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24th September 2021

Jeff Strahan
Managing Director
Water West

Sent via e-mail to: jstrahan@waterwest.com.au

Re: Ningaloo Lighthouse Resort recycled water reuse assessment

Dear Jeff,

Permeate Partners (PP) has been engaged by the Water West (WW) to undertake an investigation into recycled water reuse at Ningaloo Lighthouse Resort (the Resort). This technical memo details the outcomes from the preliminary assessment of the recycled water scheme including:

- Preliminary water balance.
- Model for Effluent Disposal via Land Irrigation (MEDLI) modelling.
- Proposed control measures for the recycled water scheme.

Preliminary water balance

A preliminary water balance has been prepared to determine the expected sewage flows from the Resort and subsequently the recycled water demands. The assumed sewage loading has been applied in accordance with *Supplement to Regulation 29 and Schedule 9 – Wastewater system loading rates*, Department of Health, Western Australia.

The water balance assumes that recycled water is reused within the Resort for:

- Internal reuses including toilet flushing and washing machines.
- Unrestricted irrigation of opens spaces and gardens in the Resort.

The detailed outputs of the preliminary water balance are included in Attachment 1 to this technical memo. The outcomes are summarised below:

- The average sewage flow from the resort is 89kL/day.
- The average recycled water demand for internal reuse is 17kL/day.
- The excess recycled water available for irrigation is 72kL/day.
- There is sufficient irrigated space within the Resort to beneficially reuse all recycled water.

The output graphs in the attachment are explained below:

- **RW destination** shows the recycled water destination in an average year. This graph demonstrates the relatively stable demand related to internal re-use which is directly proportional to the sewage inflow and seasonal irrigation demand on a monthly timestep. The graph also demonstrates that in most months the irrigation demand is greater than the RW supply.
- **MEDLI irrigation demand** shows the annual irrigation demand on a per hectare basis over the 50-year model period. This demonstrates the climatic variability and impact on the irrigation demand over the 50-year model period. The model has been set-up to achieve zero seasonal storage overflow, as such the irrigation area and storage needs to accommodate the lowest irrigation demand scenarios.
- **Seasonal storage volume** models on a daily timestep the volume in the seasonal storage dam for the 50-year model period. This accounts for rainfall and evaporation. For the modelled scenario the storage volume is always below 6.5ML.
- **Storage volume vs Irrigation area** shows the optimisation of the storage volume and irrigation area be sensitivity testing the model at increased or decreased irrigation areas and determining the storage volume required to achieve zero overflow.

MEDLI model

Water, nutrient and salt modelling was undertaken using the MEDLI. MEDLI V2 is a water and nutrient mass balance model originally developed by the Queensland Department of Natural Resources and Mines (now DERM) and the CRC for Waste Management and Pollution Control (Gardner and Davis, 1998). MEDLI is now managed by the QLD Department of Science, Information Technology and Innovation (DSITI) with Version 2 being used for this project. It is capable of simulating storage pond dynamics, irrigation scheduling, plant growth, transpiration and nutrient uptake, soil water and nutrient dynamics and salinity on a daily time step over long periods (greater than 100 years).

MEDLI is widely accepted throughout Australia as the most technically robust tool for simulating the operation of effluent or recycled water irrigation. Fundamental algorithms have been drawn from peer reviewed models and research and importantly, it is a largely first principles bio-physical model. This means it can readily be configured to simulate a range of irrigation schemes across a wide range of receiving environments.

A preliminary MEDLI model has been prepared to provide an indicative irrigation area and recycled water storage that would be required to sustainably irrigate the excess recycled water within the Resort.

The following assumptions were used to develop the preliminary MEDLI model:

Parameter	Units	Value	Comments
Model period	Years	1971-2020	
Soil Profile	-	Sand	Default soil profile in MEDLI based on observed site conditions
Turf type	-	Kikuyu	Default turf type in MEDLI.
Irrigation area	Ha	2	Nominal design point from optimisation.
Irrigation trigger	mm	8/2	Irrigation triggered at a soil water deficit of 8mm and ceased 2mm from the drained upper limit. Irrigation does occur on days where rainfall exceeds 1mm.
Seasonal/wet weather storage	ML	6.5	Nominal design point from optimisation.
Total Nitrogen concentration	mg/L	15	Final concentration to be confirm based on final agronomic requirements.
Total Phosphorous concentration	mg/L	5	Final concentration to be confirm based on final agronomic requirements.
Total dissolved solids concentration	mg/L	640	Expected recycled water TDS.

MEDLI uses actual weather data for the for the model location. As such the model accounts for the climatic fluctuations in irrigation demand to allow for the scheme to be designed to meet the “worst case” scenario associated with the lower irrigation demand periods. The irrigation in the model is only applied to meet the needs of the irrigated areas to ensure the sustainable operation of the scheme.

The detailed outputs of the preliminary MEDLI model are included in Attachment 2 to this technical memo. The key outcomes are summarised below:

- No overflow of recycled water from the seasonal/wet weather storage occurred during the model period.
- The outputs do show a small amount of leaching, however it must be noted that is almost entirely due to an initial flush of nutrient that is assumed to be present in the existing soil profile (refer soil profile assumptions in the table above). When the model stabilises and the vegetation is established there is no nutrient leaching. (Refer to the Annual nutrient leachate concentration graph on Page 19 of Attachment 2).
- No saturation of Phosphorous in the soil profile occurred during the model period.
- No salinity impacts on the crop performance occurred during the model period or beyond the rootzone.
- No irrigation run-off occurred during the model period.

Baseline monitoring of the groundwater has been undertaken as part of a separate study (Pennington Scott, September 2021). There is not anticipated that there is any impact on the groundwater due to the recycled water being beneficially reused as demonstrated in the MEDLI model. Additionally:

- There is significant depth to groundwater (i.e. >10m).
- The relative volume of the aquifer is much greater than the applied recycled water volume.
- The recycled water is high quality.

Proposed controls

The recycled water scheme will be operated in compliance with the relevant requirements of the Department of Health (DoH) and the Department of Water and Environmental Regulation (DWER). Detailed risk mitigation measures, sampling and monitoring requirements will be determined in the detailed design phase of the project however the following would be included as a minimum:

- Nutrient and Irrigation Management Plan (NIMP). The NIMP will outline the controls for managing the irrigation inclusive of:
  - Site controls and observations such as spray drift control, pooling of water, run-off, water logging, rainfall and wind.
  - Irrigated vegetation health.
  - Routine soil sampling against baseline sampling and agronomic requirements.
  - Routine groundwater sampling against baseline sampling results for the local groundwater.
  - Routine recycled water quality sampling on the discharge of the recycled water treatment plant.
  - Irrigation records of volumes and locations applied.
  - Management of weeds.
- DoH approved Recycled Water Quality Management Plan (RWQMP) inclusive of:
  - Routine recycled water sampling and monitoring requirements.
  - Recycled water treatment plant process requirements and critical control points.
  - Recycled water treatment plant operational and maintenance requirements.

The DWER operating licence will capture the reportable sampling locations, parameters and frequencies along with the reporting requirements for the scheme.

The design of the irrigated areas within the Resort in relation to turf and plant selection will need to give consideration to the recycled water quality and the requirements of the water and mass balance.

Baseline groundwater monitoring has been undertaken (Pennington Scott, September 2021) at various locations in and around the Resort. The baseline results showed low concentrations of Total Phosphorous. The level of Total nitrogen was more variable across the sampling suite.

The irrigation of recycled water will be undertaken only to meet the water and nutrient (Nitrogen and Phosphorous) demands of the irrigated vegetation. Consequently, there is not expected to be any export of nutrient from the recycled water scheme that will impact the local receiving environment.

Conclusion

The recycled water scheme is designed for **all** recycled water generated to be beneficially reused within the Resort. As such there is not expected to be any impact to the local groundwater quality or surrounding environments. Ongoing monitoring to verify the performance of the treatment infrastructure and the reuse scheme will be used to confirm this outcome in operation. The detailed risk mitigation measures and monitoring requirements will be determined during the detailed design phase in consultation with the DoH And DWER.

Best regards,

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ATTACHMENTS

- Attachment 1 – Ningaloo Lighthouse Resort preliminary water balance
- Attachment 2 – MEDLI output report