

Planning for future wastewater discharges to streams in urban-growth areas, Tasmania

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Key Points

- Future urbanisation may increase the volume of effluent discharges to waterways.
- Simple water quality modelling can be used to quantify any impacts.
- Modelling can appraise STP upgrade quality specifications based on the achievement of water quality objectives and contributions to catchment nutrient loads.

Abstract

Urban growth in the vicinity of Hadspen and Carrick in northern Tasmania is projected to increase significantly as a result of recent rezoning of land east and south-east of Hadspen. The projected growth will result in an increase in sewage inflows to the Carrick Sewage Treatment Plant (STP), requiring upgrade of existing plant infrastructure. This study examined the potential impacts of future wastewater discharges from Carrick STP on water quality in the Meander River and also to whole-of-catchment nutrient loads. We developed a simple model to simulate water quality conditions upstream and downstream of the Meander River on a daily time step for current and future scenarios. We used the model to identify contaminants of concern in the current and future effluent quality and determine the percentage of time water quality would exceed water quality objectives in the Meander River under different seasonal and flow conditions. Risk-based emission limits were recommended for the Carrick STP upgrade based on achievement of WQOs and the contribution to catchment nutrient loads. The outcomes of this study allowed future planning for Carrick STP upgrade to go-ahead with confidence.

Keywords

Wastewater, water quality, urbanisation, modelling, risk assessment

Introduction

Urban growth in the vicinity of Hadspen and Carrick in northern Tasmania is projected to increase significantly as a result of recent rezoning of land east and south-east of Hadspen. The average daily discharge of secondary-treated effluent from Carrick Sewage Treatment Plant (STP) to the Meander River is predicted to double from 600 kL/day to 1200 kL/day.

The Meander River is a major perennial river in the central north region of Tasmania with a catchment area of approximately 160,000 Ha. The Meander River joins the South Esk River immediately upstream of the Trevallyn Dam, which regulates flows into the Tamar River at Launceston.

The objective of this environmental risk assessment study was to describe the potential impacts of future effluent discharges from Carrick STP on the Meander River receiving environment.

Method

The impact of the Carrick STP wastewater discharges on downstream water quality in the Meander River was modelled using a fit-for-purpose water quality model built in Microsoft Excel. The model was built to generate water quality on a daily time-step. Input data included available ambient water quality data to inform initial conditions, daily flow series (gauged data from 2015 to 2017), current and projected wastewater quality and discharge volumes, and risk-based water quality objectives (WQOs). The structure of the model allowed various water quality indicators to be selected from a drop-down box in the worksheet (e.g. nutrients, metals, pathogens and basic physio chemistry) and run through the model simulation.

The model was calibrated for current conditions based on available routine water quality monitoring data. Upstream water quality was informed by regression relationships derived between ambient monitoring data for water quality indicators, flow and season, with the addition of upstream STP inflows from Westbury and Deloraine STP included. Future scenarios were then incorporated into the functionality of the model in a separate worksheet.

The model outputs used the flexible reporting functions in Excel, which were tailored to the project and the risk assessment approach. For example, they include comparative time-series plots of different scenarios, statistics, percentage exceedance curves (for assessment against water quality objectives), report tables and load graphs. All outputs are located within the model and linked to the model, so they automatically update with changes to the water quality indicator of interest or model set-up.

Predicted water quality conditions upstream and downstream of the STP outfall were compared to site-specific water quality objectives (WQOs) and ANZECC toxicant trigger values (TTVs). A low, medium or high risk rating was assigned to depending on the percentage of time WQOs/TTVs were achieved in the receiving environment, according to Table 1.

Table 1 Water quality risk criteria for the percentage of WQOs/TTVs were achieved in Meander River

Risk assessment	Achievement of WQOs (% of time)	Achievement of TTVs (% of time)
Low	>80%	>95%
Medium	50-80%	75-95%
High	<50%	<75%

Results

Contaminants of concern in the wastewater discharges from Carrick STP that required significant dilution in the receiving environment to meet the WQOs, according to the preliminary effluent quality specification, were nitrate and ammonia. Projected future changes in nitrate and ammonia concentrations in the Meander River, downstream of the Carrick STP discharges, were simulated using the water quality model. The results are discussed for each indicator below.

Nitrate

Nitrate concentrations (2.5 mg/L) in the upgraded Carrick STP effluent discharges would cause minimal difference in the Meander River nitrate concentrations downstream of the outfall, compared to upstream. Water quality conditions upstream of the Carrick STP outfall do not currently achieve seasonal WQOs due to point and diffuse catchment inputs. Future Carrick STP discharges would make minimal difference to the achievement of water quality objectives in the Meander River (Figure 1, Table 2). The ANZECC TTV (for protection of 95% of species; 0.7 mg/L) is met greater than 95% of the time upstream of the Carrick STP outfall (Table 3). This will not change with future Carrick STP discharges.

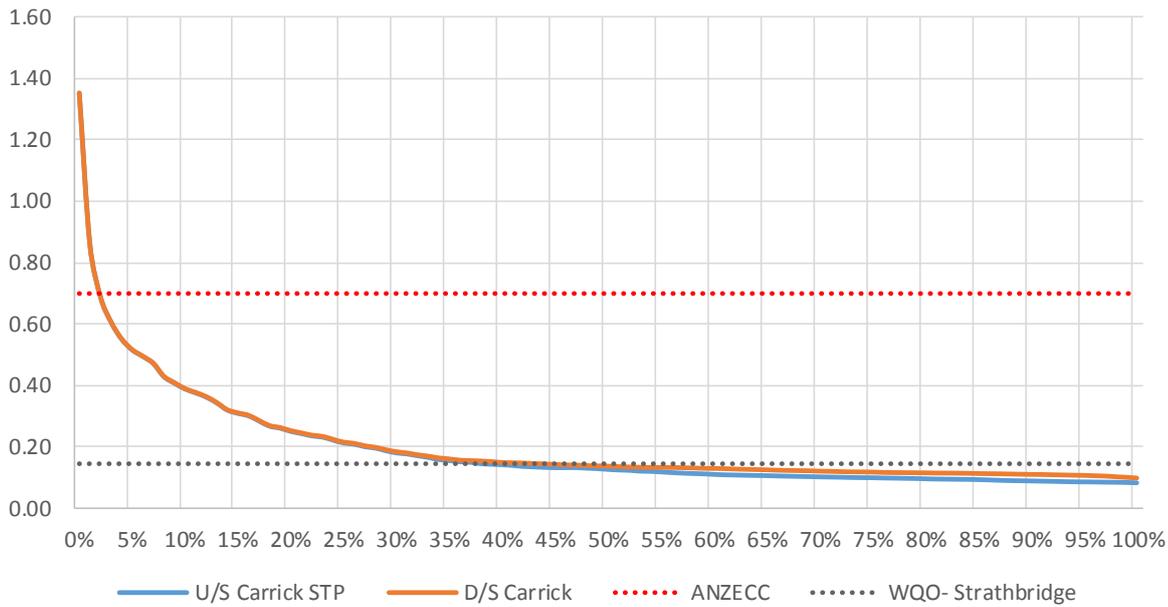


Figure 1 Comparison of the percentage duration of predicted nitrate concentrations (mg/L) in the Meander River upstream and downstream of the Carrick STP outfall

Table 2 Percentage achievement of water quality objectives for nitrate

Percentage achievement of WQOs							
Site	Annual	Summer	Autumn	Winter	Spring	50 th flow	7Q10 flows
WQOs	0.146	0.012	0.07	0.356	0.132	0.146	0.146
US Carrick	62%	0%	0%	69%	49%	96%	100%
DS Carrick	59%	0%	0%	69%	44%	90%	84%

Table 3 Percentage achievement of toxicant trigger values for nitrate

Percentage achievement of TTVs								
Site	TTV	Annual	Summer	Autumn	Winter	Spring	Median flows	7Q10 flows
US Carrick	0.7	98%	99%	99%	95%	99%	100%	100%
DS Carrick	0.7	98%	99%	99%	95%	99%	100%	100%

Ammonia

Ammonia concentrations (2 mg/L) in the upgraded Carrick STP effluent discharges would increase ammonia concentrations downstream of the outfall, compared to upstream. It would reduce the achievement of seasonal WQOs, particularly under low flow conditions in summer and autumn (Figure 2, Table 4). Ammonia is a bioavailable form of nitrogen and will be assimilated rapidly by aquatic plants and algal communities. While the river concentrations will increase downstream compared to upstream, the relatively low concentrations are unlikely to present risks of nuisance plant growth and algal blooms in the flowing receiving environment. Ammonia concentrations will be below the ANZECC TTVs at all times (Table 5).

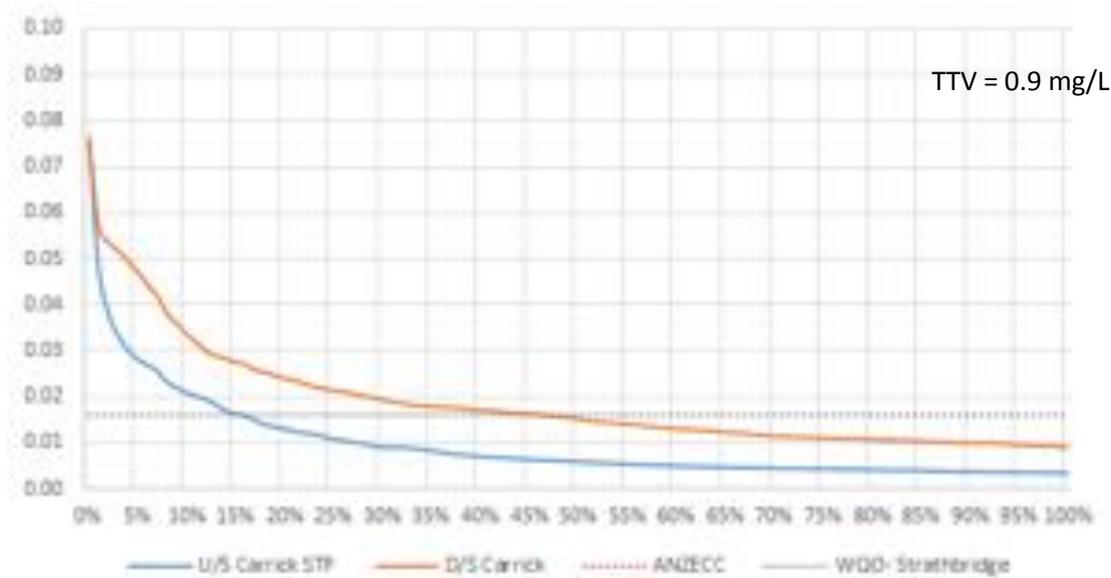


Figure 2 Comparison of the percentage duration of predicted ammonia concentrations (mg/L) in the Meander River upstream and downstream of the Carrick STP outfall

Table 4 Percentage achievement of water quality objectives for ammonia

Percentage achievement of WQOs							
Site	Annual	Summer	Autumn	Winter	Spring	50 th flow	7Q10 flows
WQOs	0.016	0.015	0.012	0.016	0.017	0.016	0.016
US Carrick	70%	97%	85%	60%	87%	100%	100%
DS Carrick	54%	28%	43%	57%	67%	52%	0%

Table 5 Percentage achievement of toxicant trigger values for ammonia

Percentage achievement of TTVs								
Site	TTV	Annual	Summer	Autumn	Winter	Spring	Median flows	7Q10 flows
US Carrick	0.9	100%	100%	100%	100%	100%	100%	100%
DS Carrick	0.9	100%	100%	100%	100%	100%	100%	100%

Contribution of Carrick STP discharges to Trevallyn Dam loads

Trevallyn Dam is a very important source of drinking water for Launceston. It is also used extensively for recreational activities including water skiing, kayaking, swimming and fishing. Trevallyn Dam also supports a commercial eel fishery (Hydro Tasmania 2010). Trevallyn Dam has a history of blue-green algal blooms that impact on its environmental values, particularly drinking water supplies and recreational users. Catchment nutrient loads, particularly during summer, are one of the main drivers of algal blooms in Trevallyn Dam (Jacobs 2016). Future discharges from Carrick STP would contribute 0.4% of the total nitrogen loads and 0.7% of the total phosphorus loads to Trevallyn Dam (Figure 3). This presents a low risk to Trevallyn Dam.

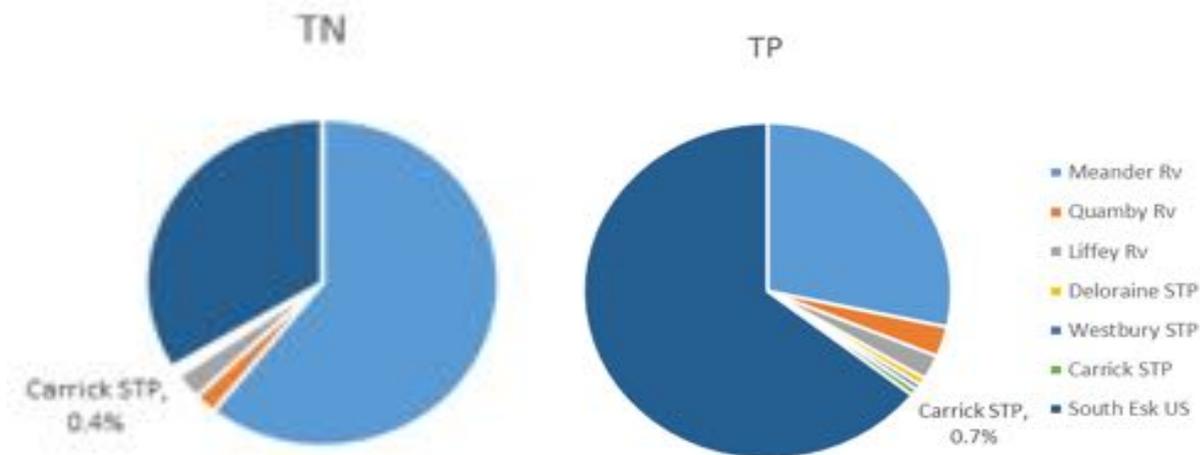


Figure 3 Carrick STP (upgrade) Total nitrogen and total phosphorus load contributions to Trevallyn Dam (average of 2015/16, 2016/17)

Conclusions

The study provided an environmental risk assessment to determine the impacts of the Carrick STP Upgrade on the Meander River receiving environment.

The overall risk to the environmental values in Meander River from the Carrick STP discharge is Low. The risk of nuisance plant growth from nutrient enrichment does increase slightly as the level of dilution from the natural river flow decreases under low flow summer and autumn conditions. However, this presents a low overall risk in the flowing Meander River environment.

Future wastewater discharges from the Carrick STP Upgrade, at the preliminary effluent quality specification, would present a low risk to the Meander River downstream of the outfall.

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Full Paper

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