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ECOSYSTEM MANAGEMENT AND MONITORING



September Quarterly Aquatic Ecosystem Monitoring Report

Liverpool City Council

September 2023

Project Liverpool Aquatic Ecosystem Monitoring 2022 - 2023

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Report Structure

This report presents the September Aquatic Ecosystem Monitoring Monthly Progress Report (Part 1) which is accompanied by the quarterly report (July 2023 to September 2023).

Part 1

Aquatic Ecosystem Monitoring Monthly Progress Report - September 2023

Monthly aquatic ecosystem monitoring of the Georges River and South Creek catchments was conducted on September 27, 2023.

September results recorded a temporal trend of turbidity, which increase from July to August, then decreased in September. No other obvious temporal trends were recorded in September compared to the July and August results.

This report provides a summary of recreation water quality indicators (Cyanobacteria, *Enterococci* and *Faecal Coliforms*) at Georges River recreation monitoring sites and observations from freshwater monitoring sites.

Badgerys Creek weather monitoring station is expected to be representative of weather conditions in the Kemps Creek catchment and Holsworthy Aerodrome station is expected to be representative of conditions in the locale of the Georges River monitoring sites.

Weather conditions during September sampling were warm to cool with 0.4 mm of rain recorded at Badgerys Creek AWS (Table 1) and 0.8 mm recorded at Holsworthy Aerodrome (Table 2) in the week prior to sampling.

Table 1: Weather observations for Badgerys Creek AWS, NSW (BOM 2023).

Date	Temp min (°C)	Temp max (°C)	Rainfall (mm)
21/09/2023	12.3	24.8	0
22/09/2023	9.6	20	0.4
23/09/2023	6.1	21.9	0
24/09/2023	7.3	22.4	0
25/09/2023	5.9	-	0
26/09/2023	10.7	-	0
27/09/2023	14.2	22.6	0

- indicates a gap in the BOM data

Table 2: Weather observations for Holsworthy Aerodrome (BOM 2023).

Date	Temp min (°C)	Temp max (°C)	Rainfall (mm)
21/09/2023	12.4	23.2	0
22/09/2023	8.7	18.7	0.2
23/09/2023	5.5	20.3	0
24/09/2023	7.7	21	0
25/09/2023	5.0	28.2	0
26/09/2023	10.4	21.5	0
27/09/2023	13.4	24.7	0.6

Blue Green Algae (Cyanobacteria) monitoring at recreation sites in the Georges River was undertaken on September 27, 2023, during medium tide.

Results show that potentially toxic cyanobacteria were not detected at any sites during sampling at all Georges River sites, and biovolume calculations indicate (Table 3) -

- NHMRC Surveillance Mode (Green Level) was triggered at the recreation monitoring GR1 and GR4 (Table 3).

Table 3: Results summary for recreation monitoring sites, September 2023.

Site	Sampled	Potentially Toxic Blue Green Algae	NHMRC Alert Level	Safety Issues
GR1	Yes	Not detected	Green	None
GR1.5	Yes	Not detected	-	None
GR2	Yes	Not detected	-	None
GR3	Yes	Not detected	-	None
GR4	Yes	Not detected	Green	None
GR5	Yes	Not detected	-	None

Three species of cyanobacteria were recorded at GR1 which included *Cyanogranis libera*, *Phormidium* spp., and *Romeria* spp. Due to the biovolume of these species, NHMRC Surveillance Mode (Green Level) was triggered.

GR1.5 recorded two species of cyanobacteria, *Cyanogranis libera* and *Romeria* spp. Biovolume of these species were not detected at concentrations high enough to trigger an NHMRC (2008) alert.

No species of cyanobacteria were recorded at GR2. Because of this, no NHMRC (2008) mode was triggered.

GR3 recorded no species of cyanobacteria. Because of this, no NHMRC (2008) mode was triggered.

Three species of cyanobacteria were recorded at GR4 which included *Planktothrix* spp., *Pseudanabaena* spp., and *Romeria* spp. Due to the biovolume of these species, NHMRC Surveillance Mode (Green Level) was triggered.

GR5 recorded one species of cyanobacteria, *Romeria* spp. Because of the low biovolume of this species, no NHMRC (2008) mode was triggered.

Due to the persistence of cyanobacteria, there is potential for future blooms to occur. NHMRC (2008) recommends weekly or fortnightly monitoring if the ‘Green’ mode is triggered (Table 4).

Table 4: Recommended monitoring actions and corresponding NHMRC Alert Levels.

Blue Green Algae Alert Level	Recommended Actions
Surveillance Mode (Green Level)	<ul style="list-style-type: none"> Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present. Fortnightly for other types including regular visual inspection of water surface for scums.
Alert Mode (Amber Level)	<ul style="list-style-type: none"> Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. Monitor weekly or fortnightly where other types are dominant. Make regular visual inspections of water surface for scums. Decide on requirement for toxicity assessment or toxin monitoring.
Action Mode (Red Level)	<ul style="list-style-type: none"> Continue monitoring as for alert mode. Immediately notify health authorities for advice on health risk. Make toxicity assessment or toxin measurement of water if this has not already been done. Health authorities warn of risk to public health (ie the authorities make a health risk assessment considering toxin monitoring data, sample type and variability).

Results of bacteria monitoring at recreation sites in September 2023 show that the ANZECC Primary Contact guidelines were exceeded at GR3, and Secondary Contact Guidelines for *Faecal coliforms* were not exceeded at any of the George River Sites. The ANZECC Secondary Contact guidelines for *Enterococci* were not exceeded at any of the Georges River sites, while the ANZECC Primary Contact guidelines for *Enterococci* was exceeded at GR3.

Table 5. Summary of conditions observed/recorded at each site during September 2023 monitoring. Orange indicates exceedance of the primary contact guideline; red indicates exceedance of the secondary contact guideline.

Recreation sites						
SITE	Sampled	Tide	<i>Faecal coliforms</i> CFU/100 mL	<i>Enterococci</i> CFU/100 mL	Safety Issues	Observations
GR1	Yes	N/A	4	5	None	Clear
GR1.5	Yes	N/A	49	11	None	Clear
GR2	Yes	N/A	5	6	None	Clear
GR3	Yes	Mid	700	210	None	Clear
GR4	Yes	Mid	5	1	None	Clear
GR5	Yes	Mid	5	1	None	Clear

Primary Contact	-	-	150	35	-	-
Secondary Contact	-	-	1000	230	-	-

Surface water samples were collected at all freshwater monitoring sites in September 2023, with the exception of KC11 and AC1 (due to construction of a pipeline). During the September monitoring period, freshwater sites monitored by this program typically had only a minimal change to the results of the previous month.

Table 6. Summary of conditions observed/recorded at each site during September 2023 monitoring.

Site	Water quality	Aquatic Macroinvertebrates	Benthic Diatoms	Flow	Observations	Safety Issues
MC1	Yes	No	No	Normal	Turbid	None
AC1	No	No	No	-	-	No access due to construction
KC1	No	No	No	None, Creek was dry	Clear	None
KC2	Yes	No	No	Normal	Clear	None
KC3	Yes	No	No	Normal	Clear	None
KC5	Yes	No	No	Normal	Clear	None

KC6	Yes	No	No	Normal	Clear	None
KC8	Yes	No	No	Normal	Clear	None
KC10	Yes	No	No	Normal	Clear	None
KC11	No	No	No	-	-	No access due to construction
KC12	Yes	No	No	Normal	Clear	None
SC1	Yes	No	No	Normal	Turbid	None
SC2	Yes	No	No	Normal	Clear	None
BC1	Yes	No	No	Normal	Turbid	None
WG	Yes	No	No	Normal	Clear	None
HC	Yes	No	No	Normal	Clear	None

All data has been supplied in an Excel spreadsheet separate this report and no safety issues were recorded/observed during monitoring.

Part 2

Introduction

This report outlines results for the quarter (July 2023 to September 2023) for the 2022-2023 monitoring period.

This report presents results of nutrient, turbidity, bacteria, and Blue Green Algae parameters which are typical indicators used to assess degradation of urban streams. Analysis of all parameters monitored by this program will be presented in the annual report.

Georges River catchment sites are reported as Recreation sites (GR1, GR1.5, GR2, GR3, GR4 and GR5) and Georges River Tributaries (AC1, MC1, HC and WG). South Creek catchment sites are reported as South Creek (SC1 and SC2), Badgerys Creek (BC1), Kemps Creek (KC1, KC5, KC8, KC10, KC11 and KC12) and Kemps Creek Tributaries (KC2, KC3 and KC6).

Freshwater monitoring sites

Water quality was variable across all freshwater monitoring sites and all sites recorded degraded water quality and impairment typical of urban streams. The phrase ‘urban stream syndrome’ (Walsh et al. 2005) was coined to describe the multiple common symptoms occurring in urban streams, including degraded water quality, geomorphology, hydrology and biodiversity. All freshwater sites frequently recorded nutrient levels (phosphorous and nitrogen) that exceeded the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for fresh and marine water quality (2000). Other parameters, including turbidity, dissolved oxygen, pH and electrical conductivity, were also recorded to be outside the ANZECC 2000 water quality guidelines at the majority of sites throughout the three-month monitoring period.

Total Nitrogen

Total nitrogen (TN) variations were constant across the Kemps Creek sites for the July 2023 - September 2023 period (Appendix 1). Results show that all sites recorded non-compliance to the ANZECC lowland river guideline for southeast Australia (0.35 mg/L). The highest concentration, 30.8 mg/L, was recorded at MC1 in July 2023, which is approximately 90 times greater than the ANZECC guideline. TN remained at similar concentrations throughout the monitoring period. There was a spatial trend where sites in the upper catchment (KC1, KC5 and KC8) had increased TN concentrations than the sites further downstream (KC10, and KC12)

Total nitrogen was variable across Kemps Creek tributary sites (Appendix 1). All sites recorded non-compliance to the ANZECC lowland river guideline for southeast Australia (0.35 mg/L). KC6 recorded the

highest TN concentration of 27.5 mg/L in September. These results are approximately 80 times higher than the recommended ANZECC guideline.

Total nitrogen within all sites of Georges River tributaries was stable except for a spike at MC1 in September. Total nitrogen did not comply with the ANZECC lowland river guideline for southeast Australia during all sample events within the three-month period. The highest concentrations were recorded at both MC1 in September at 39.6 mg/L. TN recorded at MC1 was generally higher than AC1, HC, and WG.

Total nitrogen levels in sites within the South Creek catchment were variable and did not comply with the ANZECC guideline value of 0.35 mg/L during the monitoring period (Appendix 1). TN concentration was highest at SC1 in August reaching 9.4 mg/L, followed by SC1 in July reaching 4.1 mg/L. BC1 and SC2 were generally lower than SC1.

Total phosphorous

Total phosphorous (TP) was consistently high across Kemps Creek sites, with no clear temporal trend evident (Appendix 1). All sites recorded non-compliance to the ANZECC lowland river guideline for southeast Australia of 0.025 mg/L. KC5 recorded the highest TP concentration of 4.06 mg/L in July, approximately 160 times the guideline limit.

Kemps Creek tributary sites had elevated TP and did not comply to the ANZECC guideline (Appendix 1). KC6 recorded the highest concentration of TP (2.05 mg/L) in September. KC2 and KC3 readings were relatively constant.

Georges River tributary sites had variable TP (Appendix 1). Most sites were non-compliant to the ANZECC guideline of 0.025 mg/L during all but one site visits (HC in July). Maximum TP was recorded at MC1 reading 0.16 mg/L in September. The maximum TP concentration recorded at MC1 is approximately 6 times the guideline limit.

Total phosphorus concentrations at all South Creek catchment sites (SC1, SC2, and BC1) were variable and exceeded the ANZECC guideline for all monitoring events (Appendix 1). TP was highest at SC1 in August, with a value of 0.45 mg/L. This was followed by SC1 in July, with a value of 0.28 mg/L. BC1 was generally lower than SC and SC2.

Turbidity

During the monitoring quarterly monitoring period, turbidity across the waterways of Liverpool was variable, and complied to the ANZECC guideline of between 6 and 50 NTU (Appendix 1). The highest turbidity recorded was 24.7 at KC1 in August, followed by 23.4 NTU at BC1 and HC in August. Results were below the ANZECC guideline of 6 NTU on 25 occasions.

Recreation Monitoring Sites

Turbidity

Turbidity at freshwater sites was compliant with or below the ANZECC freshwater guidelines (6-50 NTU) during this sampling period. At the estuary sites, there was no compliance with the primary contact guideline of 0.5 NTU. All estuary sites were within the secondary contact guideline of under 10 NTU in September during the sample period.

Faecal coliforms and Enterococci

Results of bacteria monitoring at the Georges River Recreation sites shows that breaches of the ANZECC primary contact guidelines for *Enterococci* occurred within in all months of this sampling period, and the ANZECC secondary contact guidelines for *Enterococci* was breached during July and August. The ANZECC primary contact guidelines *Faecal coliforms* was breached in August and September, while the ANZECC secondary contact guidelines *Faecal coliforms* was breached in July (Table 7).

The ANZECC primary contact guidelines for *Enterococci* were exceeded at GR1 in July and August.

GR1.5 exceeded the ANZECC primary contact guidelines for *Enterococci* in July.

GR2 breached the ANZECC primary contact guidelines for *Faecal coliforms* in July and September. The ANZECC primary contact guidelines for *Enterococci* were also exceeded at GR2 in August and secondary contact guidelines in July.

The ANZECC primary contact guidelines for *Faecal coliforms* were breached at GR3 in September and the secondary contact guidelines in July. GR3 exceeded the ANZECC primary contact guidelines for *Enterococci* in September and the secondary contact guidelines in July.

GR4 exceeded the ANZECC secondary contact guidelines in July and August.

No ANZECC primary and secondary contact guidelines for *Faecal coliforms* or *Enterococci* were exceeded at GR5.

Cyanobacteria (Blue Green Algae)

Monitoring of Cyanobacteria (Blue Green Algae) show that all recreation sites are susceptible to Blue Green Algae blooms, and potentially toxic species of Blue Green Algae are commonly detected (Table 7). The highest NHMRC monitoring level is 'Red Level Action Mode' followed by the 'Amber Level Alert Mode' with 'Green Level Surveillance Mode' being the lowest level in the NHMRC (2008). Each monitoring level has a recommended response.

Blue Green Algae Biovolume recorded across Georges River Estuary monitoring sites triggered the ‘Green Level Surveillance Mode’ (NHMRC 2008) at GR1 in September and at GR4 during July and September sampling. All other sites recorded levels of cyanobacteria that didn’t trigger a NHMRC response (Table 7).

Table 7: Data summary for recreation monitoring sites. Non-compliance to ANZECC (2000) primary guidelines is indicated in orange and secondary guidelines in red. NHMRC (2008) Blue Green Algae alert levels highlighted as per the a

Site	Date	<i>Faecal coliforms</i>	<i>Enterococci</i>	<i>Cyanobacteria</i>
		(cfu/100ml)	(cfu/100ml)	NHMRC Alert Level
GR1	04/07/2023	23	100	-
	21/08/2023	17	110	-
	27/09/2023	4	5	Green
GR1.5	04/07/2023	65	150	-
	21/08/2023	17	3	-
	27/09/2023	49	11	-
GR2	04/07/2023	200	260	-
	21/08/2023	100	140	-
	27/09/2023	5	6	-
GR3	04/07/2023	2200	560	-
	21/08/2023	20	7	-
	27/09/2023	700	210	-
GR4	04/07/2023	110	790	Green
	21/08/2023	140	420	-
	27/09/2023	5	1	Green
GR5	04/07/2023	20	7	-
	21/08/2023	16	30	-
	27/09/2023	5	1	-

Table 8: NHMRC Blue Green Algae Levels and recommended response (NHMRC 2008).

NHMRC MONITORING LEVEL	RECOMMENDED RESPONSE
SURVEILLANCE MODE (GREEN LEVEL)	This level involves routine sampling to measure contaminants (e.g. physical, microbial, cyanobacterial and algal).
ALERT MODE (AMBER LEVEL)	This level requires investigation into the causes of elevated contaminant levels, and increased sampling to enable a more accurate assessment of the risks to recreational users.
ACTION MODE (RED LEVEL)	This level requires the local government authority and health authorities to warn the public that the water body is considered unsuitable for recreational use.

Conclusion

It is evident that most freshwater sites across the Liverpool LGA have elevated nutrient levels, often at orders of magnitude higher than the recommended ANZECC guidelines. Elevated nutrients in the urban and peri-urban setting are commonly sourced from stormwater run-off, sewer leakage or other wastewater sources, fertiliser contamination and decay of organic material. This program cannot quantify the source of the elevated results continually recorded across the Kemps Creek sites; however, likely drivers include the combination of flow conditions and the decay of organic matter, and increased stormwater runoff due to high rainfall and the flooding events.

Results of monitoring at Georges River freshwater sites shows elevated nutrient concentrations were apparent for most of the monitoring period, the source of which is likely elevated stormwater runoff.

Statistical analysis of data collected by the monitoring program will be undertaken and presented in the annual report and program recommendations will be made.

All data has been supplied in an Excel spreadsheet separate this report and no safety issues were recorded/observed during monitoring.

If you have any questions, please get in touch.

Kind regards,



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References

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Appendix 1

Table 1: Water quality results from the sampling period July to September 2023.

	DATE	PH	EC	DISSOLVED OXYGEN	TURBIDITY	AMMONIA -N	NOX- N	TKN	TOTAL NITROGEN	TOTAL PHOSPHORUS	REACTIVE PHOSPHORUS
AC1	4/07/2023	7.76	208	77.1	1.56	0.04	0.40	0.4	0.8	0.05	0.01
AC1	21/08/2023	7.36	240.4	82.6	0.64	0.02	0.11	0.3	0.4	0.03	<0.01
AC1	27/09/2023	-	-	-	-	-	-	-	-	-	-
MC1	4/07/2023	7.76	403	99.2	21.5	0.41	0.64	1.9	2.5	0.11	0.03
MC1	21/08/2023	9.16	962	142.3	22.5	0.09	0.05	0.9	1.0	0.10	<0.01
MC1	27/09/2023	8.21	973	63.1	8.15	6.70	0.71	38.9	39.6	0.16	0.08
WG	4/07/2023	8.01	516	79.4	2.25	0.04	0.02	0.7	0.7	0.07	<0.01
WG	21/08/2023	7.72	392	61.7	3.55	0.99	0.04	1.4	1.4	0.13	0.01
WG	27/09/2023	8.12	485	52.1	3.84	0.08	0.10	1.3	1.4	0.13	0.02
HC	4/07/2023	7.64	926	45.1	3.18	0.04	0.25	0.3	0.6	0.02	<0.01
HC	21/08/2023	7.53	583	37.8	23.4	0.02	0.22	0.3	0.5	0.06	<0.01
HC	27/09/2023	7.94	1041	42.9	2.82	0.10	0.02	0.5	0.5	0.04	0.01
KC1	4/07/2023	7.79	823	73.1	0.85	0.04	26.3	3.1	29.4	3.40	3.39
KC1	21/08/2023	7.8	1166	104.6	24.7	0.04	13.1	1.8	14.9	1.79	1.69
KC1	27/09/2023	-	-	-	-	-	-	-	-	-	-
KC2	4/07/2023	7.78	1113	82.8	6.2	0.05	0.60	0.6	1.2	0.10	0.04
KC2	21/08/2023	7.82	11.47	85.7	21.3	0.01	0.04	0.4	0.4	0.06	0.02
KC2	27/09/2023	8.02	1564	33.4	5.27	0.02	0.06	0.6	0.7	0.12	0.02
KC3	4/07/2023	7.81	1006	81.1	8.55	0.02	0.15	1.2	1.4	0.33	0.13
KC3	21/08/2023	7.81	938	71.9	20	0.05	1.40	1.1	2.5	0.41	0.25
KC3	27/09/2023	8.26	1247	37.3	4.92	0.06	1.36	1.1	2.5	0.58	0.50
KC5	4/07/2023	7.84	1769	63.1	1.58	0.05	27.4	3.4	30.8	4.06	4.02
KC5	21/08/2023	7.82	1244	73.7	22.2	0.03	16.0	1.7	17.7	2.04	2.17

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KC5	27/09/2023	7.86	1860	32.2	4.18	0.06	18.5	3.9	22.4	1.36	0.47
KC6	4/07/2023	7.99	1823	69.3	2.59	0.04	4.58	1.4	6.0	0.69	0.56
KC6	21/08/2023	7.93	1347	65.4	23.1	0.02	6.30	1.2	7.5	0.88	0.80
KC6	27/09/2023	7.81	1629	43.8	4.23	0.04	23.7	3.8	27.5	2.05	2.00
KC8	4/07/2023	7.91	2445	96.3	2.96	0.02	11.4	1.6	13.0	1.42	1.40
KC8	21/08/2023	8.1	1424	103.2	21.6	0.02	6.58	1.2	7.8	0.84	0.84
KC8	27/09/2023	7.68	1563	63.1	5.6	0.05	7.35	3.5	10.8	1.83	1.01
KC10	4/07/2023	7.8	3130	76.1	1.34	0.02	9.92	2.3	12.2	1.36	1.23
KC10	21/08/2023	7.86	1748	74.5	19.85	0.05	4.59	1.0	5.6	0.72	0.69
KC10	27/09/2023	7.72	1529	48.2	4.41	0.02	9.21	2.9	12.1	1.23	1.12
KC11	4/07/2023	-	-	-	-	-	-	-	-	-	-
KC11	21/08/2023	-	-	-	-	-	-	-	-	-	-
KC11	27/09/2023	-	-	-	-	-	-	-	-	-	-
KC12	4/07/2023	7.59	3140	79.9	1.86	<0.01	9.66	1.9	11.6	1.12	1.02
KC12	21/08/2023	7.32	1765	89.9	21.7	0.05	4.36	1.2	5.6	0.67	0.63
KC12	27/09/2023	7.72	1648	52.3	4.31	0.03	1.90	1.4	3.3	0.49	0.46
SC1	4/07/2023	7.37	1233	49.1	2.93	0.03	2.00	2.1	4.1	0.28	0.06
SC1	21/08/2023	7.65	1402	56	21.1	2.31	4.07	5.3	9.4	0.45	0.28
SC1	27/09/2023	7.63	1825	38.7	7.81	0.21	1.00	1.6	2.6	0.19	0.09
SC2	4/07/2023	7.81	1431	35.1	2.97	0.04	0.31	1.2	1.5	0.24	0.01
SC2	21/08/2023	7.75	1705	63.2	22.7	0.02	0.66	0.8	1.5	0.15	0.07
SC2	27/09/2023	7.95	1333	31.6	3.81	0.09	0.43	0.8	1.2	0.12	0.07
BC1	4/07/2023	7.6	717	51.4	4.76	0.02	0.15	0.4	0.6	0.04	<0.01
BC1	21/08/2023	7.75	1129	62.8	23.4	0.01	0.01	0.6	0.6	0.04	0.01
BC1	27/09/2023	7.61	1156	56.2	5.87	0.01	<0.01	0.6	0.6	0.04	<0.01