Environmental Risk Assessment - Ngukurr WwTP WDL 234-02

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PowerWater

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Abbreviations and Glossary

Abbreviation	Definition
ANZECC	Australian Water Quality Guidelines for Fresh and Marine Waters
ARMCANZ	Agriculture and Resources Management Council of Australia and New Zealand
Assessment endpoints	The explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes.
BOD	Biochemical oxygen demand
BUD	Beneficial Use Declaration – the uses of water specified in subsection 3 of the *Water Act* (1992)
BOM	Bureau of Meteorology
CSM	Conceptual site model
Cultural values	To provide water to meet aesthetic, recreational and cultural needs.
DLPE	Department of Lands, Planning and Environment (NT)
DO	Dissolved oxygen
E. coli	*Escherichia coli*
Ebb tide	A falling tide - the phase of the tide between high water and the succeeding low water.
Environmental Values	To provide water to maintain the health of aquatic ecosystems.
EPBC	Environment Protection and Biodiversity Conservation Act
ERA	Environmental risk assessment
ET	Equivalent Tenement – an average residential dwelling or house. Other developments are converted to an ET value by relating their average water demand (or sewage flow) to demand from one average house.
Flood tide	A rising tide - the phase of the tide between low water and the next high tide.
ICEGs	Indigenous Community Engineering Guidelines
kL	Kilolitre
Km	Kilometre
L	Litre
m	Metre
m^2	Square metre
Macrotidal estuary	Estuaries where the tidal range is in excess of 4 metres.
mg	Milligram
mL	Millilitre
NOx	Nitrogen oxides – the sum of nitrate and nitrite ionic species.
NT	Northern Territory

NTU	Nephelometric turbidity units
NT EPA	Northern Territory Environmental Protection Authority
PL	Primary lagoon
Risk characterisation	The culmination of the planning, problem formulation and analysis of predicted or observed adverse ecological effects related to the assessment endpoints.
Risk hypothesis	Assumptions made in order to evaluate logical or empirical consequences, or suppositions tentatively accepted to provide a basis for evaluation. They are used to test if an activity (e.g. contaminant discharges) has adverse effects on an assessment endpoint.
SL	Secondary lagoon
SOCs	Site of conservation significance
SPS(s)	Sewage pump station(s)
SS / TSS	Suspended solids / total suspended solids
TDS	Total dissolved solids – the portion of solids in wastewater that passes through a 2.0 micron filter.
TN	Total nitrogen
TP	Total phosphorous
TPWC	Territory Parks and Wildlife Conservation Act
WDL	Waste discharge licence
WwTP	Wastewater treatment plant. All facilities that treat wastewater disposed of to the sewerage system consisting primarily of sewage as well as stormwater inflow and infiltration. These facilities may include a range of different types of treatment technologies e.g. waste stabilisation ponds.
WSP(s)	Waste stabilisation pond(s)

Executive Summary

This desktop environmental risk assessment (ERA) provides an assessment of the risks associated with the seasonal discharge of secondary treated effluent from the Ngukurr wastewater treatment plant (WwTP) point to nearby unnamed freshwater billabong.

Based on this ERA and water quality data, there is limited evidence to suggest deleterious impacts on the environmental values identified for this receiving environment.

Risks to the assessment end-points, associated with the source, were assessed as having low risk rankings. Low risk rankings were associated with impacts to environmental values including changes to the health of the billabong through the increase in BOD and oxygen depletion; increase in nutrient concentrations; and possibly nuisance plant growth. Higher risk rankings were associated with the exposure to pathogens through cultural or recreational use of the receiving environment.

The risk rankings may change as uncertainties associated with current assessments are addressed. A range of recommendations have been made in this risk assessment to address knowledge gaps and identify opportunities for improvement.

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1. Introduction

Power and Water operate the Ngukurr WwTP in respect of Waste Discharge Licence 234-02 issued on 18 December 2021. This license allows discharge of secondary treated sewage effluent from an irrigation system and seasonal overflow to an unnamed freshwater billabong.

Ngukurr is located in the north-east of the Northern Territory, 321 km east of Katherine and 635 km south-east of Darwin (Figure 1). Ngukurr has an estimated population of 1277 in 2021 (CENSUS 2021). The Wastewater Treatment Plant (WwTP) is located approximately 865 m east of the Ngukurr Community (Figure 2).

Figure 1. Ngukurr Community Locality Map (Google Earth, 2025)

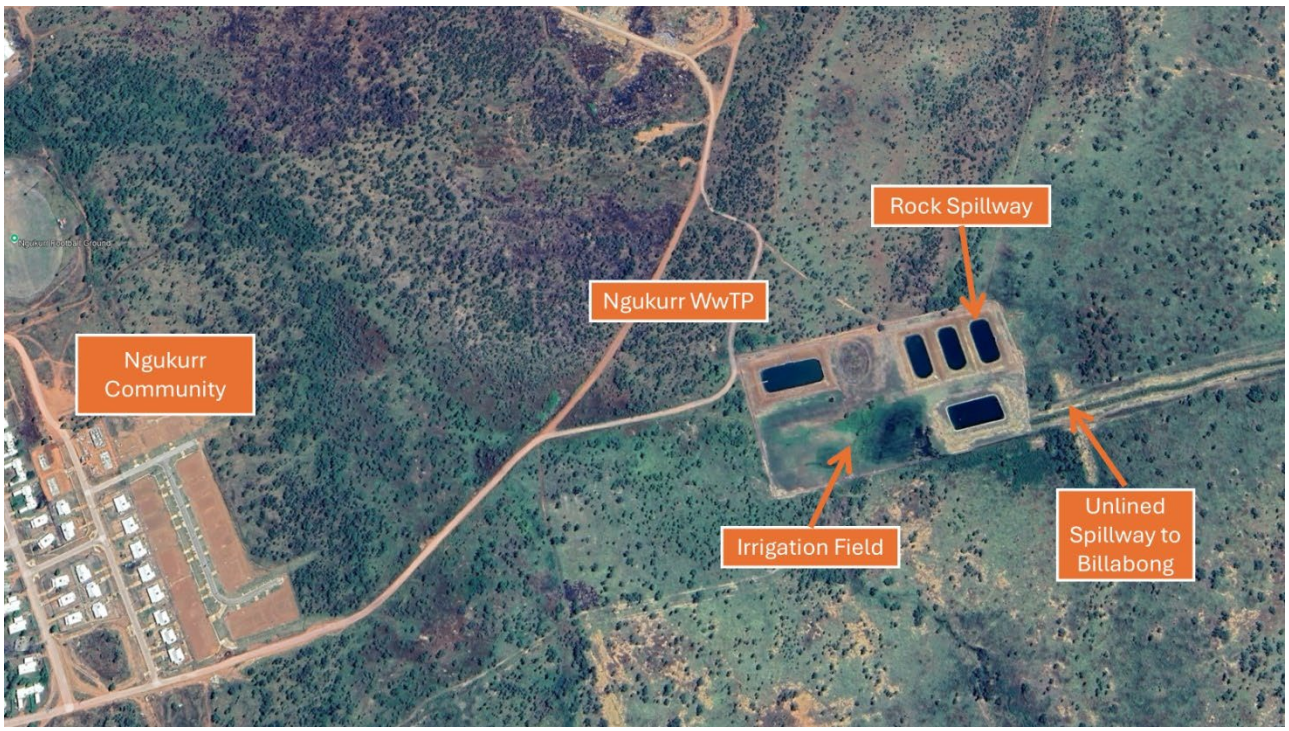

Figure 2: Ngukurr site layout including WwTP and Outfall (NT ILIS 2025)

1.1 Background

Condition 32 of this WDL requires PWC to update the environmental risk assessment for the Licenced Activity.

Condition 32 of the WDLs specifies that the Environmental Risk Assessment must:

32.1 be conducted in reference to a conceptual site model;
32.2 *characterise the impacts of discharge(s) on the relevant Environmental Values of the receiving environment;*
32.3 *assess the risk to groundwater and surface water;*
32.4 *inform the development of the Performance Improvement Plan and Consultation Plan required in condition 32 and 33;*
32.5 *be submitted to the Administrating Agency every 2 years within 10 business days after each anniversary of this licence; and*
32.6 *the Administrating Agency may require the licensee to revise, amend and/or resubmit the ERA.*

2. Risk Assessment Methodology

The purpose of the desktop ERA is to:

- identify assessment endpoints.
- characterise environmental risks associated with the facility; and
- initiate an ongoing iterative environmental risk process associated with ongoing operation of the facility.

The methodology employed has been adapted from ERAs completed by the Power and Water's Assurance Team and the Victorian EPA *Guidance for Environmental and Human Health Risk Assessment of Wastewater Discharges to Surface Waters* (VIC EPA 2023). The guidelines utilise a framework (Figure 3) consistent with current nationally and internationally accepted risk assessment approaches.

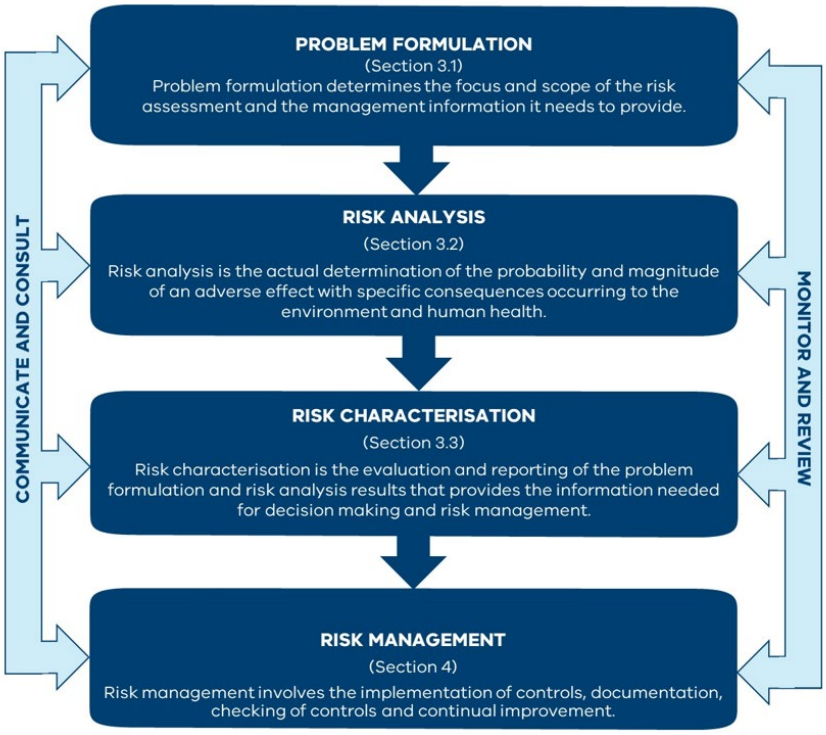

Figure 3: Risk Assessment framework for wastewater discharges to waterways (Victoria EPA, 2023)

2.1 Limitations

The following items have been identified as limitations associated with the preparation of this ERA:

- Limited amount of historical monitoring data;
- limited availability of inflow/outflow data;
- limited availability of wastewater quality data;
- use of estimated inputs used in pond performance modelling;
- remoteness of communities impacting on the ability to understand systems due to costs, logistics and available expertise; and
- limited access to pond discharge points and surrounding environment due to climatic, safety and geographic factors.

3. Problem Formulation

The purpose of this ERA is to characterise the impacts of discharge on the relevant values and has been prepared with reference to section 1.1.

This problem is explored through the following:

- characterisation of the treated effluent discharged to the receiving environment;
- characterisation of the treated effluent discharge regime and subsequent dilution of treated effluent within receiving water; and
- identified values of receiving water and assessment end-points representative of those values.

3.1 Ngukurr Wastewater Treatment Plant

The community employs a gravity-fed sewer distribution system that conveys untreated sewage from the community to the Ngukurr WwTP as illustrated in (Figure 4). The Ngukurr WwTP employs waste stabilisation pond technology to achieve secondary-level treatment of sewage effluent. Presently, the raw sewage is primarily of domestic origin, and no chemicals are introduced during the treatment process. The WwTP was originally constructed around 1981 (PWC 2021a). The treatment ponds comprise one primary anaerobic pond that feeds by gravity into three secondary facultative ponds, followed by a final tertiary maturation pond. The pond is equipped with a gravity-fed pipe that releases effluent into an open, unlined channel, which subsequently flows to an onsite irrigation system. The first and last ponds feature concrete-lined embankments, while the three middle ponds have earth-lined embankments. Although Pond 1 and Pond 4 include rock spillways for seasonal overflow, these spillways are not used.

In terms of pre-treatment, there are gross pollutant screening and maceration separation facilities located at the entrance to the pond system. The secondary method for removing gross pollutants and other suspended materials is through sedimentation, leading to the formation of sludge layers or their entrapment in concentrated surface scums that can be physically removed. Periodic desludging of the Waste Stabilisation Ponds (WSPs) is conducted as needed to eliminate accumulated solids and enhance hydraulic performance, potentially resulting in improved treatment efficacy. The most recent desludging operation in Ngukurr occurred in 2013.

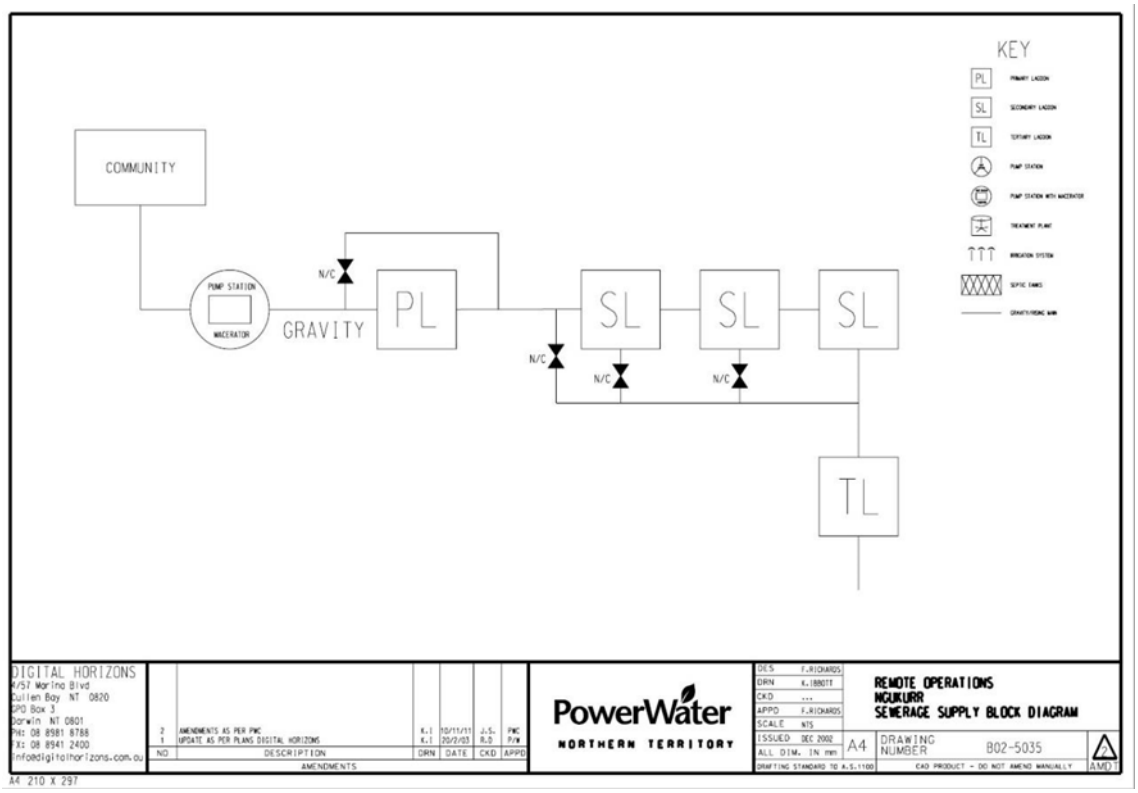

Figure 4: Ngukurr wastewater collection and treatment configuration.

3.2 Discharge Regime

The initial stage of effluent discharge from the facility involves pumping it into an onsite irrigation system positioned within the confines of the WwTP (Figure 2). However, in the event of irrigation system malfunctions or increased precipitation during the Wet Season, discharge may occur through an open, unlined drain that extends ~1.2 kilometres in length and is situated on the eastern side of the final maturation pond. This discharge takes place throughout the year and is directed either to the irrigation system or through an unlined drain.

Due to the small community population, Ngukurr has very low discharge volumes in comparison to other NT wastewater facilities in major centres (PWC Remote AMR 2025).

Some remote flow meter telemetry is available for the Ngukurr WwTP Pond outflow. Currently the recorded outflow data is inconsistent; further data collation and verification is required to determine accurate measurements for future reporting requirements.

3.3 Pond Performance

WSPs offer a low input, cost effective form of wastewater treatment that is particularly applicable in higher temperature environments with sufficient available land area. While the inputs are low, because it is largely driven by solar energy, the processes are no less complex and are largely controlled by the appropriate design and maintenance of the pond system to achieve the treatment performance required.

The ponds ultimately provide a centralised treatment barrier that prevents direct contamination of the receiving environment and have an important role in the protection of both environmental and public health.

Pond treatment performance can be measured at remote community sites utilising median biochemical oxygen demand (BOD) removal performance and median predicted *E.coli* disinfection performance. The results are a reduction in concentration levels from the primary pond inlet to the final pond outlet.

Current median removal percentages at Ngukurr WwTP:

- Biochemical Oxygen Demand (BOD): **82%**
- Free Ammonia (NH_3-N): **54.2%**
- Total Nitrogen (TN): **47%**
- Total Phosphorus (TP): **14%**

The median log reduction for the pathogens indicator is:

- *E. coli:* **5.5 log reduction**

The ponds provide a centralised treatment barrier that prevents direct contamination of the receiving environment and have an important role in the protection of both environmental and public health in this context.

For the scope of this risk assessment, wastewater quality monitoring data collected at the final pond discharge point to the receiving environment are illustrated on the conceptual site model (CSM) Appendix 1 (Figure 9), and water quality table Appendix 3 (Table 7).

3.4 Receiving Environment

The south-western corner of the WwTP within the facility fencing, an area of approximately 14,000 m^2 in size is solely allocated to irrigation (PWC 2017). The system is designed to irrigate the surrounding grassed area daily all year-round (Figure 5).

Figure 5. Irrigation area within Ngukurr WwTP (PWC 2021)

During the Wet Season high inflow to ponds occurs. During this period of the year, treated effluent from the sprinkler system may drain offsite along the fence line; to prevent this from occurring the irrigation system is turned off. As an alternative discharge point, treated effluent is gravity fed into a constructed, open, unlined drain from Pond 5, which extends 1.2 km north-east (Figure 6, Figure 7). The treated effluent then flows into a creek bed and continues to flow approximately 575 m south to the inlet of a billabong (PWC 2017). The open drain provides some additional treatment with the presence of reeds and additional evaporation.

Figure 6. Effluent discharge point to open unlined drain (PWC 2017)

Figure 7. Effluent discharge point to open unlined drain in 2021 (PWC 2021)

The final receiving environment consists of an unnamed freshwater billabong approximately 93,000 m^2 in size (Figure 8). Open Eucalyptus woodland is the dominate native vegetation type in the area, with patchy areas of Acacia and Eucalypt species sparsely spaced over tussock grasses (DENR 2018, PWC 2017). The billabong is also located within an Arnhem Aboriginal Land Trust area (NT ILIS 2018). It is not known if this billabong is present naturally year-round nor is it known if the creek has flowing water during the dry season. It appears on satellite imagery that the surrounding edges of the billabong contain some algal growth in comparison to the rest of the billabong, however this could be naturally occurring or the result of wind direction (NT ILIS 2018). Nearby land uses upstream of the billabong may consist of spraying of weeds that occur within the WwTP facility, as well as inputs from a landfill and airport located north-west of the billabong (PWC 2017). The billabong is located 900 m north of the Roper River; however, it is not known if the water from the billabong ever overflows to the river during the Wet Season.

The receiving environment is considered to have experienced minor disturbance due to the presence of vehicle tracks within the area, and tracks observed directly to the billabong (PWC 2017). The billabong is located 2 km away from the Ngukurr community, so it is possible this area may be used for recreational use for swimming. However, minimal evidence for the use of the area for recreation is present, and if it was to be used, the wastewater discharge would be limited to the Wet Season with significant rainfall dilution.

The Ngukurr WwTP is not considered to be within a groundwater bore wellhead protection zone (PWC 2021b).

Figure 8. Map of Ngukurr receiving environment (Google Earth 2025)

Ngukurr is located on the outer border of the Limmen National Park. The site is neither a Ramsar Wetland nor a world/national heritage site (Aus Gov, 2025). The area contains 4 threatened fauna species (DENR 2018). The conservation status for these species listed under the Territory Parks and Wildlife Conservation Act 2000 (TPWC) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC) are summarised below in Table 1.

Table 1. Conservation status of species at risk from the Ngukurr WwTP.

Common name	Species name	National Status (EPBC)	NT Status (TPWC)
Bird			
Mammal			
Yellow-spotted Monitor	*Varanus panoptes*	N/A	VU
Northern Quoll	*Dasyurus hallucatus*	EN	CE
Mitchell's Water Monitor	*Varanus mitchelli*	CE	VU
Brush-tailed Rabbit Rat	*Conilurus penicillatus*	VU	EN

CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, CD – Conservation Dependant, N/A – not listed

3.5 Screening Level Risk Assessment

A screening level risk assessment is used to determine if a risk to the assessment endpoint exists that should be further investigated. It is a method for prioritising risks and minimising effort in assessing low risks. Table 3 provides a summary of the screening level risk assessment.

Risk hypotheses for the stressors identified in the conceptual site model (CSM) (Appendix 1, Figure 9) are defined with respect to their potential effects on the identified values of the receiving environment.

The identified values of the receiving environment are summarised below in Table 2.

Table 2: Identified values of receiving environment at risk from the Ngukurr WwTP

Values	**Receptors**	
Cultural/ Human Health	Humans	Swimming/wading Visible water quality Sacred sites Food sourcing
Environment	Aquatic	Fish Turtles Crocodiles
	Terrestrial	Wading birds Invertebrates Mammals Reptiles
	Plants	Open Woodland Acacia and Eucalypts

Table 3. Screening level risk assessment for key indicator and stressors associated with Ngukurr WwTP discharge.

Indicator (water quality parameter)	Stressor (change to indicator)	Risk Hypothesis		Assessment end-points		Scope of this desktop ERA	Further investigation required?
		ENVIRONMENTAL	CULTURAL/ HUMAN HEALTH	ENVIRONMENTAL	CULTURAL/ HUMAN HEALTH		
Gross pollutants	Presence and accumulation of gross pollutants from influent carried through to effluent	That gross pollutants are released into environment from overflow and ingested by biota leading to kills and disturbed ecosystems. Gross pollutant accumulation in ponds affecting treatment of wastewater prior to discharge.	That gross pollutants released into environment resulting in the reduction of visual amenity in the receiving environment.	To maintain the presence of biota in the environment. To maintain the ponds treatment performance prior to discharge	To maintain the visual amenity of the environment.	The WwTP is considered a relatively effective barrier to gross pollutant entry to the receiving environment. This is due to the settling out to sludge layers and accumulation on pond surface where gross pollutants are physically removed as required. No evidence of gross pollutant accumulation during visual monitoring of discharge site (qualitative discharge criteria). No further investigation necessary at this stage.	No
Organic matter	Increase in BOD, decrease in DO	That BOD is leading to oxygen depletion in the environment resulting in loss of biota (e.g. fish kills) and changes to ecosystem structure.	That BOD is leading to odours resulting in the reduction of amenity in the receiving environment.	To conserve biota and ecosystems in surrounding environment	To maintain oxygen levels in the environment sufficient to prevent production of odours.	The median concentration of BOD in the discharge of the WwTP is 16.5 mg/L. As BOD is present in the discharge, it is determined at a screening level that further investigation is necessary.	Yes
Nutrients (nitrogen and phosphorus)	Increase in nutrient concentrations	That nutrients are leading to nuisance plant growth resulting in oxygen depletion; displacement of endemic species; diminished light availability; release of toxins; and changes to ecosystem structure.	That nutrients are resulting in the reduction of amenity of receiving environment through reduction in water clarity, objectionable discoloration and odours; toxic blooms that are a public health risk; and blooms of toxin producing species whereby the toxins bio-accumulate in shellfish and fish ingested by humans.	To maintain nutrient levels so that the levels of primary production do not have an adverse impact on ecosystem structure.	To maintain the amenity of the environment.	As nutrients are present in the discharge, it is determined at a screening level that a risk is present and further investigation is necessary.	Yes
Toxicants	Increase in free ammonia concentration	That free ammonia is resulting in toxicity to aquatic organisms in water and sediments.		To maintain the presence of biota in the environment.		The median concentration of free ammonia in the discharge of the WwTP is 5.5 mg/L. At a screening level it is determined that a risk is present and further investigation is necessary.	Yes
Pathogens	Presence of *E. coli*		That pathogens are leading to the contamination of water resulting in primary and secondary contact recreation a public health risk; and accumulation in shellfish resulting in the consumption of shellfish a public health risk.		To maintain that pathogens from municipal wastewater are not increasing the risk of illness via primary and secondary contact recreation and consumption of shellfish.	The median *E. coli* count in the discharge of the WwTP is 221/100mL. At a screening level it is determined that a risk is present and further investigation is necessary.	Yes

4. Risk Analysis and characterisation

4.1 Power and Water Risk Management Framework

Power and Water has adopted a qualitative risk assessment methodology aligned to the Australia/New Zealand Standard *"AS/NZ 4360: Risk Management"*. This process is used to assess and manage activities that have potential to cause environmental harm.

The first step in the ERA process is to identify the aspects (problem formulation i.e. discharge of treated wastewater) (section 2.0) and corresponding potential impacts associated with each assessment endpoint identified in the screening level risk assessment as seen in Table 3.

This methodology is based on knowledge of the existing environment and incorporates site specific environmental factors into the analysis of the potential impacts. An assessment of each impact is analysed for likelihood and consequence.

The categories and associated rankings for environmental impact consequences are shown in Appendix 2 (Table 5). The likelihood of an event occurring and a risk score for each potential impact is determined by combining likelihood with consequence results as seen in Appendix 2 (Figure 11).

Low to medium risks can typically be managed by routine procedures and integration into management plans, while high to extreme risks require senior management attention, immediate action or more detailed research and management planning.

3.1.1 Risk assessment for key indicators and stressors identified in screening level assessment.

Table 4: Risk assessment for key environmental and cultural assessment endpoints associated with Ngukurr WwTP discharge.

Hypothesis	Consequence	Likelihood		Inherent Risk Ranking	
Environmental					
BOD leading to oxygen depletion in the environment resulting in **loss of biota** and **changes to ecosystem structure**.	BOD median was 16.5 mg/L for the most recent monitoring period. This concentration is non-negligible but due to low discharge volumes, the total contribution is very low. Additionally, it will reach a concentration of 0.05 mg/L post-discharge due to dilution ratios which is insignificant compared to an expected BOD concentration of unpolluted waterways (K.S. Schmitz, 2025). Thus, discharge is unlikely to cause anoxia in receiving environment causing detrimental effects.	Minor	Likelihood of the discharge reaching the billabong is low due to geodetic distance. Even if the discharge was entering the billabong directly, after dilution, BOD contribution is extremely low and highly unlikely to induce anoxic conditions which may disrupt ecosystems. Dilution ratio would likely be higher than calculated in appendix 3 as the discharge would have to pass over land which would act as a buffer for volume discharged.	Unlikely	Low
Free ammonia is resulting in **toxicity to aquatic organisms** in water and sediments.	Ammonia median was 5.5 mg/L for the most recent monitoring period. The ANZECC guideline trigger value for ammonia to prevent environmental harm in freshwater ecosystems is 1.18 mg/L at expected conditions (ANZECC & ARMCANZ, 2000). Post-dilution, the concentration of 0.02 mg/L is not likely to cause biota mortality and disturb ecosystems. Additionally, no fish kills have been reported to date.	Minor	Based on the monitoring results to date, PWC considers that the likelihood of toxicity to aquatic organisms in water and sediments is unlikely. If effluent reached the billabong during the wet season, some nutrients would filer out through reeds and soil infiltration and be of low concentration due to dilution.	Unlikely	Low
Nutrients leading to **nuisance plant growth** resulting in oxygen depletion; displacement of endemic species; diminished light availability; release of toxins; and changes to ecosystem structure.	The WwTP contributes low levels of nitrogen and phosphorus (0.4 and 0.2 tonnes/year respectively). No eutrophication/ algal blooms have been observed in the discharge drain, which is an indicator or excess nutrient loads.	Minor	When discharging smaller volumes via an irrigation system, environmental stressors are not typically observed. The likelihood of any nuisance plant growth occurring is reduced by the geodetic distance from the billabong paired with the dilution that would occur at the billabong itself. Dilution ratio would likely be higher than calculated in appendix 3 as the discharge would have to pass over land which would act as a buffer for volume discharged.	Possible	Low
Cultural/ Human Health					
BOD leading to odours resulting in the **reduction of amenity** in the receiving environment.	BOD median was 16.5 mg/L for the most recent monitoring period. This concentration is non-negligible but due to low discharge volumes, the total contribution is very low. Additionally, it will reach a concentration of 0.05 mg/L post-discharge due to dilution ratios which is insignificant compared to an expected BOD concentration of unpolluted waterways (K.S. Schmitz, 2025). Thus, discharge is unlikely to cause anoxia in receiving environment leading to odour-causing, anoxia-favoured reactions.	Minor	After dilution, BOD concentration is low and highly unlikely to induce anoxia in the receiving environment. In the improbable event that some odours causing reactions were to occur, PWC considers that the likelihood of reduction in amenity from BOD is unlikely.	Unlikely	Low
Nutrients resulting in **toxic blooms** that are a public health risk; and **blooms of toxin producing species** whereby the toxins bio-accumulate in shellfish and fish ingested by humans.	The nutrient contributions by the WwTP into the surrounding environment is not considered high enough to cause a significant harmful algal bloom that will cause shellfish to accumulate biotoxins (J.K. Andres *et al*, 2019). Minimal cultural beneficial uses of the receiving environment have been observed. Low levels of nutrients in discharge to receiving environment. No shellfish or fish consumption observed in the billabong area as the river provides better food sources.	Minor	When discharging smaller volumes via an irrigation system, environmental stressors are not typically observed. The likelihood of any algal growth occurring is reduced by the distance from the billabong paired with the dilution that would occur at the billabong itself. In the improbable event of any harmful algal biotoxin accumulation in shellfish, it would be a very small, non-toxic amount, and shellfish will naturally purge themselves of the toxin (N. Dowsett *et al*, 2011). However, based on the limited recreational and cultural uses of this area, PWC considers that the likelihood of toxicant exposure is unlikely.	Unlikely	Low
Nutrients resulting in the **reduction of amenity** of receiving environment through **reduction in water clarity**, objectionable **discolouration** and **odours**.	Minimal cultural beneficial uses of the receiving environment, on rare occasions the public may access the immediate discharge site. Treated effluent was observed to be clear in the drain.	Minor	When discharging smaller volumes via an irrigation system, environmental stressors are not typically observed. The likelihood of any nuisance algal growth occurring is reduced by the distance from the billabong paired with the dilution that would occur at the billabong itself. Changes in colour/odours would also be unlikely due to low discharge volumes and significant dilution.	Unlikely	Low
Pathogens leading to the **contamination of water** resulting in a public health risk through primary and secondary contact recreation.	Discharge point is in a secured irrigation field only accessible by PWC employees. No/minimal cultural beneficial uses surrounding the irrigation field was observed or reported by the Australian government (Aus Gov, 2025). Recreational swimming occurs downstream in the river. However, the only time the discharge would reach the river is in the event of heavy flooding where recreational swimming would be unlikely and significant dilution would occur.	Minor	When discharging smaller volumes via an irrigation system, environmental stressors are not typically observed. Additionally, the discharge would undergo significant dilution within the receiving environment meaning likelihood of illness from pathogen exposure downstream is highly unlikely.	Unlikely	Low

5. Summary

The ERA found that the identified values of the nearby freshwater billabong at risk from the Ngukurr WwTP discharge were environmental and cultural/ human health.

The key stressors that posed a risk to these values were the increase in BOD and oxygen depletion; increase in nutrient concentrations; and therefore, the possibility of nuisance plant growth.

The ERA process has determined that the discharge from the Ngukurr WwTP poses low risk to the identified values of the receiving area. The influence of the discharge on the receiving environment is considered sustainable given the low discharge volumes which most only occur during the Wet Season, and the use of irrigation and evaporation where possible. The risk to cultural/ human health values are considered low, mostly due to the minimal cultural beneficial uses of the receiving environment. Based on this ERA and modelled water quality data, there is limited evidence to suggest deleterious impacts to the receiving environment.

All risk rankings have considerable uncertainties attached to the assessments. The risk rankings may change as uncertainties associated with current assessments are addressed.

Based on the ERA process and outcomes, PWC make the following recommendations:

- continue monitoring quality of wastewater discharged to the environment;
- assess pond performance;
- incorporate recommendations into future Performance Improvements Plans;
- verification of data to accurately quantify the volume of treated wastewater discharged to the environment; and
- update the ERA and CSM based on new information and additional wastewater quality data.

References

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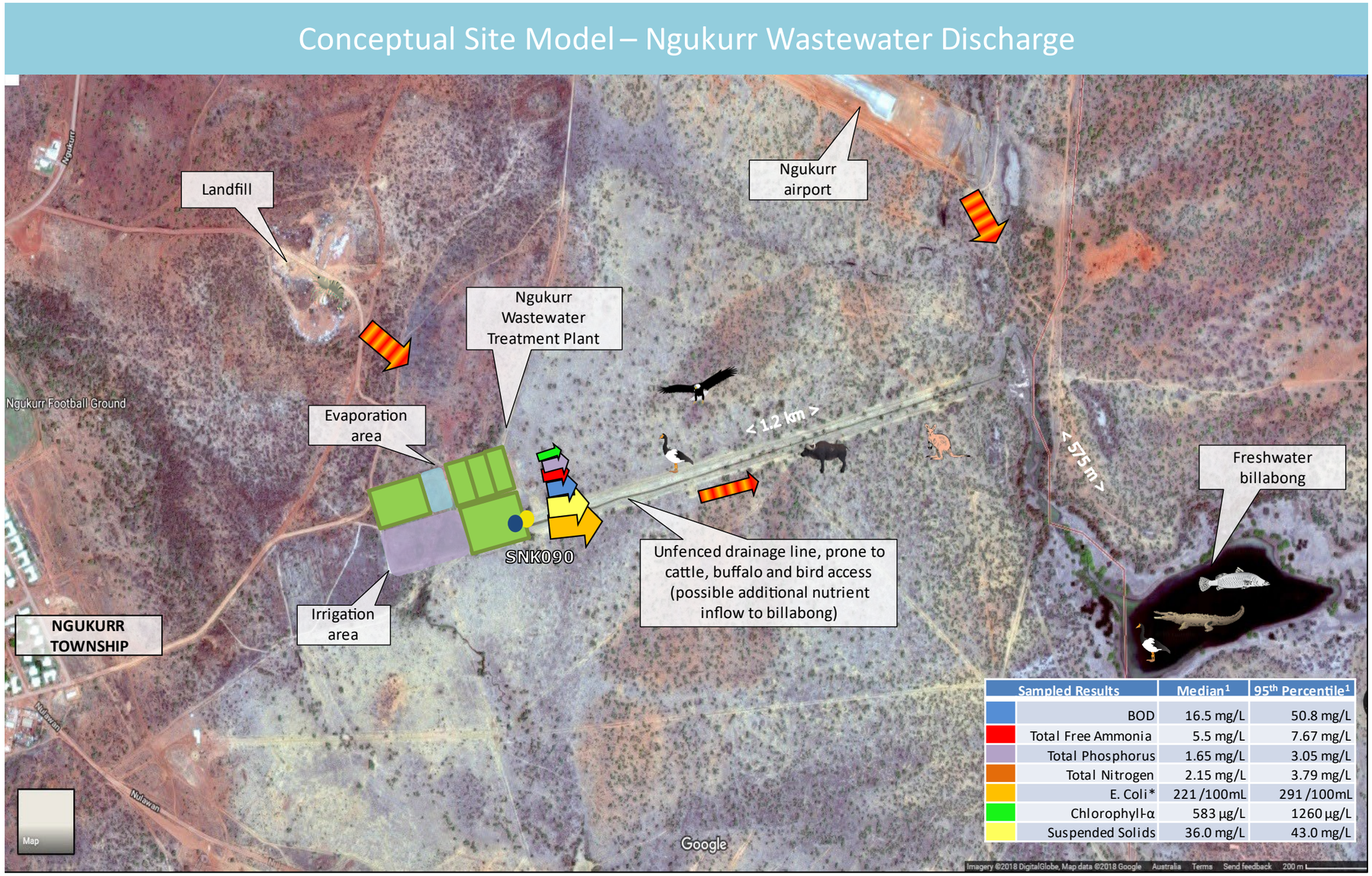
Appendices

Number	Title
Appendix 1	Ngukurr Conceptual Site Model
Appendix 2	Power and Water Risk Matrix
Appendix 3	Water quality and estimated dilution Ratio for Ngukurr WwTP

Appendix 1 – Ngukurr Conceptual Site Model



Beneficial uses as identified by Power and Water Corporation are for environmental and cultural

V 3.0 2025 D2025/437229

Sample Location
Discharge Point
Irrigation area
Evaporation area
Kites
Fish
Wallaby
Water birds
Cattle
Unknown input
Crocodile

[1] Based on PWC data –2024–2025.

PowerWater
December 2025

Figure 9: Conceptual site model for the Ngukurr WwTP.

Appendix 2 – Power and Water Risk Matrix

Table 5: Power and Water risk consequence table.

CONSEQUENCES

The consequence (impact or outcome) associated with a risk is assessed using the following criteria:

RISK CONSEQUENCE TABLE					
Category	**Insignificant**	**Minor**	**Moderate**	**Major**	**Severe**
Health and safety	**Physical**: A near miss incident without injury or illness. **Psychosocial*:** No treatment needed from a health professional. *Notes: Psychosocial harm relates to the factors in the design or management of work that increases the risk of work-related stress and can lead to psychological or physical harm.	**Physical:** An incident resulting in a minor injury or illness, and first-aid treatment applied. **Psychosocial**: Reduced ability to perform tasks, no professional treatment needed.	**Physical:** An incident resulting in an injury or illness requiring medical treatment*. **Psychosocial:** Reduced ability to perform tasks, likely needs ongoing support from a health professional. *Notes: Medical treatment relates to treatment by a medical professional at a medical facility. Treatment at a worksite by a paramedic is a first aid injury, unless they are transported to a medical facility.	**Physical:** A serious incident: ▪ Requiring hospitalisation (24hrs); and/or ▪ Resulting in long-term permanent disabling; or ▪ Exceeding of chemical exposure with acute health impacts. **Psychosocial:** Serious psychological treatment needed, reduced ability to perform tasks.	**Physical:** A serious incident resulting in any one or more of the following: ▪ One or more fatalities; ▪ One or more persons seriously injured (includes long-term disabling effect); ▪ Widespread hospitalisation of members of the public or Power and Water's workforce. **Psychosocial**: Inability to perform tasks, ongoing extensive psychological treatment.
Financial **(Impact on EBITDA)**	Loss less than $500K.	Impact between $500K and $5M.	Impact between $5m and $25m.	Impact between $25m and $50m.	Impact greater than $50m.
Legal/ regulation	▪ Individual breach of obligation, procedure or policy. ▪ Civil action, fines and/or civil penalties (refer to Financial definition)	▪ Notification to regulator required. ▪ Regulator/external auditor non-conformance or request for further explanation ▪ Functional breach of obligation, procedure or policy. ▪ Civil action, fines and/or civil penalties (refer to Financial definition)	▪ Regulator/ external auditor issues improvement notice, multiple non-conformances or provisional improvement notice. ▪ Systemic breach of obligation, procedure or policy. ▪ Civil action, fines and/or civil penalties (refer to Financial definition)	▪ Regulator issues notices, corrective action order and/or penalties ▪ Order to stop work ▪ Multiple provisional improvement notices, prohibition notice. ▪ Civil action, fines and/or civil penalties (refer to Financial definition)	▪ Successful criminal prosecution imprisonment of Power and Water director and/or officer. ▪ Royal Commission, parliamentary or other government inquiry, ▪ Loss of licence to operate. ▪ Civil action, fines and/or civil penalties (refer to Financial definition)
Environmental	Localised low level damage controlled but no remedial action required.	Localised low level damage controlled and remedied with minimal resources.	Widespread temporary damage with extended resources to remedy.	Long-term detrimental effect on environment and once controlled results in minor permanent damage.	Substantial permanent damage to widespread and sensitive areas.
Reputation	▪ No media attention; and/or ▪ Isolated community or individual issue-based concern; and/or ▪ Localised employees dissatisfaction which is managed by normal business processes;	▪ Occasional once-off negative media attention; and/or ▪ Localised community impacts and customer concerns; and/or ▪ Localised employees dissatisfaction which requires human resources in resolution;	▪ Brief adverse media attention and/or ▪ Community/customer condemnation; and/or ▪ Limited, localised loss of confidence by the community; and/or ▪ Reduced confidence of key stakeholders ▪ Localised employees dissatisfaction with localised impacts to service delivery	▪ Prolonged adverse media attention and/or ▪ Community/ customer condemnation; and/or ▪ Prolonged, widespread community/ customer loss of confidence; and/or ▪ Confidence of key stakeholders damaged ▪ Widespread dissatisfaction and loss of confidence by employees resulting in temporary service delivery	▪ Sustained adverse media attention and/or ▪ Community/customer condemnation; and/or ▪ Sustained community/ customer loss of confidence; and/or ▪ Loss of stakeholder confidence in Board and/or ▪ Management; and/or ▪ Widespread dissatisfaction by employees resulting in sustained service delivery and industrial action
Customer **(Impact due to disruption to services)**	▪ No loss of supply. Issues rectified with corrective action. ▪ Loss of water supply <= 2 hours in any urban or remote community	▪ An event resulting in loss of a single residential feeder for 15 to 30 minutes ▪ Loss of water supply >2 hrs and <= 6 hours in any remote community ▪ Loss of water supply in urban area, restored within expected timeframes (<=4 hours)	▪ An event resulting in loss of a single to multiple zone substations for up to 3 hours ▪ Loss of water supply >6 and <=12 hours in any remote community ▪ Loss of water supply in urban area outside of expected timeframes (> 4 hours and <=12 hours).	▪ An event resulting in loss of a single to multiple zone substations affecting CBD, town centres, commercial, and emergency services lasting up to 6 hours ▪ Loss of water supply >12 hours < =24 hours in any urban area or remote community.	▪ An event resulting in loss of a single to multiple zone substations affecting CBD, town centres, commercial, and emergency services lasting > 6 hours ▪ Complete loss of water supply (>24 hours) in any urban or remote community.

LIKELIHOOD

The likelihood of a risk occurring is assessed using the following scale:

(E) Almost certain	Event is expected to occur on a regular basis. One or more times per annum.	Not applicable
(D) Likely	An event is expected to occur from time to time. Once every 1 – 3 years	Probability of occurring is greater than 33%
(C) Possible	An event should occur at some time. Once every 4 – 10 years.	Probability of occurring is greater than 10% and up to and including 33%
(B) Unlikely	An event could occur at some time. Once every 11 to 30 years	Probability of occurring is greater than 3% and up to and including 10%
(A) Rare	An event not expected but possible. Less than once in 30 years	Probability of occurring is up to and including 3%

RISK RATING

Consequences and Likelihood

Likelihood \ Consequence	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Almost certain (E)	Medium	High	Very High	Extreme	Extreme
Likely (D)	Low	Medium	High	Very High	Extreme
Possible (C)	Low	Low	Medium	High	Very High
Unlikely (B)	Low	Low	Medium	High	High
Rare (A)	Low	Low	Low	Medium	Medium

ACTIONS AND REPORTING

	Low	Medium	High	Very High	Extreme
Escalation (new risk or reassessment)	Reported through risk review process.	Reported through risk review process.	Reported to executive general manager	Reported to CEO / Executive Leadership Team as soon as practicable.	Reported to Board Chair as soon as practicable.
Reporting to ARMC	Not applicable.	Not applicable.	To be reported to Audit and Risk Management Committee on a quarterly basis.	To be reported to Audit and Risk Management Committee on a quarterly basis.	Exception reporting as soon as practicable.
Tolerance	Tolerable unless otherwise determined by management.	Tolerable unless otherwise determined by management.	Tolerance to be determined by executive general manager.	Tolerance to be determined by CEO / Executive Leadership Team.	Tolerance to be determined by Board.
Risk monitoring	Reporting frequency to be annual.	Reporting frequency as per related business process.	Status to be reported to executive general manager at each business unit management meeting. Reporting frequency to be quarterly.	Status to be reported to each ELT. Reporting frequency to be quarterly	Status reported to each Board meeting. Reporting frequency to be quarterly

Note: "Escalation" refers to the escalation of **risks** (i.e. events that could happen in future) not **incidents** (events that have happened). Escalation of incidents is covered by the *HSE Incident and Investigation Management Procedure (CONTROL0070)*.

Figure 10: Power and Water likelihood, risk ranking, actions and reporting matrix.

Appendix 3 – Dilution ration for Ngukurr WwTP

The sewage subjected to treatment at the Ngukurr Wastewater Treatment Plant (WWTP) undergoes an extensive secondary treatment process before entering a controlled facility that utilizes sprinkler irrigation. This approach is supported by low average discharge rate of 349.3 KL/day within the securely enclosed facility. This deliberate measure plays in mitigating the potential risk of discharge escaping regularly, ensuring the protection of the surrounding environment from adverse impacts.

This estimated dilution ratio represents a worst-case scenario, taking into account the possibility of effluent discharge interacting with the creek during dry conditions.

Table 6. Estimated dilution ratio for Ngukurr WwTP effluent.

Location	Estimated Area (m^2)	Estimated Average Depth (m)	Water Volume (kL)	Average daily pond outflow (m^3)	Dilution Ratio
Ngukurr Unnamed Billabong	78300	1.5	117450	349.3	1:336

Table 7. 2024-2025 Monitoring Data Results for Ngukurr effluent discharge.

Sample Location/Asset: SNK090 Pond 5 Outlet		
	Median	95th Percentile
Biological Parameters		
Biological Oxygen Demand (mg/L)	16.5	50.8
Chlorophyll-a (ug/L)	583	1260
Nutrient Parameters		
Ammonia (mg/L)	5.5	7.67
Total nitrogen (mg/L)	2.15	3.79
Oxidised Nitrogen (mg/L)	0.1	0.1
Total Phosphorus (mg/L)	1.65	3.05
Pathogen Indicators		
Escherichia coli (MPN/100 mL)	221	291
Physio-chemical Parameters		
Suspended Solids (mg/L)	36.0	43.0

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