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Supplementary Environmental Information

Update to Longer Term Morphology Predictions in the Region of the Centrica and E.ON intakes and outfalls

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Able Marine Energy Park

Update to longer term morphology predictions in the region of the Centrica and E.ON intakes and outfalls

Technical Note DHR4808-01

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Contents

1. Introduction

1.1 BACKGROUND

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

AMEP will consist of a large reclamation approximately 1,300 m in length along the shore and extending 300 – 400 m out into the estuary. Immediately to the northwest of the reclamation there are two existing intake/outfall lines for two gas-fired power stations. One plant is operated by Centrica and the other by E.ON. The proposed AMEP and neighbouring E.ON and Centrica intakes and outfalls are shown in Figures 1 and 2.

An Environmental Impact Assessment was undertaken and an Environmental Statement was submitted by Able UK to the IPC on 19 December 2011. Effects of the proposed AMEP on hydrodynamics, sediment transport, and morphology were assessed and are reported in (JBA 2011a, 2011b) and (HR Wallingford 2011a, 2011b).

1.2 OBJECTIVE

The predictions of longer term changes to morphology in (HR Wallingford, 2011a) were derived from a desk-based assessment of charted morphology changes to the northwest of the Humber International Terminal (HIT) before and after construction, and from longer term morphology modelling undertaken for an earlier layout of the AMEP (Figure 3) and re-interpreted for the present layout.

This technical note updates the findings presented in that report by undertaking the longer term morphology modelling for the AMEP as defined in the IPC application and presenting the new results below.

2. Update to longer term morphology modelling

2.1 METHOD

To gain an insight into the potential longer term development of the intertidal profile along the intake-outfall lines, the model was run for an extended duration, updating the model bathymetry before each re-running of both the 3D flow and mud transport models. Initially, four iterations of the flow and mud transport models were undertaken. Before each subsequent iteration of the flow and sediment models, the model bathymetry was updated based on the results of the last run. After reviewing the results of the fourth iteration, it was decided to run one further (fifth) iteration of the models to provide further insight into the longer term changes.

Allowing for some consolidation of materials over time, the linear scaling of results for each iteration translates into a time period of approximately six weeks. That is, after five iterations of the models, the predictions are broadly representative of deposition after an elapsed time of 30 weeks.

It is considered that including morphodynamic updating in sediment modelling introduces many uncertainties. The main objective here was to use the model to understand how the morphology might develop further in this region in response to AMEP, and in particular to seek to understand at what point the estuary bed morphology might reach some sort of equilibrium (and what that might be).

The work is supported by a desk based assessment of changes to the intertidal seabed upriver of the HIT, described in (HR Wallingford, 2011a).

2.2 RESULTS

Figures 4-8 show the model predicted deposition during each iteration (0-6 weeks, 6-12 weeks, 12-18 weeks, 18-24 weeks, and 24-30 weeks).

Figure 9 shows a comparison of the initial and final bathymetries in the region around the intakes and outfalls. Figure 10a shows the predicted morphological changes along a cross-shore transect extending through the Centrica outfall to the intake. Figure 10b shows the predicted morphological changes along a cross-shore transect extending through the E.ON outfall to the intake. Finally, Figure 11 shows predicted change in morphology against time at the intakes and outfalls.

2.2.1 Centrica Intake and Outfall

The model results show the following:

- About 0.6 m of potential bed erosion (after 30 weeks) in the region of the Centrica intake, and continuing. Actual erosion will depend upon the composition of the bed.
- The Centrica outfall appears to be located at a pivot point with accretion predicted inshore of the outfall and potential erosion predicted seawards of this point.
- Inshore of the Centrica outfall, up to 2.3 m deposition is predicted after 30 weeks.

2.2.2 E.ON Intake and Outfall

The model results show the following:

- About 0.9 m of potential bed erosion (after 30 weeks) in the region of the E.ON intake, and continuing. Actual erosion will depend upon the composition of the seabed at this location.
- The proximity of the E.ON intake to the AMEP dredged pocket (sited just at the top of the side slope as shown in Figure 9) means that there is a risk connected with slope stability (not studied here).
- Accretion of the seabed at the location of the E.ON outfall is predicted to begin within 18-24 weeks of construction of AMEP.
- Inshore of the E.ON outfall, up to 3.8 m deposition is predicted after 30 weeks (2.3 m at the outfall).
- There is potential deepening around the northwestern edge of AMEP.
- There is potential for “channel” formation through the depositing materials inshore of the outfalls (i.e. the deposition may not be uniform over this region, Figure 9 – bottom panel).

2.3 INTERPRETATION AND ASSESSMENT

After more than six months of simulations, the predicted deposition has not significantly slowed in terms of volume. This is in contrast to the previous longer term morphology modelling undertaken for an earlier layout of the AMEP shown in Figure 3 and reported in (HR Wallingford, 2011a). The model results need to be understood in the context of the environmental conditions simulated, the model assumptions and limitations, and the real world. This section provides interpretation of the above results.

A comparison of Figure 9a and 9b shows the predicted accretion more than six months after construction to the northwest of the AMEP. The area predicted to accrete falls broadly within a triangle joining the northwestern flank of AMEP with a point on the high water mark located some 700 m upriver. The model predictions do not result in a smooth uniform picture of accretion, rather there is a possible “channel” along part of the northwestern flank of AMEP and possibly further upriver through an otherwise general zone of accretion.

Looking at the results in more detail it is important to note some key assumptions and limitations in the modelling. Three of the main limitations are listed below.

1. There is no bed slope routine in the model – in reality the newly deposited mud will move under gravity to form a flatter profile than the model predicts after five iterations. Near to the E.ON transect, the effect of gravity may lead to a movement of newly deposited sediments downslope and into the dredged pocket.
2. The morphological development is based upon conditions associated with a spring-neap cycle and no waves. In reality, waves will from time to time lead to re-suspension of newly deposited muds which will then be dispersed elsewhere. With waves, and indeed tide-surge events, the local deposition may be less than predicted.
3. Actual erosion is a function of the seabed composition. For example, if the bed comprises competent clay this will tend to slow down the erosion process.
4. The rate of deposition may vary greatly from season to season and year to year. Based upon limited available data on maintenance dredging requirements (HR Wallingford 2011a), the accretion rates may be lower than predicted.

Understanding these limitations, the following conclusions may be made with respect to predicted future changes in morphology at the Centrica and E.ON intakes and outfalls.

2.4 CONCLUSIONS

1. Northwest of AMEP, a broadly triangular region of deposition is predicted joining the northwest flank of AMEP with a point on the high water mark located some 700 m upriver.
2. Within this zone, deposition is not predicted to be uniform.
3. Direct deposition of sediments to the bed is predicted at the E.ON outfall.
4. Direct deposition of sediments to the bed is not predicted (after 30 weeks) at the Centrica outfall. The location of the outfall appears to be at a pivotal cross-shore location with accretion predicted inshore and potential erosion offshore of its location. The risk of deposition at the Centrica outfall appears low. However, given the Centrica outfall’s close proximity to predicted deposition and potential erosion, it is noted that wave action leading to resuspension of deposited sediments, combined with the action of gravity, will lead to movement of materials down slope. There is, therefore, a risk these sediment deposits may extend past the outfall, although at this location the accumulations are expected to be modest. Depending upon the environmental conditions there is both a slight risk of erosion and deposition at the Centrica outfall location.

5. There is potential erosion of the bed predicted at the locations of the Centrica and E.ON intakes. The actual erosion will depend on the properties of the seabed sediments.
6. The proximity of the E.ON intake to the AMEP dredged pocket (sited in close proximity to the side slope) means that there is a risk of local bed change as the side slopes stabilise.
7. There is potential channel formation around the northwest apex of AMEP (potential erosion).
8. Evidence to support a broadly triangular zone of accretion on the foreshore northwest of AMEP is found through the analysis of intertidal changes observed to the northwest of the HIT (HR Wallingford, 2011a), which shows accretion of about 1.5 m in the vertical.

3. References

HR Wallingford (2011a) Able Marine Energy Park 3D mud modelling. HR Wallingford Report EX6603 for Able UK. December 2011.

HR Wallingford (2011b) Able Marine Energy Park Dredging plume dispersion arising from capital works. HR Wallingford Report EX6627 for Able UK. November 2011.

Jeremy Benn Associates, (2011a). Able Marine Energy Park. Estuary Modelling Studies

Report V4 for Able UK. May 2011.

Jeremy Benn Associates, (2011b). Review of the Geomorphological Dynamics of the

Humber Estuary V4. Able UK. May 2011.

Figures

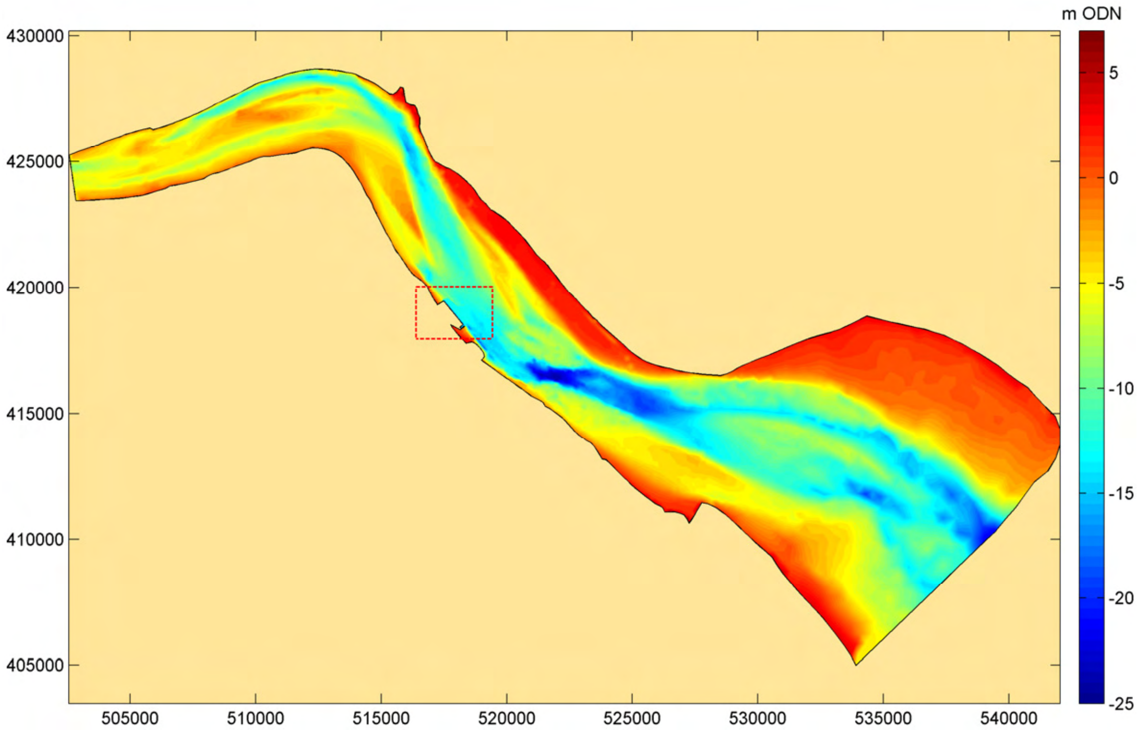

Figure 1 Humber Estuary model extent and bathymetry, showing location of AMEP

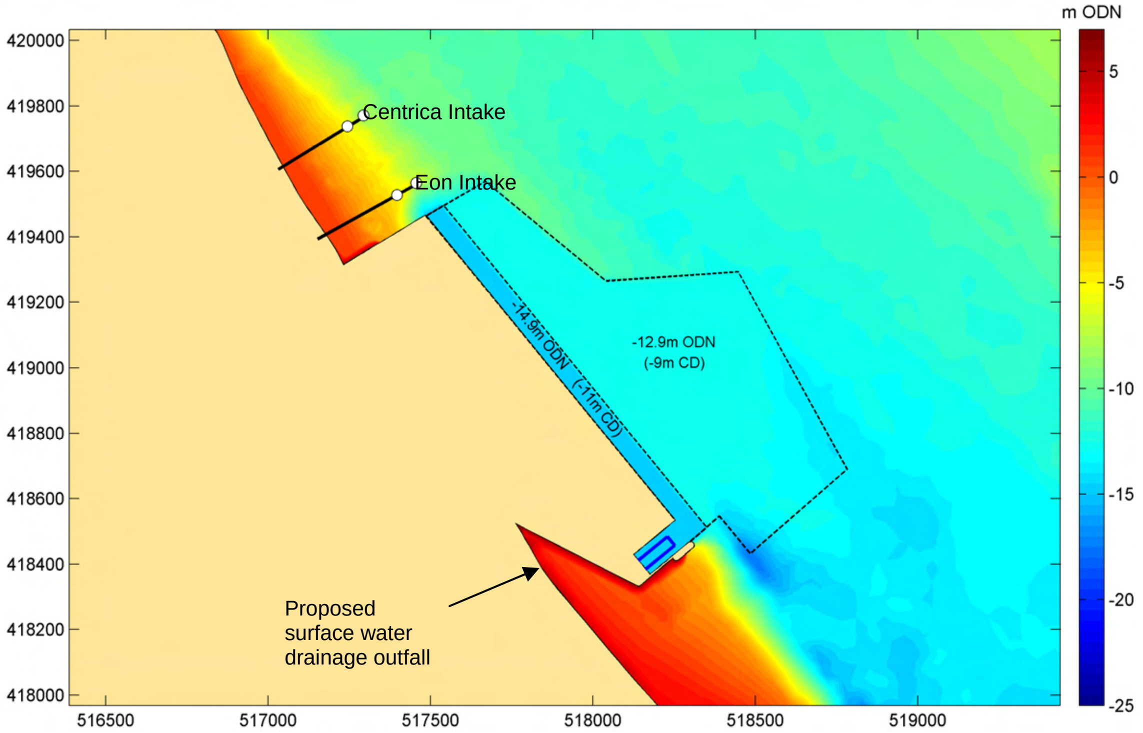

Figure 2 Model representation of bathymetry around AMEP, showing locations of E.ON and Centrica intakes and outfalls

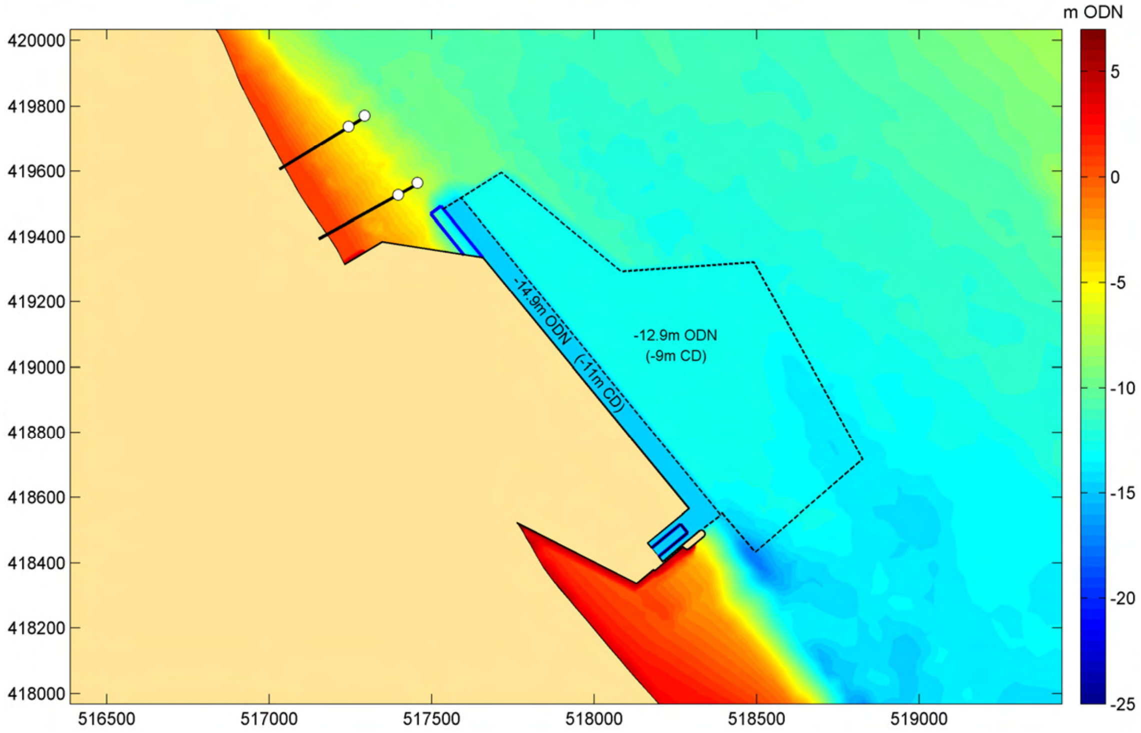

Figure 3 **Earlier arrangement of AMEP for which longer term morphology modelling was undertaken (HR Wallingford, 2011a)**

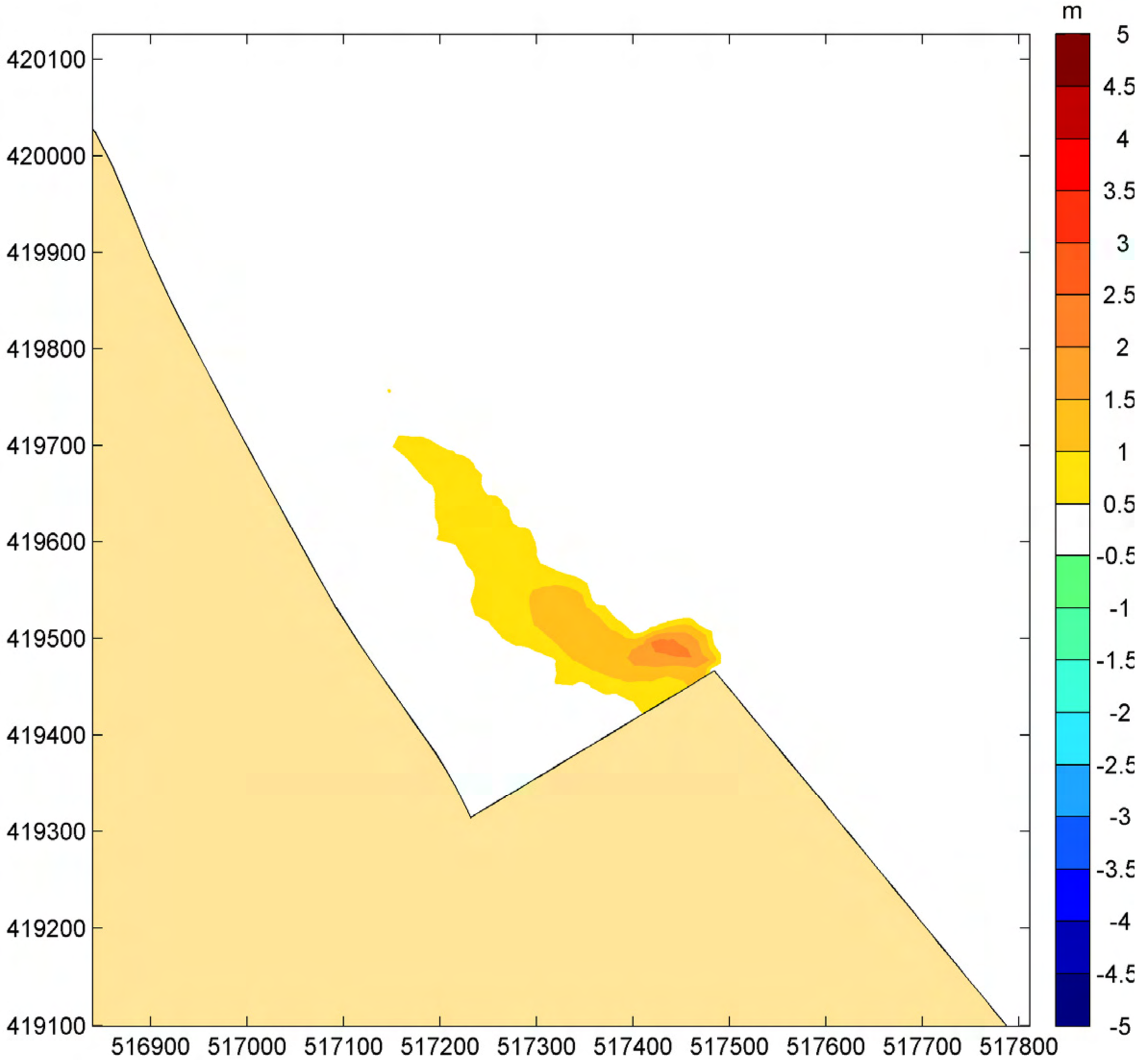

Figure 4 **Long term morphological prediction (Iteration 1 – bed difference after elapsed time of six weeks)**

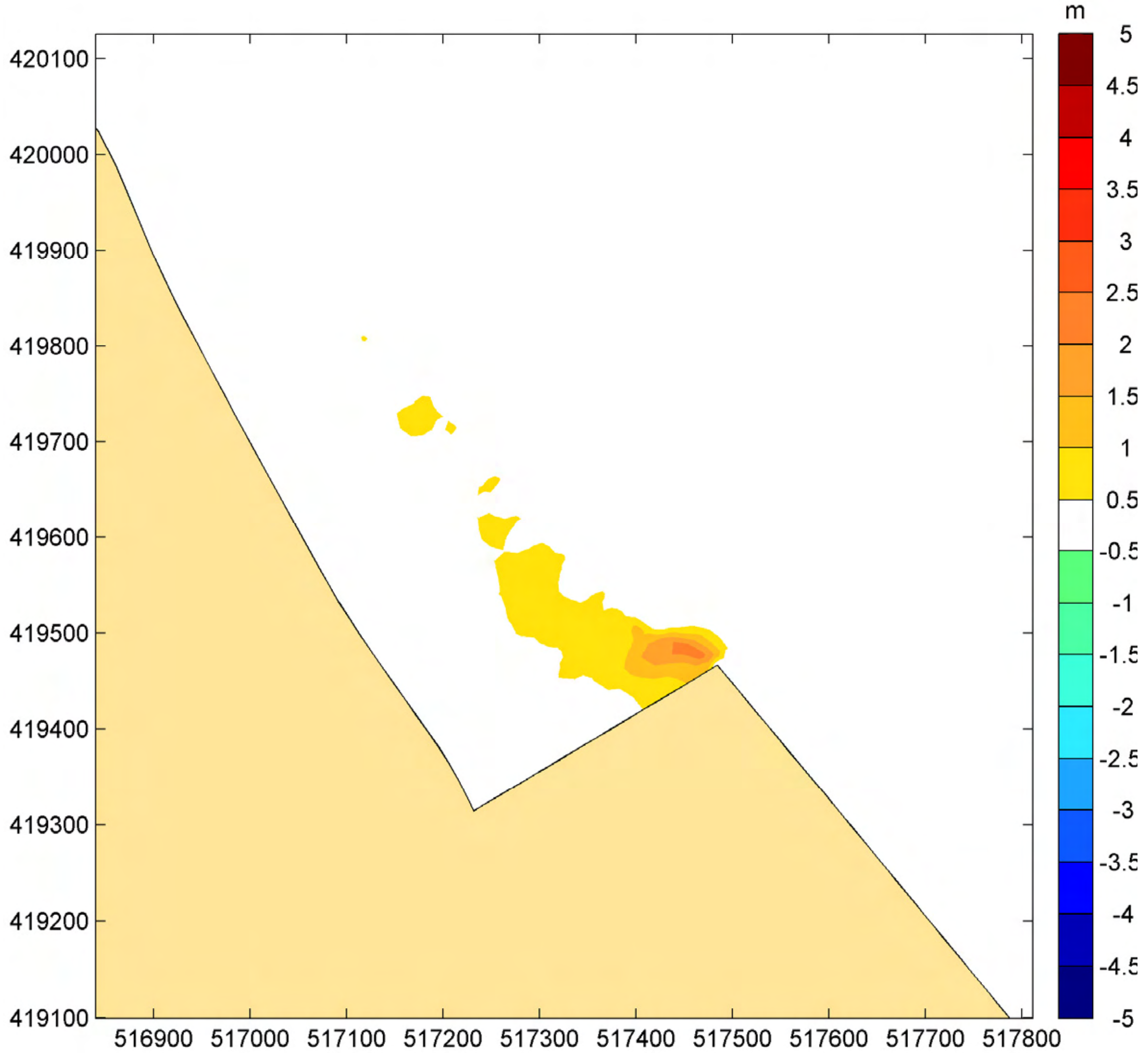

Figure 5 Long term morphological prediction (Iteration 2 – bed difference between six and twelve weeks elapsed time)

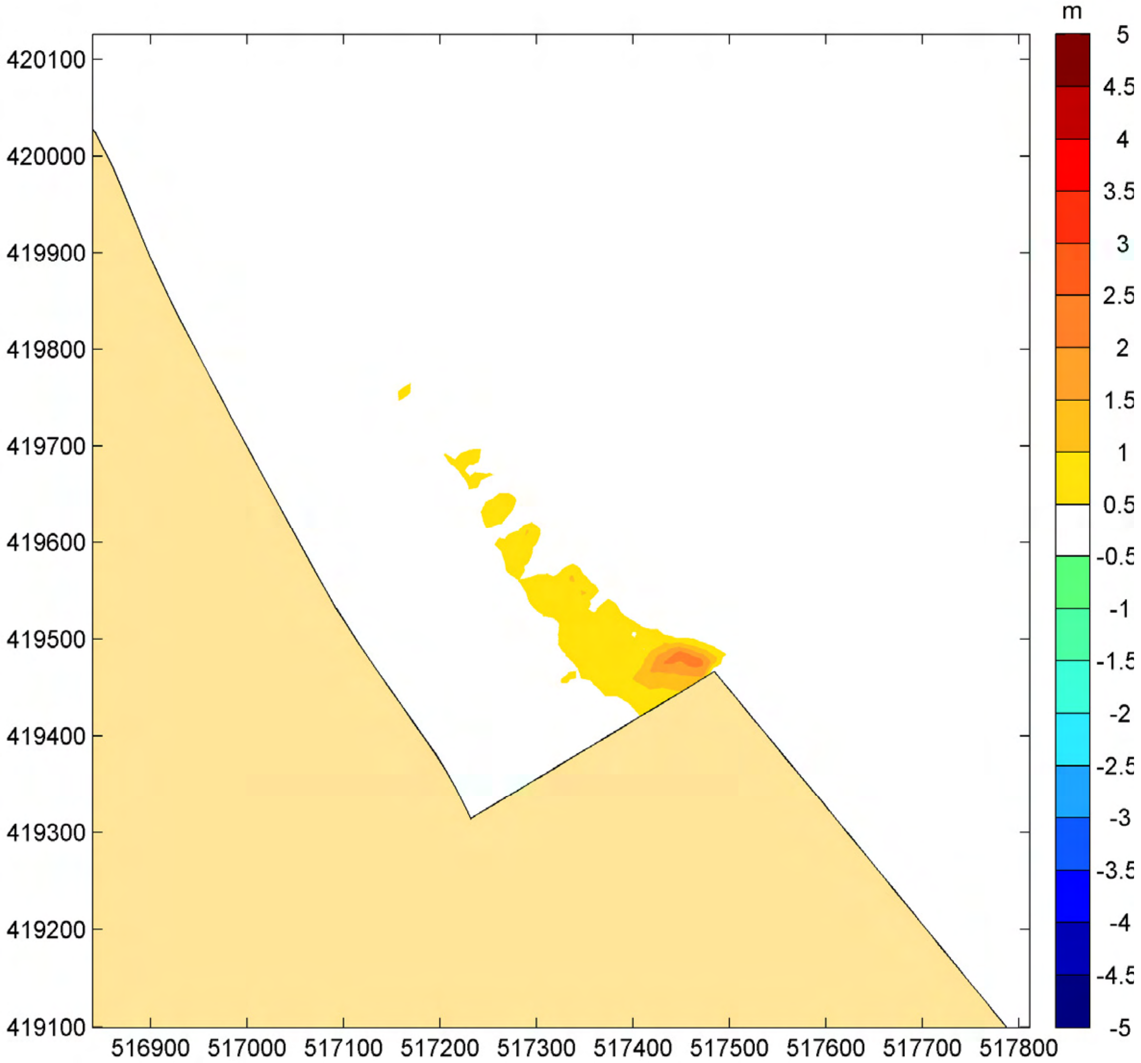

Figure 6 **Long term morphological prediction (Iteration 3 – bed difference between twelve and eighteen weeks elapsed time)**

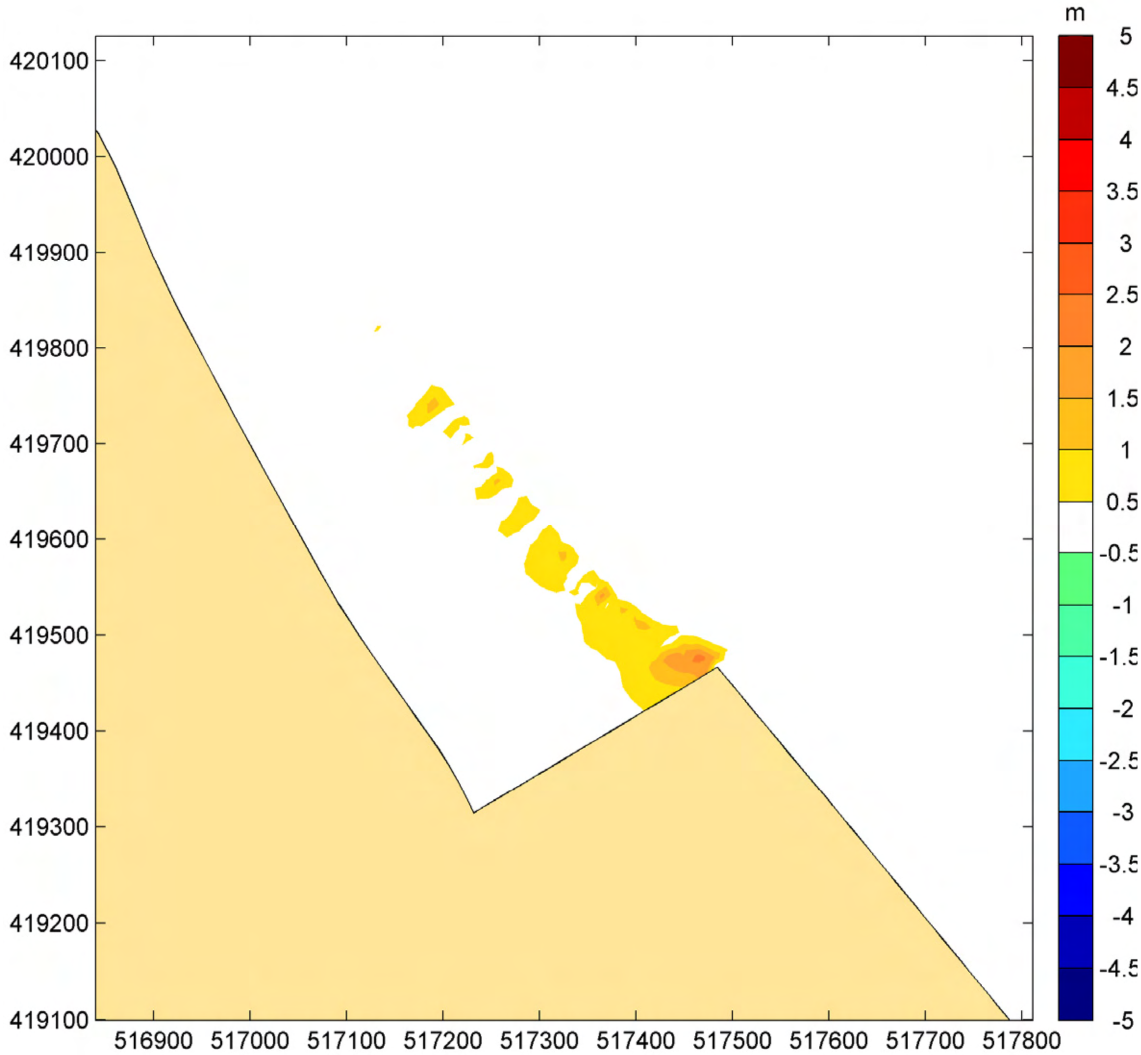

Figure 7 **Long term morphological prediction (Iteration 4 – bed difference between eighteen and twenty-four weeks elapsed time)**

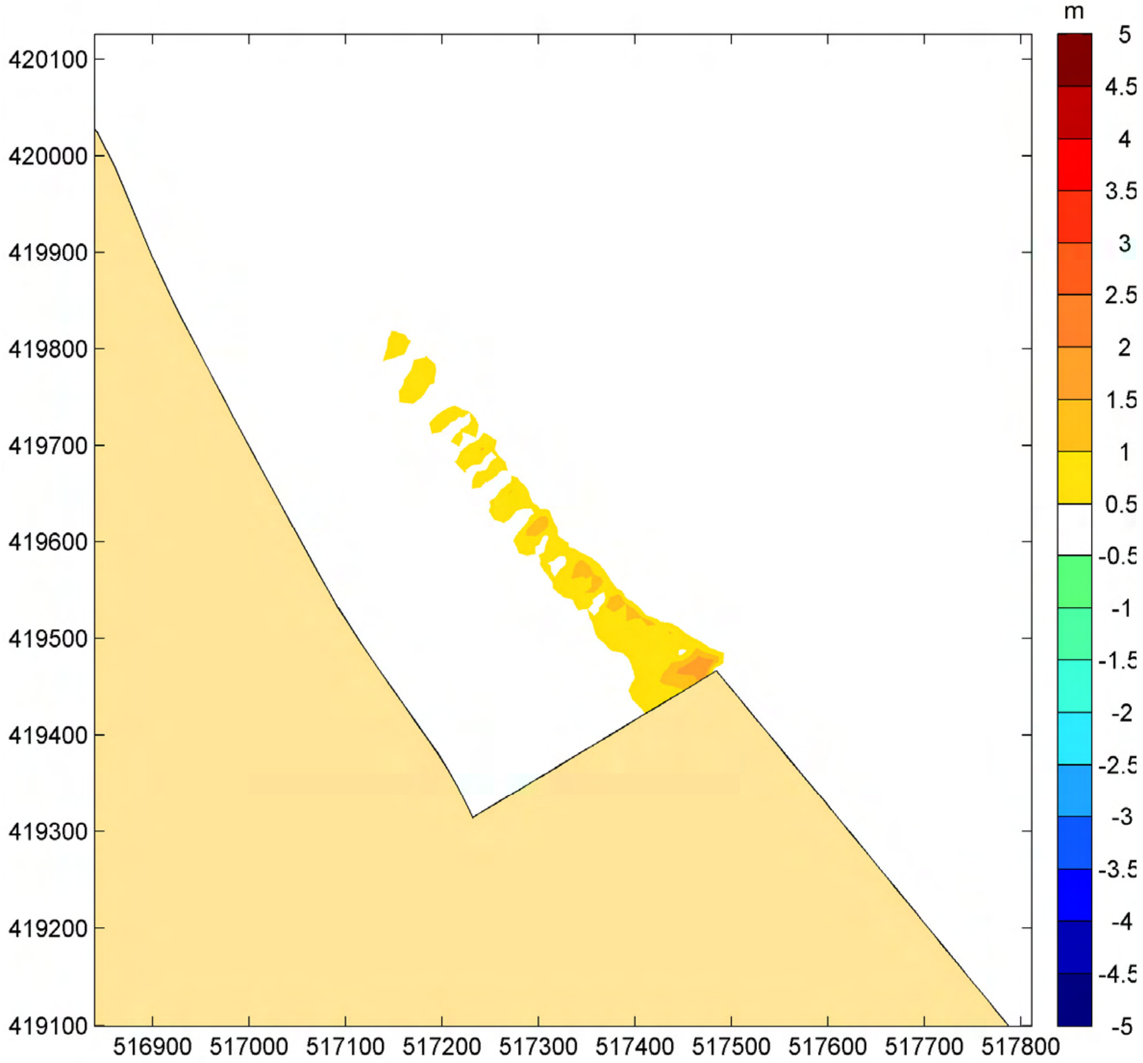

Figure 8 **Long term morphological prediction (Iteration 5 – bed difference between twenty-four and thirty weeks elapsed time)**

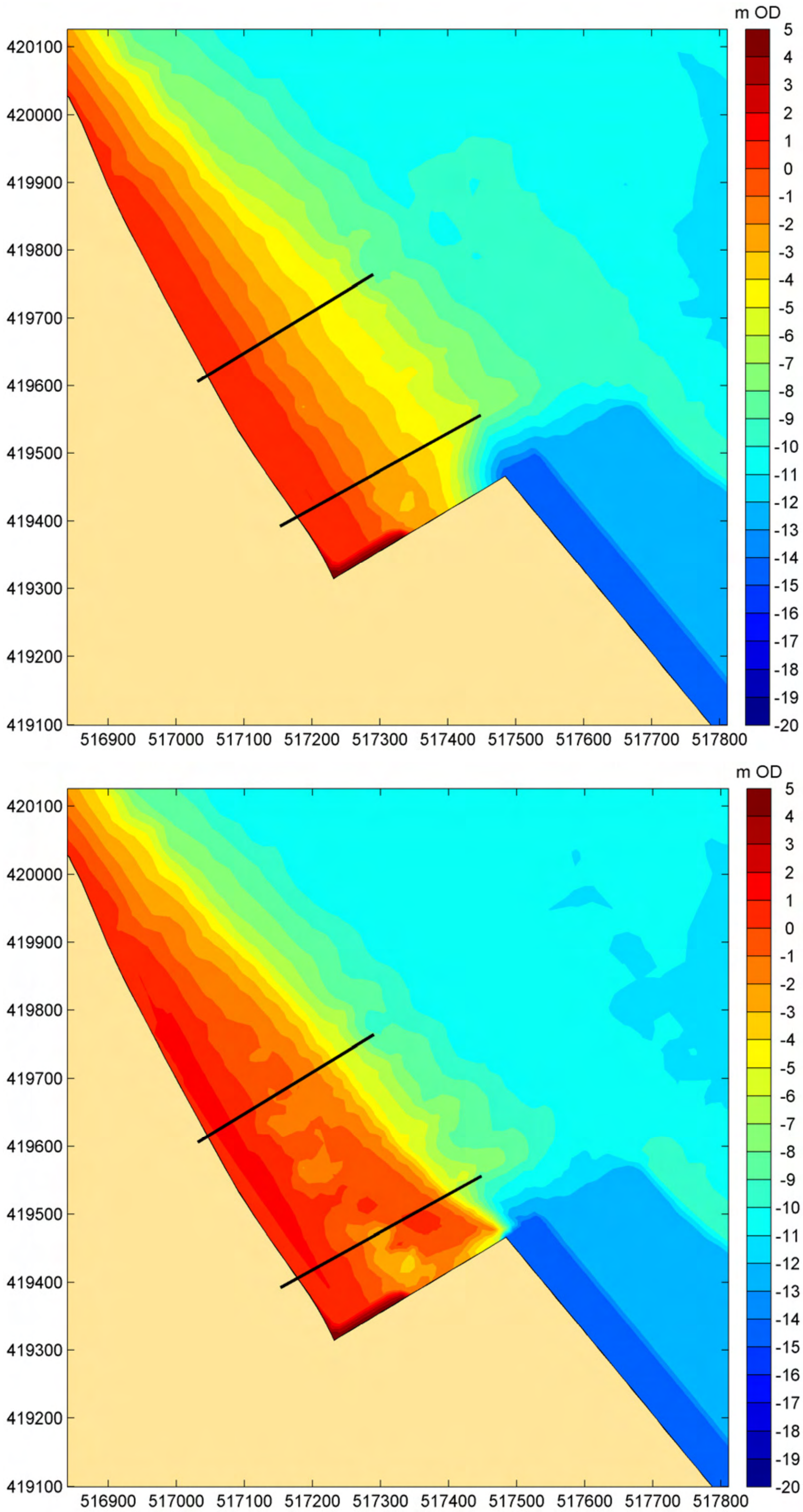

Figure 9 **Initial (start of Iteration 1 – top panel) and final predicted (end of Iteration 5 – bottom panel) bathymetry – transect lines extend through the E.ON and Centrica outfalls to the intakes.**

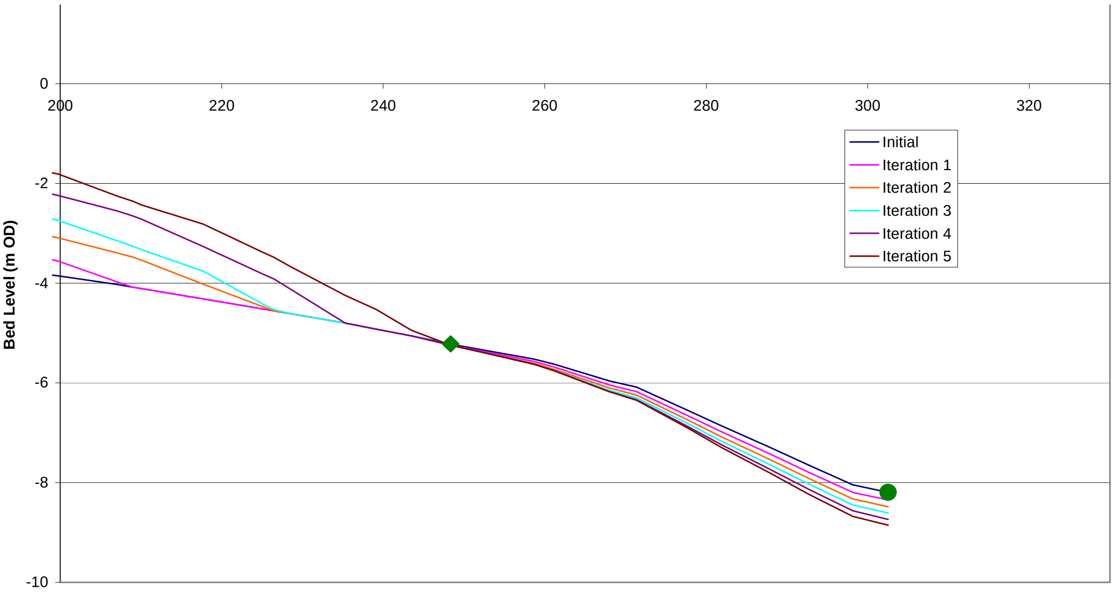

Figure 10a **Model predicted changes to morphology along a transect through the Centrica outfall (245 m chainage) and extending to the intake (about 300 m chainage) (each iteration corresponds to approximately six weeks duration)**

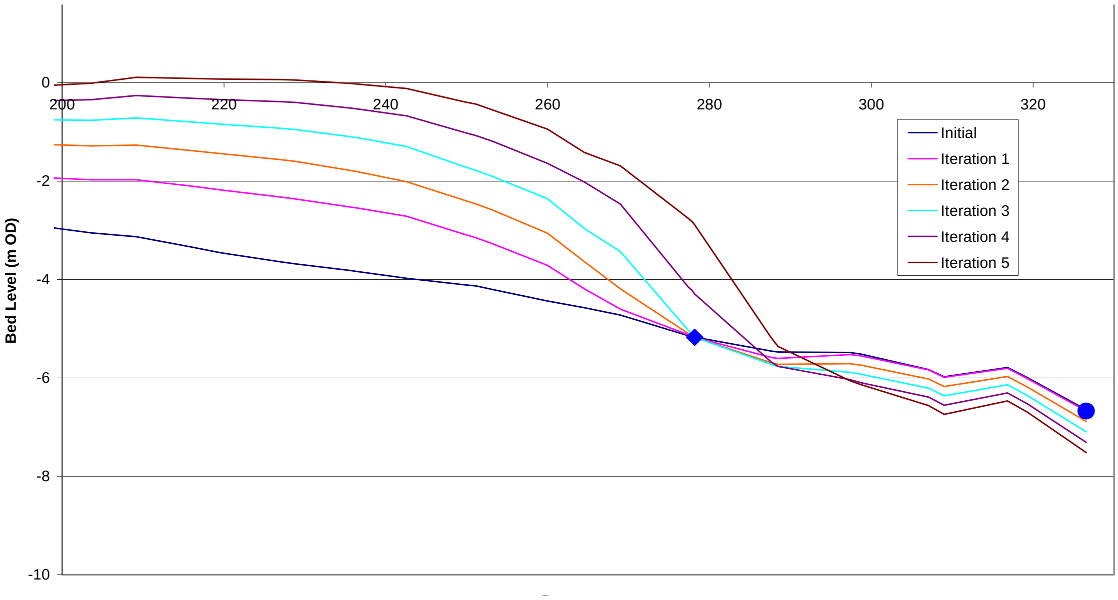

Figure 10b **Model predicted changes to morphology along a transect through the E.ON outfall (275 m chainage) and extending to the intake (325 m chainage) (each iteration corresponds to approximately six weeks duration)**

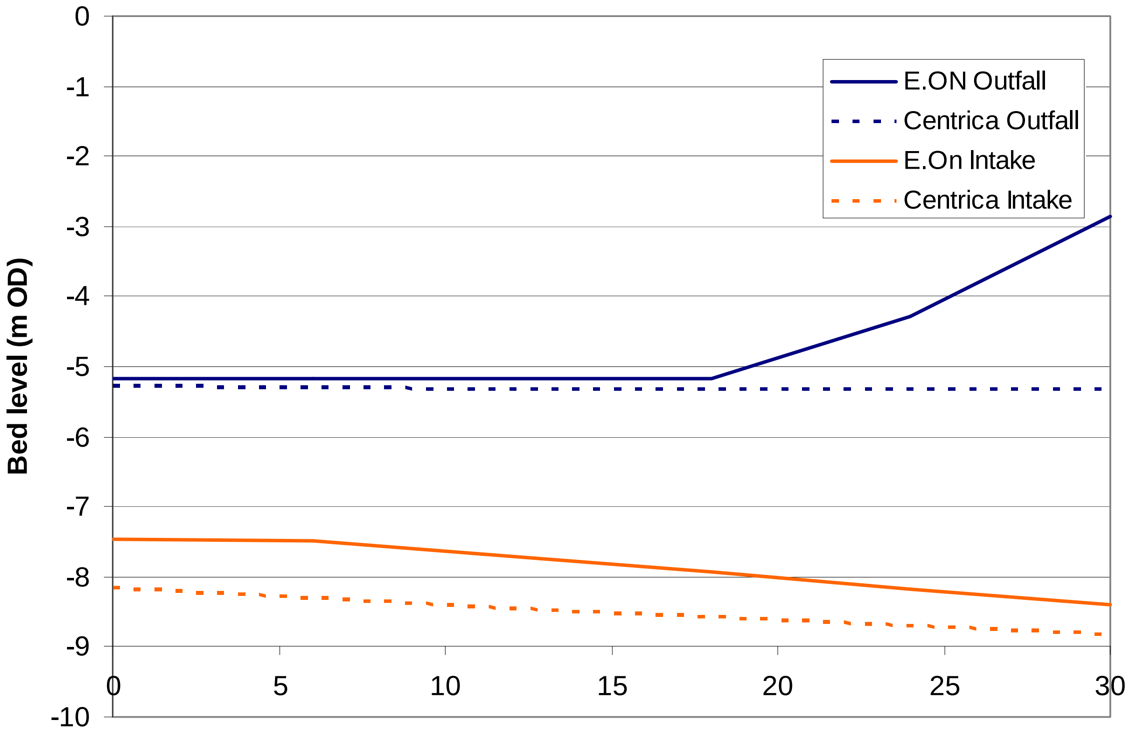

Figure 11 **Predicted longer term changes to morphology at intakes and outfalls over a period of 30 weeks**