Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009
Regulation 5(2) [a]
Document reference: TR030001/APP/14b

Supplementary Environmental Information

Assessment of the Effects of Relocation of the E.ON and Centrica Outfalls on Thermal Recirculation

Supplementary Report EX 9.7

June 2012
Revision: 0
HR Wallingford

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Able Marine Energy Park

Assessment of the effects of relocation of the E.ON and Centrica outfalls on thermal recirculation

EX 6803 R1

June 2012

Document information

Project	Able Marine Energy Park
Report title	Assessment of the effects of relocation of the E.ON and Centrica outfalls on thermal recirculation
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Client Representative	Mr Richard Cram
Project No.	DEM6878
Report No.	EX6803
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Document history

Date	Release	Prepared	Approved	Authorised	Notes
19/06/12	1.0	TEJ	CTM	GAW	

Prepared [redacted]

Approved

Authorised

Summary

Able Marine Energy Park

Assessment of the effects of re-location of the E.ON and Centrica outfalls on thermal recirculation

Report EX6803
June 2012

Able UK Ltd proposes to construct a Marine Energy Park (MEP) near Immingham on the southern bank of the Humber estuary. The MEP will be a facility for the construction of offshore wind turbines and other activities associated with sources of renewable energy.

The MEP will consist of a large reclamation approximately 1300 m long along the shore and up to 400 m wide in the offshore direction. Immediately to the north of the reclamation there are two existing pairs of intakes and outfalls for two gas-fired power stations, which are located some 2 km inland of the proposed reclamation. One plant is operated by Centrica and the other by E.ON. These outfalls discharge cooling water from the power stations.

In 2011, HR Wallingford undertook a thermal dispersion modelling study of the cooling water discharges following the construction of the quay, and predicted the effects of the construction on thermal recirculation to both intakes. Sediment transport modelling, also undertaken by HR Wallingford, has indicated that there is a high risk that the outfall structures for the E.ON plant will experience significant siltation with the quay in place. That study also indicated that there could also be significant siltation at the Centrica outfall.

One potential option to resolve the issue of siltation at both outfalls is to relocate both outfalls to the front face of the proposed MEP quay. This report presents the results of additional thermal modelling undertaken to determine the likely effect of relocating the outfalls on temperatures at the power stations' intakes.

Relocating the E.ON and Centrica outfalls to the front face of the proposed MEP quay is predicted to lead to water temperatures at the E.ON and Centrica intakes that are lower than those with the outfalls located in their present positions. Peak temperatures at the E.ON intake are predicted to be 0.4°C to 0.5°C above the ambient value for no more than 1 hour per tide. At other times, the excess temperature at the intake is predicted to be less than 0.1°C. Peak temperatures at the Centrica intake are predicted to be 0.1°C to 0.2°C above the ambient value for no more than 1 hour per tide.

Contents

1. Introduction

Able UK Ltd proposes to construct a Marine Energy Park (MEP) near Immingham on the southern bank of the Humber estuary. The MEP will be a facility for the construction of offshore wind turbines, and other activities associated with sources of renewable energy.

The MEP will consist of a large reclamation approximately 1300 m long along the shore and up to 400 m wide in the offshore direction. Immediately to the north of the reclamation there are two existing pairs of intakes and outfalls for two gas-fired power stations, which are located some 2 km inland of the proposed reclamation. One plant is operated by Centrica and the other by E.ON. These outfalls discharge cooling water from the power stations.

In 2011, HR Wallingford undertook a thermal dispersion modelling study of the cooling water discharges following the construction of the quay, and predicted the effects on thermal recirculation to the both intakes (References 1 and 2). Subsequent to that report, the design of the quay was modified to remove the breakwater close to the E.ON outfall, and to move the front (offshore) face of the quay closer to the shore.

Sediment transport modelling, also undertaken by HR Wallingford, has indicated that there is a high risk that the outfall structure for the E.ON plant will experience significant siltation with the quay in place (Reference 3). That study indicated that there could also be significant siltation at the Centrica outfall.

One potential option to resolve the issue of siltation at both outfalls is to relocate them to the front face of the proposed MEP quay. This report describes additional thermal modelling to determine the likely effect of relocating the outfalls on temperatures at power stations intakes, compared to the temperatures predicted for the existing outfall locations.

1.1 COORDINATE SYSTEM

The coordinate system used in the model and this report is British National Grid (OSGB36). Vertical positions have been related primarily to Ordnance Datum Newlyn (ODN). Units are metres in both the horizontal and vertical directions.

Some levels have been provided relative to Chart Datum (CD) which is roughly the level of lowest astronomical tide. At Immingham, CD is 3.90 m below ODN.

2. Thermal assessment

The same modelling approach used in the earlier thermal modelling (References 1, 2 and 4) was applied in this additional work. The layout of the quay, and associated dredging for the final layout of the quay, were as provided by the client for the sediment transport modelling (Reference 2). The model bathymetry for existing conditions and the developed layout are shown in Figure 2.1.

The intake and outfall flows of the two power stations have been introduced into the model. The proposed new location for E.ON outfall is on the front face of the quay, with the Centrica outfall 5 m further along the quay. The proposed elevations are the same as the existing outfalls (approximately -5 m ODN); however as the sea bed in front of the quay will be dredged to -11 m CD (-14.9 m ODN), the outfalls will no longer be located close to the sea bed. As the spatial resolution of the model is around 10 m, the two outfalls are represented at the same node in the model.

The dispersion of the thermal plumes has been simulated over several tidal cycles, for four combinations of tidal and wind conditions.

2.1 INTAKE AND OUTFALL PARAMETERS

Data provided by the power station operators suggests that the ambient water temperature is around 18°C in summer and around 10°C in winter.

The E.ON outfall temperature is about 27°C in summer, which implies that the discharge has excess temperatures of around 9°C; in winter, the outfall temperature is around 21°C which implies that the discharge has excess temperatures of around 11°C. For this study, a constant value of 10°C was assumed.

Less definite information has been supplied about the Centrica discharge, but its operation is believed to be broadly similar to the way the E.ON discharge is operated; therefore this has also been assumed to have a constant excess temperature of 10°C.

These parameters are summarised, together with the relevant flow rates, in Table 2.1.

Table 2.1 Intake and outfall parameters

	E.ON	Centrica
Intake flow rate (m^3/s)	0.7	0.4
Outfall flow rate (m^3/s)	0.7	0.3
Outfall excess temperature (°C)	10	10

2.2 ENVIRONMENTAL CONDITIONS

The thermal dispersion simulations were run for spring tides and neap tides, under calm conditions, and assuming a constant wind blowing from the west at 7 m/s. Calm conditions were used because they often give the most adverse predictions for the accumulation of heated water in the vicinity of a discharge. The wind condition was selected because the Admiralty Pilot suggests that this is representative of the most commonly occurring winds.

2.3 RESULTS

Similar results were found for all the four environmental cases tested with the two outfalls located along the front face of the proposed quay. Contour plots of surface and bed excess temperature are shown only for spring tide calm conditions (Figures 2.2 and 2.3). These plots show plume dispersion patterns at the sea surface and sea bed, at times corresponding approximately to one hour after High Water (HW) and one hour after Low Water (LW). As in the previous simulations for the existing conditions and the earlier MEP quay layout (References 1 and 2), excess temperatures above 0.5°C are predicted only very close to the Centrica and E.ON outfalls around HW and LW. As the two outfalls will now be very close together, a single combined plume is predicted to form. The plume from the relocated outfalls is not visible at the bed in the contour plots, as the outfall will no longer be located near the bed. The relatively high excess temperatures near the outfalls at HW and LW are predicted to disperse fairly rapidly.

In the previous modelling (Reference 1), the presence of the quay was predicted to increase the peak excess temperature at the E.ON intake from the existing value of less than 0.1°C to a value in excess of 0.5°C. At the Centrica intake, the quay was predicted to increase the peak excess temperature from less than 0.1°C to around 0.25°C (Reference 2).

In the case under consideration, with both outfalls relocated, the peak excess temperatures predicted at the E.ON and Centrica intakes (Figures 2.4 to 2.7) are lower than those previously predicted for the existing outfall locations. .At the site of the E.ON intake, two peaks of short duration are predicted at about 1 hour after LW and approximately 30 minutes after HW, for spring tides. These peaks are of less than one hour in duration. Under calm conditions, the surface temperature is predicted to peak at 0.4°C to 0.5°C above the ambient values while the near-bed values are less than 0.1°C.

At the Centrica intake, the surface temperature is predicted to be between 0.1°C and 0.2°C above ambient for two periods per tide of no more than one hour each after both HW and LW; while the near-bed values are predicted to be less than 0.1°C at all times.

Similar results are predicted for neap tides, and when a constant wind is applied to both tidal cases.

3. Conclusions

Relocating the E.ON and Centrica outfalls to the front face of the proposed MEP quay is predicted to lead to water temperatures at the E.ON and Centrica intakes that are lower than those with the outfalls located their present positions.

Peak temperatures at the E.ON intake are predicted to be 0.4°C to 0.5°C above the ambient value for no more than one hour twice per tide. At other times, the excess temperature at the intake is predicted to be less than 0.1°C.

Peak temperatures at the Centrica intake are predicted to be 0.1°C to 0.2°C above the ambient value for no more than one hour twice per tide.

4. References

1 HR Wallingford, 2011 Able Marine Energy Park near Immingham, Assessment of proposed reclamation impact on recirculation at E.ON intake/outfall, Report EX 6503, November 2011.
2 HR Wallingford, 2011 Able Marine Energy Park near Immingham, Assessment of proposed reclamation impact on recirculation at Centrica intake/outfall, Report EX 6502, November 2011.
3 HR Wallingford 2011 Able Marine Energy Park 3D Mud Modelling, Assessment of the effects of a proposed development on the south bank of the Humber Estuary on fine sediments, Report EX 6603, November 2011.
4 HR Wallingford 2011 Able Marine Energy Park Assessment of the effects of re location of the E.ON outfall on thermal recirculation, Technical Note DDR4808-01, December 2011.

Figures

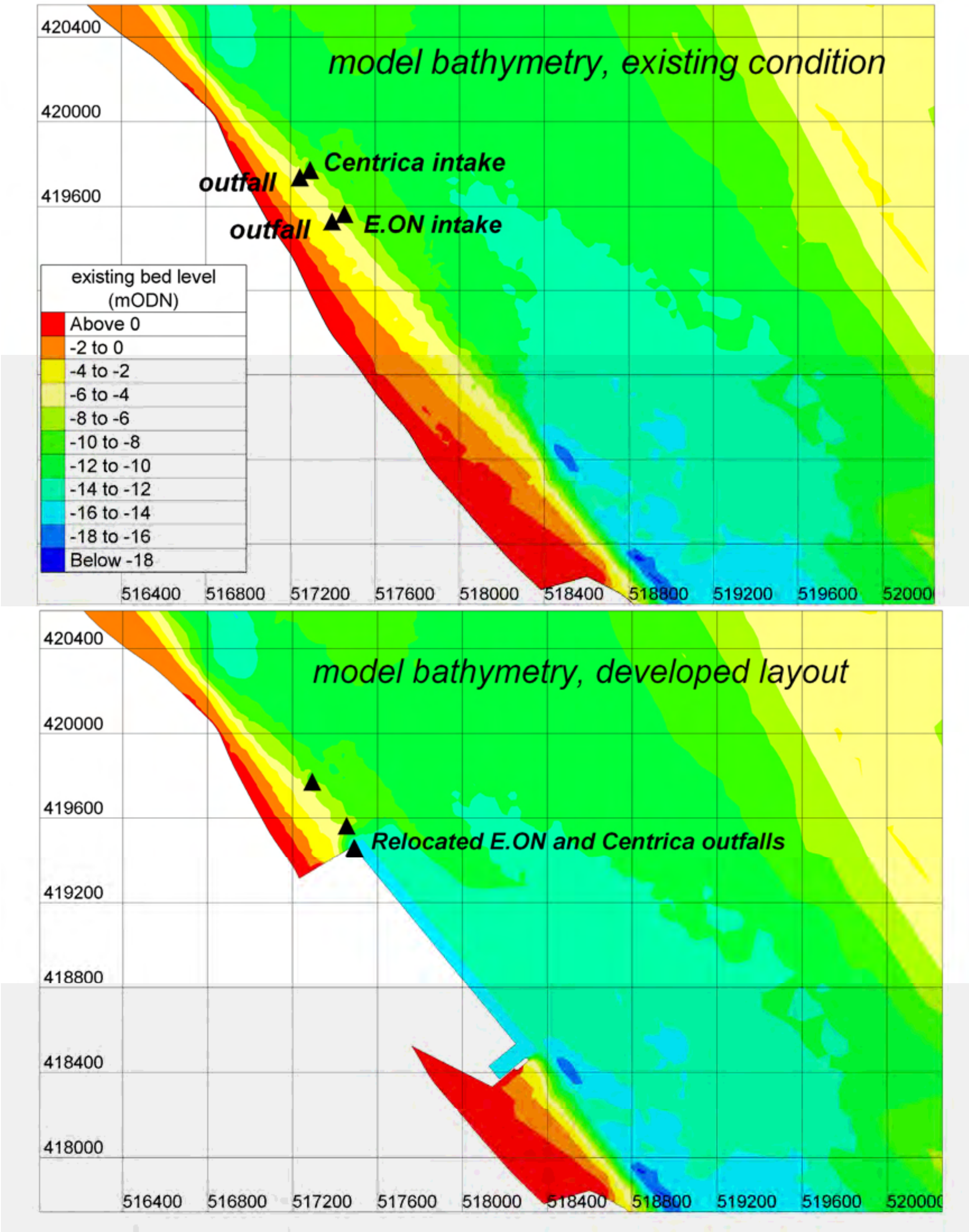


Figure 2.1 Existing and developed site layouts as represented in the model

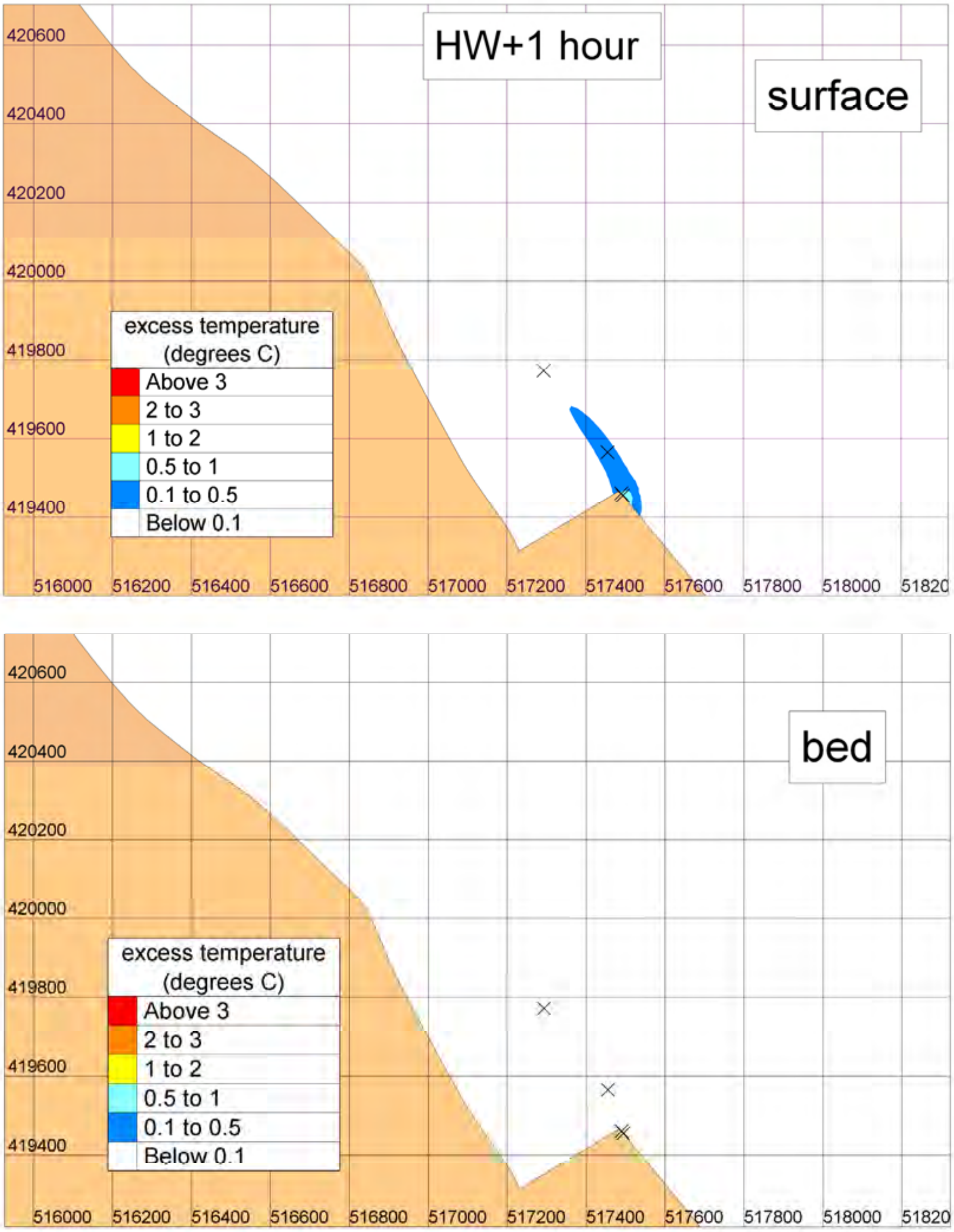
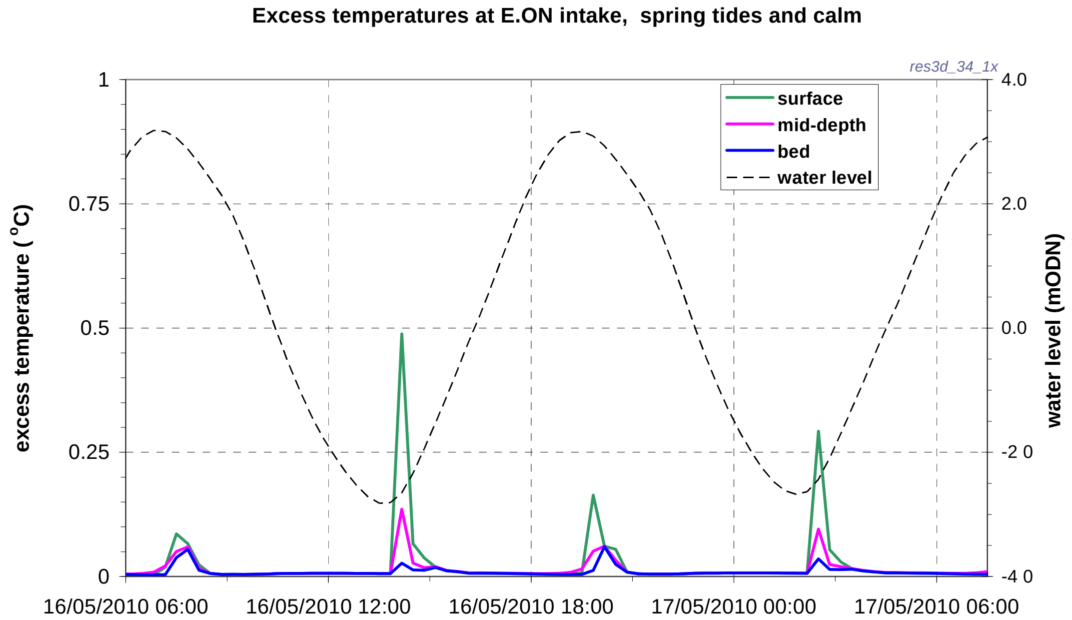


Figure 2.2 Predicted thermal dispersion patterns at one hour after High Water, with both outfalls relocated, spring tide, calm conditions

Figure 2.3 Predicted thermal dispersion patterns at one hour after Low Water, with both outfalls relocated, spring tide, calm conditions



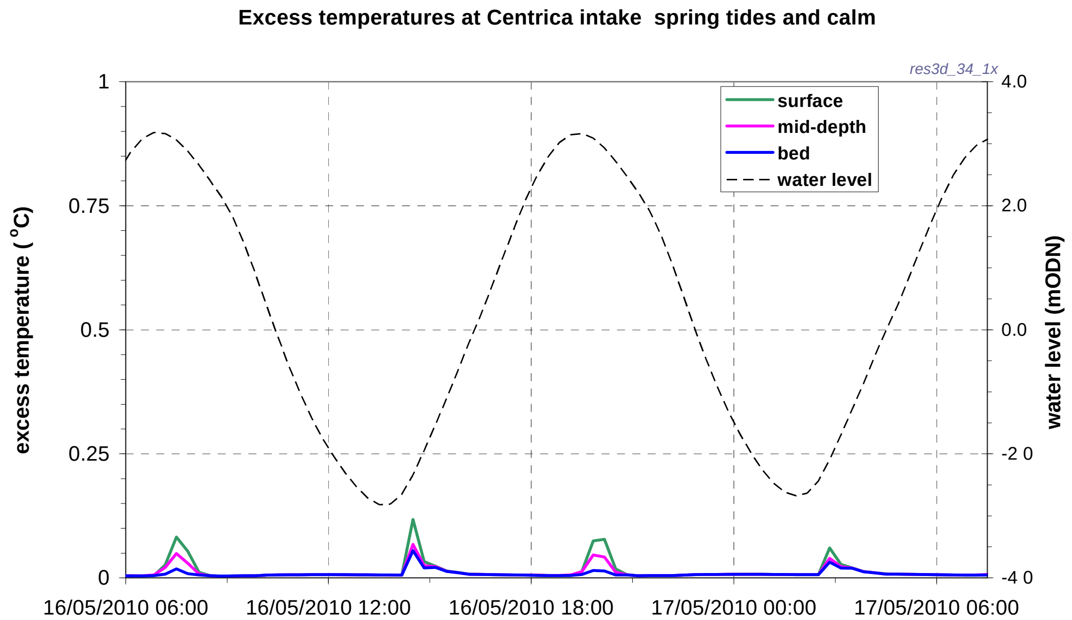
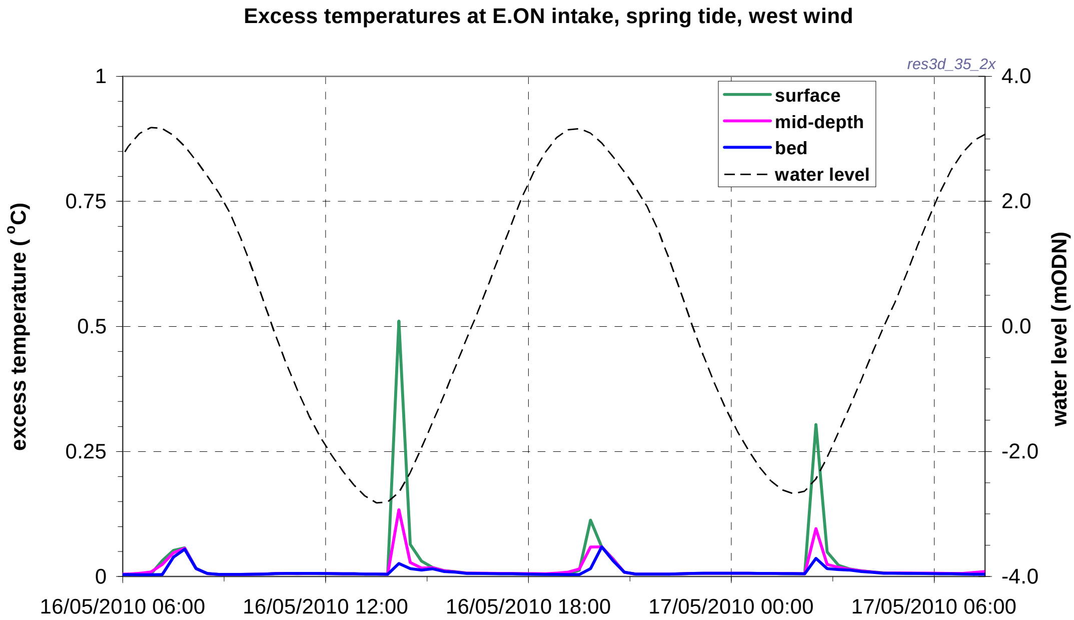


Figure 2.4 Predicted excess temperature variation at E.ON and Centrica intakes, with both outfalls re-located, spring tide, calm conditions



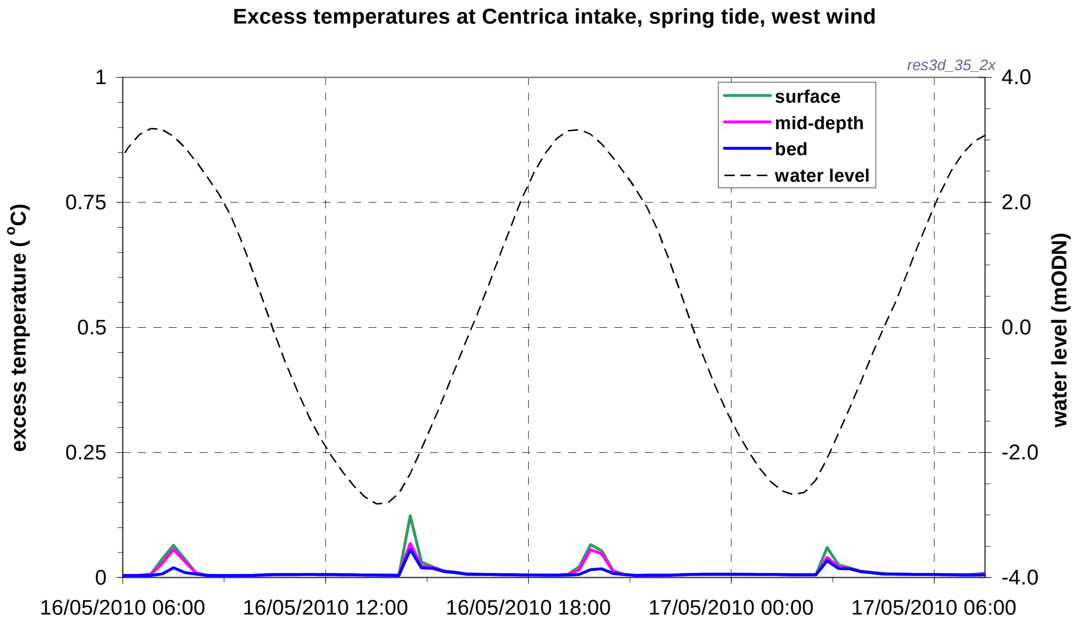
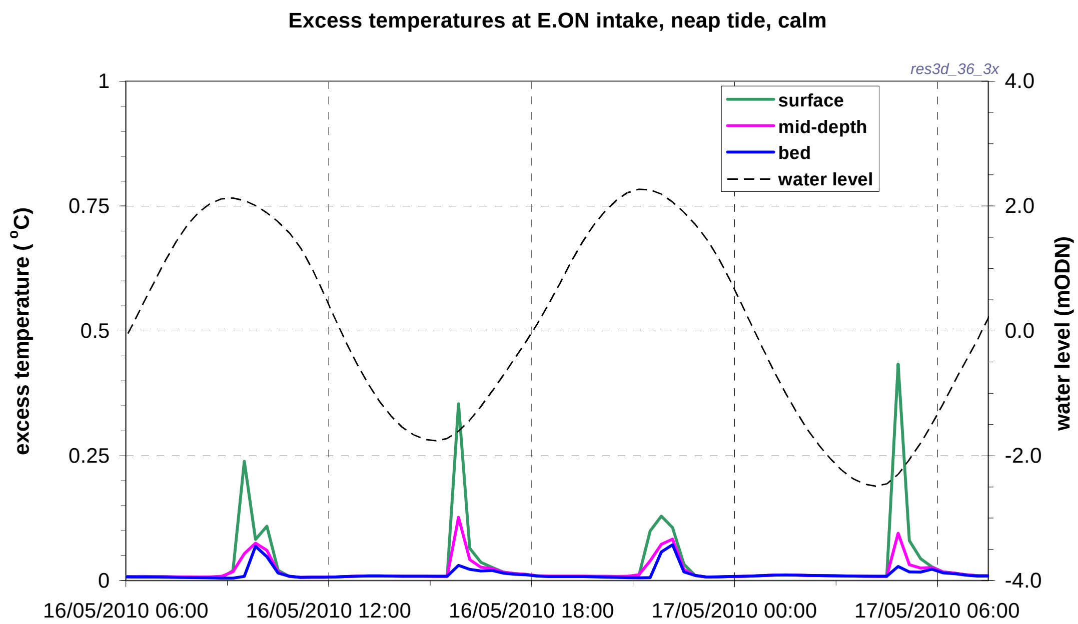


Figure 2.5 Predicted excess temperature variation at E.ON and Centrica intakes, with both outfalls re-located, spring tide, constant wind



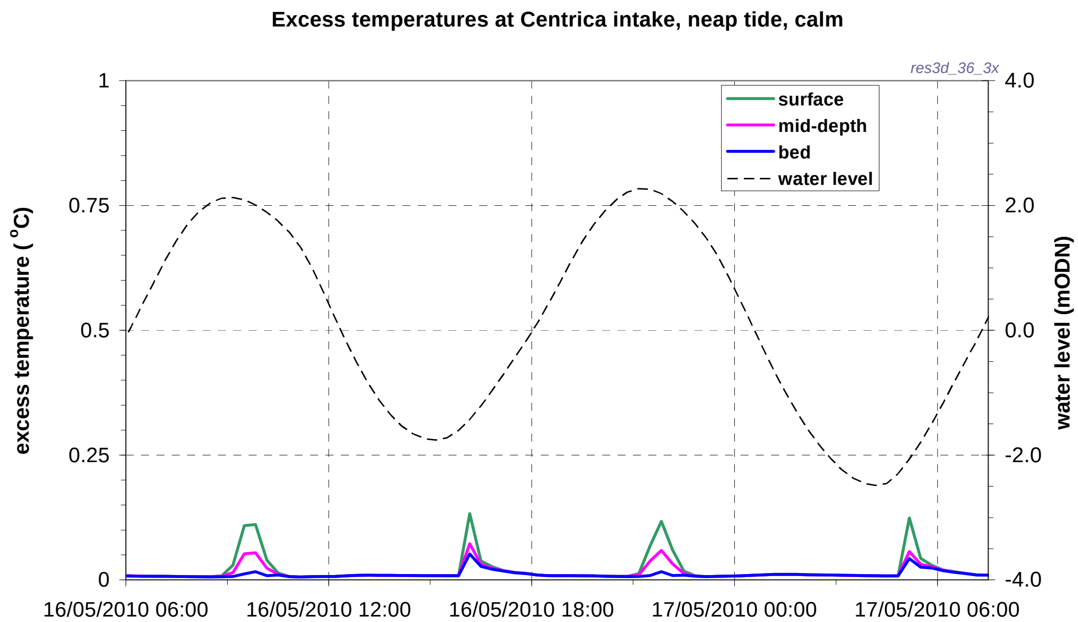
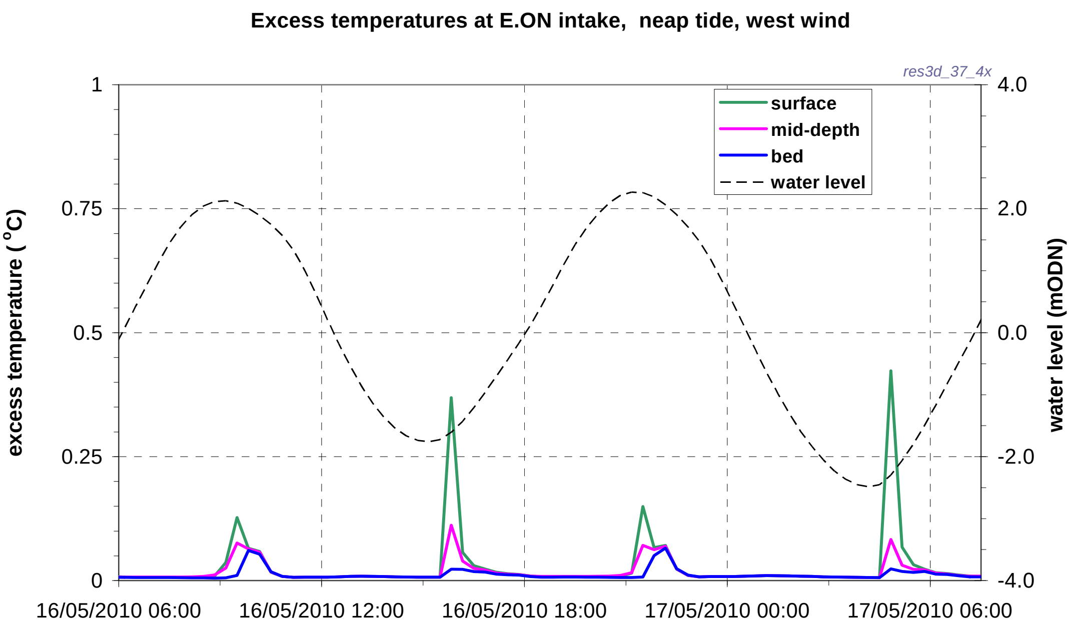


Figure 2.6 Predicted excess temperature variation at E.ON and Centrica intakes, with both outfalls re-located, neap tide, calm conditions



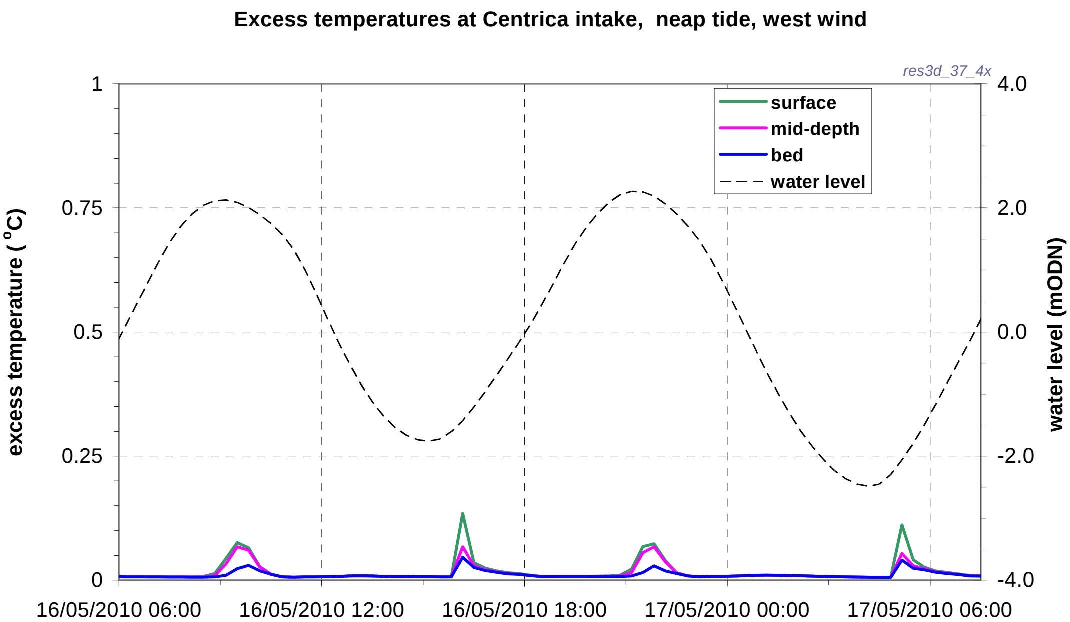


Figure 2.7 Predicted excess temperature variation at E.ON and Centrica intakes, with both outfalls re-located, neap tide, constant wind

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