2025 Environmental Risk Assessment – Acacia Larrakia Wastewater Treatment Plant WDL 225-03

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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

Power and Water Corporation (PWC) operates the Acacia Larrakia Wastewater Treatment Plant (WwTP) under Waste Discharge Licence (WDL) 225-02, authorising discharge of secondary treated effluent to the Manton River.

This assessment identifies potential risks to environmental values, cultural uses, and surface water/groundwater quality associated with treated effluent discharge. Monitoring, USCW statements, and water balance data indicate the tertiary maturation pond does not discharge to the environment. Cause of absent discharges were attributed to very low inflow volumes and high evapotranspiration preventing overflow.

Despite limited historical inflow data before issue of licence, available performance observations, theoretical modelling, and water quality monitoring indicate the ponds provide effective treatment. Key wastewater constituents (BOD, nutrients, free ammonia and E. coli) are present at low concentrations, and the estimated dilution ratio of 1:4320 at the receiving environment suggests any discharge would contribute negligible contaminant loads relative to guideline trigger values.

A screening-level assessment identified potential risks associated with organic matter, nutrients, ammonia and pathogens. Detailed risk characterisation determined that all risks to aquatic ecosystems, terrestrial species, and cultural/human receptors are low, due to the improbability of discharge and natural dilution capacity of the Manton River. No threatened species habitat or cultural values are expected to be affected under current operations, and recreational use of the receiving environment is considered unlikely due to crocodile activity and lack of evidence.

This ERA concludes that the operational risk to environmental values posed by the Acacia Larrakia WwTP is low, and any discharge (if it were to occur) is not expected to result in adverse ecological impacts. The assessment supports continuation of current monitoring and informs future performance improvement and community consultation planning as required under Conditions 32 and 33 of the WDL. Plan to collate data in order to propose surrendering the license was outlined for consideration.

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1. Introduction

PWC operate the Acacia Larrakia WwTP pursuant to Waste Discharge Licence (WDL) 225-2 issued on 11 December 2021. This WDL allows for continuous discharge of secondary treated sewage effluent from an authorised discharge point to Manton River (freshwater). Acacia Larrakia is situated in the Top End of the Northern Territory. It is part of the Manton Dam Catchment and has GDA94 coordinates of Lat -12.814, Lon 131.172 (Figure 1). Acacia Larrakia has an estimated population of 35 in 2025 (Homelands Service Provider Report 2025). The Wastewater Treatment Plant (WwTP) is located approximately 990 m east of the Acacia Larrakia Community (Figure 2).

Figure 1. Acacia Larrakia WwTP location (Google Earth Pro, 2025)

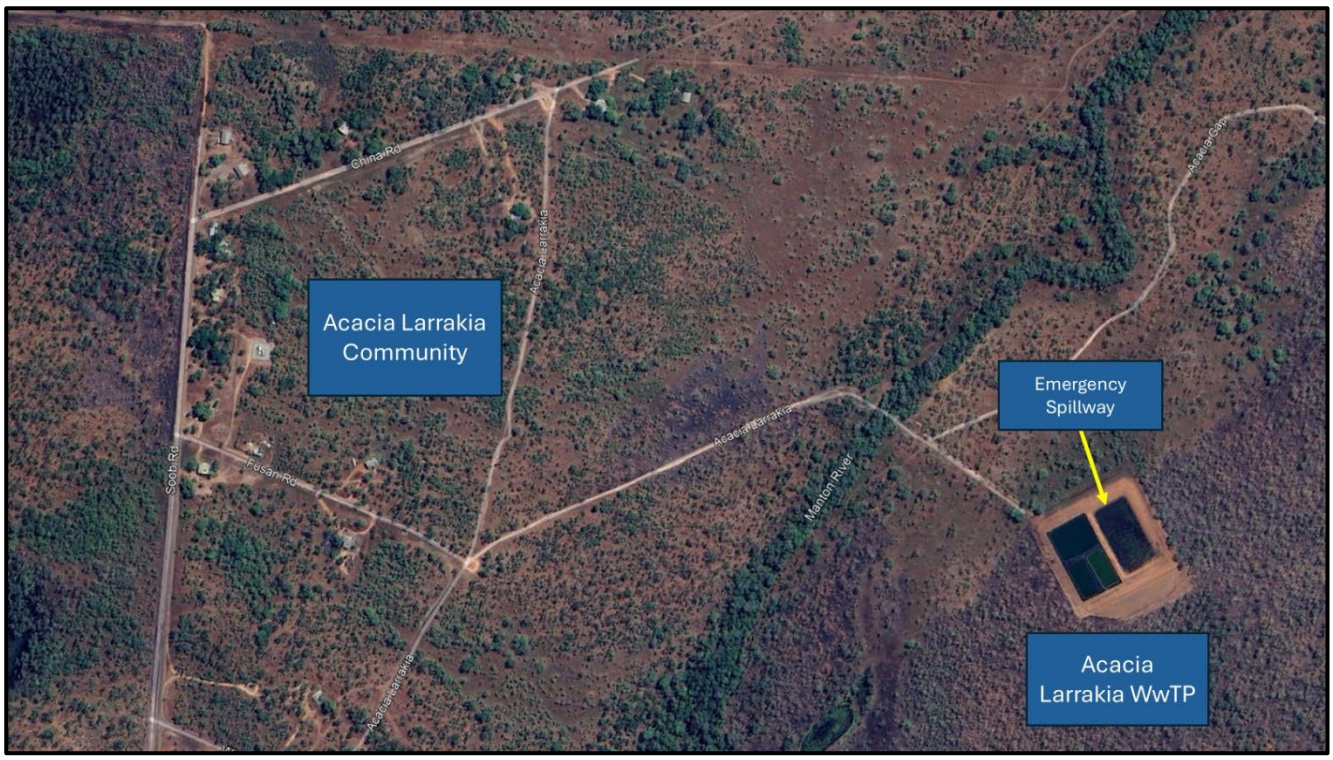

Figure 2: Acacia Larrakia site layout (NT ILIS 2025)

1.1 Background

Condition 31 of this WDL requires PWC to update the environmental risk assessment for the Licenced Activity.

Condition 31 of the WDL specifies that the Environmental Risk Assessment must:

31.1. be conducted with reference to a conceptual site model;
31.2. characterise the impacts of the discharge on the relevant Environmental Values of the receiving environment;
31.3. assess the risk to groundwater and surface water;
31.4. inform the development of the Performance Improvement Plan and Consultation Plan required in condition 32 and 33;
31.5. be submitted to the Administering Agency every 2 years within 10 business days after each anniversary date of this licence; and
31.6. the Administering Agency may require the licensee to revise, amend and 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 2025). The guidelines utilise a framework (Figure 3) consistent with current nationally and internationally accepted risk assessment approaches.

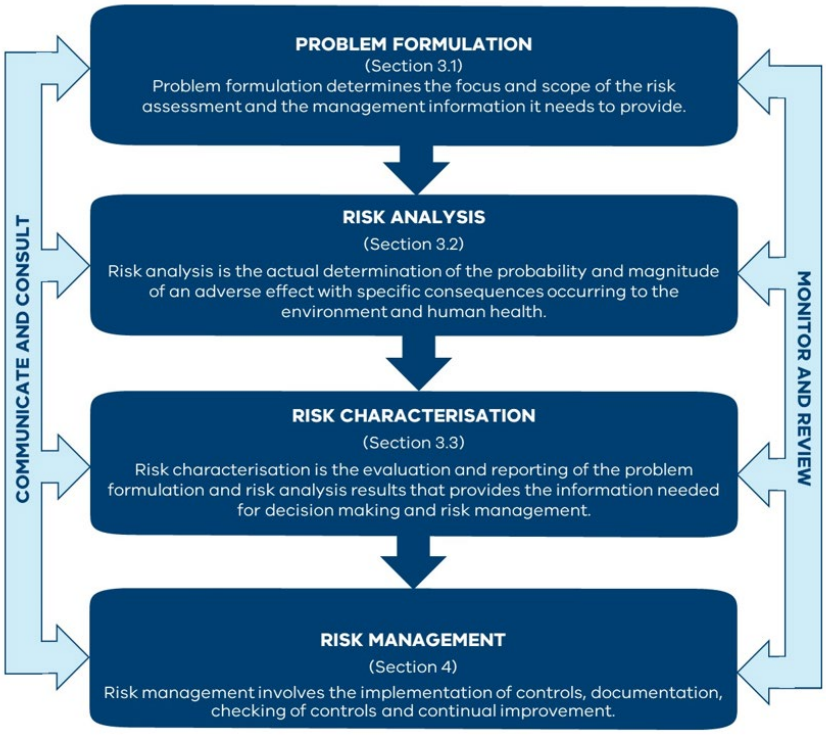

Figure 3: Risk Assessment framework for wastewater discharges to waterways (Victoria EPA, 2025)

2.1 Limitations

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

- limited availability of inflow/outflow data;
- Limited historical monitoring data;
- No inlet monitoring data;
- 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 during wet season 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 Acacia Larrakia Wastewater Treatment Plant

The community operates a pressure fed sewer reticulation system which pumps raw sewage from the community to the WwTP (Figure 4). The Acacia Larrakia WwTP utilises waste stabilisation pond technology to achieve secondary level treatment of sewage effluent. Based on current circumstances, the raw sewage is almost entirely domestic in nature with no chemicals added during the treatment process.

The WwTP was constructed in 2004 (PWC 2021a) and consists of one primary anaerobic pond, two facultative ponds, and a tertiary maturation pond. The tertiary pond contains an emergency spillway which is designed to direct any overflow waters into the nearby vegetation. The first 3 ponds have embankments with plastic lining. The evaporative pond has embankments constructed from earth. There is no gross pollutant screening, grit removal, maceration or storm flow separation located on the inlet to the pond system. The removal process for gross pollutants and other entrained materials is via sedimentation to sludge layers or entrapment in concentrated surface scums that can be physically removed. Desludging is conducted as required to maintain maximum pond performance and has not been recorded to date.

Prior to 2017, no regular wastewater monitoring was undertaken at the site, with no WDL in place. Regular wastewater monitoring commenced in January 2017, consistent with WDL 225. Samples of the final maturation pond outlet are currently conducted on a quarterly basis; however, this pond is dry for most of the year, so samples are taken from pond 3. A summary of the results for the monitoring period is provided in Appendix 3, table 7.

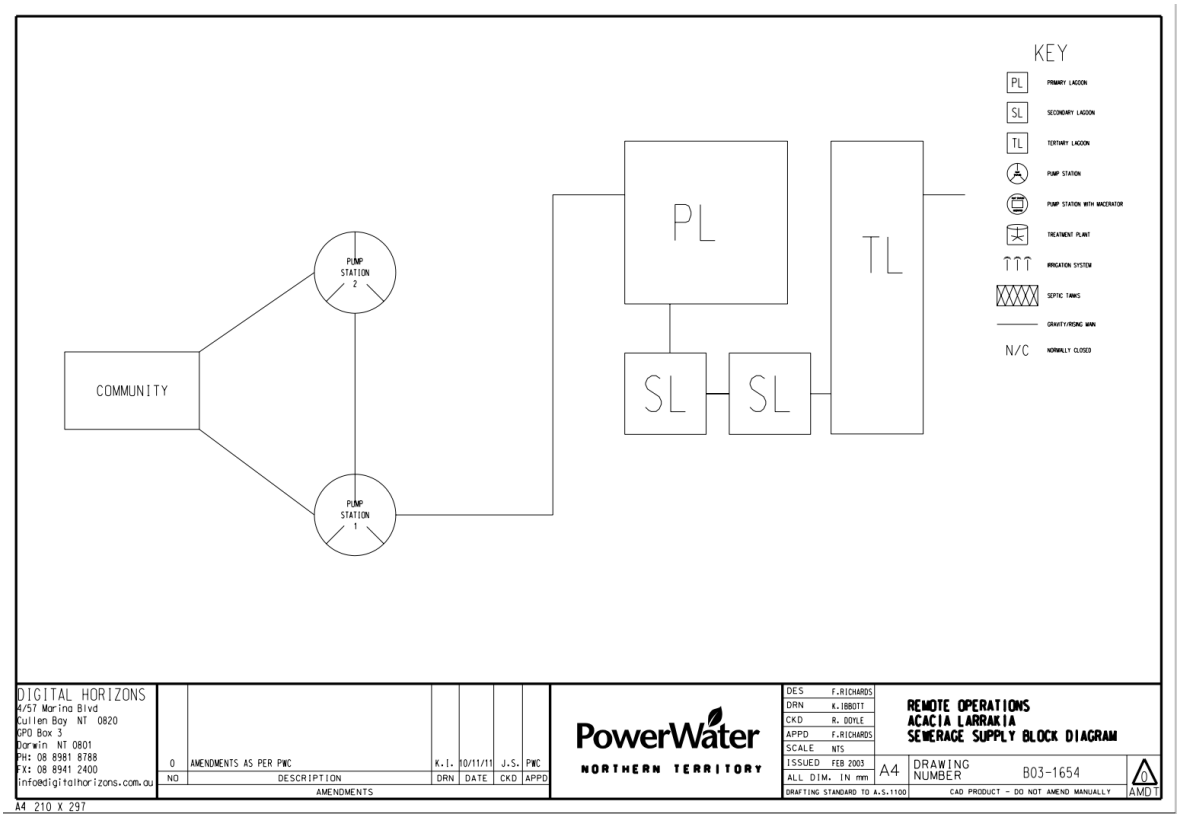

Figure 4: Acacia Larrakia wastewater collection and treatment configuration.

3.2 Discharge Regime

Any discharge from the facility occurs from a constructed spillway, approximately 10 m in length, located on the northern side of the tertiary maturation pond. However, discharge from the pond or any evidence of discharge has never been observed by the Utility support contract workers (USCWs) that have managed the monitoring program since the plant became licensed. Additionally, the tertiary pond has never been observed to approach a discharging volume and spends most of the year empty; when it is filled, it is predominantly due to extreme rainfall (PWC 2025a).

The theoretical water balance data reported for Acacia Larrakia in the 2025 remote annual monitoring report supports the no discharge hypothesis (PWC 2025b). It was calculated that low inflows combined with mid/high evapotranspiration stops water from reaching a dischargeable level.

3.3 Pond Performance

The monitoring program in WDL225-02 outlines quarterly monitoring at the final treatment pond. However, the third pond is used as a sample point (SAK003) when the tertiary pond is empty, and a sample cannot be taken. Acacia Larrakia is currently under a “homestead’ status which means funding under the Indigenous Essential Services is restricted. This means that non-essential monitoring (inflows and non-tertiary ponds) are yet to be commenced. Monitoring data is illustrated on the conceptual site model (CSM) (appendix 1, figure 9).

This lack of water quality monitoring for the inflow into the WwTP makes it difficult to numerically assess the performance of the ponds. However, during site visits, no evidence was found to indicate a drop in performance (odour, polished water, excess algae/duckweed, unusual colours or excess gross pollutants/sludge). Thus, it is likely that any discharge would consist of appropriately treated wastewater.

This is confirmed by a model-based prediction of the Acacia Larrakia WwTP performance undertaken by J. Louey-Gung using industry standard design models (J. Louey-Gung,2011). The model utilised various pond parameters to predict treated wastewater quality using mean biochemical oxygen demand (BOD) removal performance and mean predicted *E. coli* disinfection performance. The modelled water quality results at the pond outlet for mean BOD removal and *E. coli* disinfection were 39.2 mg/L (81% removal) and 2,556/100 mL (3 log removal) respectively (modelled data used as pond performance indicator only).

3.4 Receiving Environment

The immediate receiving environment consists of an unfenced low lying drainage area of open woodland, with a mixture of vegetation including Eucalyptus, Pandanus, Billy Goat Plum, and Livistonia Palm species (PWC 2021b). The initial section of grass where discharge flows from the spillway is within the WwTP boundary (Figure 5, Figure 6).

The surrounding environment is not located within a site of conservation significance but is located within classified aboriginal land. The site is neither a Ramsar Wetland nor a world/national heritage site (Australian Government, 2025)

The Acacia Larrakia WwTP discharge area is located 275 m from the Manton River and is downstream from Manton Dam. Surface water from Manton Dam is discharged daily to the Manton River (approximately 50L/s) for downstream users and environmental flows, dictated by the NT Water Act and Department of Environment and Natural Resources (PWC 2017). Manton River eventually flows into the Adelaide River. The river seen in Figure 7 is between the Acacia Larrakia Community and the WwTP with the main section of town being approximately 800 m from the river (PWC 2021b). Due to continuous daily discharges from Manton Dam, the river is expected to have a shallow flow year-round. During the Wet Season the river flows above the concrete covert and restricts access to the WwTP.

Historically, evidence of the tertiary pond having an overflow event during major storm events has previously been observed (PWC 2021b). However, it is now theorised that due to a change in population of the community, the pond no longer overflows at all. It is also unknown that if any discharge that occurs will have the capacity to exit the licenced facility, reach the river, or infiltrate into the immediate bushland (PWC 2017).

During the ERA inspection, evidence of crocodile activity was observed within the WwTP and in the surrounding environment. Crocodile presence indicates an unlikely use of recreational use of the river. The WwTPs essential services officer has also reported no observation or evidence of any recreational activities at the river supporting this claim (PWC 2017). The WwTP is not located within a groundwater production bore wellhead protection zone (PWC 2021c).

Figure 8. Rock Spillway located on pond 4 (PWC 2025)

Figure 7. Receiving environment of discharge from WwTP (PWC 2025)

Figure 5. Manton River causeway located near WwTP (PWC 2025)

Figure 6. Acacia Larrakia Dry season levels (PWC 2025)

Acacia Larrakia is located on the outer border of the Adelaide River Coastal Floodplain site of conservation significance number 12 and contains 24 threatened flora and fauna species (*Aus Gov, 2025*). 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. Migratory species have been highlighted in bold.

Table 1: Conservation status of species at risk from Acacia Larrakia WwTP (Department of Climate Change, Energy, the Environment and Water, 2025).

Common name	Species name	National Status (EPBC)	NT Status (TPWC)
Bird			
Curlew Sandpiper	*Calidris ferruginea*	CE	CE
Red Goshawk	*Erythrotriorchis radiatus*	EN	VU
Australian Painted Snipe	*Rostratula australis*	EN	EN
Gouldian Finch	*Chloebia gouldiae*	EN	VU
Sharp-tailed Sandpiper	*Calidris acuminata*	VU	N/A
Grey Falcon	*Falco hypoleucos*	VU	VU
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	VU	VU
Masked Owl (northern)	*Tyto novaehollandiae kimberli*	VU	VU
Partridge Pigeon (eastern)	*Geophaps smithii smithii*	VU	VU
Mammal			
Nabarlek (Top End)	*Petrogale concinna canescens*	EN	EN
Black-footed Tree-rat, Djintamoonga, Manbul	*Mesembriomys gouldii gouldii*	EN	EN
Northern Quoll, Digul, Wijingadda, Wiminji	*Dasyurus hallucatus*	EN	CE
Ghost Bat	*Macroderma gigas*	VU	N/A
Northern Brushtail Possum	*Trichosurus vulpecula arnhemensis*	VU	EN
Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat	*Saccolaimus saccolaimus nudicluniatus*	VU	N/A
Water Mouse, False Water Rat, Yirrkoo	*Xeromys myoides*	VU	N/A
Northern Brush-tailed Phascogale	*Phascogale pirata*	VU	EN
Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma	*Conilurus penicillatus*	VU	EN
Fawn Antechinus	*Antechinus bellus*	VU	EN
Reptile			
Mitchell's Water Monitor	*Varanus mitchelli*	CE	VU
Northern Blue-tongued Skink	*Tiliqua scincoides intermedia*	CE	N/A
Mertens' Water Monitor	*Varanus mertensi*	EN	VU
Plains Death Adder	*Acanthophis hawkei*	VU	VU
Shark			
Largetooth Sawfish, Freshwater Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish	*Pristis pristis*	EN	VU

CE – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, DD – Data Deficient 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 Acacia Larrakia WwTP

Values	Receptors	
Cultural/Human Health	Human	Swimming/wading Visible water quality Sacred sites
Environment	Aquatic	Fish Turtles Crocodiles
	Terrestrial	Wading birds Invertebrates Mammals Reptiles
	Plants	Native Vegetation • Open Woodland

Table 3. Screening level risk assessment for key indicator and stressors associated with Acacia Larrakia 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	Gross pollutants released into the environment and ingested by biota resulting in mortalities and disturbed ecosystems. Gross pollutant accumulation in ponds affecting treatment of wastewater prior to discharge.	Gross pollutants in receiving environment will reduce visual amenity.	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	BOD increase inducing anoxia in receiving environment resulting in biota mortality and disturbed ecosystems.	BOD causing undesirable odours in receiving environment from anoxia-favoured reactions	To conserve biota and ecosystems in surrounding environment	To maintain oxygen levels in the environment sufficient to prevent production of odours.	The average concentration of BOD in the discharge of Acacia Larrakia WwTP is 9.1 mg/L. As BOD is present in the discharge, it is determined at a screening level that a risk is present and further investigation is necessary.	Yes
Nutrients (nitrogen and phosphorus)	Increase in nutrient concentrations	That nutrients are leading to excessive 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 ecosystems.	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 average concentration of free ammonia in the discharge of Acacia Larrakia WwTP is 0.7 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 pathogen concentration in the discharge of Acacia Larrakia WwTP is 31/100mL. 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.

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.

4.2 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 Acacia Larrakia WwTP discharge.

Hypothesis	Consequence	Likelihood		Inherent Risk Ranking	
Environmental					
BOD is leading to oxygen depletion in the environment resulting in **loss of biota** and **changes to ecosystem structure**.	Median BOD for the most recent monitoring period was 9.1 mg/L. In the improbable event of a discharge, volumes would be extremely low. The estimated dilution ratio of 1:4320 would mean the final contribution from the discharge would be 2.11 µg/L 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 any discharge occurring at all has been calculated to be improbable. In the event of a discharge, post-dilution BOD contribution would be extremely low and highly unlikely to induce anoxic conditions which would disrupt ecosystems or cause any biota mortality, especially due to the low volume discharges that would occur.	Unlikely	Low
Free ammonia is resulting in **toxicity to aquatic organisms** in water and sediments.	Ammonia median was 0.7 mg/L for the monitoring period. However, as the pH of the effluent is high the ANZECC guideline trigger value for ammonia to prevent environmental harm in freshwater ecosystems is 0.18 mg/L at effluent conditions (ANZECC & ARMCANZ, 2000). Post-dilution would both correct pH (ANZECC guideline raised to 1.18 mg/L at receiving environment conditions) and reduce concentration of ammonia (0.162 µg/L). These levels are not high enough to cause biota mortality or disturbed ecosystems and will have minor/insignificant effects to environment depending on discharge volume.	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes. In the event of a discharge, post-dilution ammonia contribution would be extremely low and highly unlikely to cause biota mortality or disturbed ecosystems, especially due to the low volume discharges that would occur.	Unlikely	Low
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.	The WwTP contributes very low levels of nitrogen and phosphorus through theoretical discharge (0.5 mg/L and 0.3 mg/L, respectively). These concentrations are above the ANZECC screening trigger values (ANZECC & ARMCANZ, 2000) for nutrients which means a risk is present. Post-dilution concentrations of nitrogen and phosphorus (0.116 µg/L and 0.0694 µg/L, respectively) are too low to cause any effects to the environment as are now far below the screening values. No eutrophication/ algal blooms or scums were observed within the creek, which is an indicator or excess nutrient loads.	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes and nutrients may filter out into soil or be utilised by vegetation within immediate discharge area. River has continuous flow in dry season. Based on the sampling results to date, PWC considers that the likelihood of nuisance plant growth as the result of the WwTP would be unlikely. Ongoing sampling will assist to characterise discharge quality.	Unlikely	Low
Cultural/ Human Health					
BOD is leading to odours resulting in the **reduction of amenity** in the receiving environment.	Access to the discharge point is possible; however, observations during ERA inspection suggest minimal cultural beneficial uses of the receiving environment. It is assumed minimal recreation activities occur in the river due to the evidence of crocodile presence found during most recent site inspection (PWC 2021, Campbell 2012, PWC 2025c). Post-dilution concentrations are insignificant compared to an expected BOD concentration of unpolluted waterways (K.S. Schmitz, 2025) and are unlikely to cause anoxia in receiving environment leading to odour-causing, anoxia-favoured reactions.	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes. BOD concentrations post-dilution are unlikely to cause anoxia in receiving environment leading to odour-causing, anoxia-favoured reactions. This is supported by a lack of odour whilst inspecting the site and receiving environment (PWC 2025c).	Unlikely	Low
Nutrients are 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.	Minimal cultural beneficial uses of the receiving environment observed. The nutrient contributions by the WwTP into the surrounding environment is not high enough to cause a significant harmful algal bloom that will cause shellfish to accumulate biotoxins (J.K. Andres *et al*, 2019).	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes. The likelihood of any algal growth occurring is reduced by the distance from the river paired with the dilution that would occur at the river itself. Along with, local knowledge of shellfish harvesting seasons. 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).	Unlikely	Low
Nutrients are resulting in the **reduction of amenity** of receiving environment through **reduction in water clarity**, objectionable **discolouration** and **odours**.	No/minimal cultural beneficial uses surrounding the receiving environment was observed or reported by the Australian government (Aus Gov, 2025). The nutrient contributions from the WwTP are not high enough to cause any noticeable effects in the receiving environment.	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes. The likelihood of any nuisance algal growth occurring is reduced by the distance from the river paired with the dilution that would occur at the river itself. Changes in colour/odours would also be unlikely due to low discharge volumes and significant dilution.	Unlikely	Low

Pathogens are leading to the **contamination of water** resulting in a public health risk through primary and secondary contact recreation.	The receiving environment is to ground and 275m distance to the river. No/minimal cultural beneficial uses surrounding the receiving environment was observed or reported by the Australian government (Aus Gov, 2025). The area is identified as having minimal cultural beneficial uses for primary and secondary recreation and shellfish consumption in the freshwater river. Community road and culvert along road is upstream of WwTP.	Minor	Likelihood of any discharge occurring at all has been calculated to be improbable. Stressors are not typically observed with small discharge volumes. Likelihood of recreational use is unlikely due to lack of evidence or reported use. 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 identified environmental and cultural receptors within the receiving environment of Acacia Larrakia WwTP. The key stressors were assessed in this report and their individual risks to said identified receptors found in the receiving environment. The stressors analysed included BOD, Nutrients, free ammonia and pathogens.

Risk characterisation shows that all assessed stressors pose low risks under current operating conditions. Effluent quality is stable, and the secured pond facility provides reliable containment. No evidence was found to suggest adverse impacts to aquatic ecosystems, terrestrial fauna, cultural uses, or public health. The discharge regime is considered sustainable and appropriately managed. Evidence strongly suggests that the ponds do not discharge to the environment.

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

- Collate data in preparation to propose surrendering the waste discharge licence
- Incorporate findings into Performance Improvements Plans
- Update the ERA and conceptual site model as new data becomes available

References

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Appendices

Number	Title
Appendix 1	Acacia Larrakia Conceptual Site Model
Appendix 2	Power and Water Risk Matrix
Appendix 3	Water Quality Results and Dilution Ratio Calculation for Acacia Larrakia WwTP

Appendix 1 – Acacia Larrakia Conceptual Site Model

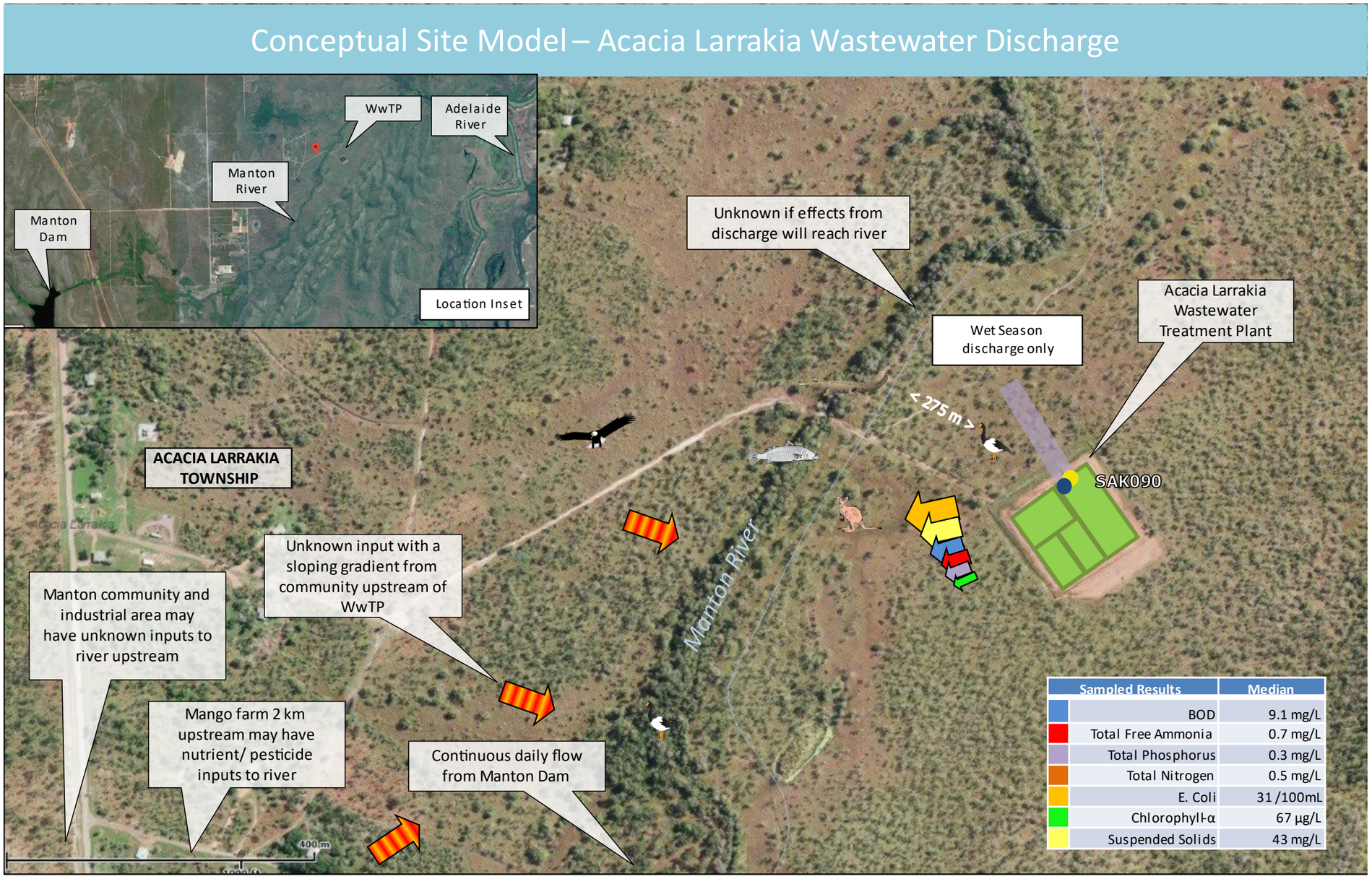

Figure 9. Conceptual site model for the Acacia Larrakia WwTP

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 – Water Quality Results and Dilution Ratio Calculation for Acacia Larrakia WwTP

The sewage treated at the Acacia Larrakia Wastewater Treatment Plant (WWTP) undergoes a comprehensive secondary treatment process before being stored in a large tertiary evaporation pond. Traditionally, discharge ratios are used to calculate the risk of environmental effects of any effluent post-discharge into a water body. However, as it has been observed that the ponds do not discharge into the environment, discharge data is absent, thus, a true ratio cannot be calculated.

For the purpose of assessing the environmental risk of the waste constituents within the effluent in the improbable event of a discharge, a theoretical discharge ratio has been calculated below. This calculation was based on a daily discharge volume of 1 kL into the receiving environment and its known flow rate. This estimated dilution ratio represents a worst-case scenario, considering effluent discharge encountering the creek during dry or no-rain conditions.

Table 6 Theoretical discharge volume calculations for WwTP

River daily flow volume (kL/Day) (PWC 2021)	Average Daily Pond Outflow (kL/Day)	Dilution Ratio
4320	1	1:4320

Table 7. Summary of PWC wastewater quality results for monitoring period

Sample Location/Asset: SAK090 pond 4 outlet		
	Median	95th Percentile
Biological Parameters		
Biological Oxygen Demand (mg/L)	9.1	12.4
Chlorophyll-a (ug/L)	67	220
Nutrient Parameters		
Ammonia (mg/L)	0.7	1.22
Total nitrogen (mg/L)	0.5	1.24
Oxidised Nitrogen (mg/L)	0.1	0.1
Total Phosphorus (mg/L)	0.3	1.94
Pathogen Indicators		
Escherichia coli (MPN/100 mL)	31	355
Physio-chemical Parameters		
Suspended Solids (mg/L)	43	68.4