2024 Monitoring Report for Katherine Wastewater Treatment Plant WDL 151-08

Reporting Period: 1 November 2023 to 31 October 2024

PowerWater

Document Details and History

Document Title:	**2024 Monitoring report for Palmerston Wastewater Treatment Plant WDL 151-08**			
TRIM Container:		F2017/3454	**Document #**	D2024/412995
Version:	**Date Prepared:**	**Prepared by:**	**Version reviewed by/Issued to:**	
Draft 0.1	30/10/2024	Ashley Beagley, Power and Water Corporation	Natasha McBride and Lenin Villamar, Power and Water Corporation	
Final 1.0	31/10/2024	Ashley Beagley, Power and Water Corporation	Tahlia Kemp, Power and Water Corporation	
Date of Submission:		31/10/2024		

Abbreviations and Glossary

Abbreviation	Definition
Al	Aluminium
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BOD	Biochemical oxygen demand
BWSP	Berrimah Waste Stabilisation Ponds
Cfu	Colony forming units (expressed per unit of a specified volume of sample)
Chl-a	Chlorophyll-a, a photosynthetic pigment present in plants, algae and cyanobacteria that is used in oxygenic photosynthesis. It can be used as a measure of algal biomass and subsequently primary production
Cu	Copper
Cu-B	Bioavailable copper in sediment (estimated by dilute acid extraction)
Cu-F	Copper filtered (dissolved fraction)
Cu:Al	Total copper in sediment normalised to total aluminium content of the sediment
Cu-T	Total copper in sediment
DHWQO(s)	Darwin Harbour water quality objective(s)
DO	Dissolved oxygen
EC	Electrical conductivity
E. coli	*Escherichia coli*
EP	Equivalent population
ERA	Environmental risk assessment
FRP	Filterable reactive phosphorous (orthophosphate)

ISQG	Interim sediment quality guidelines
Kg	Kilograms
kL	Kilolitres
L	Litres
LOP	Level of species protection (%)
LOR	Limit of reporting for chemical analysis
µg	Micrograms
mg	Milligrams
ML	Mega-litres
N	Nitrogen
NATA	National Association of Testing Authorities in Australia
NH_3-N	Total ammonia as N (NH_3 and NH_4^+ as N) as per ANZECC and ARMCANZ (2000) and ANZG (2018)
NHMRC	National Health and Medical Research Council
NO_X-N	Oxidised of nitrogen as N – the sum of nitrate and nitrite
NRETAS	Department of Natural Resources, Environment, The Arts and Sports, Northern Territory
NT	Northern Territory
NT DOH	Northern Territory Department of Health
NT EPA	Northern Territory Environment Protection Authority
NTU	Nephelometric turbidity units
Phaeo-a	Phaeophytin-a, a degradation product of chlorophyll-a
PWC	Power and Water Corporation
QA/QC	Quality assurance and quality control
SMD	A slightly-moderately disturbed aquatic ecosystem. This reflects both the management intent and subsequently the level of protection (ANZECC 95% Species Protection).

SMDZ	Slightly to moderately disturbed zone
SSTV(s)	Site specific trigger value(s)
TN	Total nitrogen
TN:TOC	Total nitrogen to total organic carbon ratio in sediment
TOC	Total organic carbon
TP	Total phosphorous
TSS	Total suspended solids
TV(s)	Trigger value(s)
WDL(s)	Waste discharge licence(s)
WQO(s)	Water quality objective(s)
WSP(s)	Waste stabilisation pond(s)
Zn	Zinc
Zn-B	Bioavailable zinc in sediment (estimated by dilute acid extraction)
Zn-F	Zinc filtered (dissolved fraction)
Zn:Al	Total zinc in sediment normalised to total aluminium content in sediment
Zn-T	Total zinc in sediment
ZOI	Zone of influence of the discharge (disturbed zone 90% species protection level or less)

Executive Summary

Power and Water Corporation (PWC) operate the Katherine Wastewater Treatment Plant (KWwTP) under Waste Discharge Licence (WDL) 151-08. This report presents the annual monitoring required under this licence for the reporting period of 1 November 2023 to 31 October 2024.

The report includes a comparison of influent and effluent loads using historical monitoring data to demonstrate the performance of the facility, taking into account inflow volumes and rainfall during discharge events. This information shows direct correlation between mass loads and discharge volume and suggests discharge has undergone substantial dilution, and further dilution is likely to take place upon its entry into the Katherine River.

Assessment of field measurements suggest that discharge quality is typical for effluent. Regarding pH levels, the 2023-24 median of 10.5 and the long term median of 9.2, indicate generally alkaline conditions, which is characteristic of water with high levels of algae. Electrical Conductivity (EC) levels have significantly decreased since 2017, the 2023-24 median EC value is 435.5 µS/cm, which is well below the long term median of 5721 µS/cm. The 2023-24 median Dissolved Oxygen (DO) value of 116.2% is an increase from the long term median DO value of 88%, and considered to be within acceptable limits for effluent.

Data collected within the 2023-24 reporting period suggests that the treatment performance of Katherine WwTP has not deteriorated when compared with previous years.

PFAS concentrations have remained well below the 95% species protection levels (HEPA 2020) for receiving waters since 2018 and several parameters fall within the Australian and New Zealand Environment and Conservation Council (ANZECC) guideline values for water quality in the receiving environment.

While many parameters meet acceptable standards, variations and occasional spikes suggest the need for monitoring and management to ensure consistent compliance with environmental guidelines.

Three discharge events occurred within the 2023-24 reporting period in accordance with the WDL limitations on discharge (i.e. when Katherine River Gauging Station, G8140001, is at a minimum flow of 66.78kL/s) to ensure sufficient dilution in the receiving environment. This assessment suggests minimal potential for environmental impact from effluent discharge into the river during the reporting period.

Table of Contents

List of Figures

List of Tables

1. Introduction

Power and Water Corporation operate the Katherine Waste Stabilisation Ponds (KWSP) to treat and evaporate the wastewater created by the Katherine Community. The KWSP is situated approximately 8km from the town, adjacent to the conservation (CN) zone of the Katherine River. The configuration of ponds includes 3 facultative, 2 maturation and 7 evaporative ponds; the latter having capacity to manage all inflows, therefore only needing to discharge to the Katherine River during high flow monsoonal events. The Katherine River is part of the Daly River catchment, which is considered a region of very high ecological value and there is a wide societal attachment to its pristine beauty and conservation value (van Dam et al. 2008). See Figure 2 for a map of the ponds with flow directions.

Figure 1: Katherine Waste Stabilisation Ponds (Google Image, 2022)

Discharges from KWSP are regulated under conditions specified in WDL151-08, which is granted under provisions of the Water Act 1992. Condition 21.3 of WDL 151-08 states:

- "Discharges from each authorised discharge point must comply with the limitations specified in Item 9".

Item 9 States:

- "Any authorised discharge must occur only when Katherine River Gauging Station, G8140001, is at a minimum flow of 66.78 kL/s".

A monitoring report is required to be submitted to the Administering Agency by October 31 of each year pursuant to condition 39 of the Waste Discharge Licence (WDL). This report supersedes the report completed for the 2022-23 reporting period.

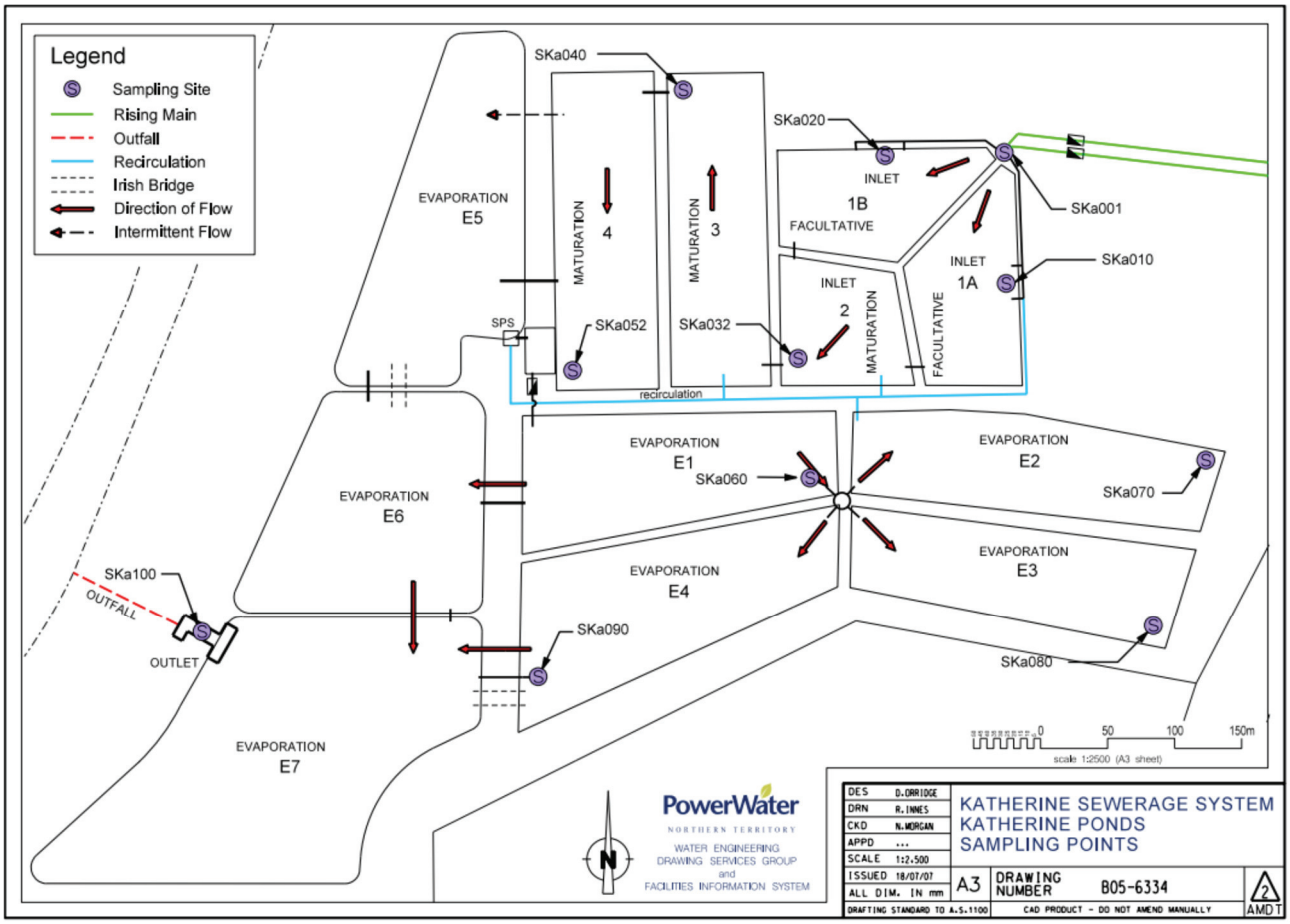

Figure 2: Katherine Waste Stabilisation Ponds Sampling Points and flow direction

2. Monitoring Objective

This report presents the results of the 2023 to 2024 data collection and assessment required for Waste Discharge Licence (WDL) 151-08 for discharge quality monitoring.

This report is prepared in accordance with conditions in WDL 151-08, issued to Power and Water Corporation pursuant to section 74 of the Water Act 1992. WDL 151-08 commenced on 8 August 2023 and the licence can be accessed via the NT EPA website via the following link;

https://ntepa.nt.gov.au/your-business/public-registers/licences-and-approvals-register/waste-discharge-licences/sewerage/power-and-water-katherine

This report has been prepared as per the following conditions in WDL148-08:

39. *The Licensee must complete and provide to the Administering Agency a report of data and information obtained through the implementation and performance of the Monitoring Program (the Monitoring Report), as prescribed by this licence, on the dates specified in Item 13.*
40. *The Licensee must ensure that each Monitoring Report:*

40.1. is prepared in accordance with the requirements of the Administering Agency 'Guideline for Reporting on Environmental Monitoring' (or any other guideline as adopted by the Administering Agency from time to time);

40.2. includes a tabulation, in Microsoft® Excel® format or another format requested by the Administering Agency, of all monitoring data required to be collected in accordance with this licence for the preceding 12 month period, including river height and flow telemetry at G8140001;

40.3. includes a tabulation of monthly and annual contaminant loads discharged from the authorised discharge point specified in Item 5 for the preceding 12 month period. Contaminant loads must be calculated for metals, metalloids, nutrients and other parameters (excluding field parameters) listed in the monitoring program specified in Item 11. The calculations must be based on the daily discharge volume and the concentration of contaminant present in the discharge on that day. On the days when a sample was not taken then the concentration of the contaminant must be estimated using Linear Interpolation methodology;

40.4. includes long term trend analysis of monitoring data to demonstrate any environmental impact associated with the Licensed Action over a minimum period of three years (of part thereof);

40.5. includes a summary of any investigations undertaken by the Licensee in accordance with this licence for the preceding 12 month period; and

40.6. includes an assessment of environmental impact from the Licensed Action.

3. Monitoring Method

As per WDL 151-08 requirements, monitoring of the KWSP effluent is limited to sampling at the discharge point during discharge events (Condition 27). Licenced discharge is only allowed to occur at times when the Katherine River flow exceeds 66.78kL/s (Condition 21.3) and as a result it is not safe to sample from any potential downstream sites. The high flow means the minimum dilution of the effluent when discharged in to the Katherine River is 1:575 (SLR 2022), greatly reducing the risk posed by any discharged contaminants.

As discharges have reduced in frequency so have the number of samples collected annually. This limits the quality of statistical comparison of data collected with guideline values and any long term trend analysis. However, it is still important to analyse and identify any notable trends in the long term sampling data (Section 4.3) and mass loads of key contaminants (Section 4.1.1).

Monitoring is conducted in accordance with the licence conditions and are as follows:

27. *From the Commencement Date of this licence, the Licensee must implement and comply with the Monitoring Program specified in Item 11.*
28. *The Licensee must to the extent practicable collect samples that are representative of discharge conditions that maximises the ability to detect potential impact from the Licenced Action, including collecting samples at sampling points.*
29. *In implementing the Monitoring Program the Licensee must to the extent practicable that samples collected at the sampling points are collected:*
    - *29.1 on the same date as discharge event; and*
    - *29.2 from the part of the waterway that provides representative (well mixed) samples.*
30. *If a sample is missed or cannot be collected at a sampling point at a frequency set in the Monitoring Program for any reason, the Licensee must revisit the sampling point to collect a sample as soon as possible after the missed collection.*

31. *The Licensee must ensure that all samples and field environmental data are collected in accordance with recognised Australian Standards and guidelines (such as AS/NZS 5667.1 1998, ANZG (2018), as updated from time to time).*
32. *For the parameters that require analysis at a laboratory, the Licensee must ensure that:*
    - *32.1 all samples are analysed at a laboratory with current NATA accreditation or equivalent; and*
    - *32.2 detection and reporting limits are appropriate to determine compliance with this licence.*
33. *The Licensee must ensure any samples collected in accordance with the Monitoring Program or in connection with the Licensed Action or this licence, are obtained by, or under the supervision of a qualified sampler.*
34. *The Licensee must ensure any plant and equipment used by the Licensee in conducting the Monitoring Program:*
    - *34.1 is reasonably fit for the purpose and use to which it is put, including that it is properly calibrated;*
    - *34.2 is maintained and operational; and*
    - *34.3 is operated by a person trained to use the plant and equipment.*
35. *The Licensee must ensure that, for each sample collected in accordance with the Monitoring Program or the Licensed Action, the following information must be recorded and retained:*
    - *35.1 the date on which the sample was collected;*
    - *35.2 the time at which the sample was collected;*
    - *35.3 the location at which the sample was collected;*
    - *35.4 the name of the person who collected the sample;*
    - *35.5 the chain of custody forms relating to the sample;*
    - *35.6 the field measurements (if any) and analytical results (if any) relating to the sample; and*
    - *35.7 laboratory quality assurance and quality control documentation.*
36. *The Licensee must for all land based monitoring points specified in the Monitoring Program:*
    - *36.1 install and maintain appropriate identification signage so that they are reasonably identifiable at all times; and*
    - *36.2 maintain safe access and egress, as is reasonably practicable.*

3.1 Monitoring sites

Samples are collected from the authorised monitoring location, SKa100 (Figure 3), as per Appendix 1 and 2 of the WDL.

Figure 3: SKa100 - authorised monitoring location/sampling point.

3.2 Monitoring frequency, parameters and trigger values

The discharge monitoring plan from Appendix 1 of the WDL is provided at Table 1 which indicates the collection of samples during discharge events.

There are no trigger values associated with discharge quality prior to entering the receiving environment during discharge events.

Table 1: Discharge monitoring frequencies and parameters.

Parameter	Units	Frequency
Field Measurements		
pH,	pH units	D
electrical conductivity (EC),	µs/cm	D
dissolved oxygen (DO),	% saturation	D
temperature	°C	D
Nutrient Indicators		
Filterable Reactive Phosphorus (FRP)	mg/L	D
Total Phosphorus (TP)	mg/L	D
Ammonia (NH3-N)	mg/L	D
Total Nitrogen (as N)	mg/L	D
Nitrate (NO3-N)	mg/L	D
Nitrite (as N)	mg/L	D
Nitrogen Oxides (as N)	mg/L	D
Bacteriological		
Escherichia coli (E. coli)	MPN/100ml	D
Enterococcus spp.	MPN/100ml	D
Metals and Metalloids		
Arsenic	µg/L	A
Cadmium	µg/L	A
Chromium	µg/L	A
Copper	µg/L	A
Nickel	µg/L	A
Lead	µg/L	A
Zinc	µg/L	A
Mercury	µg/L	A
Environmental Indicators		
Biochemical Oxygen Demand (BOD)	mg/L	D
Chemical Oxygen Demand	mg/L	D
Total Suspended Solids	mg/L	D
Volatile Suspended Solids	mg/L	D
Hardness (CaCO3)	mg/L	D
Other		
PFAS (in any form)	µg/L	A
Key: D – Once per Discharge and where a discharge event continues for 7 days or more, additional sampling must be conducted at intervals of not more than 7 days apart. A – Annual: at least once per year in which a discharge has occurred and during a discharge event.		

3.3 Sampling and analysis method

Effluent samples were collected from the authorised monitoring location (SKa100) when accessible during discharge events. Field measurements (pH, Electrical Conductivity, Dissolved Oxygen and Temperature) were measured in-situ using a handheld multi-meter probe, calibrated prior to each use. A pole was used to collect water and fill laboratory supplied sample bottled which were kept chilled in an esky before being delivered to a NATA accredited laboratory for analysis on the day of sampling.

4 Monitoring Results

4.1 Discharge volumes

Discharge from KWwTP to the Katherine River is restricted by conditions 20 – 23.8 of WDL 151-08. Annual discharge volumes from 2016 to 2024 are detailed in Table 2 and Figure 4.

Table 2 also provides a statistical assessment of the inflow and outflow of the KWwTP and rainfall in the area, which indicates this year's discharge volume and rainfall was below the median values of data from previous years.

Table 2: KWwTP Financial year inflow, outflow and rainfall 2016 to present.

Financial Year	Inflow to Katherine WSP (kL)	Discharge to Katherine River (kL)	Rainfall (mm)
2023/2024	837736	101068	1027.6
2022/2023	729832	144407	1118.8
2021/2022	751908	43600	686.5
2020/2021	860638	191582	1207.3
2019/2020	680559	0	461.8
2018/2019	938674	0	713.5
2017/2018	817941	120960	1067.4
2016/2017	890563	181345	1364.3
Statistical Assessment			
10th percentile	715050.1	0	619.09
Median	827839	111014	1048
60th percentile	842316.7014	125649.4	1077.68
75th percentile	868119.25	153641.5	1140.925
80th percentile	878593	166569.8	1171.9
90th percentile	904996.3	184416.1	1254.4
95th percentile	921835.15	187999.05	1309.35

According to the Bureau of Meteorology:

- The total rainfall in Katherine from July 2023 to June 2024 was 1027.6mm.
- The wettest month was January 2024 with 399 mm of rainfall, followed by February 2024 with 208 mm.

Three discharge events occurred within the 2023-24 reporting period, which commenced on the following dates:

- 11 January 2024,
- 29 January 2024, and
- 12 February 2024.

Figure 4 illustrates that the Katherine River height was greater than 1.67m (equivalent to a flow rate of 66.78 kL/s at Gauging Station 8140001) during discharge events from 2017 to present. This provides evidence of compliance with condition 21.3, as discharges only occurred when recorded river flow exceeds the required guideline rate.

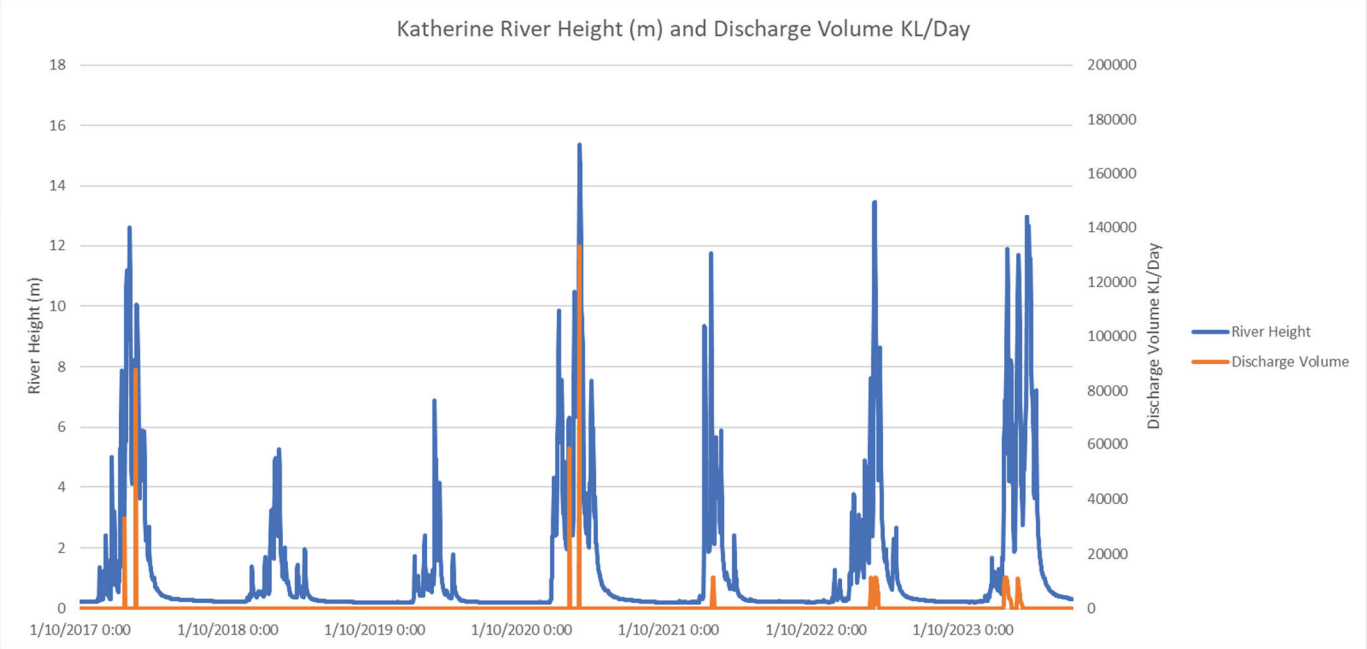

Figure 4: Katherine River Flow against KWSP discharge

4.1.1 Mass loads

As the 2023-2024 discharge volume has decreased in comparison to the previous year, mass loads of environmental stressors have generally been reduced.

Figure 5 and 6 clearly illustrate a direct and proportional relationship between the mass loads discharged and the volume of discharge from the KWwTP. This observation suggests discharge has undergone substantial dilution, and further dilution is likely to take place upon its entry into the Katherine River.

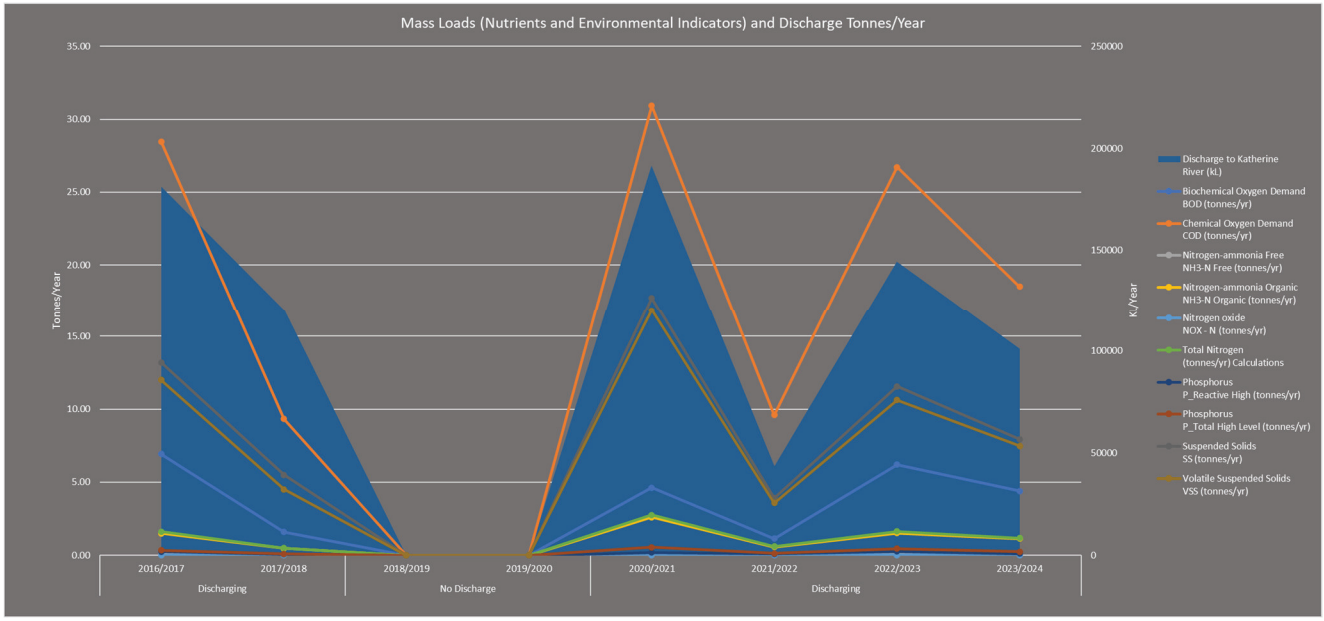

Figure 5: Mass loads (Nutrients and Environmental Indicators) and Discharge Tonnes/Year

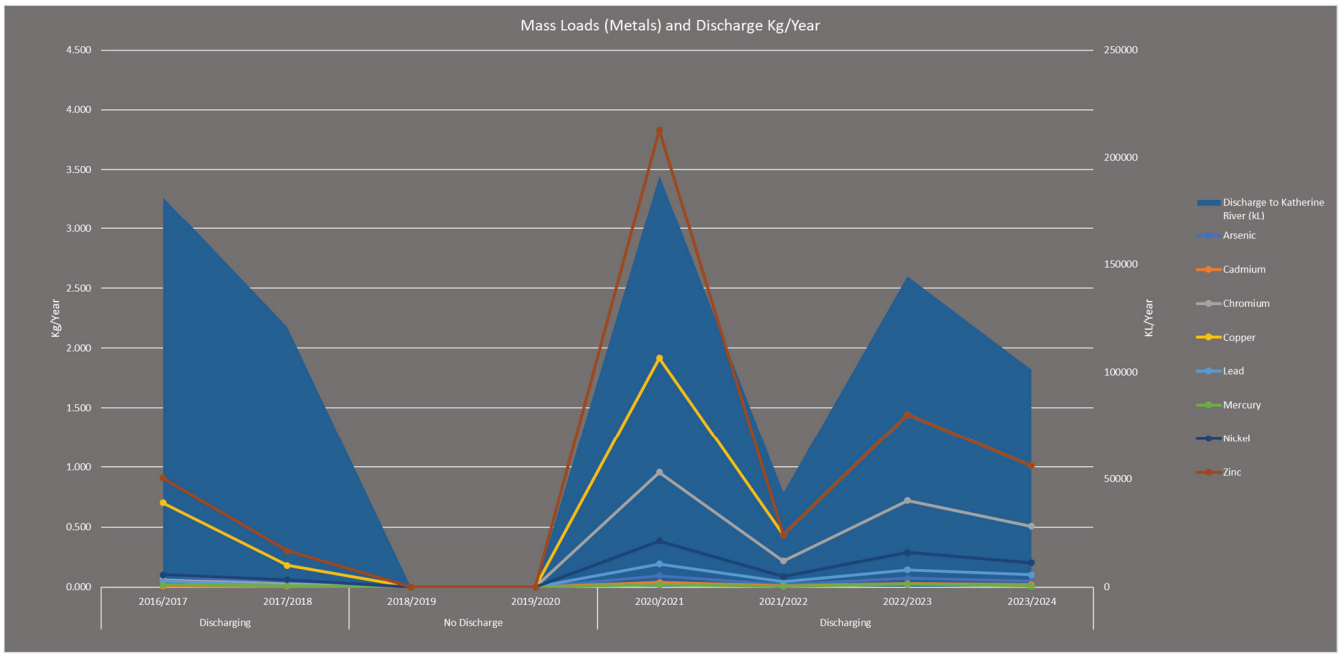

Figure 6: Mass loads (Metals) and Discharge Kg/Year

Figure 7 shows the year on year changes regarding the percent removal of key analytes from effluent loads. Aside from Nitrogen-ammonia Organic (NH3-N Organic), percent removal for all analytes have increased during the 2023-2024 reporting period in comparison to discharge events from the previous year.

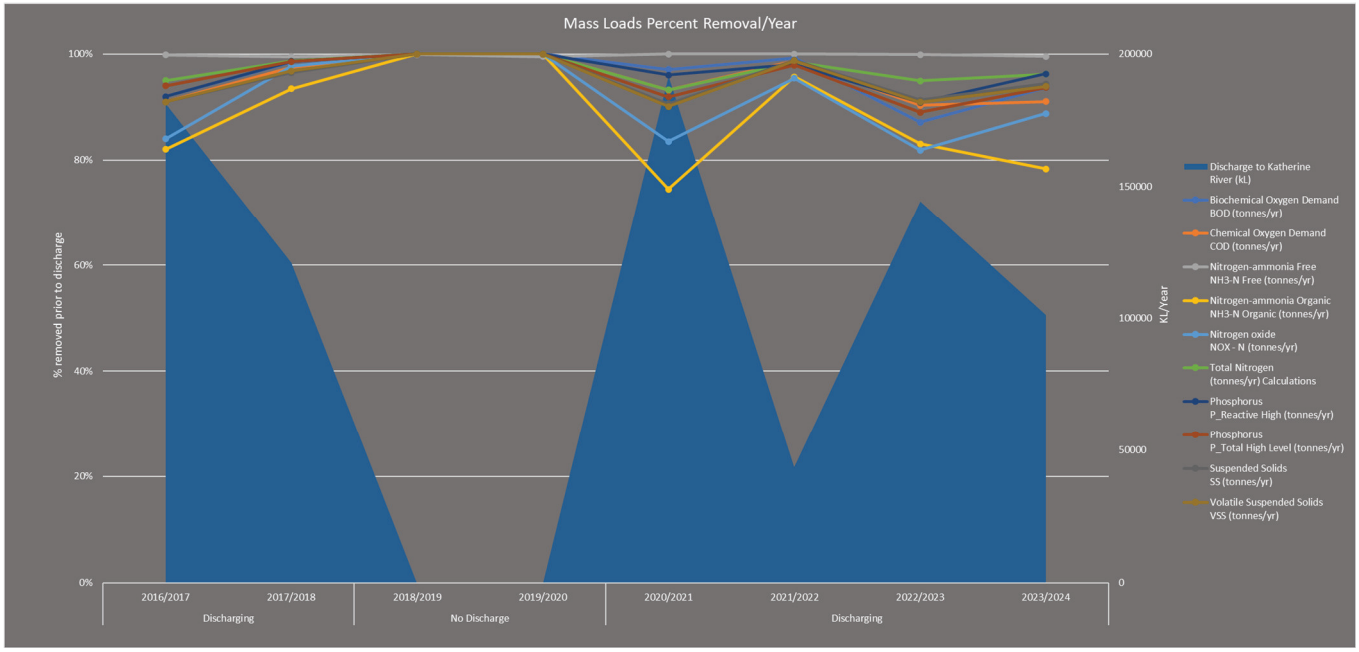

Figure 7: Mass Loads Percent Removal/Year

4.2 Long term discharge quality

The effluent discharge typically contains no gross pollutants, a moderately high nutrient content and a green colour. No odour is usually present at the discharge point as the biodegradable carbon has been stabilised and transformed into algae, contributing to the prevailing green colour.

4.3 Discharge quality trends

Since sampling data is collected during discrete events rather than regular intervals, it isn't appropriate to formulate a long term trend and instead, the discharge quality (2023-24 median) will be compared to the long term median (2014-2024).

Guideline values from the Australian and New Zealand Environment and Conservation Council (ANZECC) have also been presented for comparison, however, it is important to note that these values apply to environmental monitoring of receiving waters, whereas the data provided in this report relates to effluent within KWwTP. Further to this, no guidelines are available that are designed to be protective of the Katherine River water quality during the Wet Season when the Katherine River is in flood with respect to physio-chemical stressors or nutrients (SLR 2022).

This report provides an analysis of the parameters relevant to WDL151-08 during discharge events between 2014-2024. No discharge events occurred in 2019 and 2020 due to low rainfall and subsequent low river flows.

The 2023-24 median has been derived from three discharge events commencing on 11 January 2024, 29 January 2024 and 12 February 2024. Due to unsafe access to the monitoring location, samples were unable to be collected when the discharge event commenced on 11 January 2024. As such, the verification of discharge quality and sampling took place when access was safe for personnel to proceed on 23 January 2024.

4.3.1 Field measurements

Table 3: Long term field parameter results

Parameter	Units	Detection Limits	ANZECC Guideline	2023-24 Median	Long term Median	80th percentile	95th percentile
pH	pH units	0.01	6.0-8.0	10.5	9.2	9.59	10.015
Electrical Conductivity (field)	(µS/cm)	0.1	250	435.5	5721	7221	7625.5
Dissolved Oxygen	% saturation	0.01	80-110	116.2	88.3	127.38	210.7
Temperature	°C	0.01	-	33.55	28.85	30.61	33.866
*Note: No field measurements were recorded on 23/01/2024 due to issues with field equipment.							

pH values range from 6.9 to 10.8. The 2023-24 median pH of 10.5 was an increase from the current long term median pH of 9.2. Additionally, the 80th and 95th percentile values are pH 9.6 and 10 respectively, indicating generally alkaline conditions.

Electrical conductivity (EC) collected in the field during discharge events from 2014-2024 indicate that EC levels have significantly decreased since 2017. EC levels range from 266.0 µS/cm to 10400 µS/cm. The 2023-24 median EC value is 435.5 µS/cm, which is well below the long term median of 5721 µS/cm and both the 80th percentile and 95th percentile values.

Analysis of Dissolved Oxygen (% saturation) levels indicate a minimum of 24.01% and a maximum of 280.2%. The 2023-24 median DO value of 116.2% is an increase from the long term median DO value of 88%, but still considered to be within acceptable limits for undiluted effluent.

Discharge temperature fluctuates between 27.16°C and 36.54°C. The 2023-24 Median of 33.55°C indicates warm conditions during discharge events.

4.3.2 Nutrients

Table 4: Long term nutrient indicator results

Parameter	Units	Detection Limits	ANZECC Guideline	2023-24 Median	Long term Median	80th percentile	95th percentile
Filterable Reactive Phosphorus (FRP)	mg/L	0.05	0.004	0.6	0.97	1.6	2.11
Total Phosphorus (P)	mg/L	0.05	0.01	2.2	2.45	2.82	4.11
Ammonia Nitrogen (NH3-N)	mg/L	0.1	0.01	0.4	0.39	0.56	0.8
Total Nitrogen	mg/L	0.1	0.2	12.4	12.39	17.65	24.0
Nitrate (NO3-N)	mg/L	0.1	-	0.1	0.1	0.1	0.1
Nitrite as N (NO2-N)	mg/L	0.1	-	0.1	0.1	0.1	0.1
Nitrate + Nitrite as N (NOx-N)	mg/L	0.1	0.005	0.1	0.1	0.1	0.1

The 2023-24 median for both filterable reactive (FRP) and total phosphorous (P) are lower than the relevant long term median values. The 80th percentile value for FRP and P are 1.6mg/L and 2.82mg/L respectively, this indicates generally moderate phosphorous levels during discharge events between 2014-2024.

Ammonia levels in the discharge range from 0.2mg/L to 0.9mg/L. The 2023-24 median value of 0.4mg/L is slightly higher than the long term median of 0.39mg/L but still indicates typical ammonia levels for KWwTP.

The 2023-24 median value for total nitrogen is 12.4mg/L which is a slight increase from the long term median of 12.39mg/L. Total nitrogen in sewage discharge varies widely, values range from 5.2 mg/L to 25.6mg/L .

Nitrate and nitrite levels remain consistently low, <0.1 mg/L, with a maximum of 0.14mg/L recorded in 2015, which is positive for the health of the receiving water.

4.3.3 Bacteriological

Table 5: Long term bacteriological results

Parameter	Units	Detection Limits	ANZECC Guideline	2023-24 Median	Long term Median	80th percentile	95th percentile
E. coli	MPN/100mL	10	200	100	10	100	194.9
Enterococci	MPN/100mL	10	41-200	410	359	3075.6	10768.2

E.coli concentrations range from 16,580 MPN/100 mL to 10 MPN/100 mL, which aligns with the long term median. The 95th percentile value of 194.9 MPN/100mL and the 2023-2024 median value of 100 MPN/100mL suggests that E.coli concentrations during discharge events have generally been below the ANZECC Guideline values for receiving waters.

Similar trends are observed for Enterococci levels, with a maximum value of 141,360 MPN/100 mL and a minimum of 10 MPN/mL . The 80th percentile Enterococci value is 3075.6 MPN/100 mL, indicating relatively high levels during many recorded discharge events. The 95th percentile Enterococci concentration is substantial, at 10768.2 MPN/100 mL.

The long term and 2023-2024 median values for Enterococci are relatively low, at 359 MPN/100 mL and 410 MPN/100 mL, respectively, which suggests that, on average, the discharge quality meets acceptable standards regarding undiluted effluent.

This data highlights the considerable variability in levels of E. coli and Enterococci during discharge. While median levels appear to be within acceptable limits, the instances of extremely high contamination during specific events signifies the effect of rainfall and influent variation to the sewage ponds.

4.3.4 Metals and metalloids

Table 6: Long term metals and metalloid results

Parameter	Units	Detection Limits	ANZECC Guideline	2023-24 Median	Long term Median	80th percentile	95th percentile
Arsenic	µg/L	0.5	13	0.5	0.5	0.54	1.62
Cadmium	µg/L	0.2	0.2	0.05	0.2	0.2	0.2
Chromium	µg/L	5	3.3	0.3	5	5	5
Copper	µg/L	10	1.4	3.4	10	10	13
Lead	µg/L	1	3.4	0.2	1	1	1.3
Mercury	µg/L	0.1	0.06	0.1	0.1	0.2	0.59
Nickel	µg/L	2	11	0.5	2	2	2
Zinc	µg/L	10	8	5.0	10	10	20

When analysing metal samples, it is important to note that the laboratory detection limit for chromium, copper, mercury and zinc is higher than the ANZECC guideline value. Although the ANZECC guideline values are not a specific part of the WDL conditions, it is important to know where the quality of the discharge sits in relation to the current environmental guidelines.

Concentrations of Arsenic, Cadmium, Lead and Nickel within discharge from 2014-2024 are below the relevant ANZECC guideline values for receiving waters, and 2023-24 median for these parameters indicate a decrease from the long term median.

The 2023-24 median of 0.3 µg/L for Chromium, is below the ANZECC guideline value and represents a decrease from the long term median.

Although the 2023-24 median values for Copper, Mercury and Zinc are above the ANECC guideline values for receiving waters, concentrations have decreased in comparison to the long term median.

Overall, analysis of metal concentrations suggest that the sewage discharge is operating within acceptable parameters.

4.3.5 Environmental indicators

Table 7: Long term environmental indicator results

Parameter	Units	Detection Limits	ANZECC Guideline	2023-24 Median	Long term Median	80th percentile	95th percentile
Biological Oxygen Demand (BOD)	mg/L	2	-	48.0	50.5	72.0	110.5
Chemical Oxygen Demand (COD)	mg/L	2	-	200.0	220.0	300.0	402.5
Total Suspended Solids (TSS)	mg/L	1	15	83.0	105.5	145.6	226.6
Volatile Suspended Solids (VSS)	mg/L	1	-	77.0	102.5	135.0	210.6
Hardness (CaCO3)	mg/L	1	-	71.2	67.6	78.36	84.31

Overall, the 2023-24 mean values for environmental indicators show a decrease in comparison to long term median values, and analysis of discharge data from 2014-2024 suggests that the treatment performance of Katherine WwTP has not deteriorated.

Although Total Suspended Solids (TSS) exceed the ANZECC guidelines for a freshwater marine environment, it is important to note the discharge monitoring samples are taken form the effluent stream, whereas the ANZECC guideline values are derived for diluted flows in the environment.

4.3.6 PFAS

Table 8: Long term PFAS results

Parameter	Units	Detection Limits	HEPA (2020) 95% Guideline[1]	2023-24 Median	Long term Median	80th percentile	95th percentile
Perfluorooctanoic acid (PFOA) (ug/L)	ug/L	0.0016	220	0.0018	0.0018	0.002	0.0062
Sum (PFHxS + PFOS) (ug/L)	ug/L	0.0016	0.13	0.0025	0.0027	0.00724	0.06169

[1]HEPA (2020) Note: The PFOS guideline also applies to the PFOS+PFHxS concentration as there are no guidelines for PFHxS, it is assumed that both compounds have a similar toxicological effect.

PFAS monitoring commenced at Katherine WwTP in 2018 when the water treatment plant was commissioned to remove PAs (the source of PFAS) from the towns drinking water.

PFAS concentrations in discharge have remained well below the 95% species protection levels (HEPA 2020) for receiving waters since 2018. Considering the significant dilutions that occur on discharge the risk of environmental harm associated with the KWwTP as a PFAS source is low.

5 Monitoring Results – quality assurance/ quality control (QA/QC) evaluation

Data was collected at the frequencies defined in the Discharge Monitoring Plan (Appendix 1) of WDL151-08, with the exception of field measurements on 23 January 2024.

The following QA/QC practices for sample analysis were met by the relevant NATA accredited laboratories:

- Laboratory duplicates,
- Laboratory control samples and
- Method blanks.

6 Discussion and interpretation of results

6.1 Assessment of Environmental Impact

Environmental consultants SLR were approached to conduct an environmental risk assessment (ERA) to update the 2019 ERA. A 5 phase approach was utilised when conducting the 2022 ERA:

1. **Problem identification:** defines the objectives of the ERA, evaluates the available data and establishes a preliminary Conceptual Site Model (CSM).
2. **Receptor identification:** identifies the species that may be at risk of exposure and evaluates the level of acceptable risk in the context of the ecological values that need to be protected.
3. **Exposure assessment:** produces an estimate of the chemical exposure that may be experienced by the identified ecological receptors.
4. **Toxicity assessment:** estimates the concentration of identified contaminants of potential concern (CoPCs) that an ecosystem can be exposed to without adversely affecting the ecological values.
5. **Risk characterisation:** evaluates the lines of evidence gathered throughout the ERA to estimate the potential risks posed by CoPCs to the identified ecological receptors. Determines if the risk of harm is low and acceptable or higher.

The conceptual site model (Figure 8) gives an indication of the sensitive receptors in the catchment as well as many of the other inputs to Katherine River affecting water quality. (SLR, 2022).

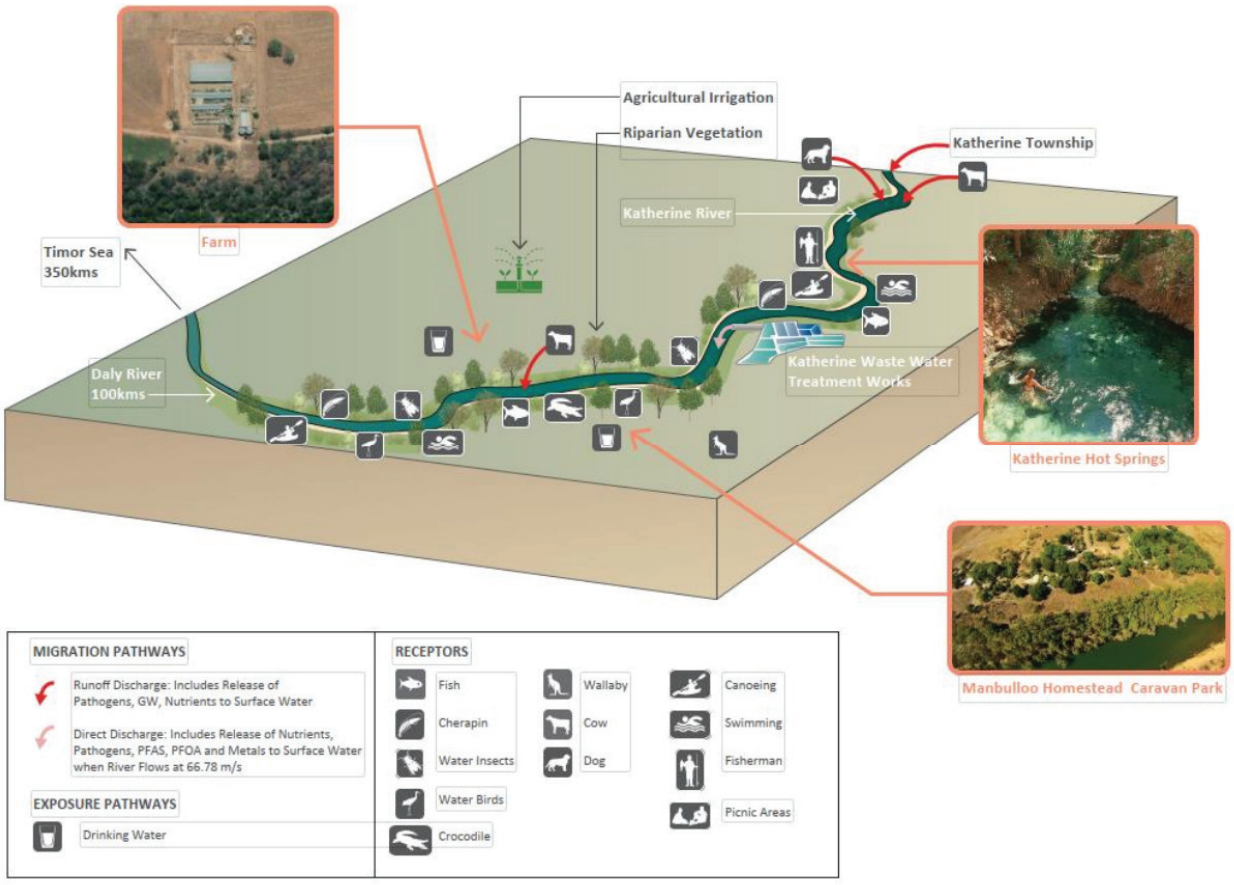

Figure 8: Katherine WwTP Discharge Conceptual Site Model

The environmental risk assessments conducted by PWC since 2011 have shown that the risk to the ecology and users of the Katherine River from the discharge from the KWwTP is low. The risk of exposure to pathogens for users drinking untreated water from the Katherine River during the Wet Season is high, but the risk does not increase with the addition of the KWSP discharge. Further detail regarding risk rankings can be found in Appendix 2.

7 Conclusion and proposed actions

Analysis of relevant parameters indicate a reduction in mass loads of contaminants discharged to Katherine River in comparison to the previous year, which can generally be linked to the reduction in discharge volume during this reporting period.

Assessment of field measurements suggest that discharge quality is typical for effluent. Regarding pH levels, the 2023-24 median of 10.5 and the long term median of 9.2 indicate generally alkaline conditions, which is normal for water with high levels of algae. Electrical Conductivity (EC) collected in the field during discharge events show that EC levels have significantly decreased since 2017, the 2023-24 median EC value is 435.5 µS/cm, which is well below the long term median of 5721 µS/cm. Dissolved oxygen levels, despite their wide range, generally align with acceptable standards. The 2023-24 median DO value of 116.2% is an increase from the long term median DO value of 88%, and considered to be within acceptable limits for effluent.

Comparison of data collected within the 2023-24 reporting with previous years suggests that the treatment performance of KWwTP has not deteriorated.

PFAS concentrations have remained well below the 95% species protection levels (HEPA 2020) for receiving waters since 2018 and several parameters fall within the ANZECC guideline values for a freshwater marine environment.

While many parameters meet acceptable standards, variations and occasional spikes suggest the need for monitoring and management to ensure consistent compliance with environmental guidelines.

8 Certification

I, Tahlia Kemp, Manager Assurance Water Services, have reviewed this report and I confirm that to the best of my knowledge and ability all the information provided in the report is true and accurate.

(*being a person authorised to legally represent the holder of the licence*)

Signature:  Date: 31 October 2024

Please note that:

- Significant penalties may apply where it is demonstrated that false or misleading information has been supplied to the NT EPA.

References

ANZECC. (2018). *Australian and New Zealand guidelines for fresh and marine water quality*. Retrieved from Water Quality Australia: https://www.waterquality.gov.au/guidelines/anz-fresh-marine

HEPA (2020) National Environmental Management Plan for PFAS V2.0: Heads of EPAs Australia and New Zealand.

Van Dam R., Bartolo R. and Bayliss P. 2008. Identification of ecological assets, pressures and threats. Chapter 2. Ecological Risk Assessments for Australia's Northern Tropical Rivers. Environmental Research Institute of the Supervising Scientist. A Report to Land and Water Australia. https://www.dcceew.gov.au/science-research/supervising-scientist/publications/tropical-rivers/ecological-risk-assessments-australias-northern-tropical-rivers

SLR. (2022). *2022 Katherine Environmental Risk Assessment.* Darwin.

Appendices

Number	Title
Appendix 1	Analysis of mass loads
Appendix 2	Risk characterisation by analyte

Appendix I - Analysis of mass loads

Table 9: Analysis of mass loads in inflow and discharge

Katherine WWTP	Biochemical Oxygen Demand BOD (tonnes/yr)	Chemical Oxygen Demand COD (tonnes/yr)	Nitrogen-ammonia Free NH3-N Free (tonnes/yr)	Nitrogen-ammonia Organic NH3-N Organic (tonnes/yr)	Nitrogen oxide NOX - N (tonnes/yr)	Total Nitrogen (tonnes/yr)	Phosphorus P_Reactive High (tonnes/yr)	Phosphorus P_Total High Level (tonnes/yr)	Suspended Solids SS (tonnes/yr)	Volatile Suspended Solids VSS (tonnes/yr)	Reporting Period
Inflow	69.71	206.85	25.77	5.25	0.05	31.06	2.82	3.72	142.00	123.28	2023-24
Discharge to Katherine River	**4.40**	**18.51**	**0.03**	**1.14**	**0.01**	**1.18**	**0.11**	**0.23**	**7.94**	**7.48**	
Mass Removed Prior to Discharge	**65.31**	**188.34**	**25.73**	**4.12**	**0.04**	**29.89**	**2.71**	**3.49**	**134.06**	**115.80**	
Percentage removed prior to discharge	**94%**	**91%**	**99.87%**	**78%**	**89%**	**96%**	**96%**	**94%**	**94%**	**94%**	
Inflow	48.22	276.00	23.29	8.96	0.04	32.29	2.92	4.00	132.86	116.97	2022-23
Discharge to Katherine River	**6.21**	**26.72**	**0.11**	**1.52**	**0.01**	**1.63**	**0.27**	**0.44**	**11.55**	**10.61**	
Mass Removed Prior to Discharge	**42.01**	**249.28**	**23.18**	**7.45**	**0.03**	**30.66**	**2.66**	**3.56**	**121.31**	**106.36**	
Percentage removed prior to discharge	**87%**	**90%**	**99.53%**	**83%**	**82%**	**95%**	**91%**	**89%**	**91%**	**91%**	
Inflow	164.84	732.40	27.82	13.34	0.05	41.21	4.08	6.46	343.46	290.57	2021-22
Discharge to Katherine River	**1.13**	**9.59**	**0.03**	**0.57**	**0.00**	**0.60**	**0.08**	**0.14**	**3.92**	**3.58**	
Mass removed prior to discharge	**163.70**	**722.81**	**27.79**	**12.78**	**0.05**	**40.61**	**4.00**	**6.33**	**339.53**	**287.00**	
Percentage removed prior to discharge	**99%**	**99%**	**99.89%**	**96%**	**95%**	**99%**	**98%**	**98%**	**99%**	**99%**	
Inflow	158.67	455.62	30.54	10.17	0.06	40.77	4.70	6.86	188.20	170.57	2020-21
Discharge to Katherine River	**4.61**	**30.92**	**0.14**	**2.59**	**0.01**	**2.75**	**0.19**	**0.55**	**17.71**	**16.83**	
Mass removed prior to discharge	**154.06**	**424.70**	**30.40**	**7.57**	**0.05**	**38.02**	**4.52**	**6.31**	**170.49**	**153.74**	
Percentage removed prior to discharge	**97%**	**93%**	**99.53%**	**74%**	**84%**	**93%**	**96%**	**92%**	**91%**	**90%**	
Inflow	120.50	340.83	21.31	9.53	0.04	30.88	4.17	5.60	152.24	138.83	2019-20
Discharge to Katherine River	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
Mass removed prior to discharge	**120.50**	**340.83**	**21.31**	**9.53**	**0.04**	**30.88**	**4.17**	**5.60**	**152.24**	**138.83**	
Percentage removed prior to discharge	**100%**	**100%**	**100.00%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	
Inflow	139.45	472.01	36.41	9.79	0.06	46.26	5.09	6.29	216.33	196.63	2018-19
Discharge to Katherine River	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
Mass removed prior to discharge	**139.45**	**472.01**	**36.41**	**9.79**	**0.06**	**46.26**	**5.09**	**6.29**	**216.33**	**196.63**	
Percentage removed prior to discharge	**100%**	**100%**	**100.00%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	
Inflow	109.89	380.34	30.26	7.13	0.07	37.47	5.09	6.12	157.84	141.65	2017-18
Discharge to Katherine River	**1.60**	**9.33**	**0.03**	**0.47**	**0.00**	**0.49**	**0.07**	**0.09**	**5.50**	**4.50**	
Mass removed prior to discharge	**108.29**	**371.01**	**30.24**	**6.66**	**0.07**	**36.97**	**5.02**	**6.03**	**152.34**	**137.15**	
Percentage removed prior to discharge	**99%**	**98%**	**99.91%**	**93%**	**98%**	**99%**	**99%**	**99%**	**97%**	**97%**	
Inflow	91.91	314.27	27.12	8.34	0.05	35.51	2.97	5.33	150.60	131.70	2016-17
Discharge to Katherine River	**6.93**	**28.46**	**0.11**	**1.49**	**0.01**	**1.61**	**0.24**	**0.33**	**13.20**	**12.00**	
Mass Removed Prior to Discharge	**84.98**	**285.81**	**27.01**	**6.85**	**0.04**	**33.90**	**2.73**	**5.00**	**137.40**	**119.70**	
Percentage removed prior to discharge	**92%**	**91%**	**99.60%**	**82%**	**84%**	**95%**	**92%**	**94%**	**91%**	**91%**	

Table 10: Analysis of metals mass loads in discharge

Year	Metals Mass Load - Kg/Year							
	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
	Kg/Year	Kg/Year	Kg/Year	Kg/Year	Kg/Year	Kg/Year	Kg/Year	Kg/Year
2016/2017	0.103	0.009	0.060	0.701	0.048	0.018	0.103	0.907
2017/2018	0.030	0.006	0.024	0.181	0.012	0.012	0.060	0.302
2018/2019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2019/2020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2020/2021	0.096	0.038	0.958	1.916	0.192	0.019	0.383	3.832
2021/2022	0.022	0.009	0.218	0.436	0.044	0.007	0.087	0.436
2022/2023	0.072	0.029	0.722	1.444	0.144	0.024	0.289	1.444
2023/2024	0.051	0.020	0.505	1.011	0.101	0.010	0.202	1.011

Appendix II - Risk characterisation by analyte

Table 11 Risk Characterisation for KWwTP 2021-2022

Analyte	Environmental Factors	Risk
Physico-chemistry	pH and EC were elevated in the discharge when compared to guidelines. However, the minimum discharge ratio between effluent and river water of 1:575 implies that any observed high pH or EC would be completely absorbed by the environment.	Low
BOD and DO	A healthy receiving water, such as the Katherine River during the Wet Season will contain between 5-7 mg/L of dissolved oxygen. The minimum discharge ratio between effluent and river water of 1:575 implies that any observed oxygen demand or low DO would be completely absorbed by the environment.	Low
Suspended Solids	Suspended solids exert an environmental effect by blocking out the sun in an environment. Robson et al. (2010) states that primary productivity in the Katherine and Daly Rivers is already limited by light in the Wet Season. This implies that the suspended solids naturally present in the ecosystem as a result of runoff already block out the light with the potential to reduce plant growth.	Low
Aluminium **Chromium** **Copper** **Mercury** **Zinc**	The water discharged to the Katherine River will receive a minimum dilution ratio of 1:575 between effluent and river water. However, the KWwTP discharges occur at a dilution of 1:1,190, therefore metals are not likely to exert a toxic effect to the ecosystem of the Katherine River in the vicinity of the discharge pipe.	Low
PFOS **PFOA**	All results meet the 95% species protection levels (HEPA 2020) and therefore considering the significant dilutions that occur on discharge the risk of environmental harm associated with the KWwTP as a PFAS source is low.	Low
Pathogens	A risk assessment workshop was conducted in May 2013 with PWC and DoHa to assess the level of risk that exists as a result of the KWwTP discharge containing pathogens to the Katherine River. Two scenarios were assessed: 1. The risk of a person becoming ill as a result of drinking water from the Katherine River when the river height is greater than 3m at G8140001 due to pathogens from catchment sources only. 2. The risk of a person becoming ill as a result of drinking water from the Katherine River when the height is greater than 3 m at G8140001 due to pathogens from catchment sources and the KWwTP. The PWC determined that catchment sources of pathogens reduced the quality of the Katherine River in the Wet Season to a point where it was unsafe to drink. As a result, it was judged that any addition of pathogens from the KWwTP would not materially increase the likelihood of illness as a result of drinking water from the Katherine River in the Wet Season. The PWC has erected signs stating that untreated water should not be used for drinking.	High High

[a] **DoH = Department of Health**

Contact

Assurance
Water Services
Power and Water Corporation
WDLCorrespondence.PWC@powerwater.com.au

powerwater.com.au