5.4 Coastal Processes

5.4.1 Introduction

An assessment has been undertaken by ABP Marine Environmental Research (ABPmer) to review the impact the finished project may have on tide and wave climate. The assessment is summarised in this section by the project engineers and is included in full in Appendix 5.4.1 of the EIS.

This section also discusses the potential impact of some of the predicted changes to tide and wave climate.

The ABPmer assessment also reviews the impact of the construction phase in relation to suspended sediment concentration (or plume dispersion) likely to arise from the dredging activities. Aspects of this study are summarised within this section.

An appendix within the ABPmer report describes in detail the nature of the computer model, setup, calibration, and validation used to form the assessment. These issues are not repeated here. The study area used in the report is large enough to ensure a robust assessment.

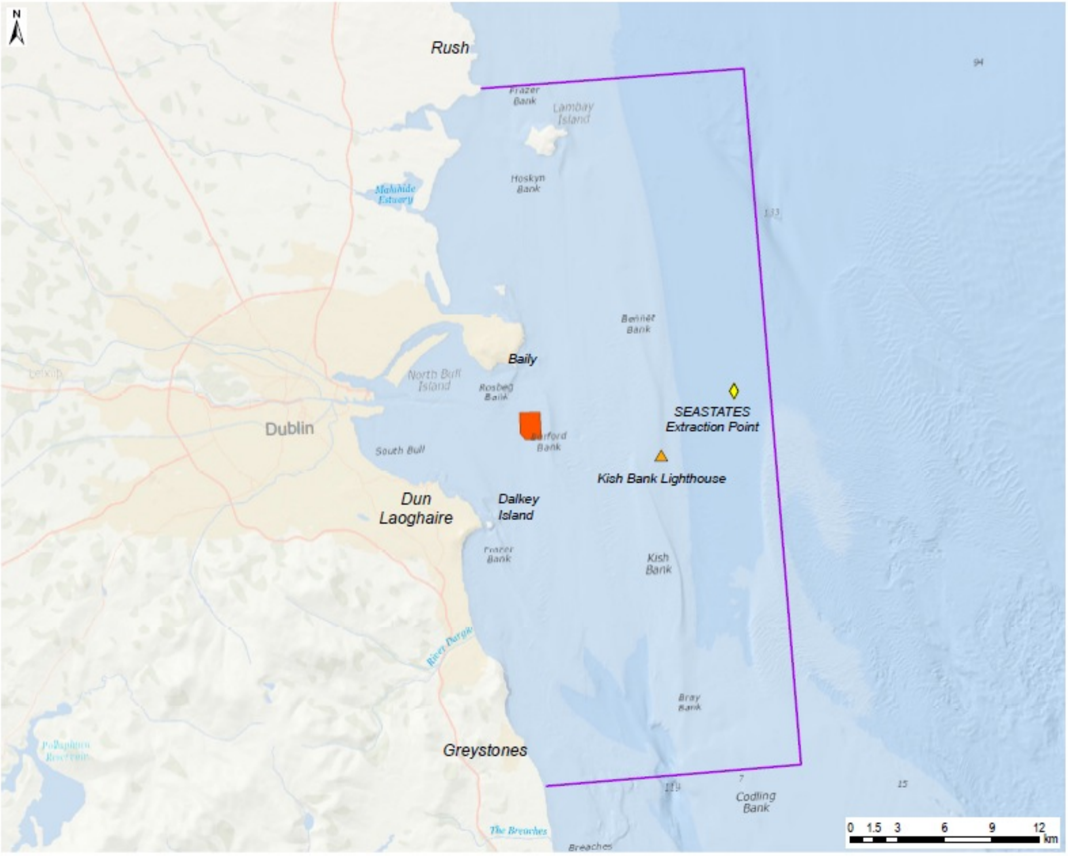

Figure 5.4.1 Coastal Processes study area

5.4.2 Receiving Environment

The existing harbour layout, water depths, tidal ranges, and the influence of storm surges on water level are discussed in section 3.3 and are shown in the application drawings.

As part of the assessment of the construction phase, the report considers the potential disposal of dredged material at the Burford Bank spoil ground, which is located immediately inshore of the northern half of Burford Bank. Burford Bank is an offshore linear sand bank feature aligned broadly parallel to the adjacent coastline and tidal access.

5.4.2.1 Existing Wave Climate

The orientation and aspect of Dublin Bay shelters it from offshore waves and wind coming from the south west clockwise through northerly directions. Waves from other directions are able to enter the bay, the greatest exposure being to waves from the east. The outside of Dun Laoghaire Harbour is exposed to these typical conditions.

For most wind/wave directions, including the most frequently occurring conditions, the harbour is sheltered from waves. Waves within the harbour are then typically the result of local wind fetch only. Waves can enter the harbour when approaching from the north clockwise through south easterly directions. In these instances they tend to mainly influence the western and central parts of the outer harbour.

5.4.2.2 Existing Wind Climate

The winds in the study area predominantly come from the westerly and south-westerly directions. Stronger winds also tend to come from these predominant wind directions, although intermediate strength winds could also come from south easterly and north easterly directions.

5.4.2.3 Existing Currents

The typical tidal currents offshore of Dublin Bay are directed to the north on the flood, and to the south on the ebb. Within the bay they follow a similar trend, while flowing around the line of the coastline. The breakwaters surrounding Dun Laoghaire Harbour present an obstruction to both flood and ebb currents that would otherwise flow parallel to the adjacent coastline. Current speeds occurring near the harbour entrance are typically 0.65 to 1 knot on a mean spring tide.

Current speeds inside of Dun Laoghaire Harbour are typically very slight (less than 0.1 knots). A stronger narrow current is set up between the entrance to the harbour and the entrance to the inner harbour on the flood and ebb tides (0.5 knots and 0.2 knots maximum respectively).

5.4.3 Characteristics Of The Proposal

The characteristics of the proposal relevant to coastal processes are the marine components of the scheme: the creation of an approach channel, and the installation of piles to support the quay structure above water level.

The layout of the approach channel is discussed in section 3.3.1; the dredging methods likely to be employed in its construction are described in section 3.5 (and how this is modelled is included in the ABPmer report); and the characteristics of the material to be dredged are discussed in section 5.3 (and also summarised in the ABPmer report).

The quay structure is described in section 3.3.2 and the part of the construction that is relevant to the coastal processes is the installation of piles ranging in size from approximately 750mm to 3.0m in diameter. The proposed method of installation is described in section 3.5.3.1.

5.4.4 Potential Impact Of The Proposal

5.4.4.1 Potential Impact during the Construction Phase – Sediment Plume Analysis

This section summarises the findings of the ABPmer report with regard to suspended sediment concentration (SSC) during dredging activities, and the subsequent deposition of this material. A review of impacts with regard to particular sensitive receptors is contained elsewhere in the EIS.

There is a history of maintenance and capital dredging operations within Dun Laoghaire Harbour and Dublin Port, using local sites such as the Burford Bank Spoil Ground for spoil disposal. The potential impact of spoil disposal at this general location has historically been consistently found to present no likely significant impacts.

The impact of the dredging activities may be characterised as a localised, short duration, temporary increase in SSC within the sediment plume. This will initially exceed background levels but will return to background levels within a matter of minutes to hours, depending on the nature of the sediment being dredged or deposited.

As would be expected, the greatest increase in SSC is at the location of the dredger during dredging. The majority of the material being dredged is sand, and this material is rapidly re-deposited to the seabed within minutes of entering suspension. Dredged material outside of the harbour consists almost entirely of sand, and so as a result there is a negligible plume created during dredging at this location (no increase in SSC further than 100m from the dredger, or at any location after a short period of time has elapsed following the end of dredging).

More disperse plumes are created during dredging inside the harbour, resulting from silts and fines present in the dredged material at this location. Silts and fines remain in suspension for a longer time than sand. It should be noted however that the majority of disperse plumes represent low levels of suspended sediment, below 5mg/l. For comparison a naturally occurring mean level of surface SSC offshore of Dublin Bay is 4-10mg/l (summer-winter), and these natural offshore levels would be expected to be much higher following storm events, or in the shallow coastal waters close to the harbour.

For most of the tidal cycle, most of the fine sediment plume accumulates in the recirculating flow patterns in the outer harbour. For a brief time under certain states of the tide the plume may enter the inner harbour or be ejected from the harbour.

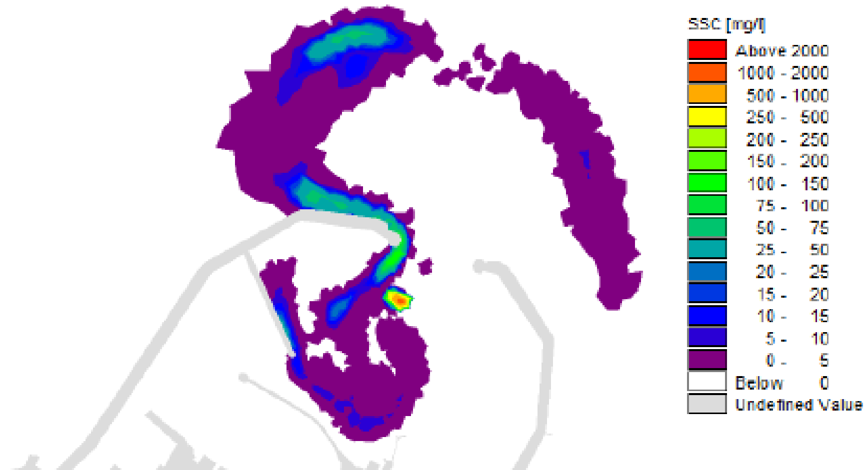

Figure 5.4.2 Example of a fine sediment plume plot for dredging inside the harbour

Sediment plumes have also been assessed for disposal of material at the Burford Bank Spoil Ground. Here the fine sediment plumes will be carried along the approximately north-south tidal axis, and are not expected to enter Dublin Bay. The plume footprints from sequential spoil releases and the dredging in the harbour have little or no potential to overlap and so cumulative impacts are not likely.

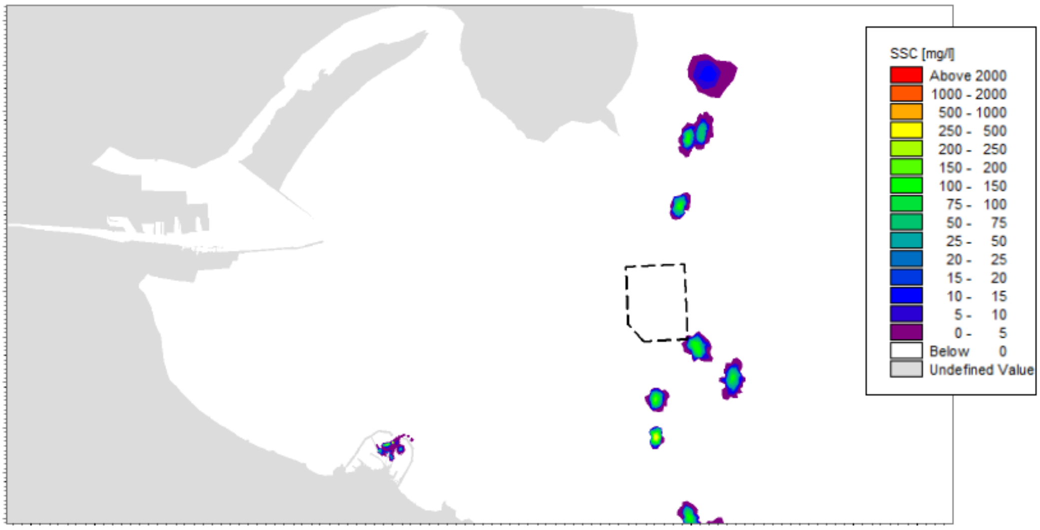

Figure 5.4.3 Example of a fine sediment plume plot at Burford Bank Spoil Ground

5.4.4.2 Potential Impact during the Construction Phase – Sediment Deposition

The material in the sediment plumes discussed in section 5.4.4.1 will ultimately deposit on the seabed. Re-suspended sands will be deposited rapidly, and within approximately 10m of the dredger. Sediments deposited back into the approach channel and above the target dredge depth will be removed by subsequent dredging.

When dredging within the harbour the re-suspended silts might be transported 250-500m from the dredged channel before being deposited with a conservative worst case resulting thickness in the order of 10mm, but generally much less (typically 0.3 to 0.8mm - refer to figure 5.4.4). A thin layer of silt or fine sediment is expected to be naturally present throughout most of the harbour, so this deposition will not change the seabed texture or sedimentary characteristics.

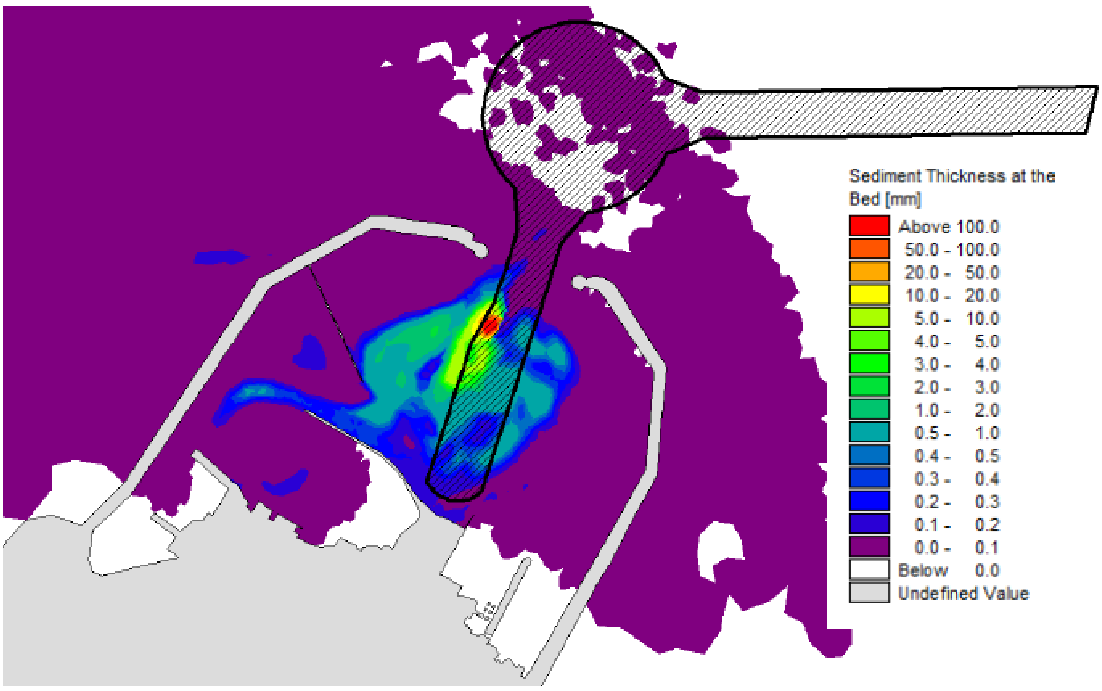

Figure 5.4.4 Sediment deposition model based on a single release point within the harbour

The use of a single point of release in the model results in a conservative estimate of the maximum local thicknesses that can be expected within 150m of the dredge footprint.

An assessment of the deposition of material has also been undertaken for disposal at the Burford Bank Spoil Ground. In this case the majority of the material will settle within the spoil ground itself. A secondary area of deposition is evident outside the spoil ground extend along the tidal axis, typically 3-10mm thick. A wider area of deposition of negligible thickness is also visible where fines are transported on residual currents.

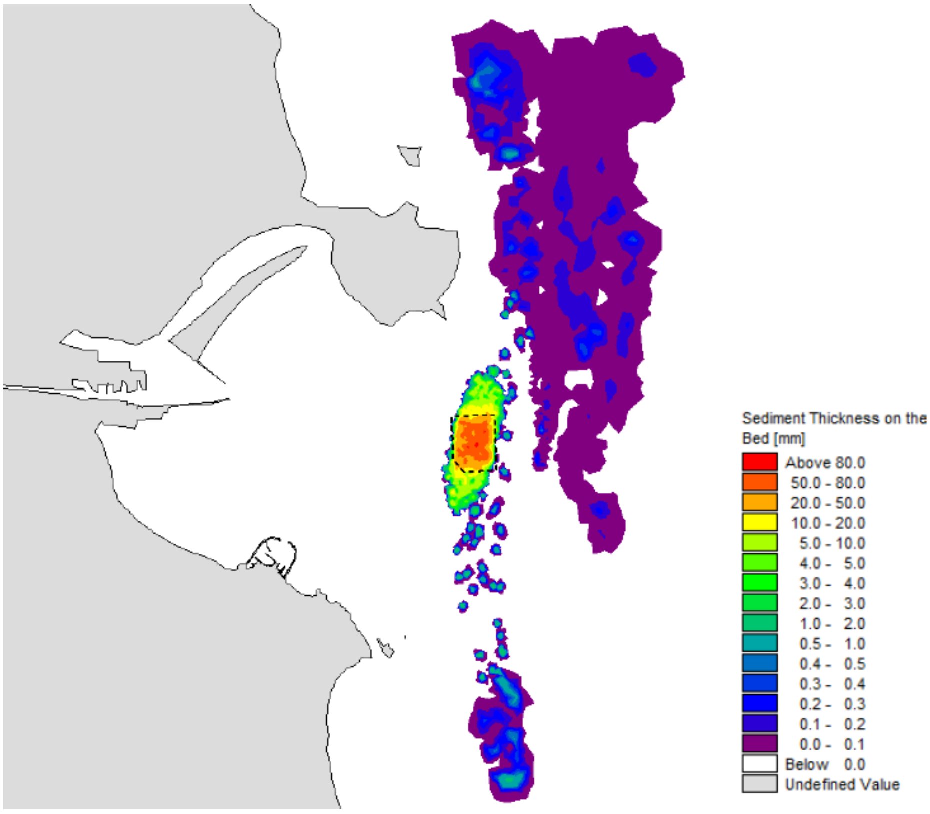

Figure 5.4.5 Sediment deposition model at the Burford Bank Spoil Ground

5.4.4.3 Potential Impact during the Operational Phase - Currents

The presence of the dredged channel is seen to have a small effect on local patterns of tidal currents. The effect is typically a reduction in local flow speed, in the order of 0.06 to 0.2knots, where the greatest influence occurs within the turning circle immediately outside of the harbour entrance. The effect is likely to be caused by the relative increase in water depth, increasing the cross section through which the currents may flow.

The absolute magnitude of the differences is very small and causes no significant change in the orientation of flow outside of the harbour entrance, or to the patterns of recirculation within the harbour.

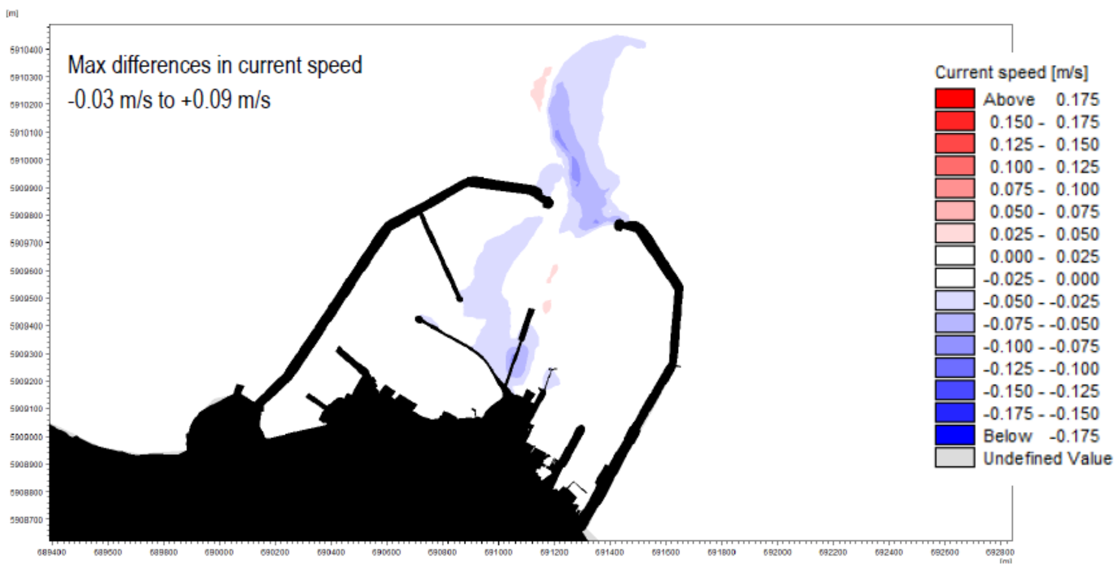

Figure 5.4.6 Worst case changes to current speed, seen during peak flood (High Water -3hrs)

5.4.4.4 Potential Impact during the Operational Phase - Waves

The modified water depth in the dredged channel affects patterns of wave refraction both inside and outside of the harbour, but only under certain conditions (certain offshore wave coming directions).

No measurable differences in local wave height are predicted to occur either inside or outside of the harbour when waves and/or winds come from the approximate south-east clockwise through north. This is due to the limited fetch from these directions.

Similarly, no significant differences in local wave height are predicted to occur either inside or outside of the harbour when waves come from any direction, where the coming wave heights are those experienced for the majority of the year.

These means that the scheme will not impact wave height during the predominant wind or wave conditions.

This section will focus on those conditions where the operational phase of the project will have a measurable effect on wave patterns inside and outside of the harbour. These conditions occur when large waves approach the harbour from the north clockwise through south-east, and are at their maximum when 'storm' waves approach the harbour entrance from just north of due east.

When measurable differences are apparent the following general patterns are consistently observed:

- A reduction in wave height inside the harbour between the harbour entrance and the entrance to the inner harbour.
- A reduction in wave height outside the harbour within the turning circle and approach channel.
- An increase in wave height inside of the harbour, in the eastern part of the harbour.
- An increase in wave height outside of the harbour to the north of the turning circle.

Of these, it is only the increase in wave height in the eastern part of the harbour (under these certain conditions) that might negatively impact on existing harbour infrastructure or users. The magnitude of increases to wave height in this area is reviewed in the next section.

5.4.4.5 Potential Impact during the Operational Phase – Wave height in the eastern harbour

The ABPmer report includes a selection of plots that show firstly the existing (baseline) wave height and direction under the selected conditions, and secondly the difference that is predicted to occur as a result of the scheme. Examples of these plots are included below.

The plots in figure 5.4.7 show the baseline conditions and wave height difference that might be expected when a 10:1 return period wave / wind event (a typical storm event that might be expected to occur up to 10 times a year) approaches the harbour entrance from the worst case direction. This plot is for mean high water springs, but a similar results can be seen on the mean low water springs plot.

Focusing on the south eastern corner of the plot, where the wave increase might affect existing harbour infrastructure, we see a predicted height increase of 5cm to 10cm. This change would apply to existing baseline conditions of 30cm to 60cm, meaning that as a result of the scheme wave height would be expected to range from 35cm to 70cm at this location. These increased waves are no larger than those that would occur naturally in the western half of the harbour under these conditions.

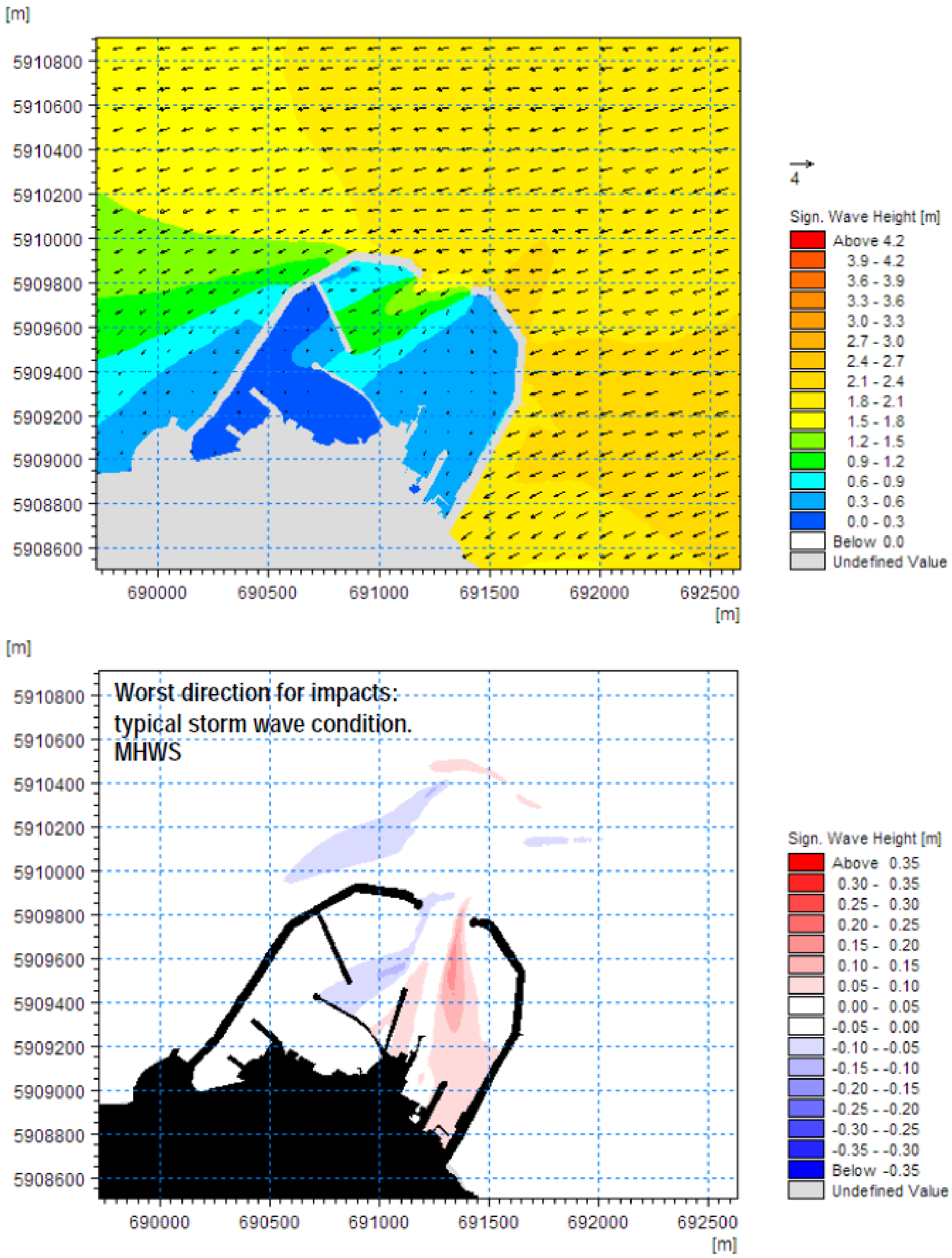

Figure 5.4.7 Baseline and difference plots for wave height, for a 10:1 return period wave / wind event approaching the harbour from the worst direction for impacts, during MHWS.

The plots in figure 5.4.8 show the baseline conditions and wave height difference that might be expected when a 1:50 return period wave / wind event (an extreme storm event that might be expected to occur only once in 50 years) approaches the harbour entrance from the worst case direction. Further, the plot applies only if this event happens to coincide with mean high water springs, as the results for mean low water springs under these conditions are less severe.

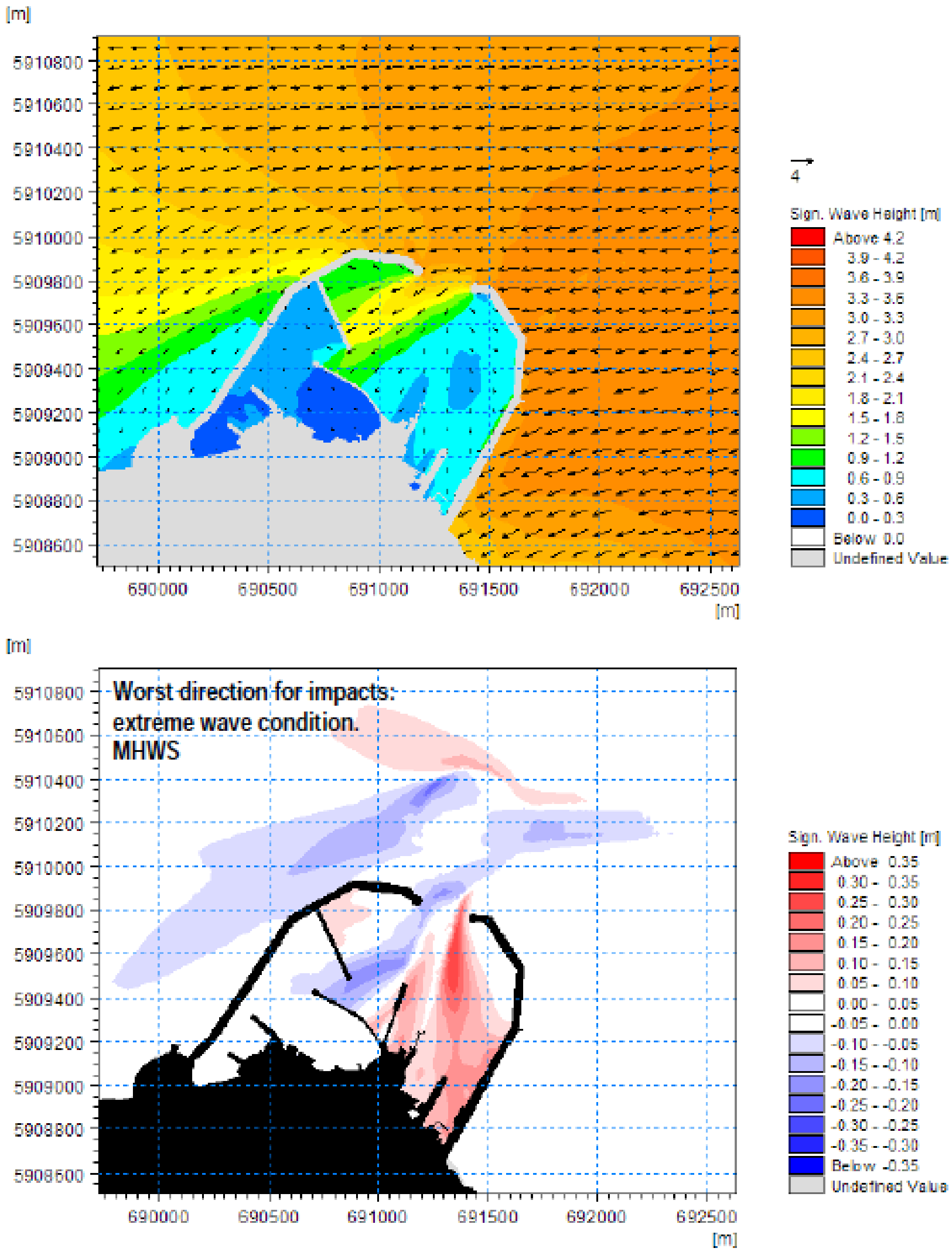

Figure 5.4.8 Baseline and difference plots for wave height, for a 1:50 return period wave / wind event approaching the harbour from the worst direction for impacts, during MHWS.

Focusing again on the south eastern corner of the plot, we see a predicted height increase of 15cm to 20cm. This change would apply to existing baseline conditions of 60cm to 90cm, meaning that as a result of the scheme wave height would be expected to range from 75cm to 110cm at this location. These increased waves are no larger than those that would occur naturally in the western half of the harbour under these conditions.

5.4.4.6 Potential Impact during the Operational Phase – Vessel Wake

The cruise ship will generate bow waves and wake waves when moving from the berth to the harbour, and this effect was considered during the navigation studies carried out separately from the ABPmer report. Attempts to quantify the likely size of the wake were unsuccessful, as it was found to be too small to register properly in the software. It is considered that the wake wave will be considerably less than 1m high, and no greater than waves that might occur under natural conditions, by the time it reaches any potentially sensitive receptors (for example the inner face of the harbour wall).

5.4.4.7 Potential Impact during the Operational Phase – Sediment Transportation and Deposition

Waves in intermediate water depths, such as in Dun Laoghaire Harbour, act to stir and mobilise seabed sediments in situ, but do not tend to cause measurable directional transport. The transport of mobilised sediment is rather controlled by the local speed and direction of currents. The rate of instantaneous sediment transport can however be increased on occasion by the additional action of waves that are sufficiently large to have an influence at the seabed.

Following completion of the dredged channel, localised long term rates of erosion and accumulation may vary slightly in those areas effected by impacts on wave height. This will not likely be time related but rather linked to episodic (storm) events. The distribution of sediments within the harbour will also continue to vary naturally due to baseline processes. Any contribution of the scheme to sediment transportation and deposition will be therefore be relatively small.

5.4.4.8 Potential Impact during the Operational Phase – Piling

The piles of the cruise terminal jetty and dolphins will have no measurable impact on current speeds (>0.01m/s) or direction (>5 degrees) at any time or location (other than possible localised wake effects within a few diameter lengths of individual piles, not resolved by the model).

The piles of the cruise terminal jetty and dolphins will have no measurable impact on wave heights (>0.05m) or direction (>5 degrees) at any time or location (other than possible localised wake effects affecting only relatively small waves within a few pile diameters of individual piles, not resolved by the model).

5.4.4.9 Do Nothing Impact

The only slight do-nothing impact is the need for very occasional maintenance dredging within the confines of the Dun Laoghaire harbour breakwaters. This leads to a short term increase in suspended sediment concentration during the dredging and dumping operations similar to those outlined in 5.4.4.1 and 5.4.4.2 above.

5.4.5 Avoidance, Remedial Or Reductive Measures

5.4.5.1 Avoidance, Remedial or Reductive Measures- Construction Phase

The proposed scheme has been found to have only a slight effect on sediment deposition and no remedial measures are required.

5.4.5.2 Avoidance, Remedial or Reductive measures – Operational Phase

The impact of the proposal on wave height is, slight both in terms of its scale and the conditions under which these impacts occur, as such no remedial or reductive measures are proposed.

It is possible that the access channel will accumulate sediment. The volume of this sediment is likely to be relatively small, as there are no sediment inputs (i.e. rivers entering the harbour) and sediment transportation is limited by the generally low current speeds. Accumulation of significant thicknesses of material within the dredged channel is likely to relate to episodic events (large storms). The rate of these effects are only likely to be fully understood over time.

The depth of the dredged channel will be surveyed at the commencement of each cruise season, and potentially during the cruise season following particularly large storm events, until the process of sediment accumulation is considered to be understood. Maintenance dredging will be undertaken if the depth of the access channel becomes insufficient for the visiting cruise vessels.

The effects of the dredging on the tidal flow are generally beneficial as there is a small decrease in current speeds in most locations, so no remedial or redctive measures are proposed.

The piling operations for the quay structure will have no measurable impacts on the coastal processes so no remedial or reductive measures are proposed.

5.4.6 Predicted Impact Of The Proposal

5.4.6.1 Predicted Impacts of the Proposal – Construction Phase

The only impact during the construction phase is the slight short term increase in Suspended Sediment Concentrations that will occur during the dredging and disposal activities described in sections 5.4.4.1 and 5.4.4.2.

5.4.6.2 Predicted Impacts of the Proposal – Operational Phase

The modified water depth in the dredged channel affects patterns of wave refraction both inside and outside of the harbour, but only under certain conditions (offshore wave coming from the north easterly quadrant) as discussed in section 5.4.4.4. This results in a small increase in wave height in the eastern part of the harbour and a small decrease in wave height in the western part of the harbour.

The piling for the quay structure and the construction of the dredged channel that form the marine elements of the proposal are considered to have no other significant impacts on thecoastal processes.

5.4.6.3 Worst Case Impact

The worst case impact is considered to be the slight increase in wave height in the eastern harbour when large waves approach from the north clockwise through to south east. During the 10:1 storm wave heights can be expected to increase by 5-10cm, while during the 1:50 year storm wave heights can be expected to increase by 15-20cm. However, in both cases there is a reduction in wave height in the western harbour and the absolute wave heights in the eastern harbour remain less than the wave height in the western harbour.