Wastewater treatment - Membrane Bio-reactor (MBR)

2) Please provide details of the Membrane Bio-reactor (MBR) contingency arrangements, such as additional freeboard or alternative facilities, for use as holding volume in emergency situations.

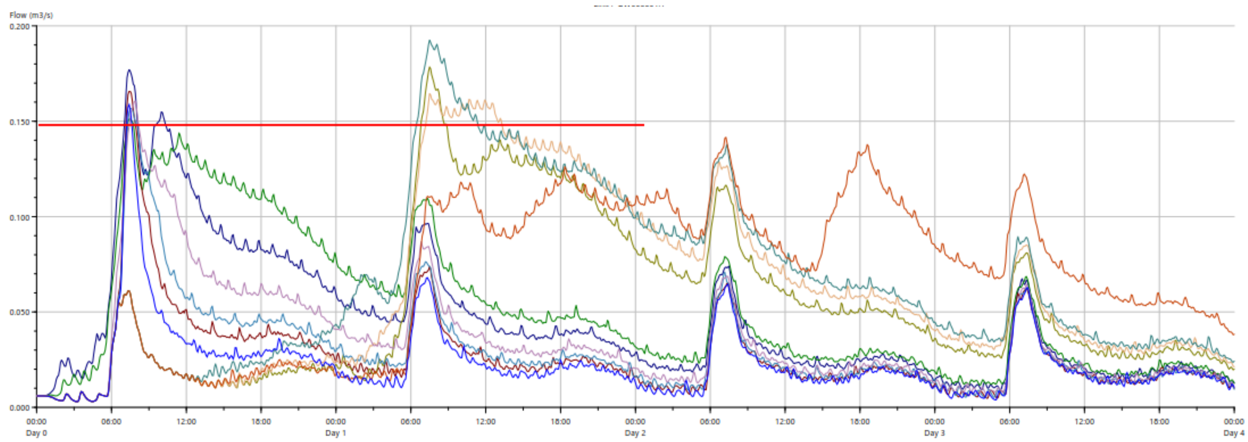
The freeboard in the MBR tanks is 350 mm (difference b/w top of concrete and the level of the overflow weir). The freeboard in the MBR tanks is designed to provide reliable operation and ensure that effluent is not spilled via the overflow if there is a process upset or pump shutdown. However; as the plant has the ability to divert all flows to the lagoons upstream of the MBR, this freeboard will not be required for storage of emergency influent volumes. Should the levels in the MBR exceed the high level value, all excess flow not able to be treated by the MBR will be diverted to the lagoons. Therefore the existing lagoon treatment plant facility will cater for emergency holding situations.

An assessment has been completed to determine the excess flows and volumes that will be diverted to the lagoon treatment plant and stored in the winter storage lagoon under all 1:5 year ARI storm events. Table 1 lists the total volume required in the winter storage to cater for these events, and also the total duration of the excess flow event when emergency storage volume will be utilised.

Table 1: Predicted Emergency Storage Volumes for events greater than 1:5 ARI

Year	**2012**	**2020**	**2030**	**2040**	**2050**
Connected Lots	4250	6250	8750	11250	13750
Emergency storage Volume (ML) required for flows greater than 12.6ML/Day	0.4	0.6	0.9	1.1	1.4
Emergency Storage Inflow Duration (Hrs)	5.7	8.3	11.7	15.0	18.3

Figure 1 shows the modelling output from the InfoWorks network model. Flows greater than 12.6ML/d (roughly 150 l/s) must be stored in the lagoon system, and is shown by the red line.



	Flow Min	Flow Max
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 12hr	0.006	0.177
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 18rh	0.006	0.151
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 2hr	0.003	0.166
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 24hr	0.003	0.178
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 3hr	0.003	0.157
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 36hr	0.003	0.165
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 48hr	0.003	0.193
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 6hr	0.003	0.161
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 72hr	0.003	0.142
>Drouin 2010>Run Group - Design>5yr ARI.I>5yr 1hr	0.003	0.159

Figure 1: Predicted inflows to Drouin WWTP (1:5 year ARI)

The winter storage at Drouin has a total capacity of 230 ML. The working capacity that can be returned back to the MBR plant via the lagoon recycle is approximately 150 ML. The proposed volume that needs to be set aside for emergency inflows from 1:5 year ARI events is less than 1% of the total capacity of the lagoon. It is recommended that Gippsland Water operate the lagoons to always have winter storage at a maximum capacity of 95%. This will allow sufficient storage for the emergency volume, as well as providing further operational flexibility to best manage returning any emergency inflows back to the MBR plant over a period of time while maximising the energy efficiency of the overall process.

3) Please provide details justifying application of a peak wet weather flow factor of 3 x average dry weather flow rate and/or facilities for peak flow equalisation during periods of peak demand.

Typically, it is appropriate to assume that peak wet weather events will have a flow capacity of up to 5 x ADWF (and depending on the region, even higher).

For Drouin, historical information shows that the 5 x ADWF is a reasonable value for a peak wet weather flow event.

If the MBR plant was the only treatment facility operating at Drouin, then it would have been necessary to provide it with a 5 x ADWF hydraulic capacity in order to ensure all flows could be treated via the MBR during wet weather events.

However, as there will be two treatment plants operating in parallel at Drouin (i.e. the existing lagoons and the MBR system), it was determined that a peak hydraulic capacity of 3 x ADWF would provide sufficient capacity for the MBR system, with the lagoons able to take any additional flows under peak wet weather conditions. Anything treated by the lagoon system and not used for irrigation, can be returned to the MBR after the wet weather event via the lagoon recycle system for additional treatment prior to discharge.

Under typical operating conditions, there will be a time-based flow split between the lagoons and the MBR system. The aim of this approach is to minimise the variation in the TKN loading to the MBR system, so that its settings can be optimised for nitrogen removal, in terms of minimal effluent nitrogen for minimal energy usage. Figure 1 shows the diurnal profile of the influent to the Drouin plant. The evening diurnal peak is actually higher than the morning peak as the main industrial contributor (Pure Harvest) discharges most of its wastewater during this time. This also increases the COD load of the evening peak, but does not significantly increase the TKN load during the evening peak. Figure 2 shows how the flows to the MBR and lagoon will vary with time of day. Figures 3 and 4 show the time-based variation in the COD and TKN loads respectively to the MBR and lagoon. The effect of the increased COD load during the evening is due to the Pure Harvest discharge, while the TKN load to the MBR remains relatively constant for most of the day.

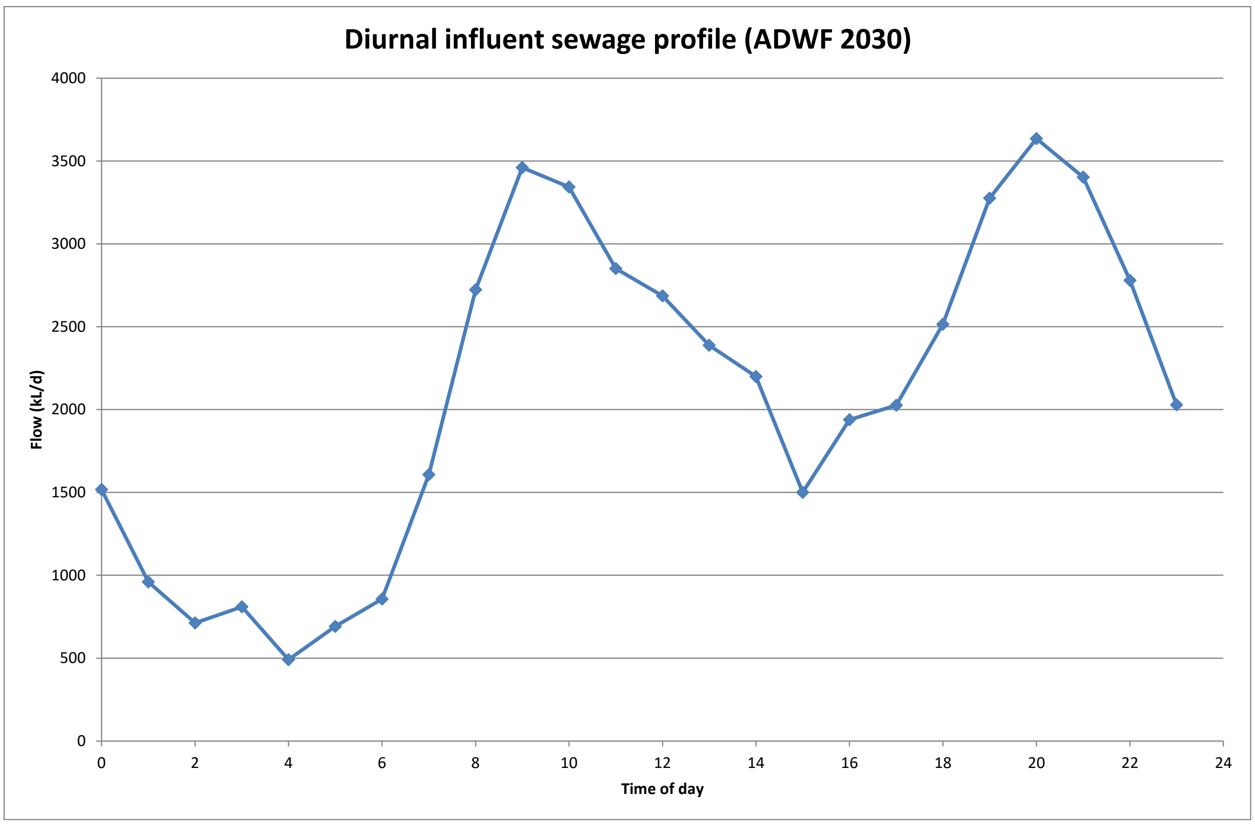


Figure 1: Diurnal sewage profile for Drouin WWTP

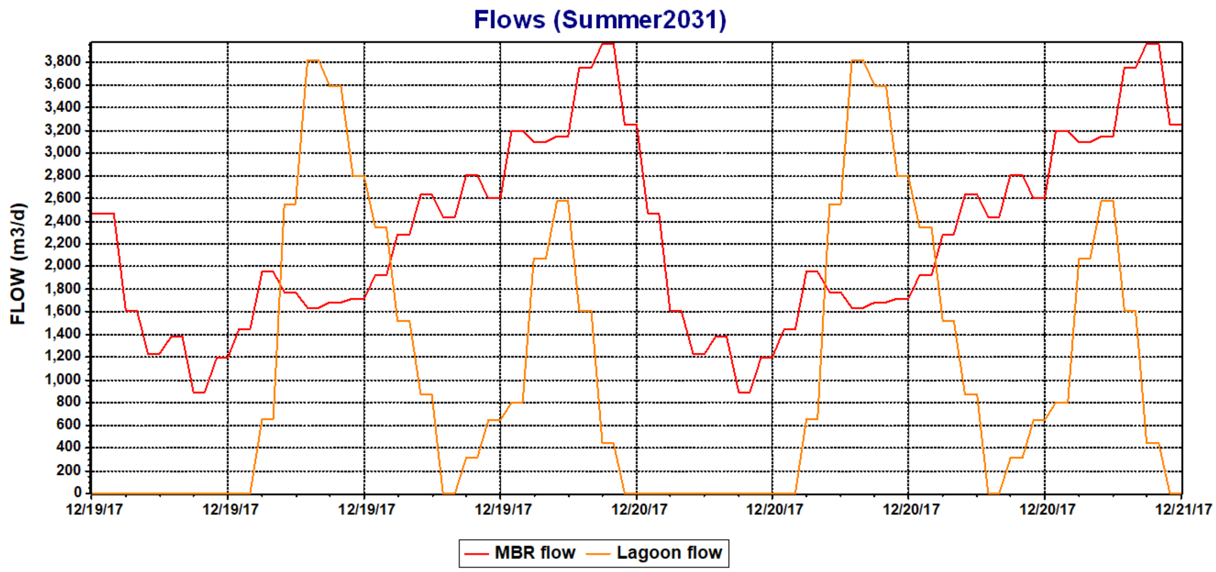


Figure 2: Flow split between MBR and lagoons vs time of day (48 hour cycle shown)

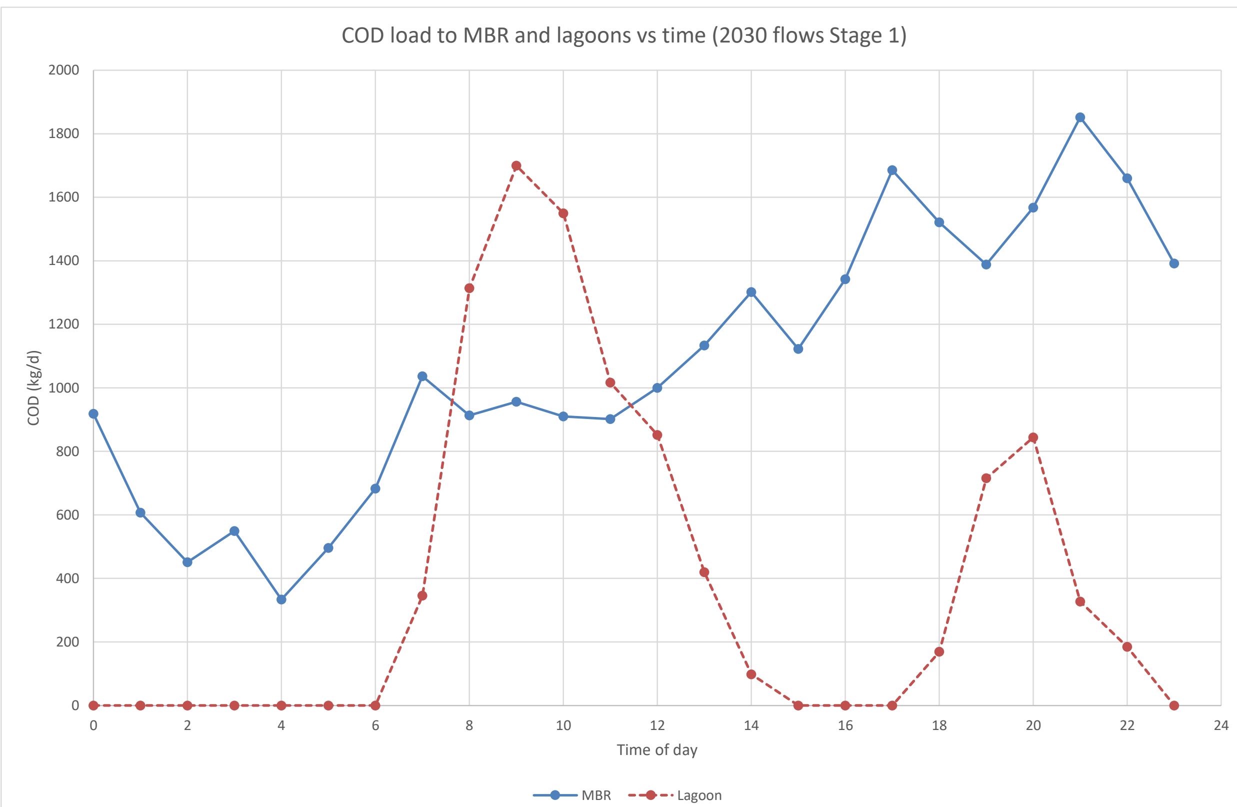


Figure 3: COD load vs time of day for MBR and lagoons

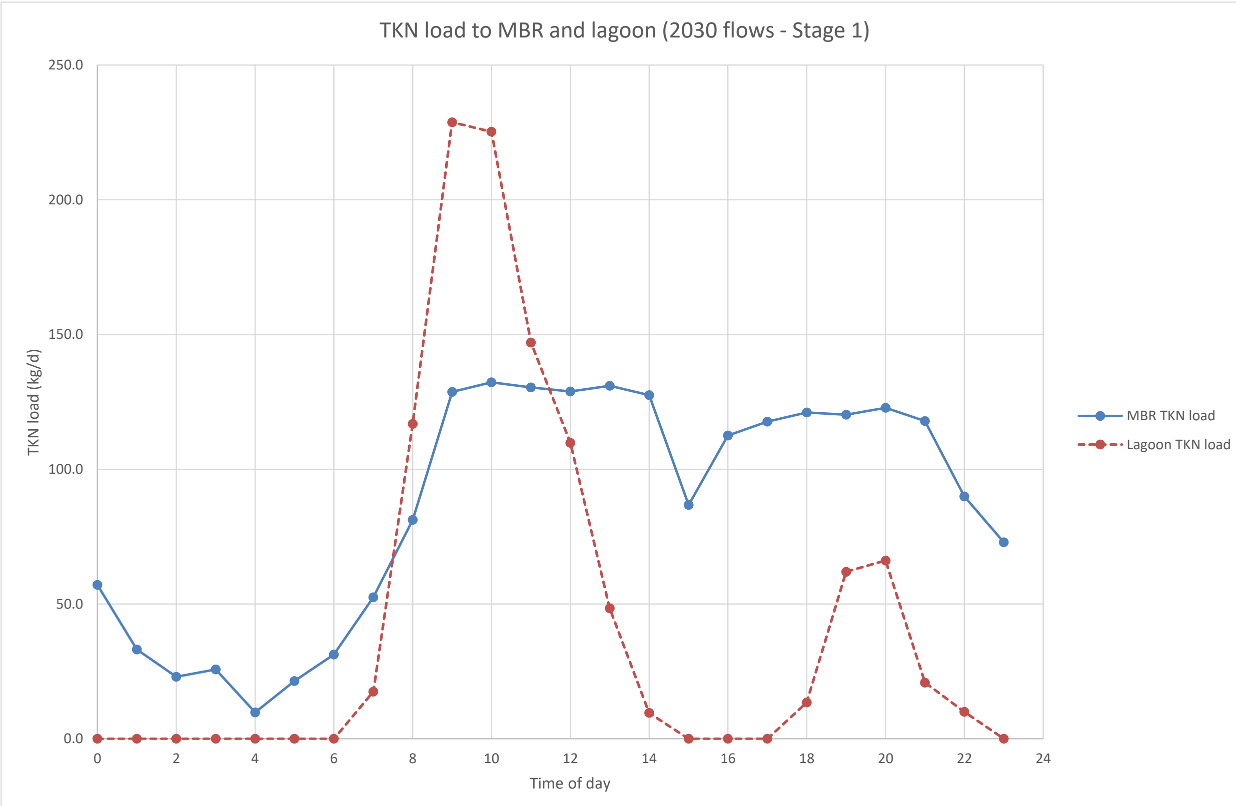


Figure 4: TKN load vs time of day for MBR and lagoons

4) Please provide details of the expected MBR effluent quality, including an assessment of metal concentrations.

The MBR is required to achieve the standards required for discharge to Shillinglaw Creek. These are annual medians and are listed below:

- Ammonia 2 mg/L
- BOD 5 mg/L
- TSS 10 mg/L
- Total N 10 mg/L
- Total P 0.3 mg/L
- E-coli 200 orgs/100 mL.

Table 2 summarizes the expected MBR effluent quality. The values are outputs from BioWin simulations under 2030 summer and winter conditions.

The range column shows the variation within a 24 hour period of the dynamic simulation and reflects the effects of the proposed variations in the flow splits between the MBR and the lagoon that are the proposed method of operating the plant. For the mixing zone consideration, the average values are applicable.

Table 2: Predicted MBR effluent quality

Parameter	Summer		Winter	
	Range	Average	Range	Average
Ammonia	**0.08–0.22**	**0.15**	**0.07–2.35**	**0.6**
Oxidised nitrogen	**1.3–8.0**	**4.2**	**0.3–6.0**	**2.8**
Total nitrogen	**2.9–10.0**	**5.8**	**1.5–9.5**	**4.6**
Total P	**0.01–0.40**	**0.1**	**0.06–0.34**	**0.1**
TSS	**<5**	**<5**	**<5**	**<5**
pH	**7.0–7.1**	**7.1**	**7.0–7.2**	**7.1**
BOD	**<5**	**<5**	**<5**	**<5**
COD	**30–32**	**31**	**19–22**	**21**

The nature of the MBR treatment process is that it is not expected to significantly reduce the metal concentration of the influent sewage, so it would be reasonable to assume that the metals concentration of the MBR effluent will be similar to that of the influent sewage. At this stage, current values for metal species in the influent at the plant are unknown; however, work is currently being undertaken to gather these data. While the specific profile and concentration of metals in the influent are being empirically established, Gippsland Water has confidence that their customer profile in Drouin presents a very low-risk for harmful levels of metals. Table 2 shows a summary of the trade waste customers in Gippsland Water's Drouin wastewater catchment by classification.

Table 2 – Tradewaste customers by categorized by Australian and New Zealand Industrial Classification (ANZSIC), Codes and Titles (2006)

Code	Division	Subdivision	Total Customers	Percentage (%)
A01	Agriculture, Forestry and Fishing	Agriculture	1	2.1
C11	Manufacturing	Food Product Manufacturing	1	2.1
C23	Manufacturing	Transport Equipment Manufacturing	1	2.1
E31	Construction	Heavy and Civil Engineering	1	2.1
G41	Retail Trade	Food Retailing	4	8.3
H44	Accommodation and Food Services	Accommodation	1	2.1
H45	Accommodation and Food Services	Food and Beveridge Services	25	52.1
P80	Education and Training	Preschool and School Education	1	2.1
P81	Education and Training	Tertiary Education	1	2.1
Q86	Health Care and Social Assistance	Residential Care Services	5	10.4
R91	Arts and Recreation Services	Sports and Recreation Activities	1	2.1

Code	Division	Subdivision	Total Customers	Percentage (%)
S94	Other Services	Repair and Maintenance	4	8.3
S95	Other Services	Personal and Other Services	2	4.2
			48	100

As displayed in Table 1, more than half of Gippsland Water's commercial customer base in Drouin comprises food preparation and manufacturing facilities, with Gippsland Water's largest industrial customer being a food processor. Bi-annual sampling of various parameters, including some metals (sodium, copper, zinc, chromium and lead), shows that only sodium and zinc are above minimum detection values of 0.01 mg L^{-1}. The average zinc value for the past 3 sampling events is 0.36 mg L^{-1} while results for sodium have average 187 mg L^{-1}. Given the current understanding of Gippsland Water's commercial and industrial waste customers, it is considered to be unlikely that harmful concentrations of metals will be present in the waste the plant receives and therefore, treated waste that is discharged to the waterway.

Figures 5 and 6 show the predicted effluent quality produced by the MBR under summer and winter conditions.

In summer, the total N varies from 3–10 mg/L, with a daily average of 6 mg/L. The ammonia averages less than 0.2 mg/L, while the total P averages less than 0.3 mg/L.

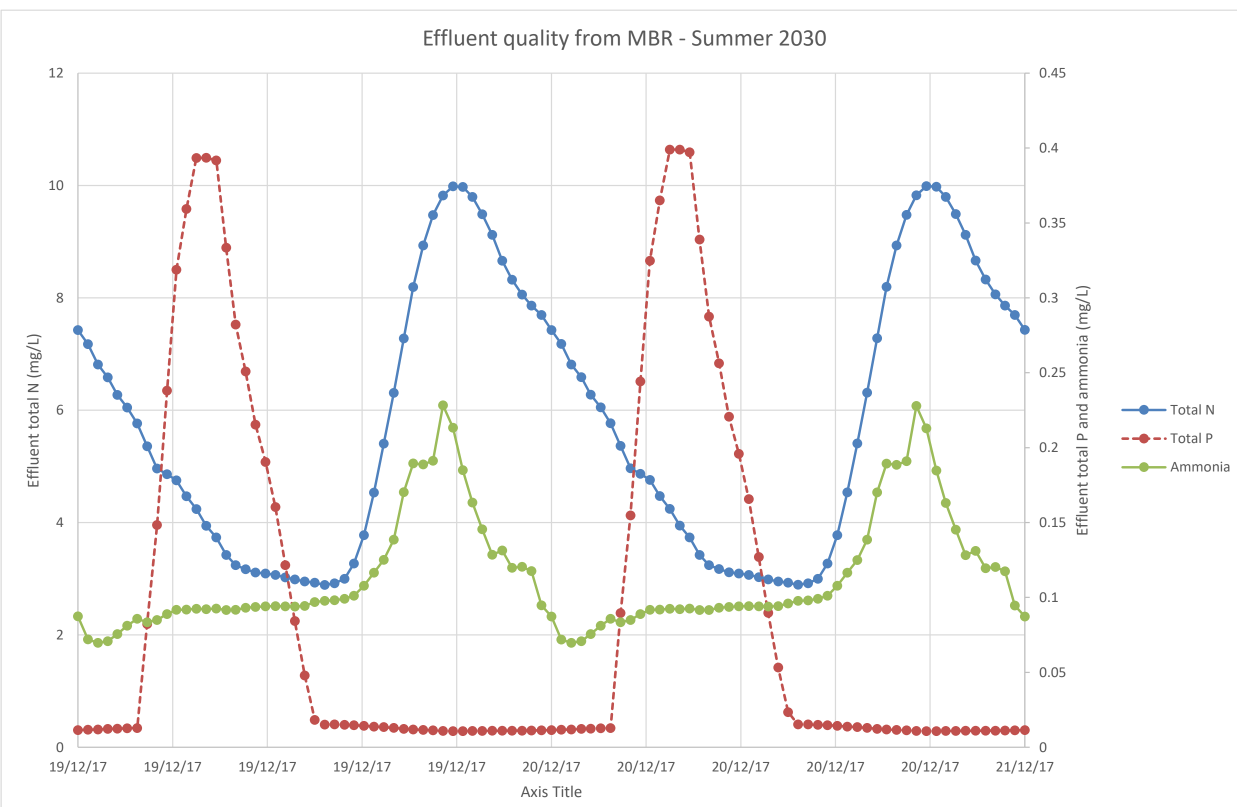


Figure 5: Predicted MBR effluent quality during summer

Under winter conditions, the effluent ammonia increases, but still achieves a daily average of less than 1 mg/L. The total N concentration decreases compared to that in summer, due to the dilution effects of infiltration. The average daily total P also decreases slightly due to the effects of dilution.

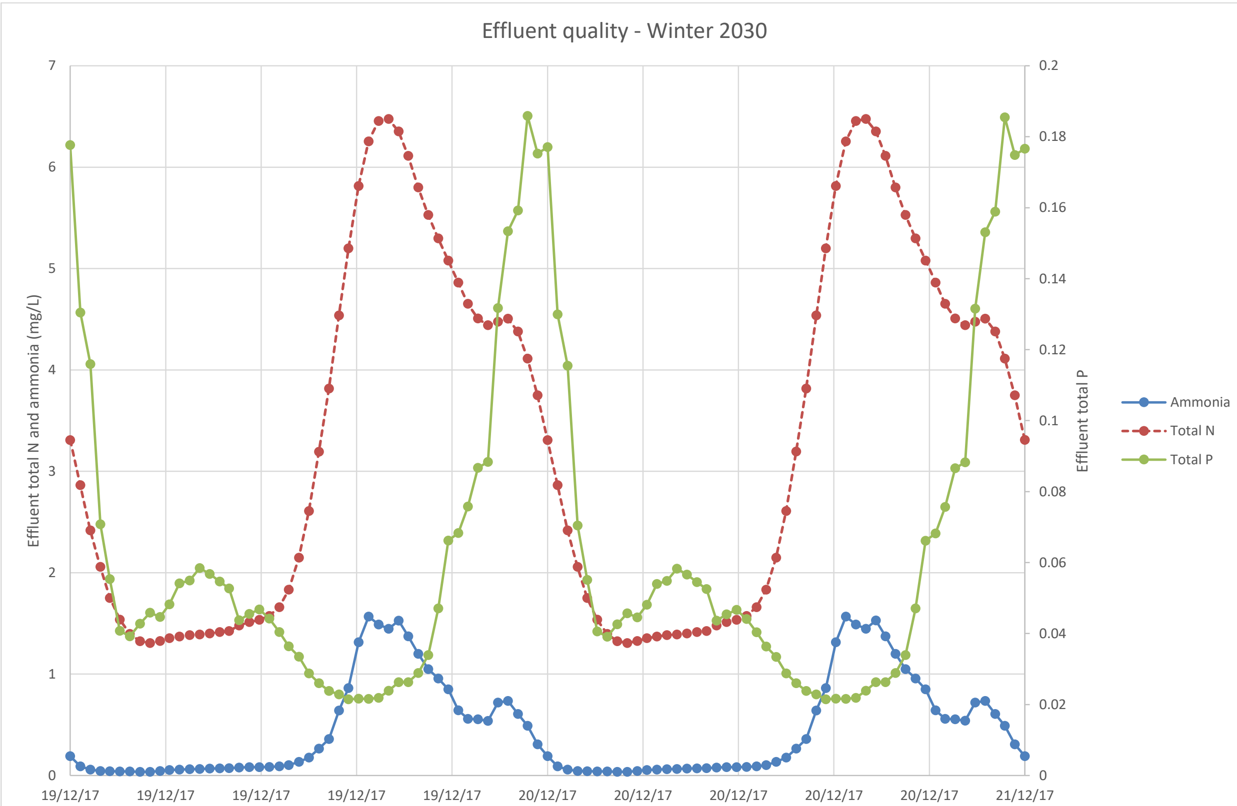


Figure 6: Predicted MBR effluent quality during winter