2025 Environmental Risk Assessment – Minjilang Wastewater Treatment Plant WDL 233-02

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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 ERA for the Minjilang WwTP, prepared in accordance with Waste Discharge Licence 233-02, evaluates the environmental risks associated with the discharge of secondary-treated effluent to a secured an unnamed tidal creek that flows into Mission Bay.

Effluent monitoring demonstrates consistent secondary treatment performance, with low concentrations of BOD, nutrients, and free ammonia. This indicates an overall sufficient effluent quality for discharge into vegetation which bears a tidal creek. Several site inspections have shown no evidence of overflows or detrimental effects to the receiving environment.

The unnamed creek flows directly into Mission Bay which is part of the Arafura Sea. A dilution assessment indicates a worst-case dilution ratio of approximately 1:5435, confirming that any influent reaching the river would be reduced to concentrations unlikely to cause environmental harm or affect any cultural use.

Overall, the ERA concludes that the Minjilang WwTP presents a low risk to cause any effects into the environment, including any risks to environmental and cultural benefits of the environment identified in this report. Treatment has been identified to be effective and natural attenuation processes mitigating potential impacts of discharge. Continued monitoring is recommended to maintain data integrity and support ongoing risk management.

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1. Introduction

PWC operates the Minjilang WwTP pursuant to Waste Discharge Licence (WDL) 233-02 issued on 11 December 2021. This WDL allows for continuous discharge of secondary treated sewage effluent from an authorised discharge point to an unnamed tidal creek that drains into Mission Bay in the Arafura Sea. Minjilang is offshore in the Top End of the Northern territory and has GDA94 coordinates of Lat -11.149 Lon 132.579. It is situated on Croker Island, 250 km northeast of Darwin (Figure 1). Minjilang has an estimated population of 311 (ABS 2021). The wastewater treatment plant (WwTP) is located approximately 550 m north of the Minjilang Township (Figure 2).

Figure 1. Minjilang WwTP Location (Google Earth Pro, 2025)

Figure 2: Minjilang WwTP and Community locality (Google Earth Pro, 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 WDLs 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.

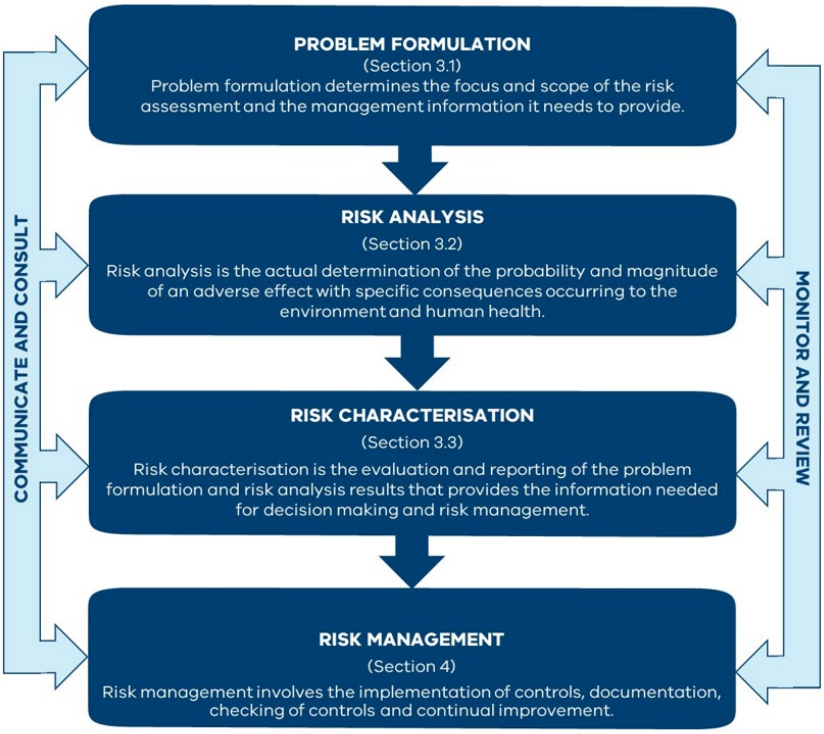

Figure 3: Risk Assessment framework for wastewater discharges to waterways (Victoria EPA, 2025)

2.1 Limitations

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

- Gaps in monitoring data due to dangerous fauna presence leading to assessments using an incomplete dataset;
- Limited historical 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 Minjilang Wastewater Treatment Plant

The community utilises a pressure fed sewer reticulation system which pumps raw sewage from the community to the WwTP (Figure 4). The Minjilang WwTP uses 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 1979 (PWC 2021a) and consists of one primary facultative pond which gravity feeds into a secondary maturation pond. The final pond contains a concrete overflow pit where effluent flows out into the outfall pipe into nearby vegetation (figure 5). The inlet to the pond is fitted with a macerator, though the majority of 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.

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 233. Samples of the final maturation pond outlet are currently conducted on a quarterly basis. A summary of the results is provided in Appendix 3, table 7.

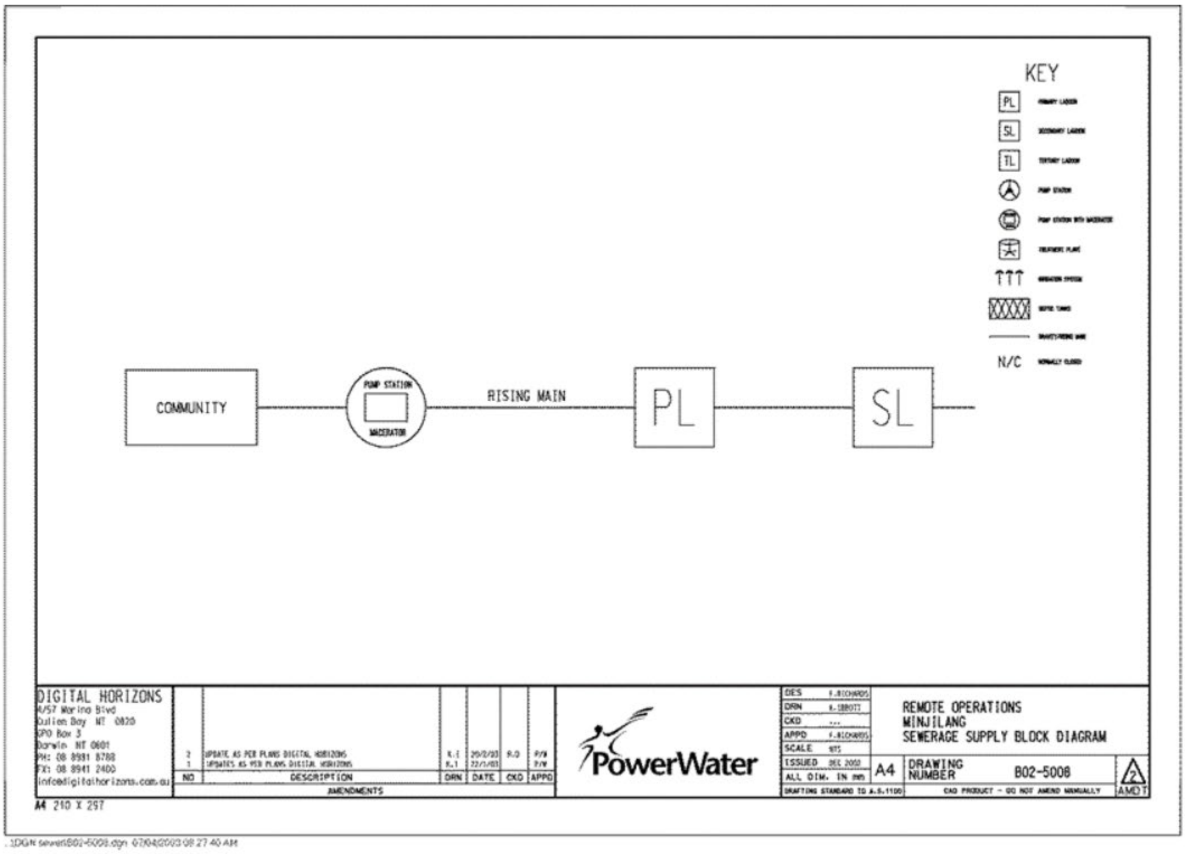

Figure 4: Minjilang wastewater collection and treatment configuration.

Figure 5: Image of concrete effluent discharge pit (PWC 2021b)

Figure 6: Minjilang WwTP Discharge Point (PWC 2021b)

3.2 Discharge Regime

Discharge from the facility occurs from a gravity outfall main approximately 90 m in length located on the north-eastern corner of the facility. From observations during site inspections discharge is thought to be more intermittent during the year (seasonal), with flow occurring into nearby vegetation (Figure 6).

3.3 Pond Performance

Waste Stabilisation Ponds offer a cost-effective wastewater treatment solution in warm climates with ample land. Though driven by solar energy, the process complexity requires appropriate pond system design and maintenance for optimal treatment. Inlet monitoring has been introduced which allowed the performance of the ponds to be assessed numerically, introducing a more in-depth operational assessment of the facility and its discharge.

Listed below are the removal efficiencies of Minjilang WwTP derived from the data medians for the most recent monitoring period:

- Biochemical Oxygen Demand (BOD): **-8.0%**
- Free Ammonia (NH_3-N): **55.91%**
- Total Nitrogen (TN): **55.32%**
- Total Phosphorus (TP): **22.62%**
- *E. coli:* **49.37%**

The ponds provide a centralised treatment barrier that prevents direct raw sewage contamination of the receiving environment and have an important role in the protection of both surrounding environmental and public health in this context. It has been identified that issues with sampling have occurred throughout the monitoring period due to safety concerns around crocodile presence at the site. As such, the assessment made above was from an incomplete, non-reflective dataset and is subject to inaccuracies. Removal of waste constituents is still occurring; however, a better assessment should be undertaken in the future when historical and complete data is available.

3.4 Receiving Environment

The immediate receiving environment consists of open forest and closed tussock grassland including Melaleuca and Eucalyptus species (DENR 2018). The area where the discharge pipe ends (as per design) contains riparian vegetation that forms part of a tidal creek that drains into Mission Bay, part of the Arafura Sea (Figure 12). From GPS imagery, the creek extends approximately 500 m from the discharge point to the Bay. It is unknown if there is a permanent creek present, and if the discharge reaches the Bay. Sections of greener vegetation observed adjacent to the WwTP in the Dry Season suggests some effluent drains into a nearby culvert and discharges to ground within the immediate area, shown below (Figure 7).

Figure 7: Culvert located nearby the WwTP where discharge pipe occurs (PWC 2021b)

The exact location of the discharge point is only viable using google docs software due to access issues caused by dense vegetation (Figure 8). The Essential Services Operator previously confirmed that the ability to gain in-situ information at the receiving environment of Minjilang WwTP is still difficult; an inspection of the creek nearby is still unable to be conducted safely. Further desktop assessment is to be carried out to confirm and record information regarding the final discharge point.

The site is neither a Ramsar Wetland nor a world/national heritage site (Aus Gov, 2025), however, it is on the border of the conservation site identified on Crocker Island (DENR 2018). The receiving environment is considered to have experienced minor disturbance due to the lack of vehicle tracks and observed recreational use of the area and is considered a relatively pristine area with conservation values identified on Crocker Island (DENR 2018). A substantial wild horse population is also present on the Island, with horses observed at the WwTP. This is not an area which is commonly used by local community members for recreation and was difficult to access; and if so, the wastewater discharge would be limited to the Wet Season with significant rainfall dilution. Due to the presence of crocodiles, it is considered unlikely that recreation such as swimming would occur within this area (Campbell 2012). Other recreational activities such as fishing, washing food utensils or drinking water have been observed to occur further south, closer to the community by the local Essential Services Officer (ESO) (PWC 2021b) (Figure 9).

Figure 8: Dense vegetation within disposal area of Minjilang WwTP (PWC 2021b)

Figure 9: Recreation area south of Minjilang WwTP (PWC 2021b)

Minjilang is located within the Croker Island Group site of conservation significance number 11 (Appendix 4, figure 12) and has recorded 31 threatened flora and 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 recorded in proximity to the Minjilang 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
Eastern Curlew	*Numenius madagascariensis*	CE	CE
Sharp-tailed Sandpiper	*Calidris acuminata*	VU	N/A
Common Greenshank	*Tringa nebularia*	EN	N/A
Greater Sand Plover	*Charadrius leschenaultii*	VU	VU
Nunivak Bar-tailed Godwit	*Limosa lapponica baueri*	EN	CE
Little Tern	*Sternula albifrons*	VU	N/A
Red Knot, Knot	*Calidris canutus*	VU	EN
Mammal			
Blue Whale	*Balaenoptera musculus*	EN	N/A
Australian Snubfin Dolphin	*Orcaella heinsohni*	VU	N/A
Australian Humpback Dolphin	*Sousa sahulensis*	VU	N/A
Ghost Bat	*Macroderma gigas*	VU	N/A
Bare-rumped Sheath-tailed Bat	*Saccolaimus saccolaimus nudicluniatus*	VU	N/A
Water Mouse	*Xeromys myoides*	VU	N/A
Northern Brush-tailed Phascogale	*Phascogale pirata*	VU	EN
Reptile			
Northern Blue-tongued Skink	*Tiliqua scincoides intermedia*	CE	N/A
Olive Ridley Turtle	*Lepidochelys olivacea*	EN	VU
Loggerhead Turtle	*Caretta caretta*	EN	VU
Leatherback Turtle	*Dermochelys coriacea*	EN	CE
Flatback Turtle	*Natator depressus*	VU	N/A
Hawksbill Turtle	*Eretmochelys imbricata*	VU	VU
Green Turtle	*Chelonia mydas*	VU	N/A
Shark			
Largetooth Sawfish	*Pristis pristis*	EN	VU
Speartooth Shark	*Glyphis glyphis*	CE	VU
Northern River Shark	*Glyphis garricki*	EN	EN
Great White Shark	*Carcharodon carcharias*	VU	N/A
Dwarf Sawfish	*Pristis clavata*	VU	VU
Green Sawfish	*Pristis zijsron*	VU	VU
Whale Shark	*Rhincodon typus*	VU	N/A

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 10) 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 Minjilang WwTP

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

Table 3. Screening level risk assessment for key indicator and stressors associated with Minjilang 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 leading to mortality 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 Minjilang WwTP is 54 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 Minjilang WwTP is 4.1 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 Minjilang WwTP is 29925/100mL. 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 Minjilang 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 54 mg/L. In the event of a discharge reaching the coastal water, volumes would be low relative to receiving environment. The estimated dilution ratio of 1:49462, this would mean the final contribution from the discharge which is insignificant compared to an expected BOD concentration of unpolluted marine waterways (M. Elkaiek- Urzola et al, 2019). Thus, discharge is unlikely to cause anoxia in receiving environment causing detrimental effects.	Minor	In the event of a discharge, post-dilution BOD contribution would be low and unlikely to induce anoxic conditions which would disrupt ecosystems or cause any biota kills, especially due to the relatively low volume discharges that would occur.	Unlikely	Low
Free ammonia is resulting in **toxicity to aquatic organisms** in water and sediments.	Ammonia median was 4.1 mg/L for the monitoring period. The ANZECC guideline trigger value for ammonia to prevent environmental harm in saltwater ecosystems is 3.2 mg/L at effluent conditions (ANZECC & ARMCANZ, 2000). Post-dilution would reduce concentration of ammonia to a negligible level which would be unlikely to cause biota mortality or disturbed ecosystems.	Minor	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 (4.2 mg/L and 3.25 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 are far below the screening values and considered to have negligible impact to the environment. No eutrophication/ algal blooms or scums were observed within the creek, which is an indicator or excess nutrient loads.	Minor	Stressors are not typically observed with small discharge volumes and nutrients may filter out into soil and 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.	Site inspections found that access to the discharge site is not likely due to heavy vegetation. This paired with distance from the community and presence of dangerous fauna supports hypothesis that minimal recreational activities occur in the area (PWC 2021b, Campbell 2012). Post-dilution concentrations are insignificant compared to an expected BOD concentration of unpolluted waterways (M. Elkaiek- Urzola et al, 2019) and are unlikely to cause anoxia in receiving environment leading to odour-causing, anoxia-favoured reactions.	Minor	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. In the improbable event that any reactions would occur, concentration produced would be negligible and wouldn't be detectable.	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 post-dilution into the surrounding environment is low and unlikely to cause a significant harmful algal bloom that will cause shellfish to accumulate biotoxins (J.K. Andres *et al*, 2019).	Minor	Stressors are not typically observed with small discharge volumes. The likelihood of any algal growth occurring is reduced by the dilution that would occur at the creek. 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). It is not expected that community members will utilise the discharge area due to dense vegetation and recreational areas being located south, closer to community.	Minor	Stressors are not typically observed with small discharge volumes. The likelihood of any nuisance algal growth occurring is reduced by the dilution that would occur at the creek. 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.	No/minimal cultural beneficial uses for primary and secondary recreation surrounding the receiving environment have been observed or reported by the Australian Government (Aus Gov, 2025). It is assumed minimal recreation activities occur in the area due to the distance to community and the presence of dangerous aquatic animals (PWC 2021b, Campbell 2012).	Minor	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

This ERA identified environmental and cultural receptors within the receiving environment of Minjilang 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, discharge volumes are small, and the inaccessible discharge site provides reliable containment. Pathways to tidal creek are limited to high tides, during which substantial dilution would occur.

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. It is important to outline that monitoring data for this period had substantial gaps due to issues with a crocodile inhabiting the ponds.

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

- Continue monitoring quality of wastewater discharged to the environment
- Address dangerous fauna in ponds in order to continue monitoring as required
- Incorporate findings into Performance Improvements Plans
- Update the ERA and conceptual site model as new data becomes available

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Appendices

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

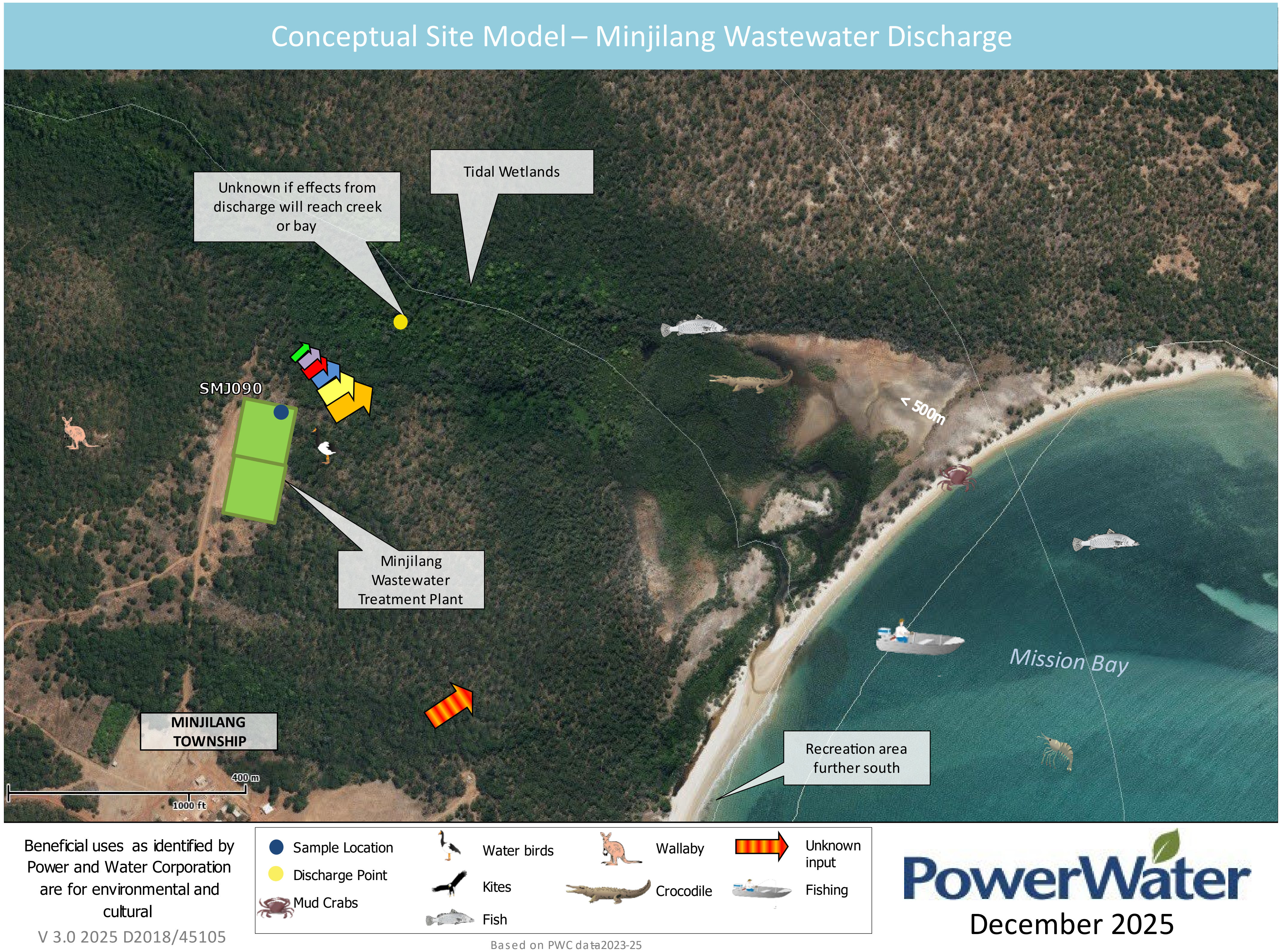

Figure 10: Conceptual site model for the Minjilang WwTP

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

Appendix 3 – Water Quality Results and Dilution Ratio Calculation for Minjilang WwTP

Dilution ratio calculated using the average daily pond outflows taken from estimations using population.

In the rare and improbable scenario where effluent discharge could potentially reach the nearby tidal creek, we rely on estimated data to establish a dilution ratio. This estimated dilution ratio represents a worst-case scenario, considering the possibility of effluent contact with the tidal wetlands during high tide levels.

Table 6. Theoretical discharge volume calculations for WwTP

River daily flow volume (kL/Day) (PWC 2021)	Average Daily Pond Outflow (kL/Day)	Dilution Ratio
445161	81.9	1:5435

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

Sample Location/Asset: SMJ090 Minjilang Pond 2 Outlet		
	Median	95th Percentile
Biological Parameters		
Biological Oxygen Demand (mg/L)	54	78.25
Chlorophyll-a (ug/L)	480.5	967
Nutrient Parameters		
Ammonia (mg/L)	4.1	7.65
Total nitrogen (mg/L)	4.2	7.75
Oxidised Nitrogen (mg/L)	0.1	0.1
Total Phosphorus (mg/L)	3.25	4.15
Pathogen Indicators		
Escherichia coli (MPN/100 mL)	29925	105169.5
Physio-chemical Parameters		
Suspended Solids (mg/L)	126	173

Appendix 4 – Crocker Island Site of Conservation Significance

Figure 12: Crocker Island site of conservation significance map (DENR 2018)