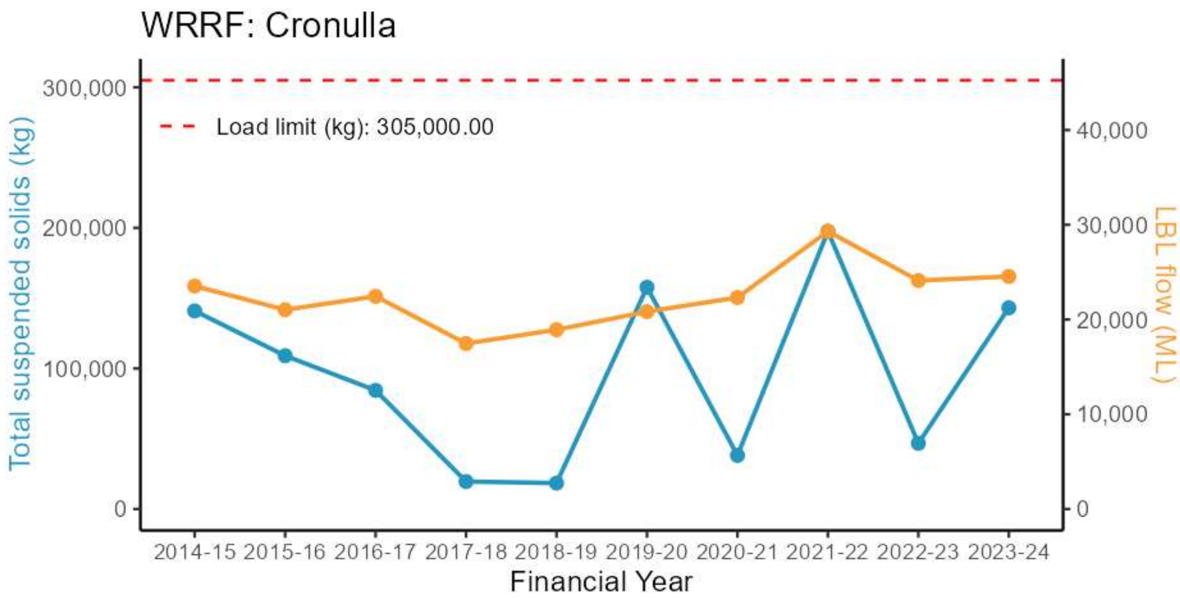




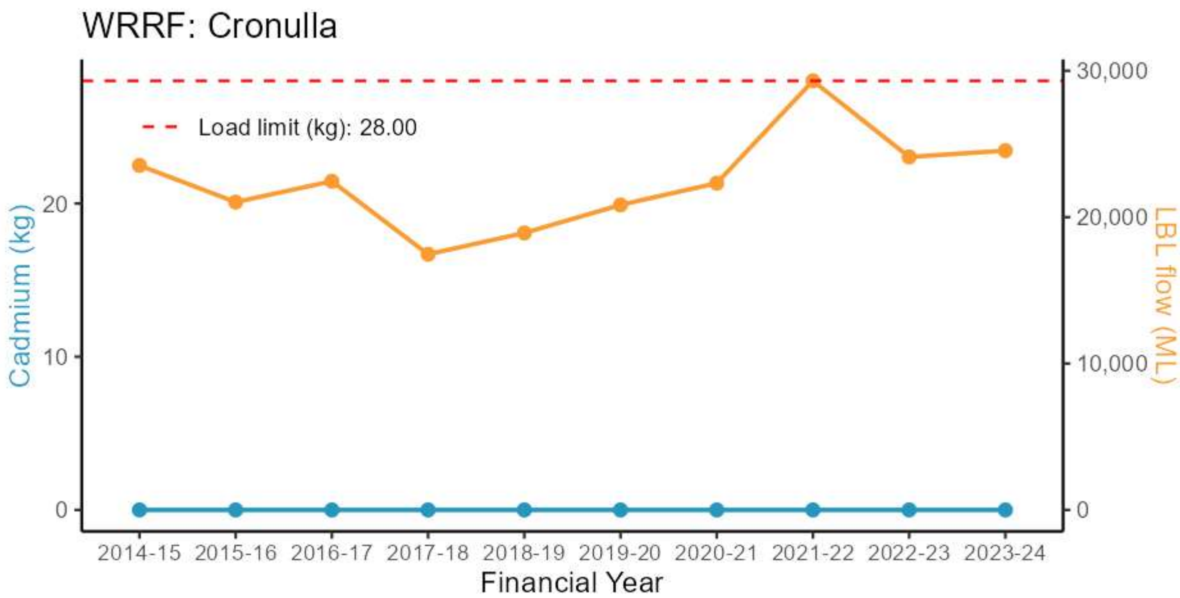
Major conventional analytes

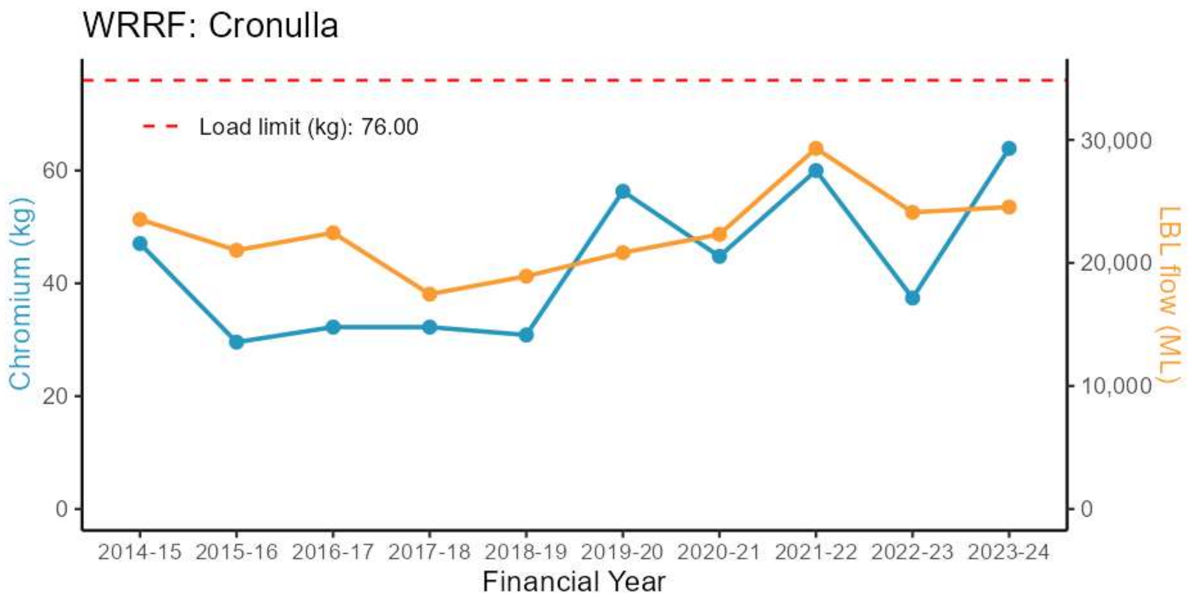


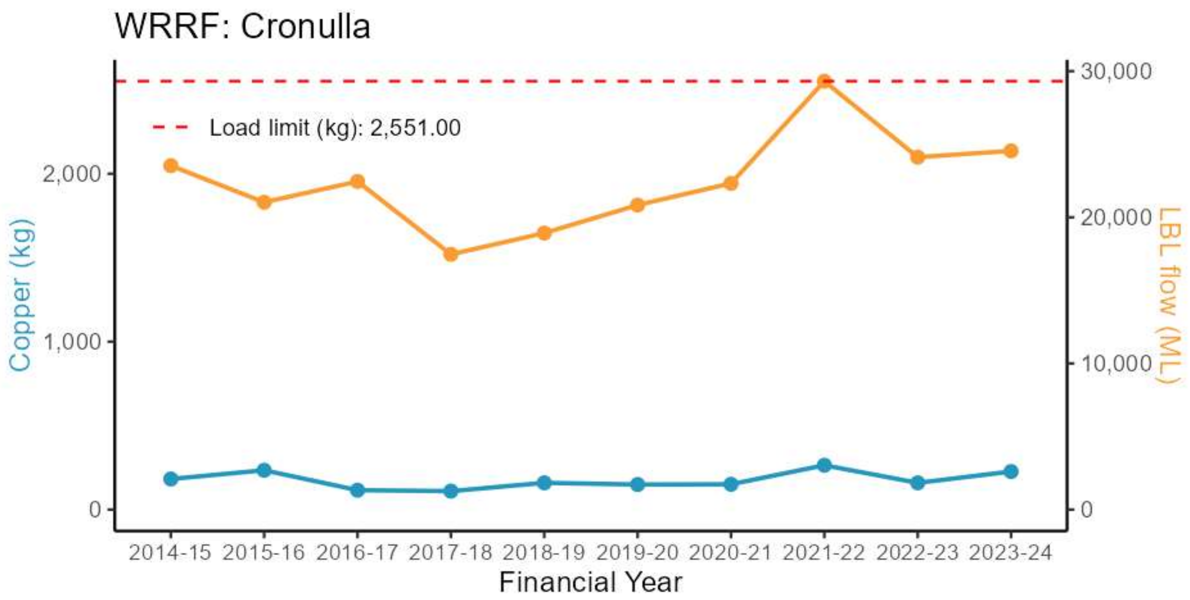


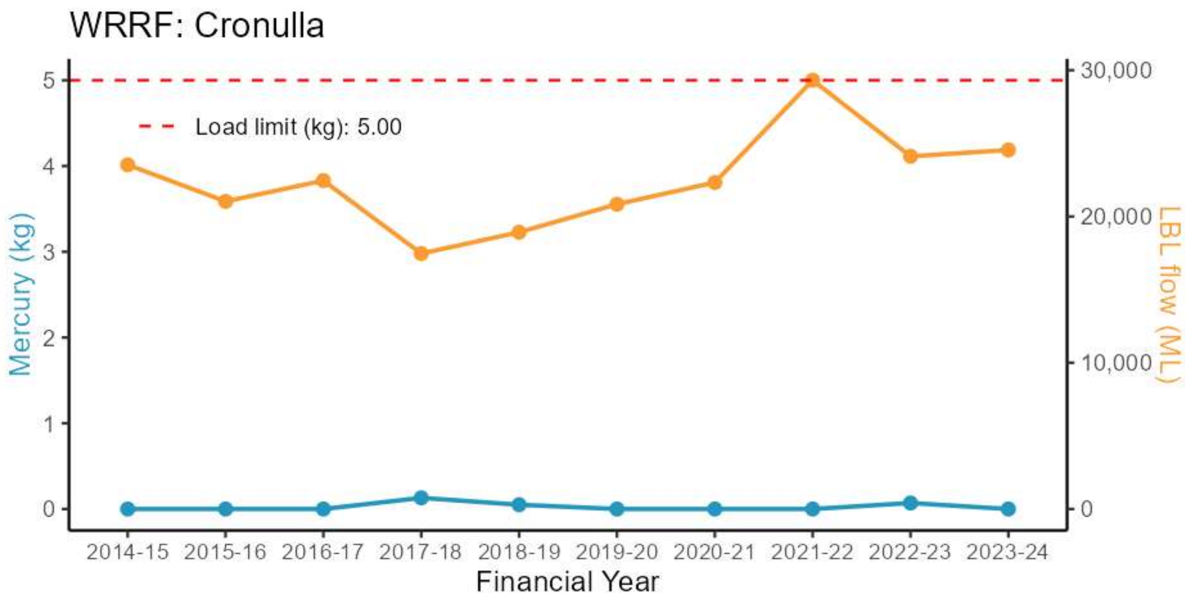


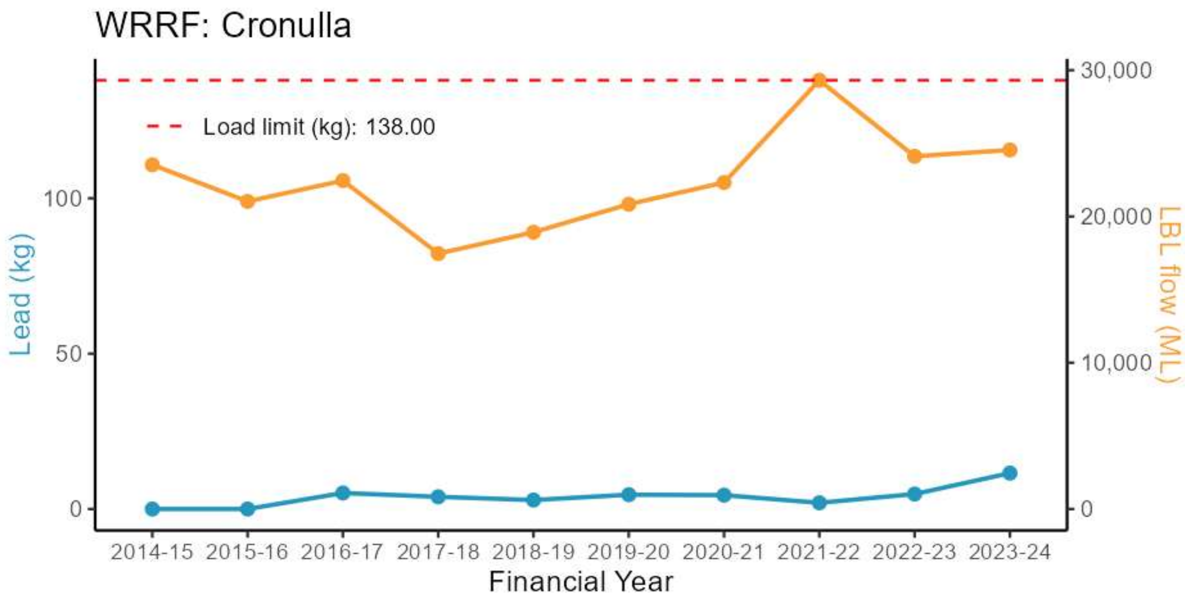
Trace metals

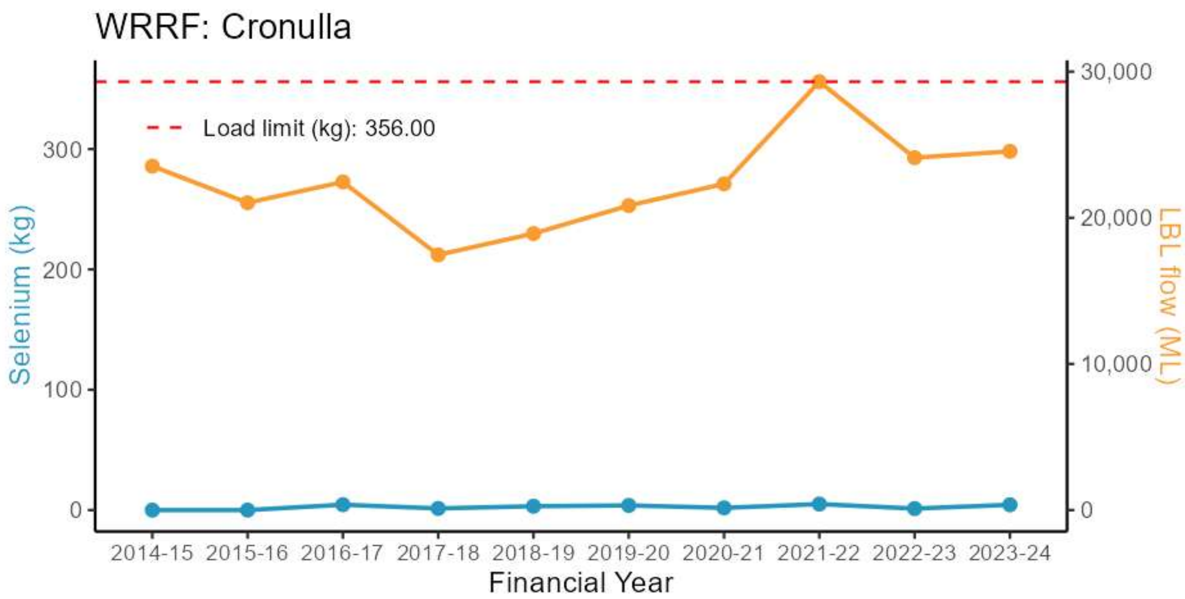


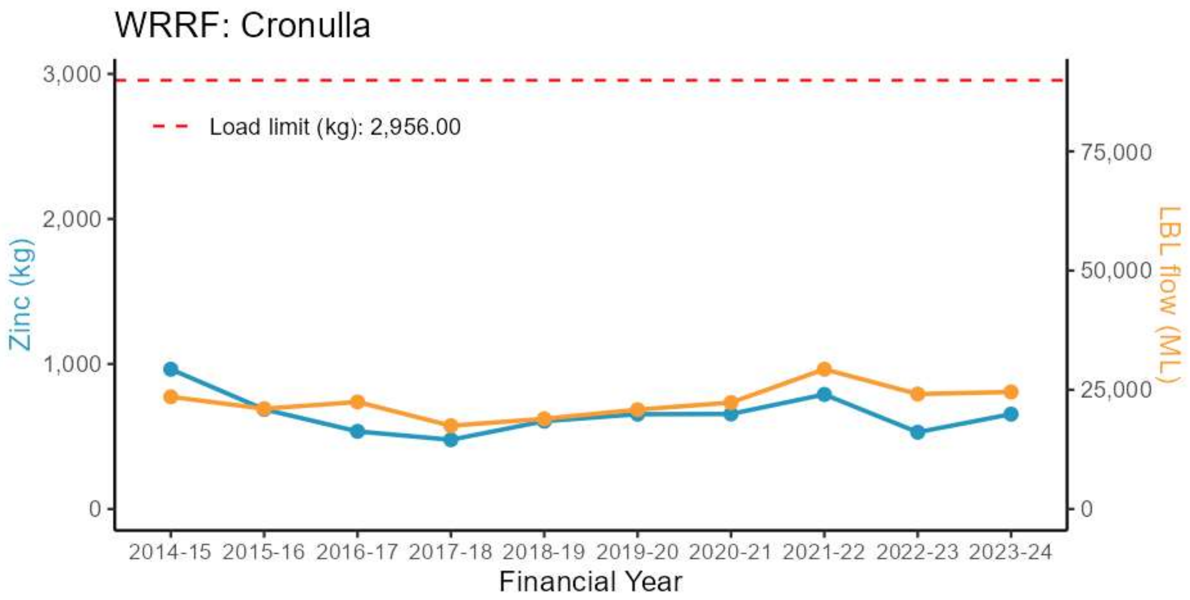

WRRF: Cronulla
Load limit (kg): 76.00
Chromium (kg)
LBL flow (ML)
0
20
40
60
0
10,000
20,000
30,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year


WRRF: Cronulla
Load limit (kg): 2,551.00
Copper (kg)
LBL flow (ML)
0
1,000
2,000
0
10,000
20,000
30,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year

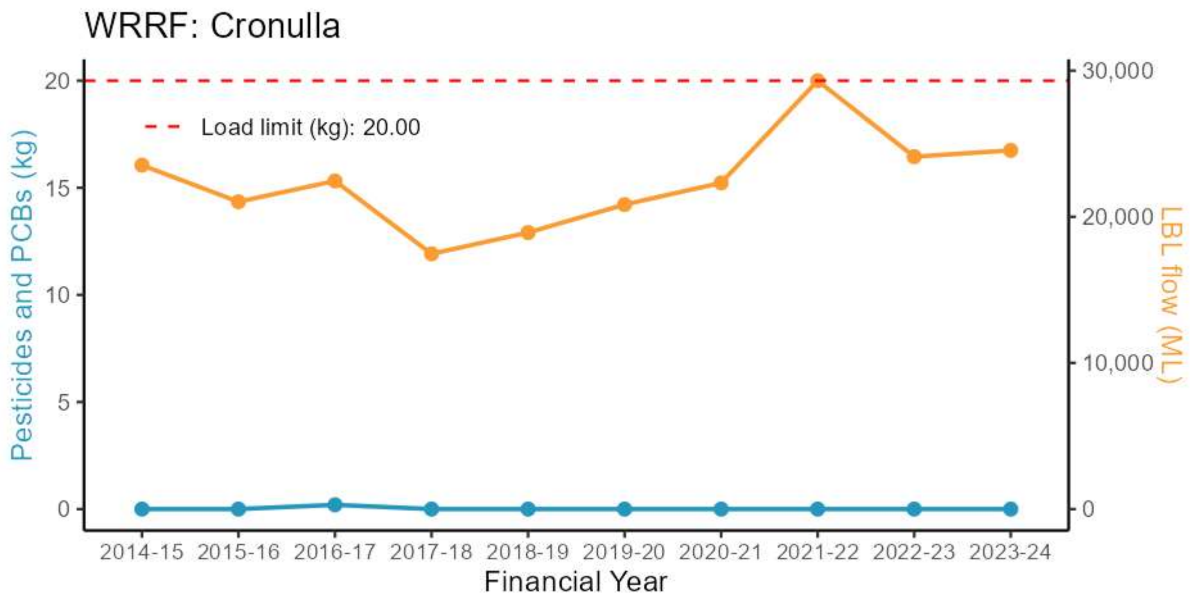

WRRF: Cronulla
Load limit (kg): 5.00
Mercury (kg)
LBL flow (ML)
Financial Year
0
1
2
3
4
5
0
10,000
20,000
30,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24


WRRF: Cronulla
Load limit (kg): 138.00
Lead (kg)
LBL flow (ML)
0
50
100
0
10,000
20,000
30,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year


WRRF: Cronulla
Load limit (kg): 356.00
Selenium (kg)
LBL flow (ML)
0
100
200
300
0
10,000
20,000
30,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



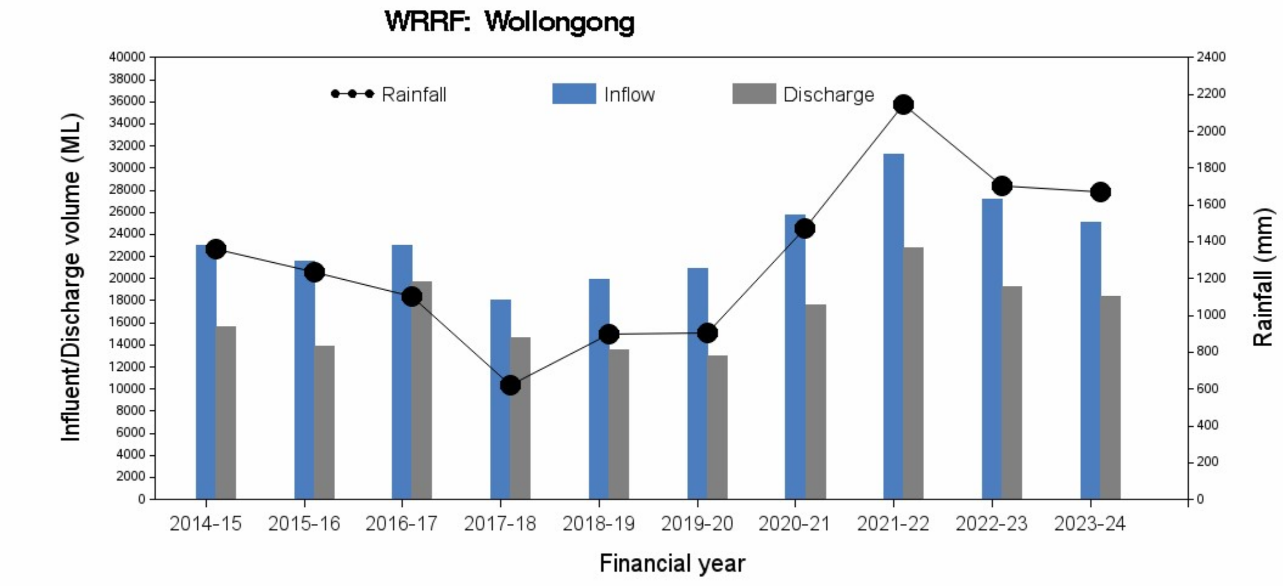
Other chemicals and organics (including pesticides)

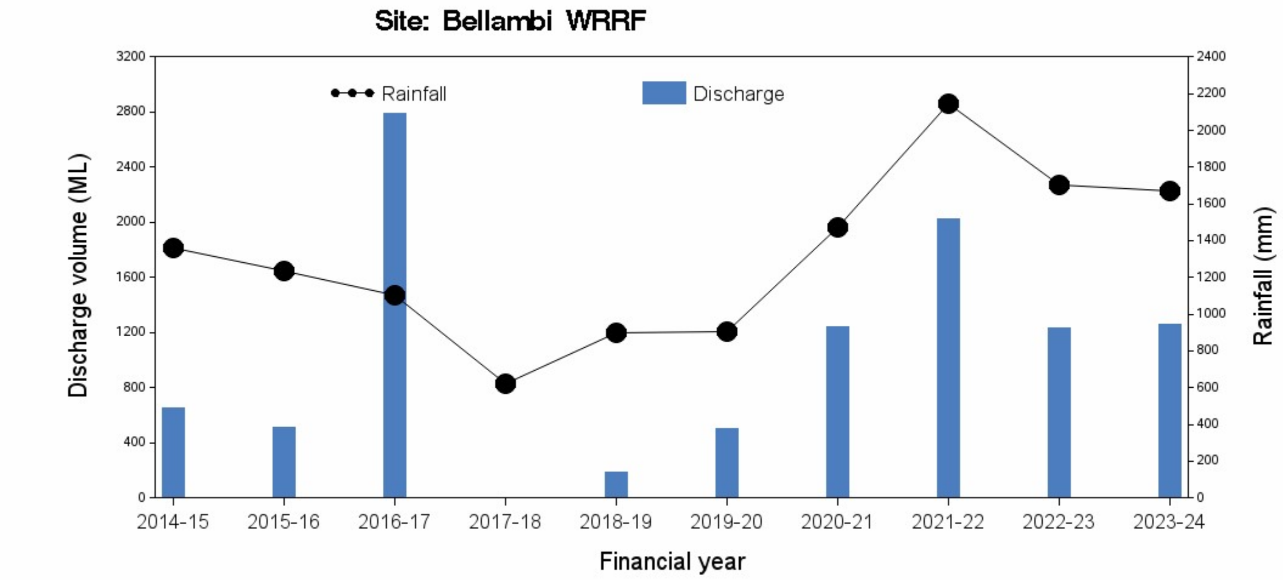


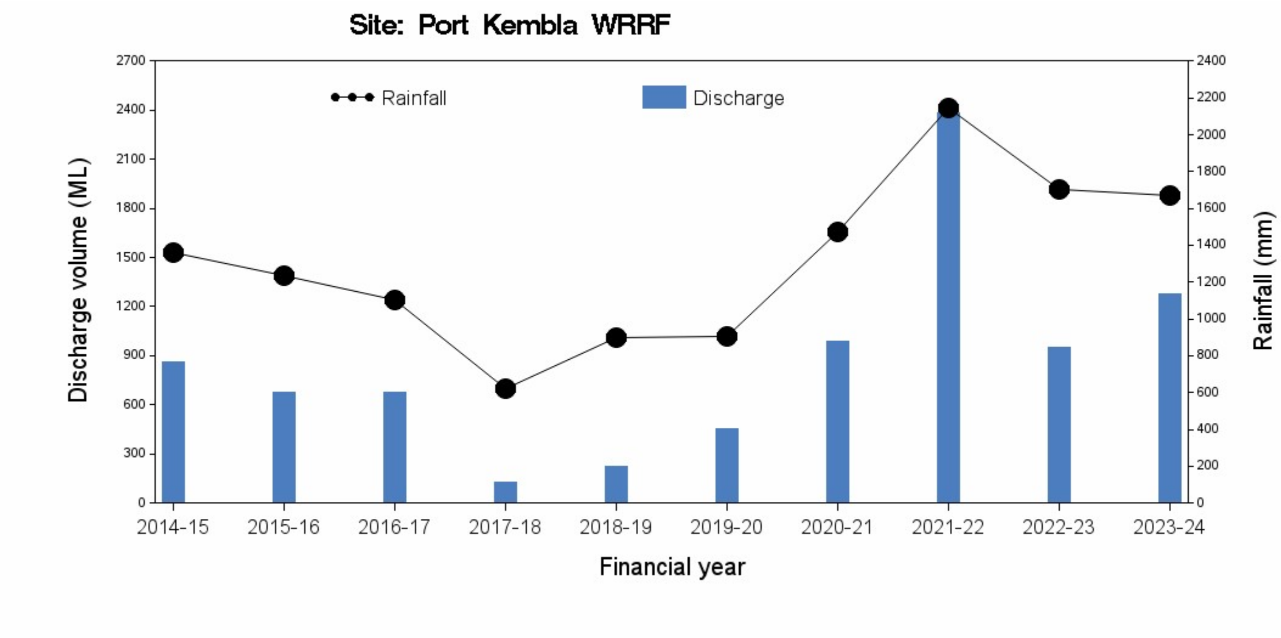
D.4. Wollongong WRRF

D.4.1. Pressure – Wastewater quantity

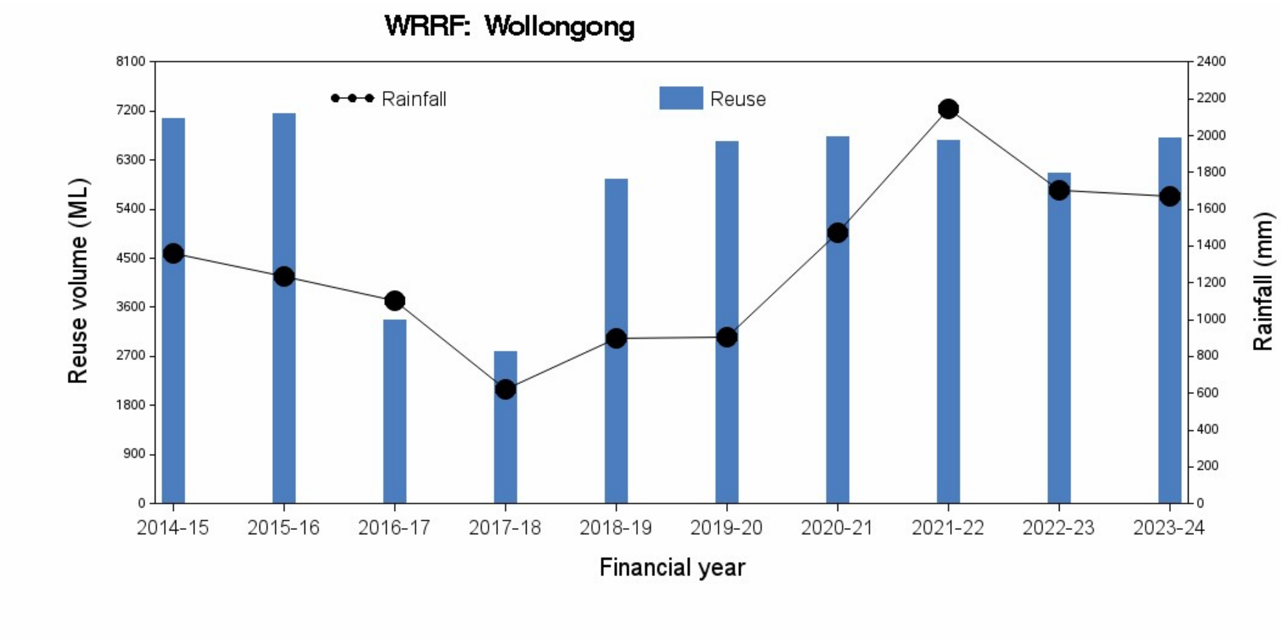
Inflow/ Discharge volume and rainfall





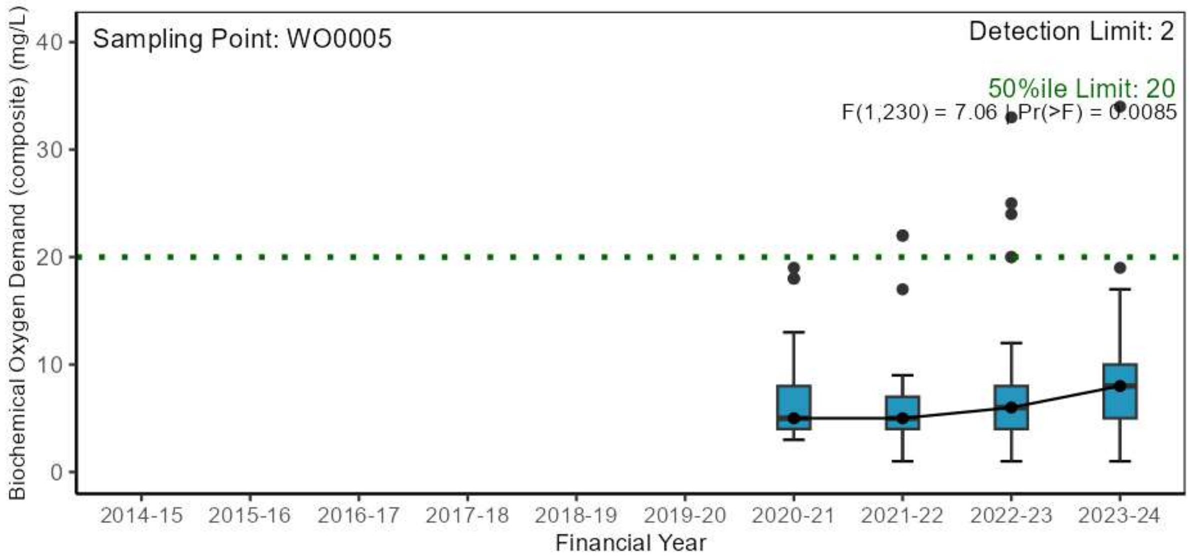


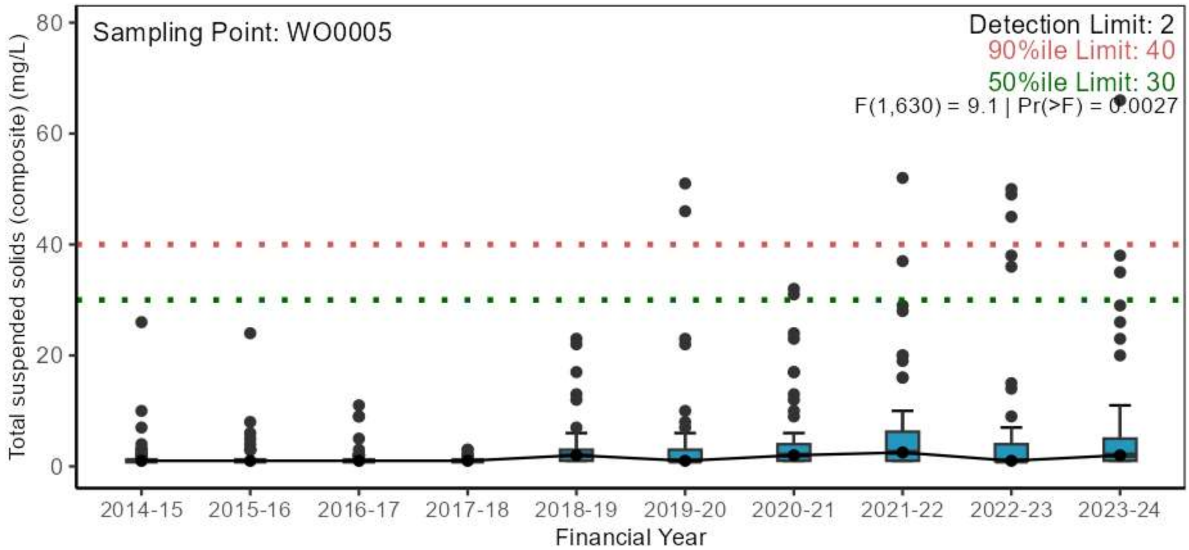
Reuse volume and rainfall



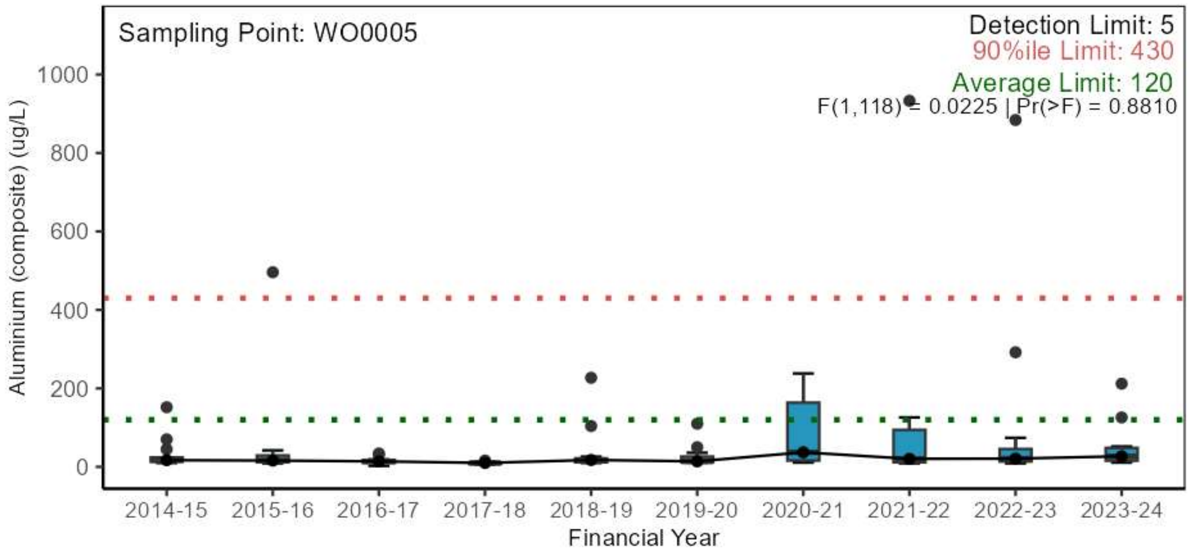
D.4.2. Pressure – Wastewater quality

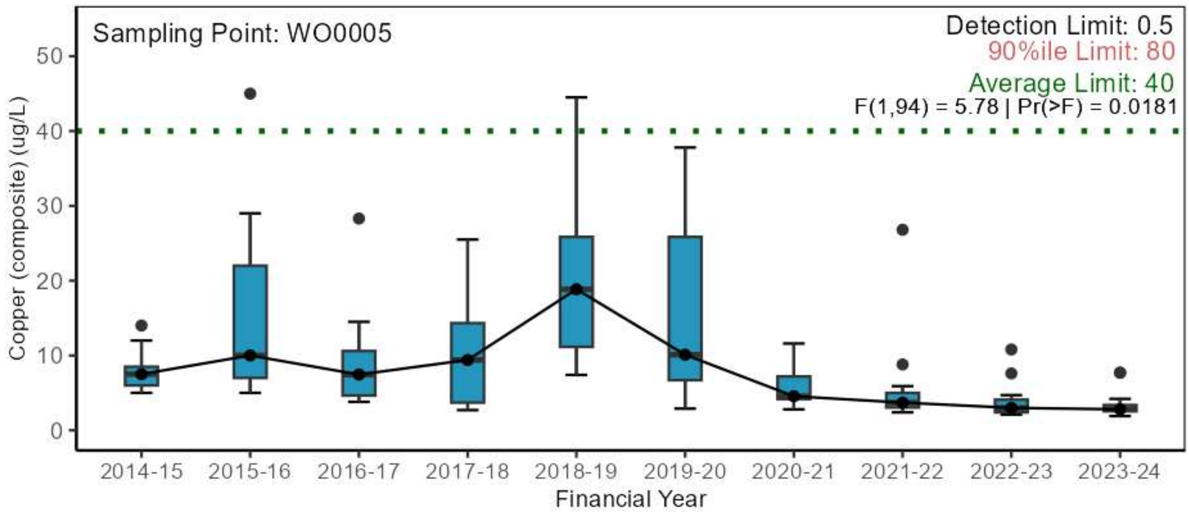
Major conventional analytes





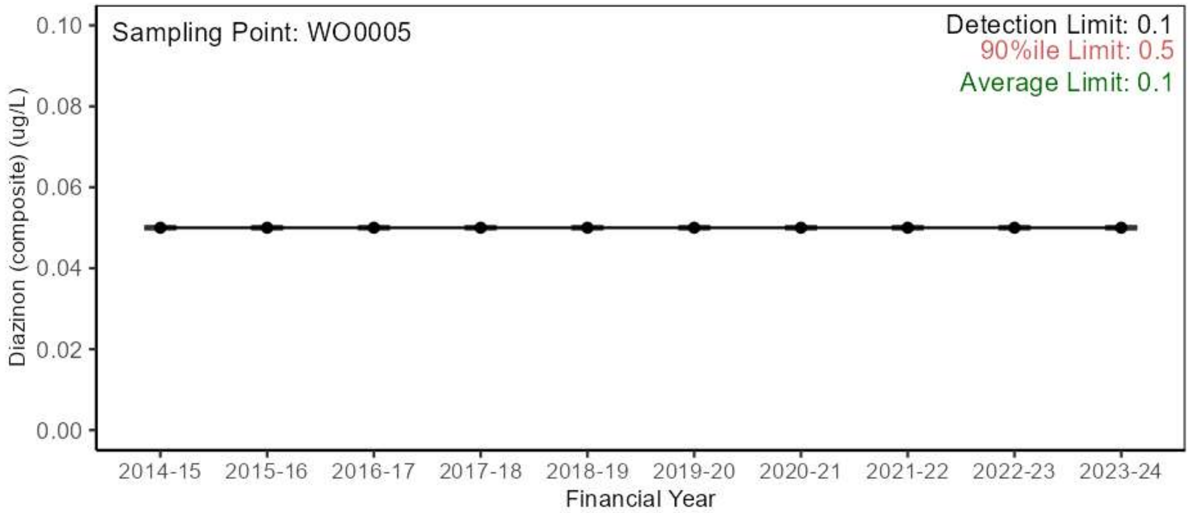
Trace metals



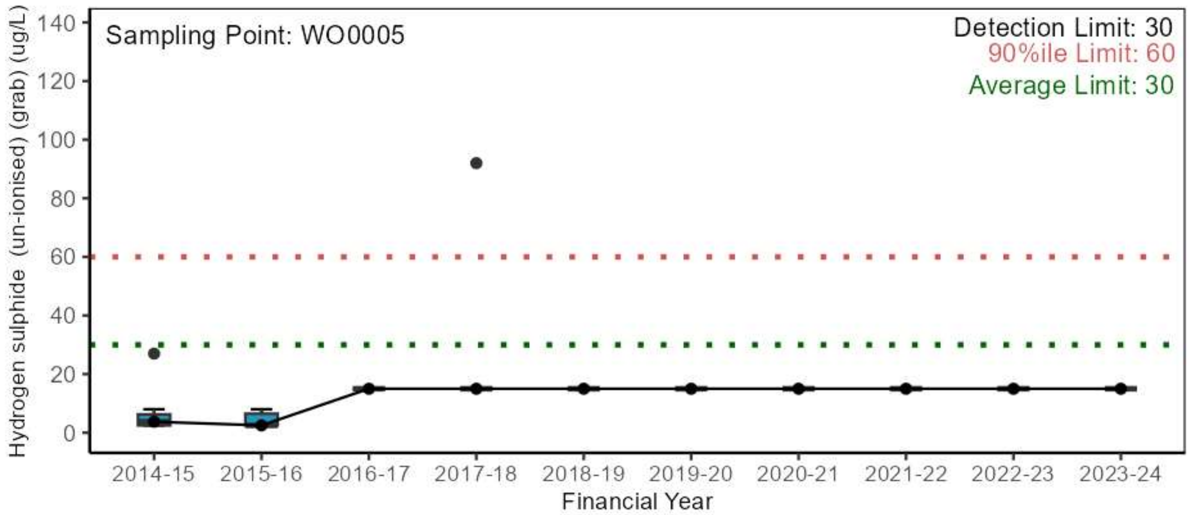


Statistical test excludes data prior to 2016-17 due to method detection limit change.

Other chemicals and organics (including pesticides)



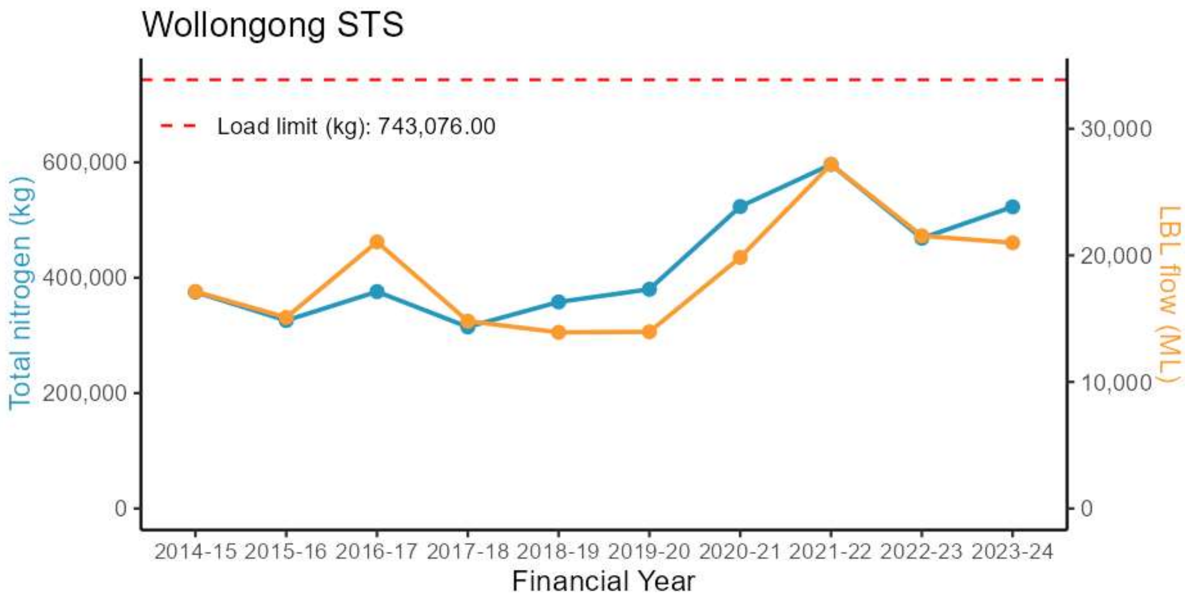
Statistical test not conducted as >90% of results were below detection limits.



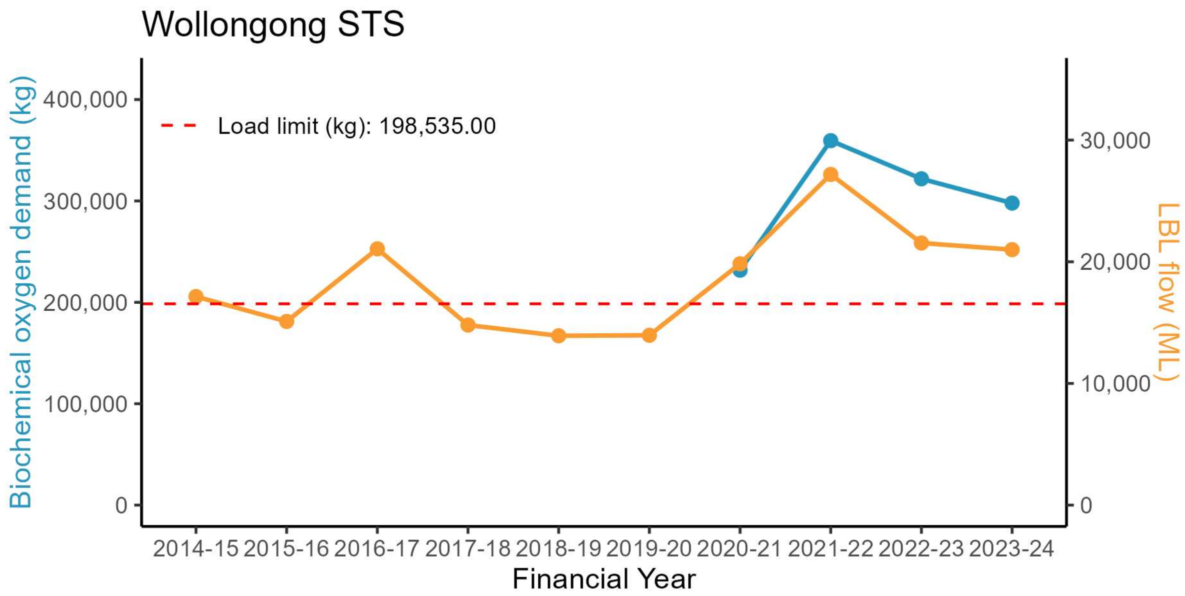
Statistical test not conducted as >90% of results were below detection limits.

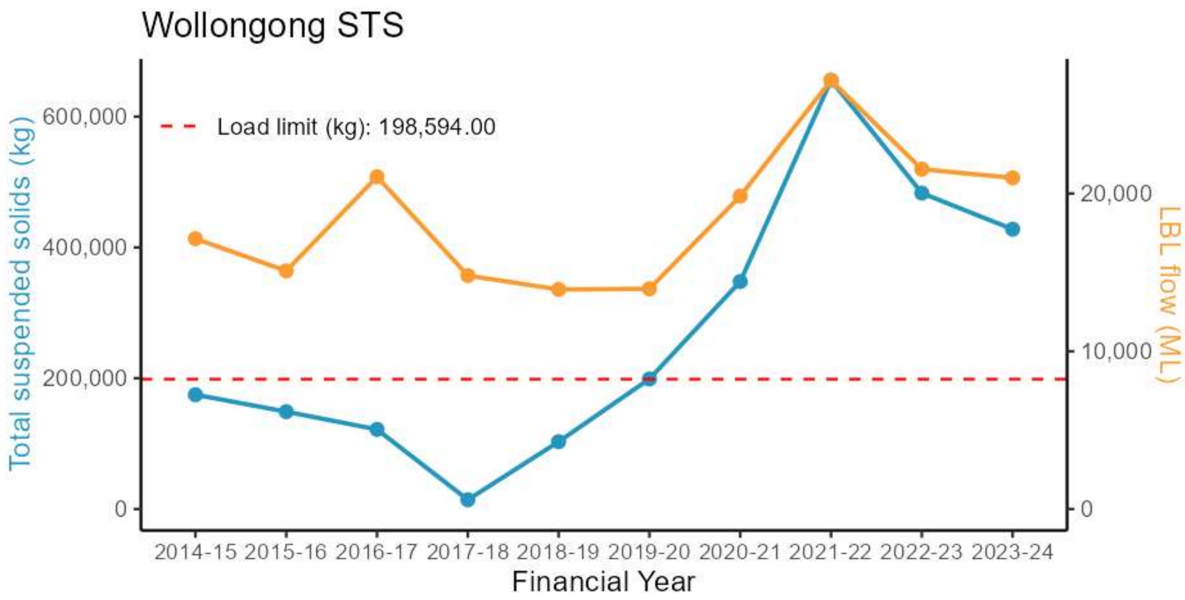
D.4.3. Pressure – Wastewater discharge load

Nutrients



Major conventional analytes

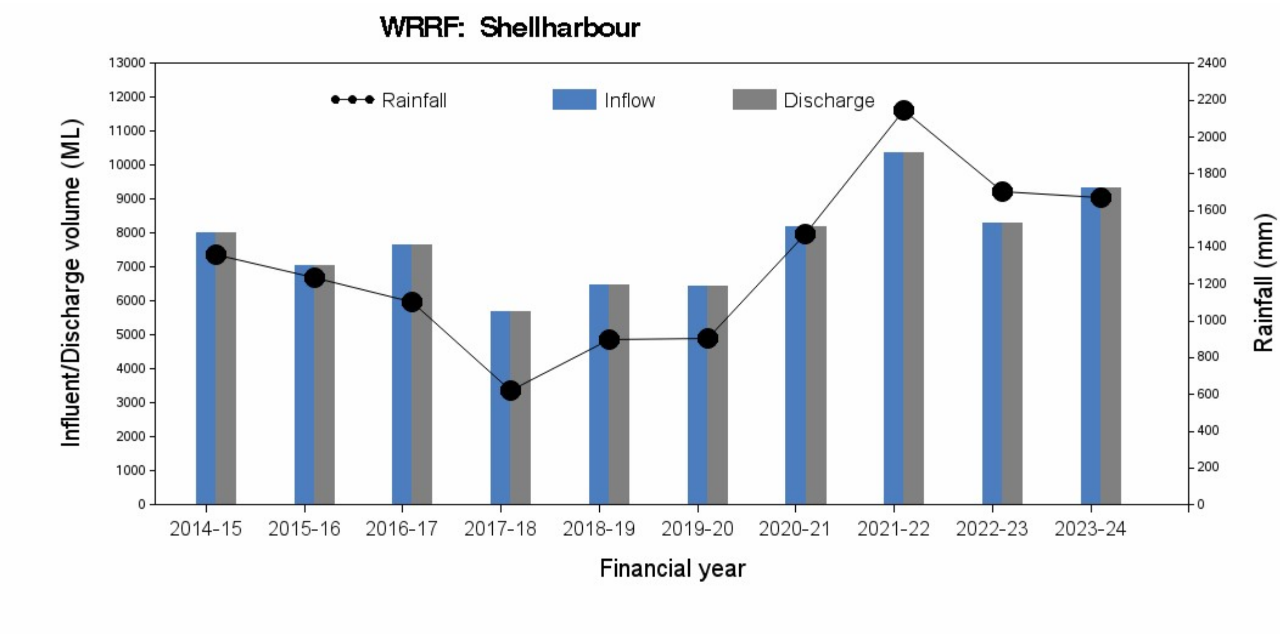




D.5. Shellharbour WRRF

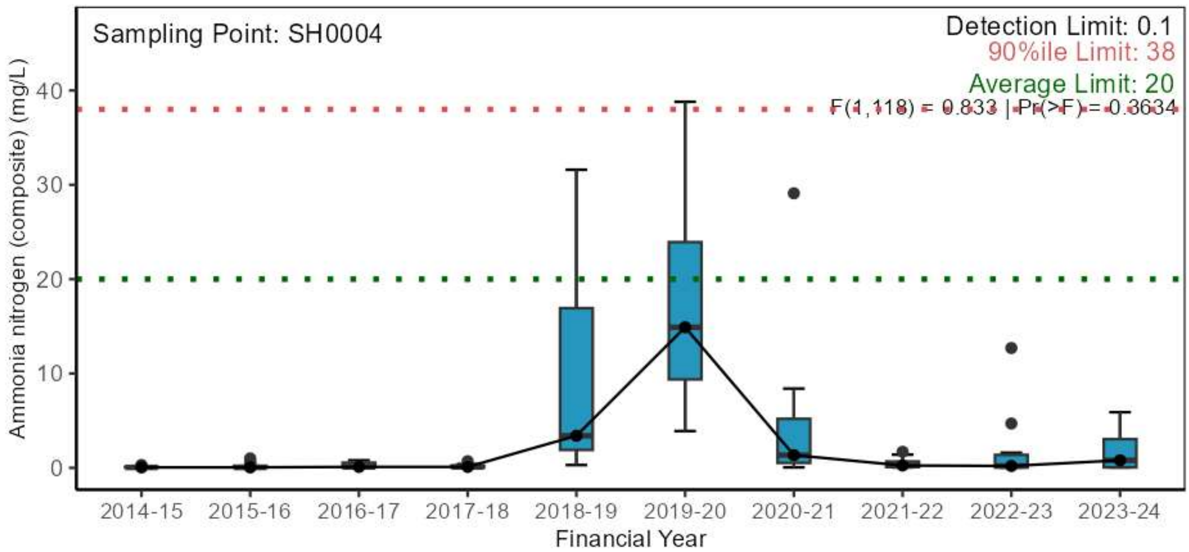
D.5.1. Pressure – Wastewater quantity

Inflow/ Discharge volume and rainfall

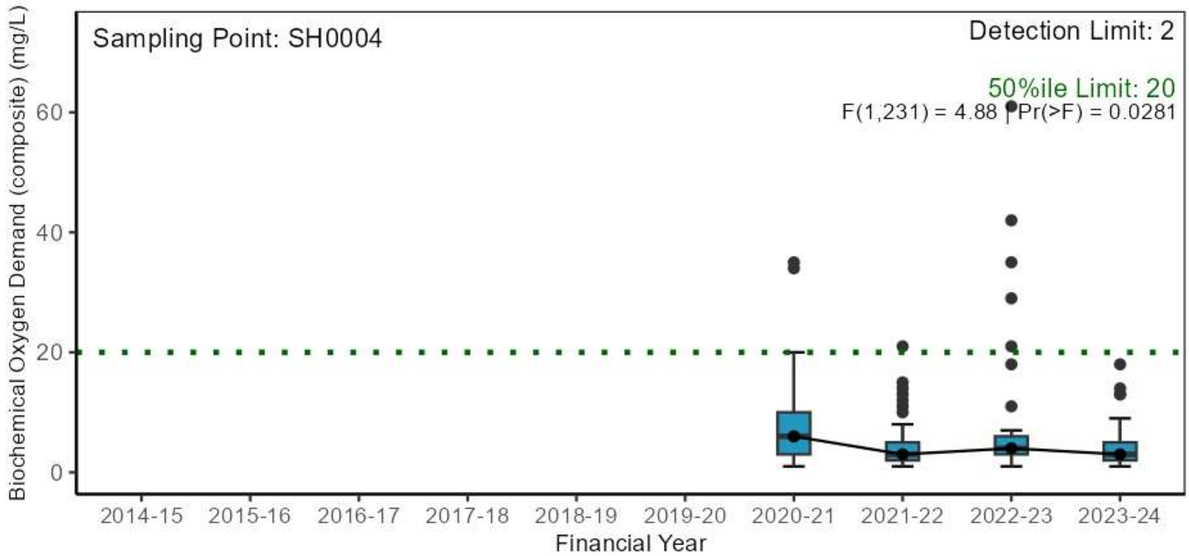


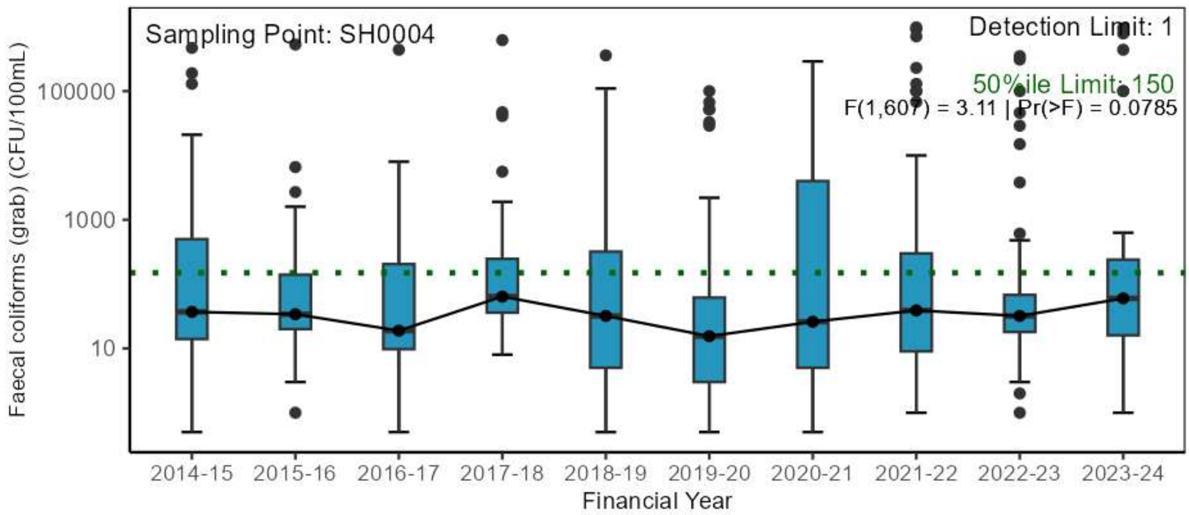
D.5.2. Pressure – Wastewater quality

Nutrients

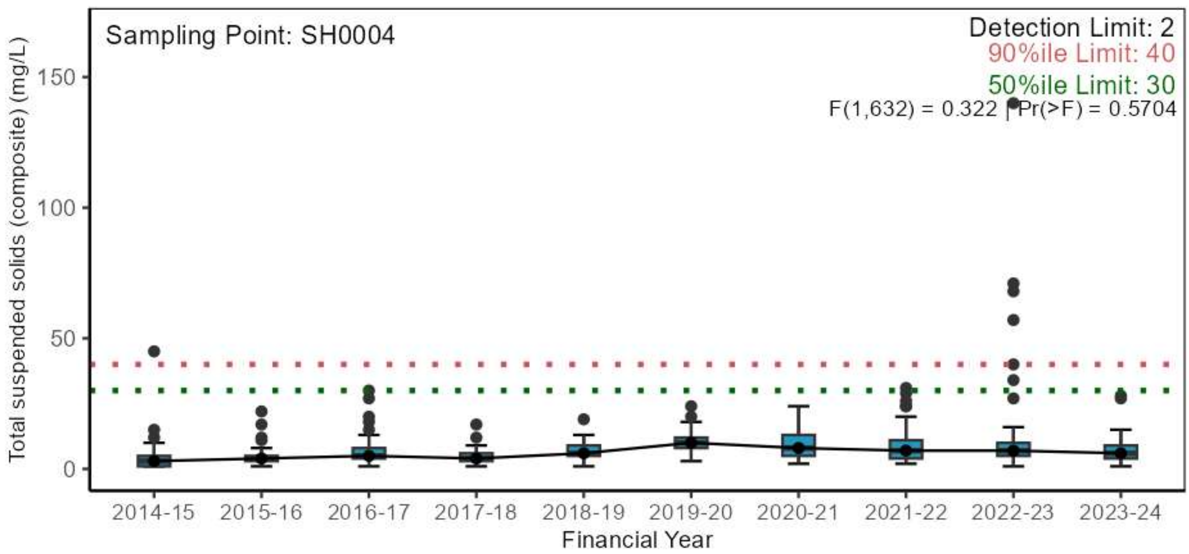


Major conventional analytes

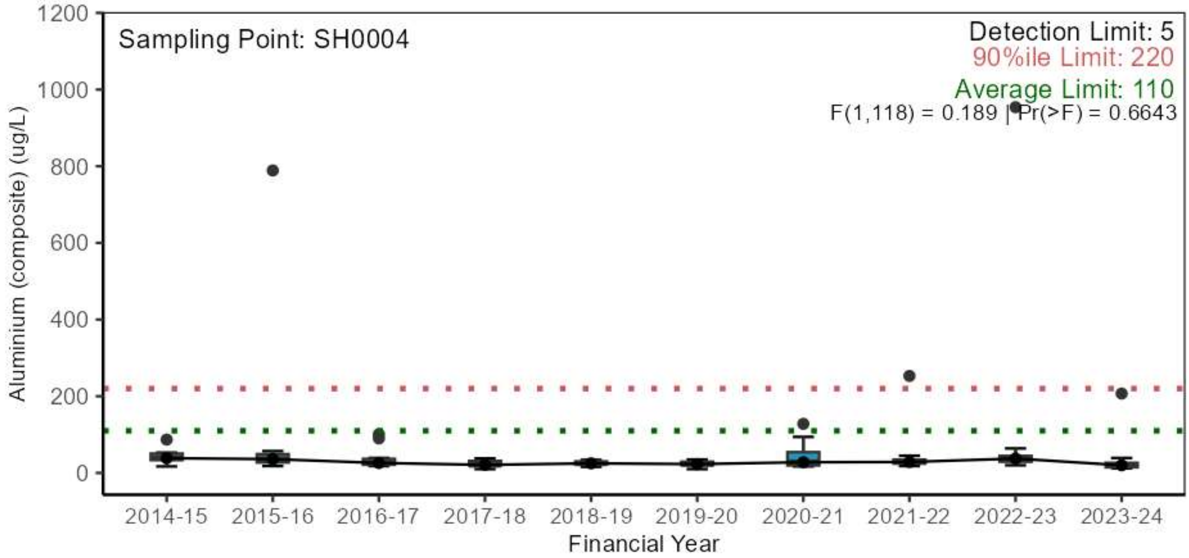


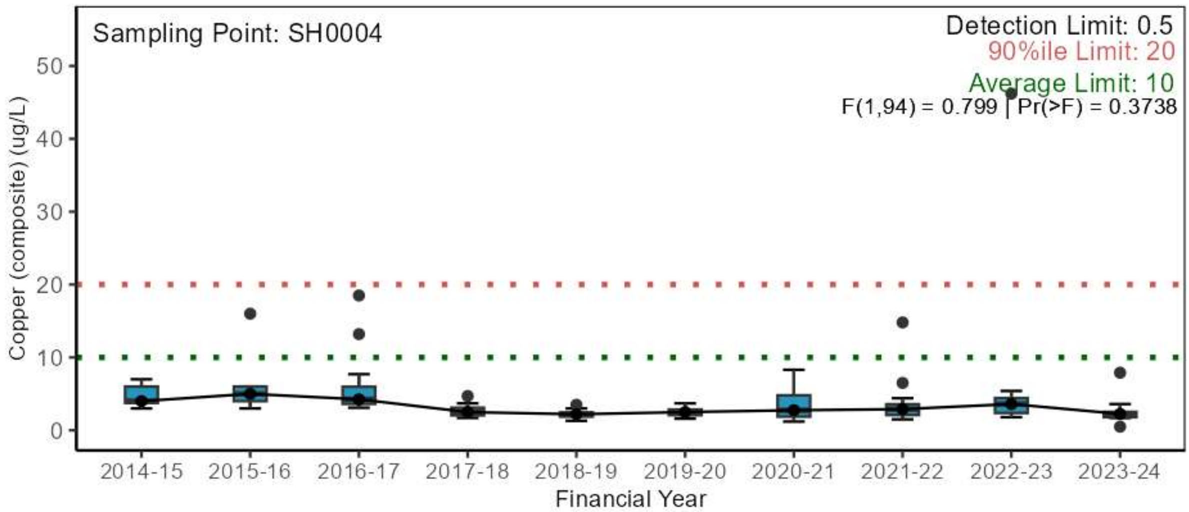


Data has been log10 transformed and y-axis backtransformed for ease of interpretation.



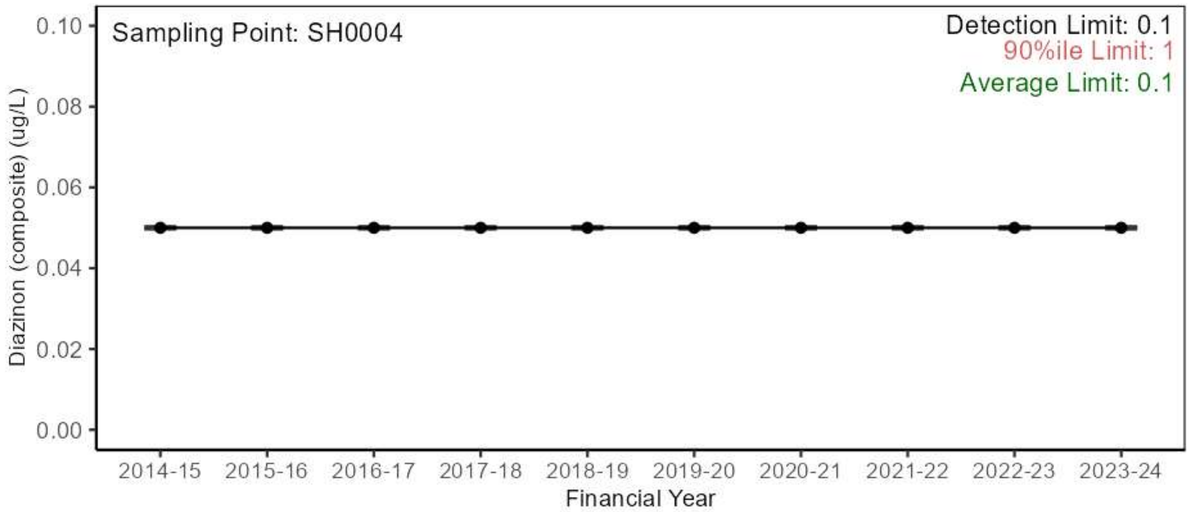
Trace metals



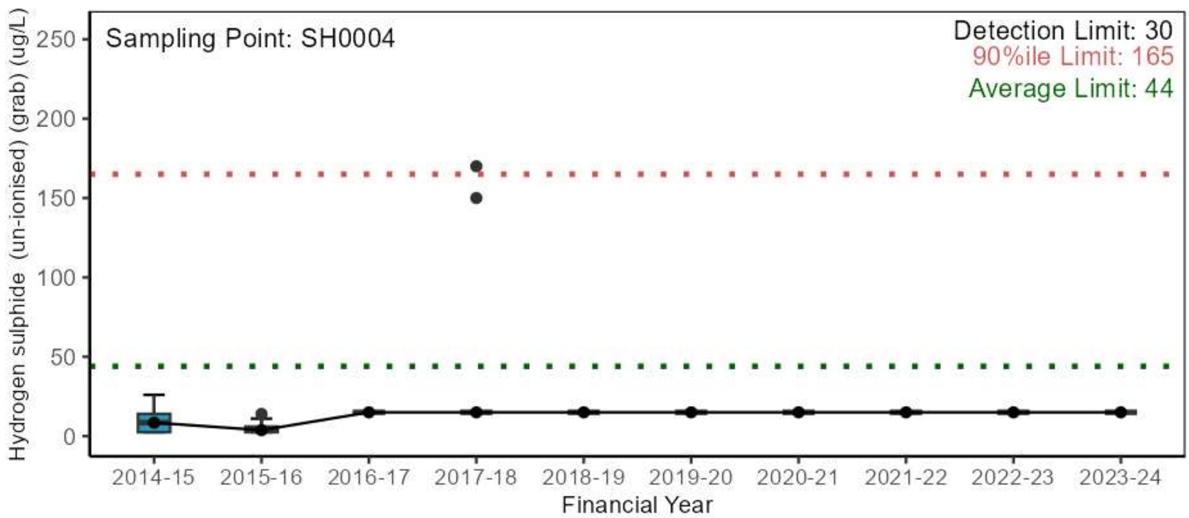


Statistical test excludes data prior to 2016-17 due to method detection limit change.

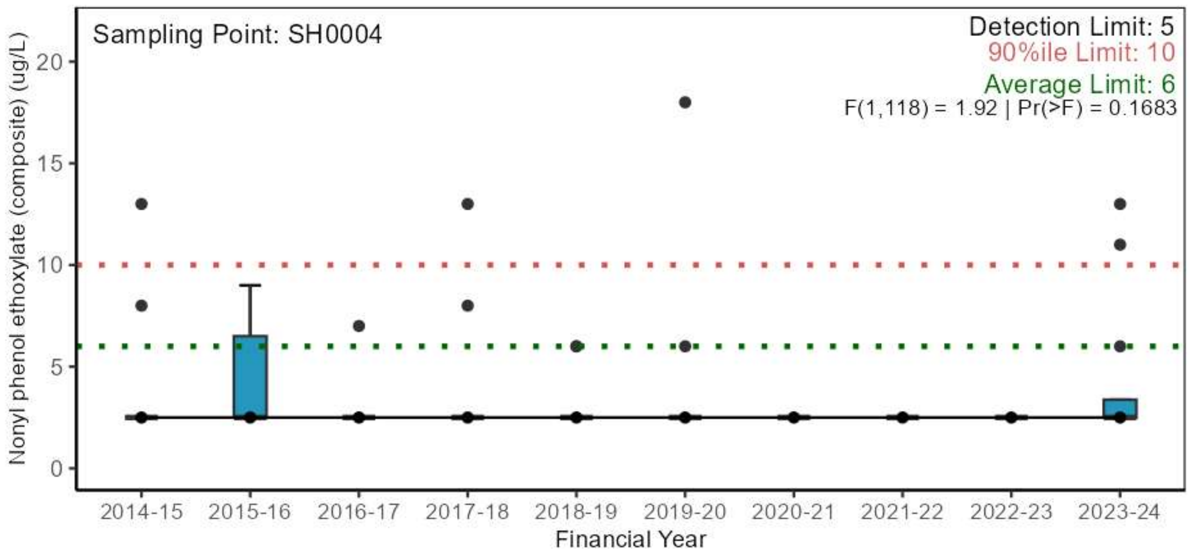
Other chemicals and organics (including pesticides)



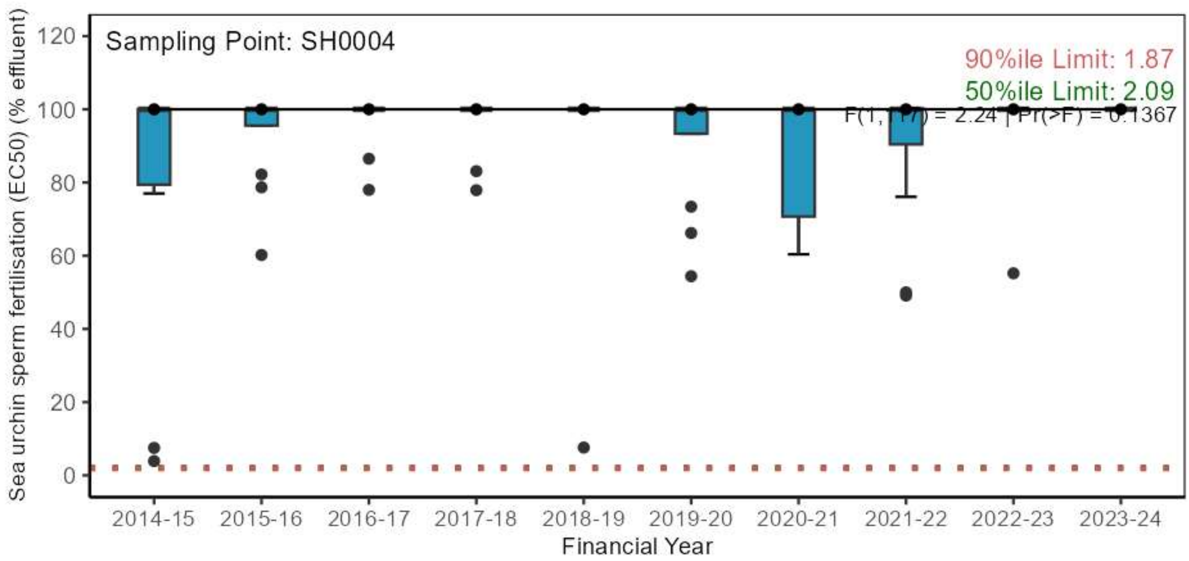
Statistical test not conducted as >90% of results were below detection limits.



Statistical test not conducted as >90% of results were below detection limits.

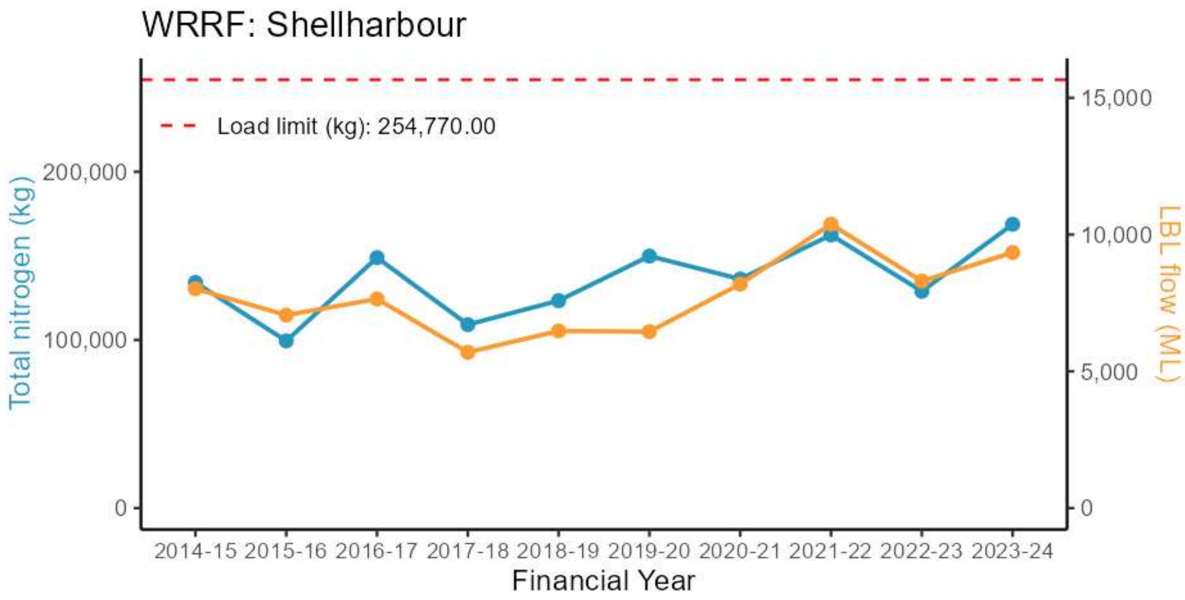


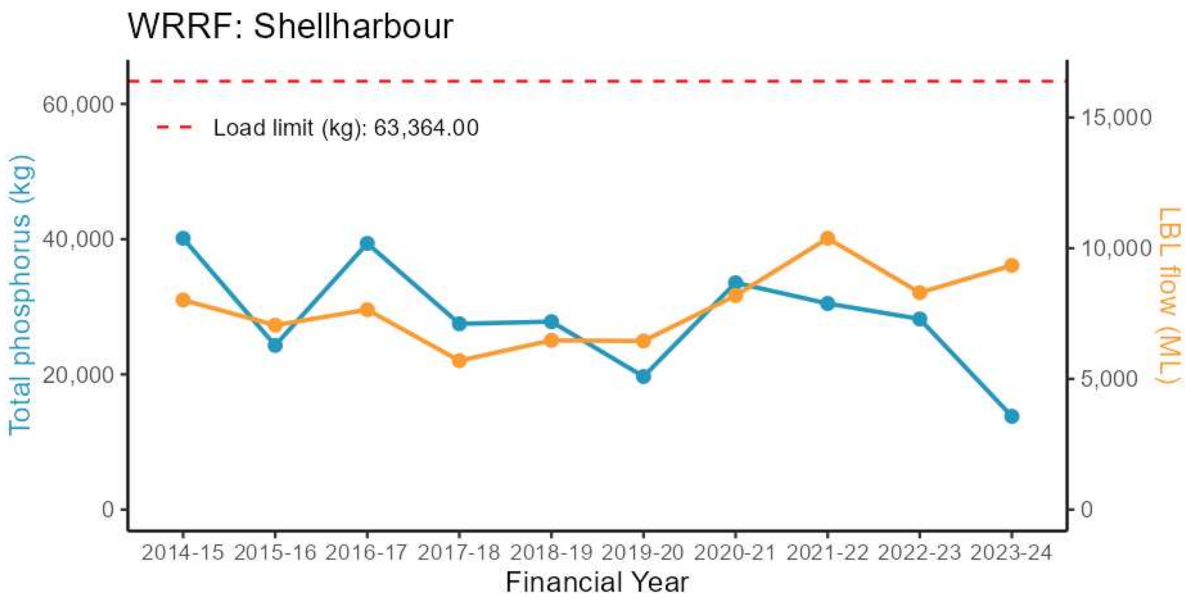
D.5.3. Pressure – Wastewater toxicity



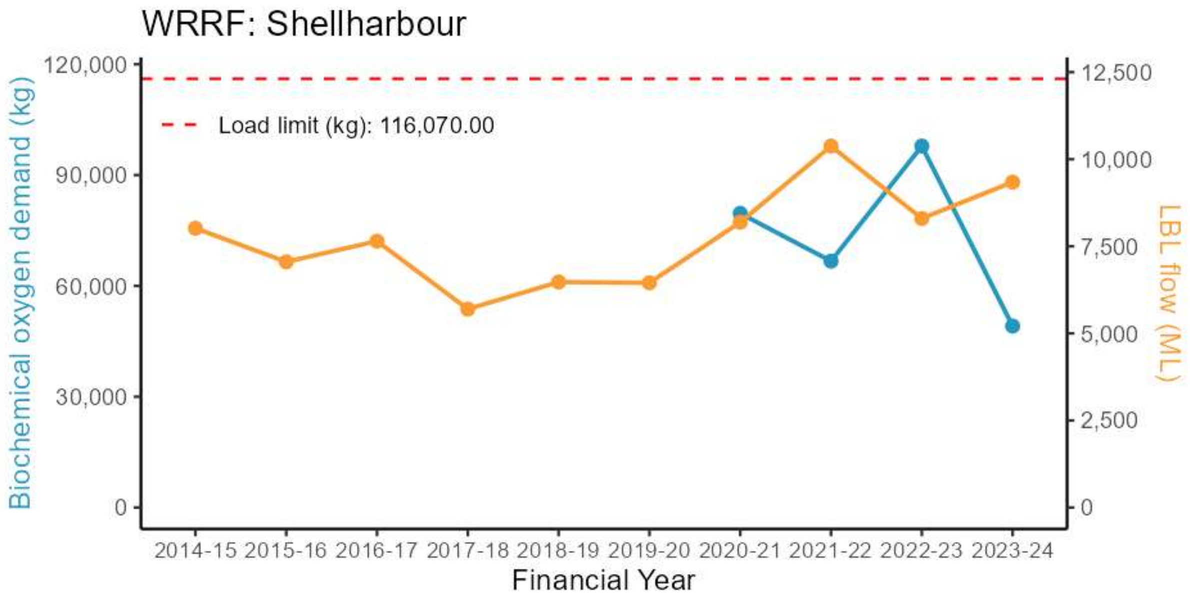
D.5.4. Pressure – Wastewater discharge load

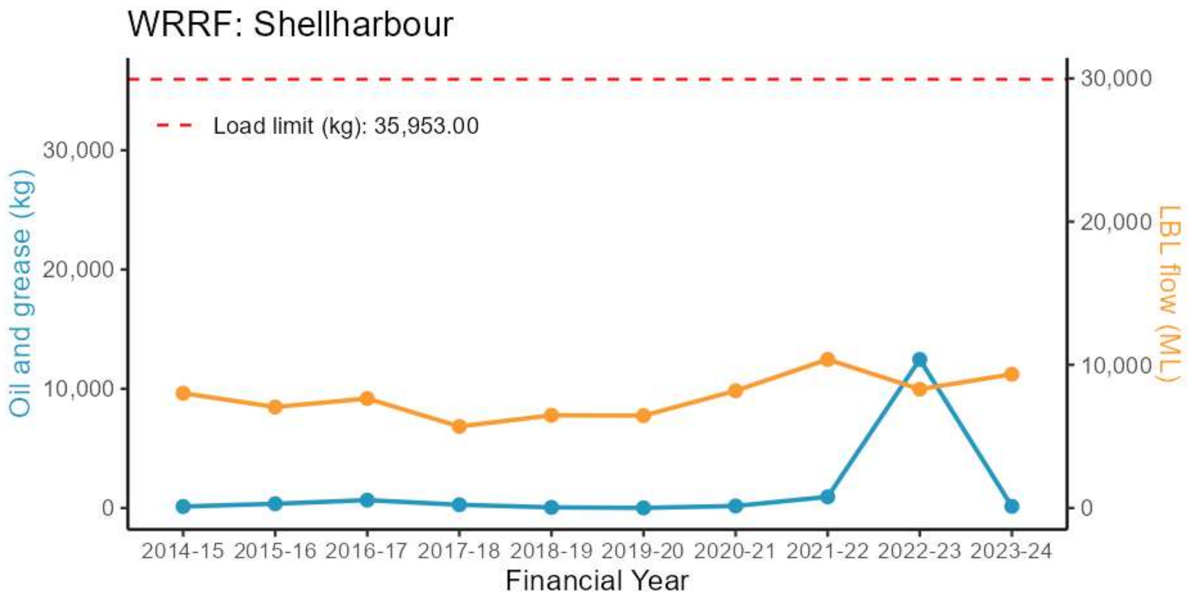
Nutrients

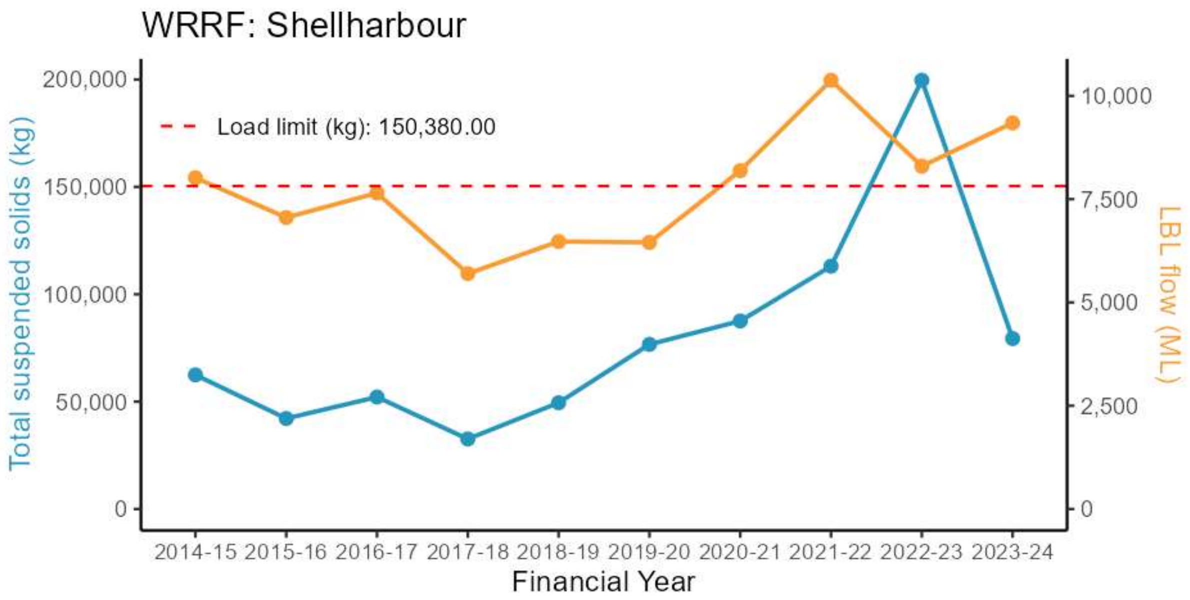




Major conventional analytes







D.5.5. Ecosystem receptor – Macroalgae and invertebrates

Monitoring of the nearshore marine environment is currently limited to three sites for determining the impact of the Shellharbour WRRF outfall. No stressor indicators are monitored, only ecosystem receptor indicators are currently included. The revised SWAM program is in the process of including water quality analytes and expanding to 30 other sites, pending the outcomes of a feasibility study.

Monitoring of rocky-intertidal communities under the shoreline outfall program assesses the potential ecological impact from the Shellharbour WRRF which discharges to the nearshore ocean environment. The structures of natural communities (without anthropogenic impacts) from two control sites were used in assessment of the Shellharbour outfall (impact) site (Volume 1 Figure 2-7). The Shellharbour outfall site is situated about 2 km north of the two control sites. The control sites are situated about 400 m apart.

The taxonomic level recorded was based on morphological characteristics that could be seen with the naked eye and the level recorded is shown in the SIMPER 2023-24 output (Table D-2). Identification of macroinvertebrate taxa and macro algae was checked against taxonomic works of Edgar (1997) and Dakin (1987).

Shoreline outfall discharges with documented measurable impacts on intertidal community structure are typically limited in spatial extent from 100 to 300 m (Fairweather 1990). These intertidal community structures were dominated by extensive covers of green macro algae. A pictorial example of a localised spatial impact of about 50 m^2 (Figure D-2) was formerly seen at Barrack Point outfall in 2001. At that time, an extensive cover of green macro algae occurred with few invertebrates (EP Consulting 2003). This was prior to upgrade works conducted at the Shellharbour WRRF in the early to mid-2000’s.

An asymmetrical permutational multivariate analysis of variance test (PERMANOVA) was conducted with ‘Control and Impact’ locations treated as a fixed factor. ‘Sites’ were nested within ‘Control and Impact’, with ‘Sites’ treated as a random factor. The outfall site was the only site under the Impact location and the two sites were under the Control locations. A fourth root transformation was applied to the data prior to a Bray-Curtis dissimilarity matrix being constructed. This matrix was the basis for PERMANOVA testing with 9999 permutations run under a reduced model, with conservative Type III sums of squares inspected to base hypothesis decisions upon.

Asymmetrical PERMANOVA indicated there was no significant difference between ‘Control and Impact’ locations for the 2023-24 survey (Table D-1).

SIMPER analysis for the 2023-24 period shows Green Algae to be the dominate taxa at the outfall location, however only contributing 22.68%. (Table D-2). The remaining majority composition of the outfall site is made up of a community structure dominated by invertebrates. Control sites 1 similarly reflected a community structure dominated by invertebrates with a lesser contribution of macro algae. Control site 2 had a higher contribution of Brown Algae contributing 43.5% while the rest of the community composition was dominated by invertebrates. The picture of the outfall site in 2023-24 (Figure D-1) reflects these SIMPER results, which is different to the green algal dominance and low number of invertebrates recorded in 2001 prior to WRRF upgrade works (Figure D-2).

In summary, the multivariate analyses of community structure of 2023-24 morphologically based intertidal rock platform community data suggested there was no measurable impact in the intertidal rock platform community near the outfall at Barrack Point from wastewater discharges from the Shellharbour WRRF. This outcome was supported by the differences apparent in the pictorial comparisons of 2001 and 2023-24. Context of 2023-24 data to the broader data collected back to 2008 is provided under the 2008 to 2023-24 data analysis below.

Permutational MANOVA
Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Control / Impact	Fixed	2
Site	Random	3

PERMANOVA table of results

Source	Dtf	SS	MS	Pseudo-F	P(perm)	Perms	P(MC)
Control / Impact	1	13486	13486	1.1235	0.6651	3	0.4482
Site(Control / Impact)	1	12004	12004	19.678	0.0001	9955	0.0001
Res	39	23790	610				
Total	41	49280					

Estimates of components of variation

Source	Estimate	Sq.root
S(Control / Impact)	79.419	8.9117
V(Site(Control / Impact))	813.83	28.528
V(Res)	610	24.698

Factors

Name	Type	Levels
Control / Impact	Fixed	2
Site	Random	3

Control site-1 – 2023-24 Average sample similarity: 63.16%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
False limpets & rock limpets (Patellogastropoda)	1.83	15.71	4.73	24.88	24.88
Barnacles (Cirripedia)	2.32	15.55	1.81	24.62	49.5
Conniwinks (Littorinidae *Bembicium*)	1.61	12.09	2.89	19.15	68.64
Nerite (Neritidae *Nerita*)	1.21	6.9	1.15	10.93	79.57
Oyster Borer (Muricidae *Morula marginalba*)	1.05	6.62	1.18	10.48	90.05
Brown algae (Phaeophyta)	1.17	3.31	0.53	5.24	95.29
Periwinkles (Littorinidae *Nodilittorina*)	0.67	1.94	0.43	3.08	98.36
Green Algae (Chlorophyta)	0.48	0.42	0.18	0.67	99.03
Red Algae (Rhodophyta)	0.51	0.33	0.18	0.53	99.56
Zebra top shell (Trochidae *Austrocochlea*)	0.31	0.28	0.18	0.44	100

Control site-2 – 2023-24 Average sample similarity: 58.46%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Brown algae (Phaeophyta)	3.3	25.43	2.04	43.5	43.5
Oyster Borer (Muricidae *Morula marginalba*)	1.29	8.99	2.24	15.39	58.89
Zebra top shell (Trochidae *Austrocochlea*)	1.37	7.24	1.16	12.38	71.27
False limpets & rock limpets (Patellogastropoda)	1.2	5.53	0.88	9.45	80.72
Barnacles (Cirripedia)	2.01	4.86	0.51	8.32	89.04
Red Algae (Rhodophyta)	0.93	3.1	0.57	5.31	94.35
Green Algae (Chlorophyta)	0.93	2.86	0.59	4.9	99.25
Conniwinks (Littorinidae *Bembicium*)	0.33	0.44	0.26	0.75	100
Nerite (Neritidae *Nerita*)	0.07	0	SD=0!	0	100

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Periwinkles (Littorinidae *Nodilittorina*)	0	0	SD=0!	0	100
Encrusting tube worm (Serpulidae *Galeolaria caespitosa*)	0.06	0	SD=0!	0	100

SD=0!: Sim/SD ratio could not be calculated due to low occurrence of taxa within site samples.

Outfall site – 2023-24 Average sample similarity: 73.50%

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Green Algae (Chlorophyta)	2.96	16.67	4.03	22.68	22.68
Zebra top shell (Trochidae *Austrocochlea*)	2.36	14.72	6.37	20.03	42.71
Red Algae (Rhodophyta)	2.85	13.34	1.46	18.15	60.85
Conniwinks (Littorinidae *Bembicium*)	1.74	9.17	2.19	12.47	73.33
Nerite (Neritidae *Nerita*)	1.36	6.77	1.51	9.22	82.54
False limpets & rock limpets (Patellogastropoda)	1.28	6.38	1.46	8.69	91.23
Oyster Borer (Muricidae *Morula marginalba*)	0.96	3.65	0.96	4.97	96.19
Barnacles (Cirripedia)	0.87	2.8	0.63	3.81	100

Figure D-1 Barrack Point with a healthy intertidal rock platform community in 2023-24

Figure D-2 Barrack Point (in 2001) with an unhealthy intertidal rock platform community impacted by wastewater discharges from the Shellharbour WRRF prior to upgrade in the early to mid-2000's

Intertidal communities Shellharbour 2008-09 to 2023-24

Inclusion of yearly replicate samples from 2008-09 to 2023-24 allowed the factor 'Time' to be included in the above asymmetrical permutational analysis of variance test (PERMANOVA). Time was comprised of 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16, 2016-17, 2017-18, 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24 surveys, which were conducted at varying times through late winter to late spring.

Asymmetrical PERMANOVA indicated there was no significant difference between 'Control and Impact' locations for the 2008-09 to 2023-24 period (Table D-3). However, differences between sites through time were indicated as significant results were returned for the 'Site (Control / Impact)' and 'Site (Control / Impact) x Time' factors (Table D-3).

The non-metric multidimensional scaling (nMDS) ordination routine of PRIMER was used to produce a 3-dimensional ordination plot. In this plot the relative distance between samples is proportional to the relative similarity in taxonomic composition and abundance – the closer the points on the graph the more similar the community (Clarke 1993). That is, site samples with similar taxa lay closer together and site samples with a differing taxon composition lie farther apart. An unconstrained ordination procedure such as nMDS inevitably introduces distortion when trying to simultaneously represent the similarities between large numbers of samples in a few dimensions. The success of the procedure is measured by a stress value, which indicates the degree of distortion imposed. In the PRIMER software package, a stress value of below 0.2 indicates an acceptable representation of the original data, although lower values are desirable. Where stress values are just above 0.2, the patterns displayed should be confirmed with other techniques such as PERMANOVA. The returned 2-dimensional stress value was 0.22 and an improved lower stress value of 0.15 was observed for the 3-dimensional ordination plot.

To understand the context of 2023-24 site data to that of previous years (2008-09 to 2022-23), site sample data were colour coded as shown in Figure D-3. Data patterns displayed in this 3-dimensional nMDS ordination plot indicated widely dispersed 2008-09 to 2022-23 Control site-1 samples overlapped with 2008-09 to 2022-23 outfall site samples. The 2023-24 outfall samples and 2023-24 Control site-1 samples also overlaid this mass of samples. While the Control site-2 samples from 2023-24 were positioned on the edge of its agglomeration of its 2008-09 to 2022-23 samples reflecting significant 'Site (Control / Impact) x Time' term of PERMANOVA model outlined above.

Under the nMDS routine, due to rank ordering of dissimilarities some detail can be hidden. This detail may be seen using a Principal Coordinates Analysis (PCO) routine as PCO is based upon original dissimilarities being projected onto axes in the space of the chosen resemblance measure (Anderson et al. 2008). As a check for any additional dimensionality in the multivariate data cloud, a PCO ordination plot was raised based on a fourth root transformation of the data and a Bray-Curtis resemblance measure. No additional dimensionality was indicated as the patterns between nMDS (Figure D-3) and PCO ordination (Figure D-4) plots were very similar.

A Canonical Analysis of Principal Coordinates (CAP) ordination plot was also produced. The CAP routine is designed to ask, 'Are there axes in the multivariate space that separate groups?' CAP is designed to purposely seek out and find groups even if differences occur in obscure directions and may not have been apparent from nMDS or PCO plots that provide views of the multivariate data cloud as a whole (Anderson et al. 2008). A similar pattern to that in the nMDS (Figure D-3) and PCO (Figure D-4) ordination plots was displayed. This also suggested no hidden dimensionality, with good agreement between the nMDS, PCO and CAP ordination plots.

An additional run of the CAP routine was undertaken with placement of 2023-24 outfall samples onto the canonical axes of the existing CAP model from the initial run. Output from the second run indicated 2023-24 outfall samples were most similar to either the Outfall 2008-09 to 2022-23 samples or Control site 1 2008-09 to 2023-24 samples (Figure D-5). This result also reflected patterns displayed in the nMDS and PCO ordination plots (Figure D-3 and Figure D-4).

The trend of taxonomic differences between sites situated close together on shorelines is known to occur and accounts for the differences between Control site-1 that is only 400 m from Control site-2 on the shoreline. It is mentioned by Underwood and Chapman (1995) who cite Underwood (1981) who states, 'on exposed shores in New South Wales there are great differences in patterns of occupancy of space from one place to another not many metres away, even though these are not a function of gradients in wave action.'

In summary, a relatively stable equilibrium in rocky-intertidal community structure was indicated from these assessments of the 2008-09 to 2023-24 monitoring data at the three Shellharbour WRRF sites studied. These results also suggest over the 2008-09 to 2023-24 period, no measurable impact had developed in the intertidal rock platform community near the outfall at Barrack Point from wastewater discharges from the Shellharbour WRRF as the community assemblage of the outfall site was very similar to Control site-1 for the 2008-09 to 2022-23 period.

Results from Control site-2 represent natural variation in rocky-intertidal community structure that has been demonstrated to occur for closely spaced shoreline sites.

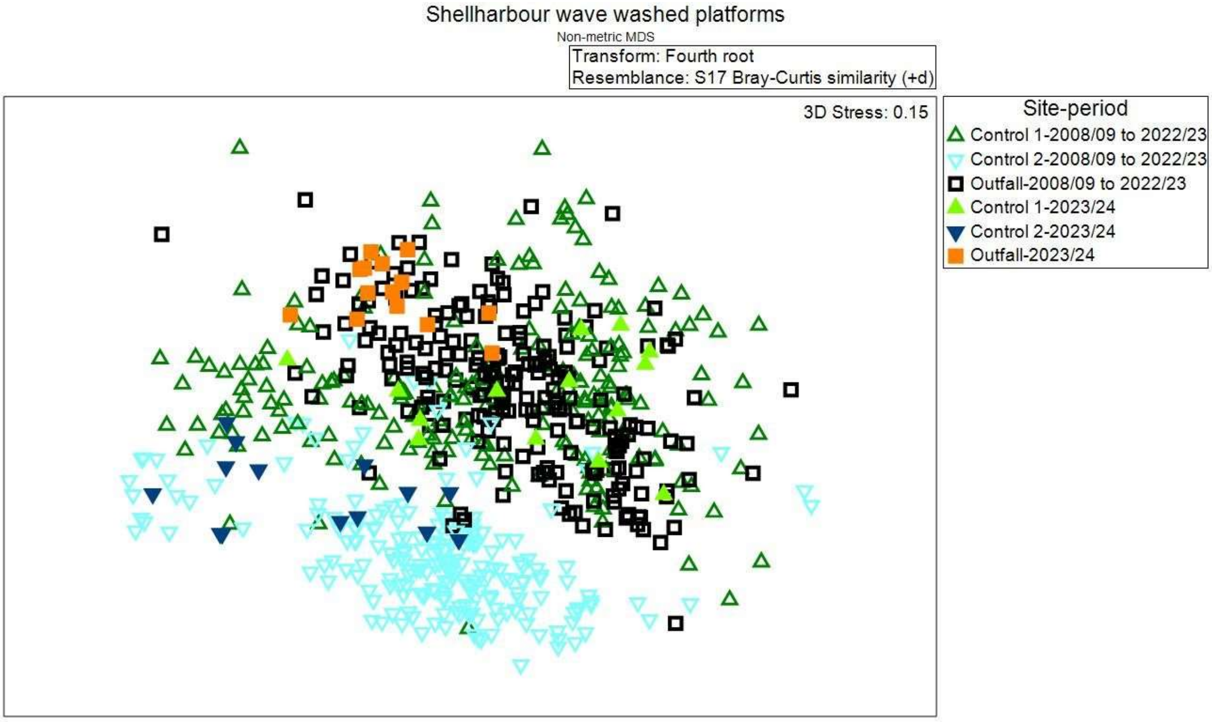


Figure D-3 Dimensions 1 and 2 of 3-dimensional nMDS ordination plot of 2008-09 to 2023-24 intertidal rock platform community

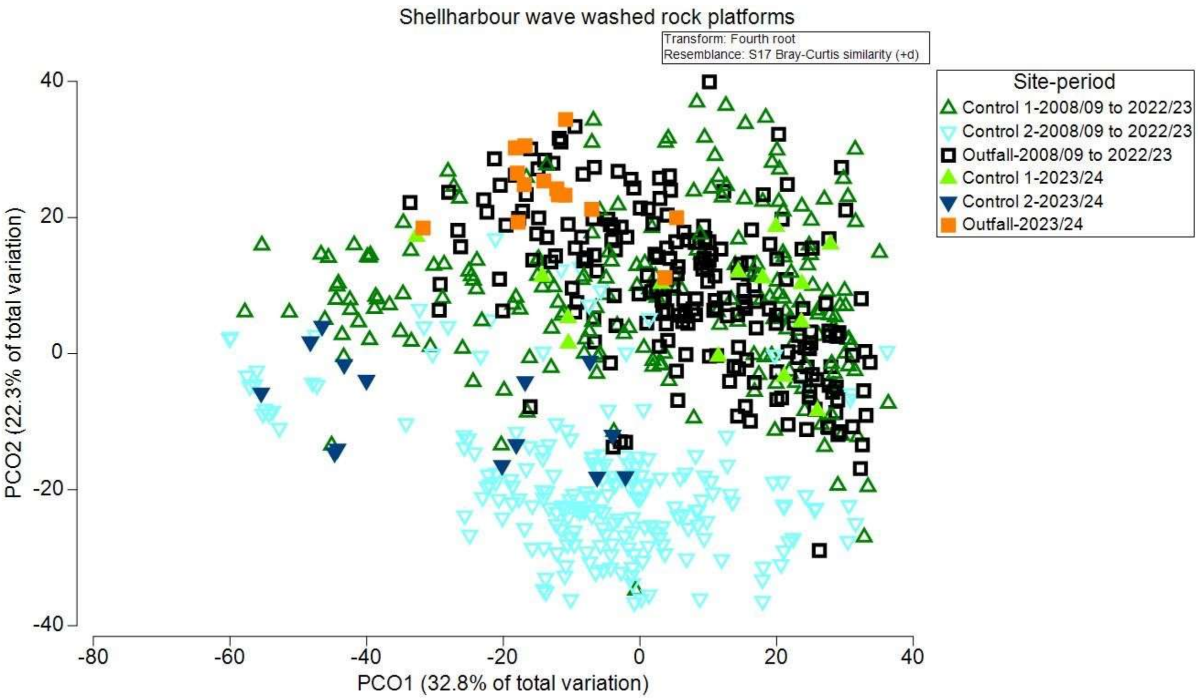


Figure D-4: PCO ordination plot of 2008-09 to 2023-24 intertidal rock platform community data – dimensional

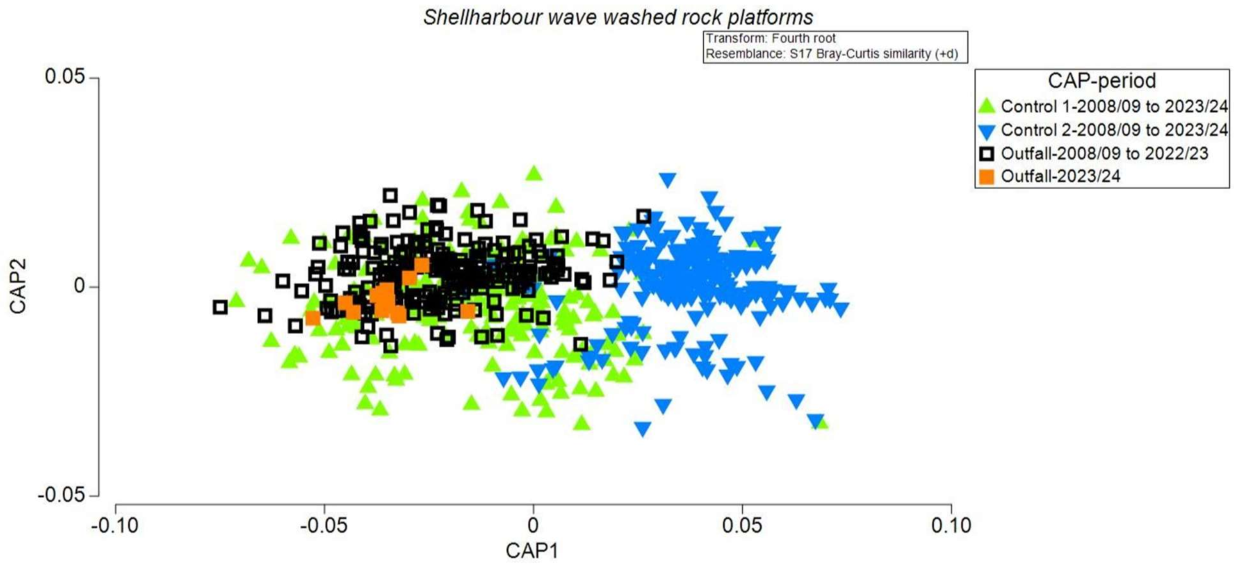


Figure D-5: CAP ordination plot of intertidal rock platform community data (2008-09 to 2023-24 for Control site-1 and Control site-2 and 2008-09 to 2022-23 outfall site) with 2023-24 outfall samples (orange squares) predicted

Sums of squares type: Type III (partial)
Fixed effects sum to zero for mixed terms
Permutation method: Permutation of residuals under a reduced model
Number of permutations: 9999

Factors

Name	Type	Levels
Control / Impact	Fixed	2
Time	Fixed	16
Site	Random	3

PERMANOVA table of results

Source	Dtf	SS	MS	Pseudo-F	P(perm)	Perms	P(MC)
Control/Impact	1	78177	78177	0.78015	0.6679	3	0.5799
Time	15	1.07E+05	7159.6	1.2599	0.1764	9890	0.1929
Site (Control/Impact)	1	98878	98878	140.94	0.0001	9955	0.0001
Control/ImpactxTime	15	73257	4883.8	0.85988	0.7188	9888	0.7152
TimexSite(Control/Impact)	15	84302	5620.2	8.0108	0.0001	9870	0.0001
Res	622	4.36E+05	701.57				
Total	669	8.95E+05					

Estimates of components of variation

Source	Estimate	Sq.root
S(Control / Impact)	-73.693	-8.5845
S(Time)	39.536	6.2878
V(Site(Control / Impact))	443.77	21.066
S(Control / ImpactxTime)	-42.637	-6.5297
V(TimexSite(Control / Impact))	355.07	18.843
V(Res)	701.57	26.487

Factor for groups: CAP-period
Factor level for new samples group: Outfall-2023/24
Number of samples: 656
Choice of m: 3

CANONICAL ANALYSIS

Correlations

Eigenvalue	Correlation	Corr.Sq.
1	0.8202	0.6727
2	0.258	0.0666

DIAGNOSTICS

m	prop.G	ssres	d_1^2	d_2^2	%correct
3	0.7093	1.2729	0.6727	0.0666	69.055

Cross Validation

Leave-one-out Allocation of Observations to Groups (for the choice of m:3)

Classified					
Orig. group	**Control 1-2008/09 to 2023/24**	**Control 2-2008/09 to 2023/24**	**Outfall-2008/09 to 2022/23**	**Total**	**%correct**
Control 1-2008/09 to 2023/24	107	21	96	224	47.768
Control 2-2008/09 to 2023/24	14	206	0	220	93.636
Outfall-2008/09 to 2022/23	65	7	140	212	66.038
Total Correct 453/656 (69.055%)	107	21	96	224	47.768

Classified					
Orig. group	**Control 1-2008/09 to 2023/24**	**Control 2-2008/09 to 2023/24**	**Outfall-2008/09 to 2022/23**	**Total**	**%correct**
Misclassification error: 30.945%					

Individual samples that were mis-classified

Sample	Orig.group	Class.group
Control 1-2018-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2018-12	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2018-13	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2018-14	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2008-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2008-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-13	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2009-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2010-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23

Sample	Orig.group	Class.group
Control 1-2010-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2010-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2010-5	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2010-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2010-9	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2010-11	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2010-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2011-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-11	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2012-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2013-7	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2013-9	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2013-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2013-13	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-11	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2014-13	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23

Sample	Orig.group	Class.group
Control 1-2014-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2015-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2015-5	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2015-8	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2015-10	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2015-11	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2015-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2016-1	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2016-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2016-12	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2017-1	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2017-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2017-5	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2017-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2017-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2017-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2017-11	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2017-14	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2019-2	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-5	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-6	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2019-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2019-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
control 1-2020-4	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
control 1-2020-5	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
control 1-2020-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
control 1-2020-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
control 1-2020-13	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2021-7	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-9	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-11	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23

Sample	Orig.group	Class.group
Control 1-2021-12	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-13	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2021-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2022-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2022-9	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2022-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2022-12	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2022-14	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2023/24-2	Control 1-2008/09 to 2023/24	Control 2-2008/09 to 2023/24
Control 1-2023/24-3	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2023/24-6	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2023/24-8	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2023/24-10	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 1-2023/24-13	Control 1-2008/09 to 2023/24	Outfall-2008/09 to 2022/23
Control 2-2008-2	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2008-6	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2008-10	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2008-13	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-1	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-2	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-3	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-4	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-7	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-8	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2019-9	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2023/24-11	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Control 2-2023/24-14	Control 2-2008/09 to 2023/24	Control 1-2008/09 to 2023/24
Outfall-2018-1	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-2	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-3	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-6	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-7	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-12	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24

Sample	Orig.group	Class.group
Outfall-2018-13	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2018-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2010-7	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2011-1	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2011-2	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2011-3	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2011-7	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2011-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2011-10	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2011-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2011-13	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2011-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2012-2	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2012-4	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2012-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2013-3	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2014-1	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2014-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2014-8	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2014-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2014-10	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2015-4	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2015-6	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2015-8	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2015-13	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2015-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-1	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2016-3	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-4	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-6	Outfall-2008/09 to 2022/23	Control 2-2008/09 to 2023/24
Outfall-2016-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-12	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-13	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2016-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-2	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-3	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24

Sample	Orig.group	Class.group
Outfall-2017-4	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-6	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-8	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-10	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2017-12	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-1	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-4	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-6	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-7	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2019-12	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-5	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-7	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-10	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-12	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2020-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2021-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2021-11	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2021-13	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2021-14	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2022-8	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24
Outfall-2022-9	Outfall-2008/09 to 2022/23	Control 1-2008/09 to 2023/24

PERMUTATION TEST

trace statistic = (tr(Q_m'HQ_m)) first squared canonical correlation = (delta_1^2)
tr(Q_m'HQ_m): 0.73931 P: 0.0001
delta_1^2: 0.67272 P: 0.0001
No. of permutations used: 9999

NEW SAMPLE

Canonical coordinate scores for New Samples

Sample	CAP1	CAP2
Outfall-2023/24-1	-0.0297	0.0022
Outfall-2023/24-2	-0.045	-0.0038
Outfall-2023/24-3	-0.0267	0.0052
Outfall-2023/24-4	-0.0157	-0.0058
Outfall-2023/24-5	-0.0375	-0.002
Outfall-2023/24-6	-0.0359	-0.0047
Outfall-2023/24-7	-0.0349	-0.0034
Outfall-2023/24-8	-0.0361	-0.0015
Outfall-2023/24-9	-0.0351	-0.0007
Outfall-2023/24-10	-0.0322	-0.0069
Outfall-2023/24-11	-0.0363	-0.0057
Outfall-2023/24-12	-0.0431	-0.006
Outfall-2023/24-13	-0.0528	-0.0075
Outfall-2023/24-14	-0.0326	-0.0062

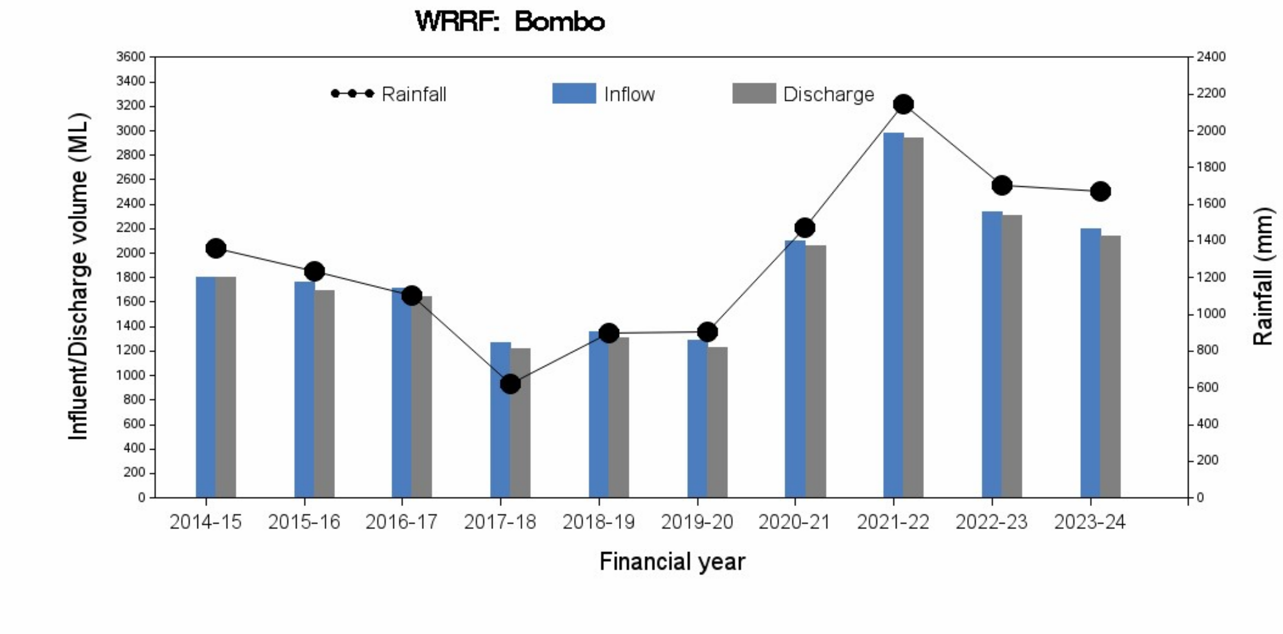
New sample classification

Sample	CAP1
Outfall-2023/24-1	Outfall-2008/09 to 2022/23
Outfall-2023/24-2	Outfall-2008/09 to 2022/23
Outfall-2023/24-3	Outfall-2008/09 to 2022/23
Outfall-2023/24-4	Control 1-2008/09 to 2023/24
Outfall-2023/24-5	Outfall-2008/09 to 2022/23
Outfall-2023/24-6	Outfall-2008/09 to 2022/23
Outfall-2023/24-7	Outfall-2008/09 to 2022/23
Outfall-2023/24-8	Outfall-2008/09 to 2022/23
Outfall-2023/24-9	Outfall-2008/09 to 2022/23
Outfall-2023/24-10	Outfall-2008/09 to 2022/23
Outfall-2023/24-11	Outfall-2008/09 to 2022/23
Outfall-2023/24-12	Outfall-2008/09 to 2022/23
Outfall-2023/24-13	Outfall-2008/09 to 2022/23
Outfall-2023/24-14	Outfall-2008/09 to 2022/23

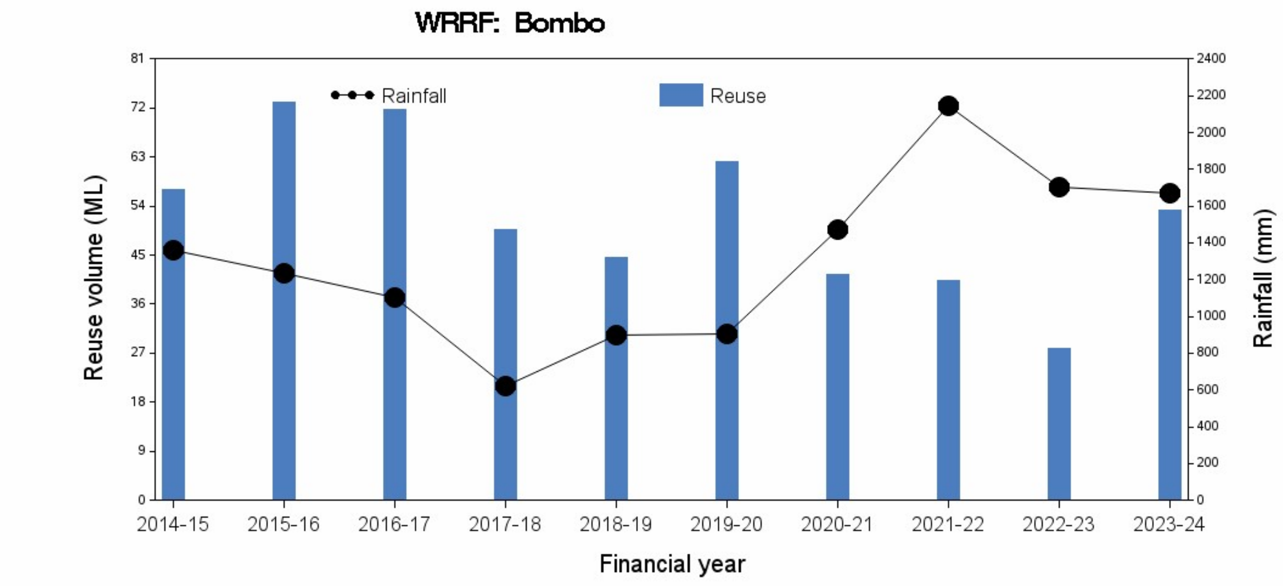
D.6. Bombo WRRF

D.6.1. Pressure – Wastewater quantity

Inflow/ Discharge volume and rainfall

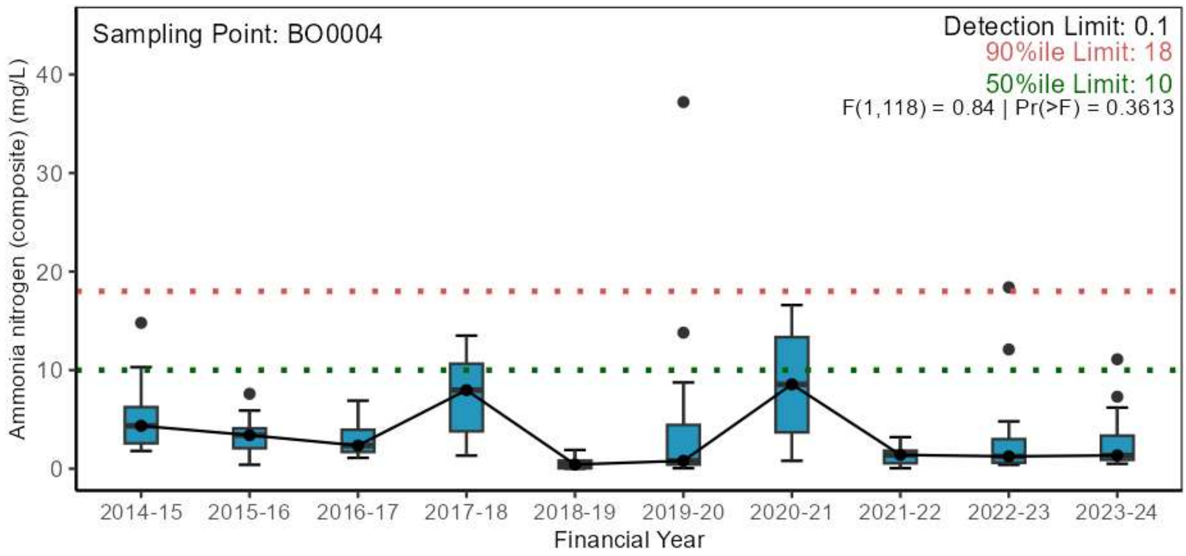


Reuse volume and rainfall

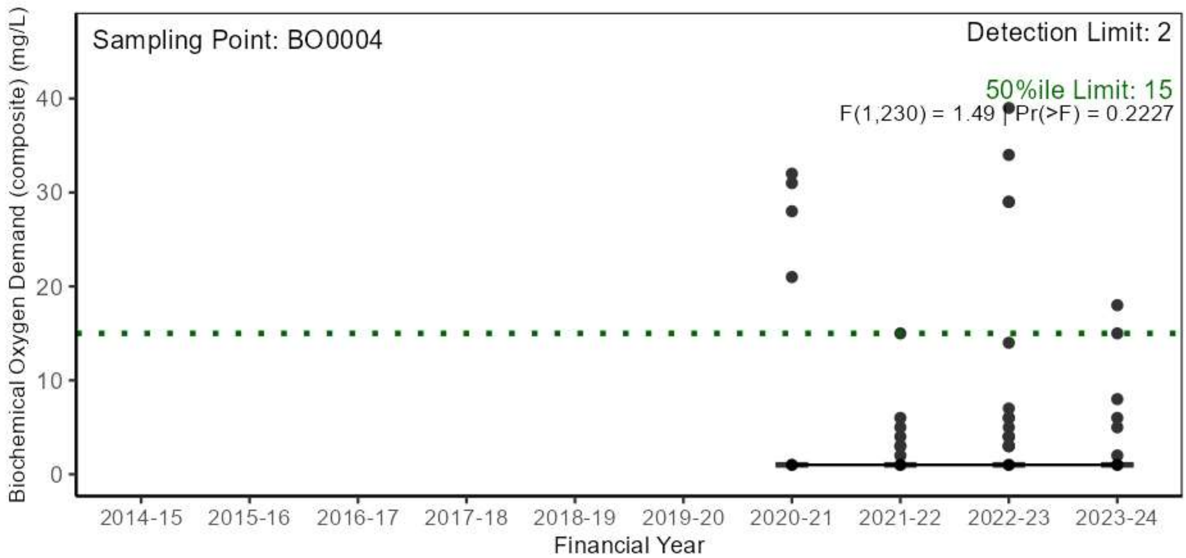


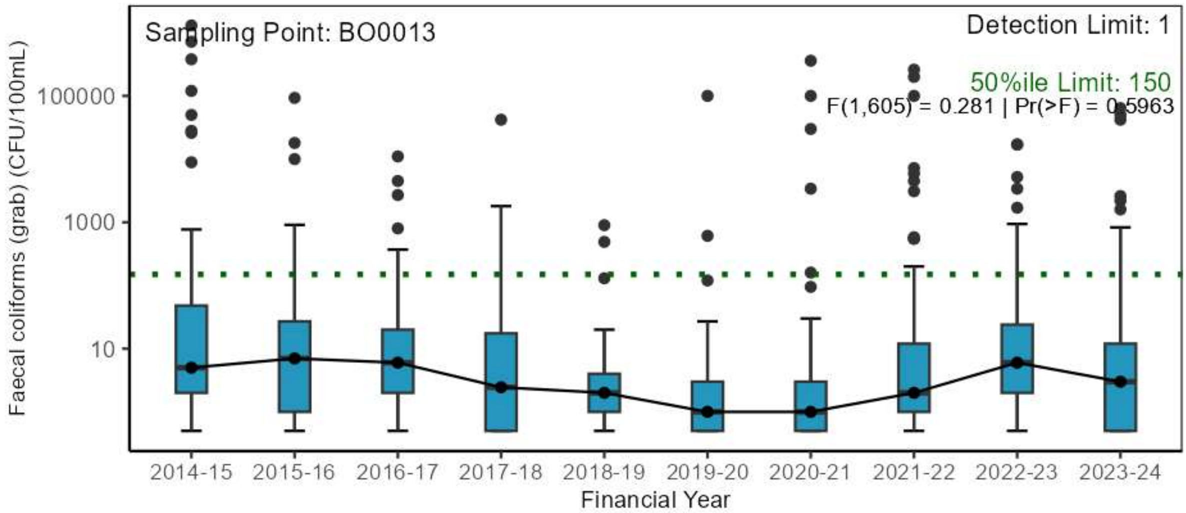
D.6.2. Pressure – Wastewater quality

Nutrients

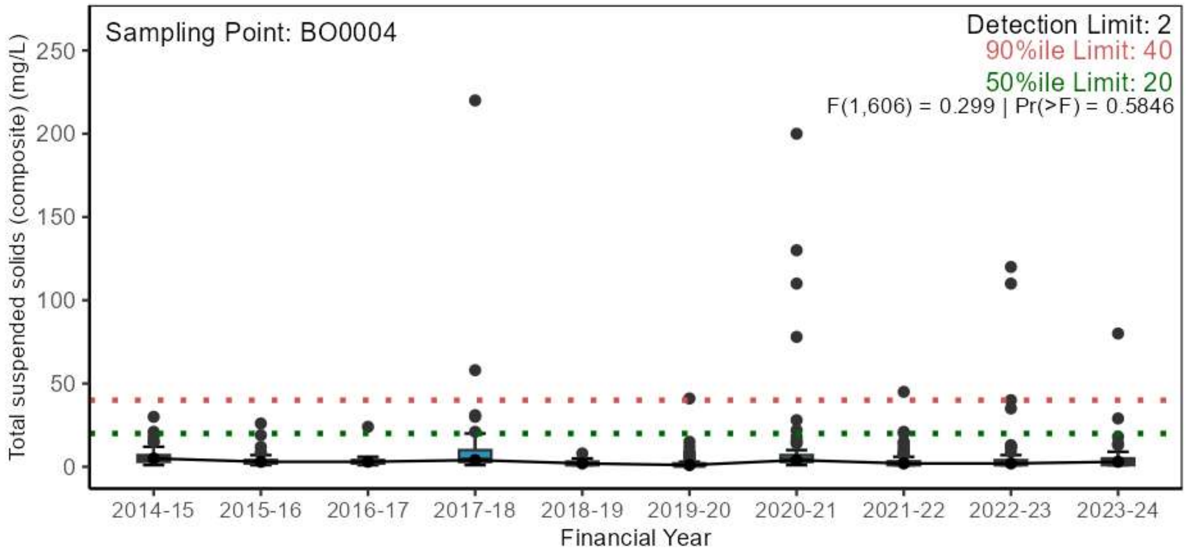


Major conventional analytes

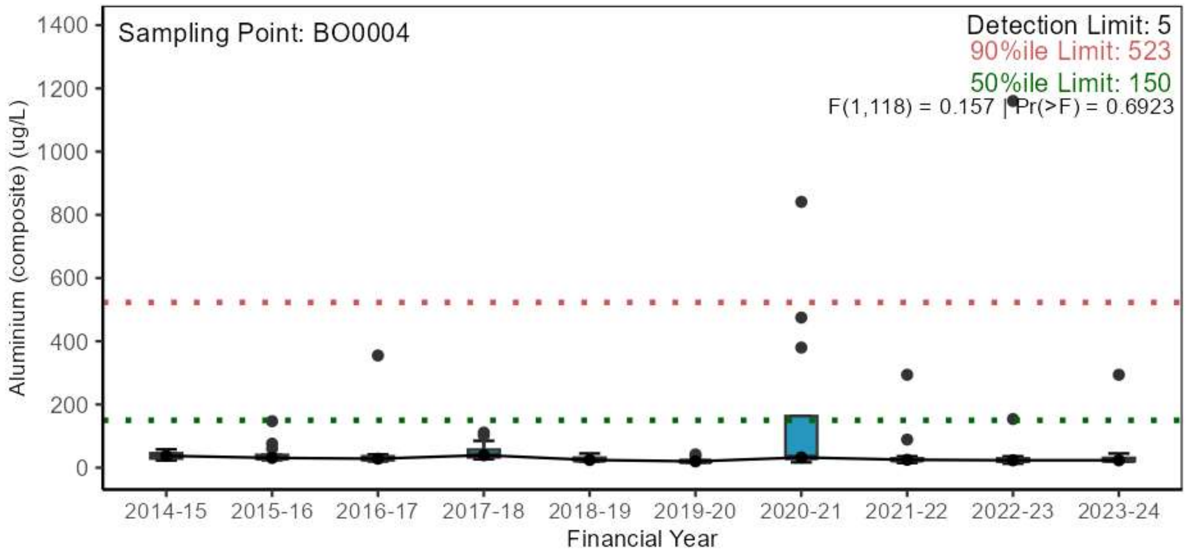


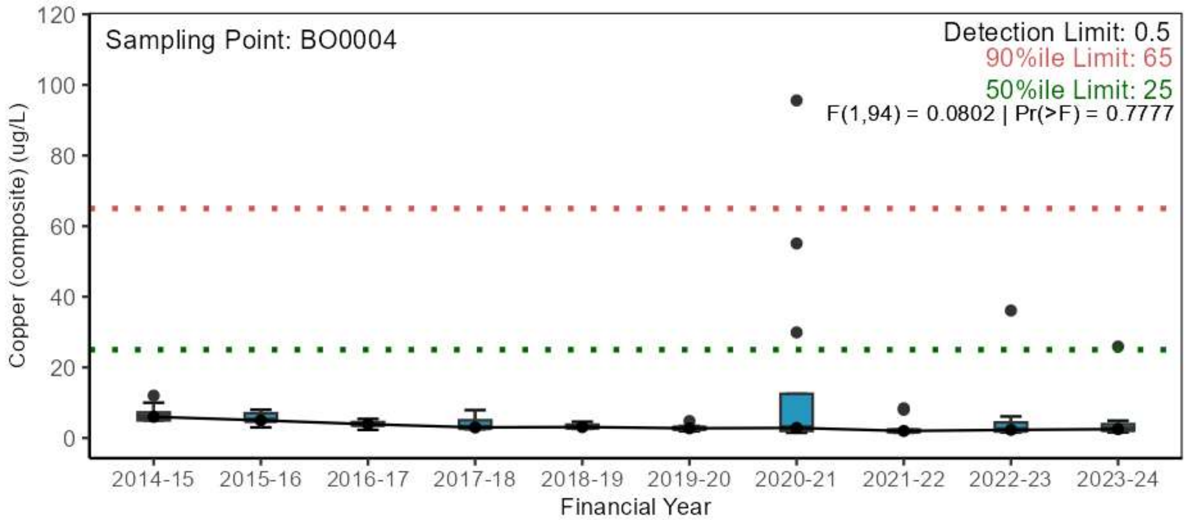


Data has been log10 transformed and y-axis backtransformed for ease of interpretation.



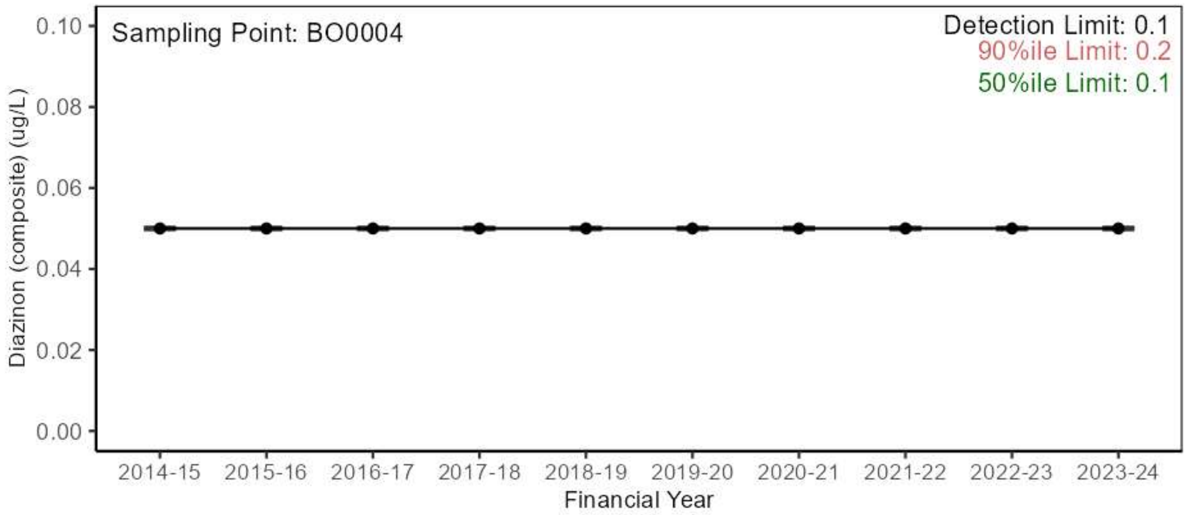
Trace metals



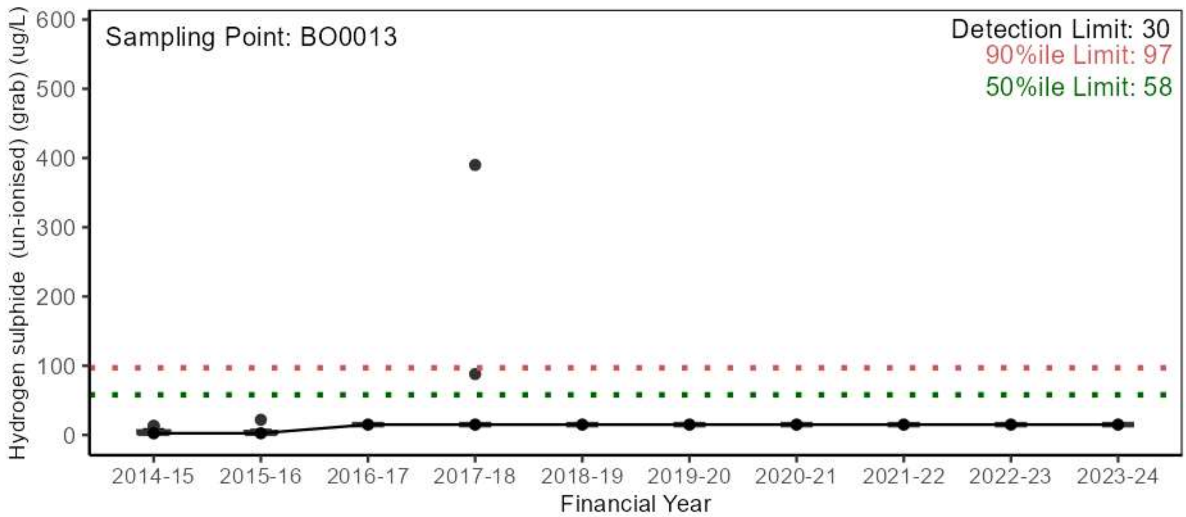


Statistical test excludes data prior to 2016-17 due to method detection limit change.

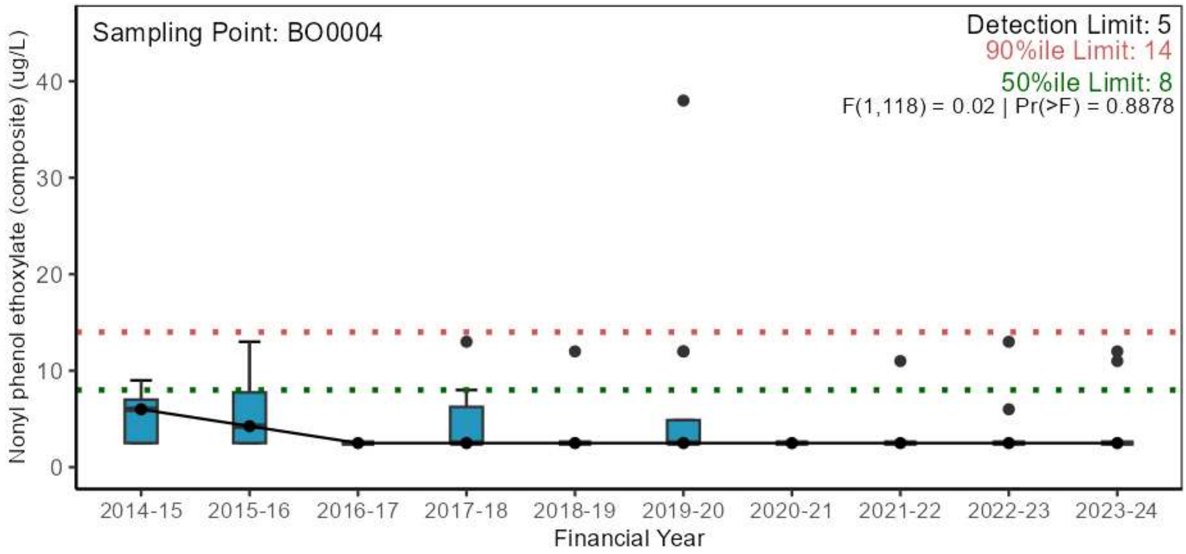
Other chemicals and organics (including pesticides)



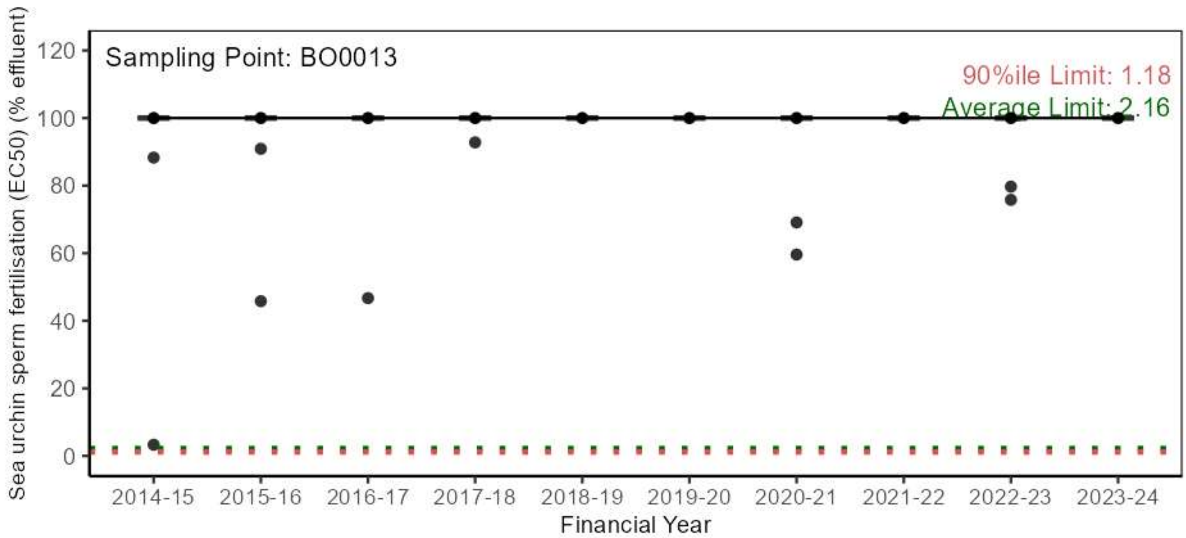
Statistical test not conducted as >90% of results were below detection limits.



Statistical test not conducted as >90% of results were below detection limits.



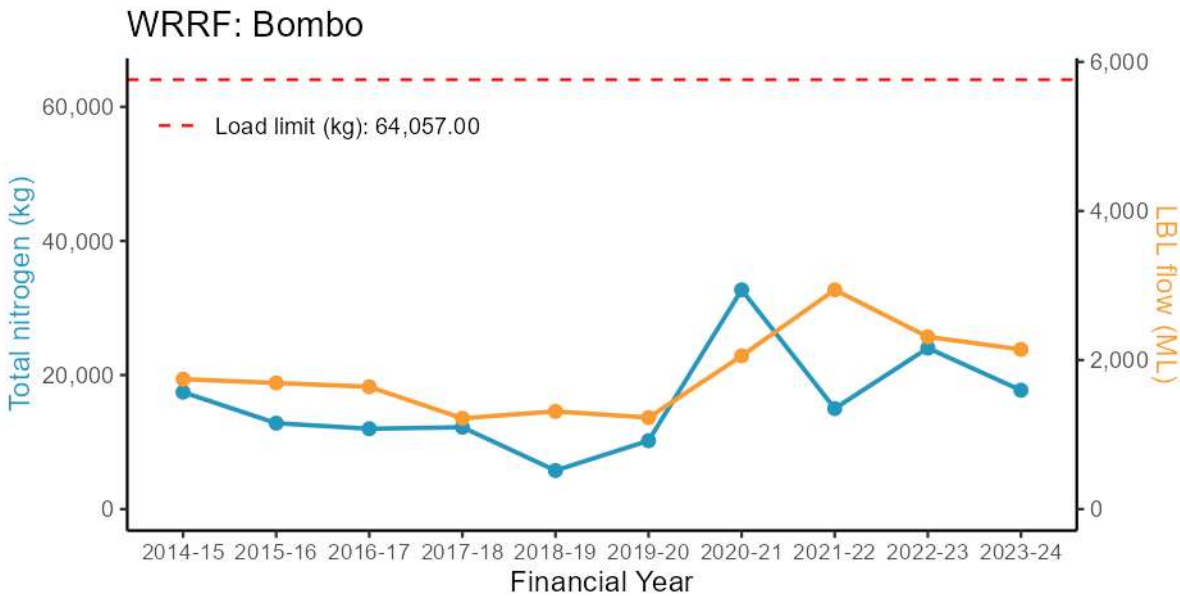
D.6.3. Pressure – Wastewater toxicity

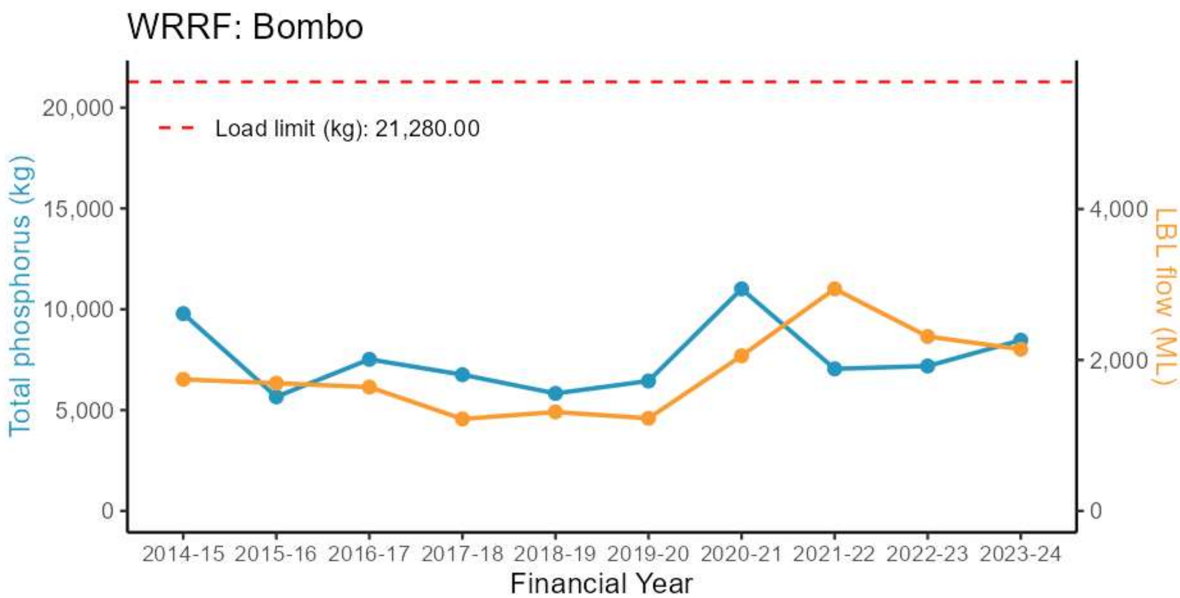


Statistical analysis was not conducted as >90% of results were recorded at 100% for the H.tuberculata fertilisation test

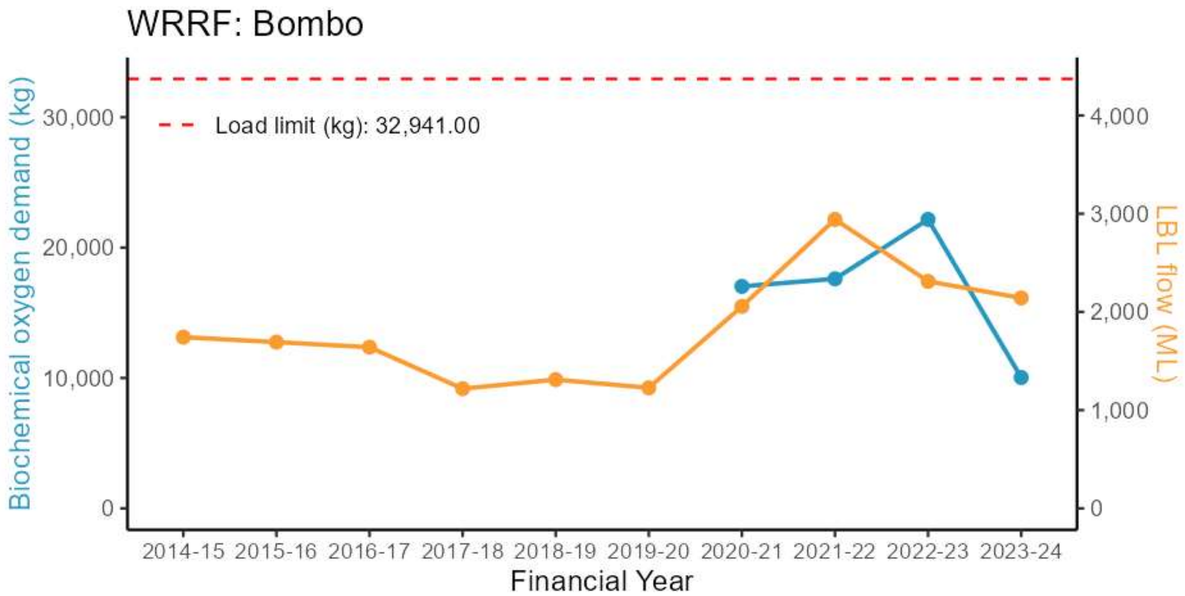
D.6.4. Pressure – Wastewater discharge load

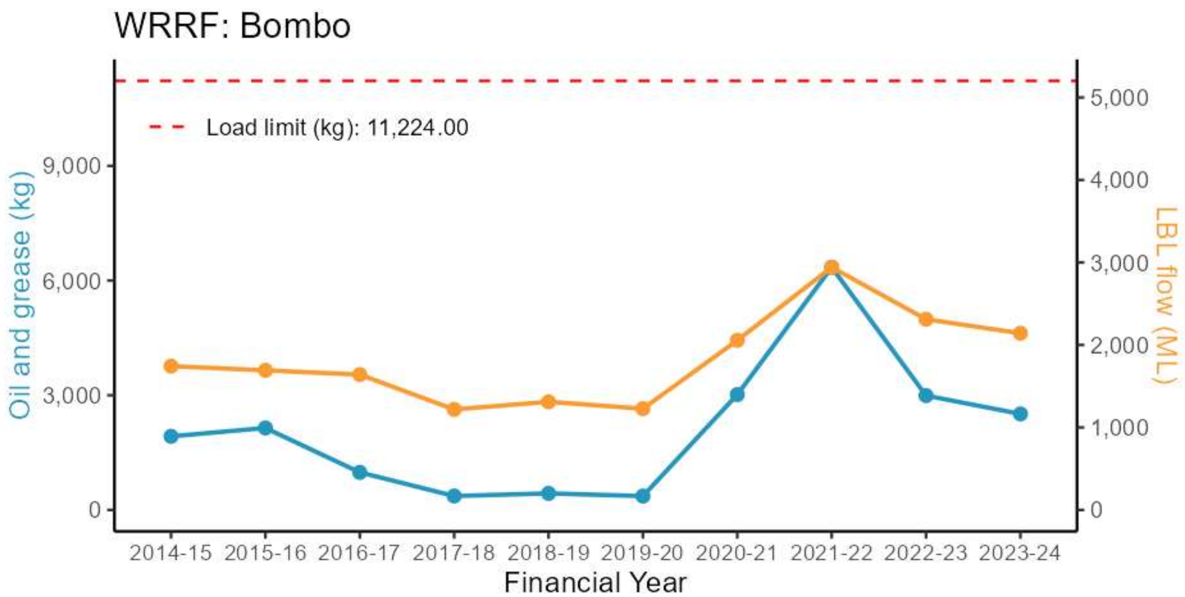
Nutrients

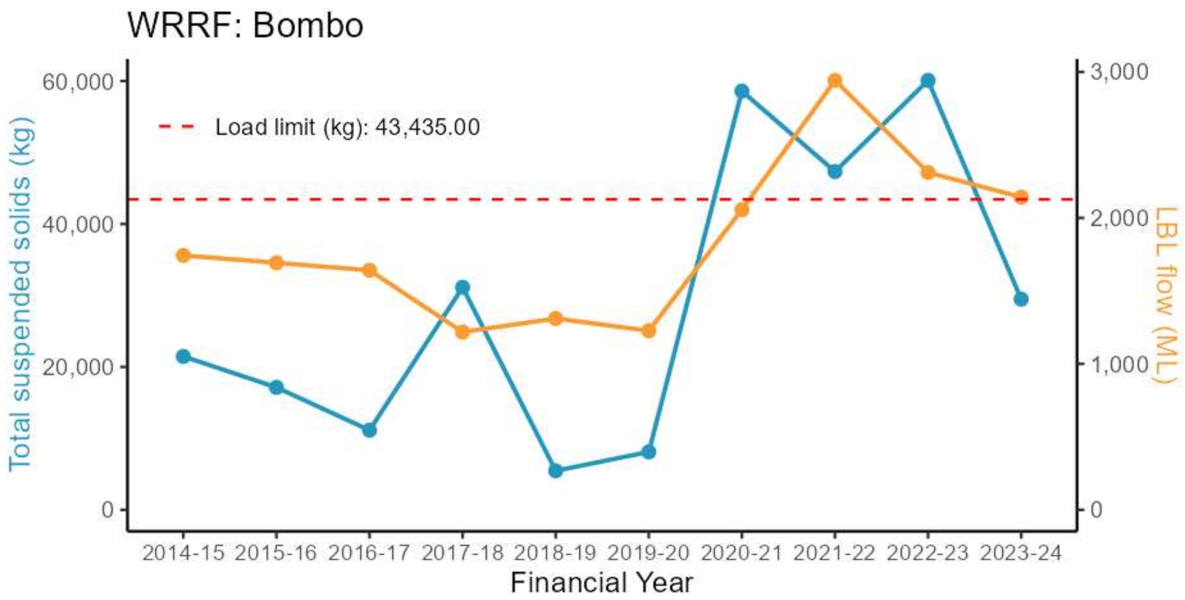




Major conventional analytes







D.7. EPL limits of Nearshore discharging WRRFs

Table D-1 EPL concentration limits for the nearshore discharging WRRFs (2023-24)

WRRF	Sampling Points	Ammonia Nitrogen (mg/L)			Biochemical Oxygen Demand (mg/L)			Faecal Coliform (cfu/100mL)	Oil and Grease (mg/L)		Total Suspended Solids (mg/L)				Sea urchin fertilisation (EC50)		
		Average	50th %-ile	90th %-ile	50th %-ile	90th %-ile	100th %-ile	50th %-ile	50th %-ile	90th %-ile	50th %-ile	80th %-ile	90th %-ile	100th %-ile	50th %-ile	Average	90th %-ile
Warriewood	WW0005 (C), (G)							200			30	40				6.7	4
Cronulla	CR0003 (C), CR0017 (G)	31		52	15	20		200	5	8	10		15			1.53	0.19
Wollongong	WO0005 (C), (G)				20						30		40				
Shellharbour	SH0004 (C), (G)	20		38	20			150			30		40		2.09		1.87
Bombo	BO0004 (C), BO0013 (G)		10	18	15			150			20		40			2.16	1.18

WRRF	Sampling Points	Aluminium (µg/L)			Copper (µg/L)			Zinc (µg/L)		Chlorpyrifos (µg/L)		Cyanide (µg/L)		Diazinon (µg/L)			Nonylphenol ethoxylate (µg/L)			Unionised H_2S (µg/L)		
		Average	50th %-ile	90th %-ile	Average	50th %-ile	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	50th %-ile	90th %-ile	Average	50th %-ile	90th %-ile	Average	50th %-ile	90th %-ile
Warriewood	WW0005 (C), (G)	80		150	15		30					17	30				11		22			
Cronulla	CR0003 (C), CR0017 (G)	100		383	50		500	55	100	0.09	1	5	10	0.2		2	8		11	38		70
Wollongong	WO0005 (C), (G)	120		430	40		80							0.1		0.5				30		60
Shellharbour	SH0004 (C), (G)	110		220	10		20							0.1		1	6		10	44		165
Bombo	BO0004 (C), BO0013 (G)		150	523		25	65								0.1	0.2		8	14		58	97

Table D-2 EPL load limits for the nearshore discharging WRRFs (2023-24)

Load limits (in kg) 2023-24	Warriewood	Cronulla	Wollongong	Shellharbour	Bombo
Total Nitrogen	299,300	735,110	743,076	254,770	64,057
Total Phosphorus	74,460	243,090	74,319	63,364	21,280
Biological Oxygen Demand	135,050	319,010	198,535	116,070	32,941
Total Suspended Solids	175,200	305,000	198,594	150,380	43,435
Oil & Grease	41,975	110,000	123,915	35,953	11,224
Cadmium		28			
Chromium		76			
Copper		2,551			
Lead		138			
Mercury		5			
Selenium		356			
Zinc		2,956			
Pesticides		20			

E. Offshore marine environment

This Appendix includes graphical presentation of all monitoring data for the Offshore Marine catchment.

The Water Resource Recovery Facilities (WRRFs) that are discharging into offshore marine environment are ordered from North (North Head) to South (Malabar).

Under each Offshore WRRF, Pressure indicator results are presented first following the **Pressure, Stressor** and **Ecosystem Receptor (P-S-ER)** causal pathway elements (E-1 to E-2).

Trend plots are included on wastewater quantity (discharge and inflow), quality, toxicity and discharge loads. Trends plots on other supplementary data are also included to improve our understanding on:

- weather condition i.e. catchment specific rainfall condition for each WRRF
- wastewater reuse/ recycling volume of the relevant WRRF.

Wastewater quality and load plots are included in following four sub-groups, and then within each sub-group, analytes presented in alphabetical order:

- nutrients
- major conventional analytes
- trace metals
- other chemicals and organics (including pesticides)

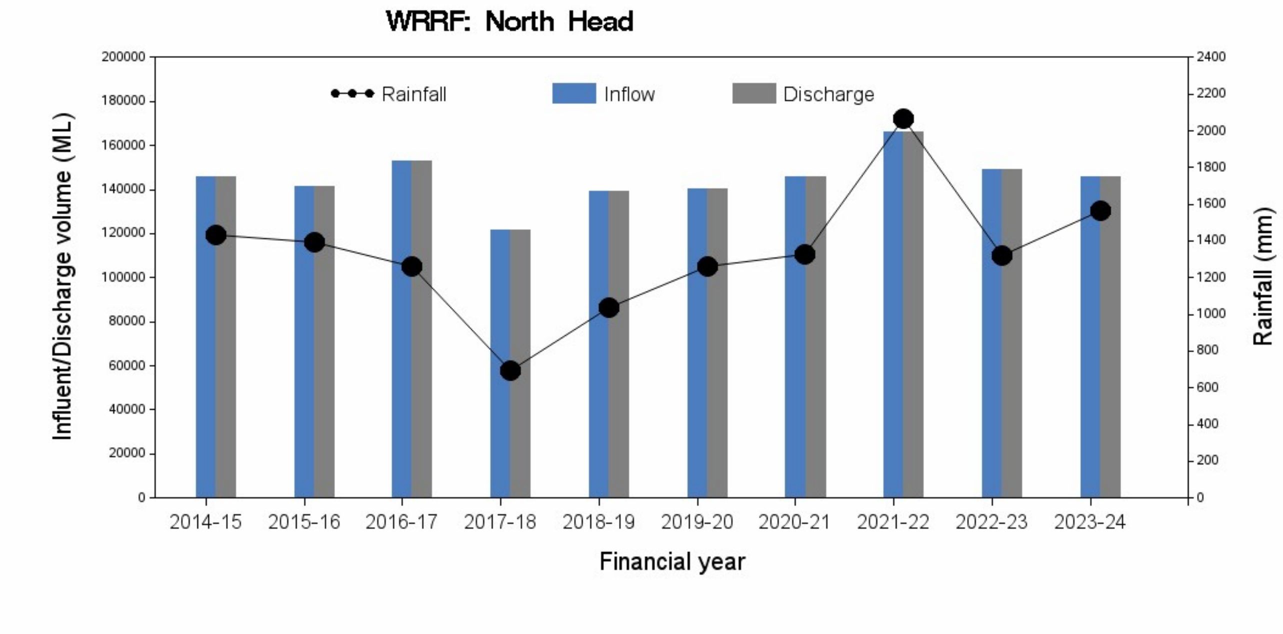
Tests conducted on wastewater are specified in the EPL issued by the NSW EPA for each WRRF (E-4). Data for all these measured analytes that have EPL concentration and load limits are included. Summary statistics are included as electronic appendices sent to the EPA.

Stressor and **Ecosystem Receptor** indicator data are presented together at the end for all three offshore WRRFs (E-5 and E-6).

E.1. North Head WRRF

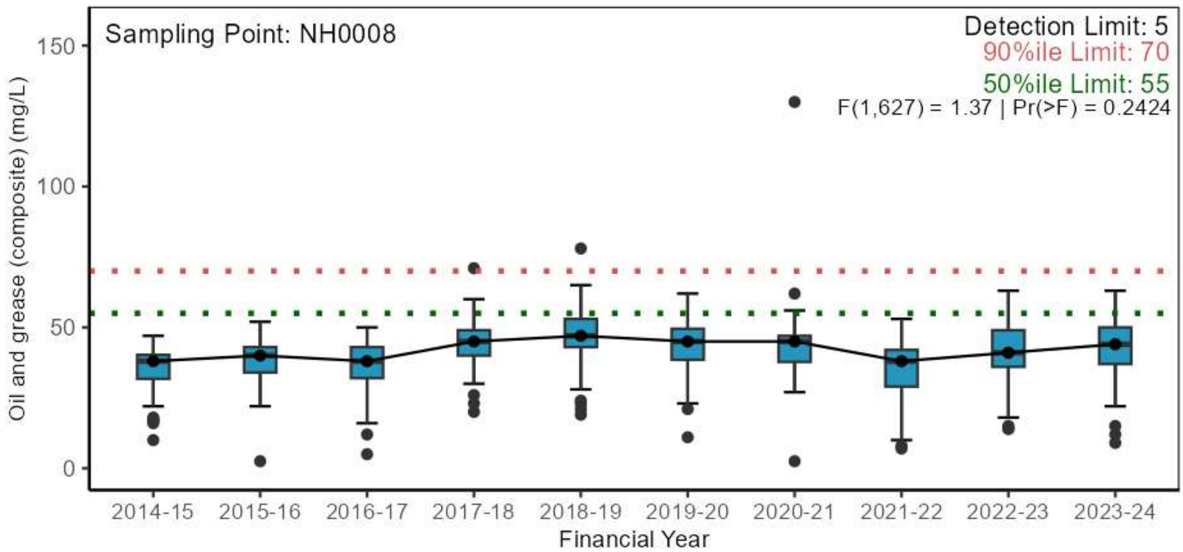
E.1.1. Pressure – Wastewater quantity

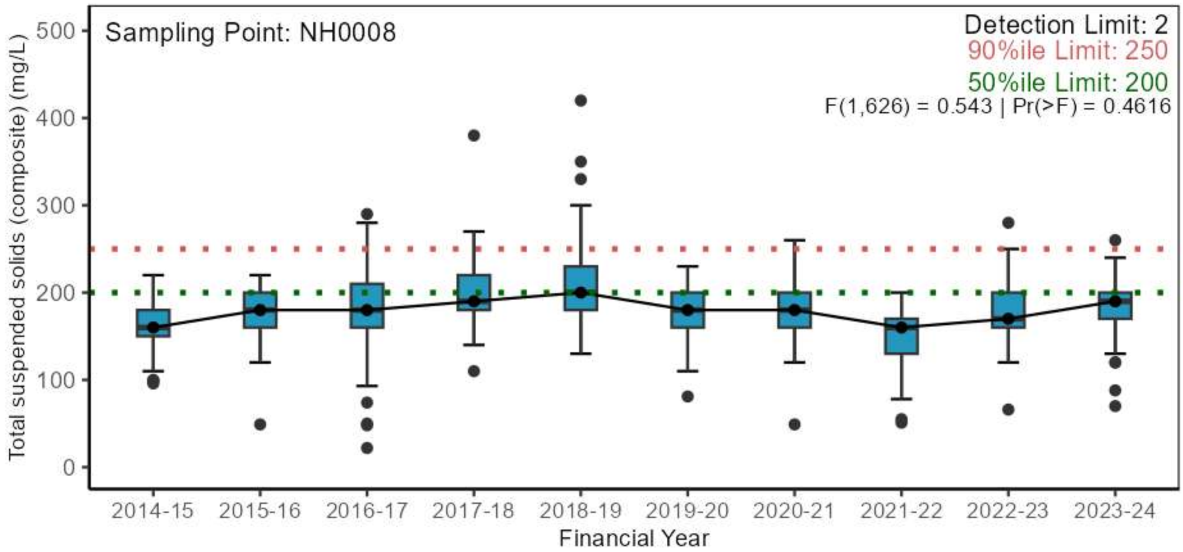
Inflow/ Discharge volume and rainfall



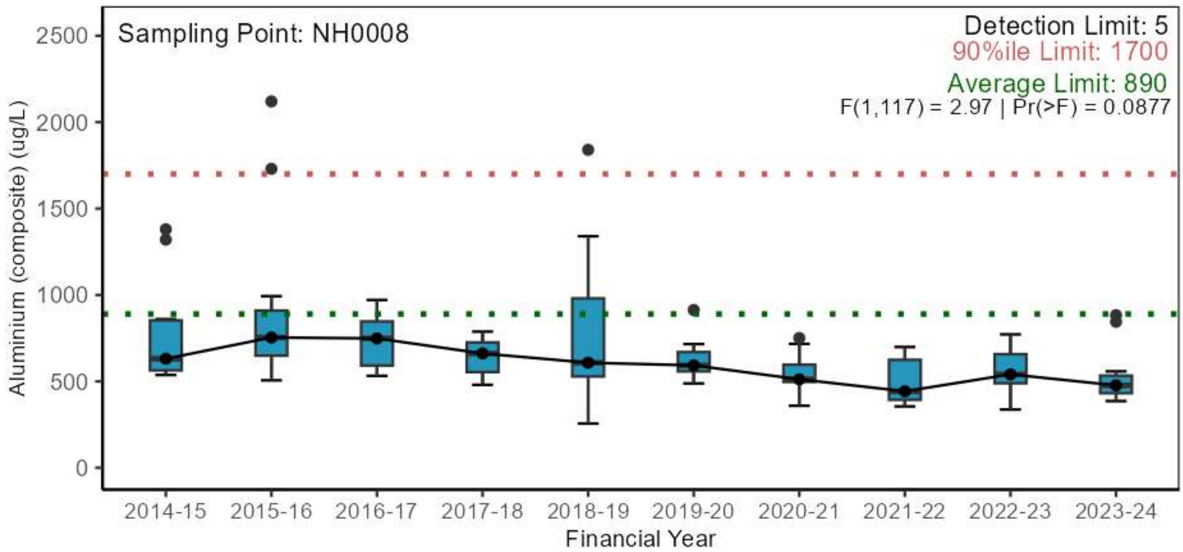
E.1.2. Pressure – Wastewater quality

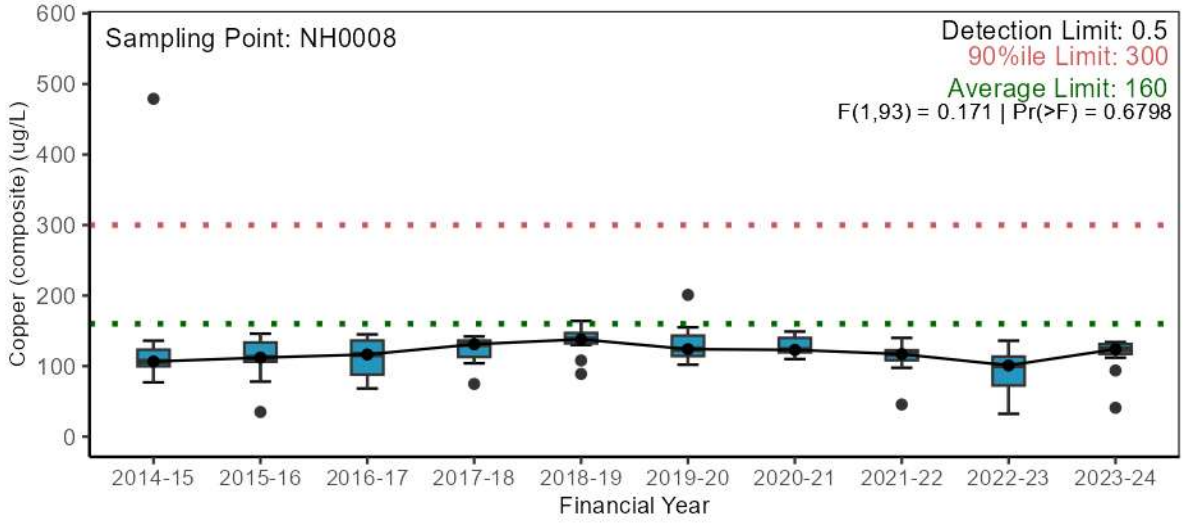
Major conventional analytes





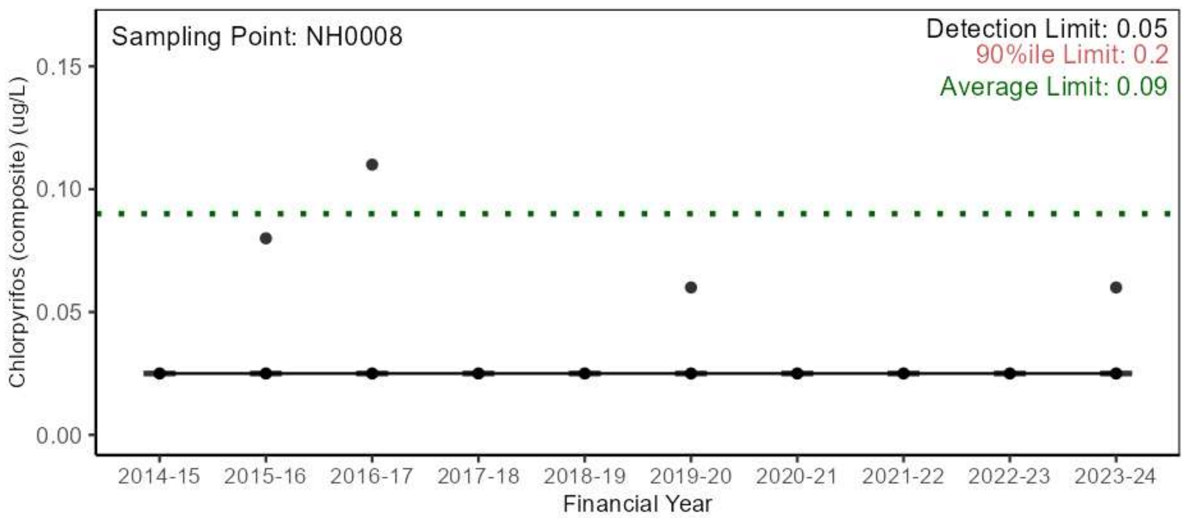
Trace metals



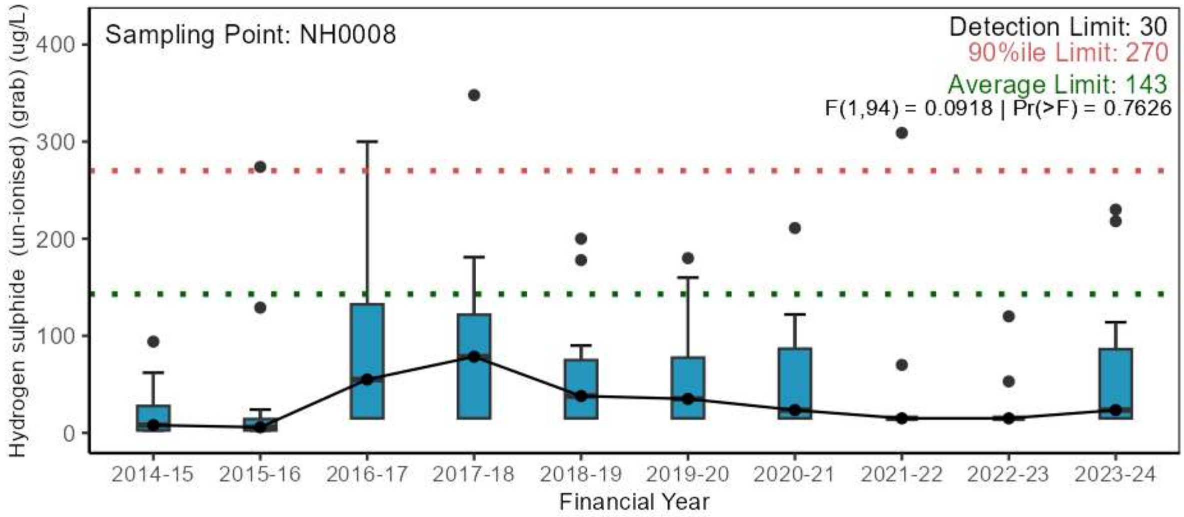


Statistical test excludes data prior to 2016-17 due to method detection limit change.

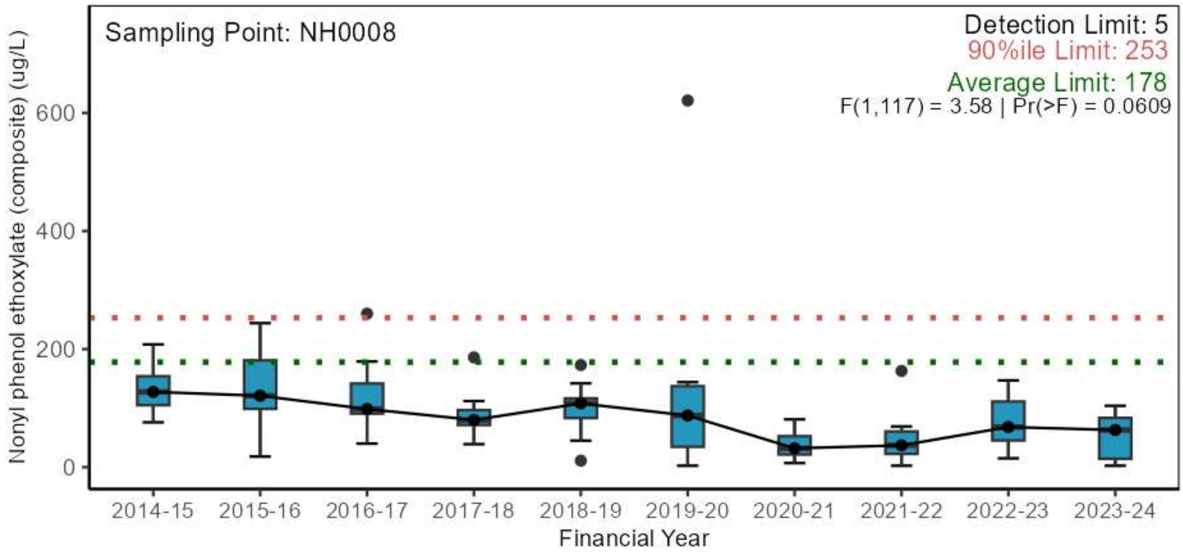
Other chemicals and organics (including pesticides)



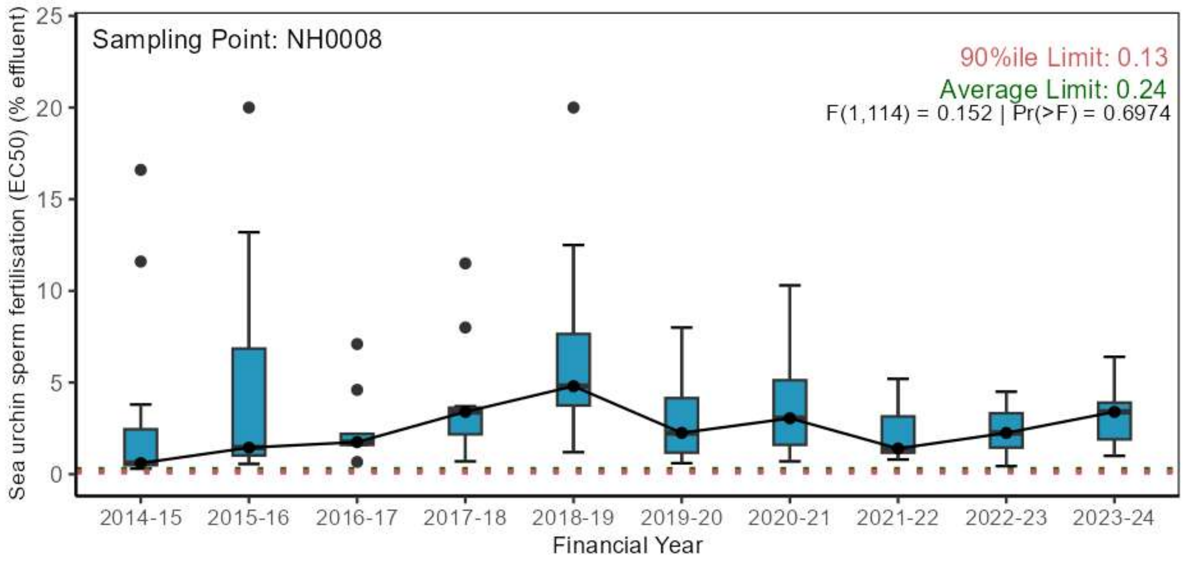
Statistical test not conducted as >90% of results were below detection limits.



Statistical test excludes data prior to 2016-17 due to method detection limit change.

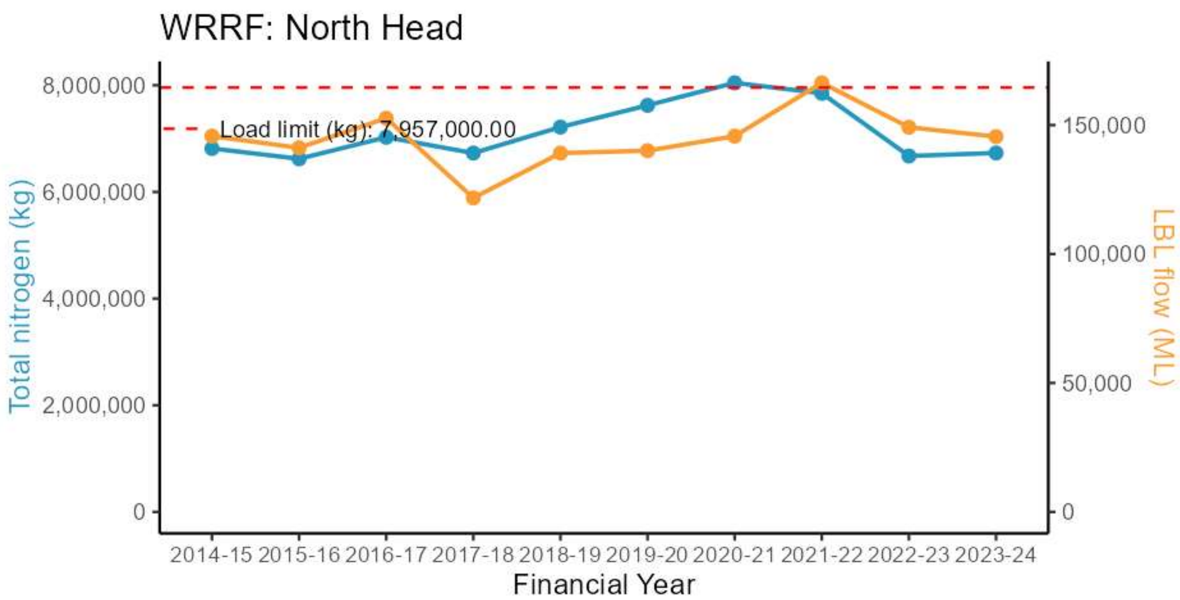


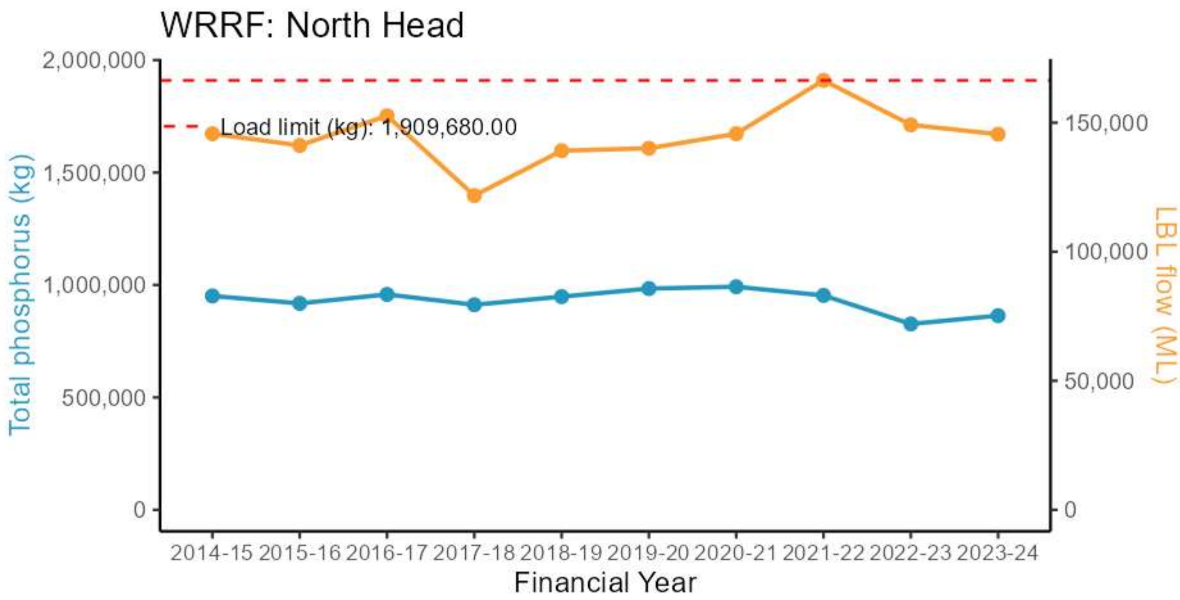
E.1.3. Pressure – Wastewater toxicity



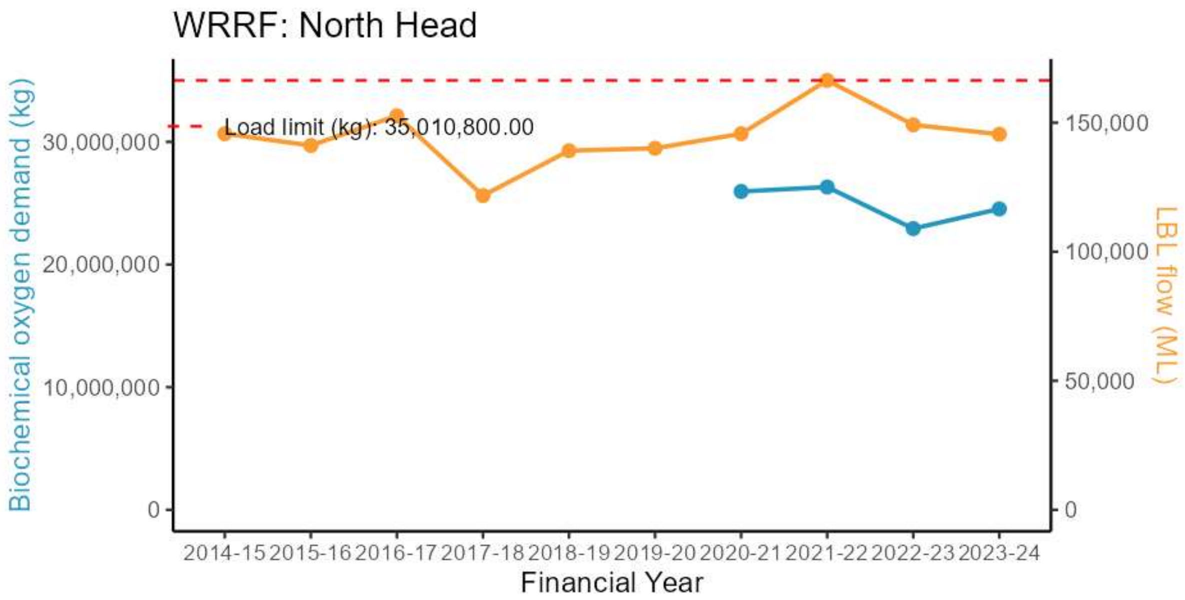
E.1.4. Pressure – Wastewater discharge load

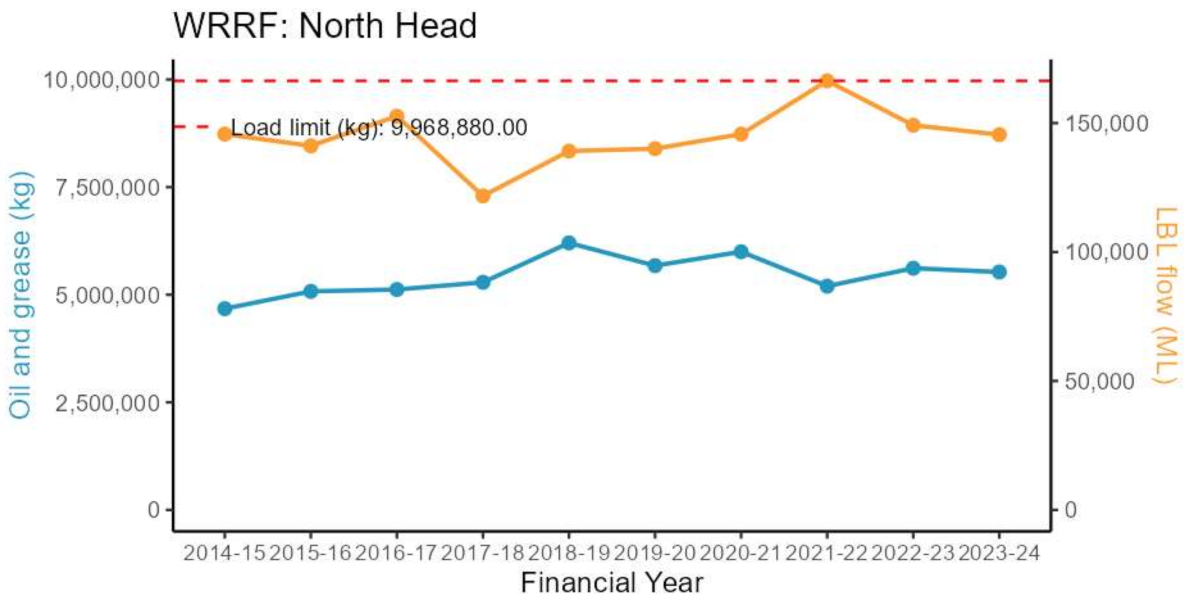
Nutrients

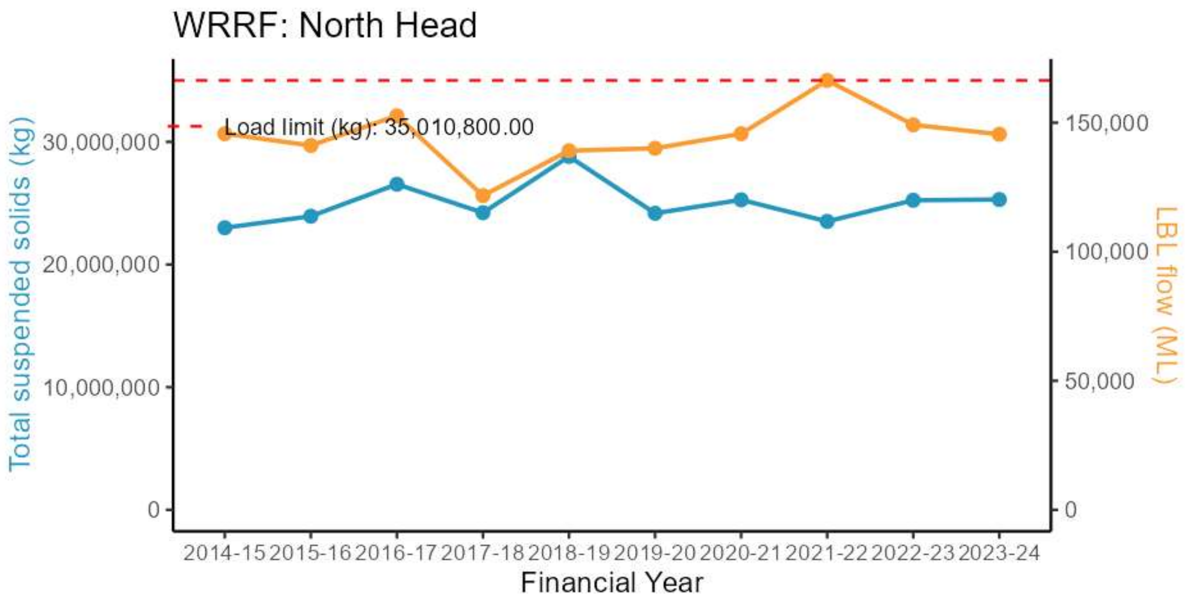



WRRF: North Head
2,000,000
1,500,000
1,000,000
500,000
0
Total phosphorus (kg)
Load limit (kg): 1,909,680.00
150,000
100,000
50,000
0
LBL flow (ML)
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year

E.1.5. Major conventional analytes

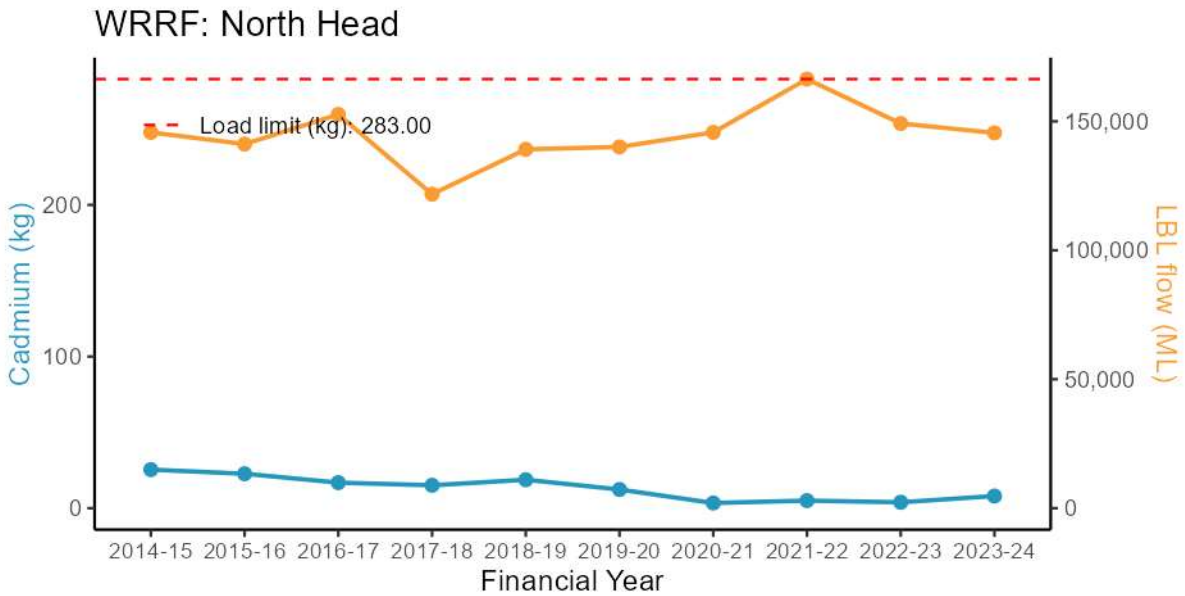


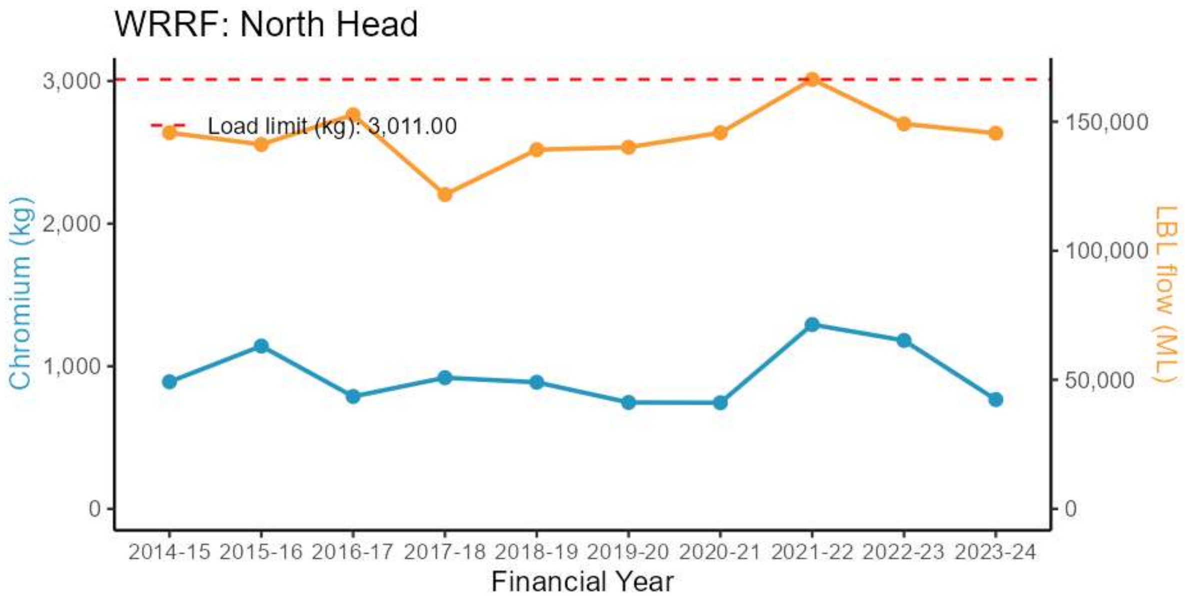


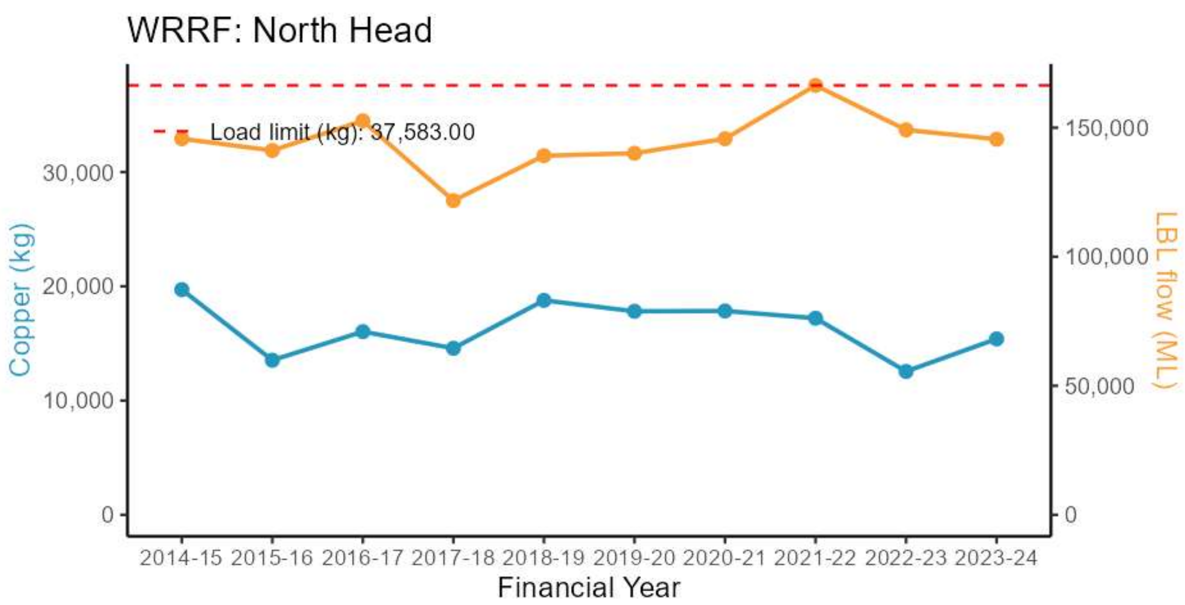


WRRF: North Head
Load limit (kg): 35,010,800.00
Total suspended solids (kg)
LBL flow (ML)
30,000,000
20,000,000
10,000,000
0
150,000
100,000
50,000
0
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year

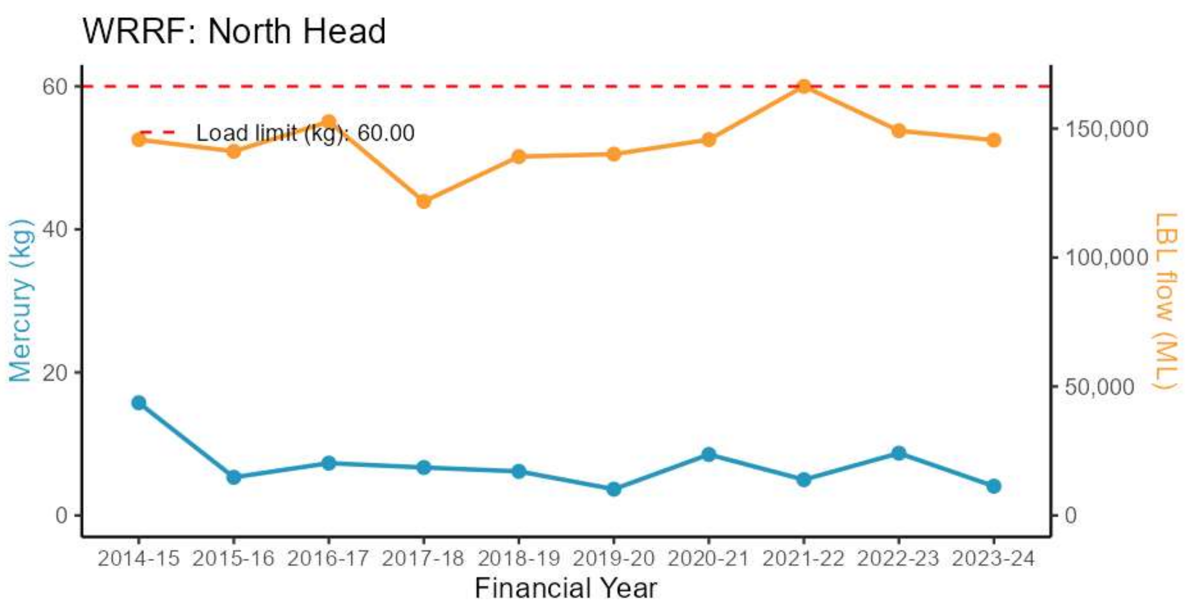
Trace metals



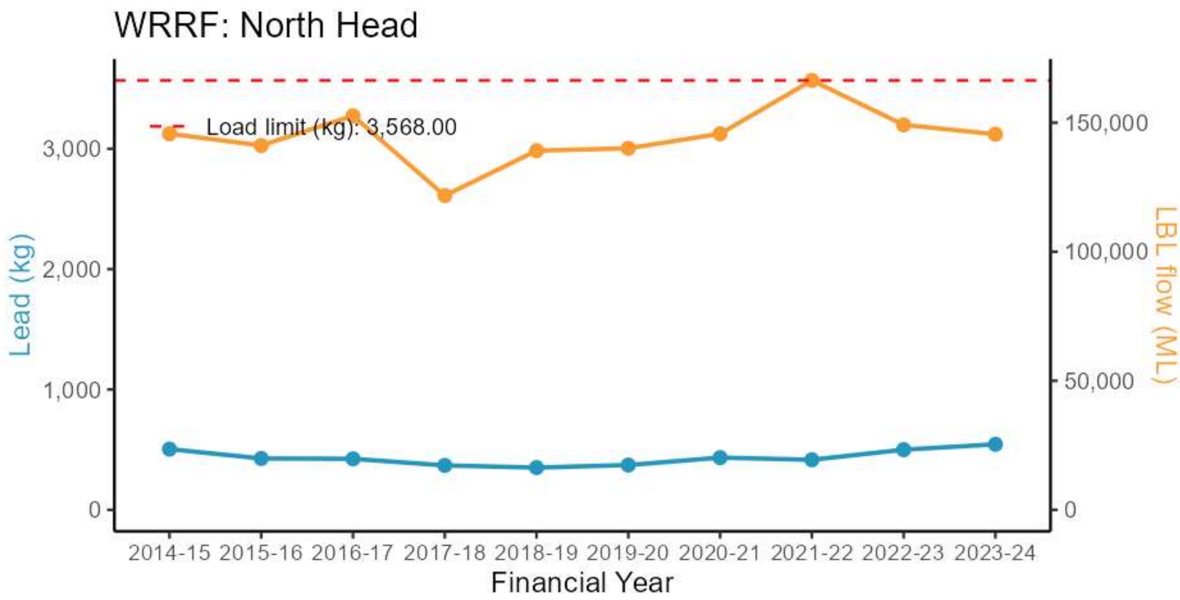


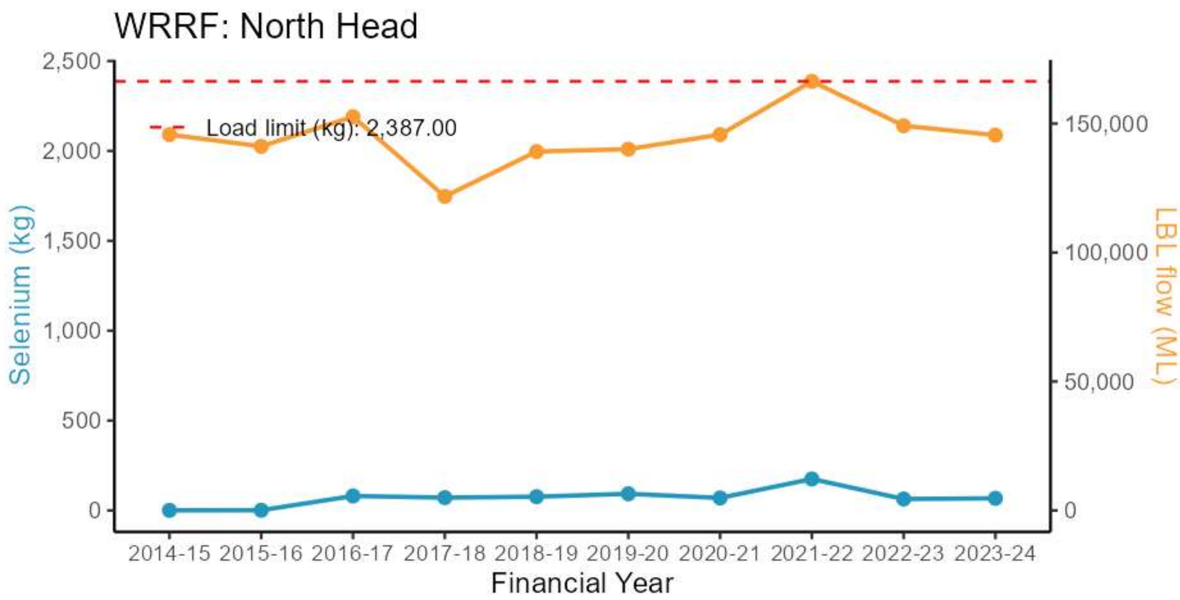


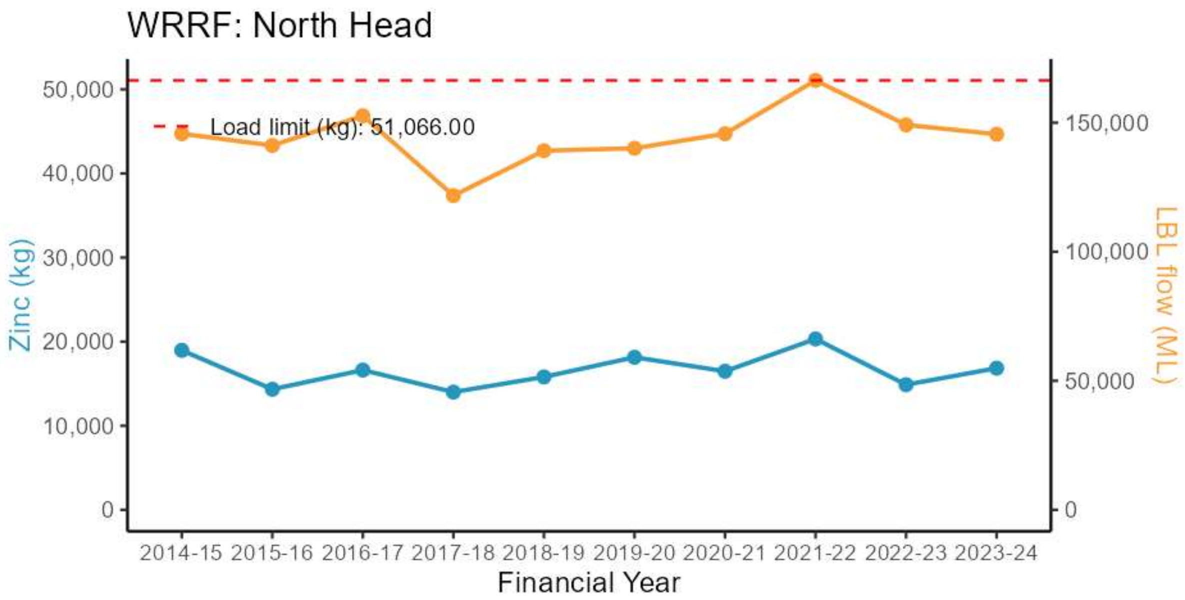
WRRF: North Head
Load limit (kg): 37,583.00
Copper (kg)
LBL flow (ML)
0
10,000
20,000
30,000
0
50,000
100,000
150,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



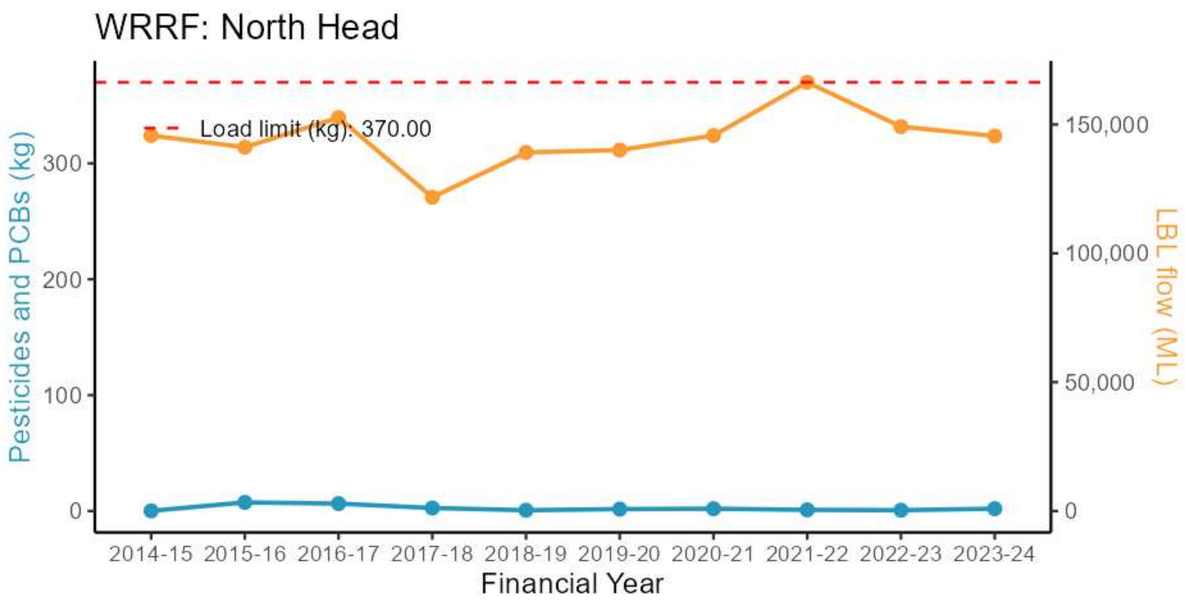
WRRF: North Head
Load limit (kg): 60.00
Mercury (kg)
LBL flow (ML)
0
20
40
60
0
50,000
100,000
150,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year


WRRF: North Head
Load limit (kg): 3,568.00
Lead (kg)
LBL flow (ML)
3,000
2,000
1,000
0
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year


WRRF: North Head
Load limit (kg): 2,387.00
Selenium (kg)
LBL flow (ML)
2,500
2,000
1,500
1,000
500
0
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year



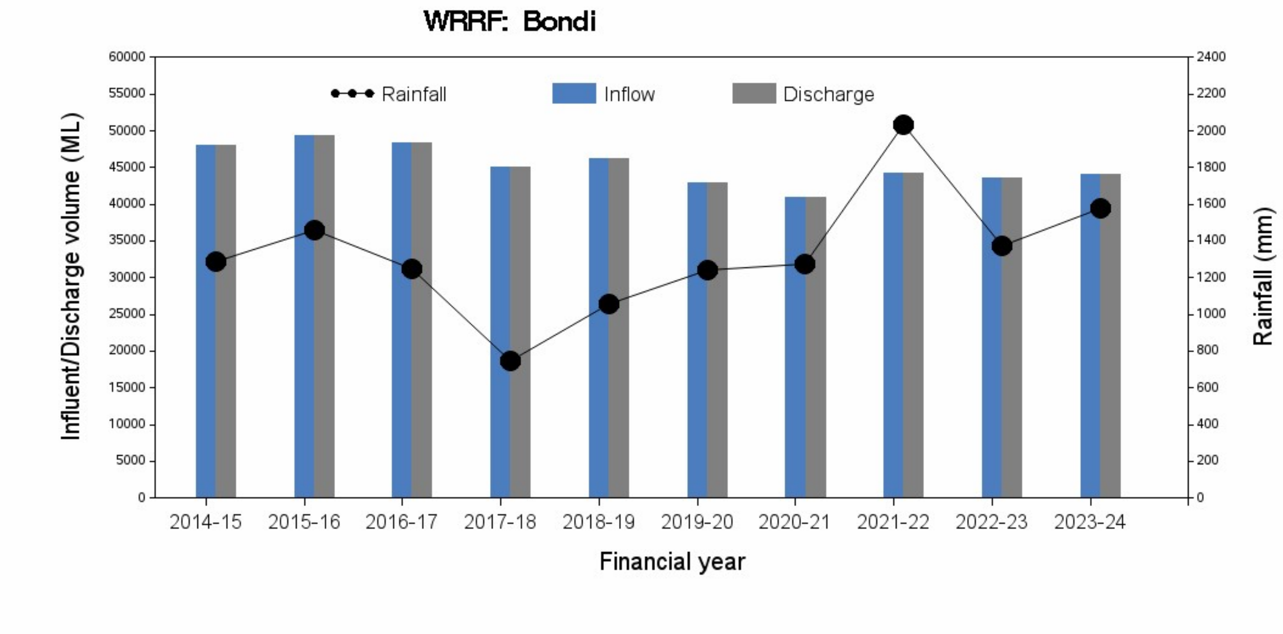
Other chemicals and organics (including pesticides)



E.2. Bondi WRRF

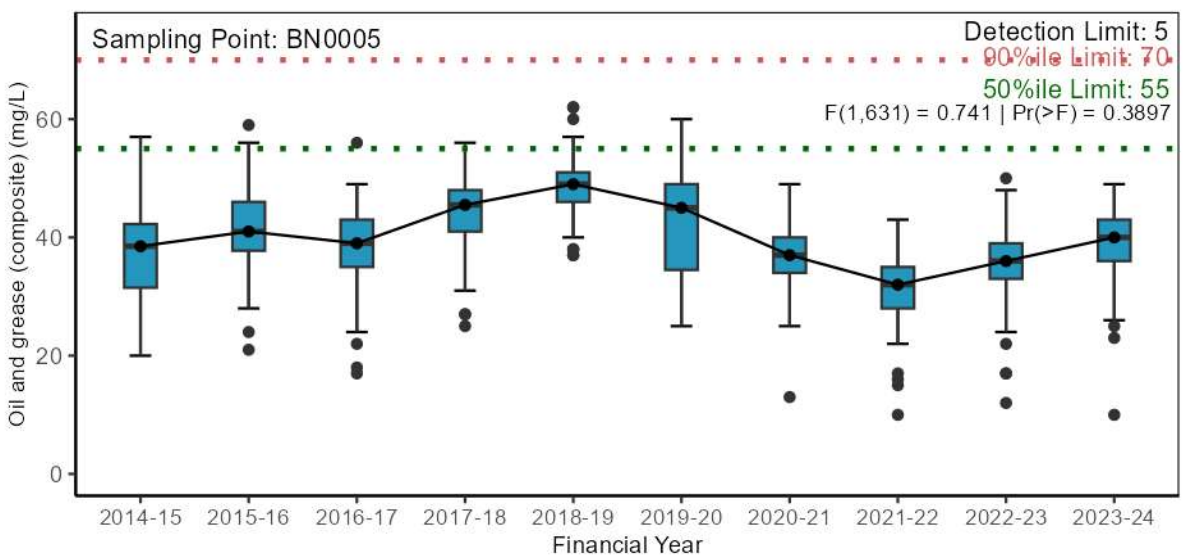
E.2.1. Pressure – Wastewater quantity

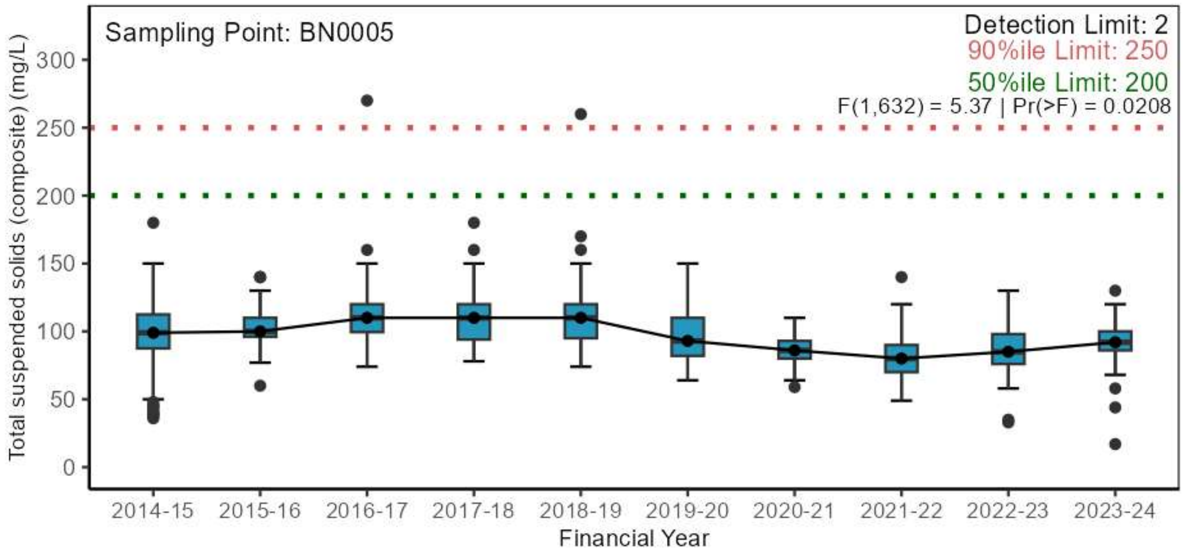
Inflow/ Discharge volume and rainfall



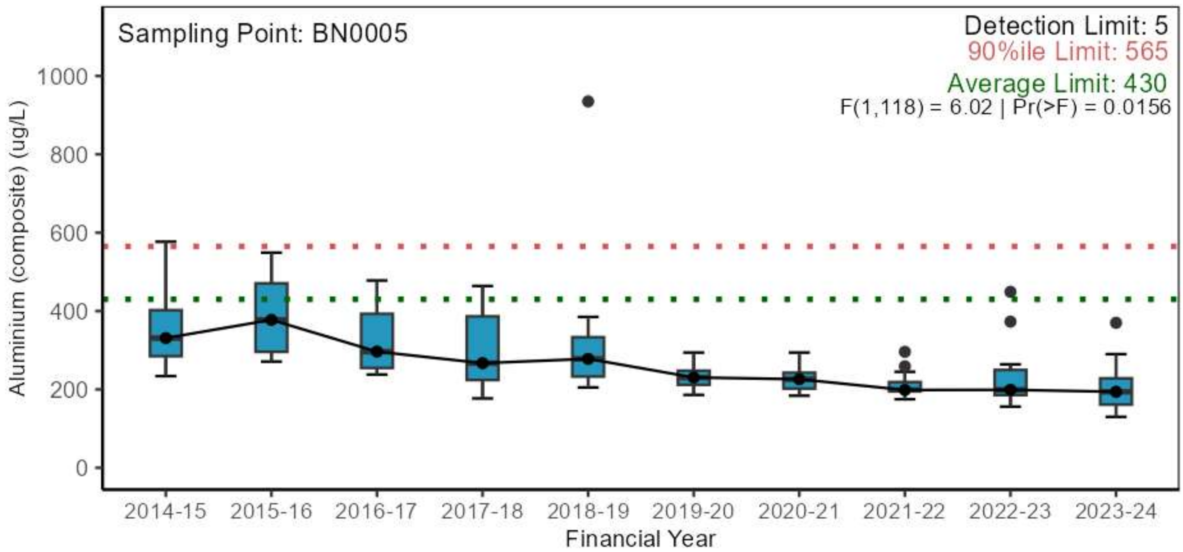
E.2.2. Pressure – Wastewater quality

Major conventional analytes

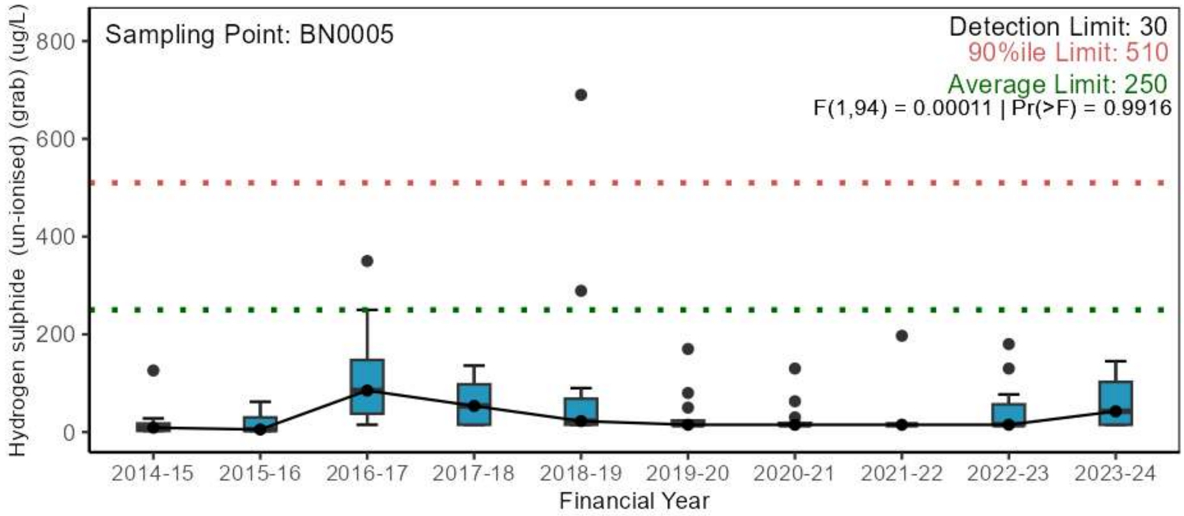




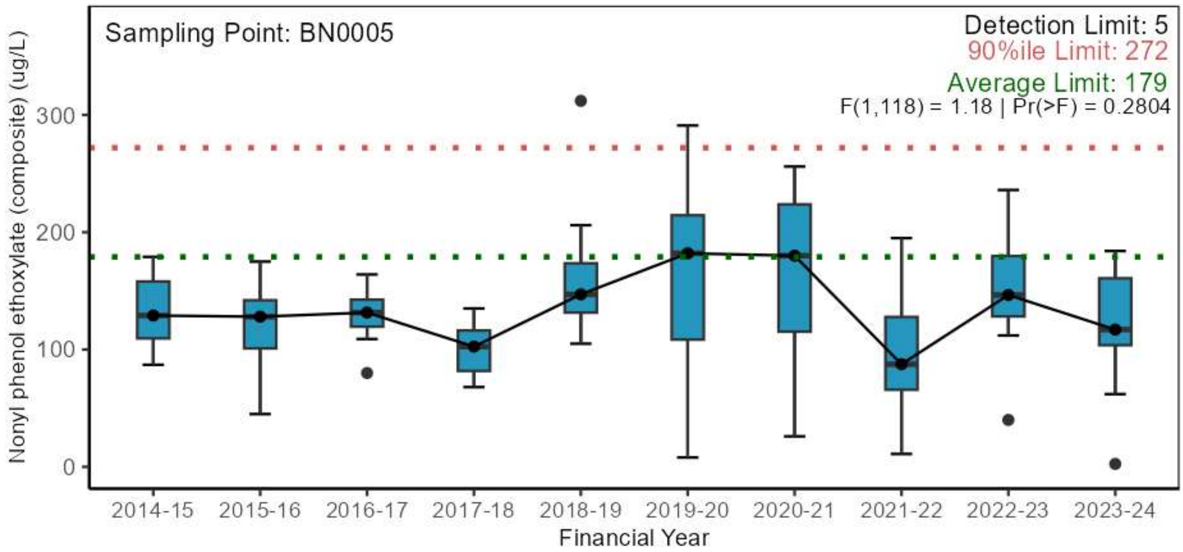
Trace metals



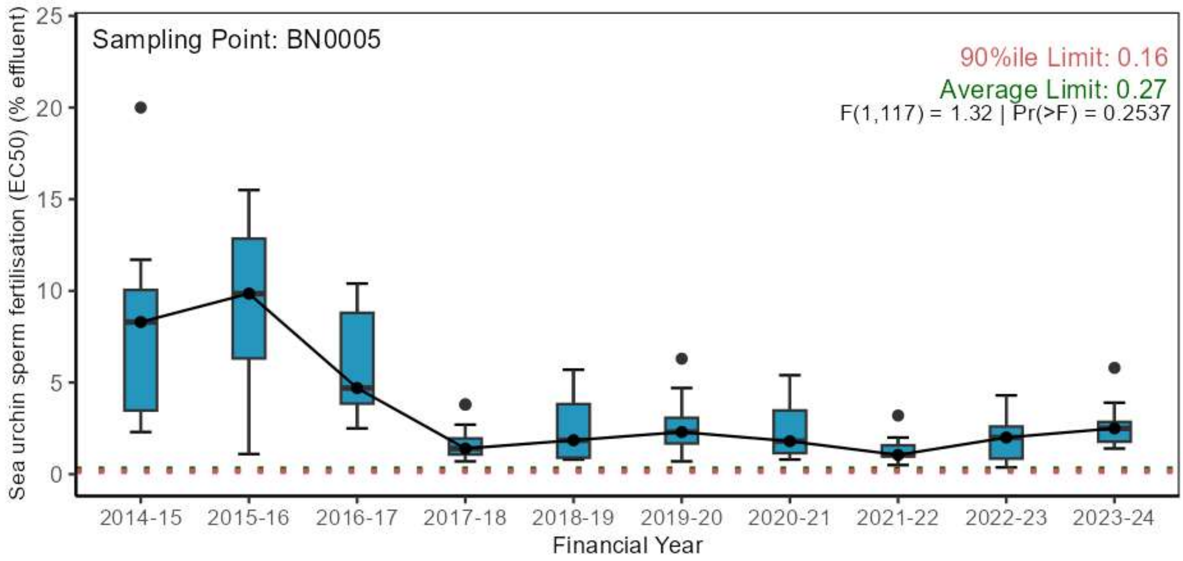
Other chemicals and organics (including pesticides)



Statistical test excludes data prior to 2016-17 due to method detection limit change.

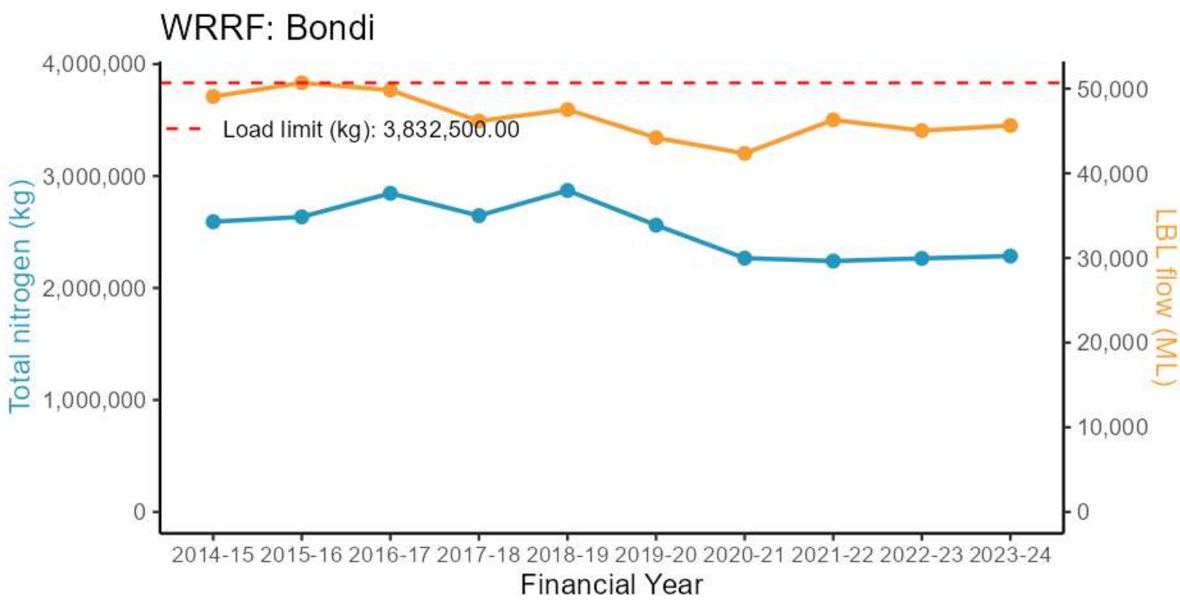


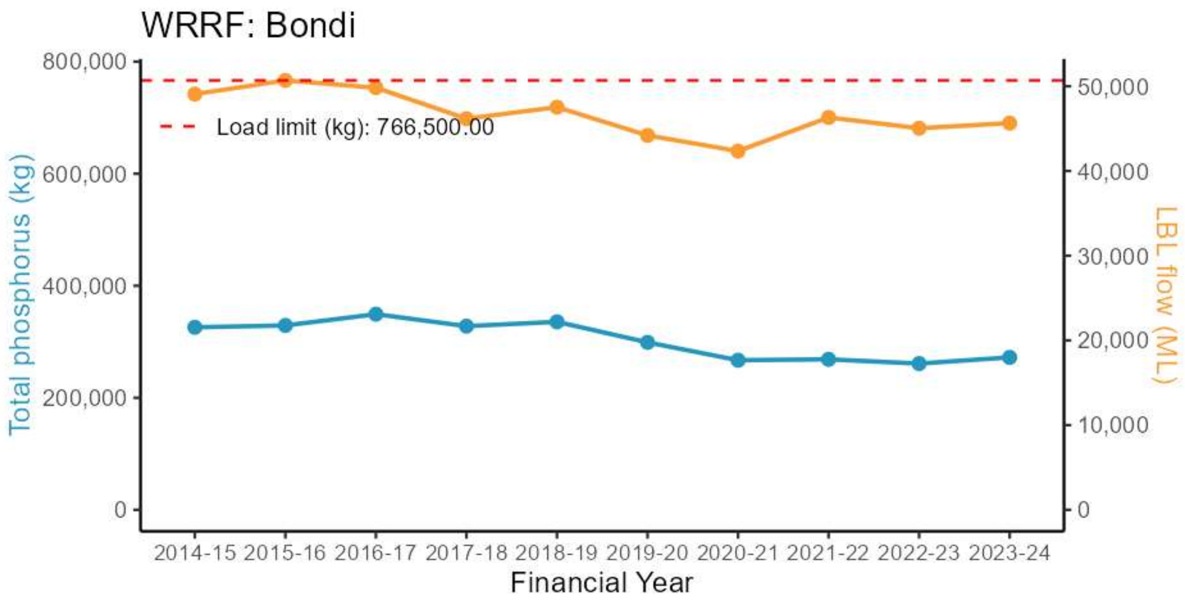
E.2.3. Pressure – Wastewater toxicity



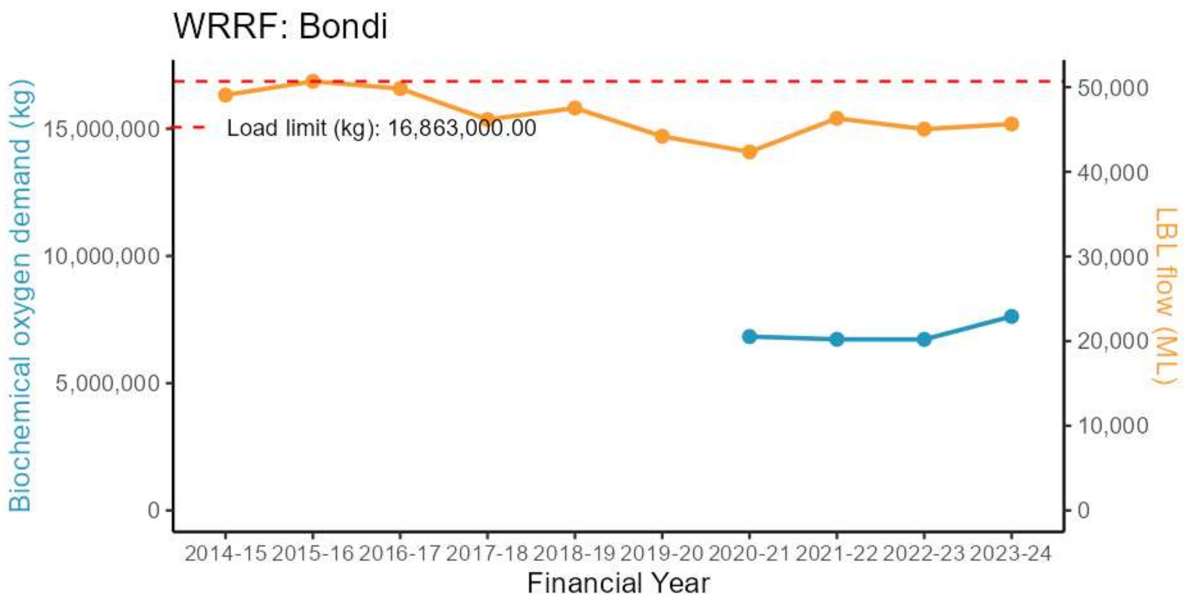
E.2.4. Pressure – Wastewater discharge load

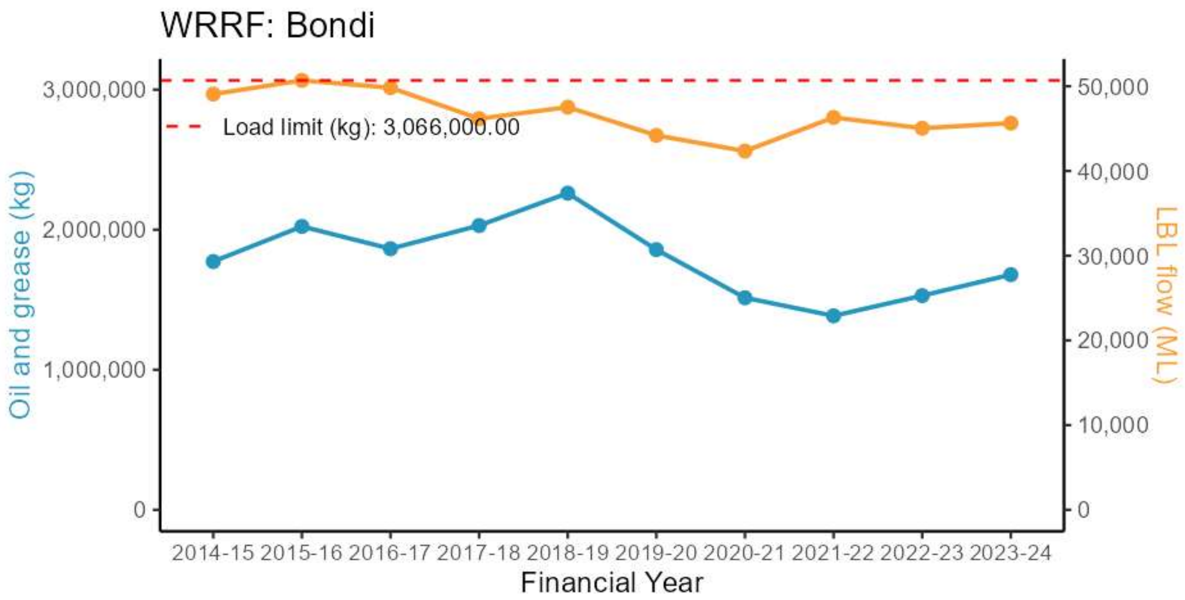
Nutrients

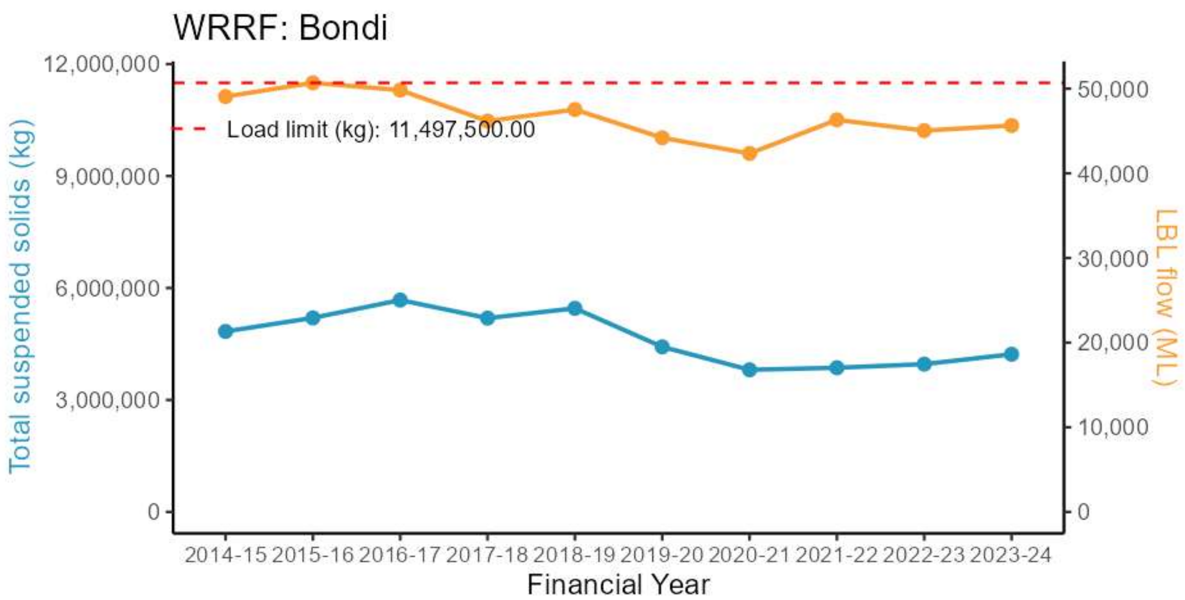




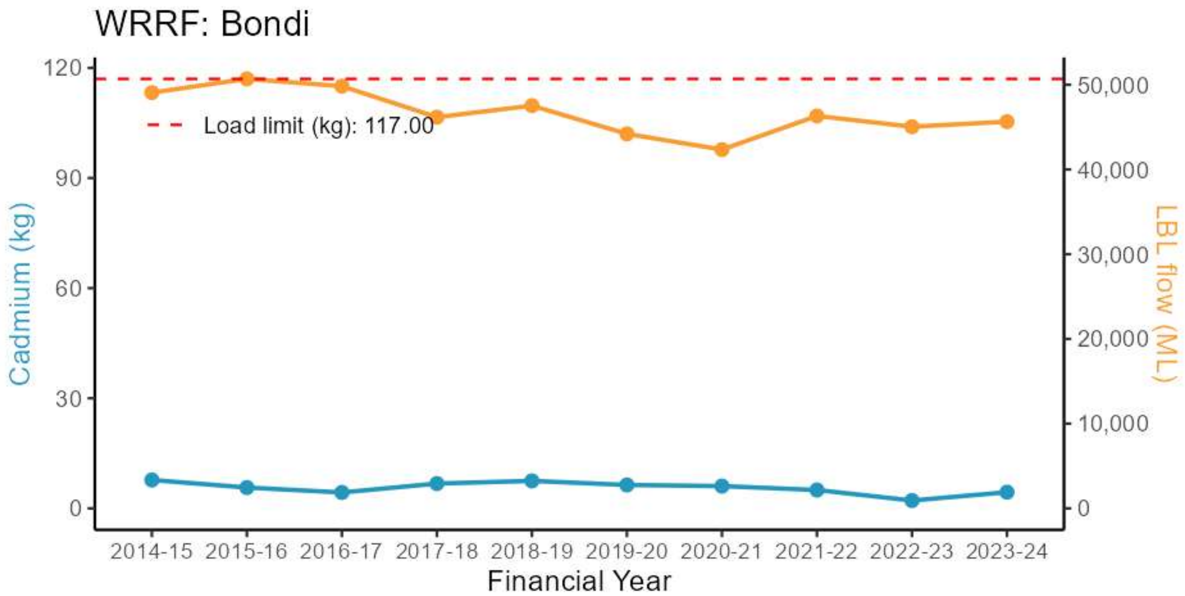
Major conventional analytes

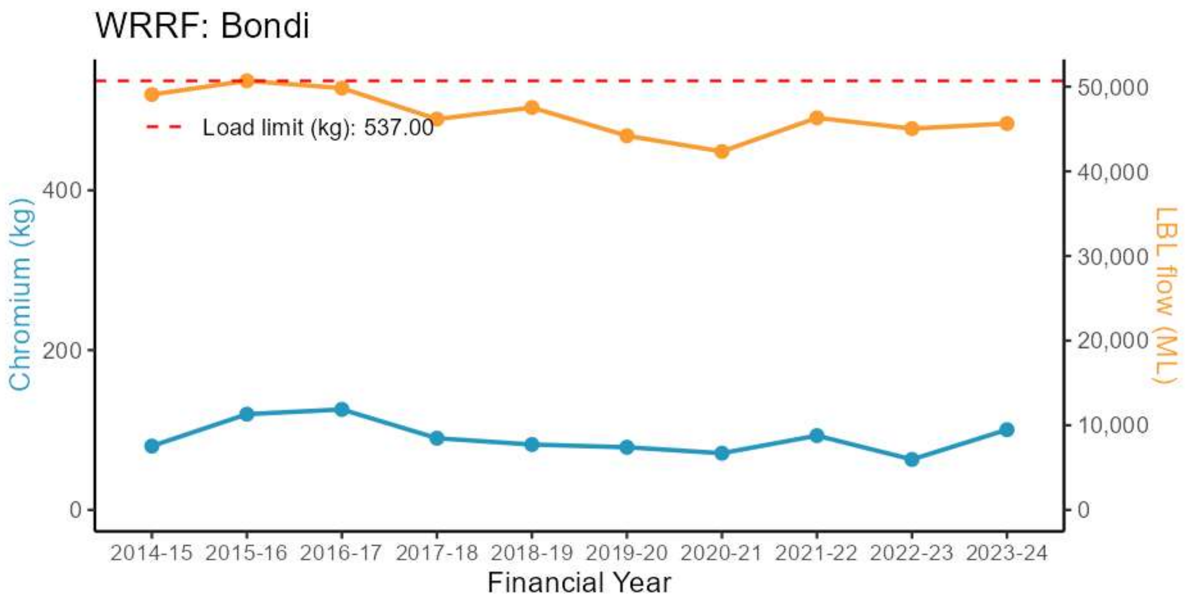


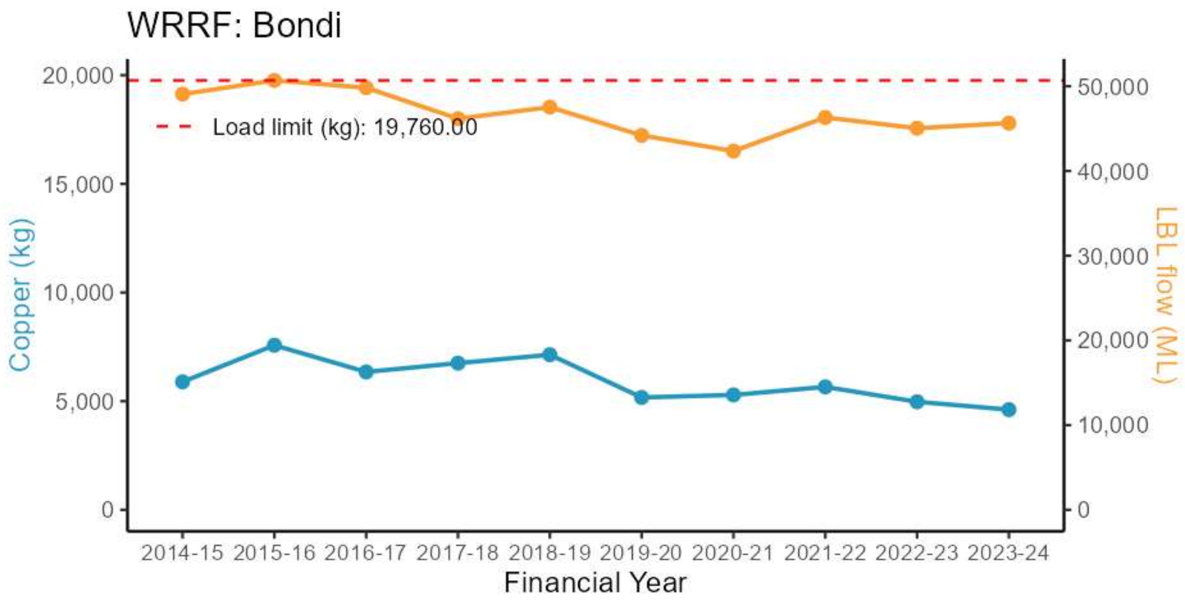

WRRF: Bondi
Load limit (kg): 3,066,000.00
Oil and grease (kg)
LBL flow (ML)
3,000,000
2,000,000
1,000,000
0
50,000
40,000
30,000
20,000
10,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

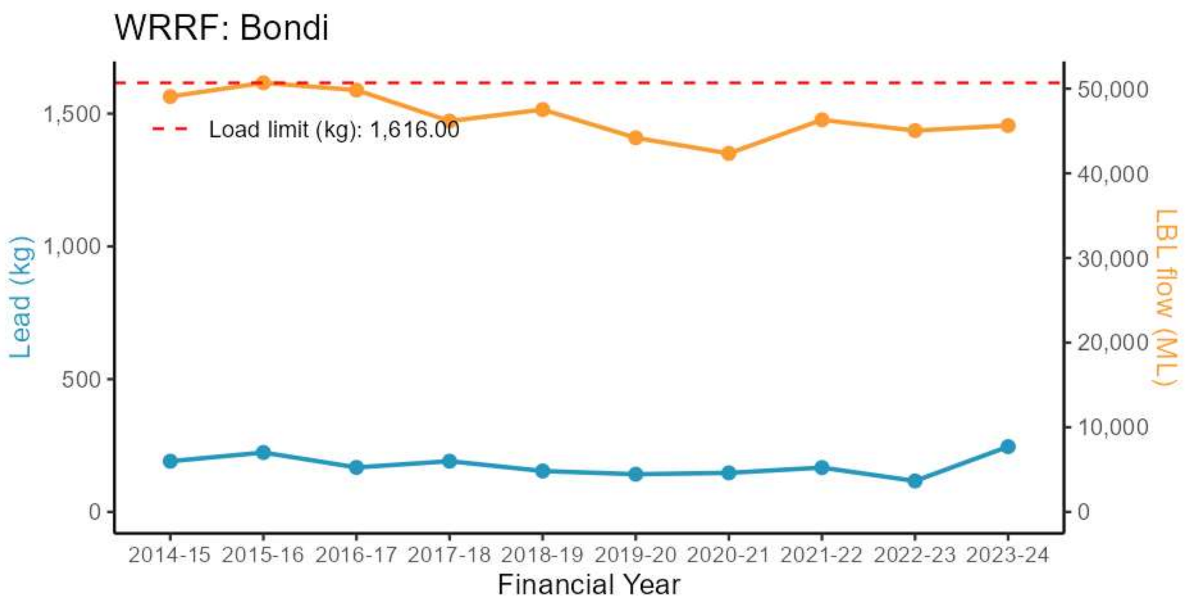

WRRF: Bondi
Load limit (kg): 11,497,500.00
Total suspended solids (kg)
LBL flow (ML)
12,000,000
9,000,000
6,000,000
3,000,000
0
50,000
40,000
30,000
20,000
10,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

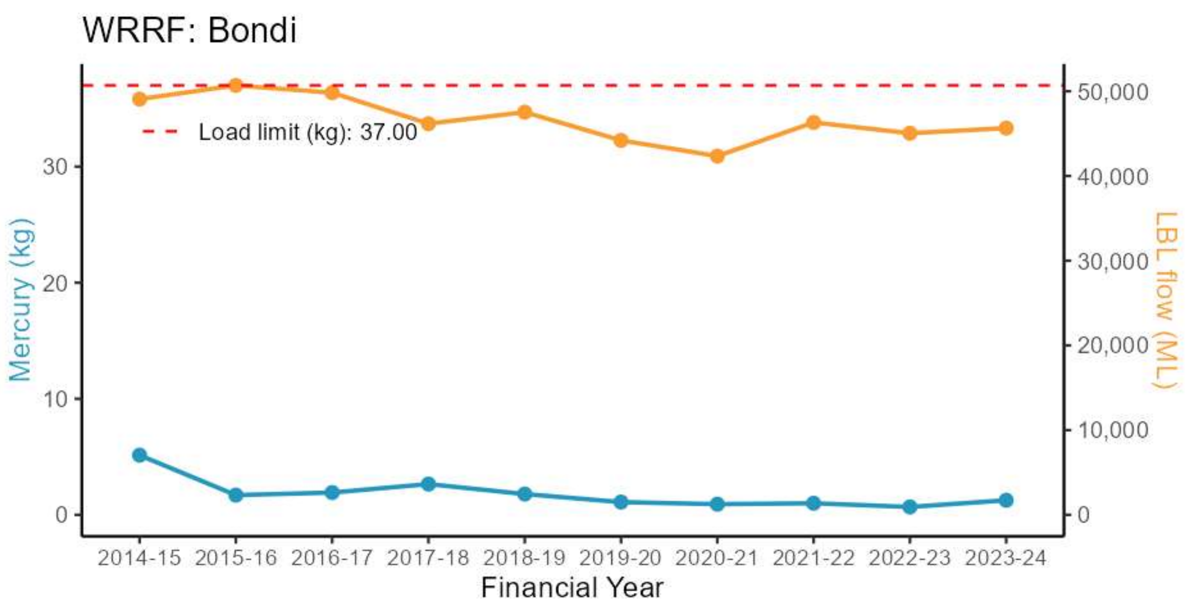
Trace metals



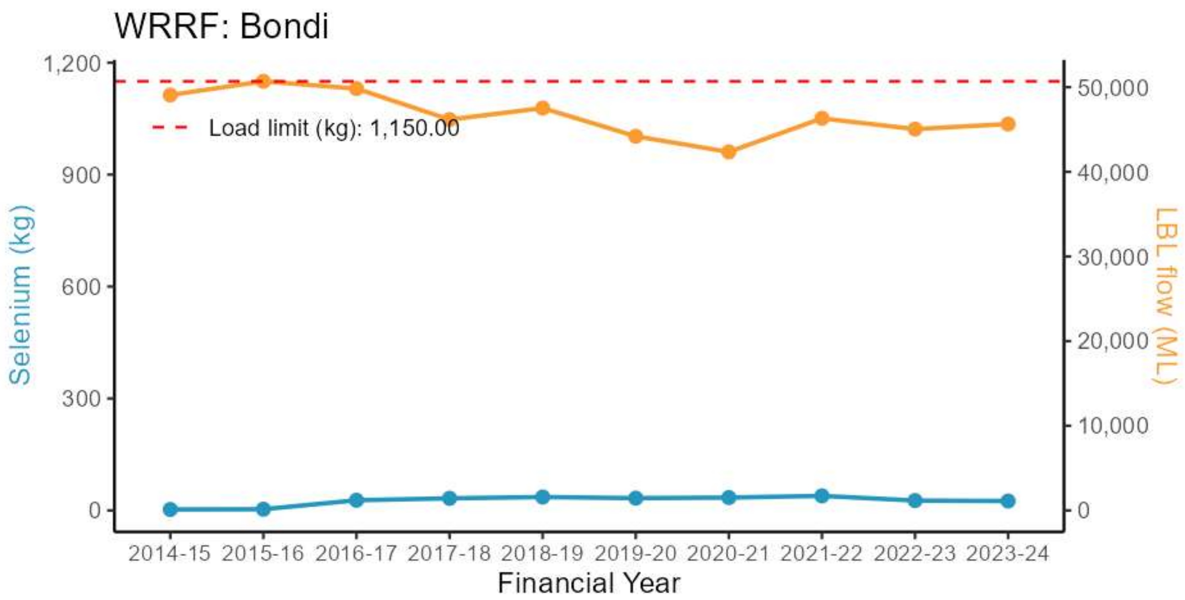



WRRF: Bondi
Load limit (kg): 19,760.00
Copper (kg)
LBL flow (ML)
20,000
15,000
10,000
5,000
0
50,000
40,000
30,000
20,000
10,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

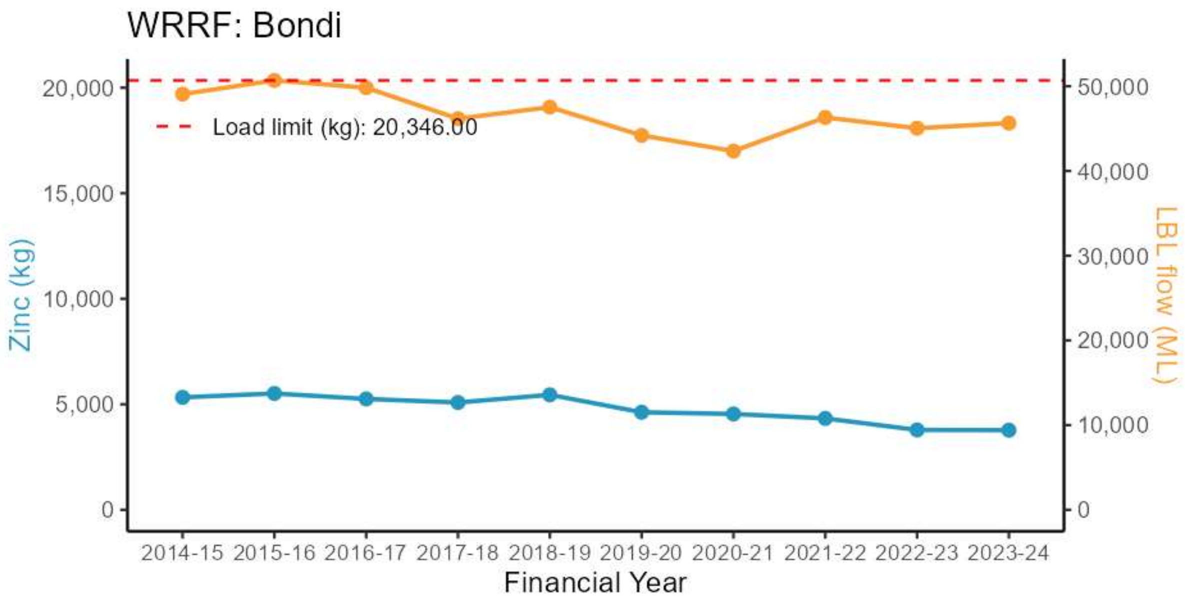

WRRF: Bondi
Load limit (kg): 1,616.00
Lead (kg)
LBL flow (ML)
1,500
1,000
500
0
50,000
40,000
30,000
20,000
10,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year



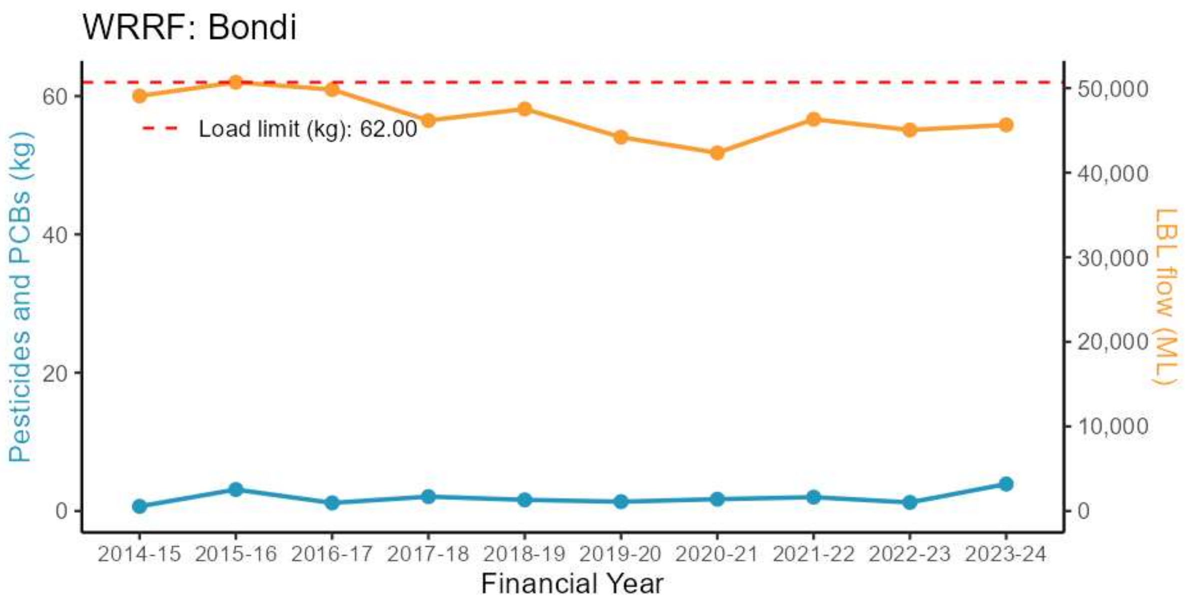
WRRF: Bondi
Load limit (kg): 37.00
Mercury (kg)
LBL flow (ML)
0
10
20
30
0
10,000
20,000
30,000
40,000
50,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



WRRF: Bondi
Load limit (kg): 1,150.00
Selenium (kg)
LBL flow (ML)
0
300
600
900
1,200
0
10,000
20,000
30,000
40,000
50,000
2014-15
2015-16
2016-17
2017-18
2018-19
2019-20
2020-21
2021-22
2022-23
2023-24
Financial Year



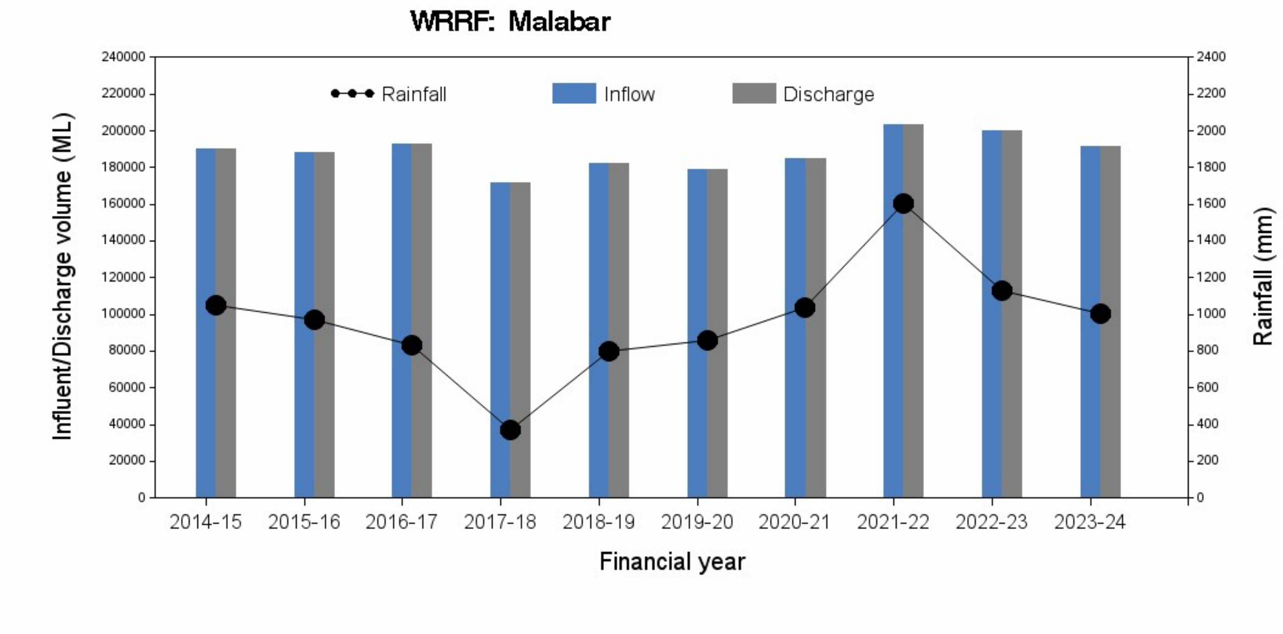
Other chemicals and organics (including pesticides)



E.3. Malabar WRRF

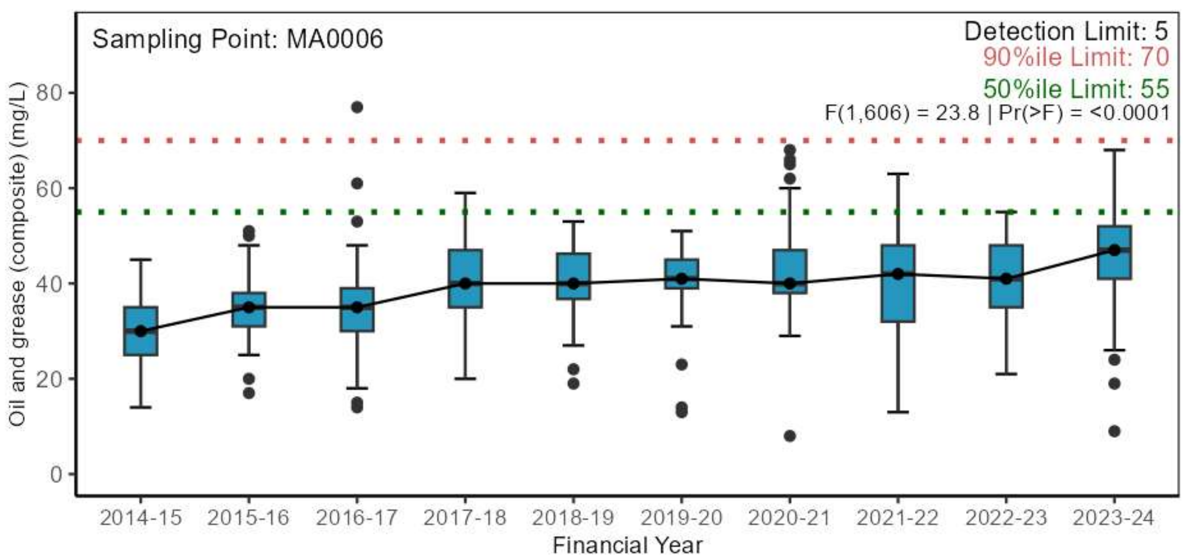
E.3.1. Pressure – Wastewater quantity

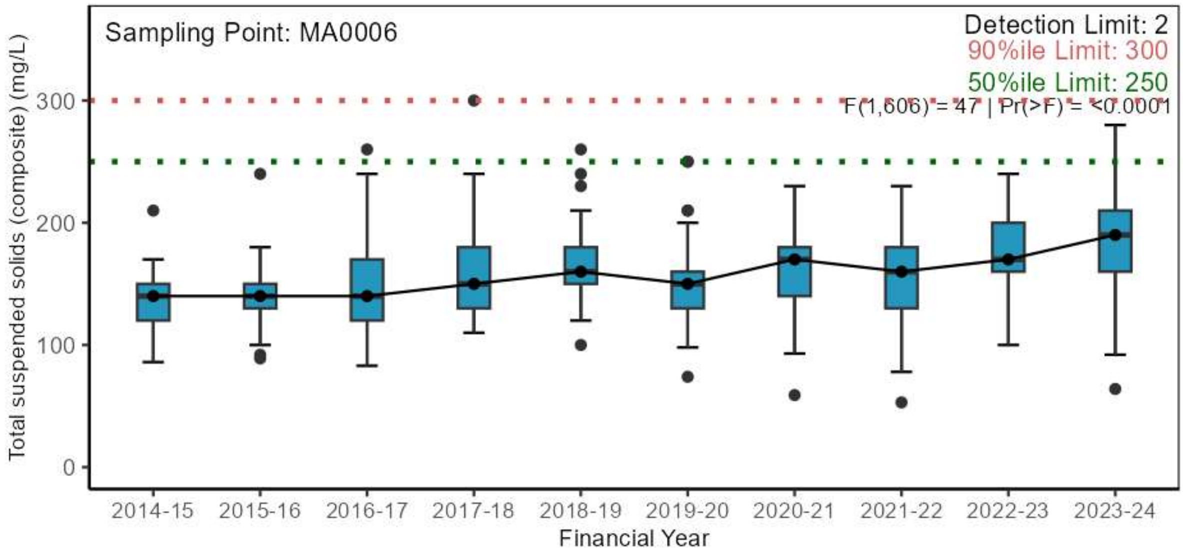
Inflow/ Discharge volume and rainfall



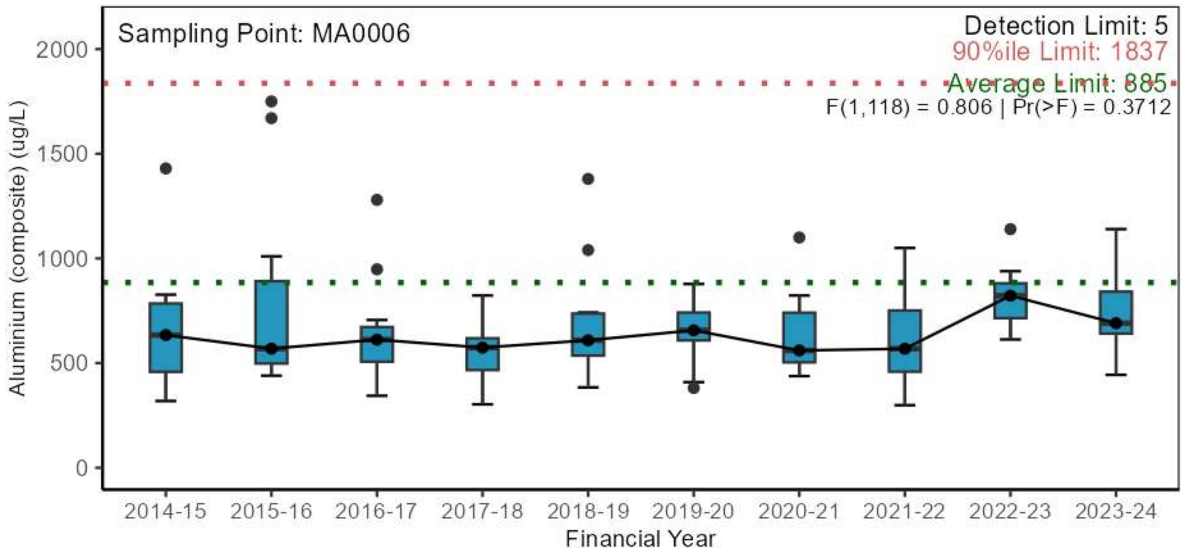
E.3.2. E-3.2 Pressure – Wastewater quality

Major conventional analytes

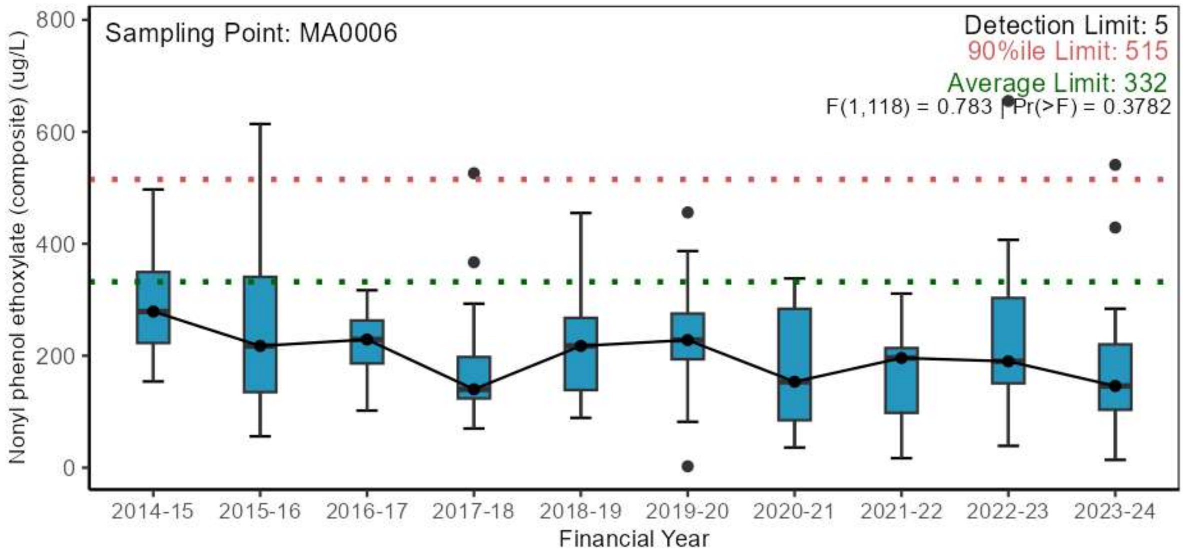


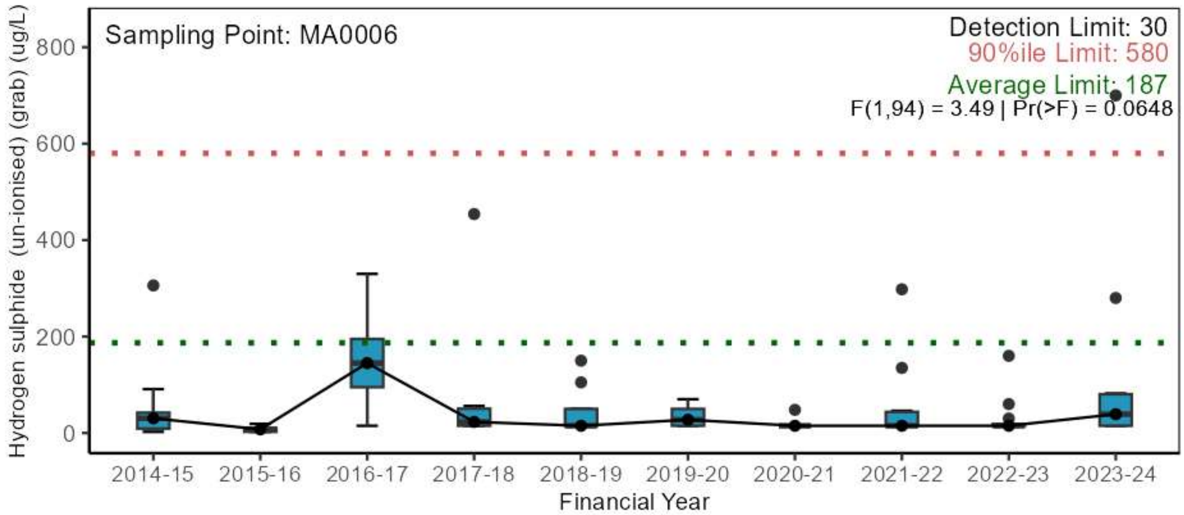


Trace metals



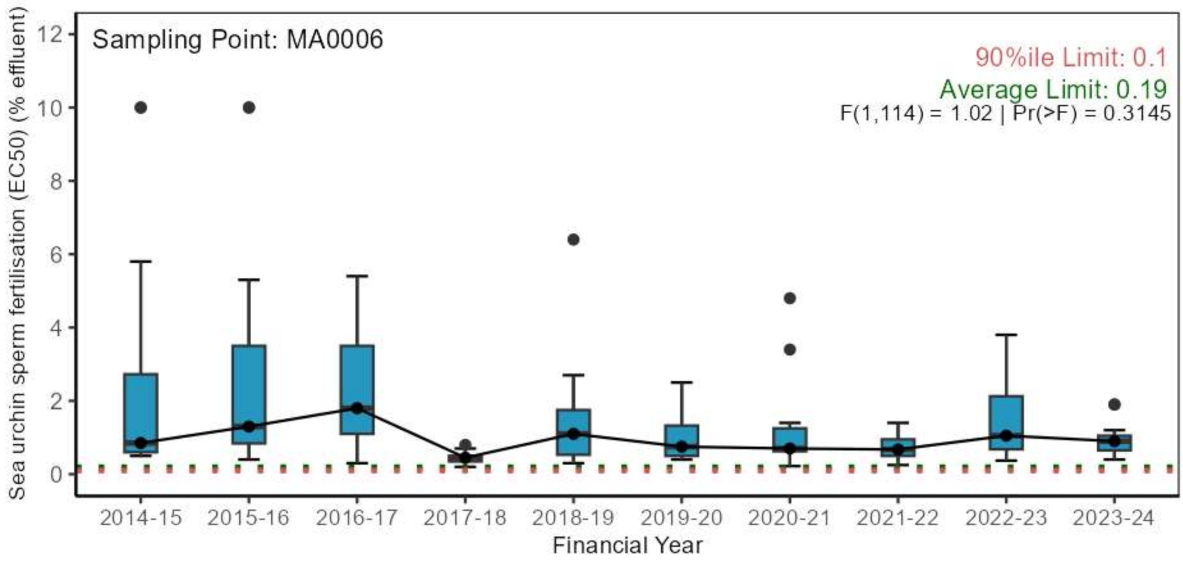
Other chemicals and organics (including pesticides)





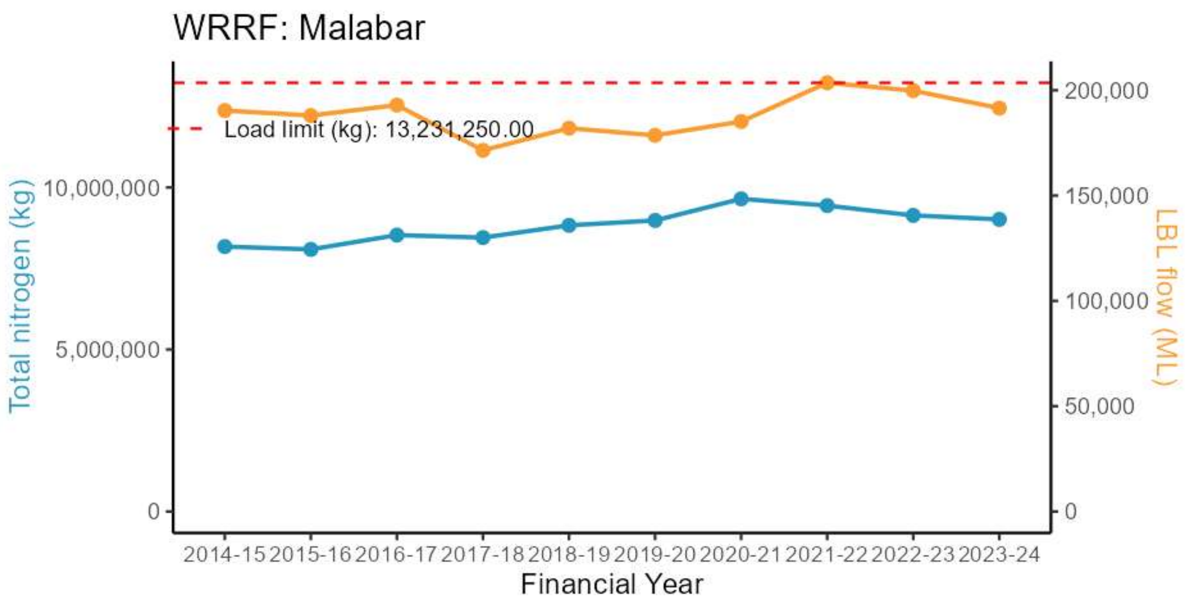
Statistical test excludes data prior to 2016-17 due to method detection limit change.

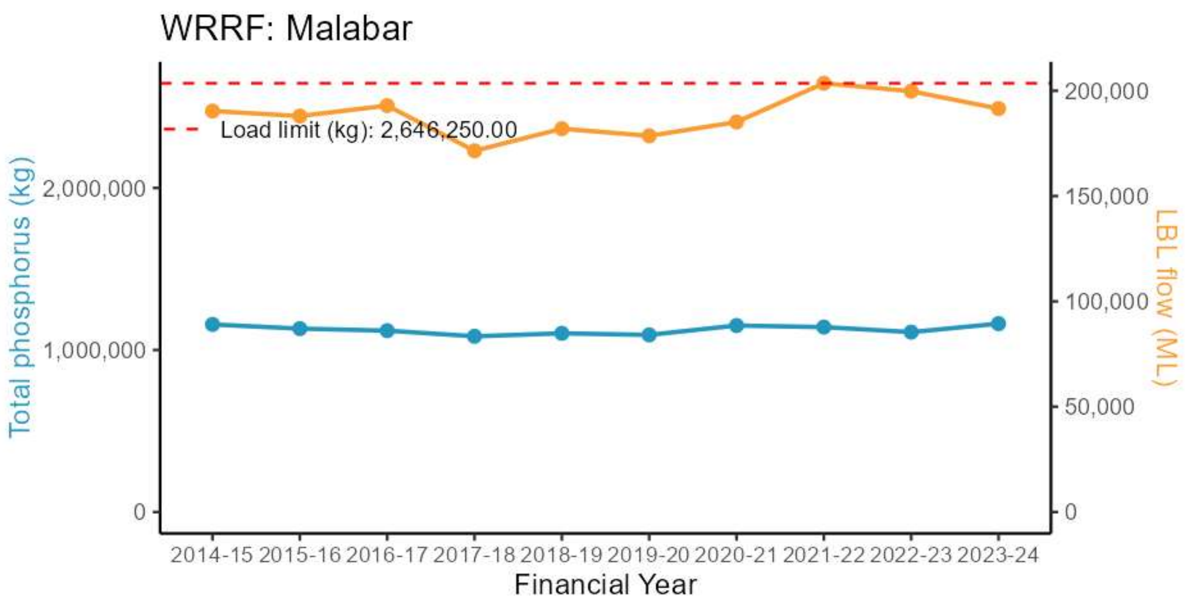
E.3.3. Pressure – Wastewater toxicity



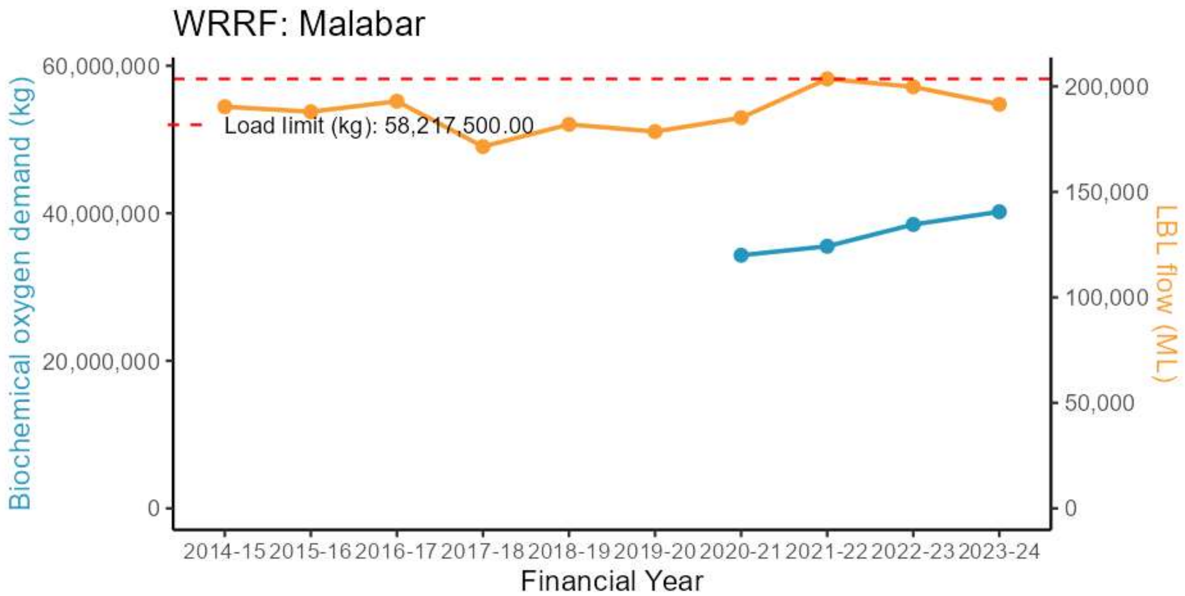
E.3.4. Pressure – Wastewater discharge load

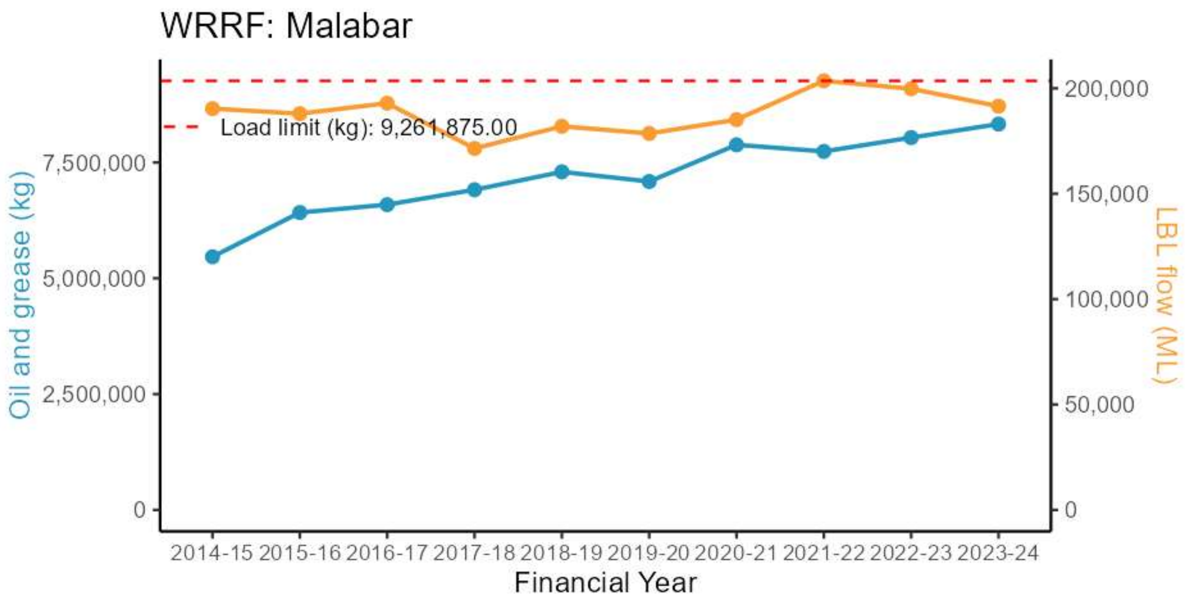
Nutrients

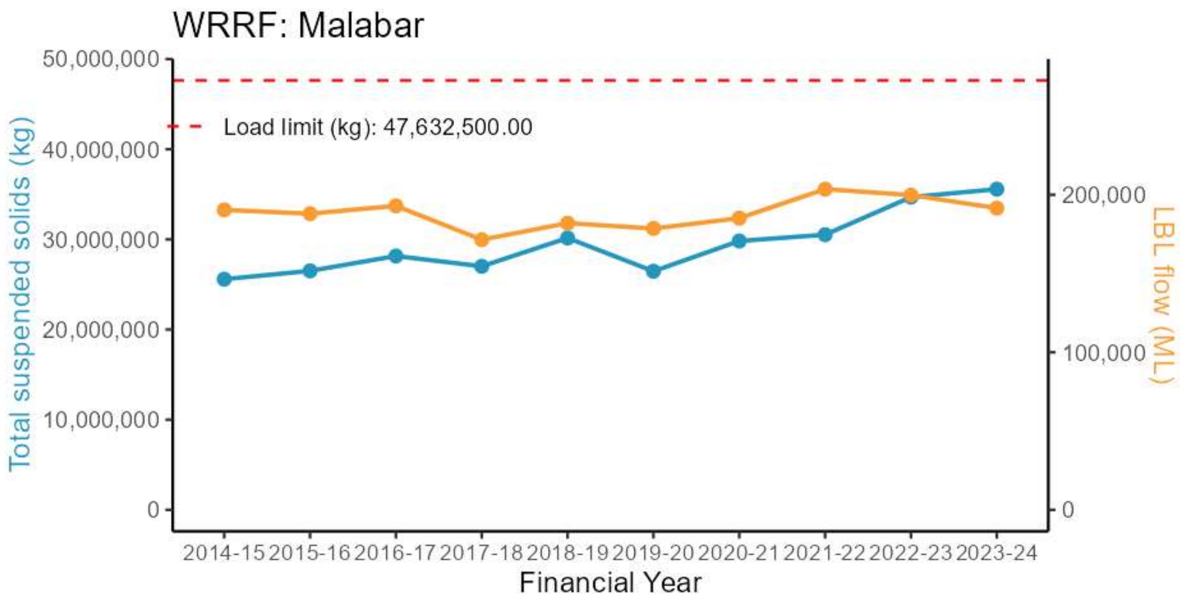




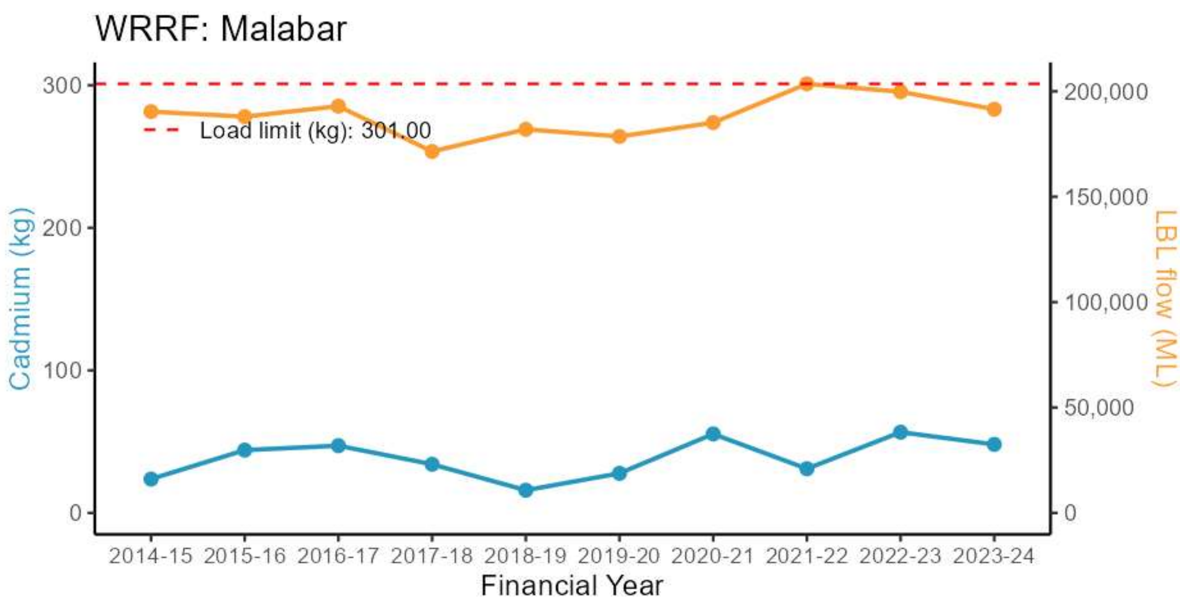
Major conventional analytes

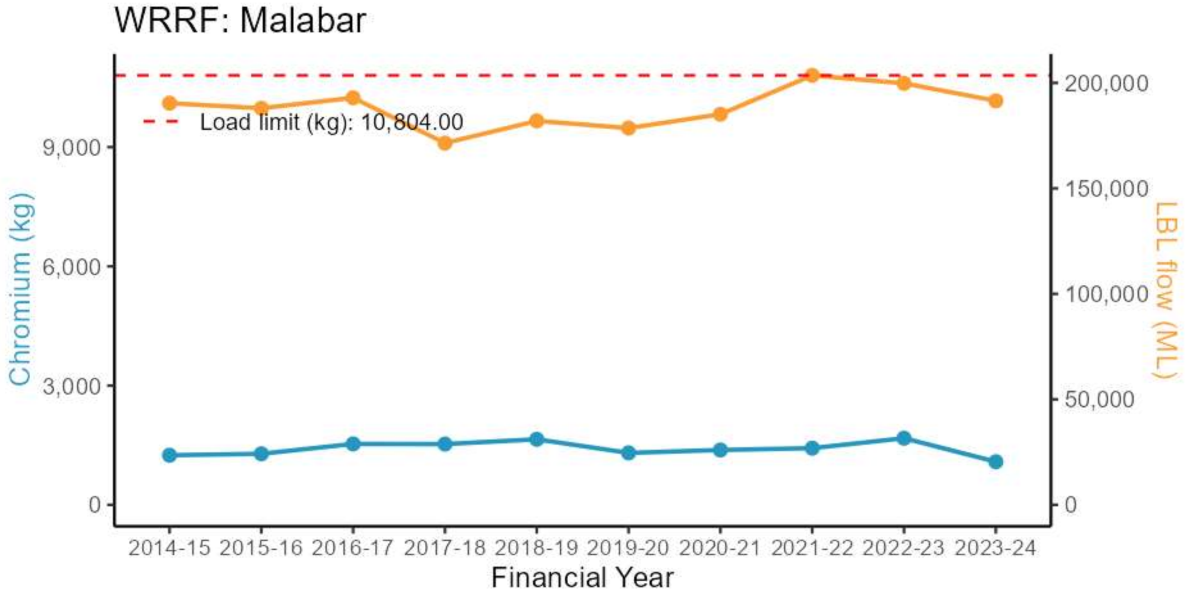




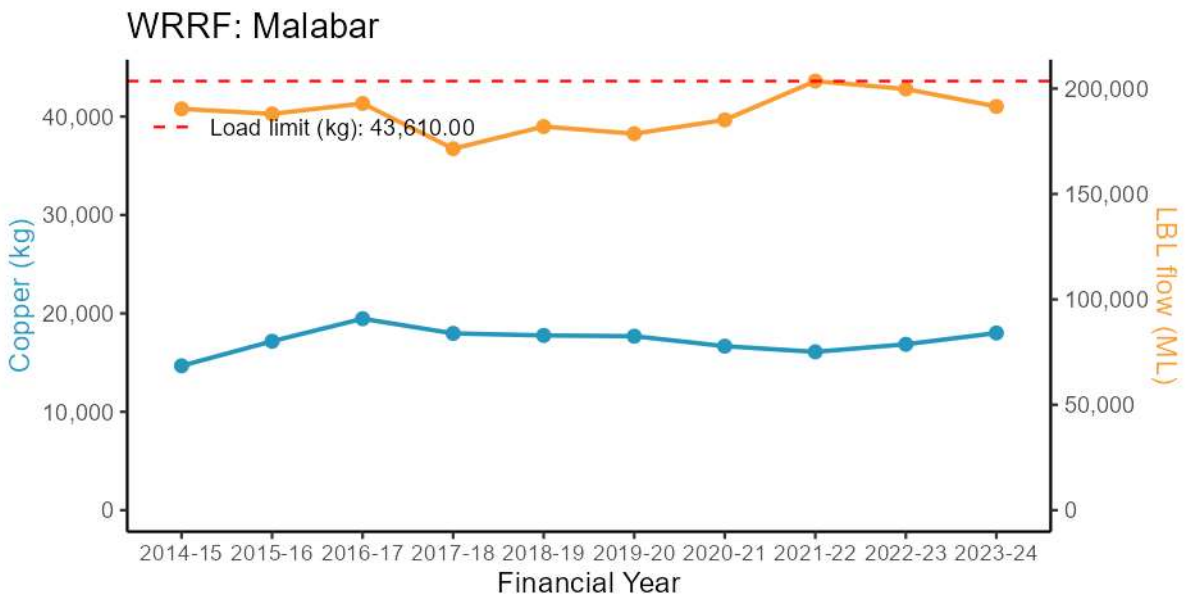


E.3.5. Trace metals

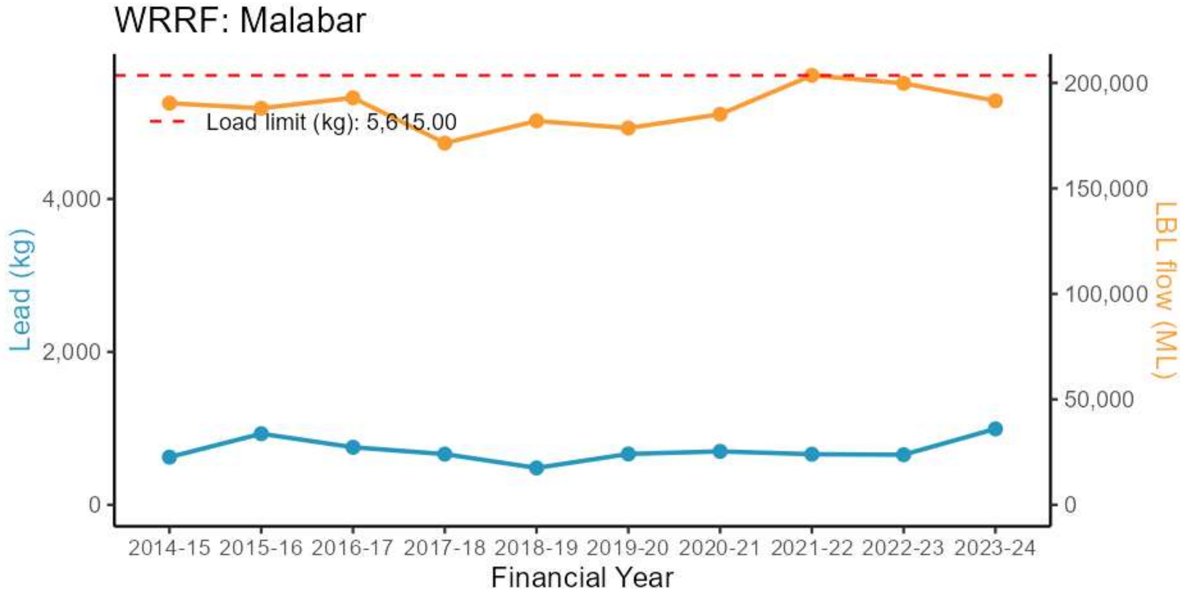


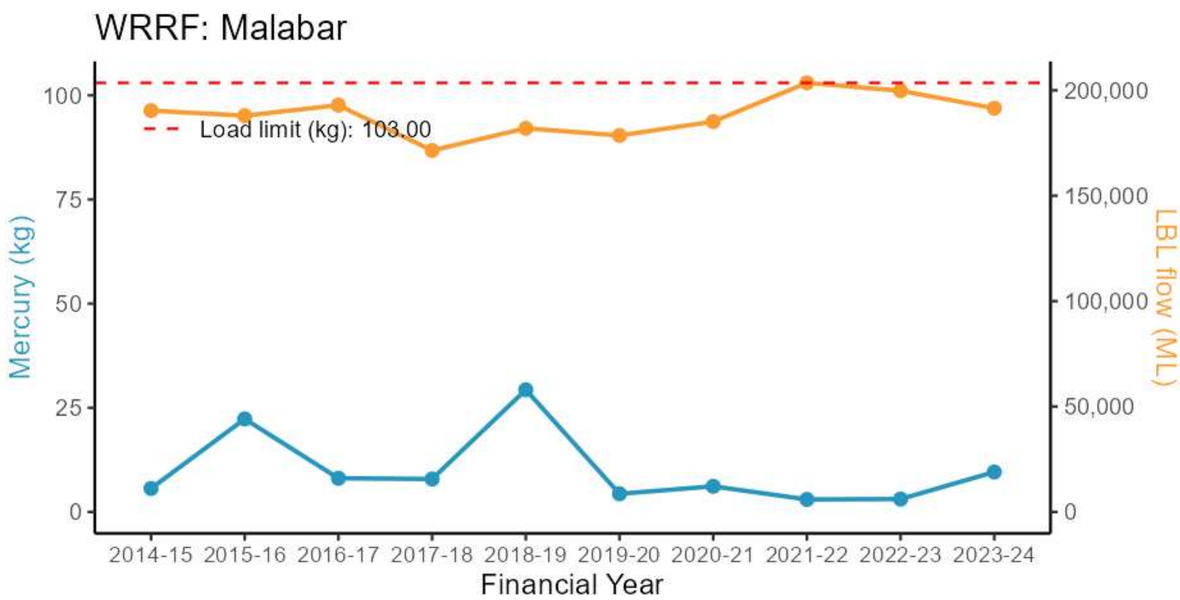


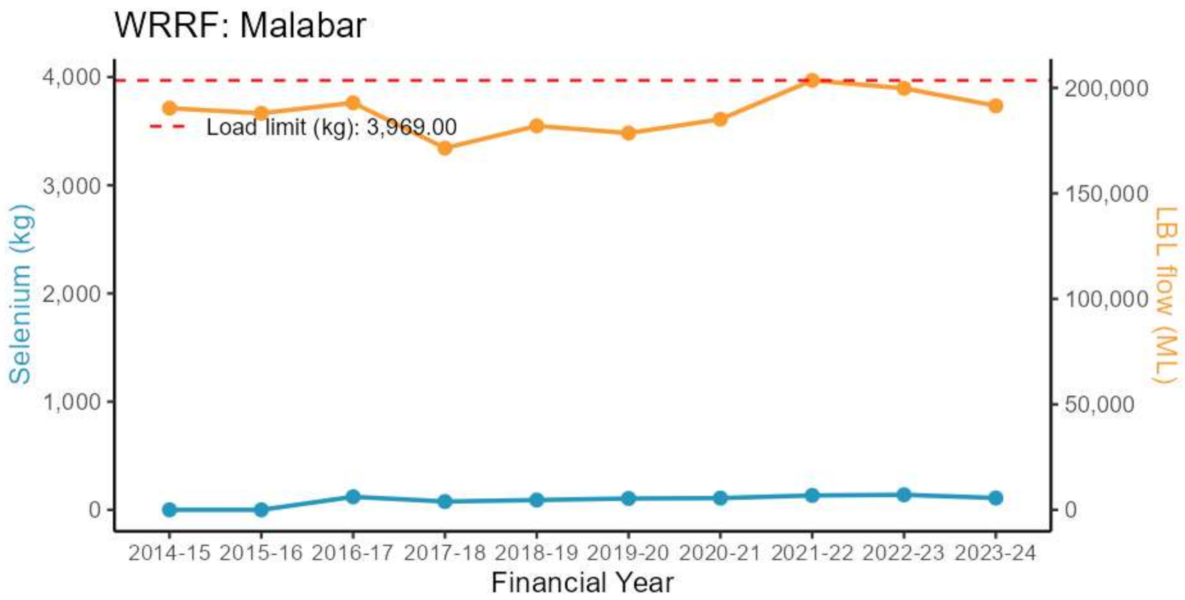
WRRF: Malabar
Load limit (kg): 10,804.00
Chromium (kg)
9,000
6,000
3,000
0
LBL flow (ML)
200,000
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

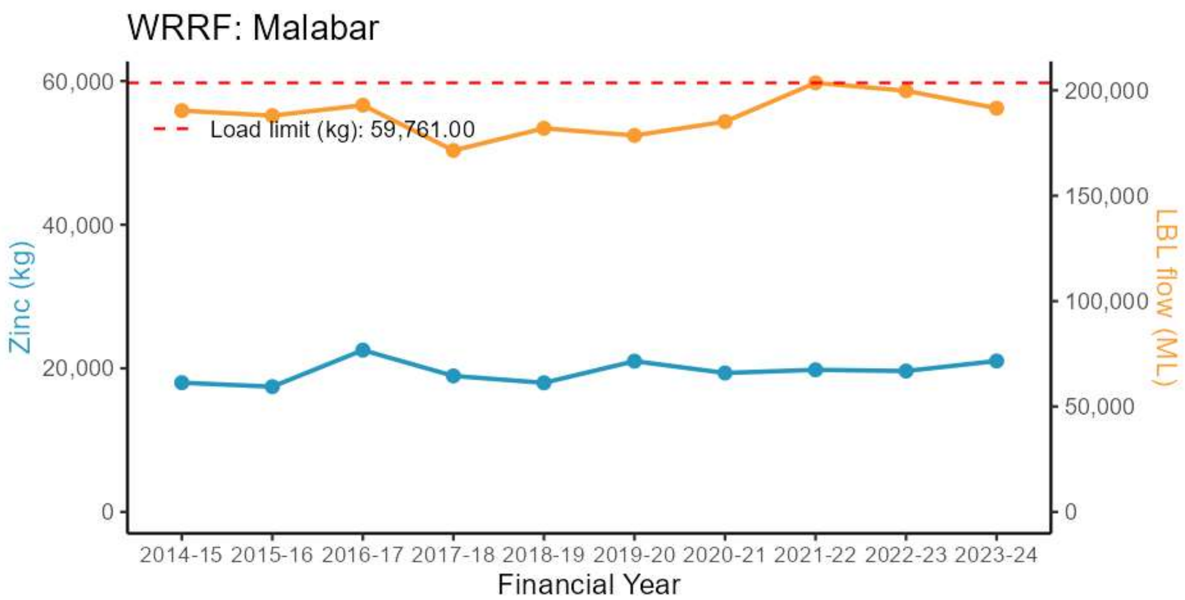


WRRF: Malabar
Load limit (kg): 43,610.00
Copper (kg)
40,000
30,000
20,000
10,000
0
LBL flow (ML)
200,000
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

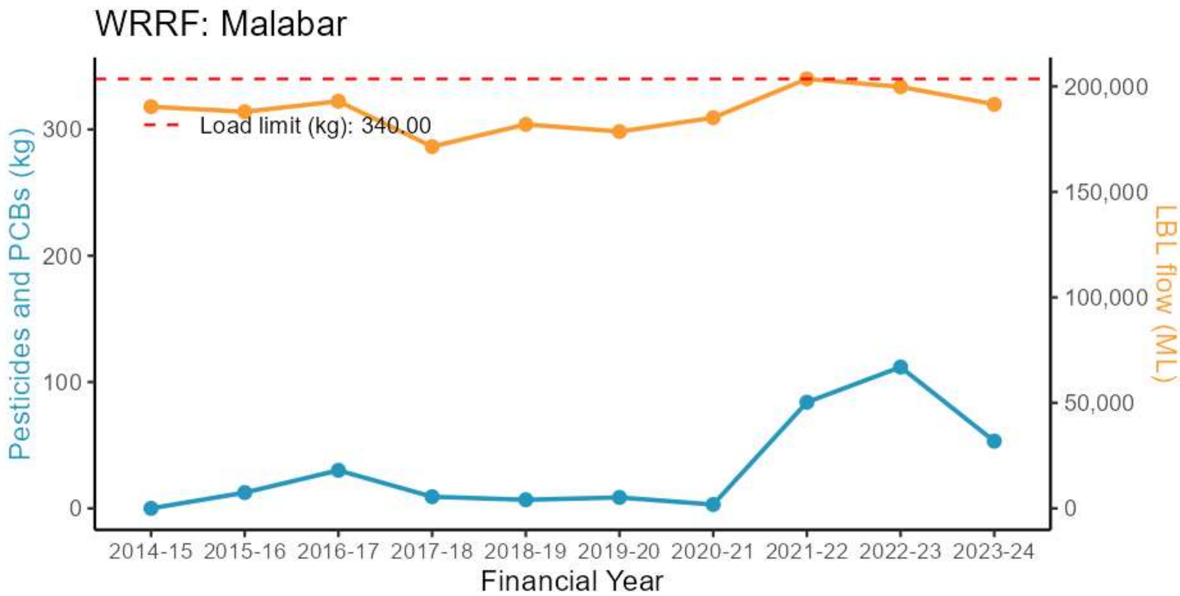

WRRF: Malabar
Load limit (kg): 5,615.00
Lead (kg)
4,000
2,000
0
200,000
150,000
100,000
50,000
0
LBL flow (ML)
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year


WRRF: Malabar
Load limit (kg): 103.00
Mercury (kg)
100
75
50
25
0
200,000
150,000
100,000
50,000
0
LBL flow (ML)
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year


WRRF: Malabar
Load limit (kg): 3,969.00
Selenium (kg)
LBL flow (ML)
4,000
3,000
2,000
1,000
0
200,000
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year


WRRF: Malabar
Load limit (kg): 59,761.00
Zinc (kg)
LBL flow (ML)
60,000
40,000
20,000
0
200,000
150,000
100,000
50,000
0
2014-15 2015-16 2016-17 2017-18 2018-19 2019-20 2020-21 2021-22 2022-23 2023-24
Financial Year

Other chemicals and organics (including pesticides)



E.4. EPL limits of Offshore discharging WRRFs

Table E-1 EPL concentration limits for the offshore discharging WRRFs (2023-24)

WRRF	Sampling Points	Oil and Grease (mg/L)		Total Suspended (mg/L)		Sea urchin fertilisation (EC50)		Aluminium (µg/L)		Copper (µg/L)		Chlorpyrifos (µg/L)		Nonylphenol ethoxylate (µg/L)		Unionised H_2S (µg/L)	
		50th %-ile	90th %-ile	50th %-ile	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	90th %-ile	Average	90th %-ile
North Head	NH0008 (C), (G)	55	70	200	250	0.24	0.13	890	1700	160	300	0.09	0.2	178	253	143	270
Bondi	BN0005 (C), (G)	55	70	200	250	0.27	0.16	430	565					179	272	250	510
Malabar	MA0006 (C), (G)	55	70	250	300	0.19	0.1	885	1837					332	515	187	580

Table E-2 EPL load limits for the offshore discharging WRRFs (2023-24)

Load limits (in kg) 2023-24	North Head	Bondi	Malabar
Total Nitrogen	7,957,000	3,832,500	13,231,250
Total Phosphorus	1,909,680	766,500	2,646,250
Biological Oxygen Demand	35,010,800	16,863,000	58,217,500
Total Suspended Solids	35,010,800	11,497,500	47,632,500
Oil & Grease	9,968,880	3,066,000	9,261,875
Cadmium	283	117	301
Chromium	3,011	537	10,804
Copper	37,583	19,760	43,610
Lead	3,568	1,616	5,615
Mercury	60	37	103
Selenium	2,387	1,150	3,969
Zinc	51,066	20,346	59,761
Pesticides	370	62	340

E.5. Ocean receiving water quality

Out of 11 chemicals assessed in 2023-24, modelled total nitrogen, total phosphorus, aluminium and copper concentrations in the receiving waters in the initial dilution zones of the deepwater ocean outfalls exceeded the ANZG (2018) guideline values for the protection of 95% of marine species. Modelled concentrations of total nitrogen and total phosphorus exceeded guideline values of 0.12 mg/L and 0.02 mg/L respectively, for the lower dilution scenario at all three deepwater ocean outfalls. Modelled concentrations of aluminium exceeded the guideline value of 0.5 ug/L at all three deepwater ocean outfalls for both modelled dilution scenarios except for the higher dilution scenario at Bondi. Modelled concentrations of copper exceeded the guideline value of 1.3 ug/L at North Head and Malabar deepwater ocean outfalls (Table E-3 to Table E-5).

Table E-3 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the SWAM (financial years) to ANZG (2018) guideline values for North Head WRRF

North Head		Chemical concentration										
		mg/L		µg/L								
		total nitrogen	total phosphorus	aluminium	cadmium	chromium	copper	mercury	lead	zinc	endosulphan	chlorpyrifos
Guideline 95th %ile for protection of marine species		0.12	0.02	0.5	5.5	10*	1.3	0.4	4.4	8	0.01	0.009
2023-24 undiluted wastewater average value		52	6.6	530	0.1	5.1	120	0.03	3.4	110	0.01	0.05
Dilution exceeded 98% of time	73:1	0.7	0.09	7.3	0.001	0.07	1.6	0.0004	0.05	1.6	0.0001	0.0007
Dilution exceeded 10% of time	700:1	0.07	0.009	0.8	0.0001	0.007	0.2	0.00004	0.005	0.2	0.00001	0.00007
2022-23 undiluted wastewater average value					0.1	7.9	95	0.06	3.3	99	0.01	0.05
Dilution exceeded 98% of time	75:1	-	-	-	0.001	0.1	1.3	0.0008	0.04	1.3	0.0001	0.0007
Dilution exceeded 10% of time	847:1	-	-	-	0.0001	0.009	0.1	0.00007	0.004	0.1	0.00001	0.00006
2021-22 undiluted wastewater average value					<0.1	7.8	112	0.03	2.4	124	0.01	0.05
Dilution exceeded 98% of time	65:1	-	-	-	0.002	0.12	1.7	0.0005	0.04	1.9	0.0002	0.0008
Dilution exceeded 10% of time	773:1	-	-	-	0.0001	0.01	0.1	0.00004	0.003	0.2	0.00001	0.00006
2020-21 undiluted wastewater average value					<0.1	5.9	128	0.06	2.9	116	<0.01	<0.05
Dilution exceeded 98% of time	64:1	-	-	-	0.002	0.09	2	0.0009	0.05	1.8	0.0002	0.0008
Dilution exceeded 10% of time	727:1	-	-	-	0.0001	0.008	0.2	0.00008	0.004	0.2	0.00001	0.00007
2019-20 undiluted wastewater average value					<0.1	5.4	132	0.03	2.6	129	<0.01	<0.05
Dilution exceeded 98% of time	78:1	-	-	-	0.001	0.07	1.7	0.0004	0.03	1.7	0.0001	0.0006
Dilution exceeded 10% of time	649:1	-	-	-	0.0002	0.008	0.2	0.00005	0.004	0.2	0.00002	0.00008
2018-19 undiluted wastewater average value					0.1	6.3	135	0.04	2.5	114	<0.01	<0.05
Dilution exceeded 98% of time	69:1	-	-	-	0.002	0.09	1.9	0.0006	0.04	1.6	0.0001	0.0007
Dilution exceeded 10% of time	685:1	-	-	-	0.0002	0.009	0.2	0.00006	0.004	0.2	0.00001	0.00007
2017-18 undiluted wastewater average value					0.1	7.4	123	0.05	3	115	<0.01	<0.05
Dilution exceeded 98% of time	92:1	-	-	-	0.001	0.08	1.3	0.0005	0.03	1.3	0.0001	0.0005
Dilution exceeded 10% of time	1245:1	-	-	-	0.00008	0.006	0.1	0.00004	0.002	0.1	0.00001	0.00004
2016-17 undiluted wastewater average value					0.1	5.3	111	0.05	2.8	109	<0.01	<0.05
Dilution exceeded 98% of time	68:1	-	-	-	0.002	0.1	1.6	0.0007	0.04	1.6	0.0001	0.0007
Dilution exceeded 10% of time	712:1	-	-	-	0.0002	0.007	0.2	0.00007	0.004	0.2	0.00001	0.00007
2015-16 undiluted wastewater average value					0.2	8.8	111	0.04	2.9	102	<0.01	<0.05
Dilution exceeded 98% of time	71:1	-	-	-	0.002	0.1	1.6	0.0006	0.04	1.4	0.0001	0.0007
Dilution exceeded 10% of time	421:1	-	-	-	0.0004	0.02	0.3	0.0001	0.007	0.2	0.00002	0.0001
2014-15 undiluted wastewater average value					0.2	6.3	138	0.1	3.5	127	<0.01	<0.05
Dilution exceeded 98% of time	85:1	-	-	-	0.002	0.07	1.6	0.001	0.04	1.5	0.0001	0.0006
Dilution exceeded 10% of time	873:1	-	-	-	0.0002	0.007	0.2	0.0001	0.004	0.15	0.00001	0.00006
2013-14 undiluted wastewater average value					0.2	3.8	104	0.2	2.6	109	<0.01	<0.05
Dilution exceeded 98% of time	72:1	-	-	-	0.003	0.05	1.4	0.003	0.04	1.5	0.0001	0.0007
Dilution exceeded 10% of time	690:1	-	-	-	0.0003	0.01	0.2	0.0004	0.004	0.16	0.00001	0.00007
2012-13 undiluted wastewater average value					0.2	6.3	101	0.08	3.7	115	<0.01	<0.05
Dilution exceeded 98% of time	84:1	-	-	-	0.002	0.08	1.2	0.001	0.04	1.4	0.0001	0.0006
Dilution exceeded 10% of time	713:1	-	-	-	0.0004	0.01	0.1	0.0001	0.005	0.2	0.00001	0.0001
2011-12 undiluted wastewater average value					0.4	4.1	79	0.09	3.6	109	<0.01	<0.05
Dilution exceeded 98% of time	81:1	-	-	-	0.005	0.05	1	0.001	0.04	1.3	0.0001	0.0006
Dilution exceeded 10% of time	818:1	-	-	-	0.0005	0.005	0.1	0.0001	0.004	0.1	0.00001	0.00006
2010-11 undiluted wastewater average value					0.4	5.3	96	0.2	3.6	130	<0.01	<0.05
Dilution exceeded 98% of time	73:1	-	-	-	0.006	0.07	1.3	0.003	0.05	1.8	0.0001	0.0007
Dilution exceeded 10% of time	595:1	-	-	-	0.0006	0.009	0.2	0.0003	0.006	0.2	0.00002	0.00008
2009-10 undiluted wastewater average value					0.4	6.2	99	0.2	4.6	122	<0.01	<0.05
Dilution exceeded 98% of time	68:1	-	-	-	0.006	0.09	1.4	0.003	0.07	1.8	0.0001	0.0007
Dilution exceeded 10% of time	798:1	-	-	-	0.0005	0.008	0.1	0.0003	0.006	0.2	0.00001	0.00006
2008-09 undiluted wastewater average value					0.4	5.8	96	0.1	4.9	121	<0.01	<0.05
Dilution exceeded 98% of time	82:1	-	-	-	0.005	0.07	1.2	0.001	0.06	1.5	0.0001	0.0006
Dilution exceeded 10% of time	774:1	-	-	-	0.0005	0.007	0.1	0.0001	0.006	0.2	0.00001	0.00006

** High reliability trigger value for chromium VI*

Blue shading indicates value exceeds ANZG (2018) guideline value

Table E-4 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the SWAM (financial years) to ANZG (2018) guideline values for Bondi WRRF

Bondi		Chemical concentration										
		mg/L		µg/L								
		total nitrogen	total phosphorus	aluminium	cadmium	chromium	copper	mercury	lead	zinc	endosulphan	chlorpyrifos
Guideline 95th %ile for protection of marine species		0.12	0.02	0.5	5.5	27.4	1.3	0.4	4.4	15	0.01	0.009
2023-24 undiluted wastewater average value		53	6.2	210	0.1	2.2	100	0.03	4.6	80	0.01	0.06
Dilution exceeded 98% of time	100:1	0.5	0.06	2.1	0.001	0.02	1	0.0003	0.05	0.8	0.0001	0.0006
Dilution exceeded 10% of time	1165:1	0.05	0.005	0.2	0.00009	0.002	0.09	0.00002	0.004	0.07	0.000009	0.00005
2022-23 undiluted wastewater average value					0.1	1.2	110	0.01	2.3	82	0.01	0.05
Dilution exceeded 98% of time	101:1	-	-	-	0.001	0.01	1.1	0.0001	0.02	0.8	0.0001	0.0005
Dilution exceeded 10% of time	1510:1	-	-	-	0.00007	0.0008	0.07	0.000007	0.002	0.05	0.000007	0.00003
2021-22 undiluted wastewater average value					0.1	1.8	124	0.02	3.1	90	0.01	0.05
Dilution exceeded 98% of time	92:1	-	-	-	0.001	0.02	1.3	0.0002	0.03	1	0.0001	0.0005
Dilution exceeded 10% of time	1271:1	-	-	-	0.0001	0.001	0.1	0.00002	0.002	0.1	0.00001	0.00004
2020-21 undiluted wastewater average value					0.1	1.5	127	0.02	3.1	105	<0.01	<0.05
Dilution exceeded 98% of time	89:1	-	-	-	0.001	0.02	1.4	0.0002	0.03	1.2	0.0001	0.0006
Dilution exceeded 10% of time	1323:1	-	-	-	0.0001	0.001	0.1	0.00002	0.002	0.1	0.00001	0.00004
2019-20 undiluted wastewater average value					<0.1	1.6	118	0.02	2.9	101	<0.01	<0.05
Dilution exceeded 98% of time	105:1	-	-	-	0.001	0.02	1.1	0.0002	0.03	1	0.0001	0.0005
Dilution exceeded 10% of time	978:1	-	-	-	0.0001	0.002	0.1	0.00002	0.003	0.1	0.00001	0.00005
2018-19 undiluted wastewater average value					0.1	1.58	152	0.03	3	113	<0.01	<0.05
Dilution exceeded 98% of time	93:1	-	-	-	0.001	0.02	1.6	0.0004	0.03	1.2	0.0001	0.0005
Dilution exceeded 10% of time	1007:1	-	-	-	0.0001	0.002	0.2	0.00003	0.003	0.1	0.00001	0.00005
2017-18 undiluted wastewater average value					0.1	1.83	148	0.05	3.98	109	<0.01	<0.05
Dilution exceeded 98% of time	114:1	-	-	-	0.0009	0.02	1.3	0.0004	0.03	1	0.0001	0.0004
Dilution exceeded 10% of time	1711:1	-	-	-	0.00006	0.001	0.1	0.00003	0.002	0.06	0.00001	0.00003
2016-17 undiluted wastewater average value					<0.1	2.4	130	0.04	3.1	105	<0.01	<0.05
Dilution exceeded 98% of time	89:1	-	-	-	0.001	0.03	1.5	0.0004	0.03	1.2	0.0001	0.001
Dilution exceeded 10% of time	1018:1	-	-	-	0.0001	0.002	0.1	0.00004	0.003	0.1	0.00001	0.00005
2015-16 undiluted wastewater average value					0.1	2.3	152	0.03	4.1	108	<0.01	<0.05
Dilution exceeded 98% of time	92:1	-	-	-	0.001	0.02	1.6	0.0004	0.04	1.2	0.0001	0.0005
Dilution exceeded 10% of time	623:1	-	-	-	0.0002	0.004	0.2	0.00005	0.007	0.2	0.00002	0.00008
2014-15 undiluted wastewater average value					0.2	1.5	121	0.1	3.6	108	<0.01	<0.05
Dilution exceeded 98% of time	111:1	-	-	-	0.001	0.01	1.1	0.001	0.03	1	0.00009	0.0005
Dilution exceeded 10% of time	1522:1	-	-	-	0.0001	0.001	0.08	0.00007	0.002	0.07	0.000007	0.00003
2013-14 undiluted wastewater average value					0.1	1.1	120	0.07	3.6	106	<0.01	<0.05
Dilution exceeded 98% of time	89:1	-	-	-	0.001	0.01	1.3	0.001	0.04	1.2	0.0001	0.0006
Dilution exceeded 10% of time	943:1	-	-	-	0.0001	0.001	0.1	0.0001	0.004	0.1	0.00001	0.00005
2012-13 undiluted wastewater average value					0.3	2.3	125	0.09	5.4	123	<0.01	<0.05
Dilution exceeded 98% of time	102:1	-	-	-	0.003	0.02	1.2	0.001	0.05	1.2	0.0001	0.0005
Dilution exceeded 10% of time	1033:1	-	-	-	0.0003	0.002	0.1	0.0001	0.005	0.1	0.00001	0.0001
2011-12 undiluted wastewater average value					0.2	1.6	110	0.06	5.1	102	<0.01	<0.05
Dilution exceeded 98% of time	104:1	-	-	-	0.002	0.02	1.1	0.001	0.05	1	0.0001	0.0005
Dilution exceeded 10% of time	1353:1	-	-	-	0.0001	0.001	0.08	0.00004	0.004	0.08	0.00001	0.00004
2010-11 undiluted wastewater average value					0.1	1.8	113	<0.1	3.5	104	<0.01	<0.05
Dilution exceeded 98% of time	93:1	-	-	-	0.001	0.02	1.2	0.001	0.04	1.1	0.0001	0.0005
Dilution exceeded 10% of time	917:1	-	-	-	0.0001	0.002	0.1	0.0001	0.004	0.1	0.00001	0.00005
2009-10 undiluted wastewater average value					0.2	1.8	110	<0.1	4.4	102	<0.01	<0.05
Dilution exceeded 98% of time	86:1	-	-	-	0.002	0.02	1.3	0.001	0.05	1.2	0.0001	0.0006
Dilution exceeded 10% of time	1233:1	-	-	-	0.0002	0.001	0.1	0.00008	0.004	0.08	0.000008	0.00004
2008-09 undiluted wastewater average value					0.1	2.3	118	<0.1	4.7	106	<0.01	<0.05
Dilution exceeded 98% of time	108:1	-	-	-	0.001	0.02	1.1	0.001	0.04	1	0.0001	0.0005
Dilution exceeded 10% of time	1271:1	-	-	-	0.00008	0.002	0.09	0.00008	0.004	0.08	0.000008	0.00004

** High reliability trigger value for chromium VI*

Blue shading indicates value exceeds ANZG (2018) guideline value

Table E-5 Comparison of modelled chemical concentrations near the deepwater ocean outfalls for the SWAM (financial years) to ANZG (2018) guideline values for Malabar WRRF

Malabar		Chemical concentration										
		mg/L		µg/L								
		total nitrogen	total phosphorus	aluminium	cadmium	chromium	copper	mercury	lead	zinc	endosulphan	chlorpyrifos
Guideline 95th %ile for protection of marine species		0.12	0.02	0.5	5.5	27.4	1.3	0.4	4.4	15	0.01	0.009
2023-24 undiluted wastewater average value		49	6.3	740	0.2	5.6	93	0.04	4.7	110	0.01	0.2
Dilution exceeded 98% of time	67:1	0.7	0.09	11	0.004	0.08	1.4	0.0007	0.07	1.6	0.0001	0.003
Dilution exceeded 10% of time	487:1	0.1	0.01	1.5	0.0005	0.01	0.2	0.00009	0.01	0.2	0.00002	0.0005
2022-23 undiluted wastewater average value					0.3	8.5	85	0.02	3.3	98	0.01	0.4
Dilution exceeded 98% of time	65:1	-	-	-	0.004	0.1	1.3	0.0002	0.05	1.5	0.0002	0.006
Dilution exceeded 10% of time	632:1	-	-	-	0.0005	0.01	0.1	0.00002	0.005	0.2	0.00002	0.0007
2021-22 undiluted wastewater average value					0.2	6.9	79	0.02	3.2	97	0.01	0.07
Dilution exceeded 98% of time	58:1	-	-	-	0.003	0.12	1.4	0.0003	0.06	1.7	0.0002	0.0012
Dilution exceeded 10% of time	575:1	-	-	-	0.0003	0.012	0.1	0.00003	0.006	0.2	0.00002	0.00012
2020-21 undiluted wastewater average value					0.3	7.3	90	0.04	3.7	103	<0.01	0.08
Dilution exceeded 98% of time	61:1	-	-	-	0.005	0.12	1.5	0.0007	0.06	1.7	0.0002	0.0013
Dilution exceeded 10% of time	589:1	-	-	-	0.0005	0.012	0.2	0.00007	0.006	0.2	0.00002	0.00014
2019-20 undiluted wastewater average value					0.2	7.4	100	0.02	3.6	116	<0.01	<0.05
Dilution exceeded 98% of time	70:1	-	-	-	0.003	0.11	1.4	0.0003	0.05	1.7	0.0001	0.0007
Dilution exceeded 10% of time	426:1	-	-	-	0.0005	0.017	0.2	0.00005	0.008	0.3	0.00002	0.00012
2018-19 undiluted wastewater average value					0.1	9.1	98	0.2	2.7	99	<0.01	<0.05
Dilution exceeded 98% of time	64:1	-	-	-	0.002	0.1	1.5	0.003	0.04	1.6	0.0002	0.0008
Dilution exceeded 10% of time	470:1	-	-	-	0.0002	0.02	0.2	0.0003	0.006	0.2	0.00002	0.0001
2017-18 undiluted wastewater average value					0.2	9	105	0.05	3.9	111	<0.01	<0.05
Dilution exceeded 98% of time	68:1	-	-	-	0.003	0.1	1.5	0.0007	0.06	1.6	0.0001	0.0007
Dilution exceeded 10% of time	824:1	-	-	-	0.0002	0.01	0.1	0.00006	0.005	0.1	0.00001	0.00006
2016-17 undiluted wastewater average value					0.3	8.1	103	0.04	4	118	<0.01	0.124
Dilution exceeded 98% of time	56:1	-	-	-	0.004	0.1	1.8	0.0008	0.07	2.1	0.0002	0.002
Dilution exceeded 10% of time	515:1	-	-	-	0.0005	0.02	0.2	0.0001	0.008	0.2	0.00002	0.0002
2015-16 undiluted wastewater average value					0.2	6.8	91	0.13	4.8	92	<0.01	<0.05
Dilution exceeded 98% of time	55:1	-	-	-	0.004	0.1	1.7	0.002	0.09	1.7	0.0002	0.0009
Dilution exceeded 10% of time	244:1	-	-	-	0.0009	0.03	0.4	0.0005	0.02	0.4	0.00004	0.0002
2014-15 undiluted wastewater average value					0.1	6.5	78	0.03	3.3	94	<0.01	<0.05
Dilution exceeded 98% of time	70:1	-	-	-	0.002	0.09	1.1	0.0004	0.05	1.3	0.0001	0.0007
Dilution exceeded 10% of time	665:1	-	-	-	0.0002	0.01	0.1	0.00005	0.005	0.1	0.00002	0.00008
2013-14 undiluted wastewater average value					0.2	9.3	80	0.05	3.3	102	<0.01	<0.05
Dilution exceeded 98% of time	56:1	-	-	-	0.004	0.17	1.4	0.001	0.06	1.8	0.0002	0.0009
Dilution exceeded 10% of time	478:1	-	-	-	0.0004	0.02	0.2	0.0001	0.01	0.2	0.00002	0.0001
2012-13 undiluted wastewater average value					0.2	6	74	0.07	4.3	97	<0.01	<0.05
Dilution exceeded 98% of time	65:1	-	-	-	0.003	0.09	1.1	0.001	0.07	1.5	0.0002	0.0008
Dilution exceeded 10% of time	507:1	-	-	-	0.0003	0.01	0.1	0.0001	0.01	0.2	0.00002	0.0001
2011-12 undiluted wastewater average value					0.2	7.8	74	0.06	4.2	107	<0.01	<0.05
Dilution exceeded 98% of time	68:1	-	-	-	0.003	0.11	1.1	0.001	0.06	1.6	0.0001	0.0007
Dilution exceeded 10% of time	578:1	-	-	-	0.0003	0.01	0.1	0.0001	0.007	0.2	0.00002	0.00009
2010-11 undiluted wastewater average value					0.1	7.8	59	<0.1	2.7	86	<0.01	<0.05
Dilution exceeded 98% of time	55:1	-	-	-	0.002	0.14	1.1	0.002	0.05	1.6	0.0002	0.0009
Dilution exceeded 10% of time	448:1	-	-	-	0.0002	0.02	0.1	0.0002	0.006	0.2	0.00002	0.0001
2009-10 undiluted wastewater average value					0.3	10.2	67	<0.1	13.3	86	<0.01	<0.05
Dilution exceeded 98% of time	55:1	-	-	-	0.005	0.19	1.2	0.002	0.24	1.6	0.0002	0.0009
Dilution exceeded 10% of time	551:1	-	-	-	0.0005	0.02	0.1	0.0002	0.02	0.2	0.00002	0.00009
2008-09 undiluted wastewater average value					0.2	7	68	<0.1	4.1	90	<0.01	<0.05
Dilution exceeded 98% of time	67:1	-	-	-	0.003	0.1	1	0.001	0.06	1.3	0.0001	0.0007
Dilution exceeded 10% of time	550:1	-	-	-	0.0004	0.01	0.1	0.0002	0.007	0.2	0.00002	0.00009

** High reliability trigger value for chromium VI*

Blue shading indicates value exceeds ANZG (2018) guideline value

E.6. Ocean sediment quality and ecosystem health

Approximately 80% of Sydney's wastewater is treated at the North Head, Bondi and Malabar WWRFs and discharged through three deepwater ocean outfalls located between 2 and 4 km offshore, in waters between 65-80 m deep. As a general description, these deepwater ocean outfalls discharge wastewater through multiple diffusers that spread it over 500 to 750 m, which achieves rapid dilution that approximately ranges from design targets of 300:1 to 500:1, depending on oceanographic conditions and the diffuser field. The purpose of the diffusers is to release wastewater into the ocean at volumes that are unlikely to be toxic once mixing has occurred. The distance from the discharge point to the boundary of the initial dilution zone varies considerably, depending on ocean and discharge conditions. It is defined to occur when the vertical momentum and buoyancy of the wastewater are the same as that of the surrounding water. The initial dilution zone is also referred to as the initial mixing zone or the end of the near-field.

E.6.1. Offshore marine sediment quality

For the 2023-24 'surveillance' year, results were obtained from the analytes measured at both sites (1 and 2) of the six locations listed in Table E-6.

Table E-6 Locations and analytes measured in 2023-24

Sites 1 and 2 of locations	Analytes measured
Bondi Long Reef Marley Beach Port Hacking	Total Organic Carbon Sediment grain size Total acid extractable metals
Malabar 0km North Head	Total Organic Carbon Sediment grain size Total acid extractable metals Nutrients – TKN and TP Organic compounds – PAHs, pesticides and PCBs

Coordinates for the grid centre for each site of the nine locations of the study are provided in Table . Actual geographical coordinates of each sample collected in the 2023-24 surveillance year from sites 1 and 2 for each of the six locations are listed in Table .

Sediment grain size analyses were undertaken on sediment samples from all sites. Results for sediment granulometry size classes were calculated for <0.063 mm (%), >0.063 mm (%) and >2.0 mm (%) categories. Summary statistics including mean and standard deviation are presented in Table 7 with all raw data presented in Table E-8. Levels were similar to those seen in past years (Figure E-1).

Table E-7 Summary statistics of TOC and sediment grain size measured in 2023-24

Sites	TOC %		<0.063mm		>0.063mm		>2.0mm	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Long Reef 1	0.3	0.1	4.0	1.4	92.7	5.6	3.2	5.6
Long Reef 2	0.4	0.2	4.8	2.1	71.6	19.7	23.6	21.2
North Head 1	0.3	0.1	4.3	1.1	91.5	5.0	4.2	4.5
North Head 2	0.6	0.5	4.7	2.3	90.3	5.2	5.0	3.2
Bondi 1	0.5	0.2	4.5	1.4	94.9	1.6	0.6	0.3
Bondi 2	0.6	0.2	5.5	3.2	94.0	3.3	0.4	0.3
Malabar 0km 1	0.6	0.2	8.1	2.4	90.5	2.4	1.3	0.2
Malabar 0km 2	0.3	0.1	6.1	1.7	92.1	1.5	1.8	1.0
Port Hacking 1	0.6	0.1	10.6	1.7	89.0	1.6	0.4	0.2
Port Hacking 2	0.6	0.1	10.5	1.5	88.1	3.2	1.3	1.8
Marley Beach 1	0.6	0.1	13.0	1.7	86.5	1.7	0.4	0.3
Marley Beach 2	0.7	0.1	11.4	0.6	87.6	0.8	1.0	0.8

Table E-8 TOC and sediment grain size for each sample measured in 2023-24

Site description		TOC	<0.063 mm	>0.063 mm	>2.0 mm
	Replicate	%	%	%	%
Long Reef 1	1	0.20	3.38	95.1	1.52
Long Reef 1	2	0.17	3.26	96.3	0.44
Long Reef 1	3	0.42	3.75	83.0	13.2
Long Reef 1	4	0.25	3.15	96.3	0.56
Long Reef 1	5	0.29	6.52	93.0	0.47
Long Reef 2	1	0.44	4.58	86.2	9.17
Long Reef 2	2	0.21	2.55	42.6	54.8
Long Reef 2	3	0.64	8.28	85.6	6.08
Long Reef 2	4	0.23	4.44	84.0	11.5
Long Reef 2	5	0.30	3.99	59.4	36.6
North Head 1	1	0.31	5.22	82.6	12.1
North Head 1	2	0.53	5.61	93.1	1.28
North Head 1	3	0.23	3.71	94.2	2.09
North Head 1	4	0.20	3.40	92.6	3.96
North Head 1	5	0.20	3.39	94.8	1.81
North Head 2	1	1.07	4.67	89.0	6.29

Site description		TOC	<0.063 mm	>0.063 mm	>2.0 mm
	Replicate	%	%	%	%
North Head 2	2	0.23	2.99	96.0	1.00
North Head 2	3	0.46	6.52	88.5	4.97
North Head 2	4	0.14	1.83	94.9	3.30
North Head 2	5	1.08	7.25	83.3	9.45
Bondi 1	1	0.25	4.38	95.1	0.49
Bondi 1	2	0.54	4.82	94.4	0.80
Bondi 1	3	0.32	4.15	95.3	0.57
Bondi 1	4	0.53	2.59	97.1	0.29
Bondi 1	5	0.79	6.43	92.6	0.95
Bondi 2	1	0.44	4.26	95.6	0.14
Bondi 2	2	0.96	11.2	88.2	0.59
Bondi 2	3	0.41	2.97	96.4	0.66
Bondi 2	4	0.59	4.91	94.5	0.63
Bondi 2	5	0.37	4.30	95.5	0.16
Malabar 0 km 1	1	0.69	8.33	90.6	1.08
Malabar 0 km 1	2	0.64	7.32	91.5	1.14
Malabar 0 km 1	3	0.76	11.1	87.2	1.65
Malabar 0 km 1	4	0.26	4.71	93.8	1.47
Malabar 0 km 1	5	0.70	9.27	89.5	1.22
Malabar 0 km 2	1	0.47	7.89	90.7	1.44
Malabar 0 km 2	2	0.52	8.06	90.8	1.15
Malabar 0 km 2	3	0.31	5.04	93.9	1.05
Malabar 0 km 2	4	0.21	4.74	93.6	1.66
Malabar 0 km 2	5	0.22	4.91	91.5	3.57
Port Hacking 1	1	0.66	10.2	89.4	0.33
Port Hacking 1	2	0.61	9.48	89.8	0.74
Port Hacking 1	3	0.51	8.96	90.7	0.31
Port Hacking 1	4	0.70	13.3	86.5	0.17
Port Hacking 1	5	0.63	11.2	88.6	0.22
Port Hacking 2	1	0.47	12.8	82.7	4.52
Port Hacking 2	2	0.54	9.37	90.2	0.40
Port Hacking 2	3	0.65	9.70	89.8	0.55
Port Hacking 2	4	0.66	9.57	90.0	0.46
Port Hacking 2	5	0.50	11.3	88.0	0.67

Site description		TOC	<0.063 mm	>0.063 mm	>2.0 mm
	Replicate	%	%	%	%
Marley Beach 1	1	0.58	13.9	85.6	0.46
Marley Beach 1	2	0.62	14.0	85.3	0.75
Marley Beach 1	3	0.82	14.6	85.1	0.24
Marley Beach 1	4	0.62	10.4	88.9	0.65
Marley Beach 1	5	0.59	12.3	87.6	0.14
Marley Beach 2	1	0.79	12.3	87.1	0.65
Marley Beach 2	2	0.63	10.8	86.8	2.31
Marley Beach 2	3	0.59	10.9	88.4	0.62
Marley Beach 2	4	0.65	11.8	87.1	1.15
Marley Beach 2	5	0.66	11.2	88.6	0.29

In 2023-24, the TOC % content for all ten samples collected from the Malabar 0 km location was less than the EPA specified 99th percentile trigger value of 1.2%. No specific trigger value has been set for either Bondi or North Head.

TOC % content was also less than 1.2% for all ten samples collected from North Head and Bondi. Over the 2001 to 2024 period, 23 TOC values were recorded from a total of 1587 samples to exceed 1.2% across a few of the nine locations – Malabar 3 km, 5 km and 7 km are sampled in assessment years (Table E-9). The most recent exceedance was in 2020. This suggests that the values recorded in previous years may be examples of the higher variability seen from time to time, rather than an indication of TOC build up and subsequent anoxic conditions around this deepwater outfall. High anoxia conditions would be more likely to impact benthic community structure.

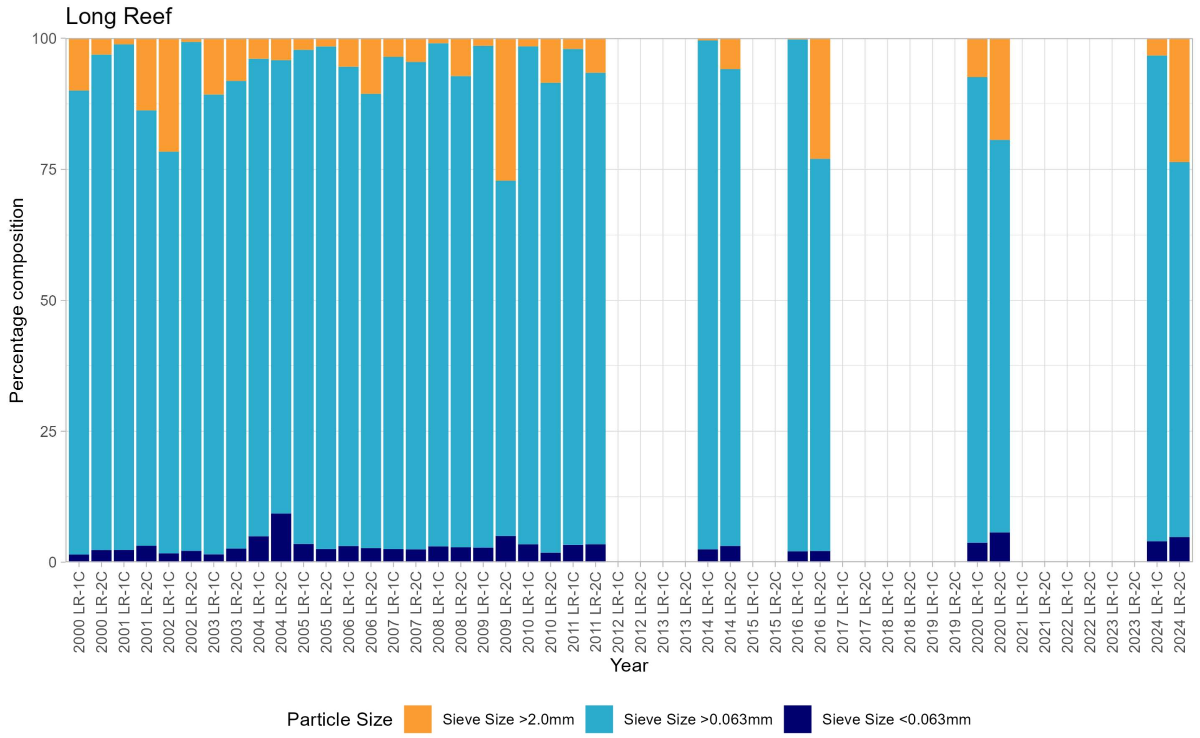
These TOC results suggest the prevailing currents that induce sediment movement and move effluent plumes away from the diffuser arrays, have contributed to the low anoxia conditions in the benthic sediments around the diffuser arrays.

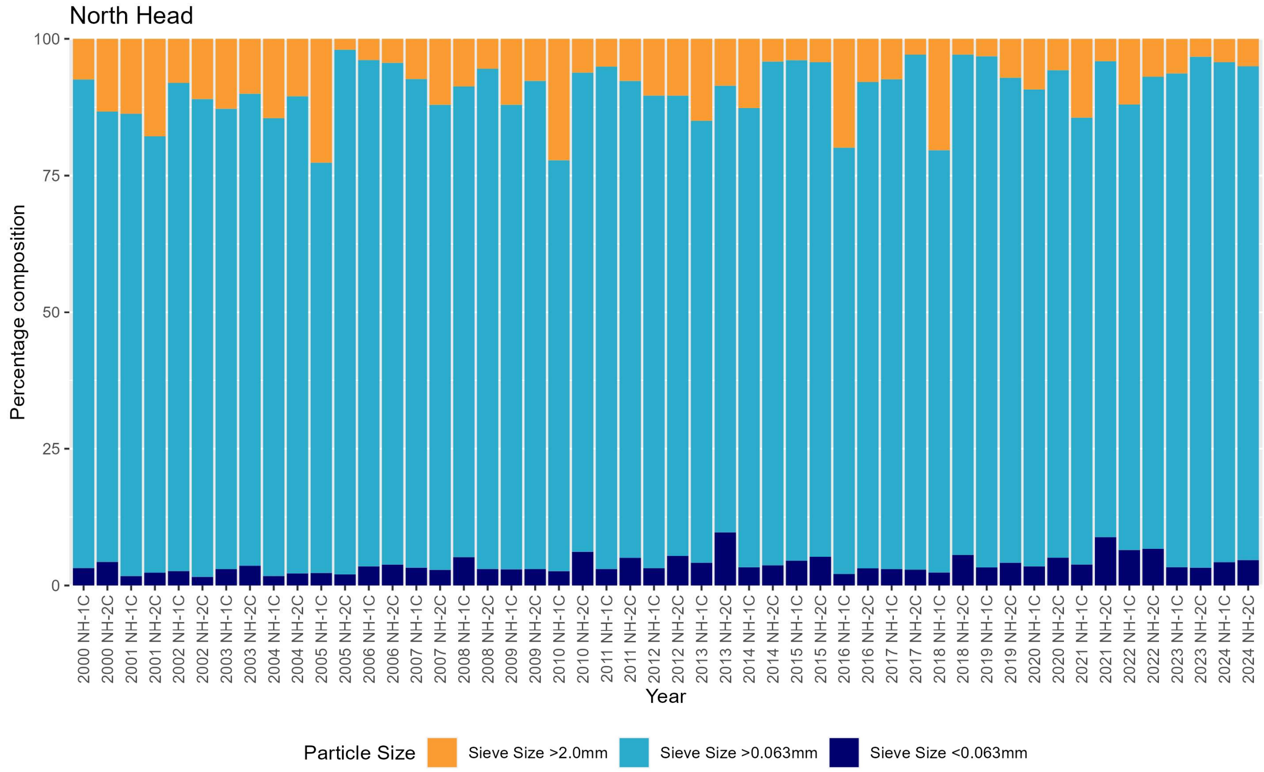
The average levels of fine sediments observed in 2023-24 were similar to those seen in past years, with no apparent build-up of fine particles (<0.063 mm) at all six locations (Figure E-1). This suggests that metal concentrations in the sediment were unlikely to have increased at the North Head, Bondi, and Malabar 0 km deepwater outfall locations.

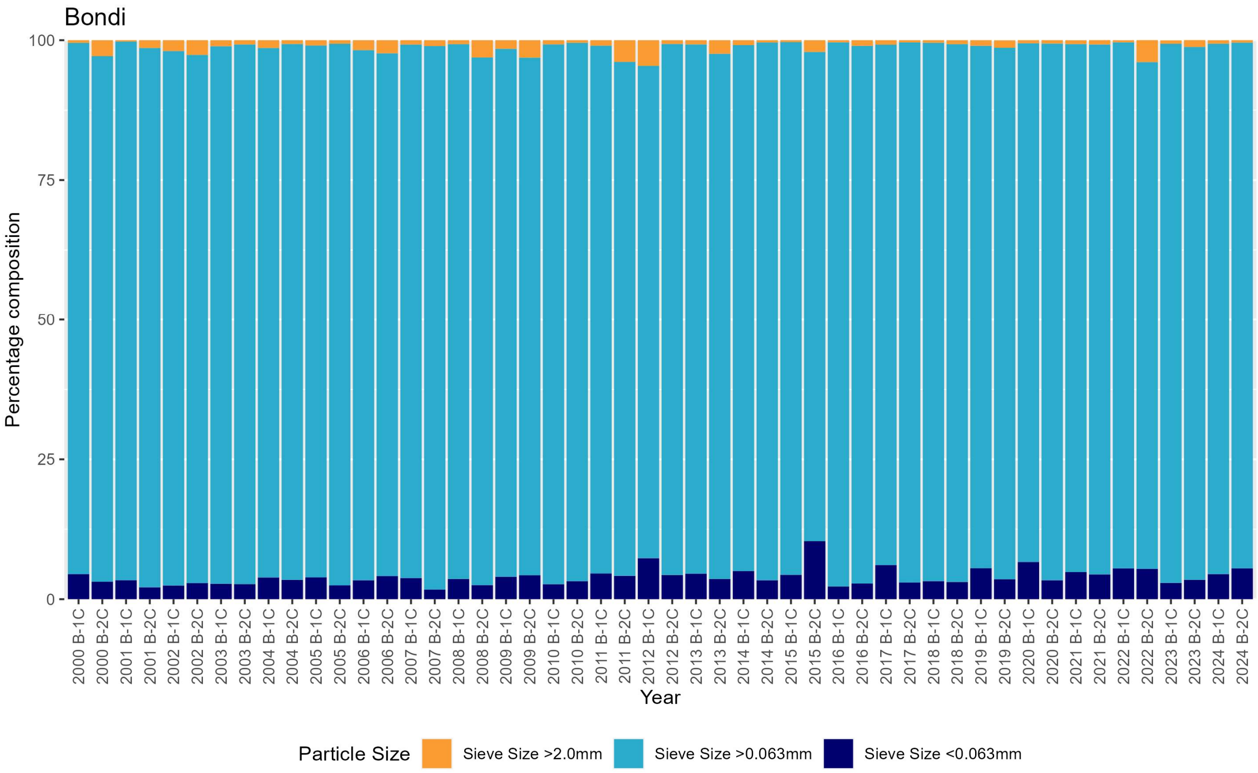
With high levels of anoxia unlikely, together with the probable lack of build-up in chemical concentrations in the fine sediments, the benthic community structure of the Malabar 0 km location was unlikely to have changed beyond the levels recorded in past assessment years. A check of the 2023-24 benthic community structure was made next to see if it was similar to past assessment years.

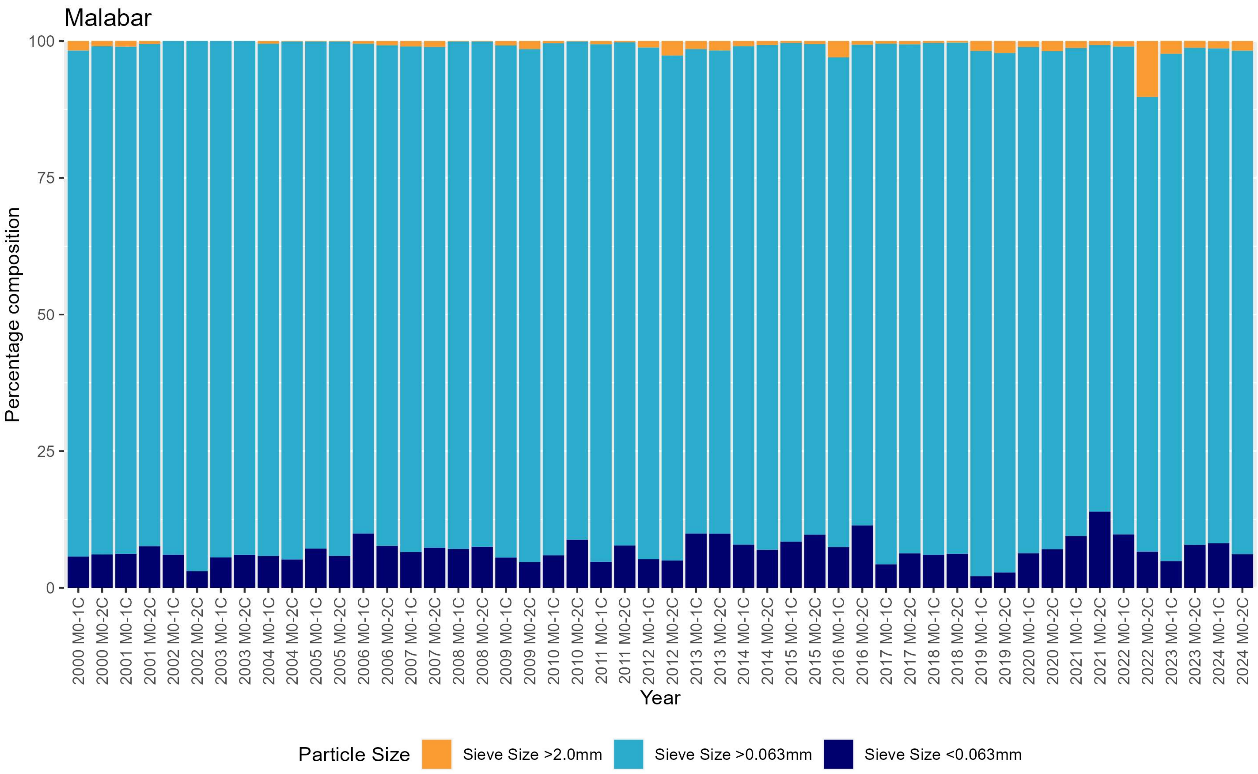
Table E-9 TOC % replicate values equal or above 1.2% content from 2001 to 2024

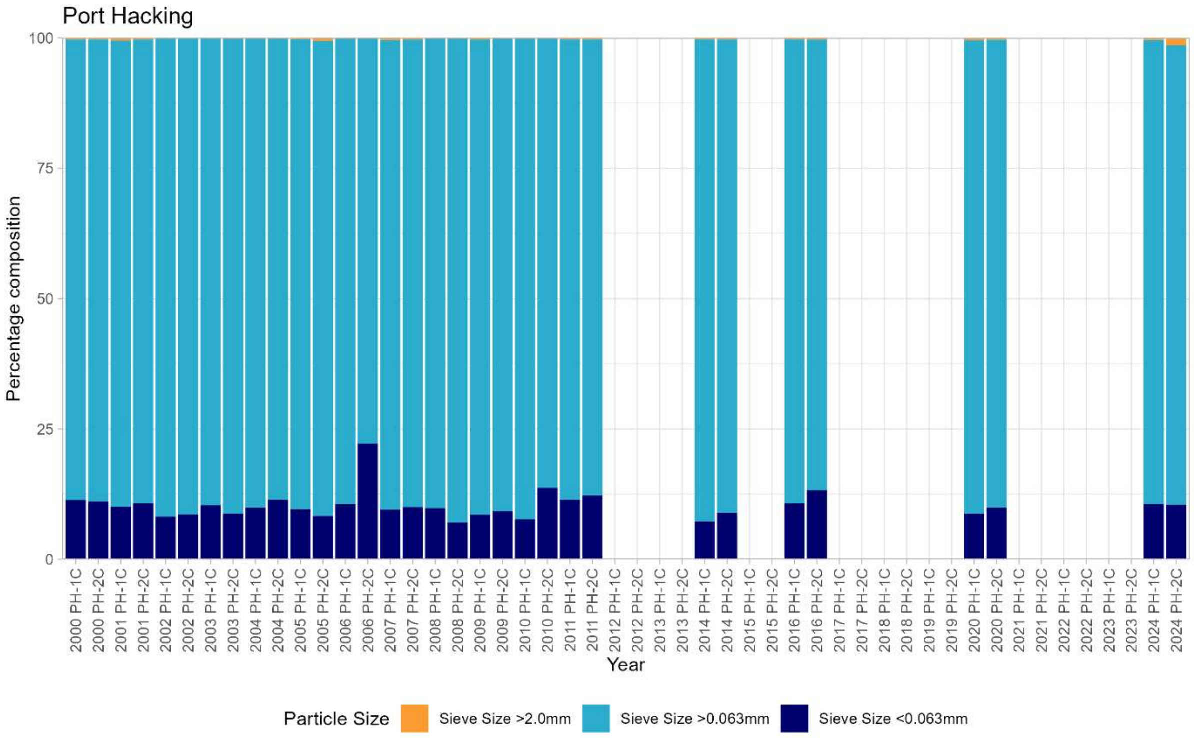
Year	Location	TOC %
2002	North Head outfall	1.5
2002	North Head outfall	1.9
2002	Long Reef reference	4.4
2003	North Head outfall	1.3
2003	Long Reef reference	1.5
2003	Long Reef reference	1.3
2005	Long Reef reference	1.9
2005	Long Reef reference	1.6
2005	Long Reef reference	1.8
2006	Bondi outfall	1.5
2006	Malabar 7 km	1.8
2007	North Head outfall	1.4
2009	Malabar 7 km	3.5
2011	North Head outfall	3.5
2016	Malabar 0 km outfall	1.2
2015	Bondi outfall	2.0
2017	North Head outfall	1.7
2017	North Head outfall	1.6
2018	North Head outfall	1.2
2018	North Head outfall	1.4
2020	Long Reef reference	1.4
2020	Malabar 5 km	1.9
2020	Malabar 7 km	1.2


Long Reef
Percentage composition
Year
Particle Size
Sieve Size >2.0mm
Sieve Size >0.063mm
Sieve Size <0.063mm


North Head
Percentage composition
Year
Particle Size
Sieve Size >2.0mm
Sieve Size >0.063mm
Sieve Size <0.063mm


Bondi
Percentage composition
Year
Particle Size
Sieve Size >2.0mm
Sieve Size >0.063mm
Sieve Size <0.063mm


Malabar
Percentage composition
Year
Particle Size
Sieve Size >2.0mm
Sieve Size >0.063mm
Sieve Size <0.063mm



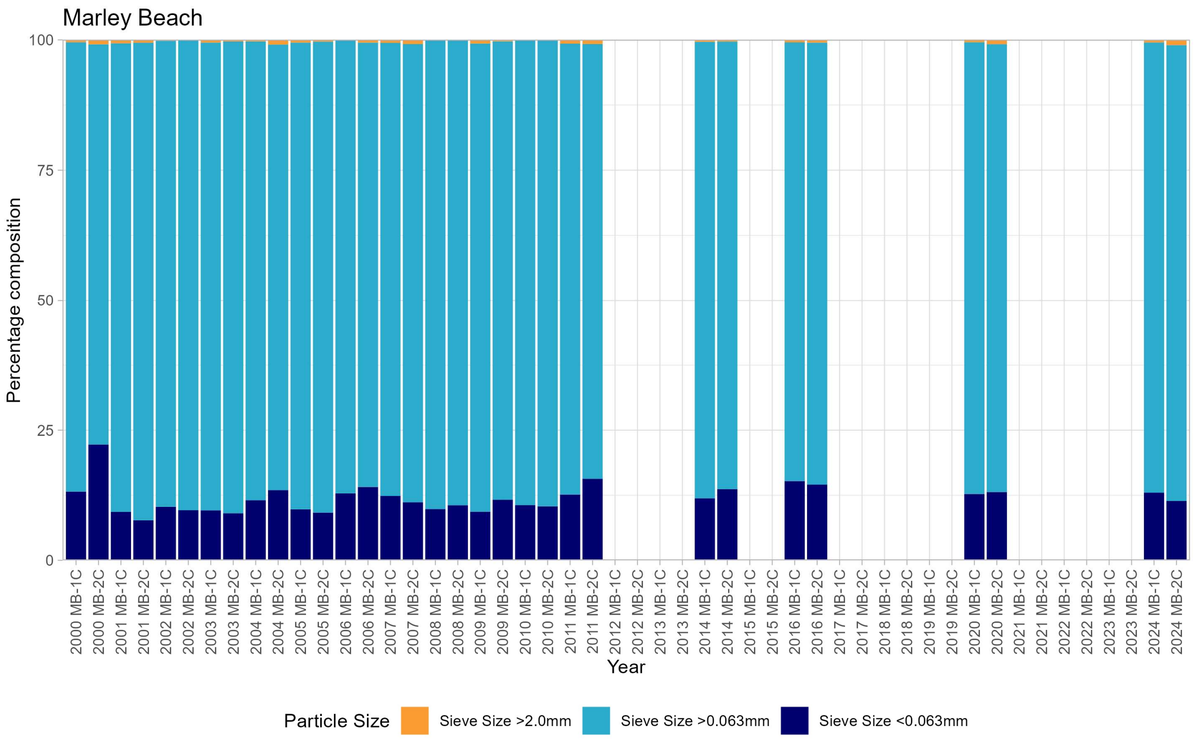


Figure E-1 Cumulative sediment particle size composition by three size classes for: Long Reef, North Head, Bondi, Malabar 0 km, Port Hacking and Marley Beach, from 2000 to 2024

Long Reef, Port Hacking and Marley Beach were not sampled in surveillance years from 2012 to 2023

E.6.2. Offshore marine sediment fauna communities

A summary of the benthic macrofauna data from the Malabar 0 km location is presented in Table E-10. In 2023-24, the most common fauna types (taxa) were Crustaceans and Polychaete worms, which also had the highest abundances out of all groups. Other taxa groups such as Molluscs and Echinoderms had less animal types and lower abundances (Table E-10). While abundances and the exact number of taxa varied between years, this year's taxonomic structure was similar to most years with the exception of 2012, where Crustacean abundance outnumbered Polychaete worm individuals (Figure E-2), however the difference in taxa counts between these groups were marginal in 2023-24.

The detailed benthic community dataset collected in 2023-24 is provided in Table E-10. The Polychaete worm of the family Maldanidae was the most abundant taxon, which was collected in all 10 samples representing 44% of the total Polychaete worms collected in 2023-24 (Table E-11). Maldanidae is described as an indicator of low organic input conditions (Dean, 2008). The next most abundant polychaete worm was Spionidae, contributing approximately 15% of all polychaete worms collected in 2023-24. These polychaete worms have been collected in other monitoring years with about the same contributions to the taxonomic assemblage at the Malabar 0km location.

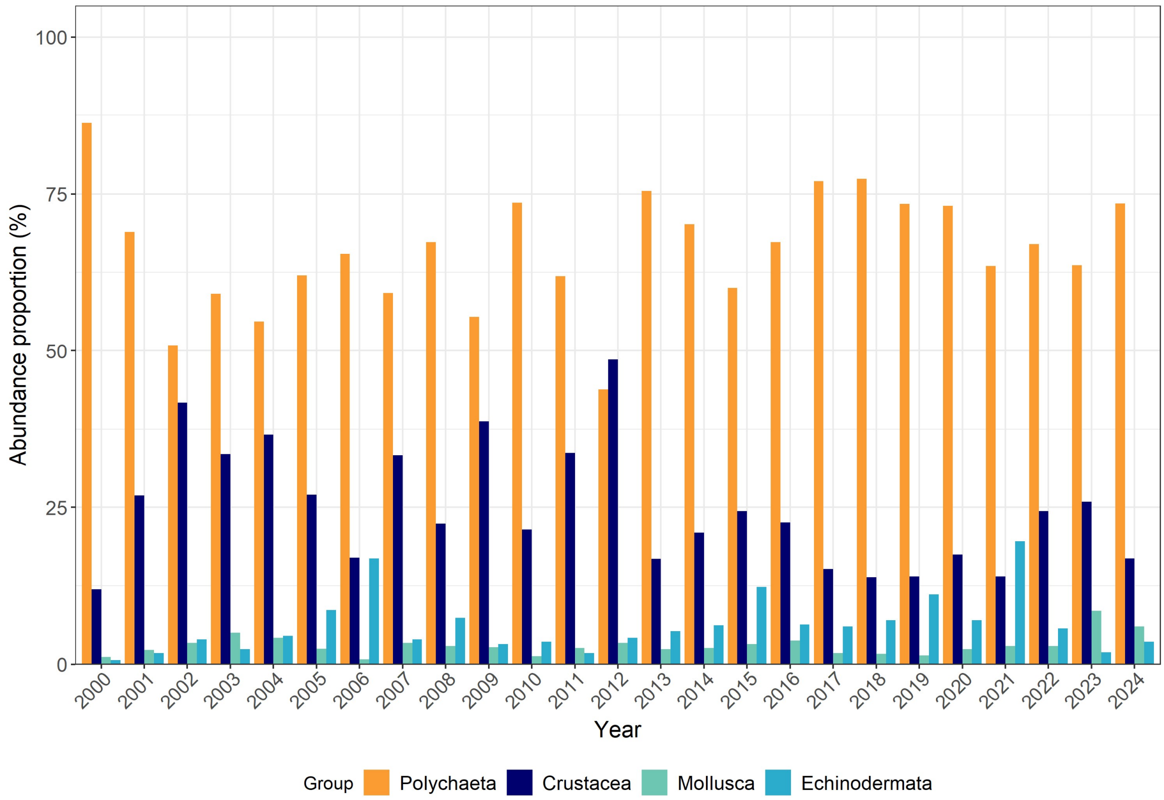
Table E-10 Summary of benthic macrofauna at Malabar 0 km location in 2023-24

Summary statistics based on taxa	Sum	% Contribution
Total number of taxa	83	100
Number of Crustaceans	29	34.9
Number of Polychaetes	28	33.7
Number of Molluscs	15	18.1
Number of other worm phyla	5	6
Number of other phyla	4	4.8
Number of Echinoderms	2	2.4
Summary statistics based on abundance	**Sum**	**% Contribution**
Total number of individuals	1999	100
Number of Polychaetes	1448	72.4
Number of Crustaceans	332	16.6
Number of Molluscs	119	5.95
Number of Echinoderms	71	3.55
Number of other worm phyla	18	0.9
Number of other phyla	11	0.55

The composition of the Polychaeta, Crustacea, Mollusca and Echinodermata has been observed to vary up and down in both number of taxa and in number of individuals over the 2000 to 2024 period (Figure E-2). The total number of individuals was lower than the previous year (2022-23) as fewer samples were collected in 2023-24, as recommended in the STSIMP Recommendations Report (van Dam et al 2023). Despite smaller sample numbers, there does not appear to be a sustained decline or increase in any of these four taxonomic groups over the 24 years of monitoring.

In addition to the above coarse check of the taxonomic structure, a finer comparison of the taxonomic structure at the Malabar 0 km location was made against that from past ‘assessment’ years to see if it was typical of that seen in the past. This was done by placing the 2024 samples from the Malabar outfall location onto the canonical axes of the existing Canonical Analysis of Principal coordinates (CAP) model of interpretive-year data (2002, 2005, 2008, 2011, 2014, 2016, 2020) with the outputted sample allocations inspected for fit of 2024 samples to past samples.

A first pass of the CAP routine was run and after viewing diagnostic statistics an ‘m’ value of 17 was chosen to make the second pass. The second pass indicated a 60% allocation success and the first squared canonical correlation was reasonably large (d1^2 = 0.85). The Pillar’s trace statistic was significant (2.4329, p = 0.0001) and indicated there was more than one group of samples in multivariate space. The Cross Validation Leave-one-out Allocation of Observations to Groups statistic reflected a number of overlapped and mixed groups of samples with no one location having all of its samples being allocated solely to it. Rather, misclassified samples were mostly assigned to locations immediately north or south of that location or nearby locations (Table E-10). The allocation based on taxonomic structure of the 10 samples collected in 2023-24 from the Malabar 0 km location was to either the Malabar 0 km location or to other nearby locations with a similar allocation as seen in the base 7-year assessment data analysis. The resultant CAP plot is shown in Figure E-3.



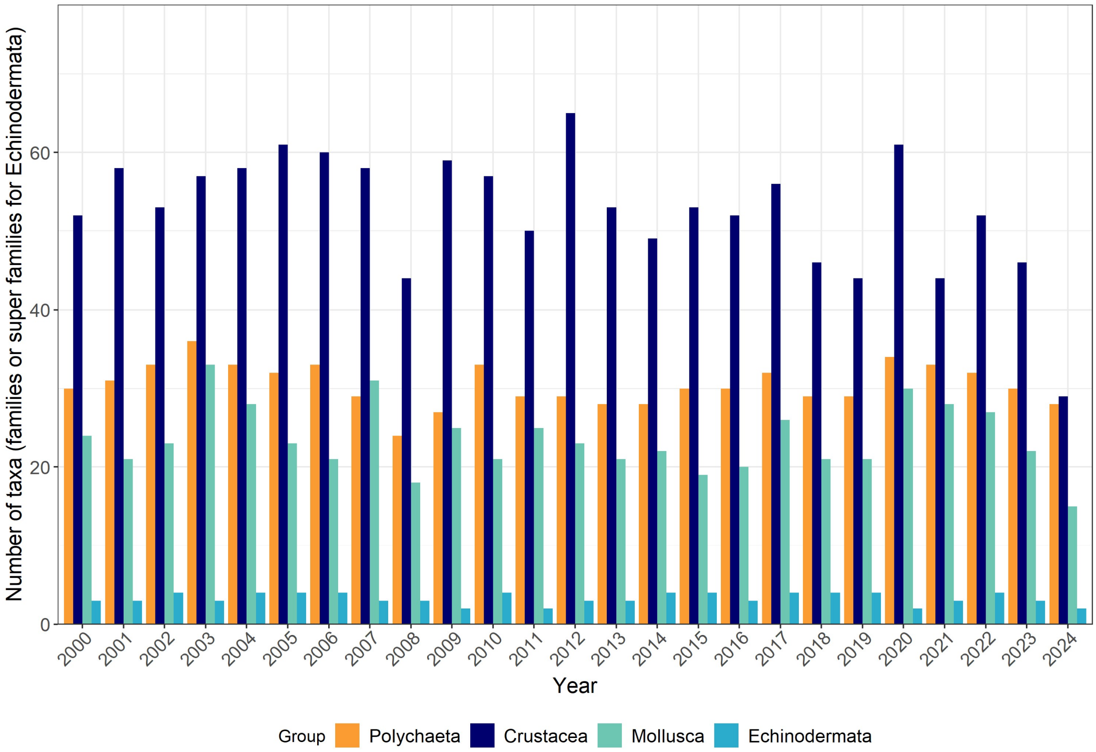


Figure E-2 Counts and number of taxa at Malabar 0 km location each year from 2000 to 2024

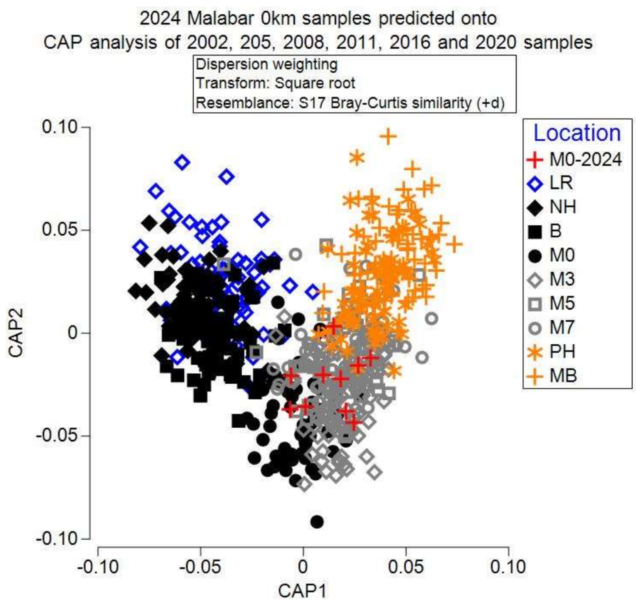


Figure E-3 CAP plot with Malabar 0 km location 2024 sample prediction compared to past assessment years

OSP summary for 2023-24

TOC % content results suggested elevated levels of anoxia were unlikely to have built-up in benthic sediment in 2023-24. There also appeared to be a lack of build-up of fine sediment particles, which in turn suggests sedimentary metal concentrations did not increase in 2023-24. Without changes in those sediment characteristics, the benthic community structure at the Malabar deepwater ocean outfall location was unlikely to have changed beyond the levels recorded in past 'assessment' years. The check of the 2023-24 benthic community structure to past 'assessment' years also suggested community structure was within ranges seen in the past 'assessment' years.

Table E-11 Allocated location group for Malabar 0 km samples of 2024 which were predicted onto the base CAP analysis of samples collected from all nine locations in 2002, 2005, 2008, 2011, 2014, 2016 and 2020 assessment years

2024 Malabar 0 km site and replicate sample number	Allocated location group
M01C-2024-1	M3
M01C-2024-2	M5
M01C-2024-3	M3
M01C-2024-4	M7
M01C-2024-5	M0
M02C-2024-1	M0
M02C-2024-2	M5
M02C-2024-3	M0
M02C-2024-4	M5
M02C-2024-5	M0

Table E-12 Statistics from the cross-validation leave-one-out allocation of samples to location groups of 2002, 2005, 2008, 2011, 2014, 2016 and 2020 from base CAP analysis

Original group	LR	NH	B	M0	M3	M5	M7	PH	MB	Total samples	% correct
LR	49	14	4	1	0	1	1	0	0	70	70
NH	10	51	8	1	0	0	0	0	0	70	73
B	4	8	57	1	0	0	0	0	0	70	81
M0	3	3	3	49	7	3	2	0	0	70	70
M3	1	0	0	8	44	13	3	1	0	70	63
M5	2	0	0	6	15	22	19	4	2	70	31
M7	1	0	1	4	9	16	28	9	2	70	40
PH	0	0	0	0	1	8	12	25	24	70	36
MB	0	0	0	0	0	0	4	16	50	70	71

Table E-13 EPA sampling site coordinate grid centres

Sites of location	Easting (grid centre)	Northing (grid centre)	Latitude (S)	Longitude (E)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)
Long Reef 1	349791.41	6266903.05	33o43.630'	151o22.720'	349666.41	6266778.05
Long Reef 2	349315.23	6264892.50	33o44.707'	151o22.393'	349190.23	6264767.50
North Head 1	347436.95	6257934.94	33o48.460'	151o21.100'	347311.95	6257809.94
North Head 2	347463.41	6256056.66	33o49.470'	151o21.100'	347338.41	6255931.66
Bondi 1	343415.85	6248226.10	33o53.670'	151o18.400'	343290.85	6248101.10
Bondi 2	344024.31	6250792.20	33o52.300'	151o18.820'	343899.31	6250667.20
Malabar 0 km 1	342807.40	6238966.99	33o58.680'	151o17.900'	342682.40	6238841.99
Malabar 0 km 2	343468.76	6239125.72	33o58.600'	151o18.325'	343343.76	6239000.72
Malabar 3 km 1	341378.85	6236506.71	34o00.000'	151o16.950'	341253.85	6236381.71
Malabar 3 km 2	341590.48	6236612.53	33o59.945'	151o17.085'	341465.48	6236487.53
Malabar 5 km 1	340638.12	6234628.44	34o01.000'	151o16.450'	340513.12	6234503.44
Malabar 5 km 2	340902.67	6234469.71	34o01.100'	151o16.615'	340777.67	6234344.71
Malabar 7 km 1	339527.03	6233041.16	34o01.860'	151o15.705'	339402.03	6232916.16
Malabar 7 km 2	339394.75	6232723.70	34o02.030'	151o15.615'	339269.75	6232598.70
Port Hacking 1	336749.29	6228649.70	34o04.200'	151o13.850'	336624.29	6228524.70
Port Hacking 2	336749.29	6228411.60	34o04.334'	151o13.845'	336624.29	6228286.60
Marley 1	331643.55	6221348.22	34o08.105'	151o10.450'	331518.55	6221223.22
Marley 2	331722.92	6221163.04	34o08.205'	151o10.500'	331597.92	6221038.04

Table E-14 Actual sub-sampling coordinates from collection of 2023-24 samples from sites 1 and 2 of 6 locations with replicate samples numbers

Location	Easting (grid centre)	Northing (grid centre)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number x co-ord (0-5)	Random number y co-ord (0-5)	Grid Easting	Grid Northing
Long Reef 1								
Replicate 1	349791.41	6266903.05	349666.41	6266778.05	3	5	349834.75	6267018.637
Replicate 2	349791.41	6266903.05	349666.41	6266778.05	4	3	349886.665	6266932.479
Replicate 3	349791.41	6266903.05	349666.41	6266778.05	2	4	349779.9052	6266966.193
Replicate 4	349791.41	6266903.05	349666.41	6266778.05	1	0	349719.5294	6266780.272
Replicate 5	349791.41	6266903.05	349666.41	6266778.05	0	0	349688.0565	6266799.338
Long Reef 2								
Replicate 1	349315.23	6264892.5	349190.23	6264767.5	3	0	349348.9096	6264772.47
Replicate 2	349315.23	6264892.5	349190.23	6264767.5	2	4	349278.5025	6264979.227
Replicate 3	349315.23	6264892.5	349190.23	6264767.5	4	5	349405.065	6265016.658
Replicate 4	349315.23	6264892.5	349190.23	6264767.5	4	0	349414.9621	6264791.225
Replicate 5	349315.23	6264892.5	349190.23	6264767.5	1	5	349243.795	6265012.417
North Head site 1								
Replicate 1	347436.95	6257934.94	347311.95	6257809.94	0	5	347332.4804	6258036.92
Replicate 2	347436.95	6257934.94	347311.95	6257809.94	2	3	347414.6355	6257935.073
Replicate 3	347436.95	6257934.94	347311.95	6257809.94	1	1	347346.1438	6257821.27
Replicate 4	347436.95	6257934.94	347311.95	6257809.94	3	4	347463.9204	6257995.432

Location	Easting (grid centre)	Northing (grid centre)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number x co-ord (0-5)	Random number y co-ord (0-5)	Grid Easting	Grid Northing
Replicate 5	347436.95	6257934.94	347311.95	6257809.94	1	3	347377.6748	6257956.125
North Head site 2								
Replicate 1	347463.41	6256056.66	347338.41	6255931.66	2	2	347460.953	6256026.618
Replicate 2	347463.41	6256056.66	347338.41	6255931.66	4	2	347534.4056	6256022.383
Replicate 3	347463.41	6256056.66	347338.41	6255931.66	1	3	347405.9552	6256057.078
Replicate 4	347463.41	6256056.66	347338.41	6255931.66	1	1	347405.6149	6255958.705
Replicate 5	347463.41	6256056.66	347338.41	6255931.66	1	3	347390.1613	6256099.272
Bondi site 1								
Replicate 1	343415.85	6248226.1	343290.85	6248101.1	4	1	343473.5637	6248126.106
Replicate 2	343415.85	6248226.1	343290.85	6248101.1	3	3	343447.8979	6248253.446
Replicate 3	343415.85	6248226.1	343290.85	6248101.1	3	1	343425.3346	6248128.621
Replicate 4	343415.85	6248226.1	343290.85	6248101.1	4	3	343511.196	6248241.27
Replicate 5	343415.85	6248226.1	343290.85	6248101.1	4	0	343492.6059	6248125.315
Bondi site 2								
Replicate 1	344024.31	6250792.2	343899.31	6250667.2	1	4	343927.2964	6250845.786
Replicate 2	344024.31	6250792.2	343899.31	6250667.2	1	1	343971.9941	6250697.92
Replicate 3	344024.31	6250792.2	343899.31	6250667.2	4	1	344092.426	6250727.46
Replicate 4	344024.31	6250792.2	343899.31	6250667.2	0	2	343900.8432	6250746.403
Replicate 5	344024.31	6250792.2	343899.31	6250667.2	2	0	343974.7389	6250678.352

Location	Easting (grid centre)	Northing (grid centre)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number x co-ord (0-5)	Random number y co-ord (0-5)	Grid Easting	Grid Northing
Malabar 0 km site 1								
Replicate 1	342807.4	6238966.99	342682.4	6238841.99	2	2	342793.0089	6238926.248
Replicate 2	342807.4	6238966.99	342682.4	6238841.99	1	2	342735.9709	6238935.29
Replicate 3	342807.4	6238966.99	342682.4	6238841.99	2	3	342774.1584	6239014.302
Replicate 4	342807.4	6238966.99	342682.4	6238841.99	4	5	342890.1981	6239079.944
Replicate 5	342807.4	6238966.99	342682.4	6238841.99	5	2	342918.5496	6238954.102
Malabar 0 km site 2								
Replicate 1	343468.76	6239125.72	343343.76	6239000.72	4	1	343523.585	6239032.073
Replicate 2	343468.76	6239125.72	343343.76	6239000.72	4	5	343549.8062	6239229.217
Replicate 3	343468.76	6239125.72	343343.76	6239000.72	2	1	343434.6563	6239043.744
Replicate 4	343468.76	6239125.72	343343.76	6239000.72	0	5	343347.794	6239247.279
Replicate 5	343468.76	6239125.72	343343.76	6239000.72	1	0	343417.9492	6239023.196
Port Hacking 1								
Replicate 1	336749.29	6228649.7	336624.29	6228524.7	2	2	336709.4821	6228649.104
Replicate 2	336749.29	6228649.7	336624.29	6228524.7	3	1	336778.4058	6228593.883
Replicate 3	336749.29	6228649.7	336624.29	6228524.7	1	1	336694.7357	6228575.111
Replicate 4	336749.29	6228649.7	336624.29	6228524.7	5	2	336872.8219	6228603.816
Replicate 5	336749.29	6228649.7	336624.29	6228524.7	4	0	336810.7286	6228536.165
Port Hacking 2								

Location	Easting (grid centre)	Northing (grid centre)	Easting (converted to represent 0 co-ord, x value)	Northing (converted to represent 0 co-ord, y value)	Random number x co-ord (0-5)	Random number y co-ord (0-5)	Grid Easting	Grid Northing
Replicate 1	336749.29	6228411.6	336624.29	6228286.6	2	0	336721.907	6228305.257
Replicate 2	336749.29	6228411.6	336624.29	6228286.6	2	4	336699.8623	6228497.481
Replicate 3	336749.29	6228411.6	336624.29	6228286.6	0	1	336633.7251	6228357.598
Replicate 4	336749.29	6228411.6	336624.29	6228286.6	3	4	336793.6036	6228485.107
Replicate 5	336749.29	6228411.6	336624.29	6228286.6	1	5	336676.1701	6228513.157
Marley Beach 1								
Replicate 1	331643.55	6221348.22	331518.55	6221223.22	3	0	331662.1265	6221237.262
Replicate 2	331643.55	6221348.22	331518.55	6221223.22	3	4	331663.8858	6221402.641
Replicate 3	331643.55	6221348.22	331518.55	6221223.22	3	3	331689.2097	6221384.69
Replicate 4	331643.55	6221348.22	331518.55	6221223.22	5	0	331745.4013	6221223.565
Replicate 5	331643.55	6221348.22	331518.55	6221223.22	1	0	331593.0735	6221226.619
Marley Beach 2								
Replicate 1	331722.92	6221163.04	331597.92	6221038.04	4	3	331812.31	6221163.604
Replicate 2	331722.92	6221163.04	331597.92	6221038.04	1	2	331656.9917	6221114.515
Replicate 3	331722.92	6221163.04	331597.92	6221038.04	0	4	331599.1114	6221223.824
Replicate 4	331722.92	6221163.04	331597.92	6221038.04	3	4	331753.1352	6221244.287
Replicate 5	331722.92	6221163.04	331597.92	6221038.04	2	4	331721.662	6221240.443

Table E-15 Invertebrate data from the Malabar 0 km location in 2023-24 from sites 1 and 2

Phylum	Class	Order	Family	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02
			Replicate	1	2	3	4	5	1	2	3	4	5
Annelida	Clitellata		Oligochaeta					1					
Annelida	Polychaeta	Amphinomida	Amphinomidae						1				
Annelida	Polychaeta	Eunicida	Lumbrineridae	11	14	12	3	16	18	14	3	2	10
Annelida	Polychaeta	Eunicida	Onuphidae	4	1		8	6	6	3	4		14
Annelida	Polychaeta	Phyllodocida	Fauveliopsidae				1						
Annelida	Polychaeta	Phyllodocida	Glyceridae										1
Annelida	Polychaeta	Phyllodocida	Nephtyidae	1				1				1	
Annelida	Polychaeta	Phyllodocida	Nereididae	3	2	5	2	11	4	1	2		1
Annelida	Polychaeta	Phyllodocida	Phyllodocidae					3					
Annelida	Polychaeta	Phyllodocida	Polynoidae	3	1	1			1				1
Annelida	Polychaeta	Phyllodocida	Sigalionidae		1								
Annelida	Polychaeta	Phyllodocida	Goniadidae		1			1			1		1
Annelida	Polychaeta	Phyllodocida	Syllidae	22	16	21	3	39	10	8	10	5	5
Annelida	Polychaeta	Sabellida	Sabellidae		6	8		8	4		9		1
Annelida	Polychaeta	Sabellida	Oweniidae			3	5	1	7	1			5
Annelida	Polychaeta	Scolecida	Capitellidae	1	1	4	1	1	1			1	1
Annelida	Polychaeta	Scolecida	Maldanidae	45	47	128	11	172	82	13	64	17	56
Annelida	Polychaeta	Scolecida	Paraonidae	3	2	1		2	1	2	1	1	
Annelida	Polychaeta	Scolecida	Opheliidae	2		2		2		1	4		
Annelida	Polychaeta	Scolecida	Orbiniidae	6	6	6	1	9	1		3	2	4

Phylum	Class	Order	Family	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02
Annelida	Polychaeta	Spionida	Poecilochaetidae	2	1								1
Annelida	Polychaeta	Spionida	Spionidae	44	39	45	11	26	16	15	12	5	10
Annelida	Polychaeta	Spionida	Chaetopteridae	4	4	1	1			3	3		1
Annelida	Polychaeta	Terebellida	Ampharetidae		1	1	2			1			21
Annelida	Polychaeta	Terebellida	Cirratulidae	1	2	5	3	2			2	1	2
Annelida	Polychaeta	Terebellida	Pectinariidae	1		2		2		1	1		
Annelida	Polychaeta	Terebellida	Terebellidae						2				
Annelida	Polychaeta	Terebellida	Trichobranchidae			2							
Annelida	Polychaeta	Unkown	Unknown Polychaete								1		
Annelida	Polycheata	Terebellida	Trichobranchidae/Terebellidae	21	2	8			9	1		1	1
Arthropoda	Malacostraca	Amphipoda	Ampeliscidae					1	1	1			
Arthropoda	Malacostraca	Amphipoda	Aoridae/Isaeidae/Photidae/Unciolidae	3	1	7		2	1	2	1		1
Arthropoda	Malacostraca	Amphipoda	Atylidae								1		
Arthropoda	Malacostraca	Amphipoda	Ischyroceridae						4		1		1
Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae			1		1					
Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3		3		4		1	4		1
Arthropoda	Malacostraca	Amphipoda	Melitidae	1									
Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	1	1	3		2					
Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	4	2	1	2	2		1		2	
Arthropoda	Malacostraca	Amphipoda	Synopiidae								1		
Arthropoda	Malacostraca	Decapoda	Callianassidae	1								1	
Arthropoda	Malacostraca	Decapoda	Hexapodidae	3		1	1		1	1			1

Phylum	Class	Order	Family	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02
Arthropoda	Malacostraca	Decapoda	Pasiphaeidae						1	1		1	
Arthropoda	Malacostraca	Decapoda	Processidae								1		
Arthropoda	Malacostraca	Decapoda	Unknown Decapoda	1									
Arthropoda	Malacostraca	Isopoda	Anthuridae			4		2	3	2	1		
Arthropoda	Malacostraca	Isopoda	Arcturidae								1		
Arthropoda	Malacostraca	Isopoda	Cirolanidae						1				1
Arthropoda	Malacostraca	Isopoda	Leptanthuridae			1				1			
Arthropoda	Malacostraca	Isopoda	Paramunnidae	1	2								
Arthropoda	Malacostraca	Isopoda	Paranthuridae		2			1	1	2	3	1	3
Arthropoda	Malacostraca	Nebaliacea	Nebaliidae				1				1		
Arthropoda	Malacostraca	Tanaidacea	Apseudidae	1	1		1		1		1		
Arthropoda	Malacostraca	Tanaidacea	Leptocheliidae		1	3	2	27	50	1	11	1	17
Arthropoda	Malacostraca	Tanaidacea	Neotanaidae/Leptocheliidae		1	7		11			2		1
Arthropoda	Malacostraca	Tanaidacea	Paratanaidae	2	2	5		33	5		2		
Arthropoda	Maxillopoda	Calanoida	Calanoida	1					1				
Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	4	5	3	1	2					2
Arthropoda	Ostracoda	Myodocopida	Cypridinidae/Rutidermatidae							1			
Arthropoda	Ostracoda	Myodocopida	Philomedidae		1		1						
Arthropoda	Ostracoda	Myodocopida	Sarsiellidae			1		1			3		
Arthropoda	Pycnogonida	Unknown	Pycnogonida					8					2
Bryozoa	Indeterminate	Indeterminate	P.Bryozoa										1
Chordata	Ascidiacea		C. Ascidiacea								1		

Phylum	Class	Order	Family	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02
Cnidaria	Anthozoa	Actinaria	O. Actiniaria		3			1		3			
Echinodermata	Echinoidea		Echinoidea				1	2	3		2		5
Echinodermata	Ophiuroidea		Ophiuroidea		1		1		48		2	5	1
Mollusca	Aplacophora	Chaetodermatida	Chaetodermatidae					1	3		1		2
Mollusca	Bivalva	Lucinoida	Lucinidae		1	2		3	1				3
Mollusca	Bivalva	Mytiloida	Mytilidae			1		1					
Mollusca	Bivalva	Nuculida	Nuculanidae				15						
Mollusca	Bivalva	Nuculida	Nuculidae		1	1				1	1		1
Mollusca	Bivalva	Pectinoida	Propeamussiidae								1		2
Mollusca	Bivalva	Solemyoida	Solemyidae	1	2	2	1	4		1	1		
Mollusca	Bivalva	Veneroida	Galeommatidae	1	1	2	4	5	1		2		
Mollusca	Gastropoda	Littorinimorpha	Anabathridae						9				
Mollusca	Gastropoda	Littorinimorpha	Rissoidae								1		
Mollusca	Gastropoda	Neogastropoda	Marginellidae				2						
Mollusca	Gastropoda	Neogastropoda	Nassariidae		14	5	4	1	2	1	1	2	2
Mollusca	Gastropoda	Neogastropoda	Turridae	1									
Mollusca	Gastropoda	(unassigned) Heterobranchia	Acteonidae								1		
Mollusca	Scaphopoda	Dentaliida	Laevidentaliidae		1			1					1
Nematoda	Indeterminate	Indeterminate	P. Nematoda								1	2	1
Nemertea	Indeterminate	Indeterminate	P. Nemertea	2	2	1	2	1					1
Platyhelminthes	Indeterminate	Indeterminate	P. Platyhelminthes								2	1	

Phylum	Class	Order	Family	M01	M01	M01	M01	M01	M02	M02	M02	M02	M02
Sipuncula	Indeterminate	Indeterminate	P. Sipuncula				1						

F. Wastewater overflows

F.1. Wet weather overflows

Table F-1 Trend in wet weather wastewater overflow frequency and volumes for inland WWTPs wastewater system (2017-18 to 2023-24)

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Picton	0	0	0	0	1	7.5	3	1	4	18.4	7	16.2	3	13.1
West Camden	0	0	2	1.0	1	65.1	4	105	5	287.2	6	128.6	4	114.3
Wallacia	0	0	3	2.2	4	28.6	9	34	7	69.3	2	15.8	3	10.6
Penrith	0	0	4	12.2	6	173.0	5	126	11	241.6	8	88.9	5	78.7
Winmalee	0	0	1	0.1	2	98.0	1	35	3	15.6	2	16.7	1	19.9
North Richmond	0	0	2	0.4	3	15.6	3	37	2	42.5	2	9.8	4	30.0
Richmond	0	0	0	0	1	2.1	1	0	3	10.6	1	0	2	5.5
St Marys	0	0	10	71.7	6	399.7	6	445	11	864.5	5	473.1	7	240.2
Quakers Hill	1	12.2	8	280.0	4	538.2	8	853	11	1378.0	7	487.4	11	383.4
Riverstone	0	0	2	0.5	1	34.9	3	142	5	235.8	5	95.5	9	87.3
Castle Hill	0	0	4	4.6	2	75.5	3	63	4	124.8	3	40.3	6	29.4
Rouse Hill	0	0	2	8.1	1	111.9	0	124	4	242.0	1	72.0	5	51.0
Hornsby Heights	0	0	0	0	1	1.1	1	0	4	0.4	0	0	1	0
West Hornsby	0	0	8	42.9	2	91.8	3	60	5	103.0	2	34.0	3	33.2

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Brooklyn-Danger Island	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0	0
All inland systems	1	12.2	46	423.7	15	1643	50	2025	79	3633.6	51	1478.3	64	1096.5

MOF: Maximum overflow frequency

SOV: System overflow volume

Table F-2 Trend in wet weather wastewater overflow frequency and volumes for ocean WWTPs wastewater system (2017-18 to 2023-24)

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Warriewood	1	3.5	2	4.8	5	157.7	2	95	6	247.4	5	23.1	4	43.1
North Head / Northern suburbs	16	279.9	23	3,801.0	16	9,861.0	26	9,300	29	21,127.9	38	3,697.8	31	7,305.4
Bondi	5	11.7	10	179.5	12	489.1	14	302	18	693.0	20	281.3	21	540.2
Malabar/Southern suburbs	20	2,415.0	28	6,586.5	18	15,593.2	38	13,207	47	37973.0	41	16,866.8	37	15,297.9
Cronulla	-	0.03	8	28.0	9	659.7	7	361	15	1281.0	12	1,147.2	13	587.5
Wollongong	2	0.2	5	25.0	2	59.3	6	34	10	189.3	8	217.9	11	198.5
Bellambi	1	0.0	19	46.2	4	159.8	8	70	10	340.5	23	1,387.7	17	1,278.3
Port Kembla	2	0.7	4	6.7	2	142.4	9	113	13	348.7	19	475.6	16	224.1

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)	MOF	SOV (ML)
Shellharbour	1	1.5	4	2.6	1	106.3	7	167	16	302.1	9	561.8	9	484.5
Kiama/Bombo	4	2.5	6	4.1	2	3.0	9	173	13	452.7	14	288.7	13	256.4
All ocean systems	52	2,715.0	109	10,684.4	71	27,232	126	23,821	177	62,955.6	189	26,426.2	172	26,215.9

MOF: Maximum overflow frequency

SOV: System overflow volume

F.2. Dry weather overflows that reach waterways

Table F-3 Trend in dry weather wastewater overflow that reach waterways, frequency and volumes for inland wastewater systems (2017-18 to 2023-24)

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
Picton	2	22	3	45	4	28	0	0	1	1	2	3	0	0
West Camden	7	1,079	1	7	3	35	4	29	9	287	4	41	4	95
Wallacia	1	13	1	9	0	0	1	21	0	0	0	0	0	0
Penrith	11	287	3	73	10	180	4	210	7	303	4	86	16	357
Winmalee	11	580	8	180	5	99	23	364	9	304	4	66	10	128
North Richmond	0	0	2	14	1	6	0	0	0	0	0	0	0	0
Richmond	0	0	0	0	0	0	0	0	1	5	1	1	1	1
St Marys	0	0	4	170	8	192	4	111	4	45	6	59	6	336
Quakers Hill	5	123	10	866	4	130	5	85	12	167	1	14	9	186
Riverstone	1	87	1	57	2	36	0	0	2	60	2	3	2	54
Castle Hill	4	74	8	213	2	20	3	61	8	235	2	16	12	241
Rouse Hill	1	10	9	318	8	163	8	78	3	51	3	33	17	499
Hornsby Heights	3	2	4	37	9	147	12	99	10	35	4	38	15	94
West Hornsby	6	27	9	391	5	100	9	319	11	292	8	517	17	217
Brooklyn-Danger Island	0	0	0	0	0	0	0	0	0	0	1	1	0	0

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
All inland systems	52	2,304	63	2,380	61	1,138	73	1,377	77	1,785	42	878	109	2,208

Table F-4 Trend in dry weather wastewater overflow that reach waterways, frequency and volumes for coastal WWTPs wastewater system (2016-17 to 2022-23)

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
Warriewood	6	39	3	27	7	55	9	87	16	189	9	47	21	143
North Head / Northern suburbs	147	10,197	170	16,151	176	7,948	155	6,215	103	2,850	88	2,958	167	5,477
Bondi	16	960	30	1,424	22	1,480	28	2,599	26	1,223	28	2,752	21	1,031
Malabar/Southern suburbs	75	6,112	79	6,853	133	9,530	133	11,072	82	7,614	80	7,033	103	13,417
Cronulla	42	2,205	54	2,279	41	693	29	311	26	522	18	334	36	573
Wollongong	11	132	28	551	27	649	26	276	23	1,011	14	163	21	360
Port Kembla	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shellharbour	3	387	3	42	4	172	5	527	5	51	5	28	8	118
Kiama/Bombo	1	7	2	34	2	39	3	39	4	99	0	0	1	70

Wastewater system	2017-18		2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)	Frequency	Volume (KL)
All ocean systems	301	20,039	369	27,361	412	20,567	388	21,126	285	13,559	242	13,315	378	21,190

G. Recreational water quality – Harbour and beaches

The analysis of the Beachwatch data has been designed to identify potential wastewater overflows or leakage under dry weather conditions. Overflows or leakage reaching the waterways during dry weather conditions pose a risk to public health. The wet weather public health risk for recreational activities in waterways (harbour and beaches) are well known.

Assumptions behind the data for Beachwatch analysis:

- *Enterococci* results without a respective conductivity value were excluded. Conductivity results for various sites were not available mainly due to instrument failures at the time of collecting samples. Conductivity data is required to separate dry weather data from wet weather data.
- Only dry weather results were included in these plots. *Enterococci* results associated with conductivity below 30,000 µS/cm were considered wet weather and not included in these plots.

  Data labels: Maximum *Enterococci* values for each financial year were labelled where *Enterococci* values ≥ 35 cfu/100mL, which is the primary contact recreation guideline (ANZG 2018).

- Bubble colour: Bubbles where Enterococci values ≥ 35 cfu/100mL are filled with orange and bubbles where *Enterococci* values ≥ 230 cfu/100mL are filled with orange and marked with red outer ring.
- Bubble size: Bubble sizes are comparable between sites. Actual bubble size is in the range of 0 to 70 which reflect *Enterococci* counts of 0 cfu/100mL to 70,000 cfu/100mL (min to max *Enterococci* count for last 10-year period).

The Beachwatch results are presented in the following order, similar to monitoring programs and sub-catchments as stated in the method section of Volume 1:

Sydney Beaches

- Northern Sydney
- Central Sydney
- Southern Sydney

Illawarra Beaches

- Wollongong
- Shellharbour
- Bombo

Harbours

- Botany Bay and Georges River
- Port Hackings

- Port Jackson
- Middle Harbour
- Pittwater

The sites under each sub-catchment are presented in the order from north coast to south coast. When the sub-catchment is a harbour with sites on both coasts then sites on south coasts were stated first and then following clockwise direction to the north coast.

Table G-1 Short-listed dry weather *Enterococci* exceptions data (≥35 cfu/100mL) based on catchment rainfall condition (2023-24) (72hr rain ≤ 2mm)

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
Austinmer Beach	10-Oct-23	53	54200	0.2	68228	Bellambi AWS
	15-Nov-23	140	54100	0	68228	
	14-Mar-24	230	53600	0	68228	
Balmoral Baths	30-Jan-24	150	50300	1.8	66006	Sydney Botanic Gardens
Barrenjoey Beach	2-Aug-23	110	52500	0.2	66141	Mona Vale Golf Club
	5-Jun-24	120	49600	0	66141	
Bayview Baths	4-Jul-23	78	52100	0	66141	Mona Vale Golf Club
	9-Nov-23	80	53900	0	66141	
	18-Dec-23	58	53100	0	66141	
	29-Feb-24	180	52200	0.6	66141	
	22-Mar-24	35	54400	0.6	66141	
	28-Mar-24	54	52700	1.4	66141	
	15-Apr-24	310	44540	0.6	66141	
	5-Jun-24	340	42710	0	66141	
Bellambi Beach	09-Nov-23	41	53600	0	68228	Bellambi AWS
	15-Nov-23	120	54000	0	68228	
	31-May-24	47	52800	0	68228	
Bilarong Reserve	25-Sep-23	90	45000	0	66126	Collaroy (Long Reef Golf Club)
	11-Oct-23	160	45560	0	66126	
	17-Oct-23	320	44540	0.4	66126	
	9-Nov-23	720	42550	0	66126	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	15-Nov-23	290	42240	0.6	66126	
	21-Nov-23	1200	33170	1.2	66126	
	13-Dec-23	37	43860	0.2	66126	
	1-Feb-24	120	39110	2	66126	
	13-Feb-24	38	44330	1.6	66126	
	19-Feb-24	150	34140	1.6	66126	
	29-Feb-24	360	31660	0.4	66126	
	6-Mar-24	1600	34850	0	66126	
	15-Apr-24	110	35200	0	66126	
	20-May-24	56	36370	1.5	66126	
	31-May-24	82	43070	0	66126	
Bilgola Beach	22-Mar-24	94	53700	0.6	66141	Mona Vale Golf Club
Boat Harbour	13-Jul-23	100	52500	0	66058	Sans Souci (Public School)
	5-Sep-23	66	52800	0	66058	
	13-Nov-23	560	53700	0	66058	
	20-Nov-23	180	53500	0	66058	
	12-Jan-24	36	52100	0	66058	
	12-Feb-24	680	54400	0	66058	
	28-Feb-24	230	53300	2	66058	
	15-Mar-24	72	53500	1	66058	
	21-Mar-24	530	53600	1	66058	
	4-Apr-24	150	53500	0	66058	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	12-Apr-24	40	51900	1	66058	
	18-Apr-24	170	53100	0	66058	
	29-Apr-24	37	51200	0	66058	
Bondi Beach	13-Nov-23	290	54100	1	66098	Rose Bay (Royal Sydney Golf Club)
	5-Mar-24	550	54200	0.6	66098	
Brighton Le Sands Bath	4-Oct-23	800	51300	0	66037	Sydney Airport AMO
	12-Dec-23	480	51500	0	66037	
	7-Mar-24	36	51400	0	66037	
	9-Apr-24	54	38510	0	66037	
Bronte Beach	1-Aug-23	360	53800	0	66052	Randwick (Randwick St)
	1-Nov-23	44	53400	1	66052	
	13-Nov-23	220	54000	0.6	66052	
	11-Dec-23	62	54600	1.8	66052	
	12-Jan-24	36	54200	0.4	66052	
	18-Apr-24	300	52100	0.2	66052	
Bulli Beach	15-Nov-23	36	54000	0	68228	Bellambi AWS
Cabarita Beach	30-Oct-23	40	51600	1.4	66048	Concord (Brays Rd)
Carss Point Baths	8-Nov-23	50	49500	2	66058	Sans Souci (Public School)
	14-Nov-23	520	49400	1	66058	
	28-Nov-23	120	50700	2	66058	
	12-Dec-23	140	48300	0	66058	
	15-Feb-24	500	46500	1	66058	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	27-Feb-24	40	43760	1	66058	
	13-Mar-24	200	48200	0	66058	
	2-Apr-24	98	50500	0	66058	
	17-Apr-24	150	39010	0	66058	
	24-Apr-24	39	43860	0	66058	
	30-Apr-24	38	45880	0	66058	
Chinamans Beach	23-Jan-24	40	51400	2	66214	Sydney (Observatory Hill)
	30-Jan-24	280	50700	0.8	66214	
	20-Feb-24	750	44880	0	66214	
Chiswick Baths	16-Nov-23	35	53000	2	66034	Abbotsford (Blackwall Point Rd)
	30-Jan-24	55	46400	1.8	66034	
Clareville Beach	4-Jul-23	220	52600	0	66141	Mona Vale Golf Club
	15-Apr-24	36	43880	0.6	66141	
Clontarf Pool	30-Jan-24	270	50800	1	66011	Chatswood Bowling Club
	26-Feb-24	52	47700	1	66011	
	16-Apr-24	150	45000	0	66011	
Clovelly Beach	13-Nov-23	260	53400	0.6	66052	Randwick (Randwick St)
	5-Mar-24	86	53100	0.4	66052	
	18-Apr-24	76	52500	0.2	66052	
Como Baths	2-Nov-23	39	52900	0	66148	Peakhurst Golf Club
	8-Nov-23	60	49000	2	66148	
	14-Nov-23	340	54700	0	66148	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	23-Nov-23	260	47300	1	66148	
	12-Dec-23	54	48200	0	66148	
	27-Feb-24	50	44740	0	66148	
	13-Mar-24	100	47700	0	66148	
Congwong Bay	13-Nov-23	290	53400	0.8	66037	Sydney Airport AMO
	4-Apr-24	90	53900	1.4	66037	
	18-Apr-24	110	49600	0.6	66037	
Coogee Beach	1-Nov-23	48	53600	1	66052	Randwick (Randwick St)
	13-Nov-23	1200	54200	0.6	66052	
	24-Jan-24	44	54500	0	66052	
	11-Mar-24	170	53300	0	66052	
Davidson Reserve	16-Nov-23	100	52400	0.2	66188	Belrose (Evelyn Place)
Dawn Fraser Pool	16-Nov-23	44	52400	0.6	66214	Sydney (Observatory Hill)
	30-Jan-24	190	48100	0.8	66214	
	20-Feb-24	450	46000	0	66214	
	4-Mar-24	72	49800	1.8	66214	
Dee Why Beach	15-Nov-23	1200	54800	0.6	66126	Collaroy (Long Reef Golf Club)
	19-Feb-24	52	54100	1.6	66126	
Dolls Point Baths	2-Nov-23	64	51000	0	66058	Sans Souci (Public School)
	8-Nov-23	70	48400	2	66058	
	14-Nov-23	140	51000	1	66058	
	28-Nov-23	90	51900	2	66058	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	28-Nov-23	70	52000	2	66058	
	29-Jan-24	580	50700	0	66058	
	15-Feb-24	110	40400	1	66058	
	27-Feb-24	120	47600	1	66058	
	13-Mar-24	80	48800	0	66058	
	2-Apr-24	120	52050	0	66058	
	9-Apr-24	620	43940	0	66058	
	17-Apr-24	58	42850	0	66058	
	30-Apr-24	36	44130	0	66058	
Edwards Beach	23-Jan-24	120	51500	0.6	66006	Sydney Botanic Gardens
	30-Jan-24	230	51600	1.8	66006	
	4-Mar-24	42	51800	1.2	66006	
Elouera Beach	13-Nov-23	42	53800	0	66058	Sans Souci (Public School)
	11-Dec-23	84	54300	0	66058	
Entrance Lagoon Beach	12-Jul-23	69	54000	0	68246	Blackbutt (Tammar Place)
	4-Oct-23	960	53700	0	68246	
	26-Jan-24	65	53000	0	68246	
	1-Feb-24	98	52500	1	68246	
	13-Feb-24	68	51600	0	68246	
	8-Mar-24	220	53300	0	68246	
	13-Apr-24	47	47700	0	68246	
Foreshores Beach	14-Nov-23	100	53200	0.8	66037	Sydney Airport AMO

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	19-Dec-23	46	48000	0	66037	
	27-Feb-24	230	50000	0	66037	
	1-Mar-24	82	46800	0	66037	
	13-Mar-24	80	48700	0	66037	
	2-Apr-24	76	52300	0	66037	
	9-Apr-24	290	36000	0	66037	
	17-Apr-24	200	35490	0	66037	
Forty Baskets Pool	30-Jan-24	90	51000	1.2	66126	Collaroy (Long Reef Golf Club)
	2-Feb-24	100	52200	0.8	66126	
Frenchmans Bay	14-Nov-23	50	53200	0.8	66037	Sydney Airport AMO
	12-Dec-23	110	52300	0	66037	
	19-Dec-23	56	52400	0	66037	
	7-Mar-24	480	53400	0	66037	
Gordons Bay	13-Nov-23	480	53400	0.6	66052	Randwick (Randwick St)
Greenhills Beach	13-Nov-23	100	53900	0	66058	Sans Souci (Public School)
	12-Jan-24	37	53100	0	66058	
	21-Mar-24	83	53700	1	66058	
	27-Jun-24	80	51600	0	66058	
Greenwich Baths	16-Nov-23	200	53600	0.6	66214	Sydney (Observatory Hill)
	23-Jan-24	480	48400	2	66214	
	30-Jan-24	110	48800	0.8	66214	
	20-Feb-24	1300	34800	0	66214	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	26-Feb-24	180	48400	0.6	66214	
	14-Mar-24	440	51200	0	66214	
Gunnamatta Bay Baths	8-Nov-23	50	50700	2	66058	Sans Souci (Public School)
	25-Mar-24	200	53400	0	66058	
	16-May-24	48	41270	0	66058	
Gurney Cr Baths	30-Jan-24	100	49900	1	66011	Chatswood Bowling Club
	4-Mar-24	70	50200	1	66011	
Gymea Bay Bath	8-Nov-23	70	42760	2	66176	Audley (Royal National Park)
	12-Dec-23	250	51200	0	66176	
	19-Dec-23	40	53800	0	66176	
	5-Feb-24	140	52400	0	66176	
	9-Feb-24	680	48300	0	66176	
	27-Feb-24	500	47700	0	66176	
	7-Mar-24	70	50500	0	66176	
	25-Mar-24	640	51700	1	66176	
	13-Jun-24	68	37780	0	66176	
Hayes St Beach	16-Nov-23	210	53000	0.6	66214	Sydney (Observatory Hill)
	23-Jan-24	560	48000	2	66214	
	30-Jan-24	120	50900	0.8	66214	
	20-Feb-24	800	47200	0	66214	
	26-Feb-24	160	50700	0.6	66214	
	4-Mar-24	52	51600	1.8	66214	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	8-Mar-24	36	52200	0	66214	
	26-Mar-24	140	52500	0	66214	
Horderns Beach	14-Nov-23	40	53500	1	66176	Audley (Royal National Park)
	27-Feb-24	40	53700	0	66176	
	1-Mar-24	40	53100	0	66176	
	13-Mar-24	120	53800	0	66176	
	9-Apr-24	58	52000	0	66176	
Jew Fish Bay Baths	8-Nov-23	45	42840	2	66148	Peakhurst Golf Club
	14-Nov-23	300	48400	0	66148	
	23-Nov-23	400	47000	1	66148	
	29-Jan-24	190	40090	1	66148	
Jibbon Beach	19-Dec-23	100	53800	0	66176	Audley (Royal National Park)
	27-Feb-24	36	53100	0	66176	
	1-Mar-24	35	53400	0	66176	
Kiama Beach	15-Nov-23	37	54000	0	68252	Kiama (Brighton St)
	21-Nov-23	100	54300	0.4	68252	
	8-Jan-24	72	54100	2	68252	
Kyeemagh Baths	26-Oct-23	36	52600	1.4	66037	Sydney Airport AMO
	14-Nov-23	100	53400	0.8	66037	
	12-Dec-23	190	50900	0	66037	
	29-Jan-24	100	51000	0.5	66037	
	27-Feb-24	60	48000	0	66037	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	13-Mar-24	270	50400	0	66037	
	9-Apr-24	54	38570	0	66037	
Lilli Pilli Baths	8-Nov-23	100	45850	2	66176	Audley (Royal National Park)
	5-Feb-24	100	53300	0	66176	
	1-Mar-24	74	52100	0	66176	
	25-Mar-24	800	53400	1	66176	
	9-Apr-24	240	32650	0	66176	
Little Bay	4-Sep-23	38	53900	0.4	66037	Sydney Airport AMO
	3-Oct-23	44	52600	0	66037	
	13-Nov-23	1000	53900	0.8	66037	
	4-Apr-24	280	53600	1.4	66037	
	18-Apr-24	48	52400	0.6	66037	
	14-Jun-24	45	53100	0	66037	
Little Manly Cove	2-Feb-24	37	52200	0.8	66126	Collaroy (Long Reef Golf Club)
	4-Mar-24	80	52100	0.8	66126	
	14-Mar-24	150	52700	0	66126	
	26-Mar-24	37	53300	0	66126	
Long Reef Beach	15-Apr-24	50	54000	0	66126	Collaroy (Long Reef Golf Club)
	12-Jun-24	38	48700	0	66126	
Malabar Beach	13-Oct-23	35	53500	1.6	66052	Randwick (Randwick St)
	1-Nov-23	42	53800	1	66052	
	13-Nov-23	100	53400	0.6	66052	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	11-Dec-23	42	53700	1.8	66052	
	12-Jan-24	44	53500	0.4	66052	
	5-Mar-24	35	53500	0.4	66052	
Manly Cove	30-Jan-24	370	52300	1.2	66126	Collaroy (Long Reef Golf Club)
	14-Mar-24	180	52700	0	66126	
Maroubra Beach	13-Nov-23	210	53400	0.6	66052	Randwick (Randwick St)
	5-Mar-24	35	52900	0.4	66052	
Monterey Baths	14-Nov-23	35	53400	1	66058	Sans Souci (Public School)
	28-Nov-23	100	52400	2	66058	
	12-Dec-23	96	52300	0	66058	
	9-Apr-24	120	44050	0	66058	
Murray Rose Pool (formerly Redleaf Pool)	2-Feb-24	110	52400	0.8	66098	Rose Bay (Royal Sydney Golf Club)
	14-Feb-24	270	51200	0.2	66098	
	14-Mar-24	170	52400	0	66098	
Narrabeen Lagoon (Birdwood Park)	4-Jul-23	42	49800	0	66141	Mona Vale Golf Club
	17-Jul-23	130	47700	0	66141	
	2-Aug-23	40	42600	0.2	66141	
	15-Nov-23	120	46000	0.6	66141	
	6-Mar-24	44	41420	0	66141	
	12-Mar-24	130	40200	0.4	66141	
Newport Beach	13-Dec-23	41	53300	0.2	66141	Mona Vale Golf Club
North Cronulla Beach	13-Nov-23	170	53700	0	66058	Sans Souci (Public School)

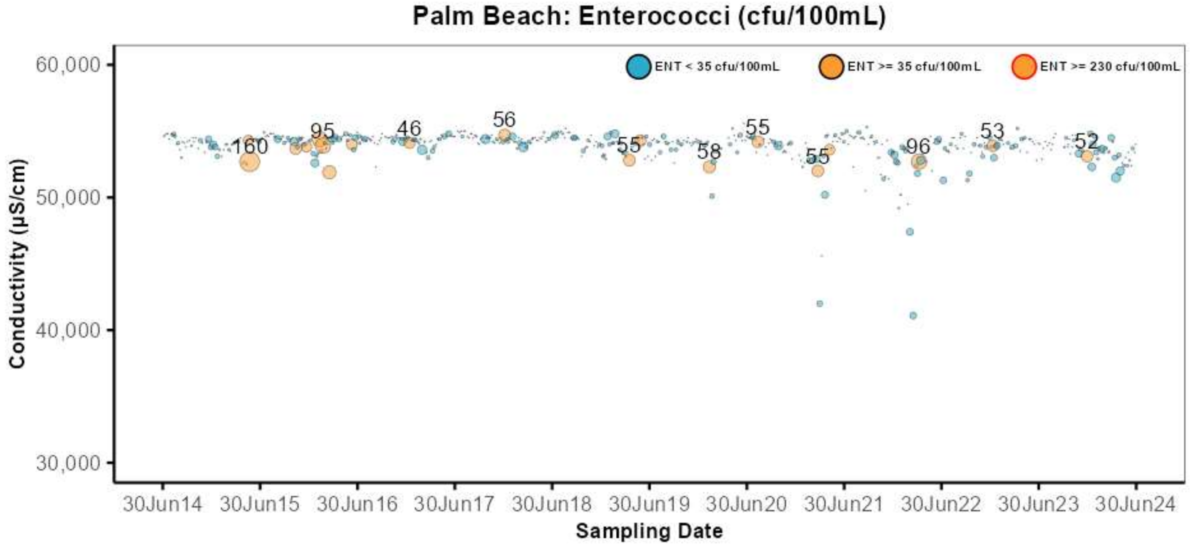
Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
North Narrabeen Beach	19-Feb-24	240	53700	1.6	66126	Collaroy (Long Reef Golf Club)
	26-Apr-24	130	53400	0	66126	
North Scotland Island	15-Apr-24	120	44850	0.6	66141	Mona Vale Golf Club
North Steyne Beach	6-Mar-24	49	53500	0	66126	Collaroy (Long Reef Golf Club)
Northbridge Baths	30-Jan-24	38	50100	1	66011	Chatswood Bowling Club
	14-Mar-24	48	51400	0	66011	
	26-Mar-24	40	51700	0	66011	
Oak Park	13-Nov-23	140	54000	0	66058	Sans Souci (Public School)
Oatley Bay Baths	8-Nov-23	67	47800	2	66148	Peakhurst Golf Club
	14-Nov-23	100	46100	0	66148	
	23-Nov-23	320	46390	1	66148	
	27-Feb-24	69	40430	0	66148	
Paradise Beach Baths	15-Apr-24	42	39520	0.6	66141	Mona Vale Golf Club
Port Kembla Beach	15-Nov-23	73	53900	0	68246	Blackbutt (Tammar Place)
	14-Jan-24	180	53500	0.2	68246	
Queenscliff Beach	29-Feb-24	38	53300	0.4	66126	Collaroy (Long Reef Golf Club)
Ramsgate Bath	28-Nov-23	120	52100	2	66058	Sans Souci (Public School)
	27-Feb-24	310	49100	1	66058	
	9-Apr-24	38	46200	0	66058	
	17-Apr-24	190	46200	0	66058	
Rose Bay Beach	2-Feb-24	520	51500	0.8	66098	Rose Bay (Royal Sydney Golf Club)
	8-Mar-24	40	52000	0	66098	

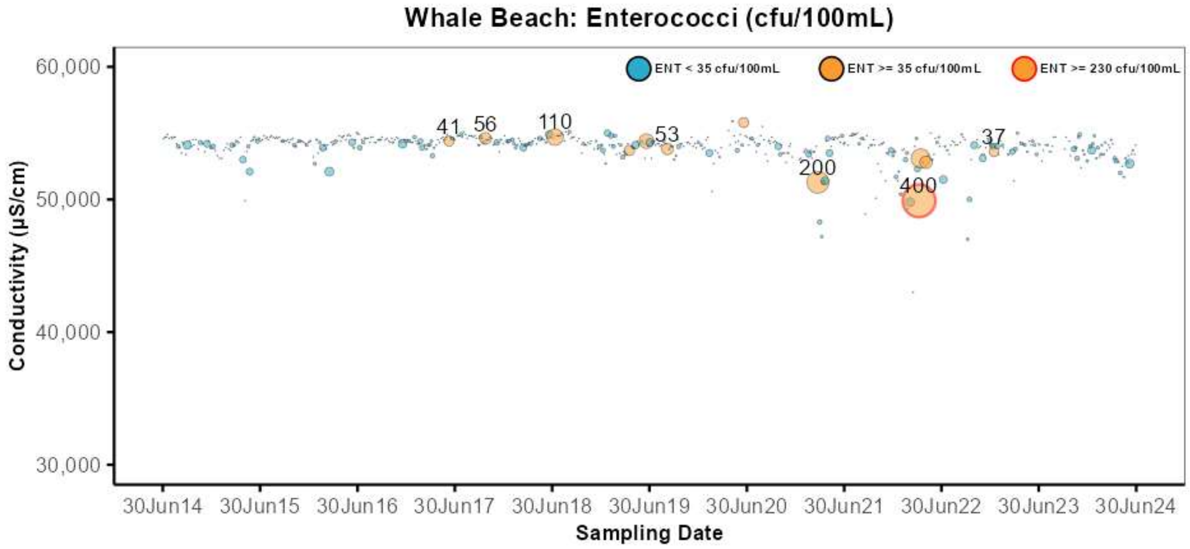
Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	14-Mar-24	210	50600	0	66098	
Sandringham Baths	14-Nov-23	150	52100	1	66058	Sans Souci (Public School)
	5-Feb-24	680	51000	0	66058	
	1-Mar-24	35	48600	1	66058	
	9-Apr-24	40	44310	0	66058	
	17-Apr-24	100	44640	0	66058	
Shelly Beach (Manly)	15-Nov-23	840	54200	0.6	66126	Collaroy (Long Reef Golf Club)
	21-Nov-23	140	54600	1.2	66126	
	13-Dec-23	42	54400	0.2	66126	
	1-Feb-24	120	53500	2	66126	
	13-Feb-24	50	54100	1.6	66126	
	19-Feb-24	90	53100	1.6	66126	
	6-Mar-24	80	54100	0	66126	
	20-May-24	47	54100	1.5	66126	
Shelly Beach (Sutherland)	13-Nov-23	74	53900	0	66058	Sans Souci (Public School)
Silver Beach	8-Nov-23	47	52500	2	66058	Sans Souci (Public School)
	22-Jan-24	310	52400	0	66058	
	7-Mar-24	45	53200	0	66058	
	9-Apr-24	40	42100	0	66058	
South Cronulla Beach	20-Jul-23	400	53500	0	66058	Sans Souci (Public School)
	13-Nov-23	540	53700	0	66058	
	12-Jan-24	42	53700	0	66058	

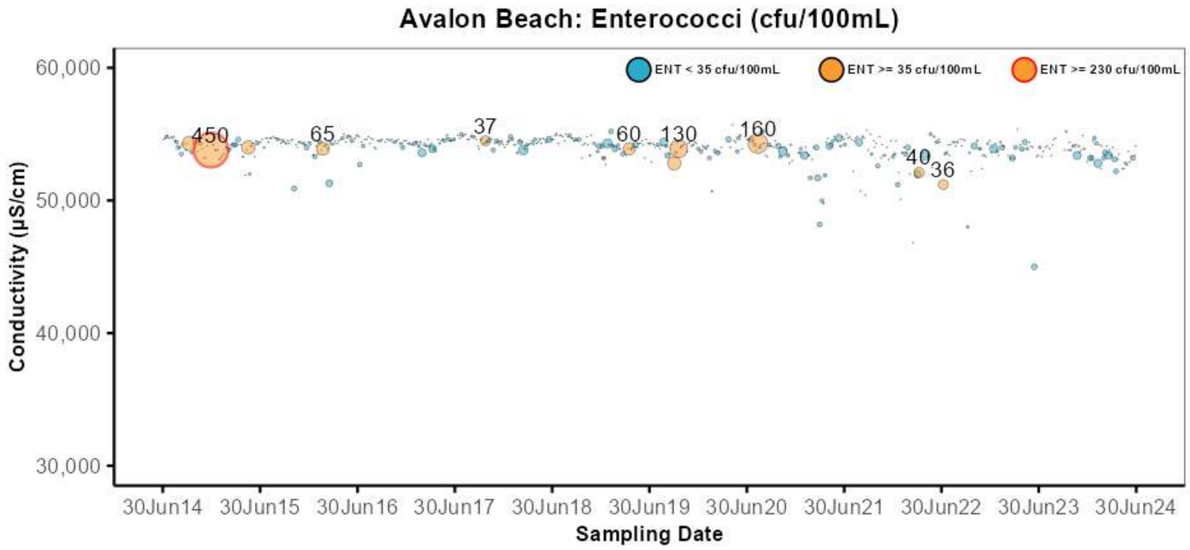
Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	5-Mar-24	46	54000	0	66058	
	18-Apr-24	80	53100	0	66058	
South Maroubra Beach	24-Jan-24	39	54400	0	66052	Randwick (Randwick St)
South Maroubra Rockpool	24-Jan-24	110	54500	0	66052	Randwick (Randwick St)
	11-Mar-24	150	52308	0	66052	
	18-Apr-24	100	53100	0.2	66052	
South Steyne Beach	19-Feb-24	140	53500	1.6	66126	Collaroy (Long Reef Golf Club)
	12-Mar-24	36	53600	0	66126	
Tamarama Beach	13-Nov-23	50	53100	1	66098	Rose Bay (Royal Sydney Golf Club)
	24-Jan-24	39	53100	0	66098	
Tambourine Bay	16-Nov-23	130	52700	0	66011	Chatswood Bowling Club
	22-Nov-23	110	50800	2	66011	
	30-Jan-24	270	41888	1	66011	
	8-Mar-24	62	47900	0	66011	
Taylors Point Baths	29-Feb-24	36	52400	0.6	66141	Mona Vale Golf Club
The Basin	15-Apr-24	150	46550	0.6	66141	Mona Vale Golf Club
Thirroul Beach	15-Nov-23	62	54100	0	68228	Bellambi AWS
Turimetta Beach	15-Apr-24	44	53400	0.6	66141	Mona Vale Golf Club
Wanda Beach	13-Nov-23	180	54100	0	66058	Sans Souci (Public School)
Watsons Bay	16-Apr-24	41	49500	0.2	66098	Rose Bay (Royal Sydney Golf Club)
Woodford Bay	22-Nov-23	45	52000	2	66011	Chatswood Bowling Club
	30-Jan-24	130	45900	1	66011	

Name	Date	*Enterococci* (cfu/100mL)	Conductivity (µS/cm)	72 hours Rain (mm)	Station Number	Rainfall Station Name
	4-Mar-24	35	48800	1	66011	
Woolwich Baths	16-Nov-23	110	51900	2	66034	Abbotsford (Blackwall Point Rd)
	30-Jan-24	230	45900	1.8	66034	
	8-Mar-24	78	49200	2	66034	
Woonona Beach	15-Nov-23	38	54100	0	68228	Bellambi AWS
Yarra Bay	2-Nov-23	240	52500	0	66037	Sydney Airport AMO
	14-Nov-23	100	53400	0.8	66037	
	27-Feb-24	35	51100	0	66037	
	1-Mar-24	52	52000	0	66037	
	9-Apr-24	230	40970	0	66037	

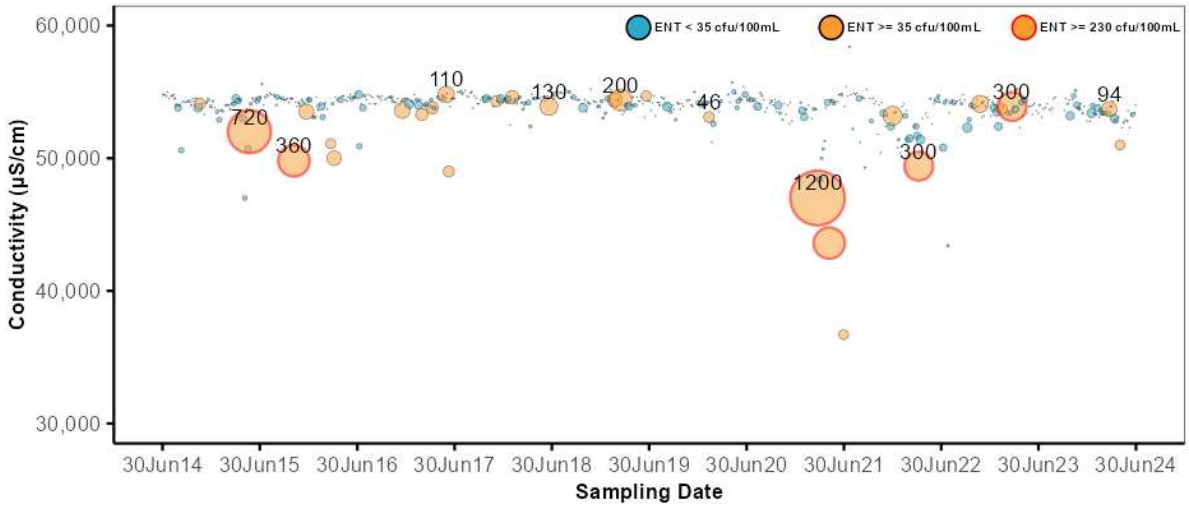
G.1. Sydney Beaches: Northern Sydney



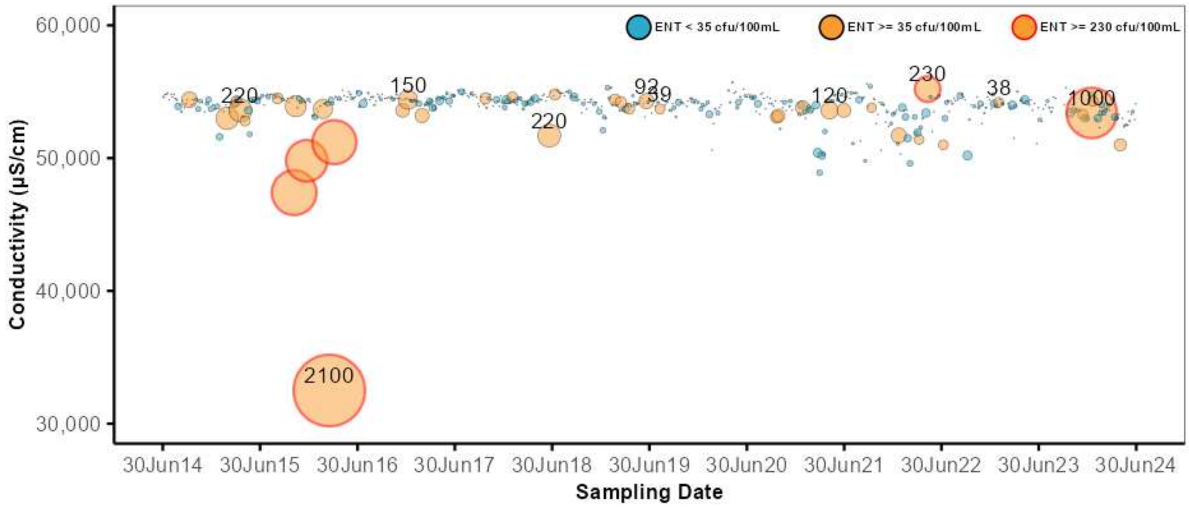




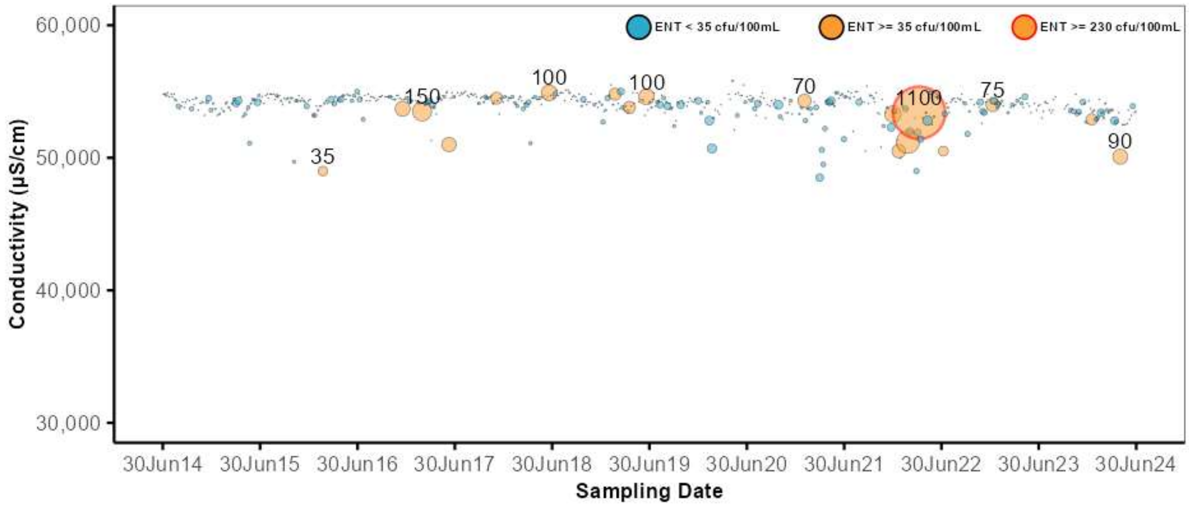
Bilgola Beach: Enterococci (cfu/100mL)



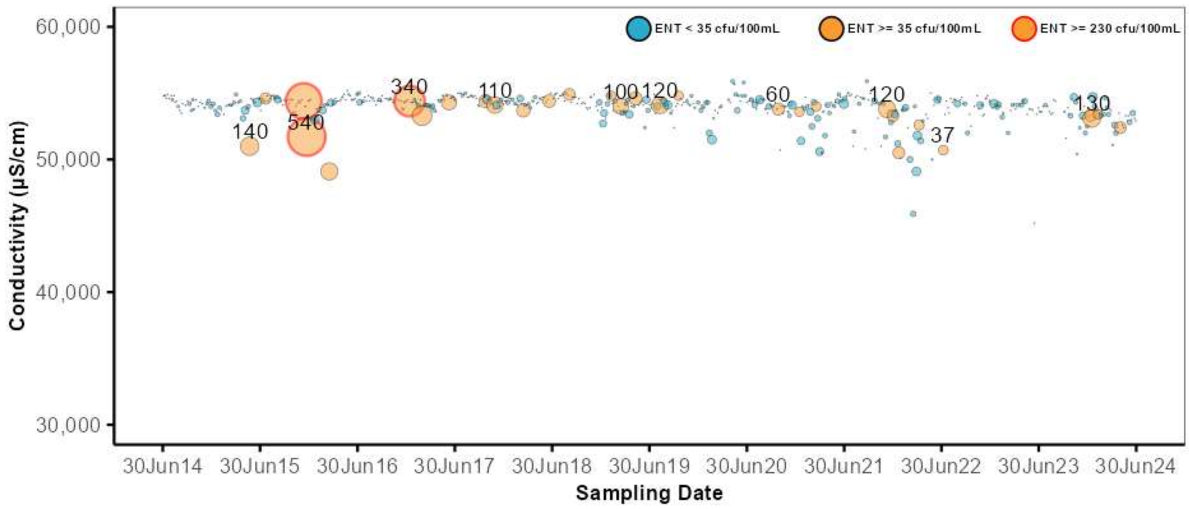
Newport Beach: Enterococci (cfu/100mL)



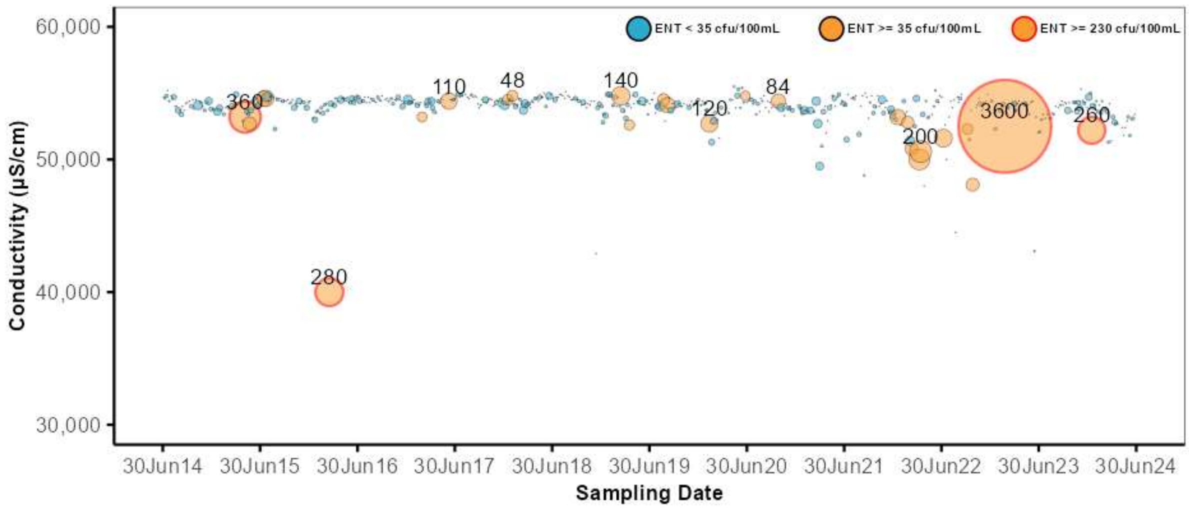
Bungan Beach: Enterococci (cfu/100mL)



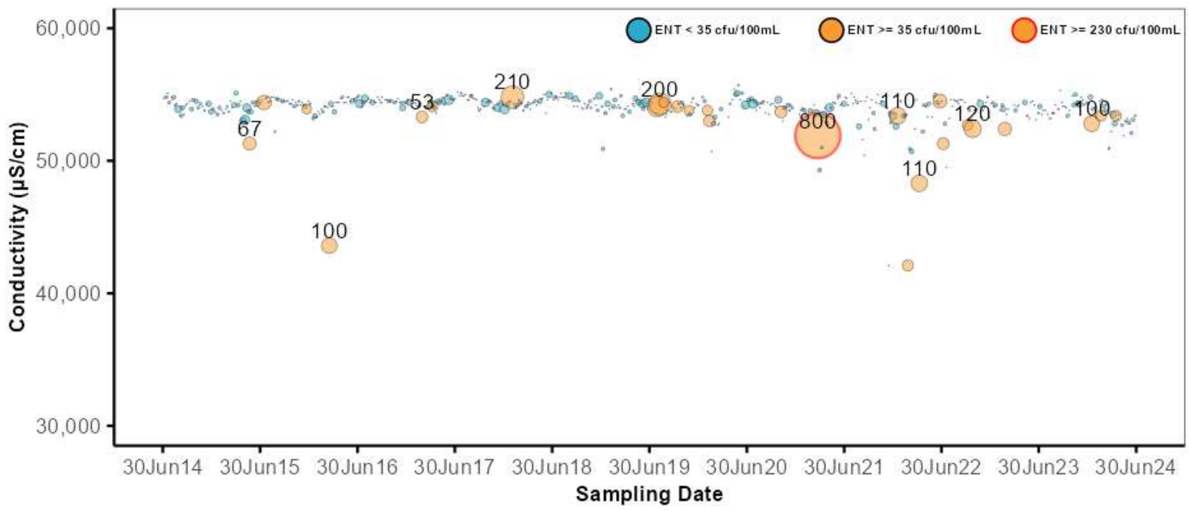
Mona Vale Beach: Enterococci (cfu/100mL)



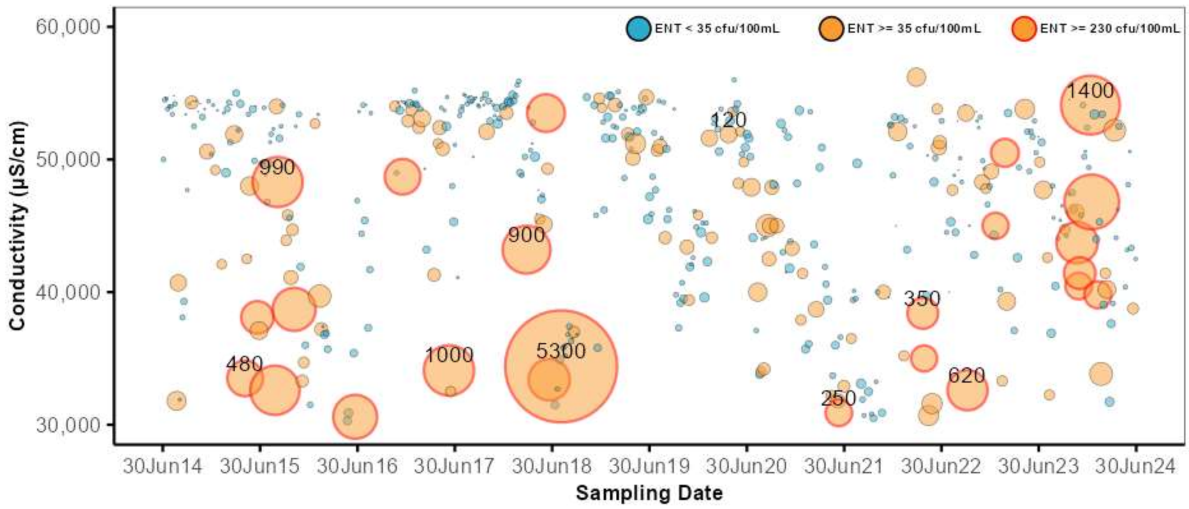
Warriewood Beach: Enterococci (cfu/100mL)



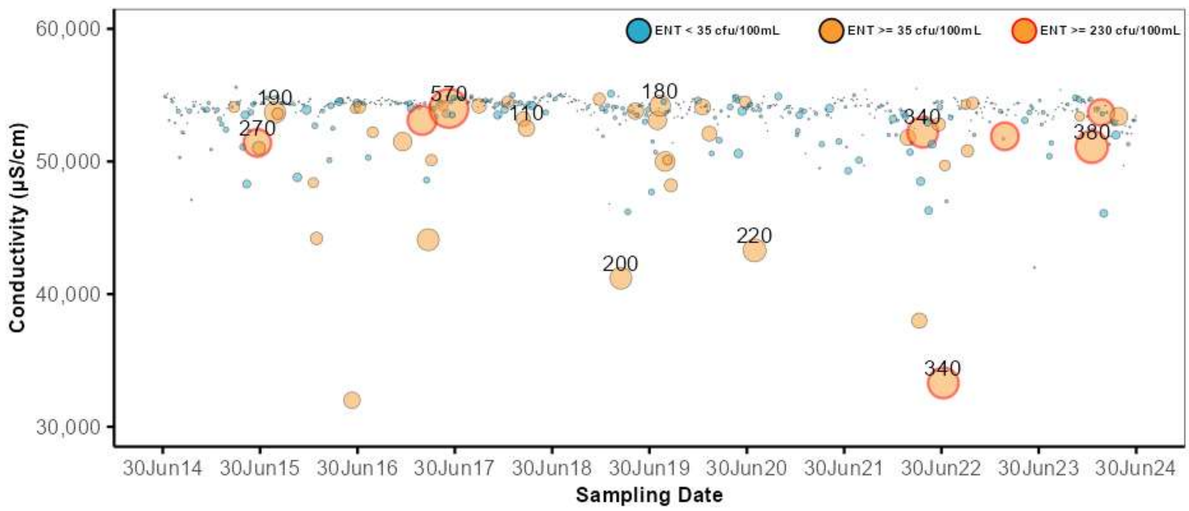
Turimetta Beach: Enterococci (cfu/100mL)



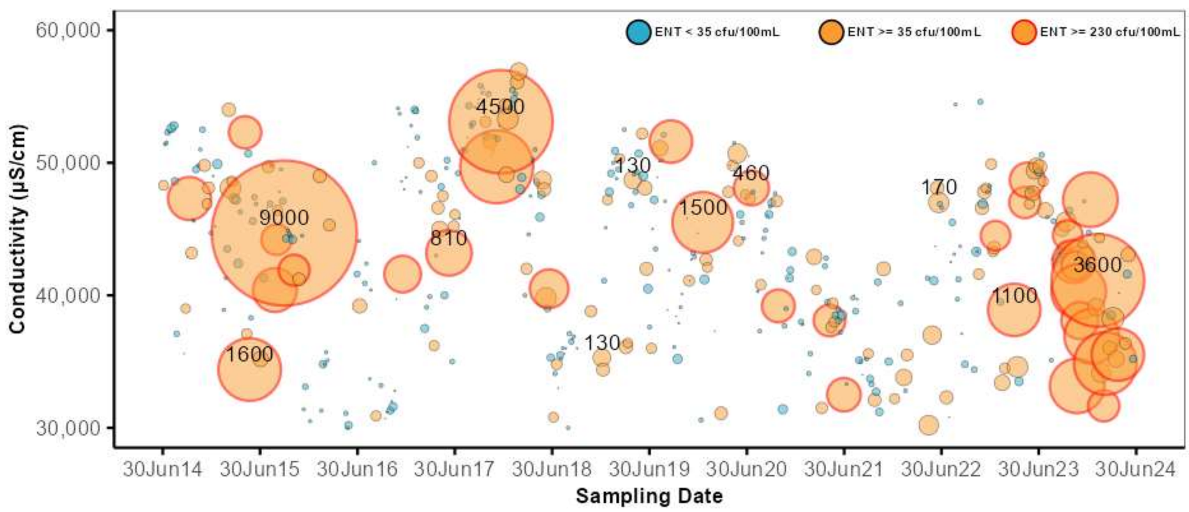
Narrabeen Lagoon (Birdwood Park): Enterococci (cfu/100mL)



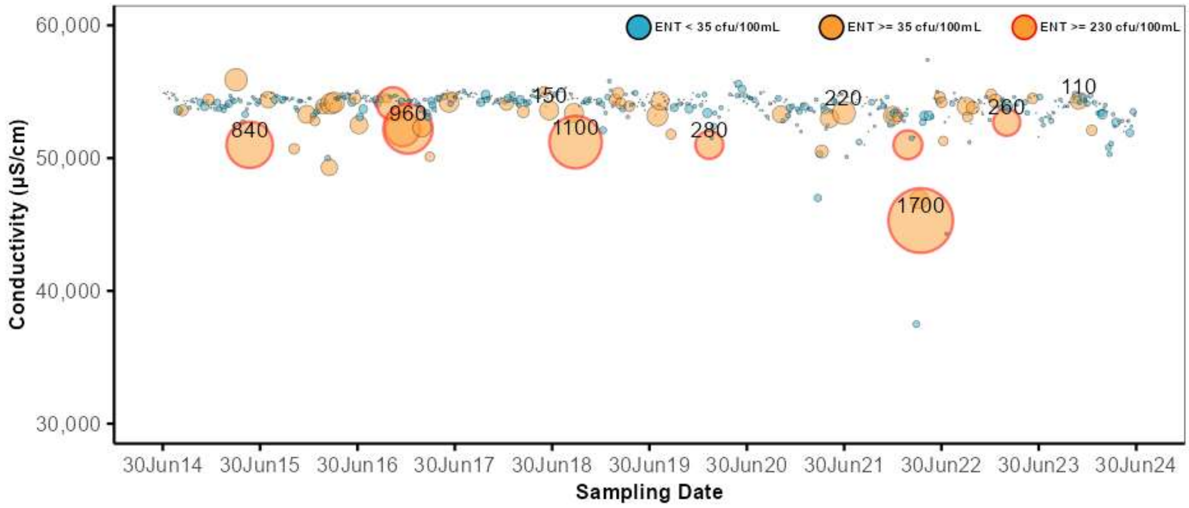
North Narrabeen Beach: Enterococci (cfu/100mL)



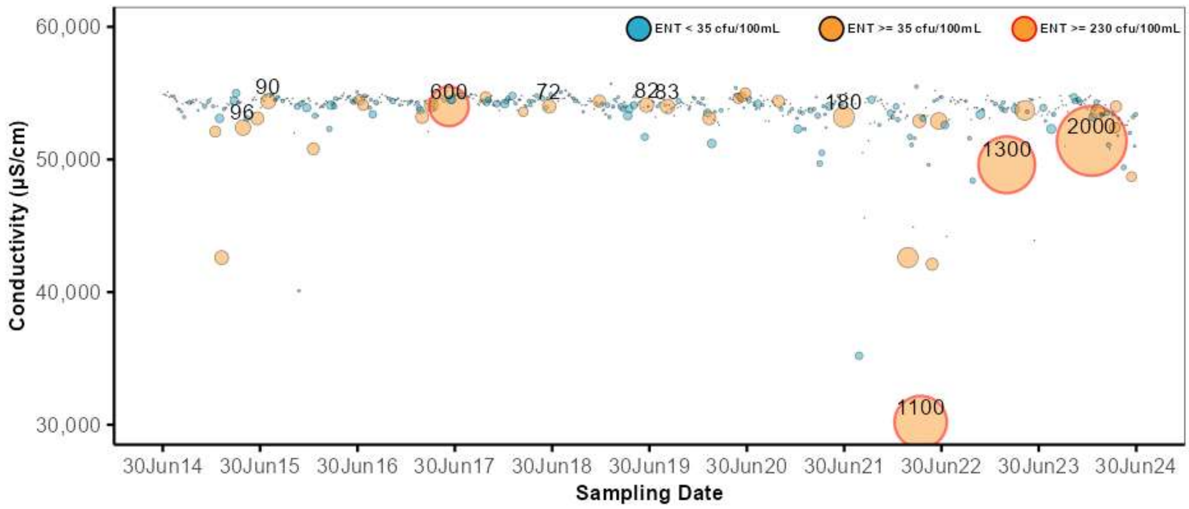
Bilarong Reserve: Enterococci (cfu/100mL)



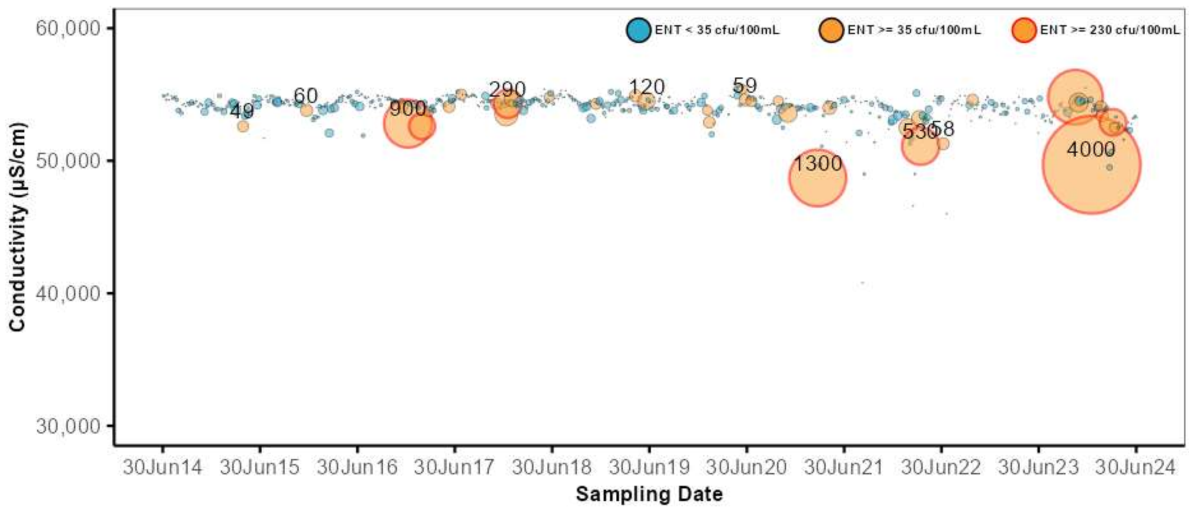
Collaroy Beach: Enterococci (cfu/100mL)

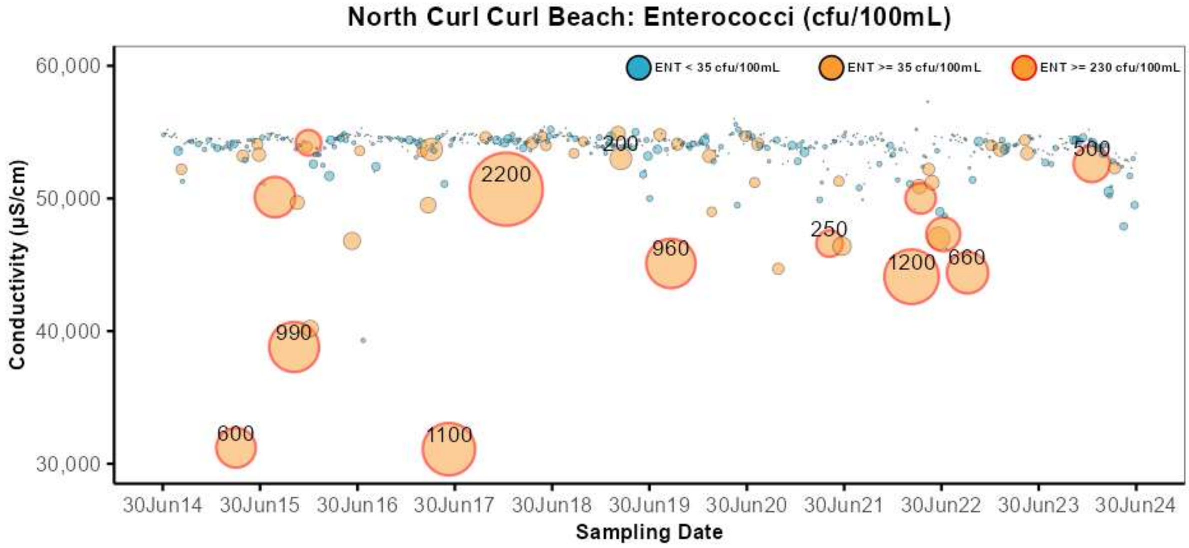


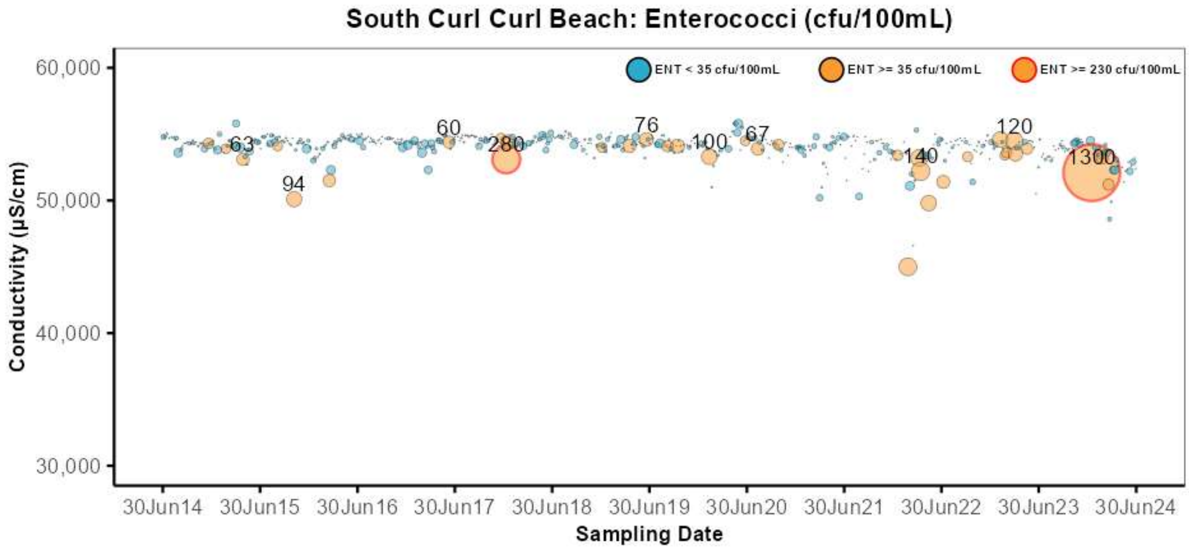
Long Reef Beach: Enterococci (cfu/100mL)

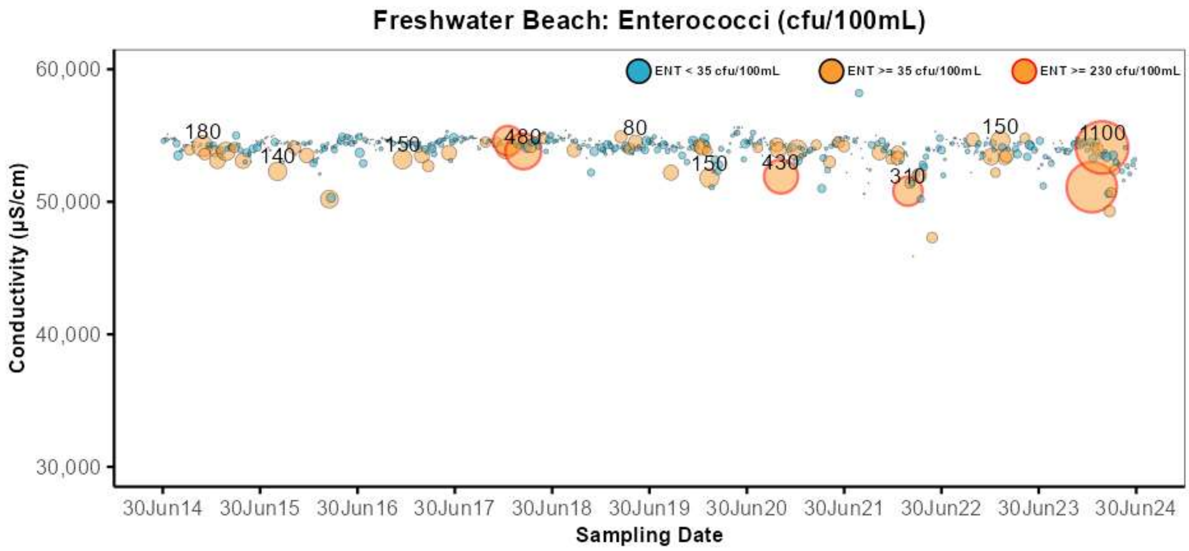


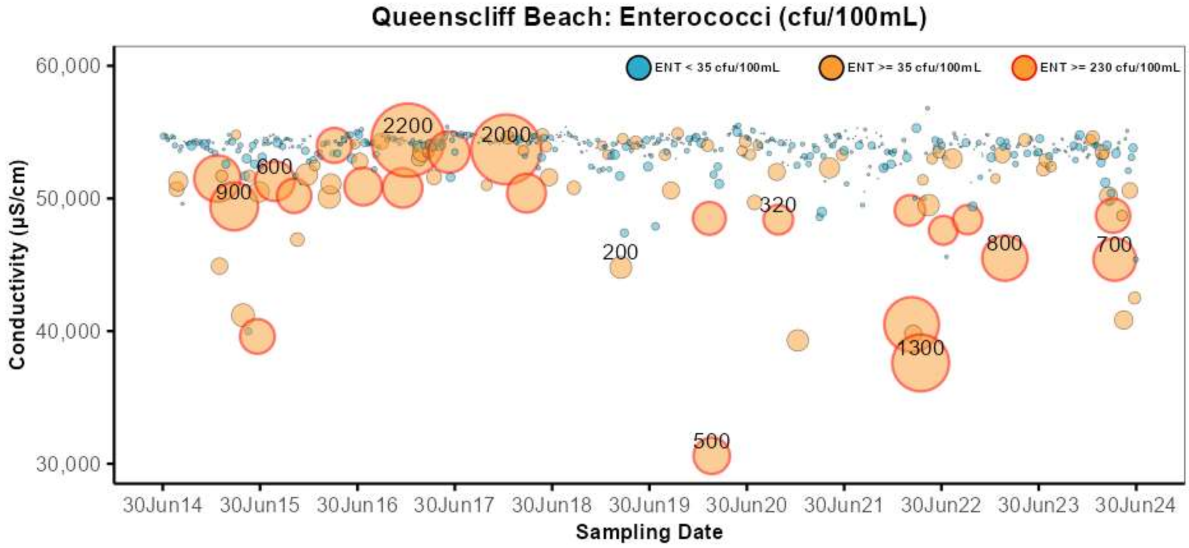
Dee Why Beach: Enterococci (cfu/100mL)

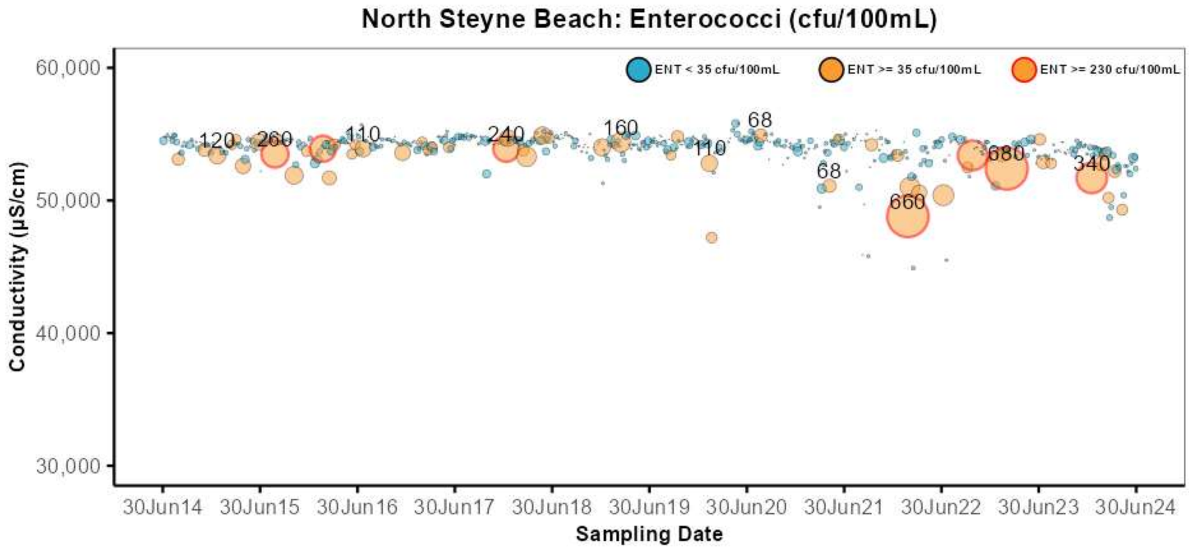


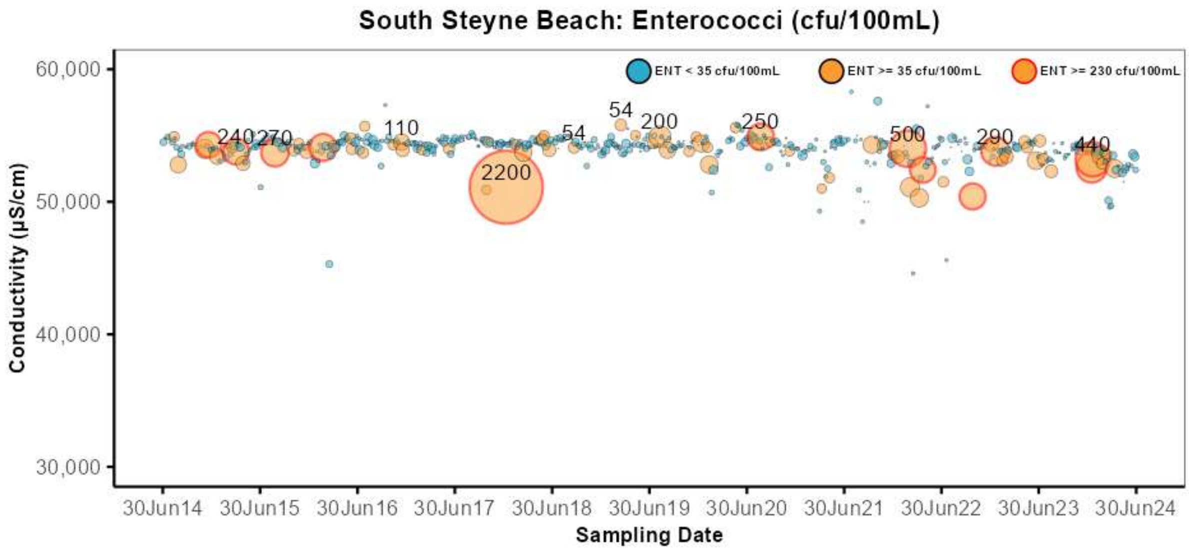

North Curl Curl Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
200
2200
500
250
960
1200
660
990
600
1100
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


South Curl Curl Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
63
60
280
76
100
67
120
140
1300
94
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

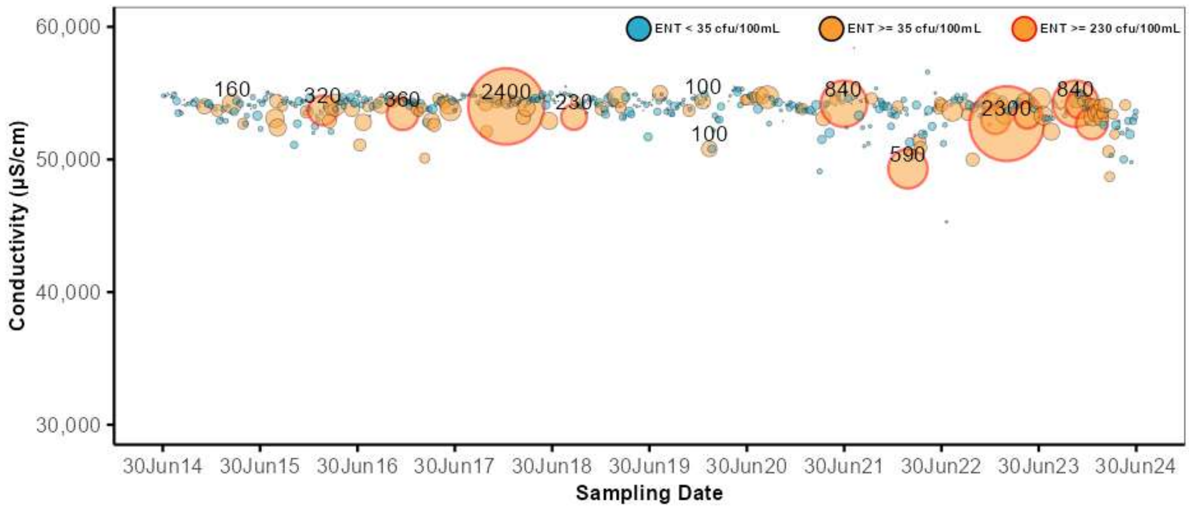

Freshwater Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
180
140
150
480
80
150
430
150
310
1100
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


Queenscliff Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
2200
2000
600
900
320
200
800
700
1300
500
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


North Steyne Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
120
260
110
240
160
110
68
68
680
340
660
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

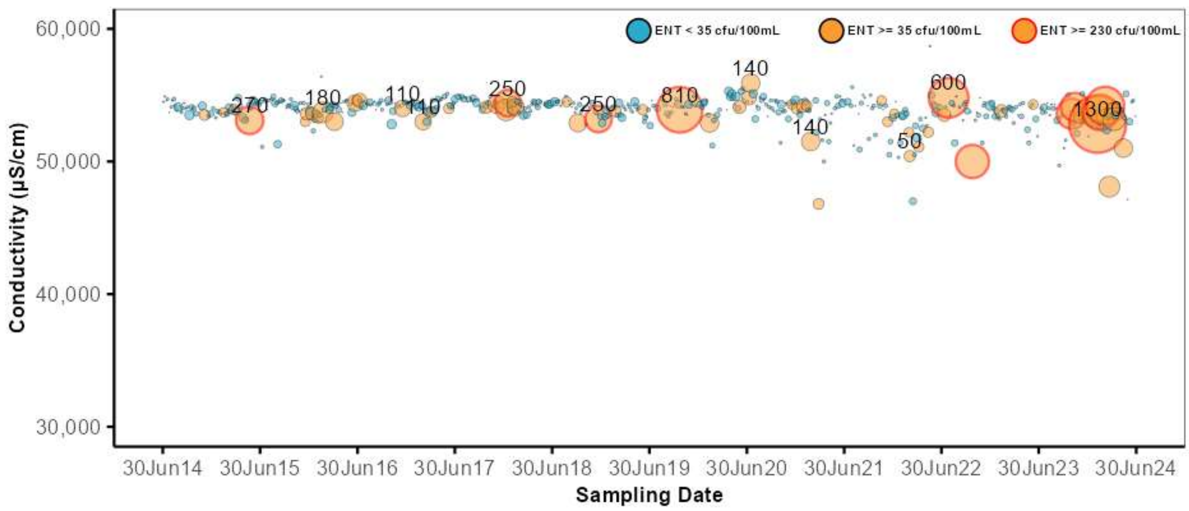

South Steyne Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
240
270
110
54
54
200
250
500
290
440
2200
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

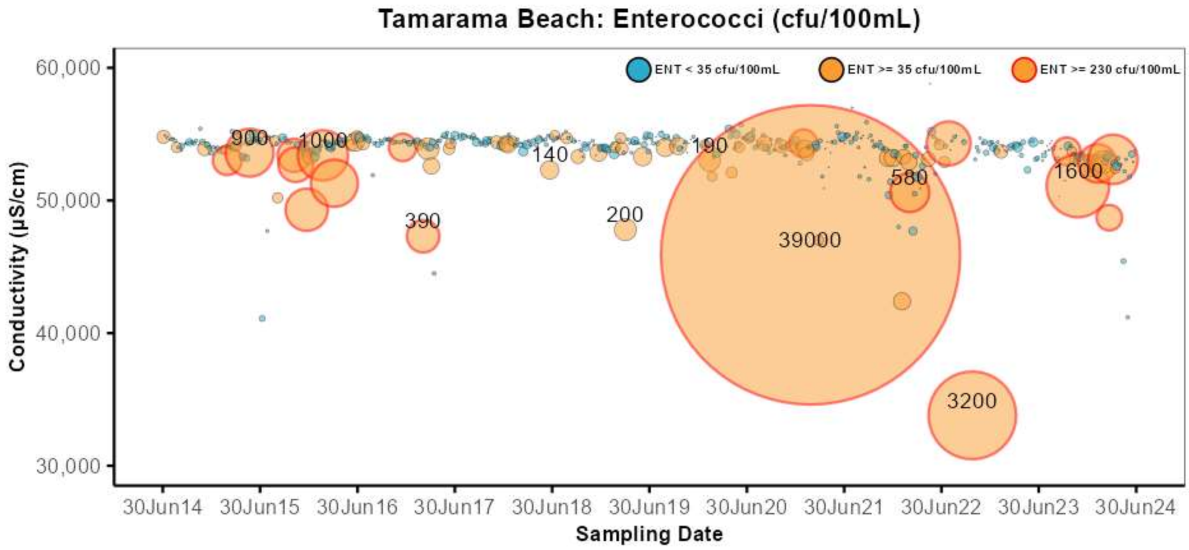
Shelly Beach (Manly): Enterococci (cfu/100mL)

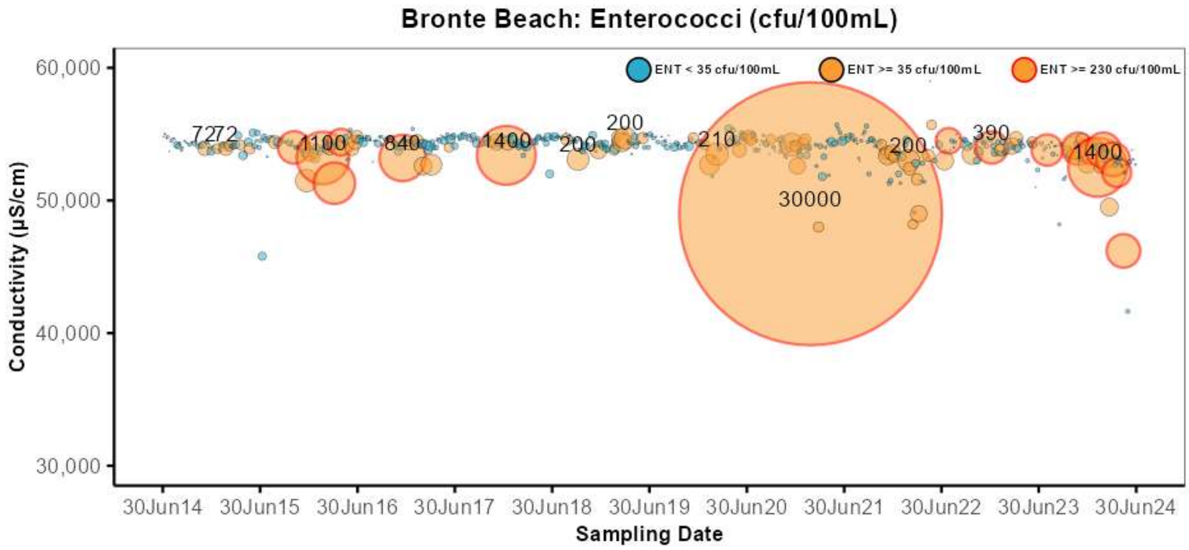


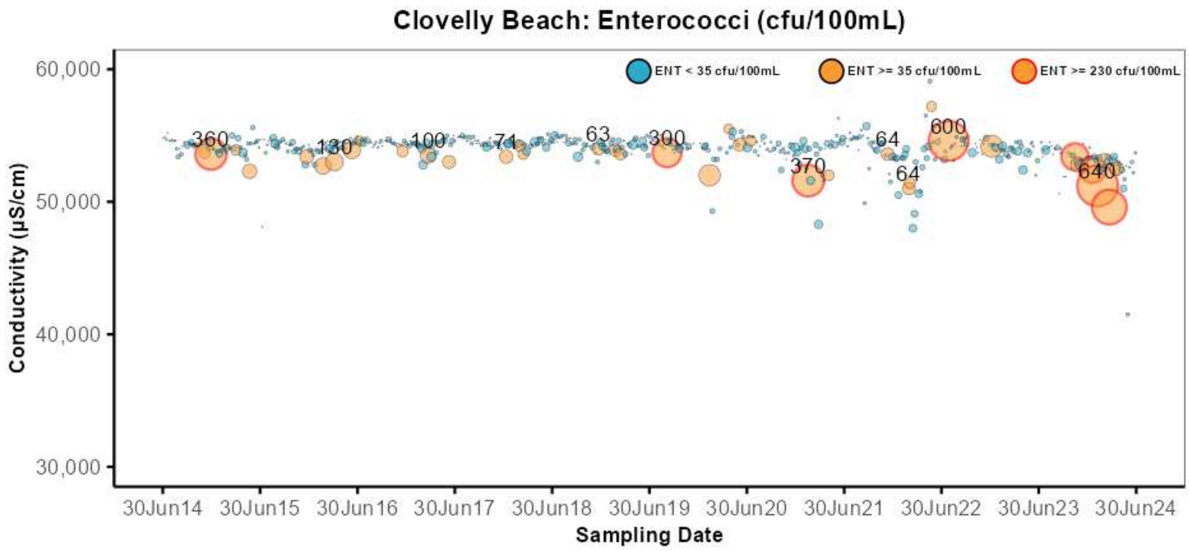
G.2. Sydney Beaches: Central Sydney

Bondi Beach: Enterococci (cfu/100mL)

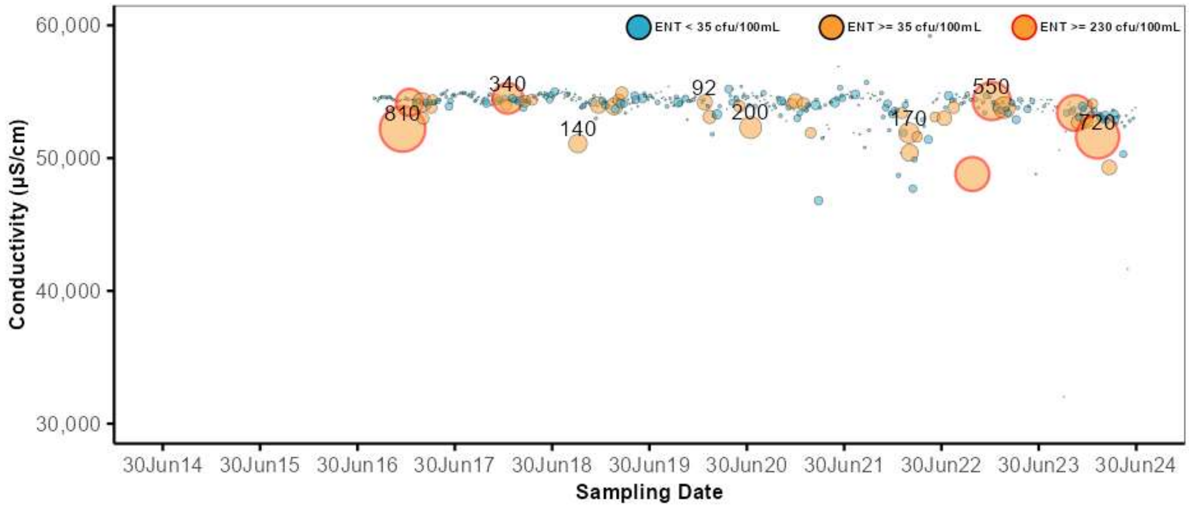



Tamarama Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
900
1000
140
190
580
1600
390
200
39000
3200
60,000
50,000
40,000
30,000
Conductivity (µS/cm)
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

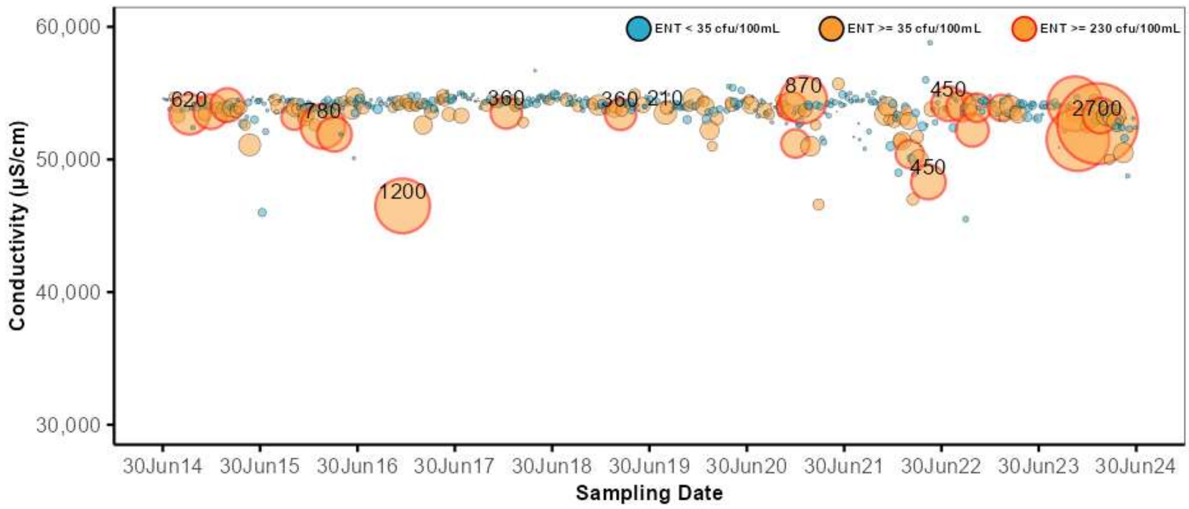

Bronte Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
7272
1100
840
1400
200
200
210
200
390
1400
30000
60,000
50,000
40,000
30,000
Conductivity (µS/cm)
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


Clovelly Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
360
130
100
71
63
300
370
64
64
600
640
60,000
50,000
40,000
30,000
Conductivity (µS/cm)
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

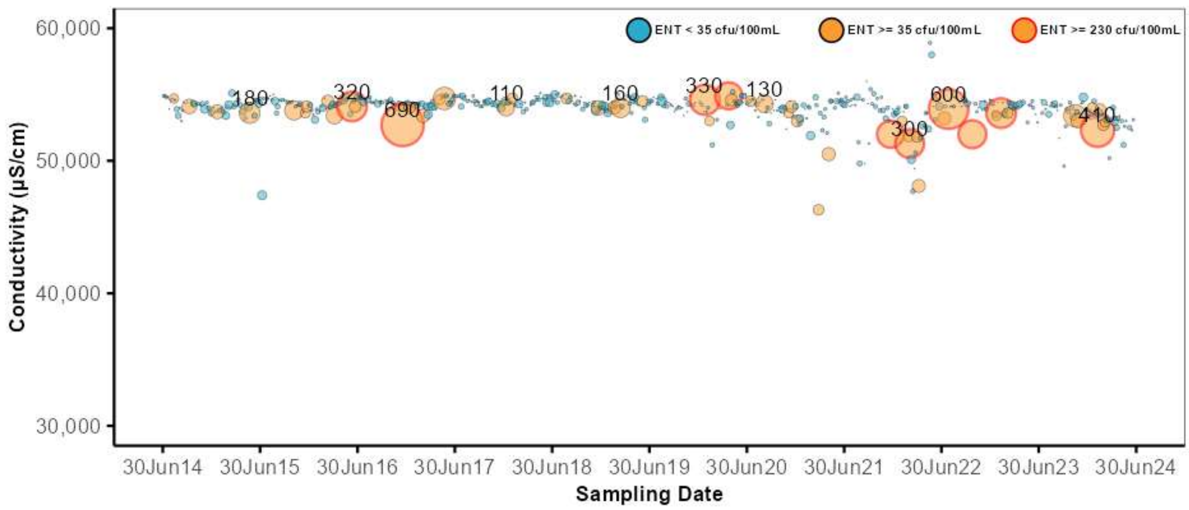
Gordons Bay: Enterococci (cfu/100mL)



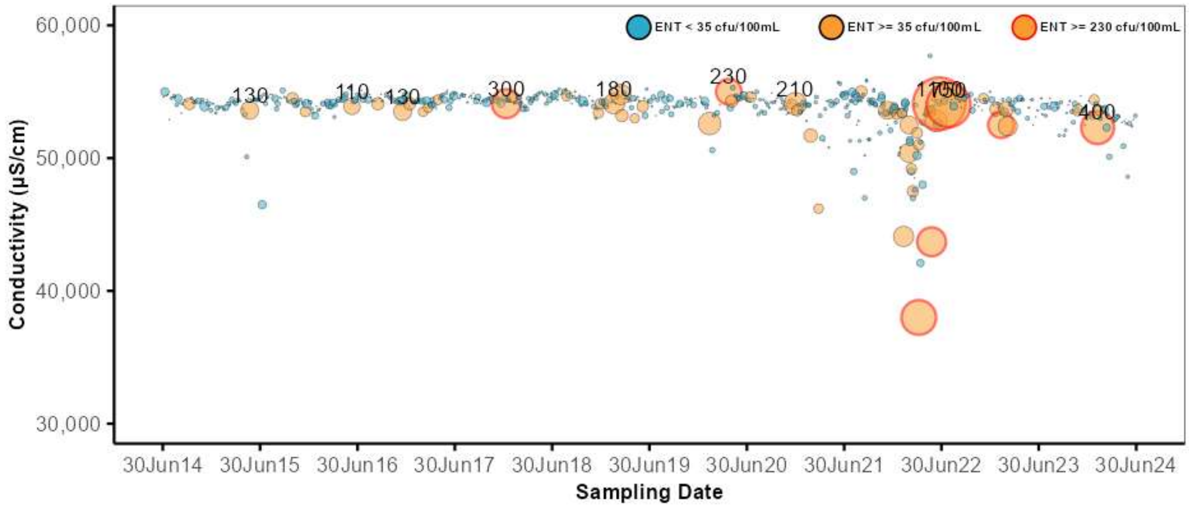
Coogee Beach: Enterococci (cfu/100mL)



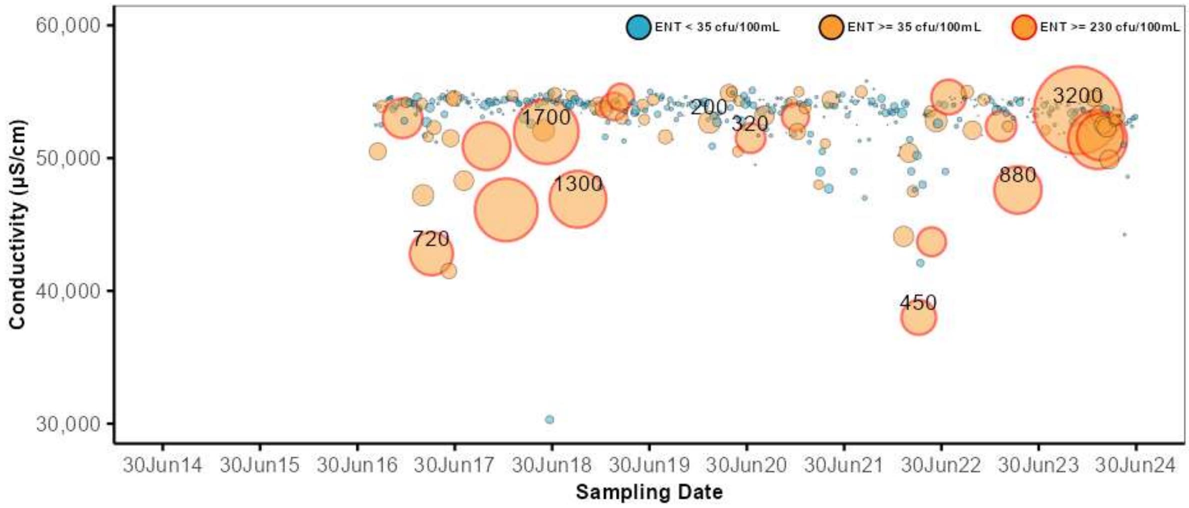
Maroubra Beach: Enterococci (cfu/100mL)



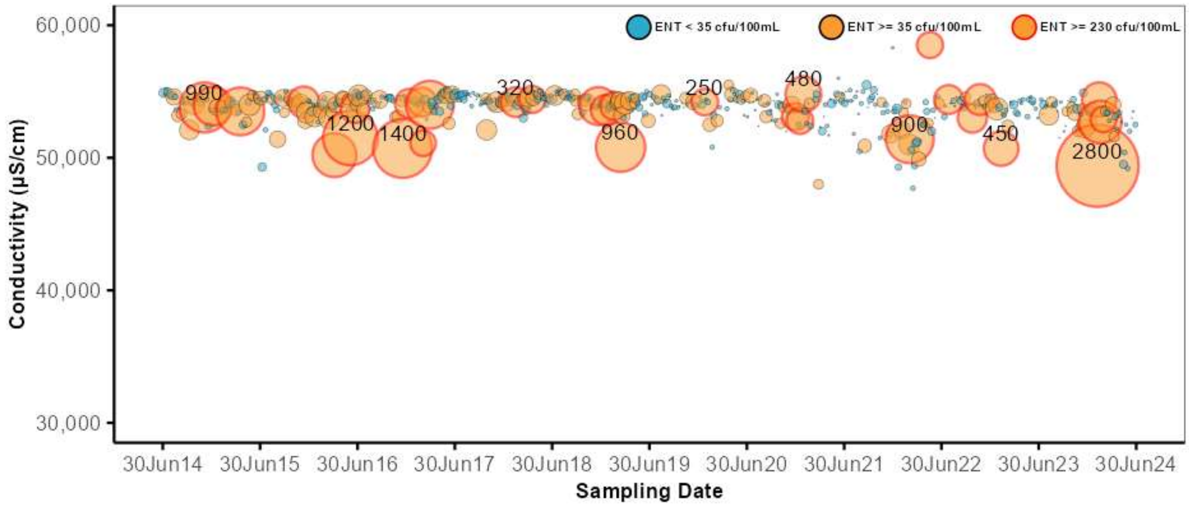
South Maroubra Beach: Enterococci (cfu/100mL)



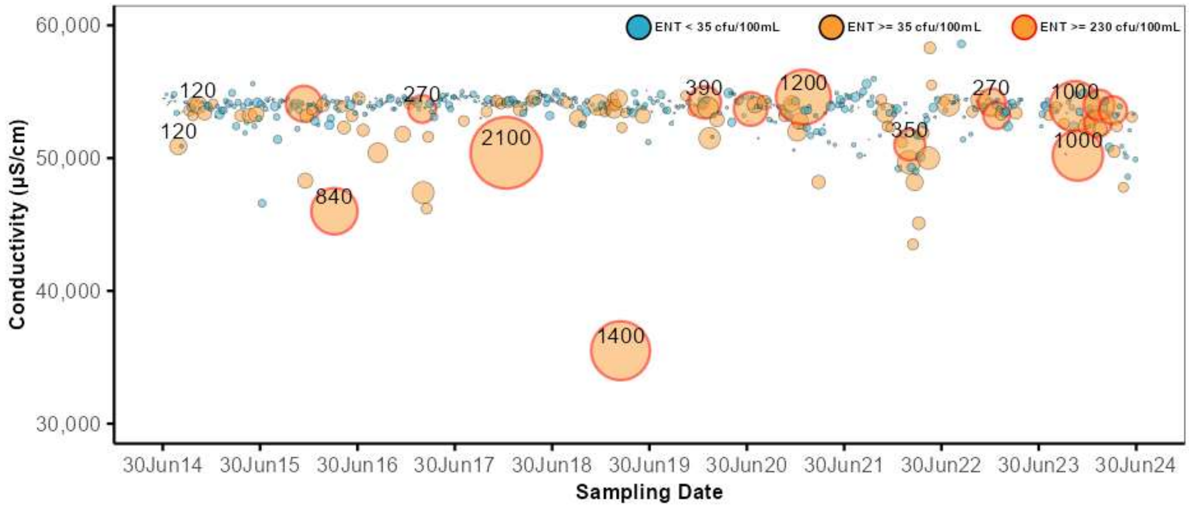
South Maroubra Rockpool: Enterococci (cfu/100mL)



Malabar Beach: Enterococci (cfu/100mL)

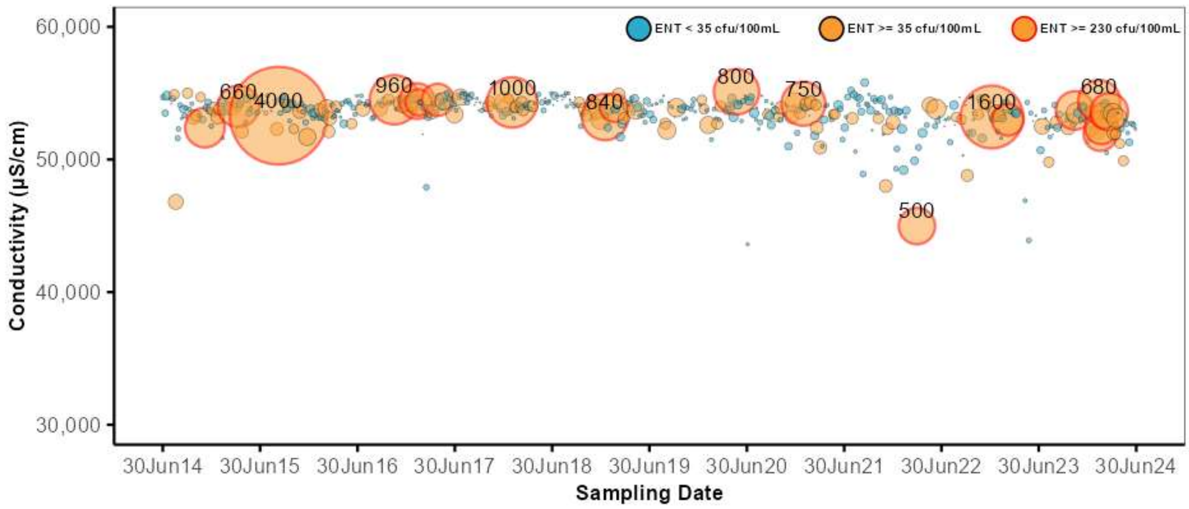


Little Bay: Enterococci (cfu/100mL)

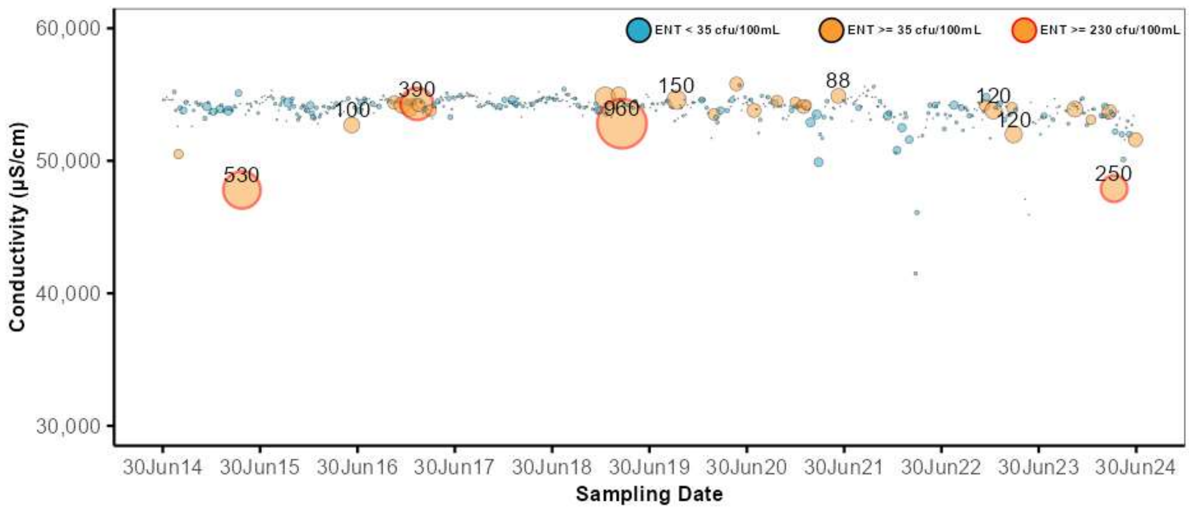


G.3. Sydney Beaches: Southern Sydney

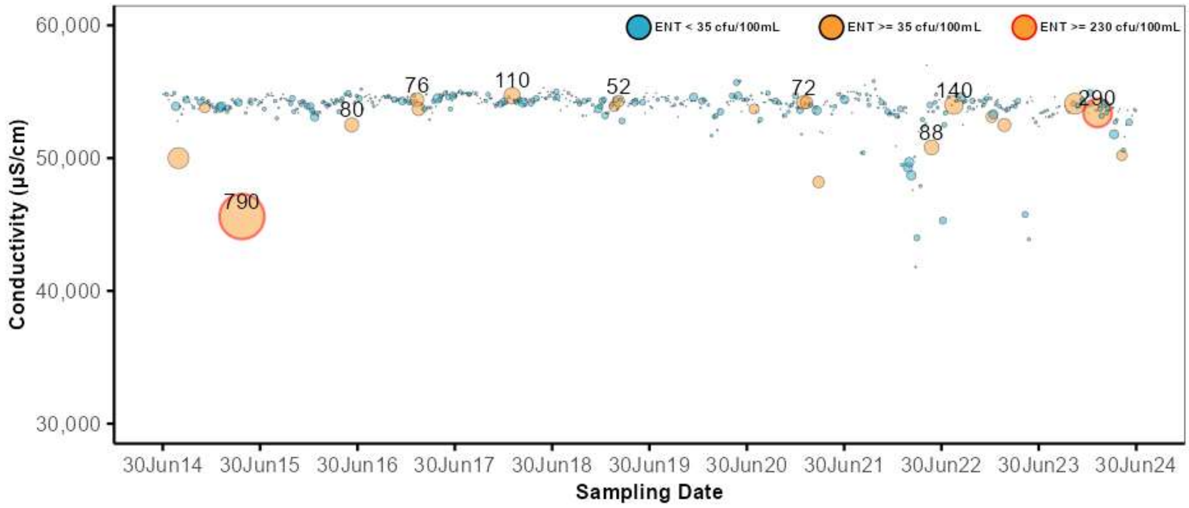
Boat Harbour: Enterococci (cfu/100mL)



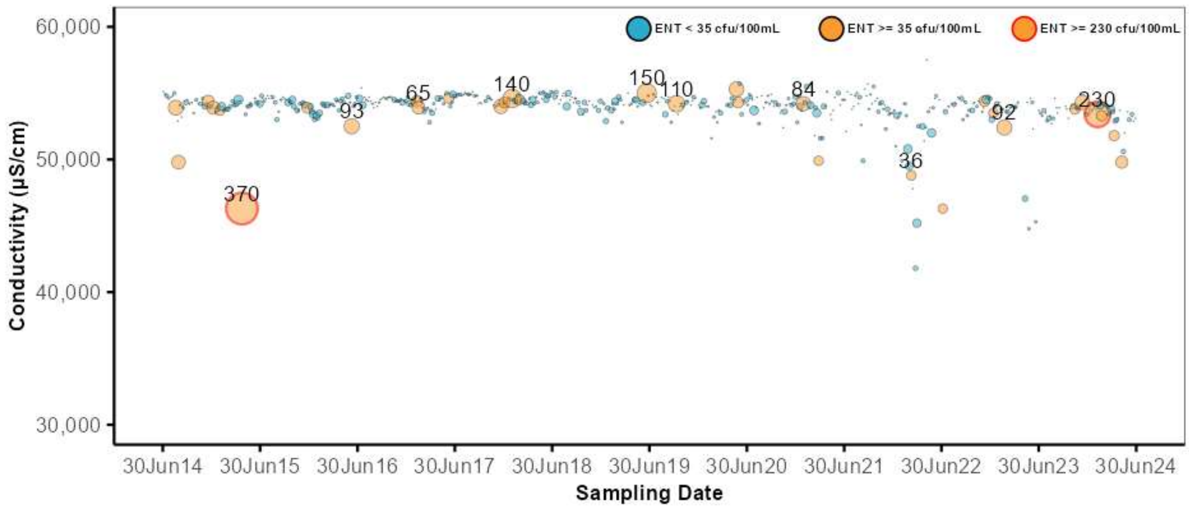
Greenhills Beach: Enterococci (cfu/100mL)



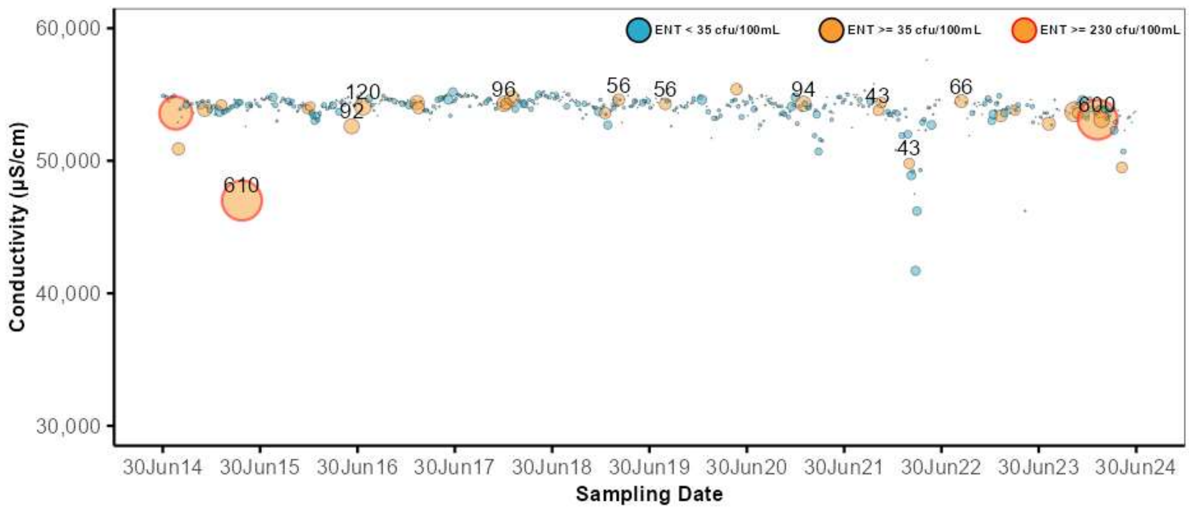
Wanda Beach: Enterococci (cfu/100mL)



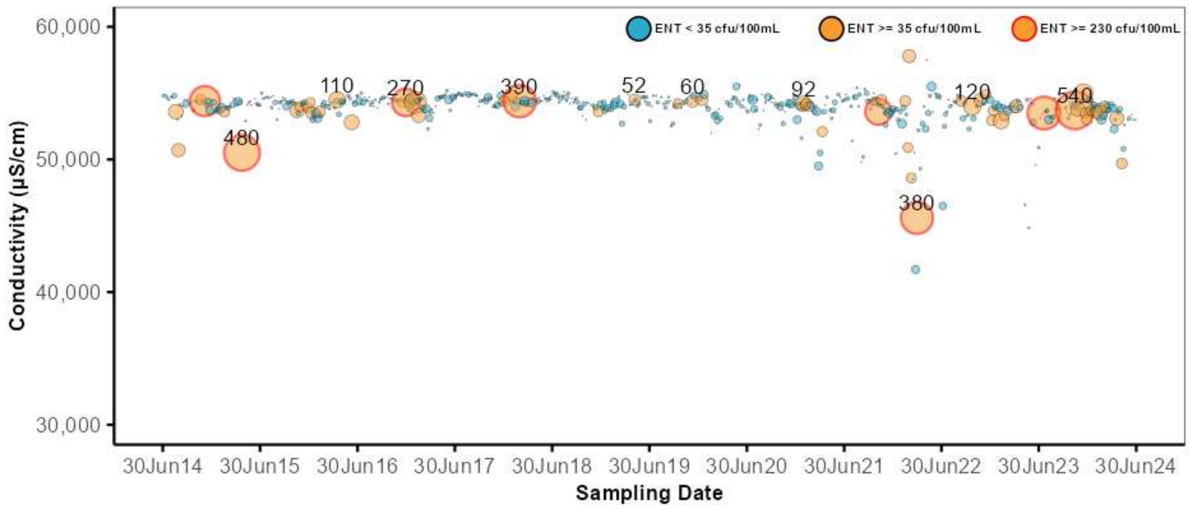
Elouera Beach: Enterococci (cfu/100mL)



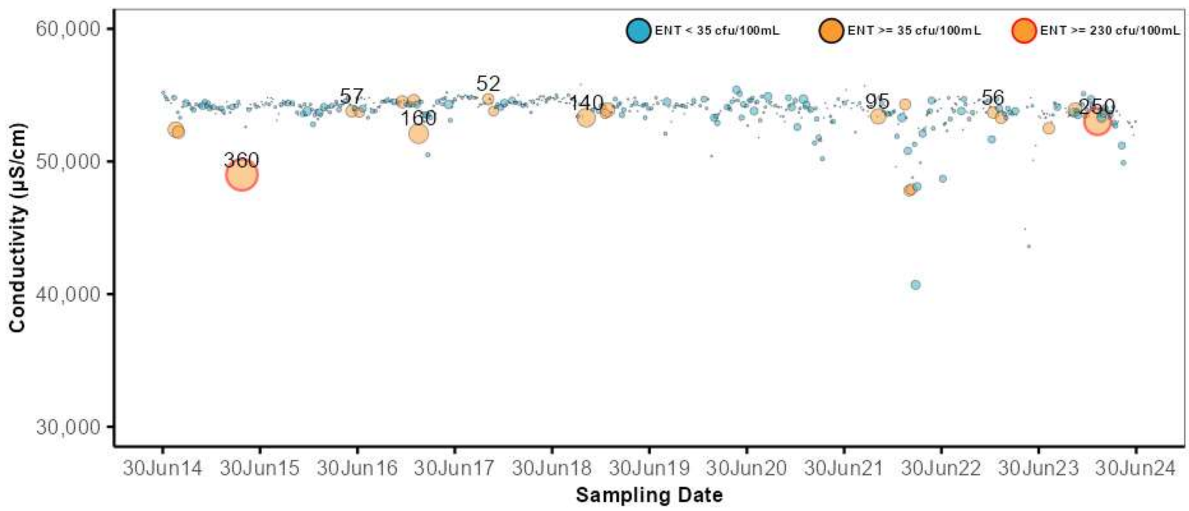
North Cronulla Beach: Enterococci (cfu/100mL)



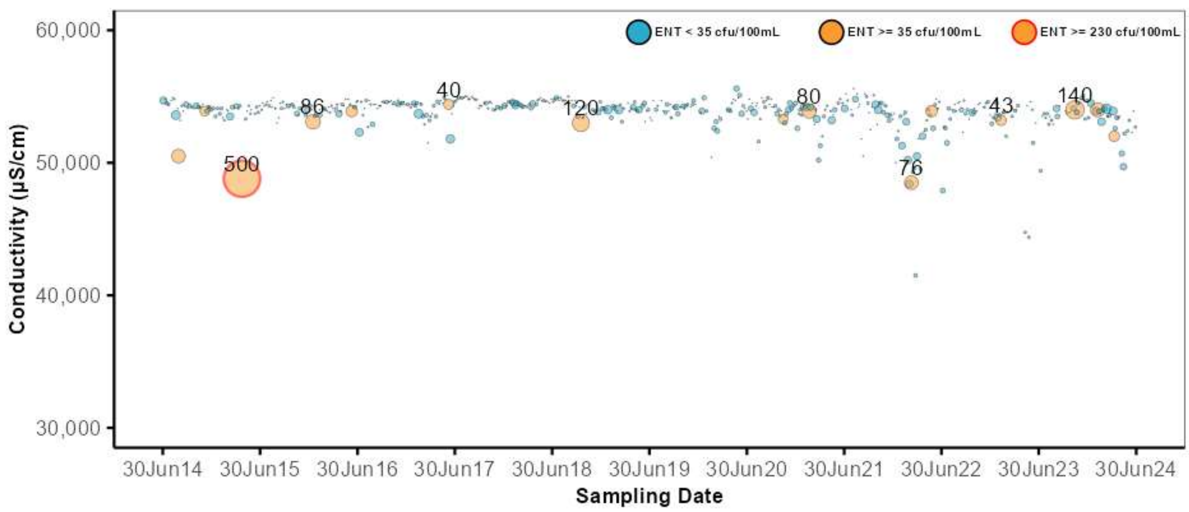
South Cronulla Beach: Enterococci (cfu/100mL)



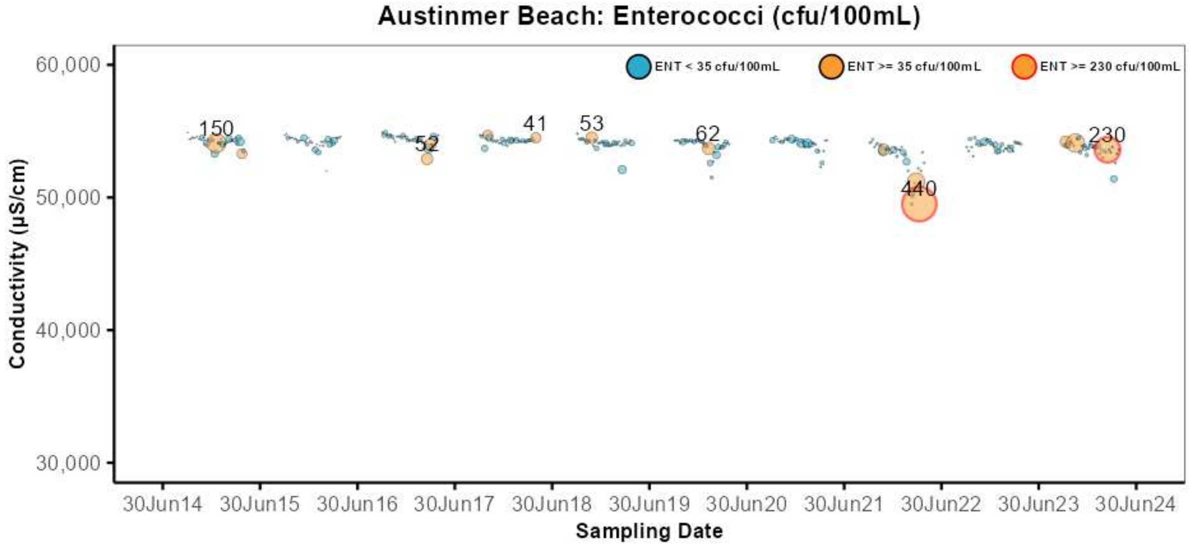
Shelly Beach (Sutherland): Enterococci (cfu/100mL)

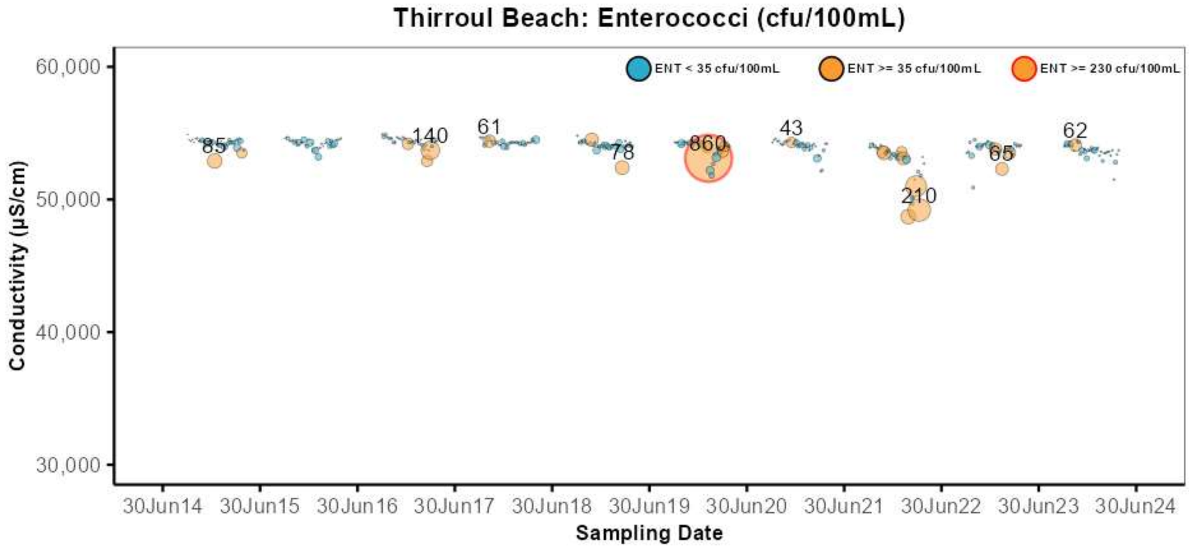


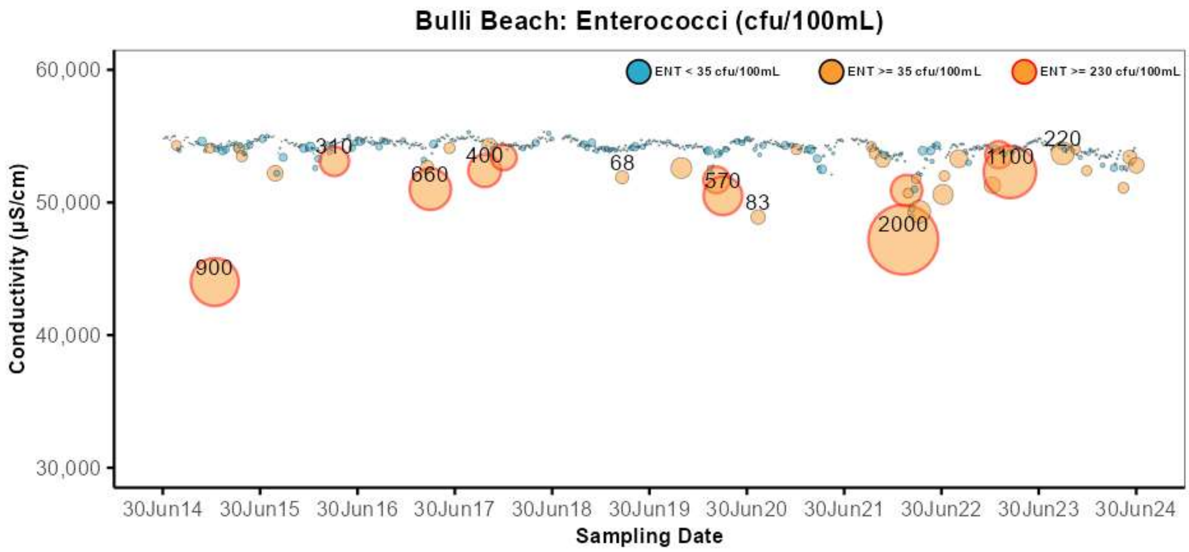
Oak Park: Enterococci (cfu/100mL)

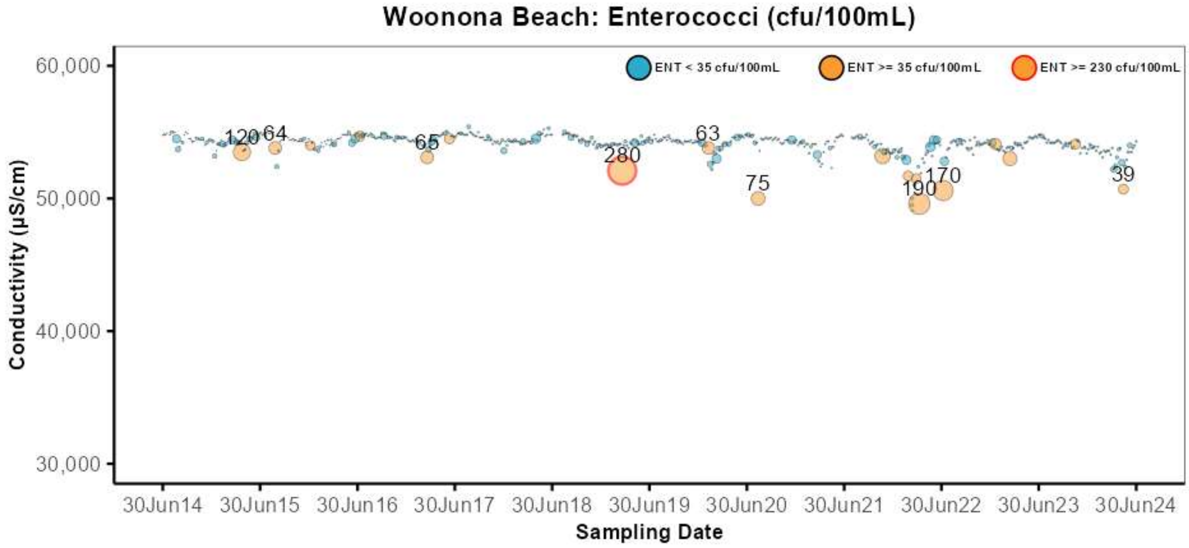


G.4. Illawarra Beaches: Wollongong

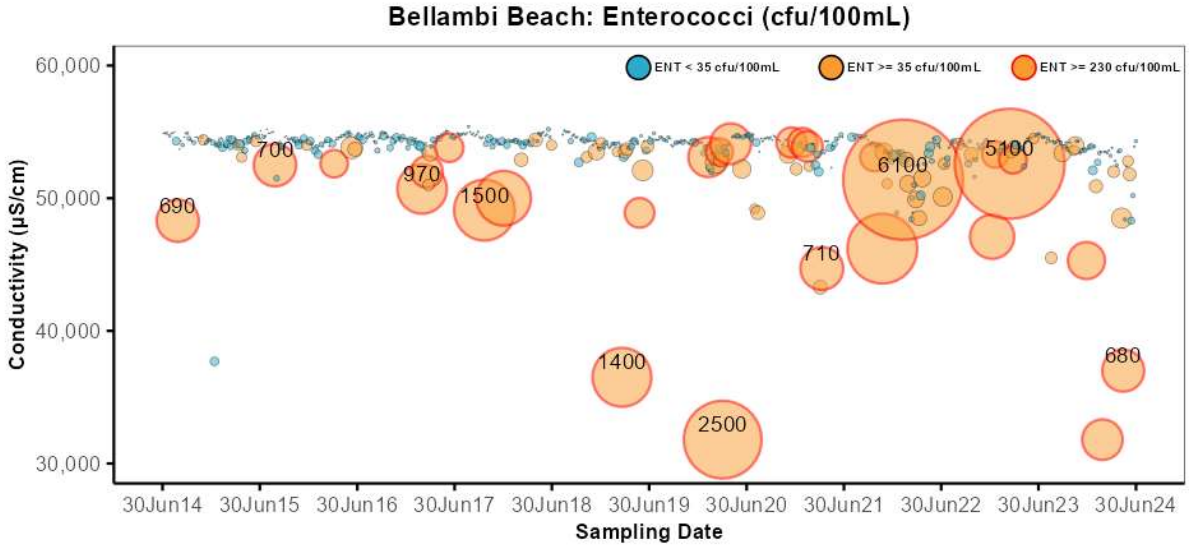




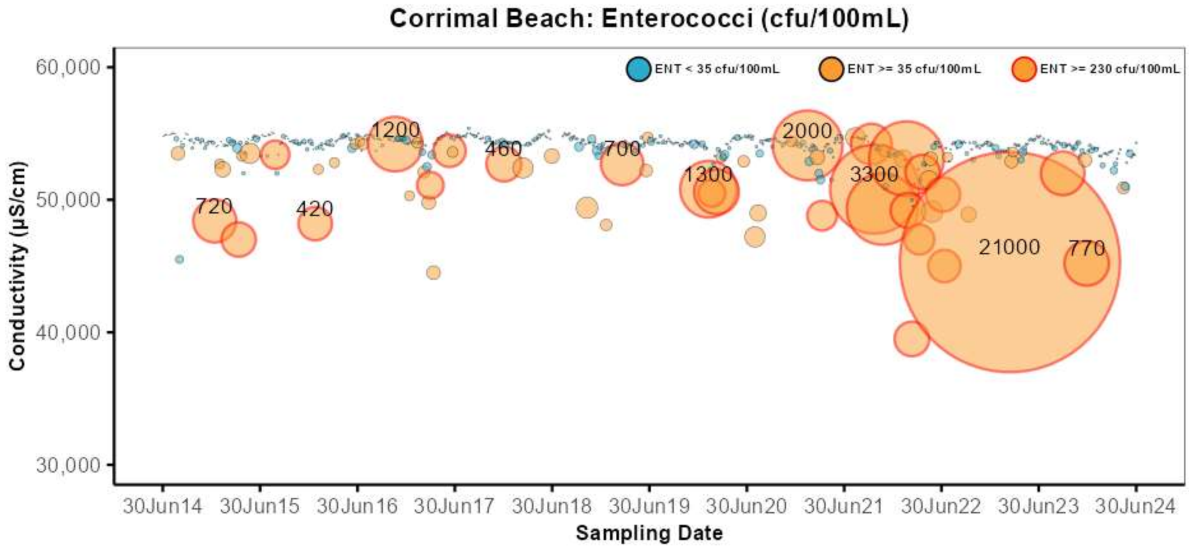




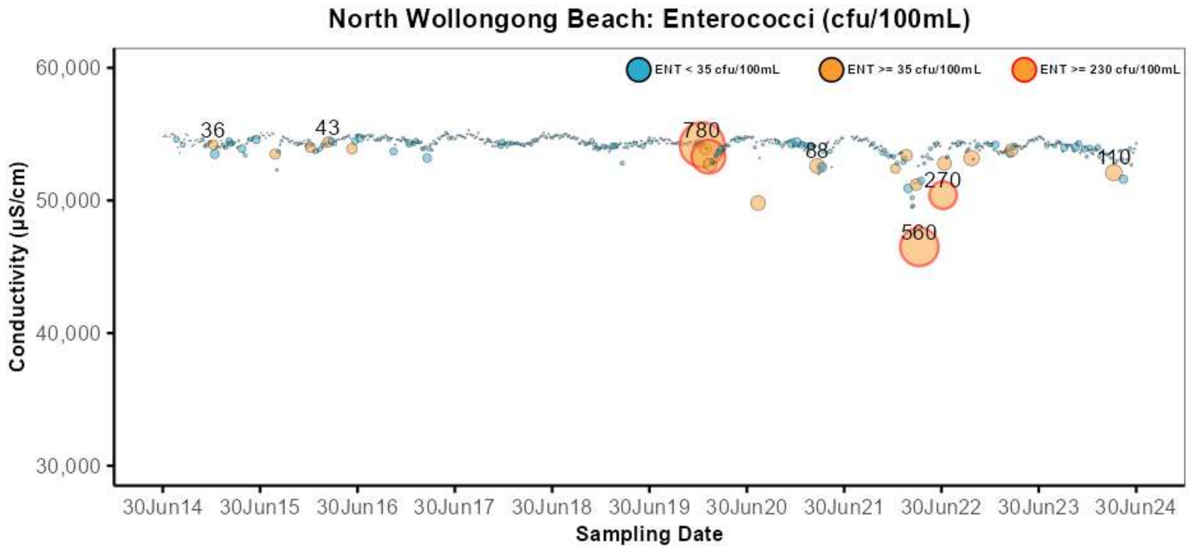
Woonona Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
120
64
65
280
63
75
190
170
39
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

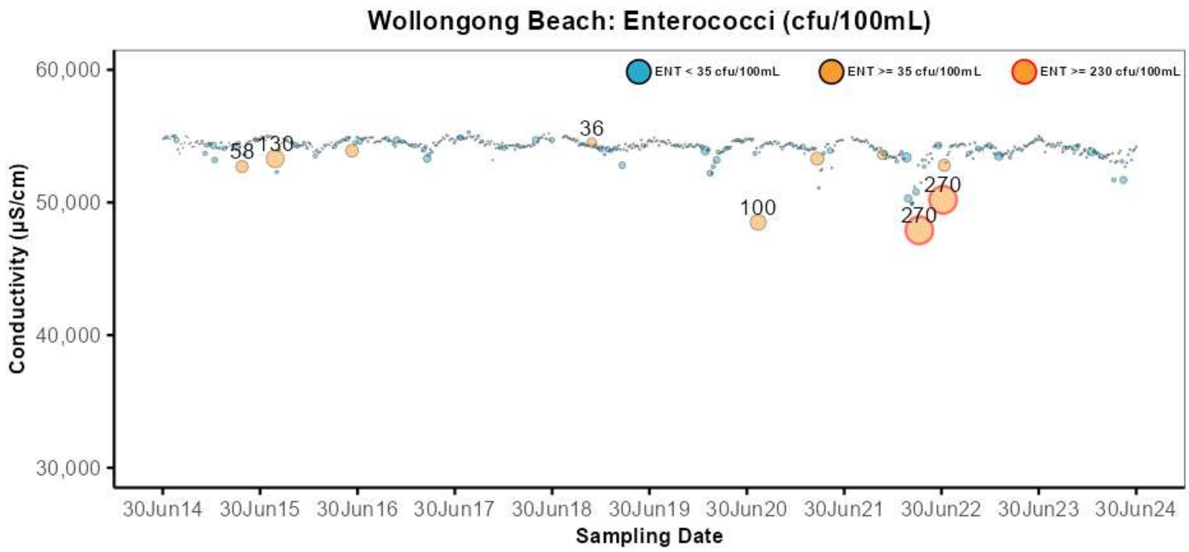


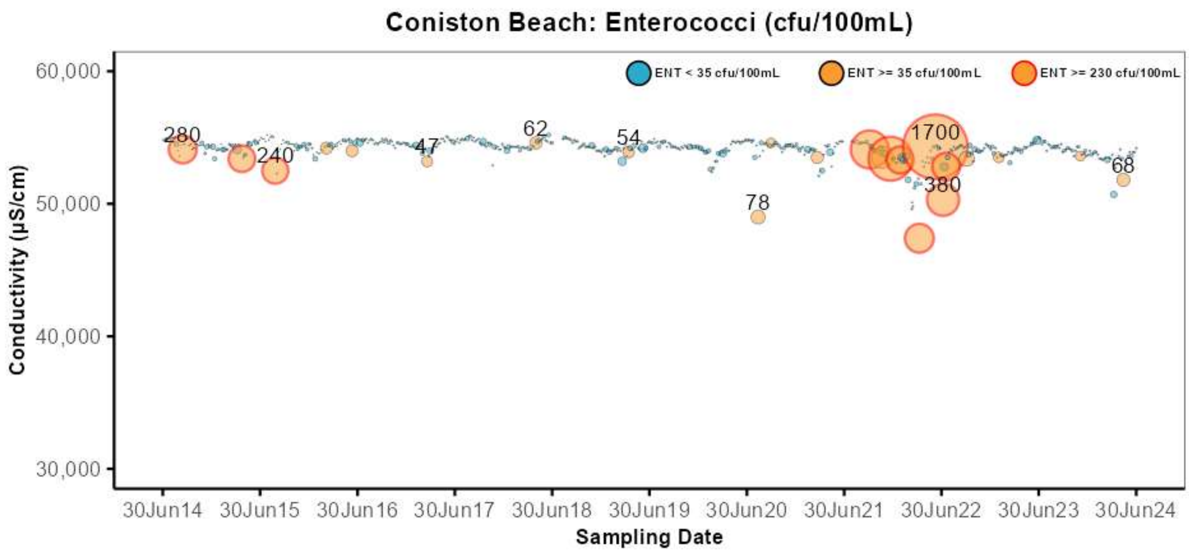
Bellambi Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
690
700
970
1500
1400
2500
710
6100
5100
680
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

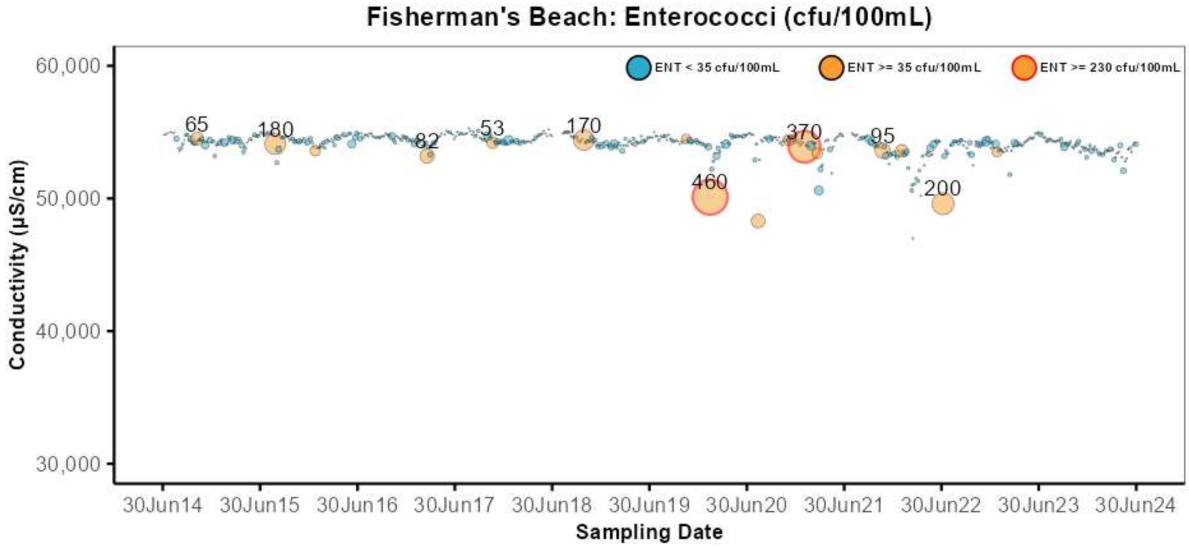


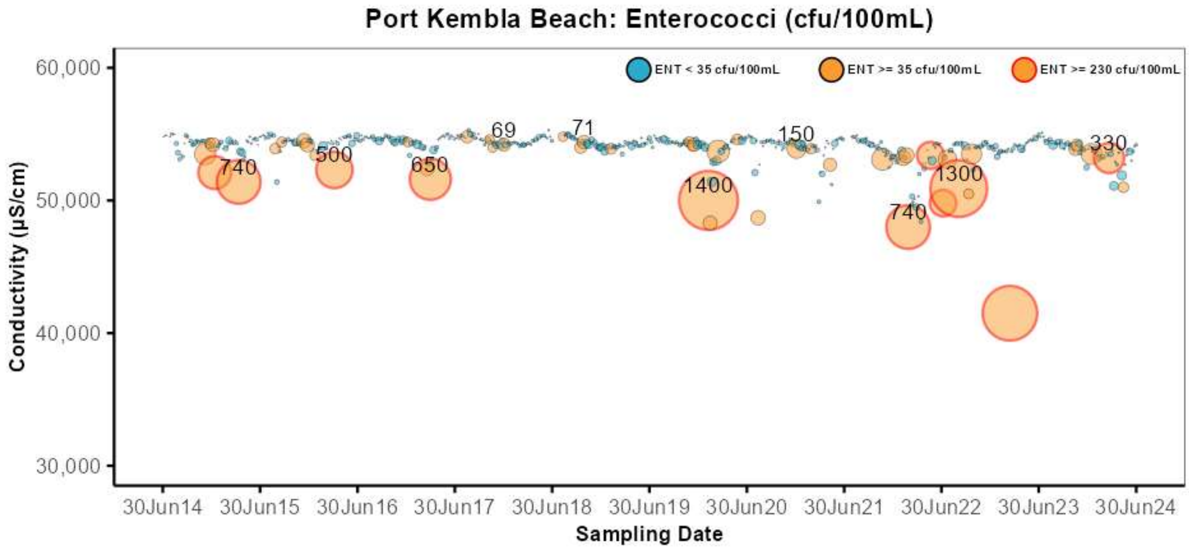
Corrimal Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
720
420
1200
460
700
1300
2000
3300
21000
770
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


North Wollongong Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
36
43
780
88
270
560
110
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

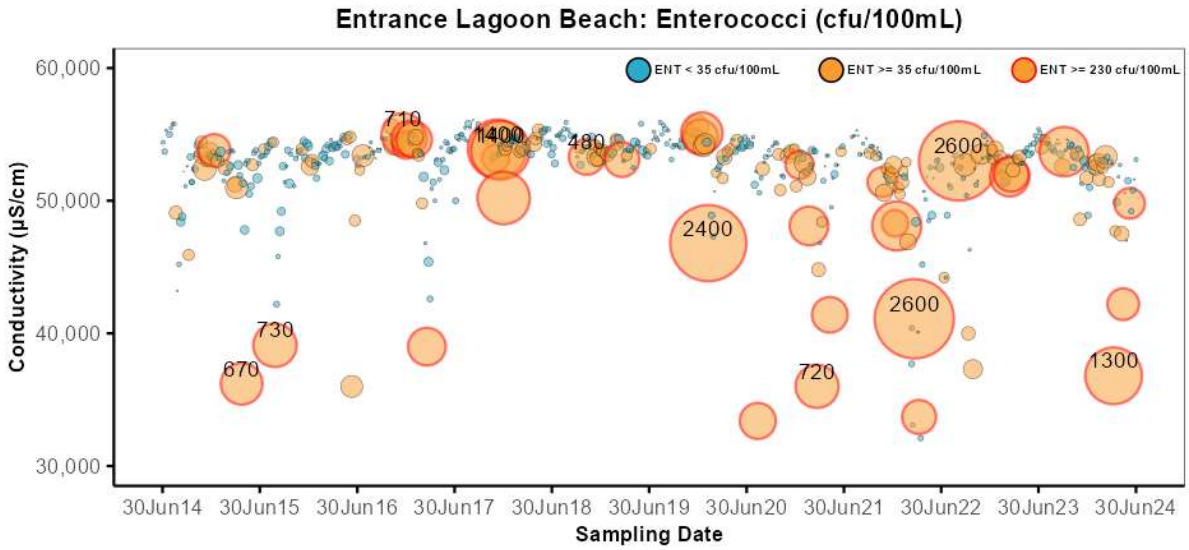

Wollongong Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
58
130
36
100
270
270
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

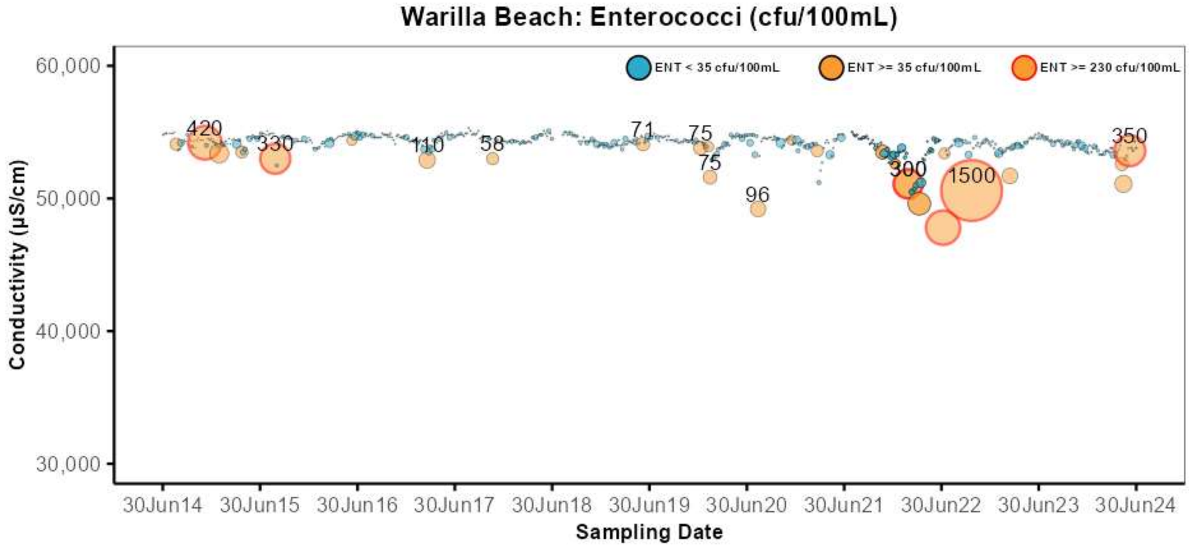

Coniston Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
280
240
47
62
54
78
1700
380
68
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

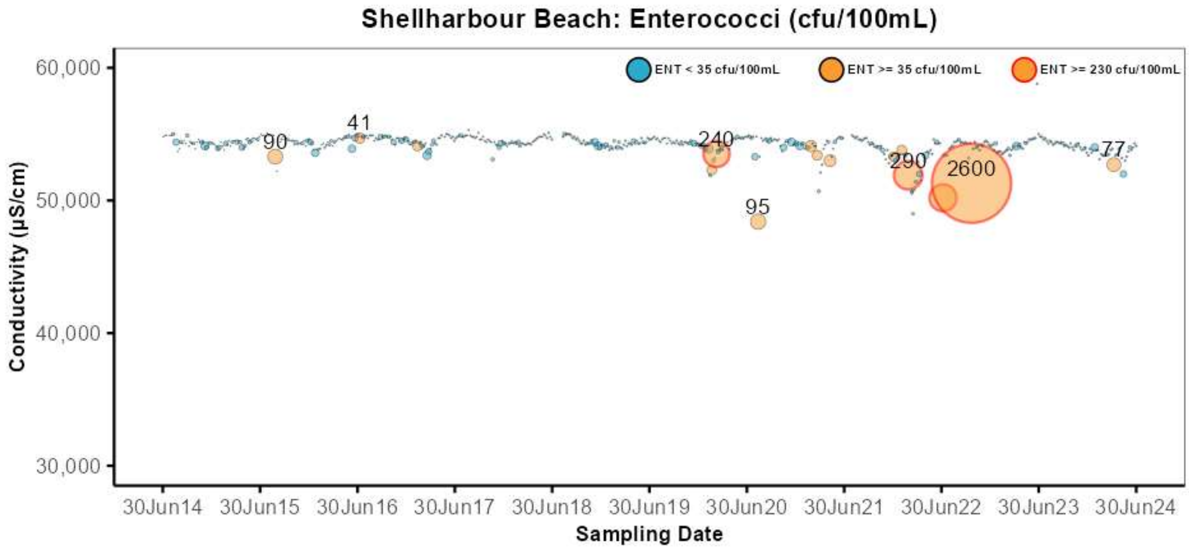




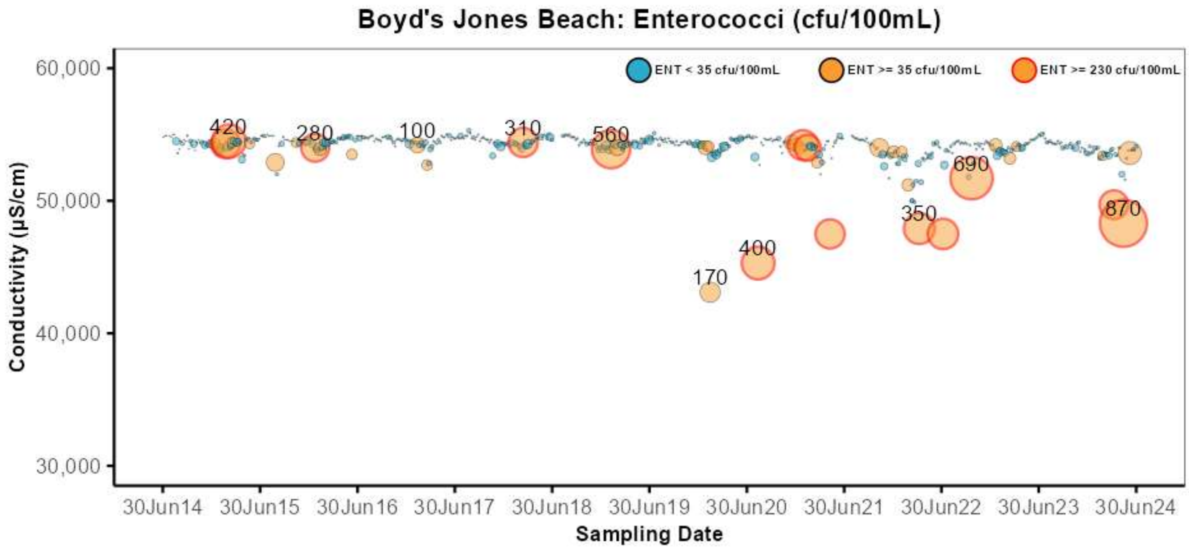
G.5. Illawarra Beaches: Shellharbour

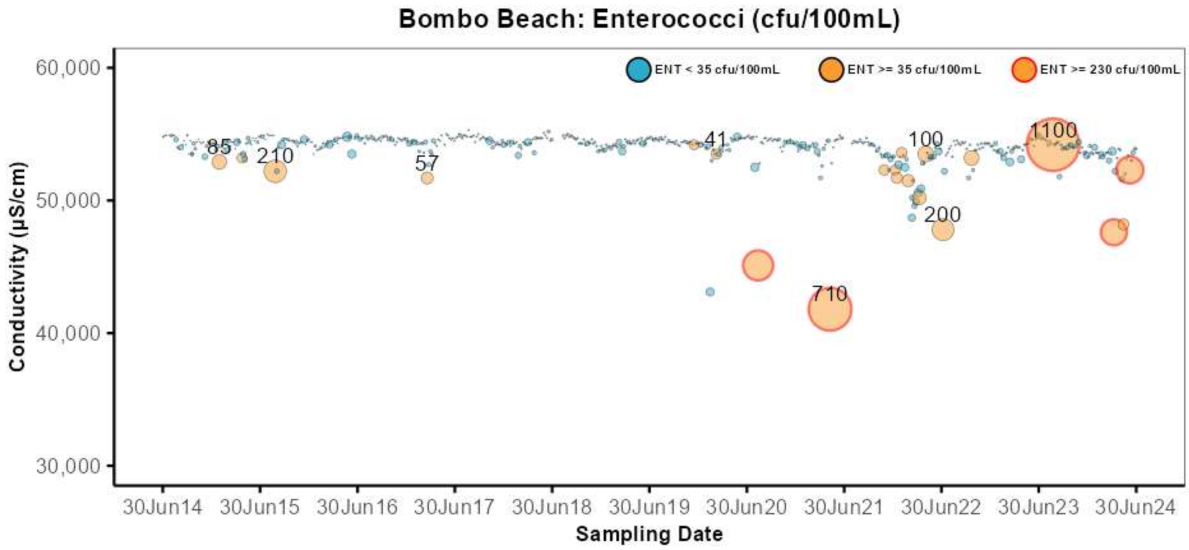


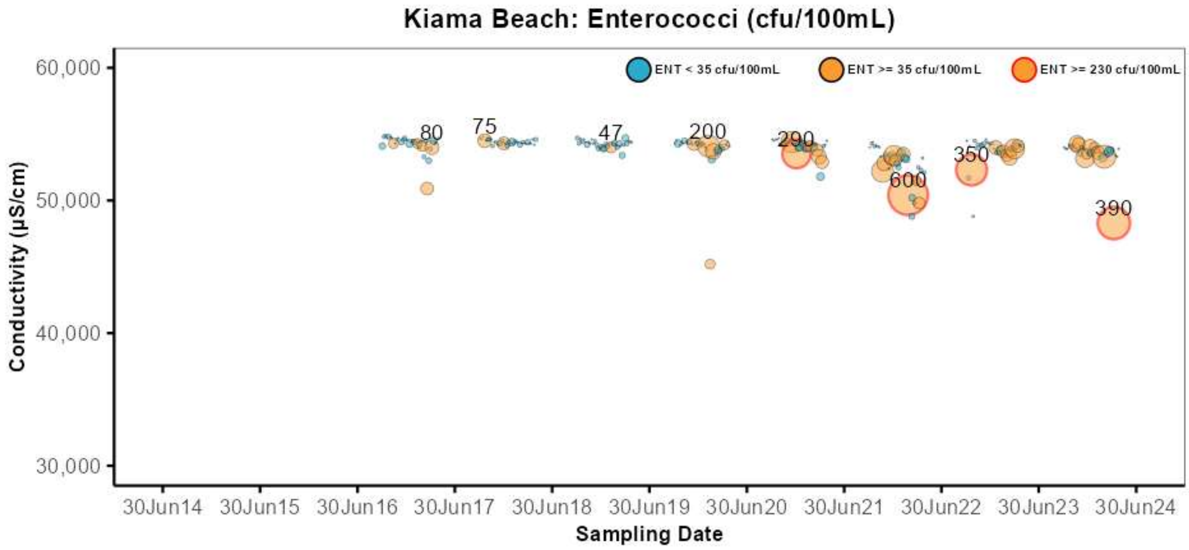


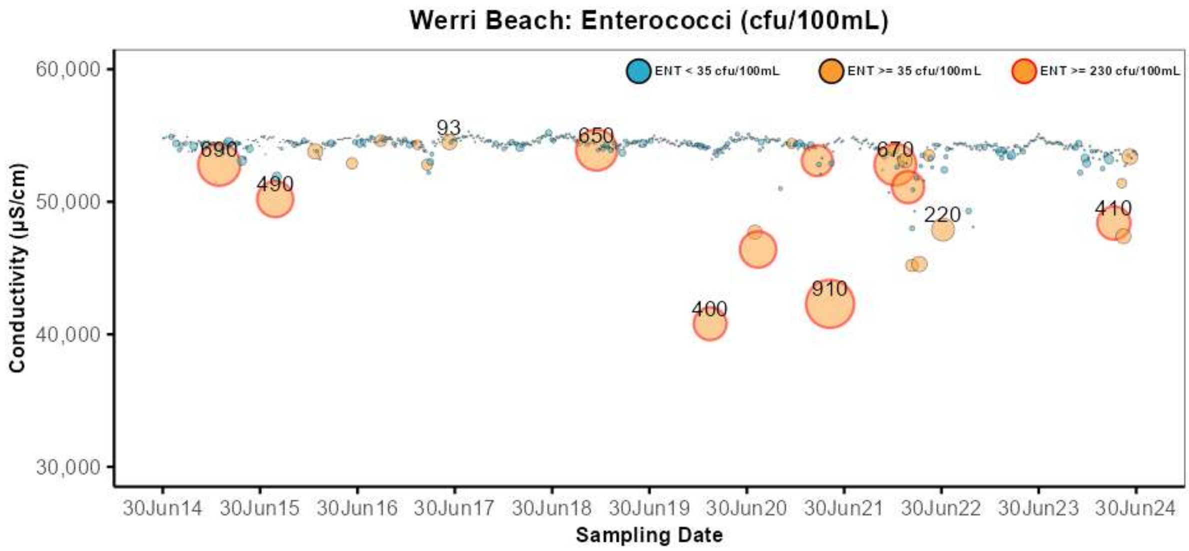


G.6. Illawarra Beaches: Bombo

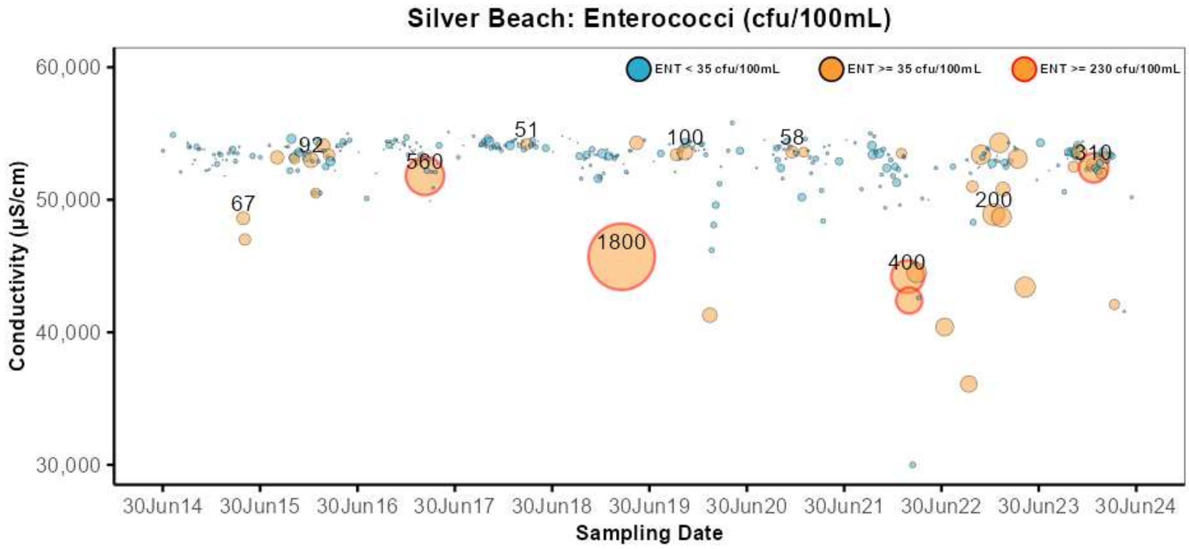


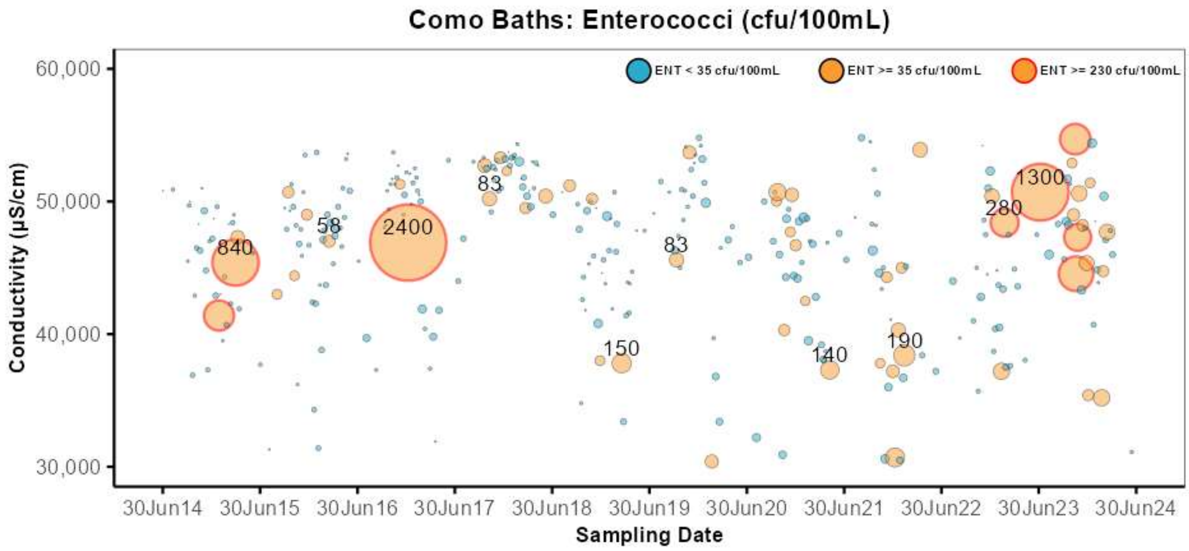

Bombo Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
85
210
57
41
710
100
200
1100
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


Kiama Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
80
75
47
200
290
600
350
390
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

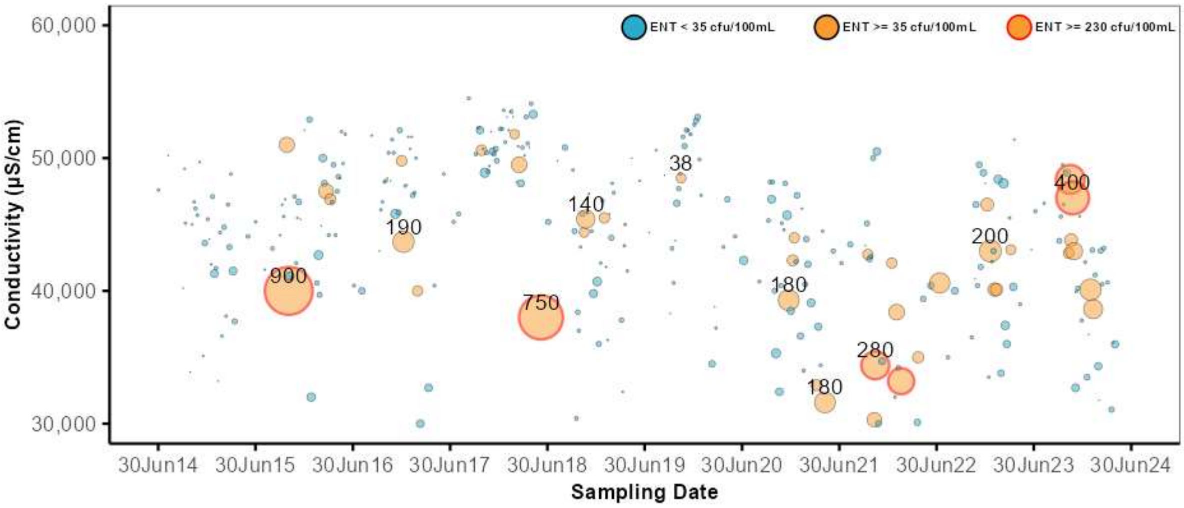

Werri Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
690
490
93
650
400
910
670
220
410
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

G.7. Sydney Harbour and Estuaries: Botany Bay and Georges River

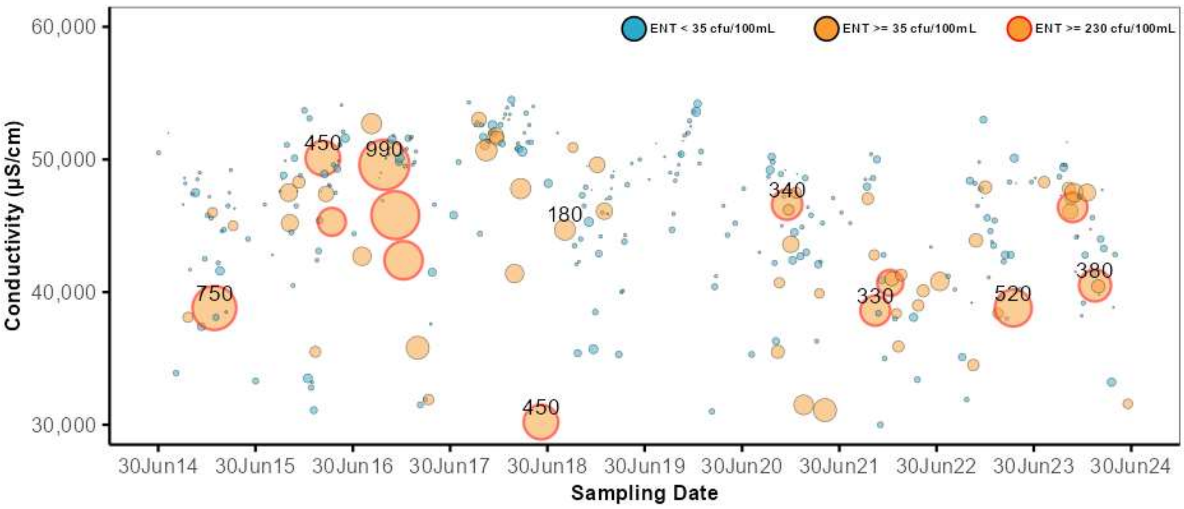




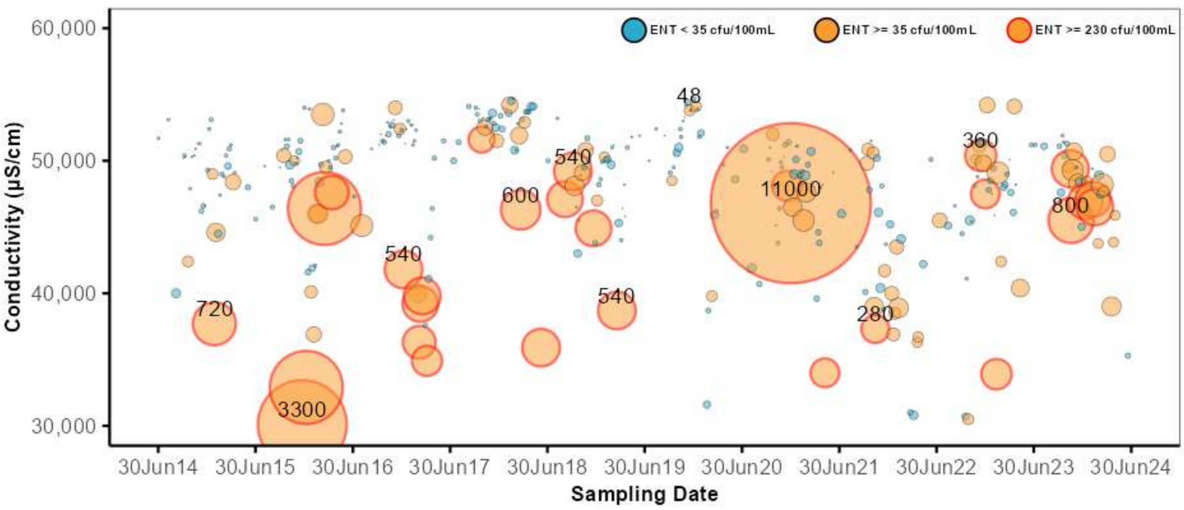
Jew Fish Bay Baths: Enterococci (cfu/100mL)



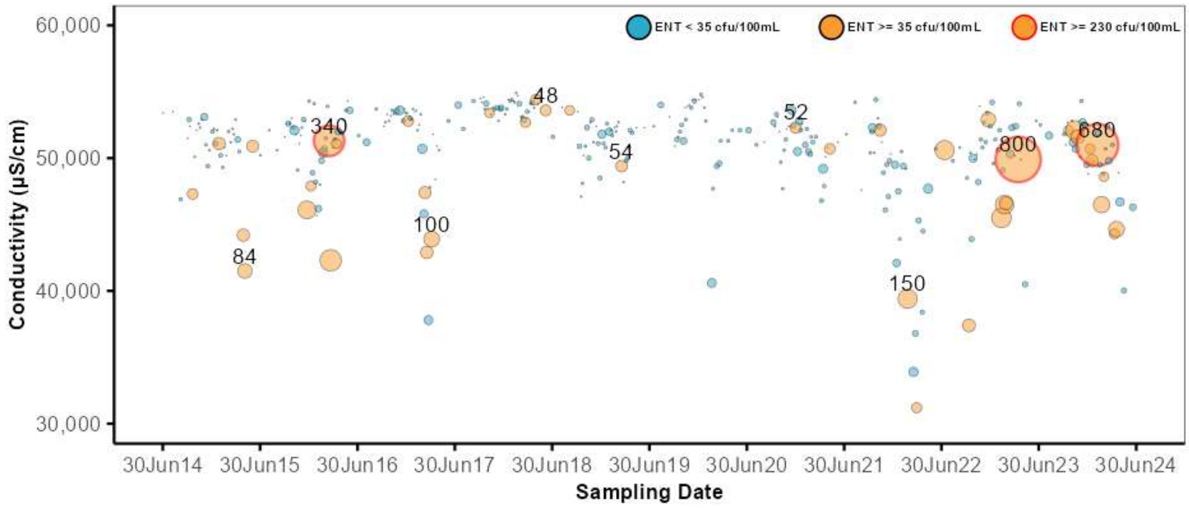
Oatley Bay Baths: Enterococci (cfu/100mL)



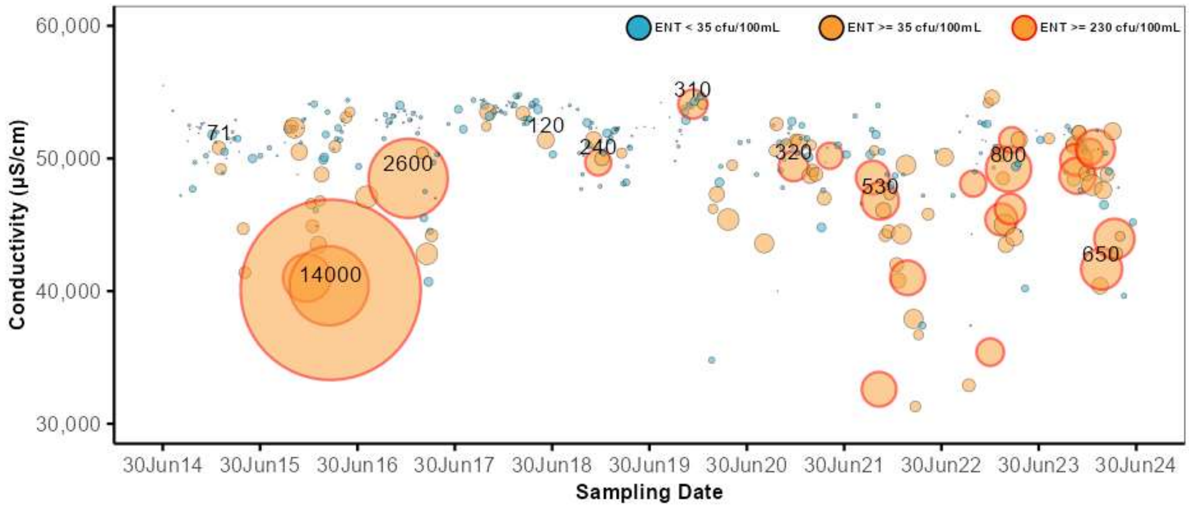
Carss Point Baths: Enterococci (cfu/100mL)



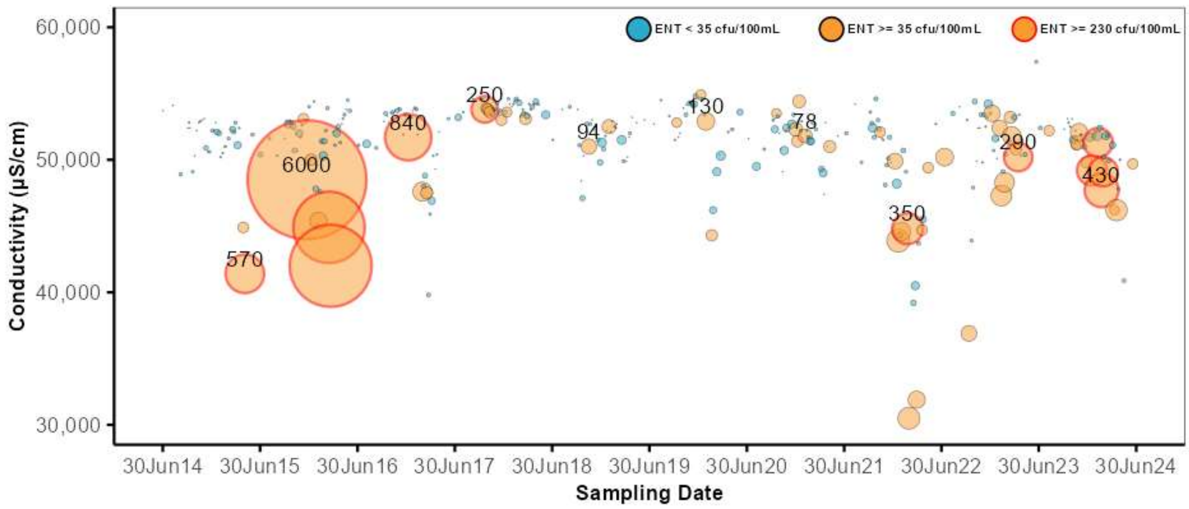
Sandringham Baths: Enterococci (cfu/100mL)

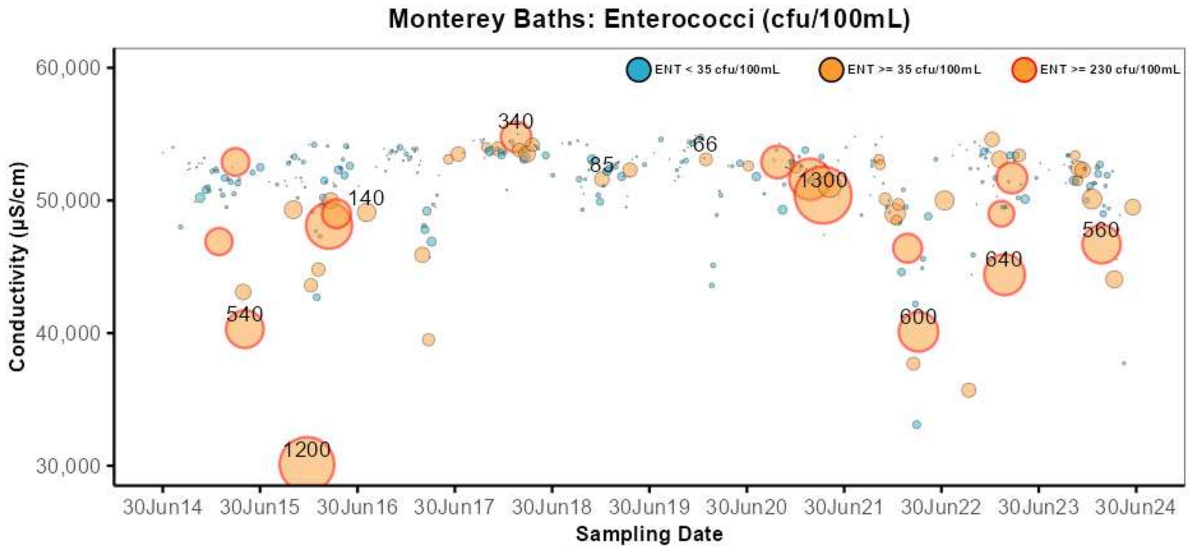


Dolls Point Baths: Enterococci (cfu/100mL)

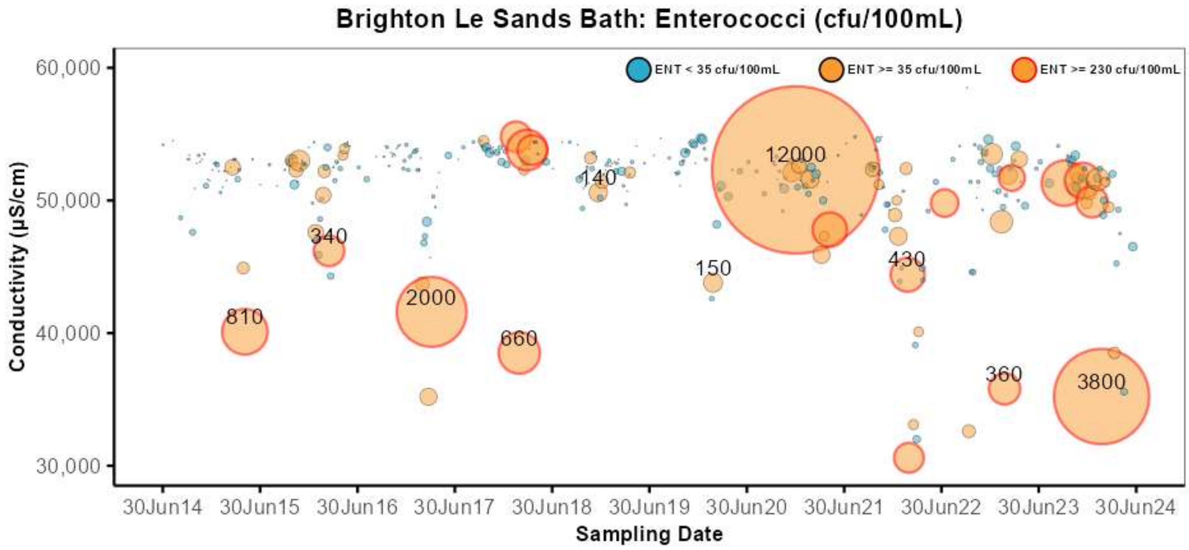


Ramsgate Bath: Enterococci (cfu/100mL)

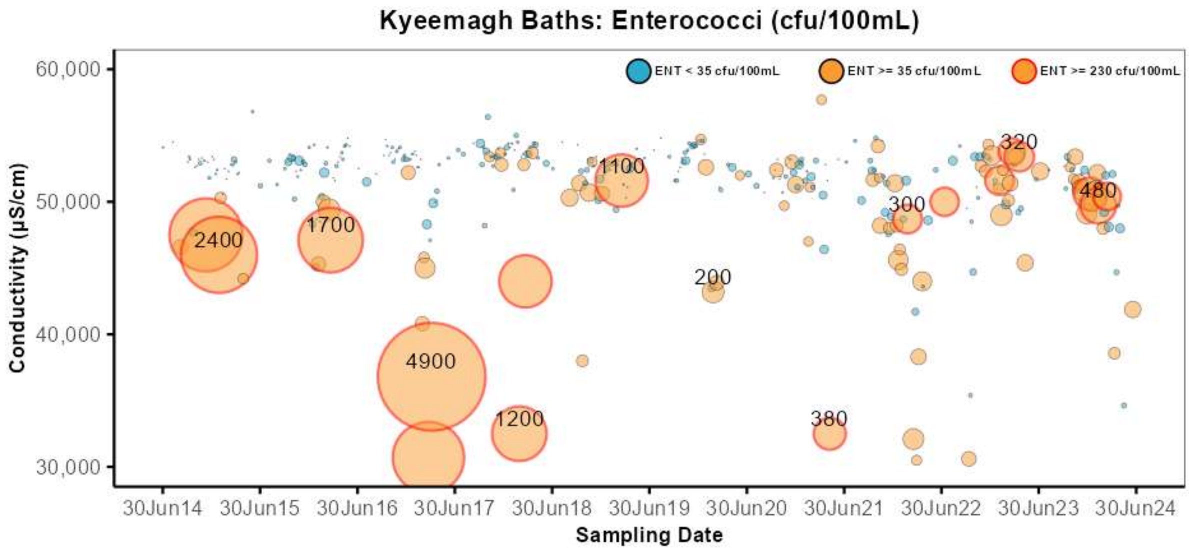




Monterey Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
340
66
85
140
1300
560
640
540
600
1200
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

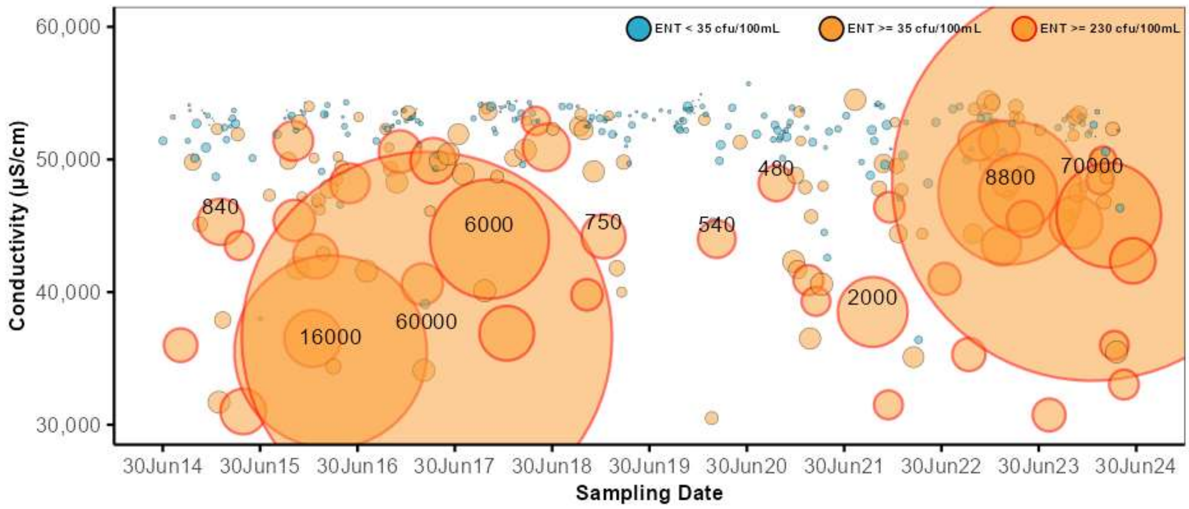


Brighton Le Sands Bath: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
12000
140
340
150
430
2000
810
660
360
3800
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

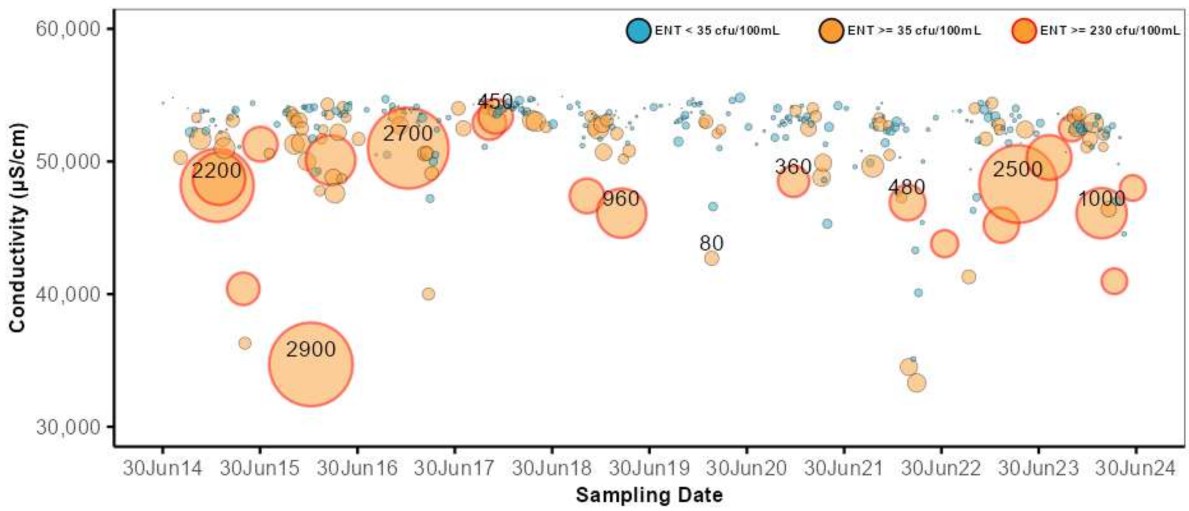


Kyeemagh Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
320
1100
480
300
2400
1700
200
4900
1200
380
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

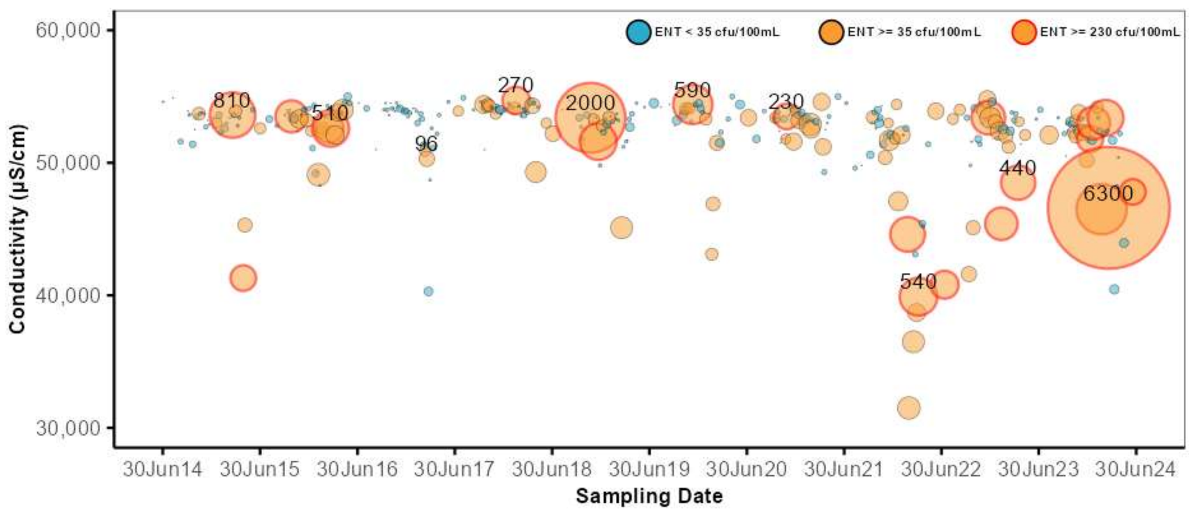
Foreshores Beach: Enterococci (cfu/100mL)

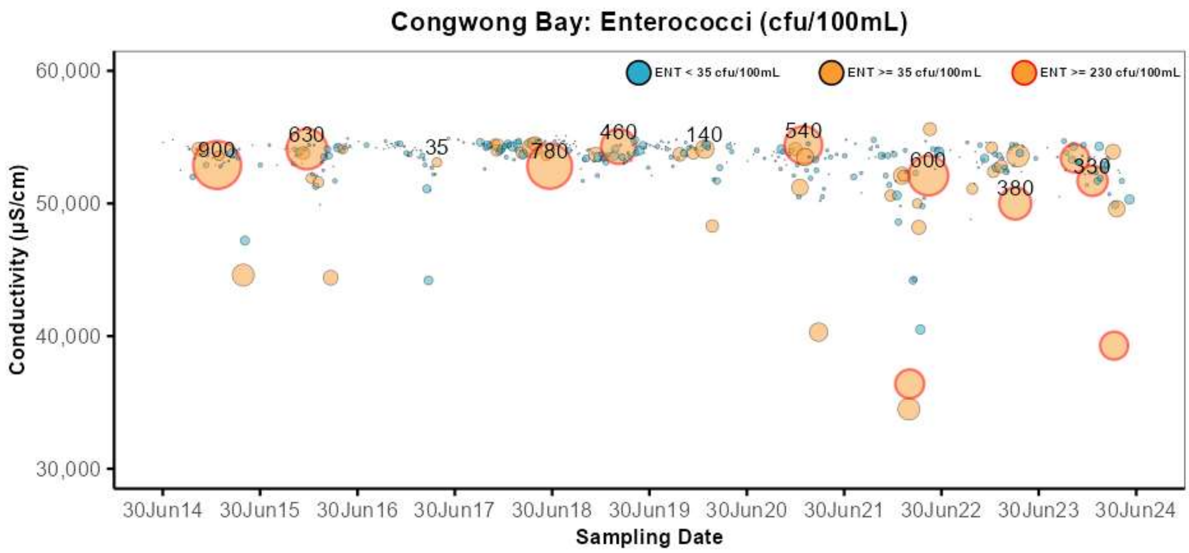


Yarra Bay: Enterococci (cfu/100mL)

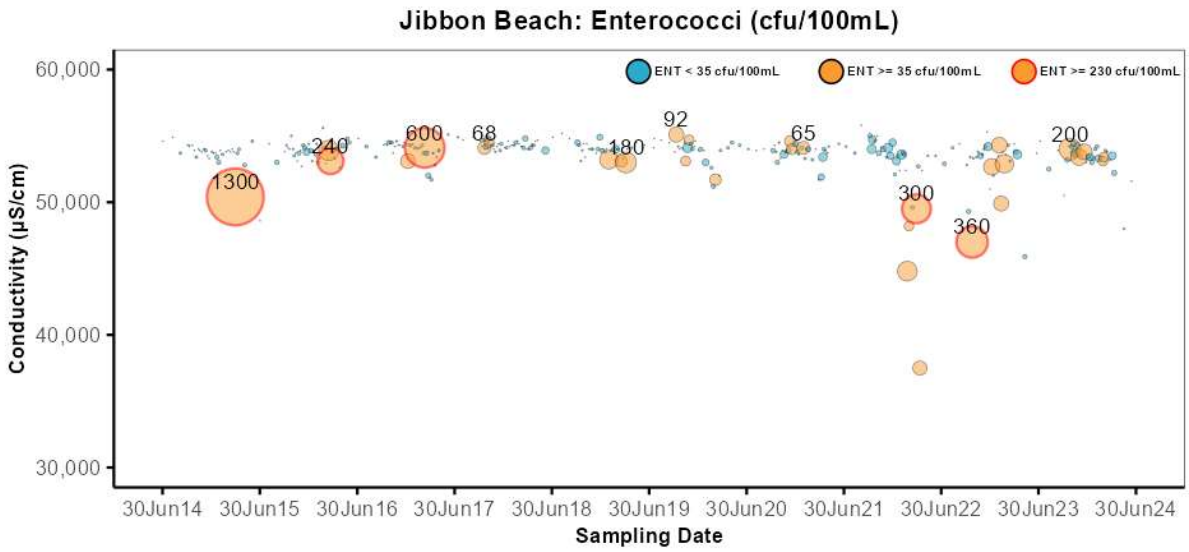


Frenchmans Bay: Enterococci (cfu/100mL)

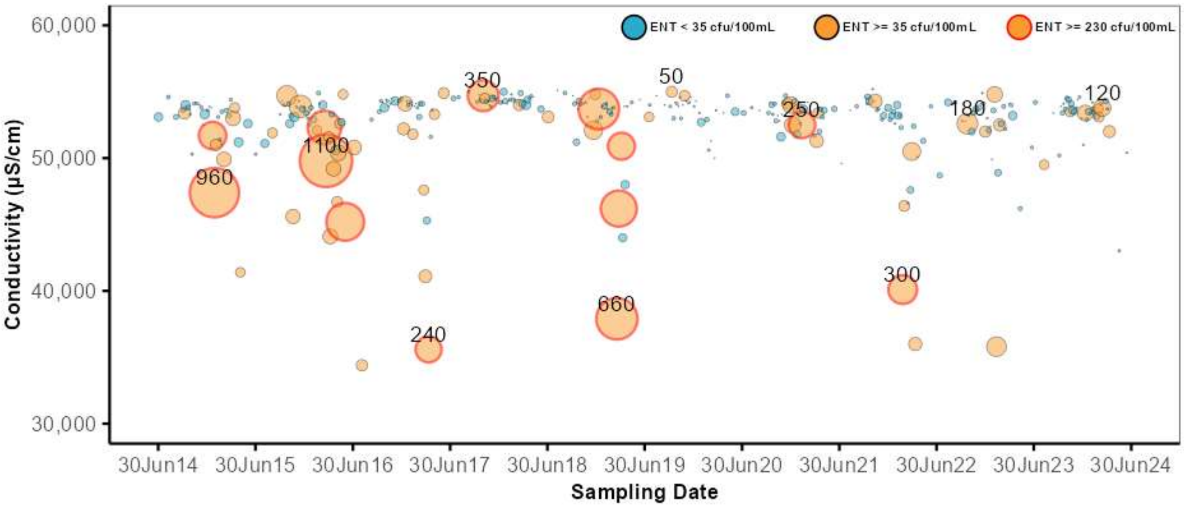




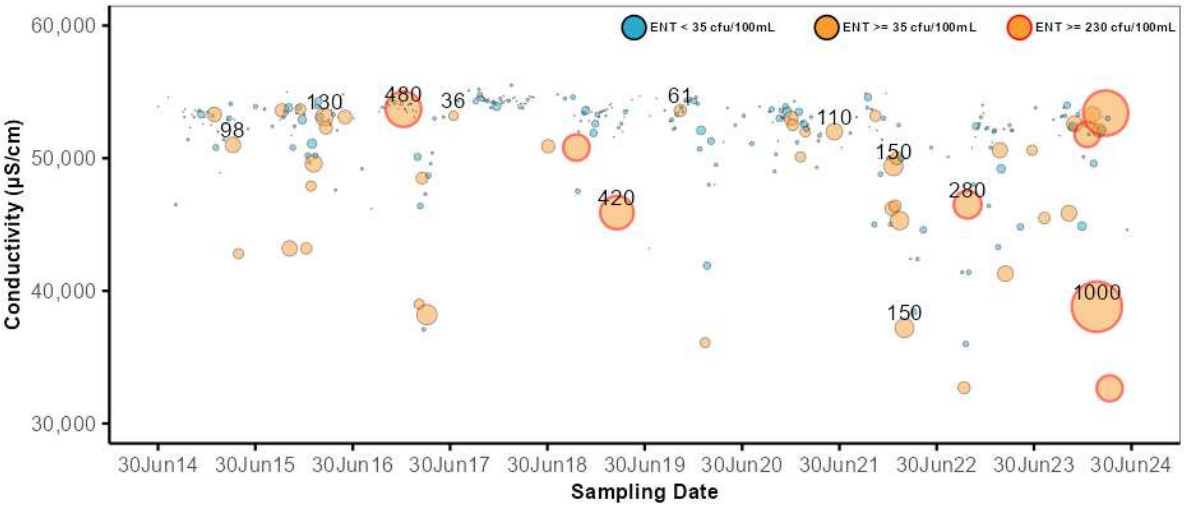
G.8. Sydney Harbour and Estuaries: Port Hacking



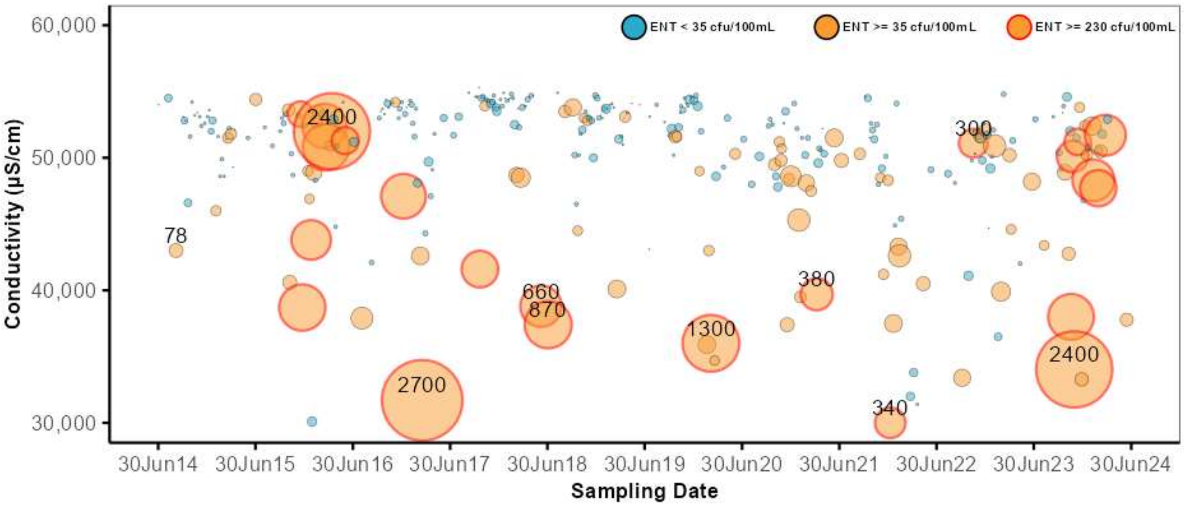
Horderns Beach: Enterococci (cfu/100mL)



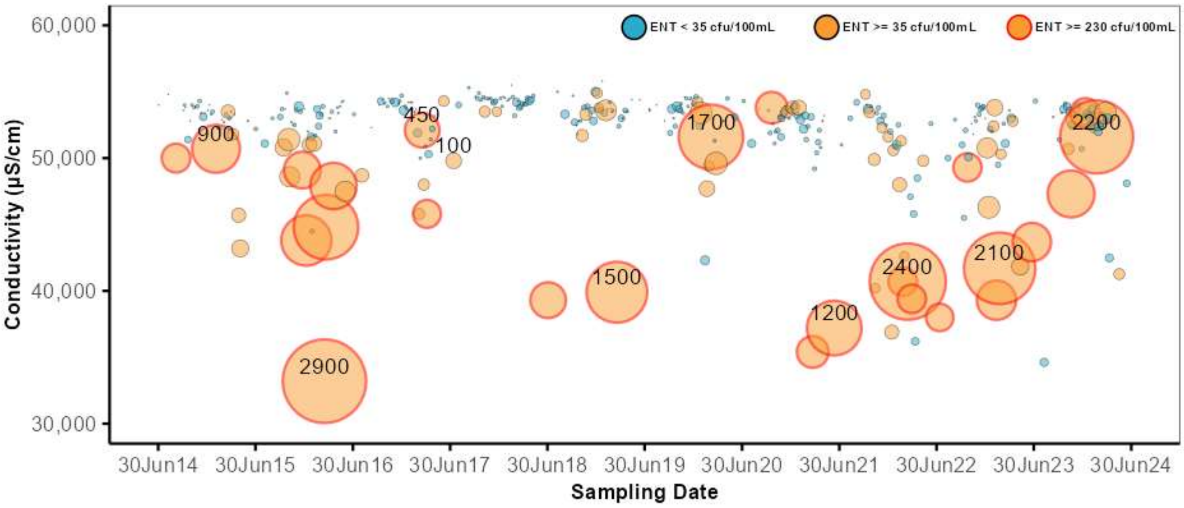
Lilli Pilli Baths: Enterococci (cfu/100mL)



Gymea Bay Bath: Enterococci (cfu/100mL)

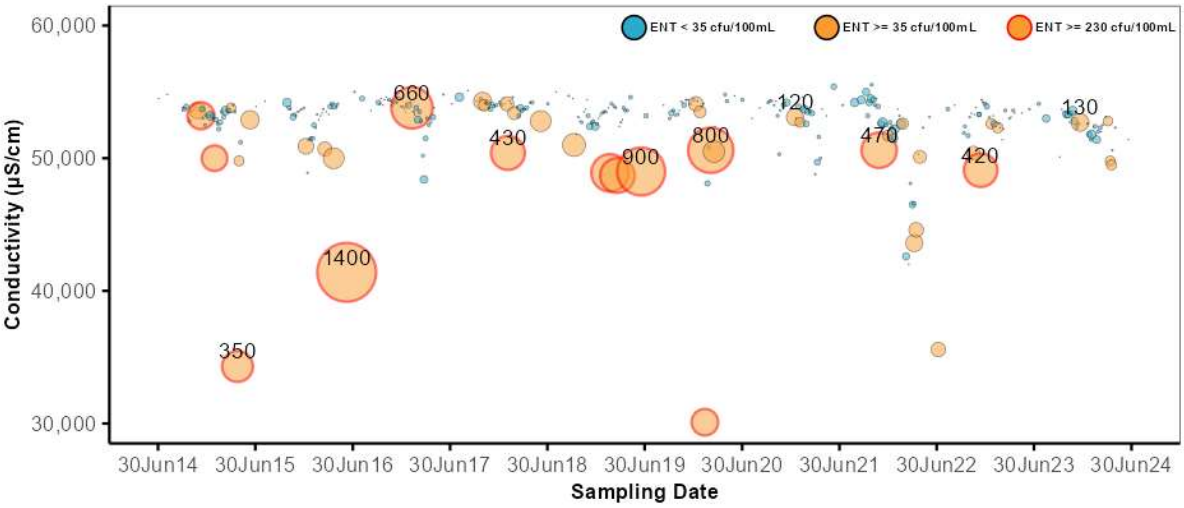


Gunnamatta Bay Baths: Enterococci (cfu/100mL)

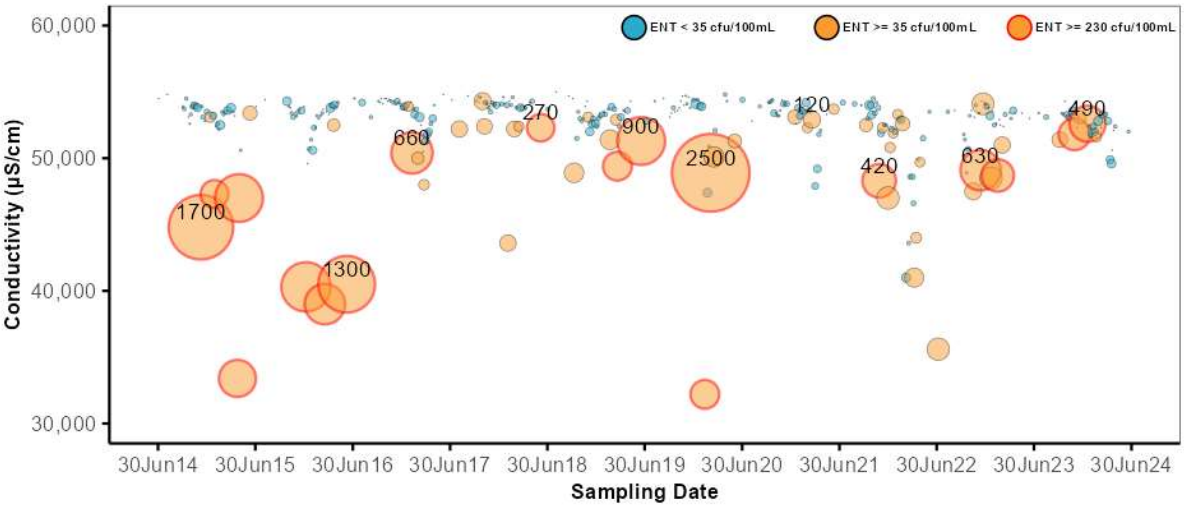


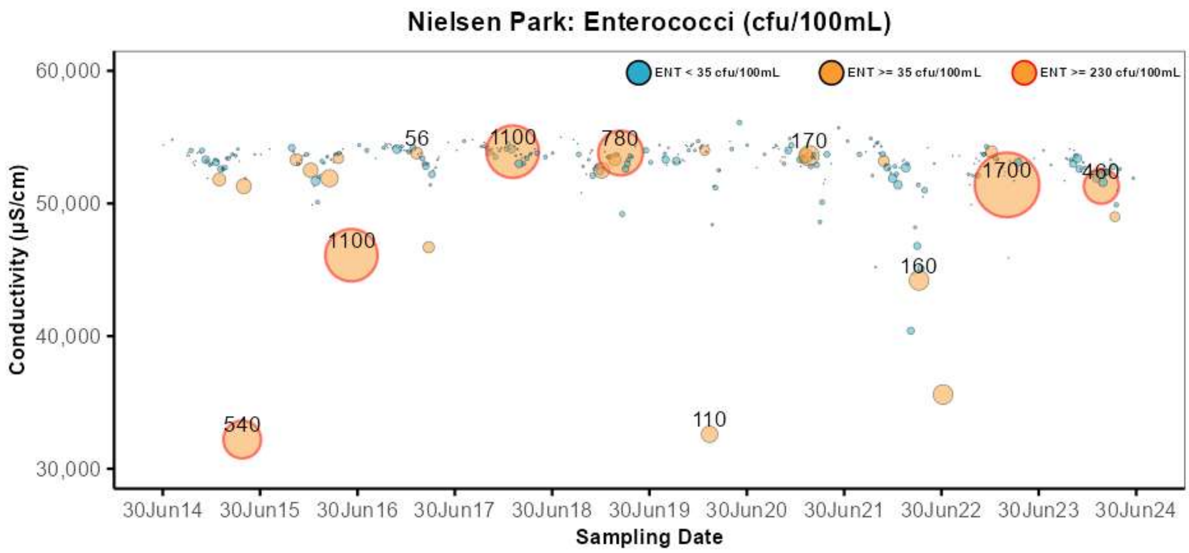
G.9. Sydney Harbour and Estuaries: Port Jackson

Watsons Bay: Enterococci (cfu/100mL)

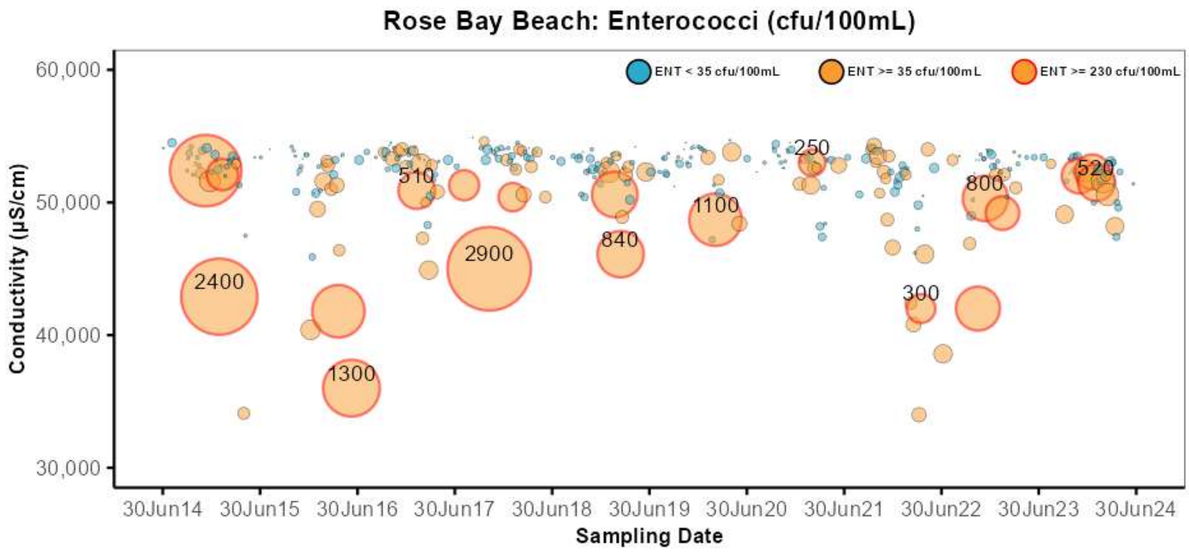


Parsley Bay: Enterococci (cfu/100mL)

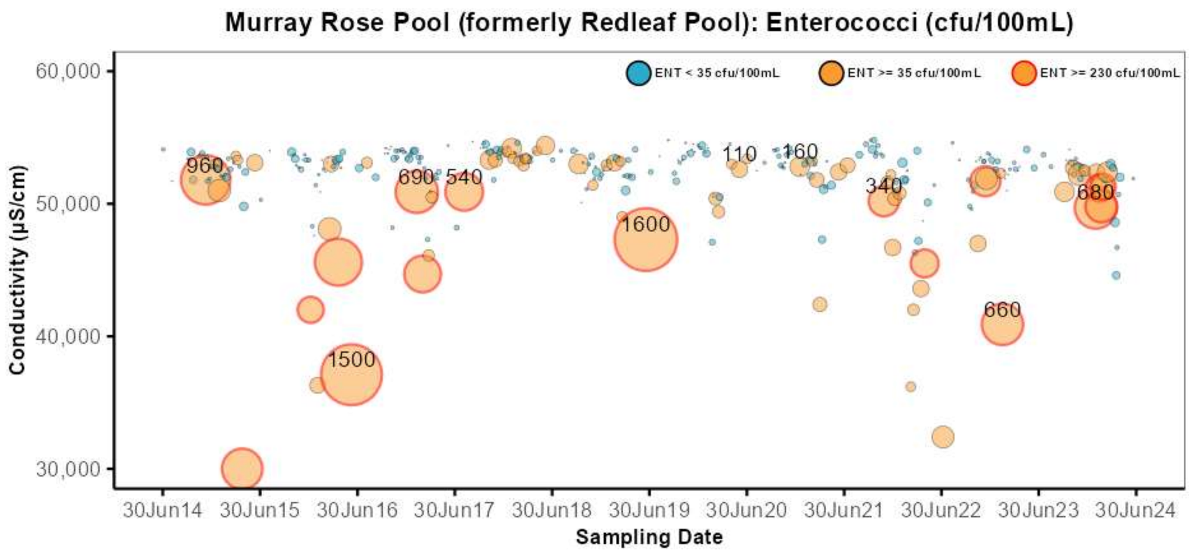




Nielsen Park: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
56
1100
780
170
1700
460
1100
160
540
110
30Jun14 30Jun15 30Jun16 30Jun17 30Jun18 30Jun19 30Jun20 30Jun21 30Jun22 30Jun23 30Jun24
Sampling Date

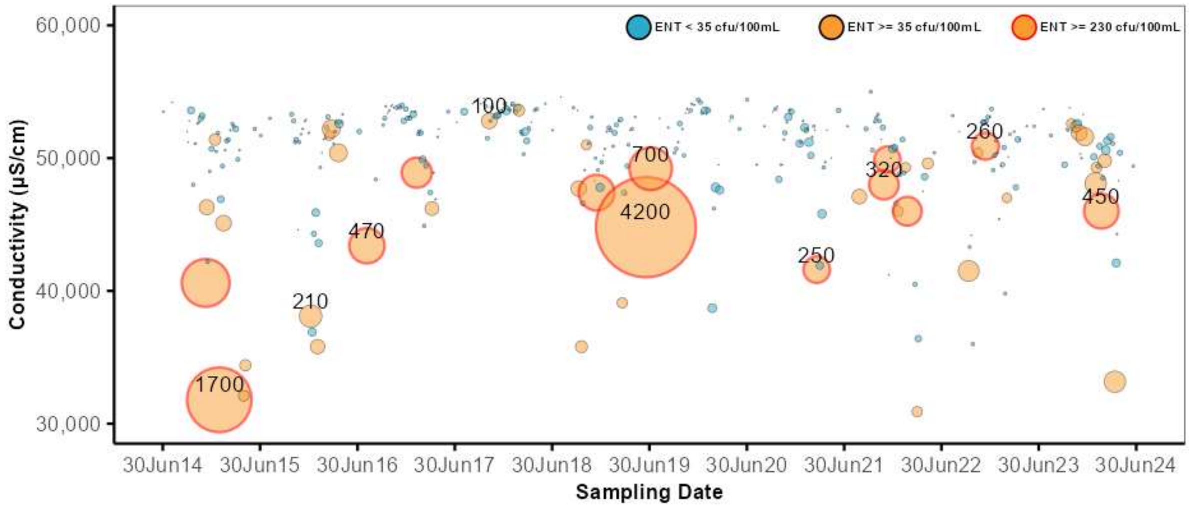


Rose Bay Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
250
520
510
800
1100
840
2900
2400
300
1300
30Jun14 30Jun15 30Jun16 30Jun17 30Jun18 30Jun19 30Jun20 30Jun21 30Jun22 30Jun23 30Jun24
Sampling Date

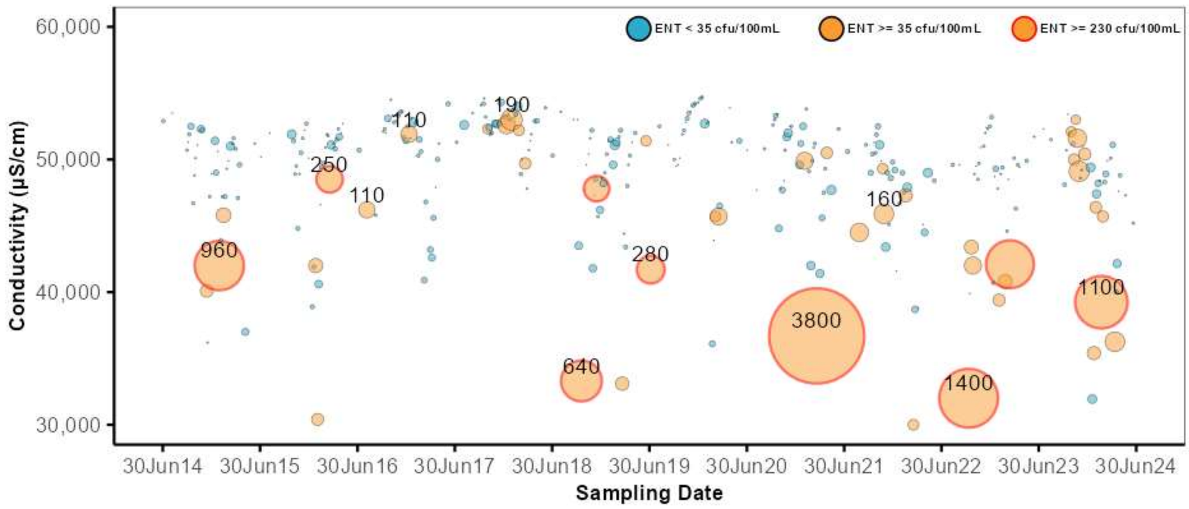


Murray Rose Pool (formerly Redleaf Pool): Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
110
160
960
690
540
340
680
1600
660
1500
30Jun14 30Jun15 30Jun16 30Jun17 30Jun18 30Jun19 30Jun20 30Jun21 30Jun22 30Jun23 30Jun24
Sampling Date

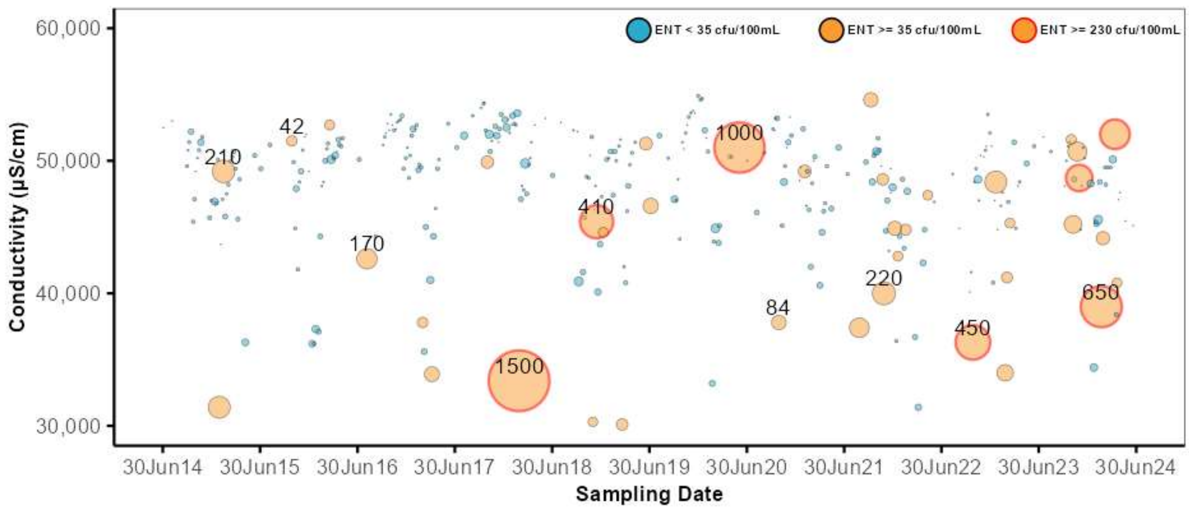
Dawn Fraser Pool: Enterococci (cfu/100mL)

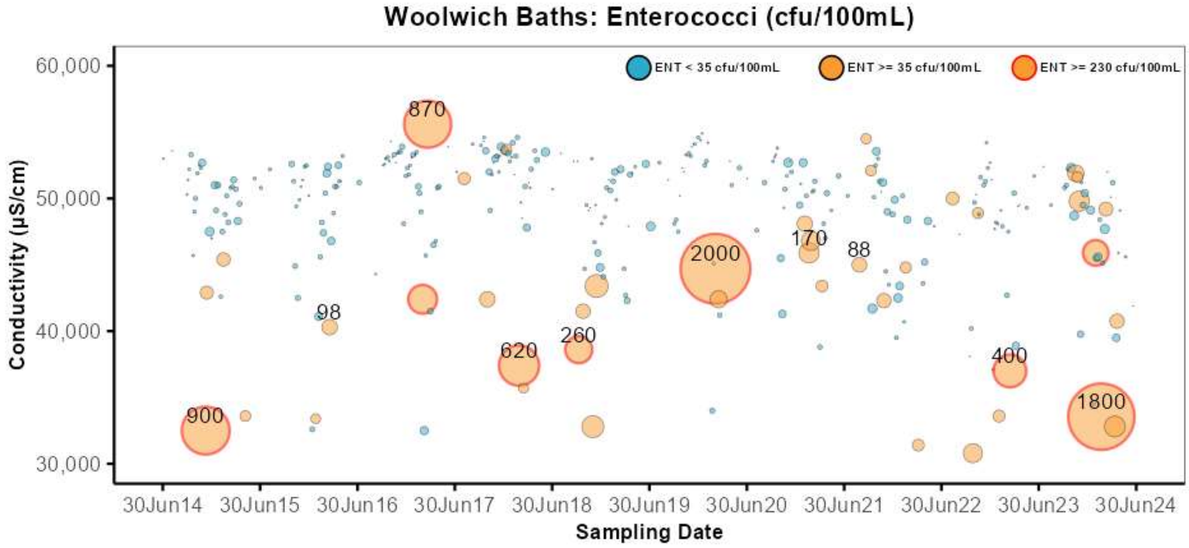


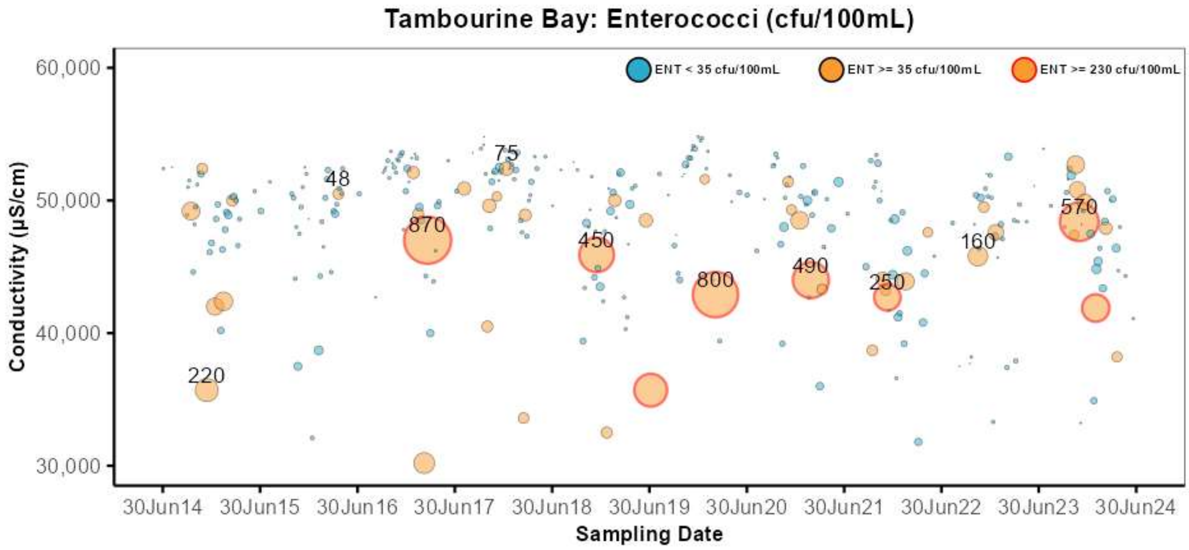
Chiswick Baths: Enterococci (cfu/100mL)

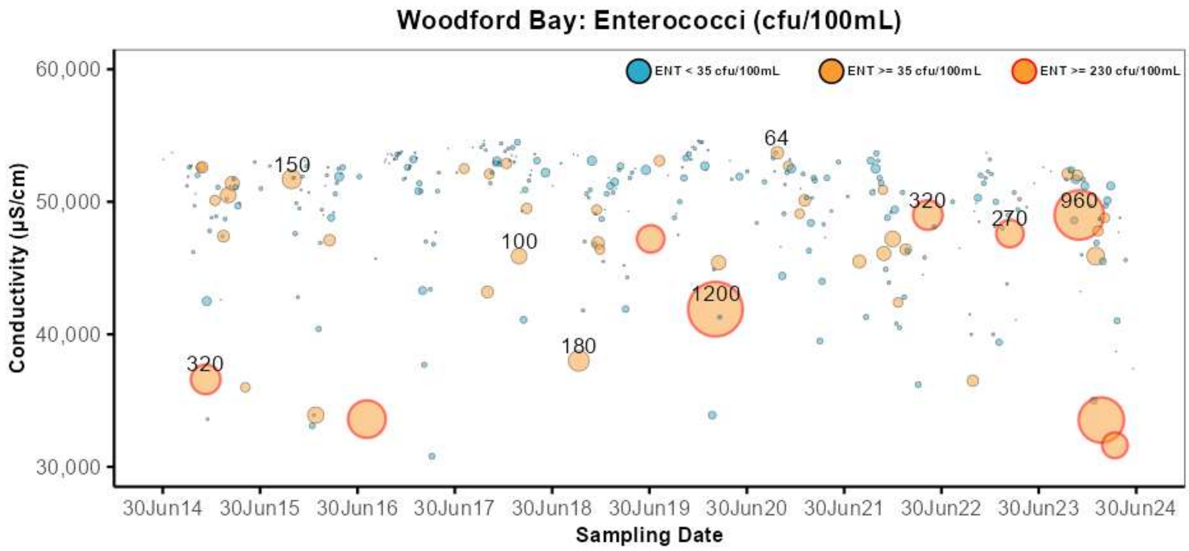


Cabarita Beach: Enterococci (cfu/100mL)

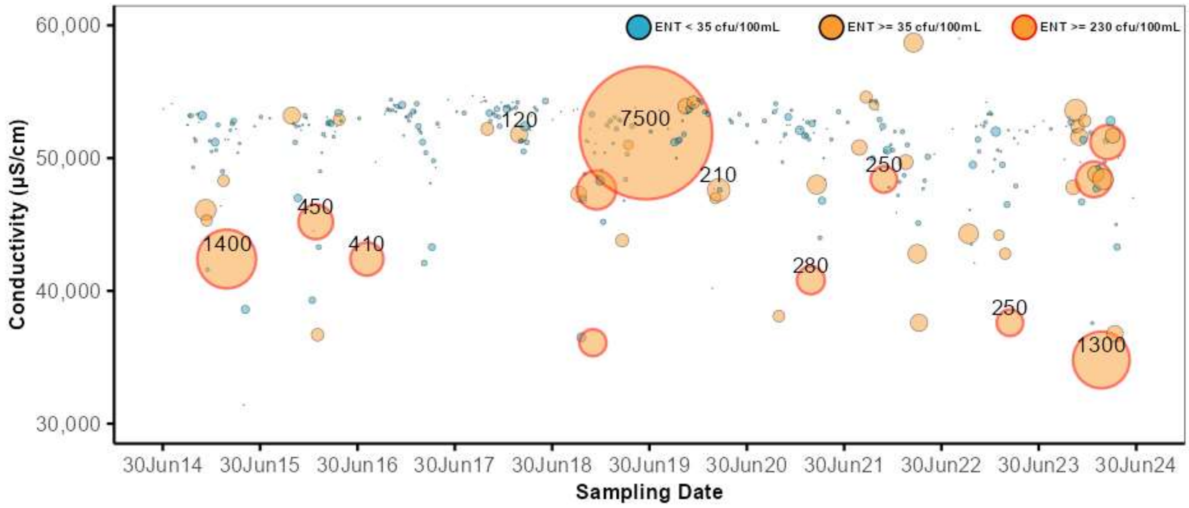



Woolwich Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
870
98
2000
170
88
620
260
400
900
1800

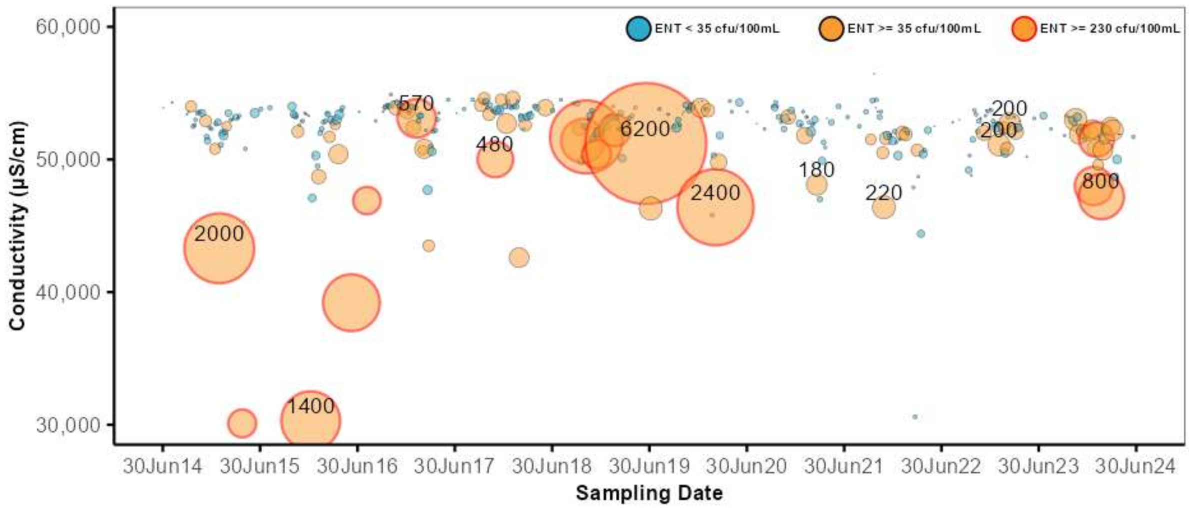

Tambourine Bay: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
75
48
870
450
800
490
250
160
570
220


Woodford Bay: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
64
150
320
270
960
100
1200
180
320

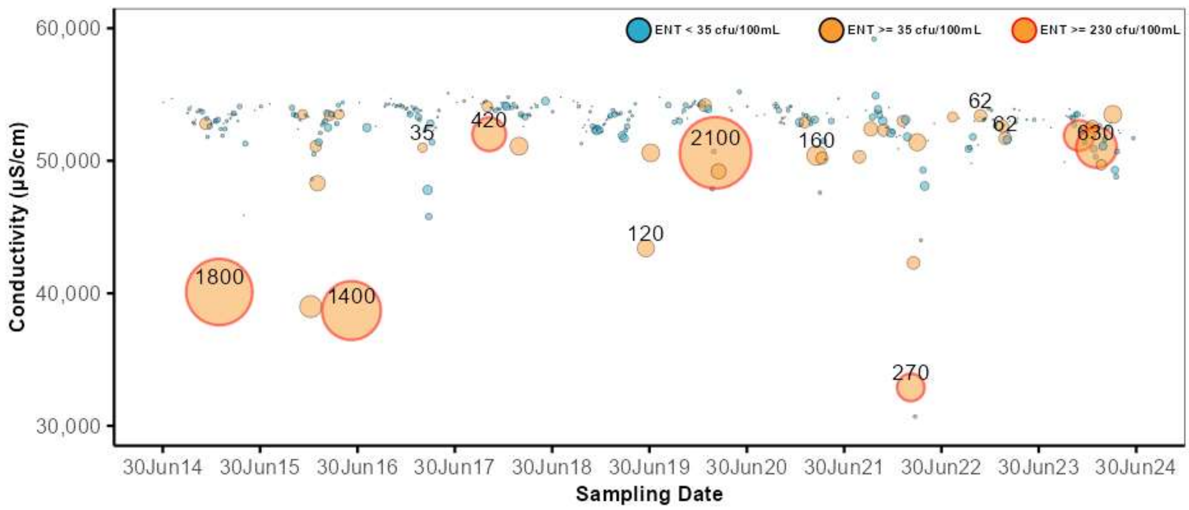
Greenwich Baths: Enterococci (cfu/100mL)



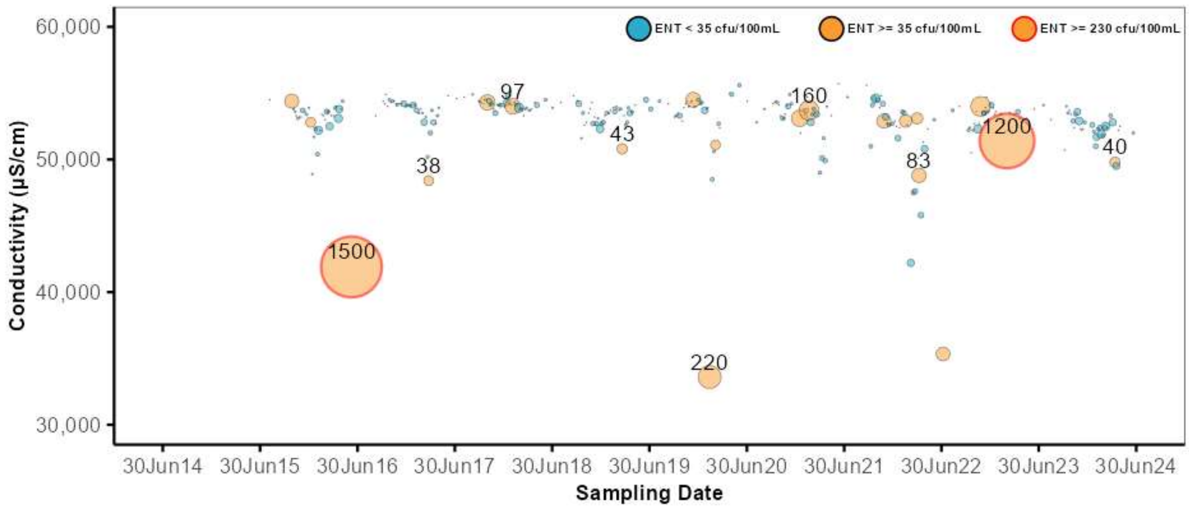
Hayes St Beach: Enterococci (cfu/100mL)



Clifton Garden: Enterococci (cfu/100mL)

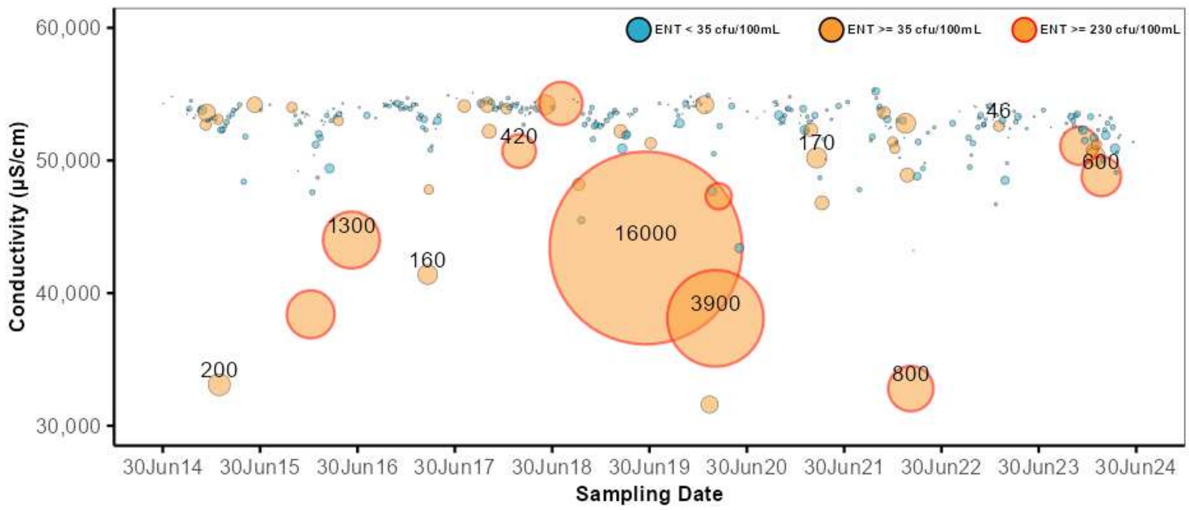


Camp Cove: Enterococci (cfu/100mL)

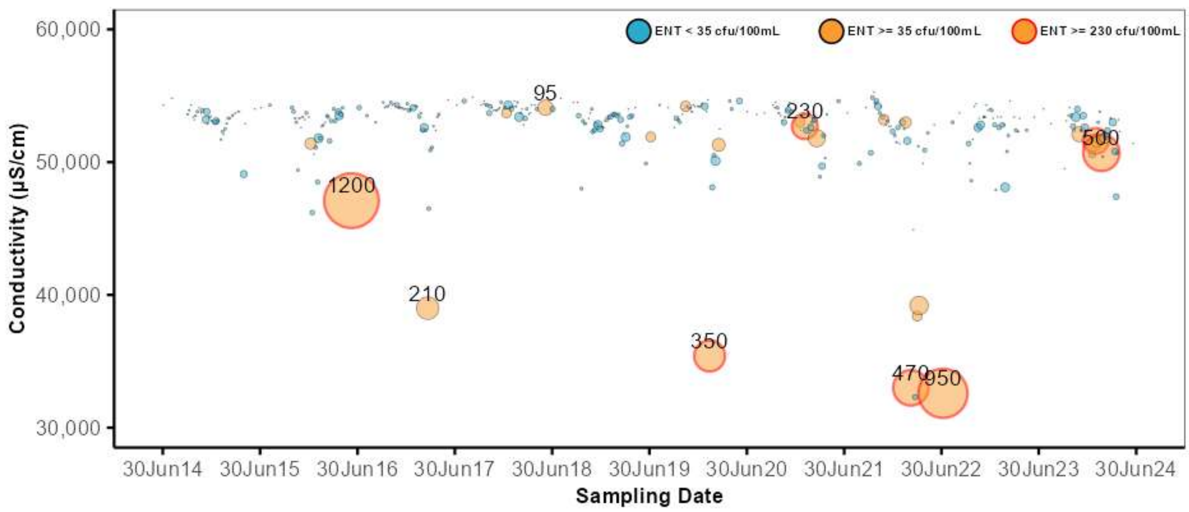


G.10. Sydney Harbour and Estuaries: Middle Harbour

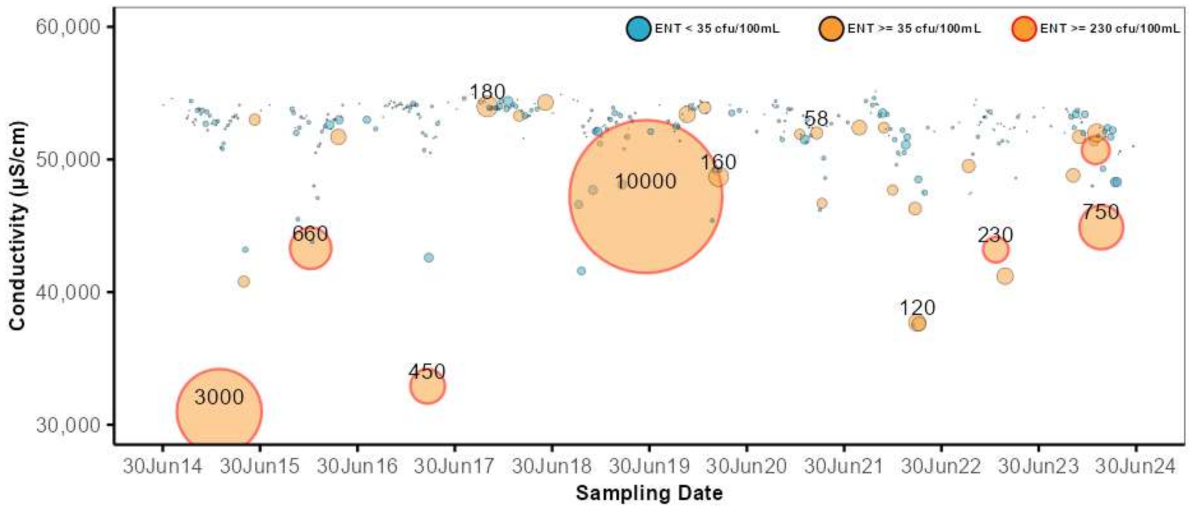
Balmoral Baths: Enterococci (cfu/100mL)



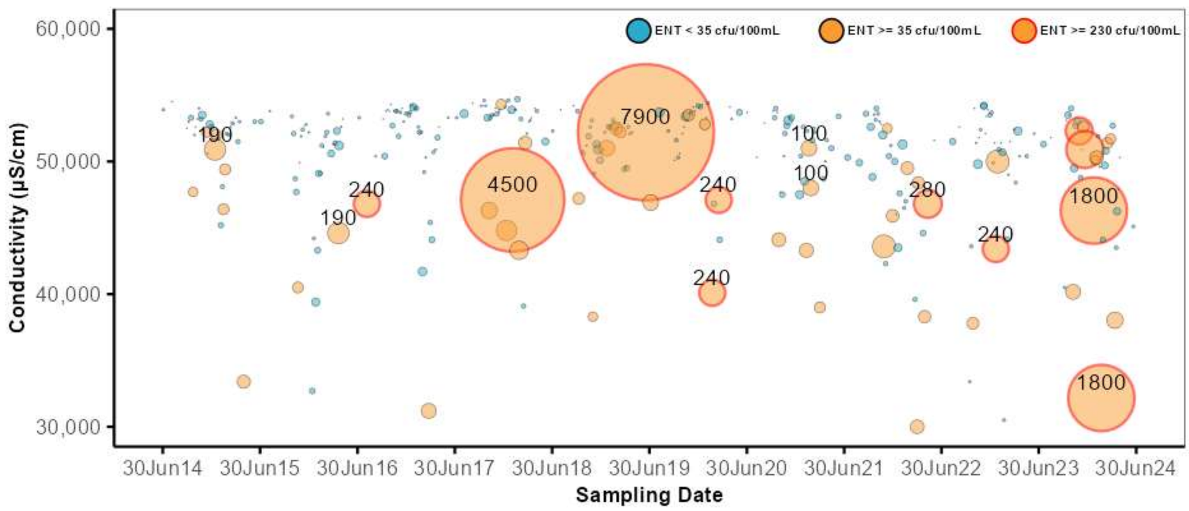
Edwards Beach: Enterococci (cfu/100mL)



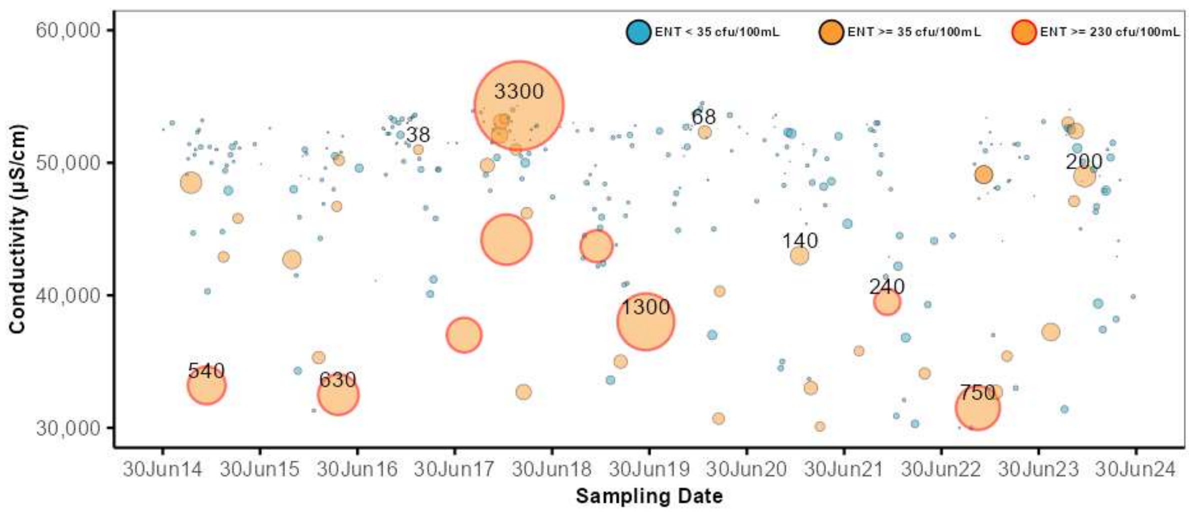
Chinamans Beach: Enterococci (cfu/100mL)

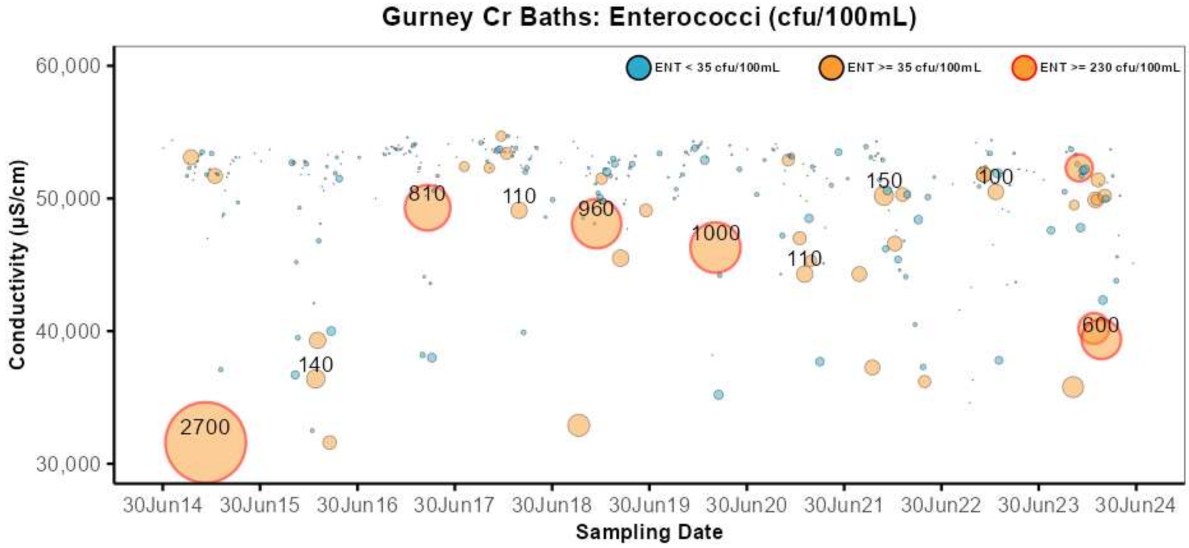


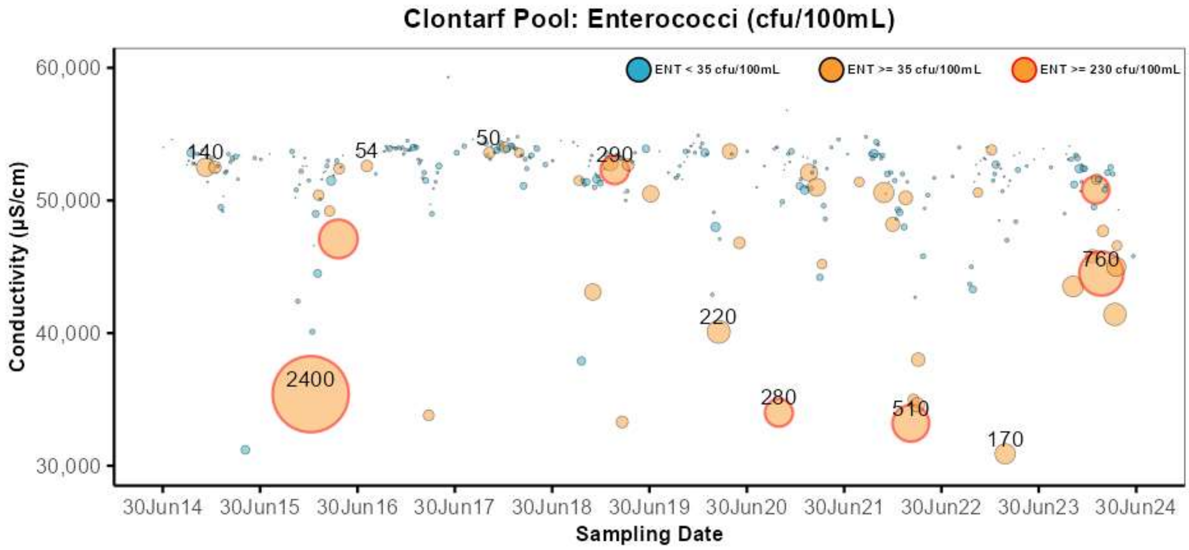
Northbridge Baths: Enterococci (cfu/100mL)

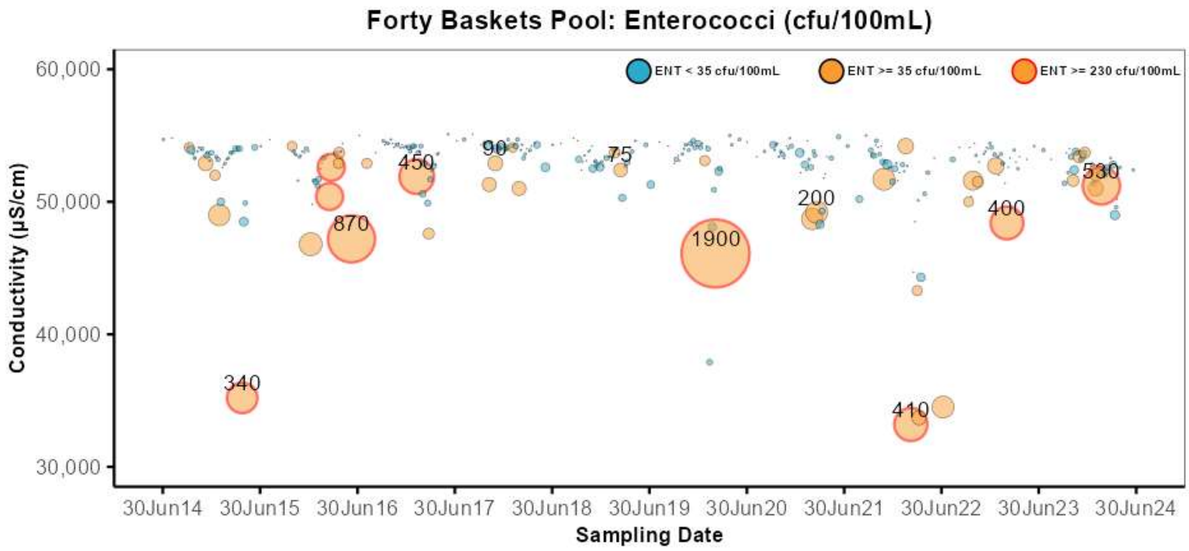


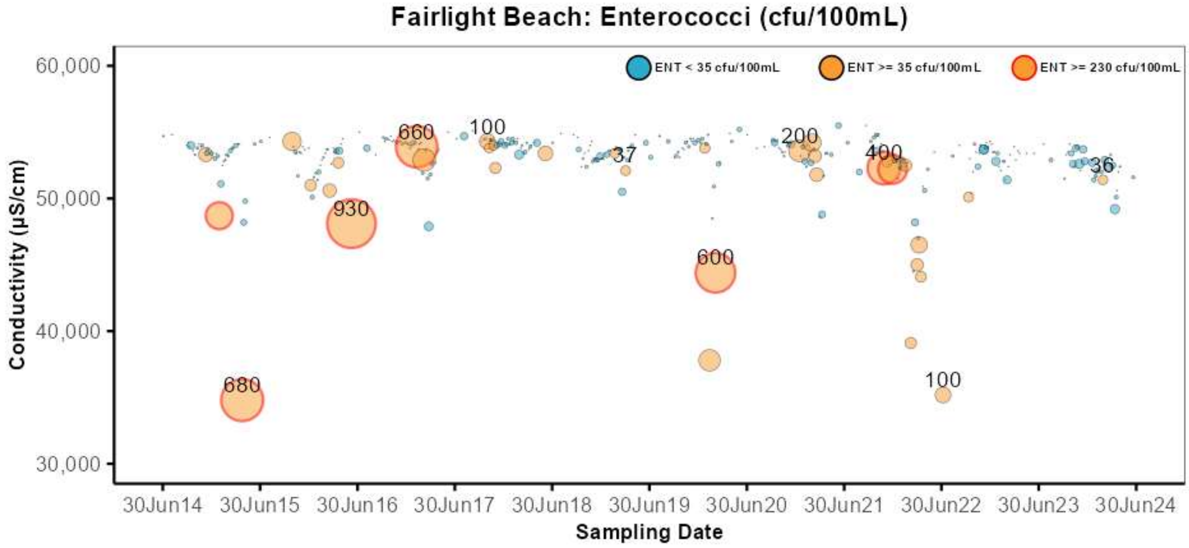
Davidson Reserve: Enterococci (cfu/100mL)

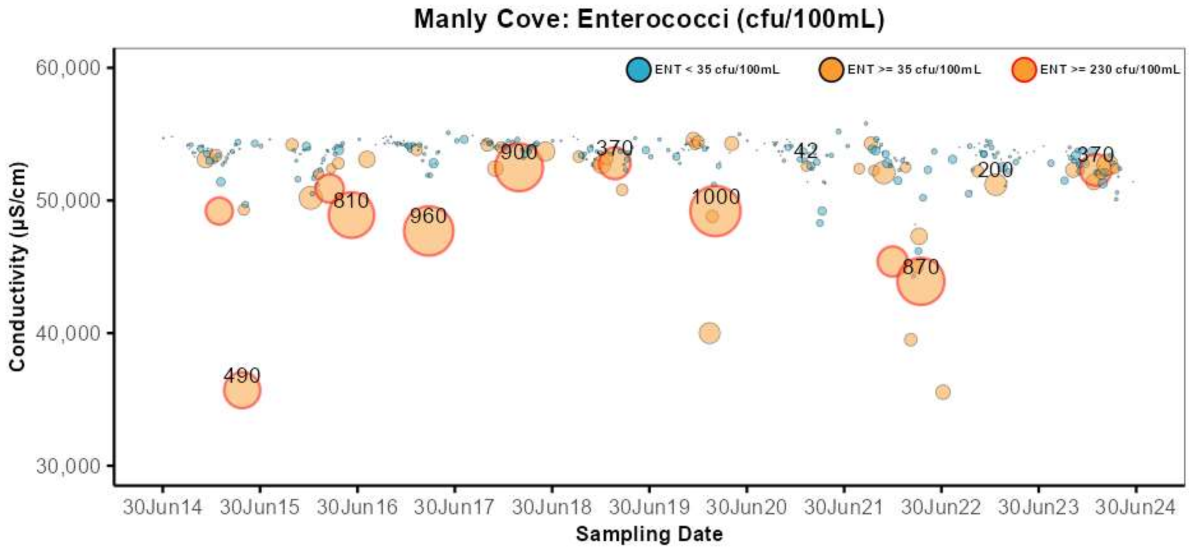


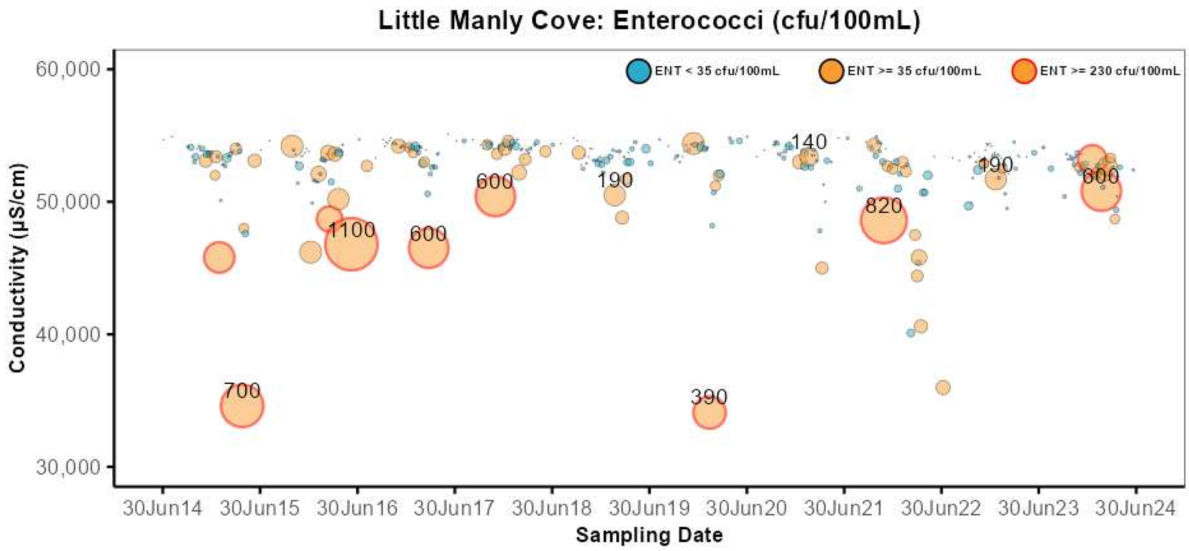

Gurney Cr Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
2700
140
810
110
960
1000
110
150
100
600
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date


Clontarf Pool: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
140
54
50
290
2400
220
280
510
170
760
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

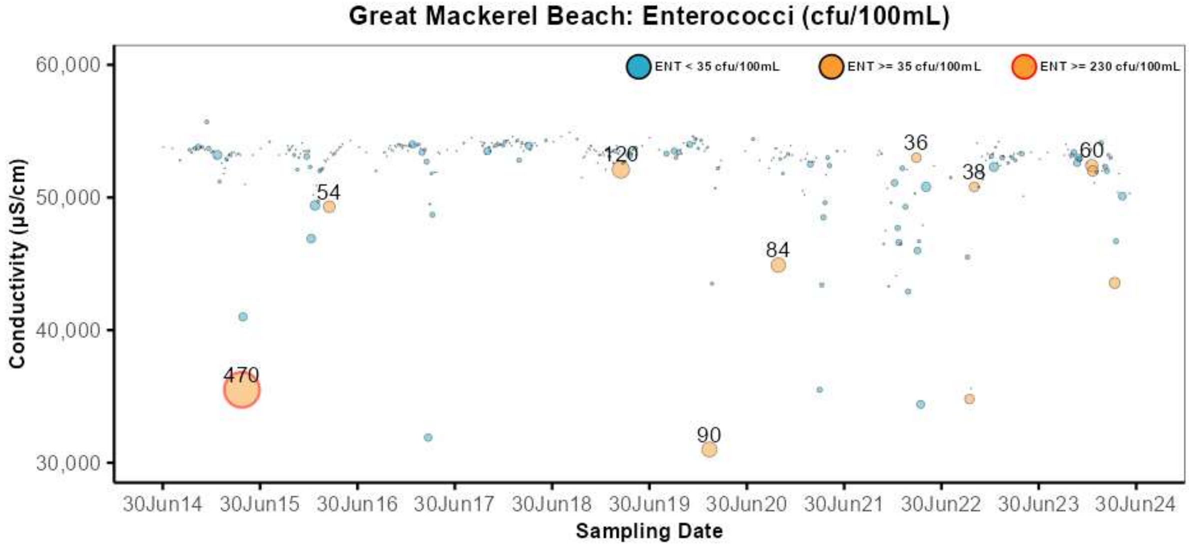

Forty Baskets Pool: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
340
870
450
90
75
1900
200
410
400
530
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

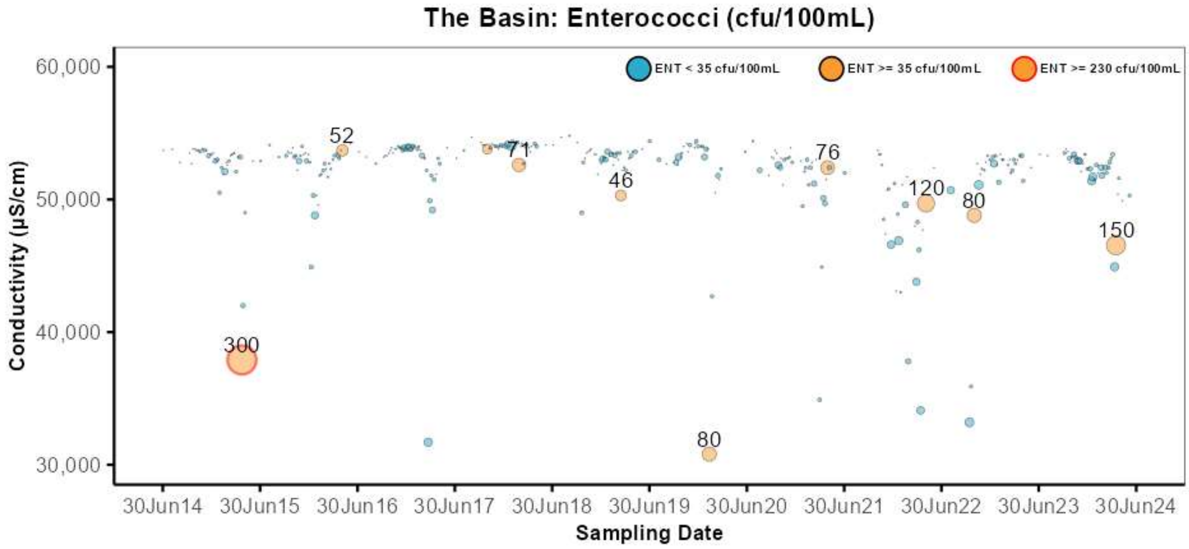

Fairlight Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24

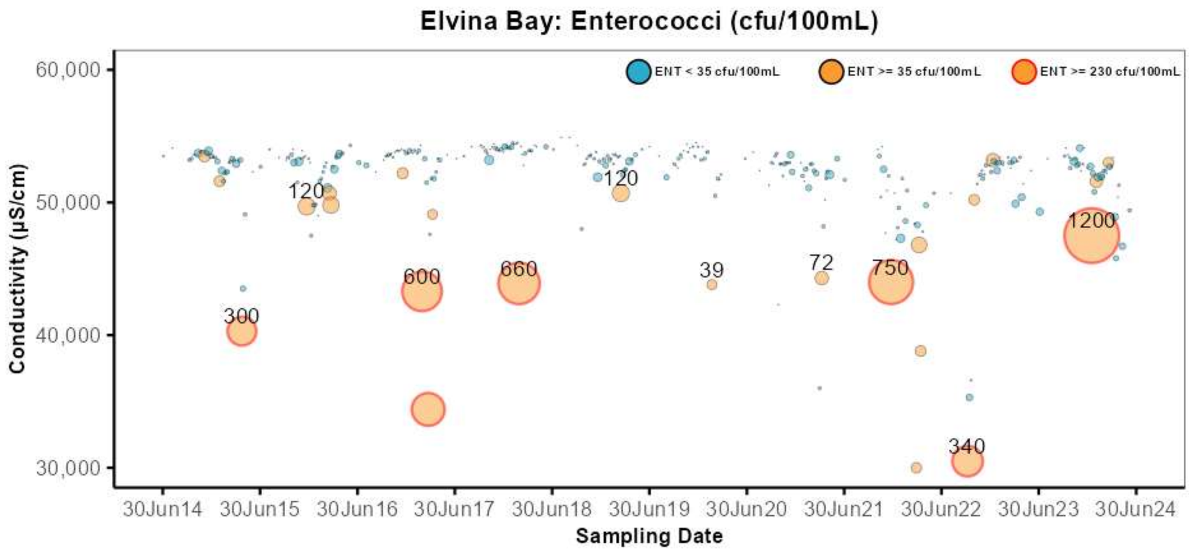

Manly Cove: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date


Little Manly Cove: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date

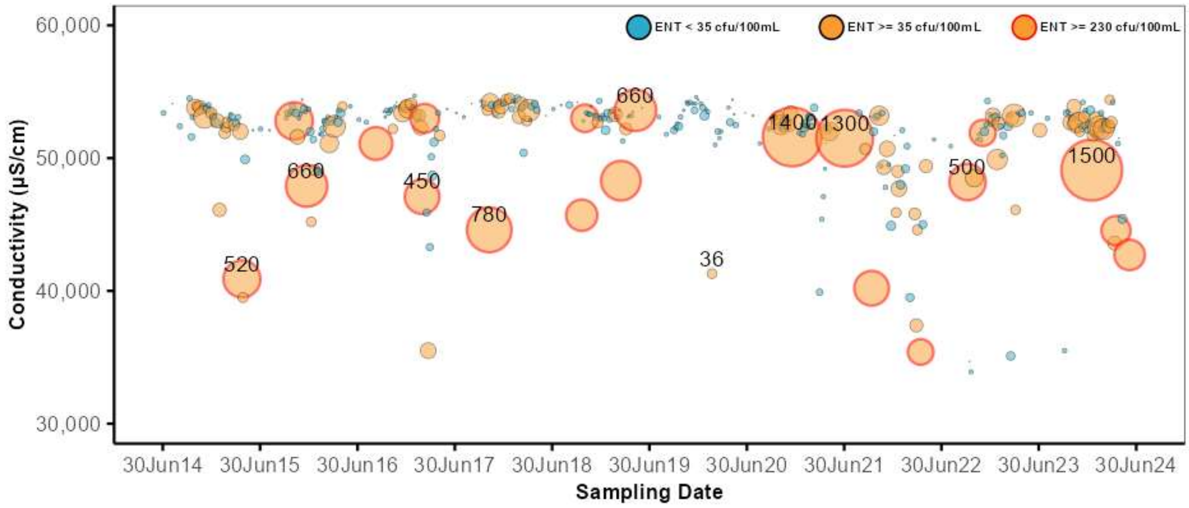
G.11. Sydney Harbour and Estuaries: Pittwater



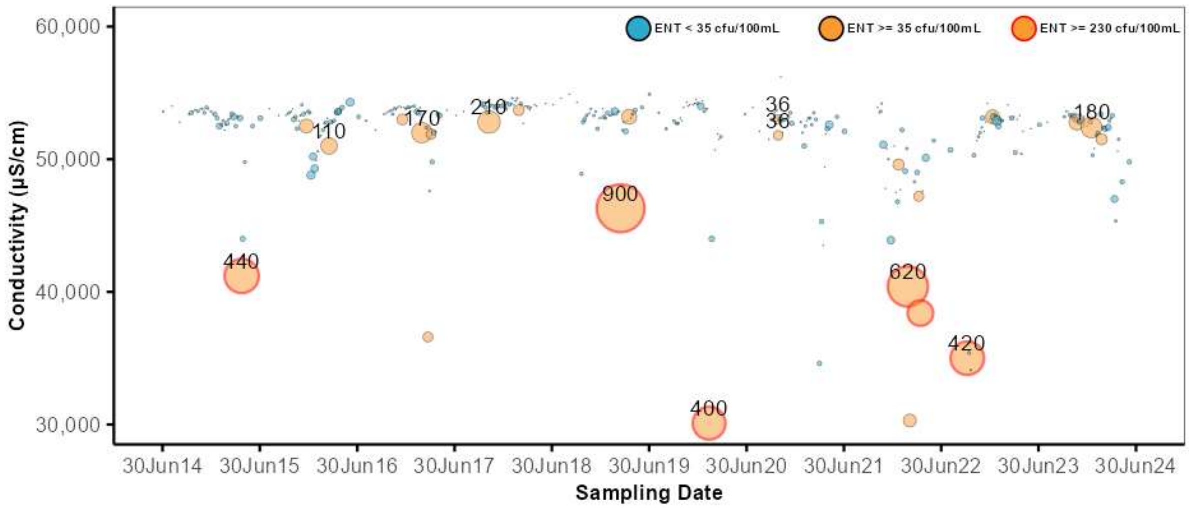




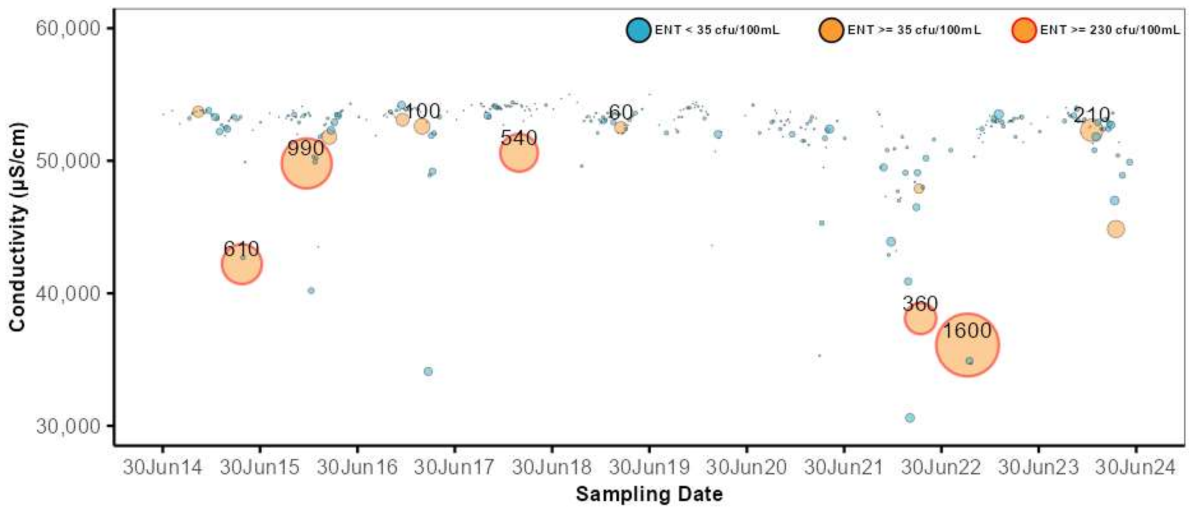
Bayview Baths: Enterococci (cfu/100mL)

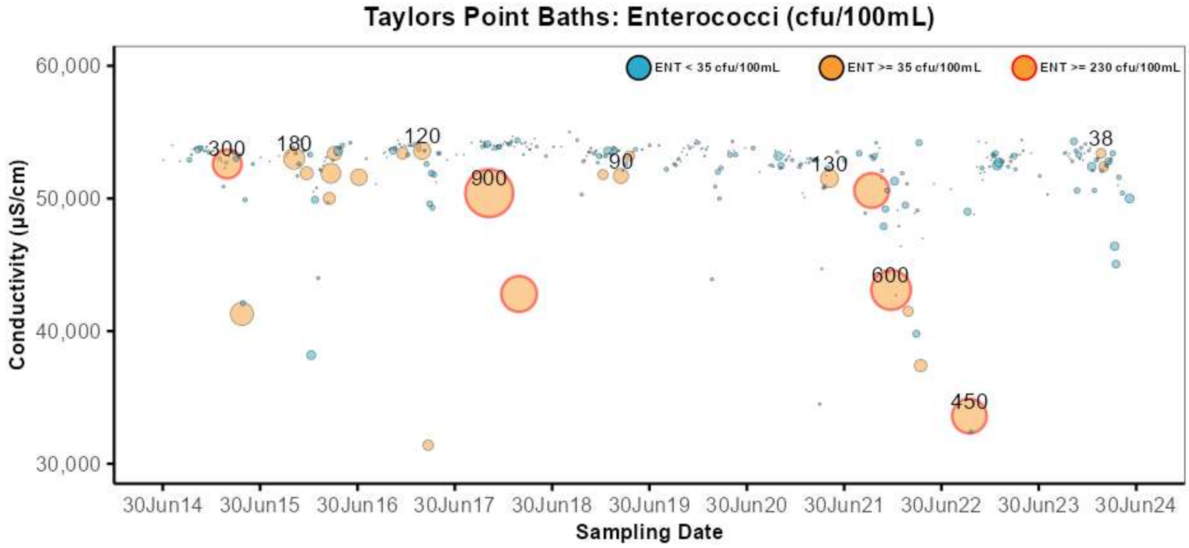


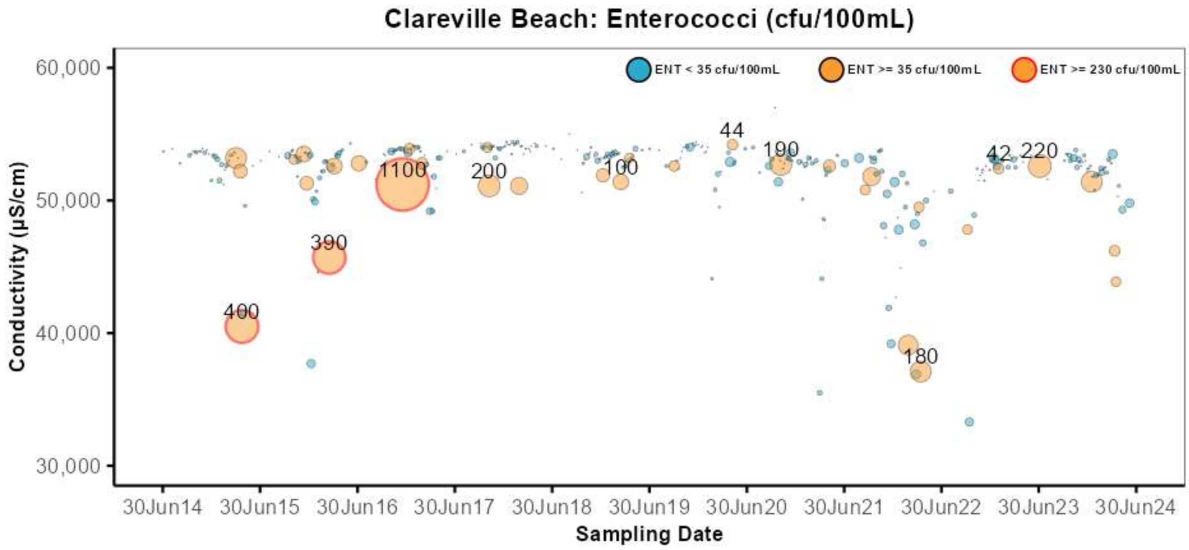
South Scotland Island: Enterococci (cfu/100mL)

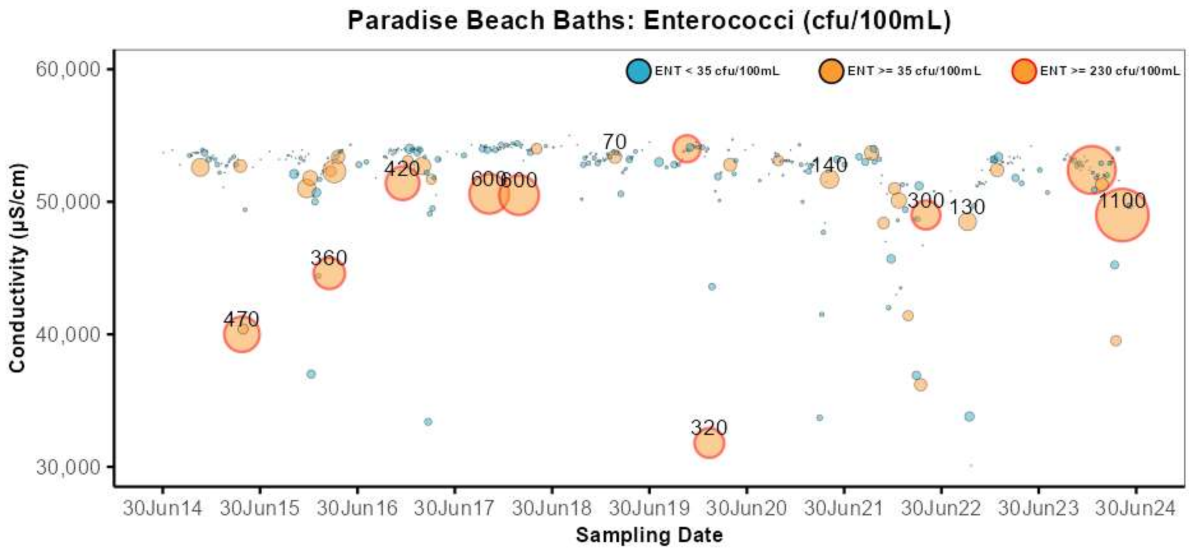


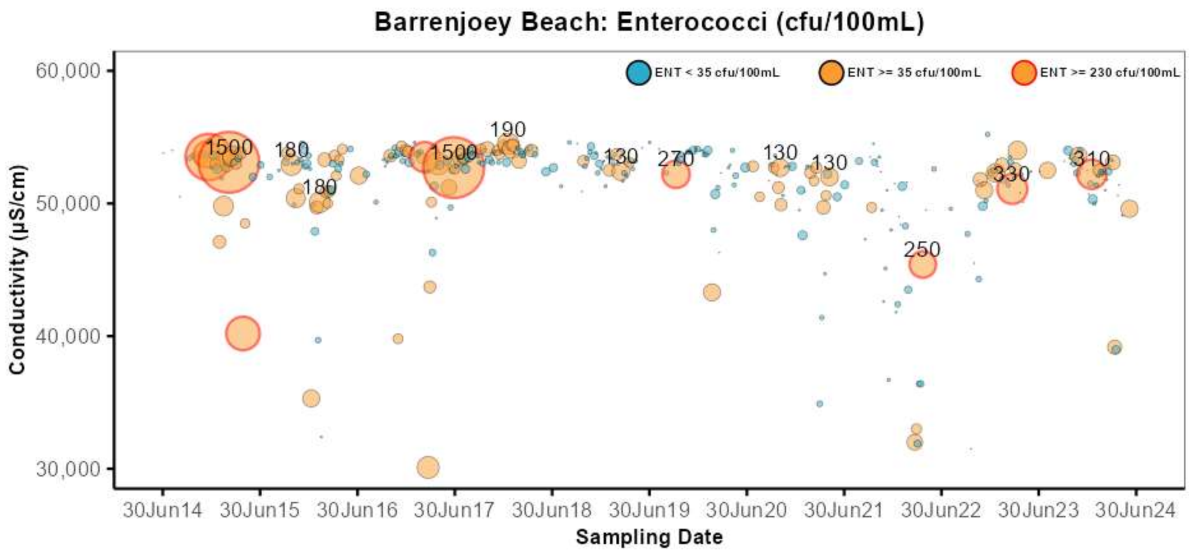
North Scotland Island: Enterococci (cfu/100mL)




Taylors Point Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
60,000
50,000
40,000
30,000
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
300
180
120
900
90
130
38
600
450


Clareville Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
60,000
50,000
40,000
30,000
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
44
190
42
220
1100
200
100
390
400
180


Paradise Beach Baths: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
Sampling Date
60,000
50,000
40,000
30,000
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
70
420
600
600
140
300
130
1100
360
470
320


Barrenjoey Beach: Enterococci (cfu/100mL)
ENT < 35 cfu/100mL
ENT >= 35 cfu/100mL
ENT >= 230 cfu/100mL
Conductivity (µS/cm)
60,000
50,000
40,000
30,000
1500
180
180
1500
190
130
270
130
130
250
330
310
30Jun14
30Jun15
30Jun16
30Jun17
30Jun18
30Jun19
30Jun20
30Jun21
30Jun22
30Jun23
30Jun24
Sampling Date

H. Electronic appendices

Multiple data and data summary files are provided to the EPA as electronic appendices under the following three categories and type of data/ monitoring programs. Further details on this data and any other supporting data (historical) including metadata can be provided on request.

H.1. Descriptive statistics

Data summaries on descriptive statistics for all metrics for the key monitoring programs are provided in electronic appendices as Microsoft excel files. The criteria to prepare the files includes:

- Presenting each summary statistic within a column to the same level of precision (i.e. with the same number of decimal places) - easier to compare.
- Presenting the percentiles, minimum and maximum summary statistics with the precision of the scale of measurement.

The number of variables presented in these summary statistics files varied by the type of data analysed and their significance to improve our understanding. List of files provided as electronic appendices by each type of data/ monitoring programs are provided below.

Table H-1 List of electronic appendix files on descriptive statistics

Data	File name
Wastewater	EA_WW_01 Yearly WWRF catchment rainfall, wastewater inflow, discharge, reuse volume
	EA_WW_02 Yearly WWRF LBL flow and load summary
	EA_WW_03 Yearly WWRF discharge concentration summary
Wastewater overflows	EA_WWO_01 DWLP SCAMPs results for each EPL, 2023-24
Receiving water quality and ecosystem health (phytoplankton)	EA_WQ&EH_01 Yearly Hawkesbury-Nepean River – water quality and chlorophyll-a data summary (2023-24)
	EA_WQ&EH_02 Yearly Georges River – water quality and chlorophyll-a data summary (2023-24)
	EA_WQ_01 Yearly reference sites – water quality data summary (2023-24)

H.2. Statistical model details and outputs

Statistical analysis outcome tables for the Hawkesbury-Nepean River paired and SoE sites are provided as two separate electronic appendices (H-2).

Table H-2 List of electronic appendix files on analysis datasets

Data	File name
Receiving water quality and ecosystem health (phytoplankton)	EA_WQ&EH_03 ANOVA and EMMEANs outcomes for paired sites
	EA_WQ&EH_04 ANOVA and EMMEANs outcomes for SoE sites

H.3. Analysis datasets

Analysis datasets for the key monitoring programs are provided in electronic appendices as Microsoft excel files. List of files provided as electronic appendices for each type of data are provided below.

Table H-3 List of electronic appendix files on analysis datasets

Data	File name
Receiving water quality, ecosystem health and ocean sediment data	EA_WQ&EH_05 Hawkesbury-Nepean River – water quality and chlorophyll-a data (2023-24)
	EA_WQ&EH_06 Georges River – water quality and chlorophyll-a data (2023-24)
	EA_WQ_02 Reference site – water quality data 2023-24
	EA_EH_01 Hawkesbury-Nepean River – Phytoplankton biovolume data (SoE sites) by all group (2014-24)
	EA_EH_02 Hawkesbury-Nepean River – Phytoplankton counts (SoE sites) 2023-24
	EA_EH_03 Freshwater ecology indicator data 2023-24
	EA_EH_04 Shellharbour community data 2023-24
	EA_EH_05 Ocean sediment program indicator data 2023-24