Canterbury City Council

Stodmarsh Grove Ferry Modelling Report

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1	07/06/23	All	All	Draft report issued for client comments	RM
2	14/08/23	All	All	Draft report issued following comments from Natural England	RM
3	11/12/23	All	All	Final report issued following comments from Natural England	RM

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1. Introduction

The Stodmarsh wetland complex, comprising a series of open water lakes, reedbeds and marsh, is situated adjacent to the upper tidal reach of the Great Stour east of Canterbury. It has historically suffered from eutrophication as a result of excessive nutrients entering from the catchment, specifically total nitrogen (TN) and total phosphorus (TP) (APEM, 2016). The wetland area is an important habitat that holds various statutory designations: Site of Special Scientific Interest (SSSI), Ramsar site, Special Protection Area (SPA) and Special Area of Conservation (SAC). The north eastern half of the area is a National Nature Reserve (NNR). Several of the SSSI units are not meeting the TN and TP water quality standards for favourable condition, with potential impacts on important wildlife for which the area is designated (Environment Agency, 2019).

This study is in relation to a proposed housing development at Herne Bay, within the Canterbury City Council (CCC) local authority boundary. The May Street Herne Bay Water Treatment Works (WwTW) discharges treated final effluent into the Great Stour at Grove Ferry downstream of Stodmarsh.

Due to the tidal influence on this river system, there is the possibility that this discharge at Grove Ferry could have potential connectivity with Stodmarsh, as Stodmarsh lies downstream of the tidal limit. Therefore, any inputs of TN and TP from May Street Herne Bay WwTW could be transported upstream and enter Stodmarsh. CCC has therefore asked APEM, supported by Intertek Energy and Water Consultancy Services (Intertek), to model the possibility of a connectivity between the discharge at Grove Ferry and Stodmarsh. Two scenarios were modelled, a scenario based on the current TN and TP loadings discharged at Grove Ferry, and a 2040 scenario reflecting the increased nutrient loadings resulting from the proposed housing development at Herne Bay.

2. Methodology

An existing one-dimensional (1D) MIKE 11 Stour Model was used to determine the loadings and concentration of TN and TP between the discharge and entry point of Stodmarsh, specifically at the sluice gate and Hersden Tidal Lake. The modelling approach for this study is the same as the previous study carried out for Dover District Council (the Dambridge WwTW in Wingham investigation) and it used a precautionary approach.

The model is capable of modelling both flows and pollutant transport in the area of interest, and undertaking model runs to determine whether there is connectivity between May Street Herne Bay WwTW and Stodmarsh. The Stour Model was developed for a previous study for Dover District Council. The model was calibrated and validated against field measurements of water level, flow and salinity. The calibration and validation data includes historical (2016 – 2021) flow data from the EA gauge at Plucks Gutter, located below the confluence of the

Great Stour and Little Stour, salinity field data, and water level from the Shoothill GaugeMap. The calibration is considered the best achievable based on the available data and is sufficient for the purposes of the study. Full details on the modelling methodology are presented in the previous report for the Dover District Council study (APEM, 2022). The key details for the modelling investigation are summarised below:

- The outfall for the final effluent from Southern Water's May Street Herne Bay WwTW is located at Grove Ferry (NGR TR 2376 6319).
- The entrance to Stodmarsh is assumed to be a single point located towards the lower reach of the site.
- Hersden Tidal Lake is assumed to be a single point located at the downstream boundary of the lake and Great Stour.
- The flow from the WwTW in 2022 was 5,903,000 litre/day and it will increase due to development to 7,326,000 litre/day by 2040.
- The permit level for total phosphorus was 2 mg/l in 2022 and it will be reduced to 0.3 mg/l by 2040.
- There will no change to the permit level for nitrogen (ammoniacal nitrogen), which is 5 mg/l (during the period 1 April to 31 October) and 10 mg/l (during the period 1 November to 31 March).
- For TN in the permitted discharge a concentration of 27mg/l was assumed (this value was recommended by Natural England).

Information for the final effluent discharge including for the growth scenario was provided by Southern Water. Information on the operation of the water level at Stodmarsh was provided by Natural England for the previous study, describing a sluice gate that restricts flow between the Great Stour and Stodmarsh. Connectivity is only possible either when the sluice is open, or when the river level at the sluice is greater than 2.44 m and overtops the sluice. However, we understand that the management of this sluice at Stodmarsh may change in future.

3. Results

The results of the modelling are summarised in this section. Appendix 1 contains further details and is based on the report issued by Intertek.

There were two scenarios that were modelled for this study for TN and TP discharges from the WwTW: a 2022 permit scenario and a 2040 permit scenario. It should be noted that the modelling is conservative, with no allowance made for any natural processes that would lead to the removal of TN or TP. It is therefore a worst case scenario, which is consistent with the previous investigation approach delivered for Dover District Council.

The key findings from the modelling study are summarised below.

Stodmarsh

- The TP loading entering Stodmarsh will be reduced from 5.41 kg/year to 1.02 kg/year by 2040. However, the TN loading will increase from 73 kg/year to 91 kg/year by 2040.
- The maximum concentration of TP at Stodmarsh will be reduced from 0.033 mg/l to 0.006 mg/l by 2040. However, the maximum concentration of TN will increase from 0.445 mg/l to 0.549 mg/l by 2040.
- The percentage of the total load from Herne Bay WwTW that would reach Stodmarsh would be 0.13%.

Hersden Tidal Lake

- The TP loading reaching Hersden Tidal Lake will be reduced from 0.00100 kg/year to 0.00019 kg/year by 2040. However, the TN loading will increase from 0.01336 kg/year to 0.01671 kg/year by 2040.
- The maximum concentration of TP at Hersden Tidal Lake will be reduced from 0.000017 mg/l to 0.000003 mg/l by 2040. However, the maximum TN concentration will increase from 0.00023 mg/l to 0.00029 mg/l by 2040.
- The percentage of the total load from Herne Bay WwTW that would reach Hersden Tidal Lake would be 0.00002%.

4. Conclusion

In conclusion, in order to put the modelling results into context the annual loadings reaching the lakes were converted to a population equivalent value. This assumes a per capita loading of 0.06g/day for TP and 3.2g/day for TN. It shows that the increase in nutrients would be as follows:

- Stodmarsh – TP will be reduced from 247.2 to 46.4 PE; TN will be increased from 62.6 to 78.2 PE.
- Hersden Tidal Lake – TP will be reduced from 0.046 to 0.009 PE; TN will be increased from 0.011 to 0.014PE.

The modelling study has demonstrated that there is some potential connectivity between the WwTW outfall and Stodmarsh. However, the TP loading will be reduced by an equivalent of 200.8 people by 2040 and the TN loading will increase by the equivalent of 15.6 people. The study has also showed that there is minimal connectivity between the WwTW outfall and Hersden Tidal Lake.

5. References

APEM (2016) Stodmarsh SSSI, SPA and NNR Lake Hydrology Project – Phase 1. APEM Scientific Report P00000115 for Natural England, April 2016. vi + 36 pp.

APEM (2022). Stodmarsh Water Quality Modelling. APEM Scientific Report P00006031. Dover District Council, September 2022, Final, 32 pp

Environment Agency, 2019. Investigation Specification Form - Stodmarsh N2000 and Ramsar site rCSMG investigation, 7pp.

Appendix 1 Modelling Report

Memorandum

To	r.moore@apemltd.co.uk (APEM)				
CC	paul.taylor@intertek.com (Intertek)				
From	jack.unsworth@intertek.com (Intertek)				
File Ref	P2605_AHMAY22_Rev1				
Subject	May Street Herne Bay: Stodmarsh Hydrological Modelling	**Pages**	3	**Date**	11/08/2023

Intertek Energy and Water Consultancy Services (Intertek) have been commissioned by APEM, on behalf of Canterbury City Council (CCC), to undertake an investigation to determine hydrodynamic connectivity between May Street Herne Bay waste water treatment work (WwTW) and two key receptors in the River Great Stour. The assessment considered the nutrient load from the May Street Herne Bay WwTW under a baseline (current) condition, and a future scenario with population growth with a design horizon of 2040.

This memorandum provides details of the assessment, including the main results and conclusions. The study has utilised a detailed calibrated and validated hydrodynamic model of the Great Stour, which was built using the industry standard MIKE11 modelling software for a previous similar study undertaken by Intertek for APEM, on behalf of Dover District Council (DDC). The previous study for DDC was very similar to this study for CCC and assessed the connectivity between the Dambridge WwTW and the same two key receptors. The same approach, which was agreed with Natural England (NE), using the same model has been applied. DDC have given permission for the MIKE11 model to be used for this study for CCC. Full details of the model development, calibration and validation (as well as the modelling approach) are provided in the Intertek report [P2441_R5393_Rev3] issued to APEM in November 2021.

This modelling assessment aims to establish the total nutrient load that can potentially reach two key sensitive receptors on the Great Stour. The two key receptors are the sluice gate, which connects the main channel of the Great Stour to the Stodmarsh National Nature Reserve (NNR) Lake, and the entrance to the Hersden Tidal Lake further upstream. The May Street Herne Bay WwTW and these two locations of interest are shown in Figure 1-1:.

Figure 1-1 The Stour Model and Extraction Locations

There are two scenarios that were modelled for each location: the 2022 and 2040 population for the Total Phosphorous (TP) and Total Nitrogen (TN) at the permit levels for the two scenarios. Table 1-1 details the concentration values for TP and TN, which have been provided by Southern Water (SWS) and NE. It should be noted that the permit for TP is reduced in the 2040 scenario.

Table 1-1 Local Plan Nutrient Budget Figures (SWS)

Scenario	Population	Wastewater l/day	Permit Level (mg/l)	
			Total Nitrogen*	Total Phosphorous
2022	8,600	5,903,000	27	2
2040	17,900	7,326,000	27	0.3

*There is no permit for TN, and therefore a conservative standard default value, as provided by NE, has been used.

The Great Stour Model has been amended to include the nutrient loads from the WwTW as flows and concentrations defined in Table 1-1. Four model runs have been undertaken, with each scenario covered by two model runs (one for TN and one for TP). Table 1-2 shows the model results extracted at the sluice gate at the entrance to the NNR Lake and Table 1-3 shows the model results extracted at the entrance to Hersden Tidal Lake.

The model outputs a time series, at 15-minute intervals, for flows and concentrations of nutrients predicted at the two points in the Great Stour that connect to the receptors. These model outputs have been converted into values for annual mass with maximum nutrient concentrations also given.

As the lake systems are not included explicitly in the model, a conservative approach has been adopted to calculate the nutrient loads entering the lake systems from the May Street Herne Bay WwTW, by assuming that all nutrients reaching the entrance under flood tides would remain in the lake system without flushing out during the ebb tides.

Table 1-2 and Table 1-3 provide potential annual nutrient loads to the upstream lake systems and the maximum nutrient concentrations at the entrances to NNR Lake and Hersden Tidal Lake respectively.

Table 1-2 Model results for the Sluice gate at the entrance to the NNR Lake

Scenario	TP (kg per year)	TN (kg per year)	TP Max (mg/l)	TN Max (mg/l)
2022	5.41	73.08	0.033	0.445
2040	1.02	91.38	0.006	0.549

Table 1-3 Model results at the entrance to Hersden Tidal Lake

Scenario	TP (kg per year)	TN (kg per year)	TP Max (mg/l)	TN Max (mg/l)
2022	0.00100	0.01336	0.000017	0.000234
2040	0.00019	0.01671	0.000003	0.000289

To put the impacts of the May Street Herne Bay WwTW discharge on the lake systems into context, the potential annual nutrient loads reaching the lake systems are converted into population equivalent by using one population equivalent loads of 0.06 g per day for TP and 3.2 g per day for TN, provided by Nature England. Table 1-4 and Table 1-5 show the population equivalent loads that potentially reach the NNR Lake and Hersden Tidal Lake respectively.

Table 1-4 Population equivalent at the entrance to the NNR Lake

Scenario	TP (PE)	TN (PE)
2022	247.2	62.6
2040	46.4	78.2

Table 1-5 Population equivalent at the entrance to Hersden Tidal Lake

Scenario	TP (PE)	TN (PE)
2022	0.046	0.011
2040	0.009	0.014

The results of the modelling show that there is negligible connectivity between the May Street Herne Bay WwTW and the Hersden Tidal Lake location.

The results indicate the total nutrient loads that reach the sluice gate at the entrance to the NNR Lake are larger due to its proximity to the works, with TN increasing by 6.3 PE in 2040 compared with the 2022 baseline, although TP is reduced due to the lower discharge load in 2040. However, it should be noted that the modelled results are conservative, as detailed previously, and that the actual impacts from the works could be much lower. The conservatism in the modelled input values could be reduced by using measured values from samples taken from the final effluent. However, conservatism in the modelling approach (i.e. to include the effect of the

hydrodynamics of the lakes themselves) cannot be reduced with confidence without explicitly including the lake systems in the model.