REPORT

Holyhead Waterfront Regeneration Scheme ES

Appendix 6.4: Coastal Processes Modelling Specification

Client: Conygar Holyhead Ltd.

Reference: PB8908-RHD-ZZ-ZZ-RP-Z-0034

Status: Final/P01.01

Date: 14 June 2021

Royal HaskoningDHV

Enhancing Society Together

Note

HaskoningDHV UK Ltd.
Industry & Buildings

To:	Natural Resources Wales
From:	Ben Hughes
Date:	07 December 2020
Copy:	
Our reference:	PB8908-RHD-ZZ-ZZ-NT-Z-0033
Classification:	Project related
Checked by:	Jamie Gardiner

Subject: **Holyhead Waterfront Regeneration Scheme EIA - Proposed modelling specification**

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1 Introduction

1.1 Background to the project

Detailed planning permission, a marine licence and a Harbour Revision Order (HRO) are being sought for the Holyhead Waterfront Regeneration Scheme ('the Proposed Scheme'), a mixed-use regeneration scheme which would include marine elements such as the construction of a new marina and the installation of a protective breakwater in Holyhead New Harbour. Some superficial capital dredging of the seabed within the footprint of the breakwater may be required prior to installation, in order to provide a stable surface; however, ground assessment work is ongoing to determine whether it will be required. If not, the breakwater will be laid directly on to the existing seabed and no dredging will be undertaken. If dredging is undertaken, material will be disposed of at Holyhead North offshore disposal site (IS043), on the assumption that this is acceptable.

An environmental impact assessment (EIA) scoping report was issued to Natural Resources Wales' (NRW) licencing team in October 2020, to determine the scope of the EIA in terms of meeting the requirements of the Marine Works (EIA) Regulations 2007 (as amended). A scoping opinion from NRW is pending (reference: SC2006).

In anticipation of the NRW scoping opinion, we have envisaged the need for numerical modelling studies to be undertaken to support an assessment of the nature and extent of potential effects on coastal processes. Specifically, it is anticipated that the modelling will provide a prediction of how the potential dredging and consequent installation of the proposed new breakwater may lead to changes in hydrodynamic processes and water quality within the New Harbour and environs.

Figure 1 provides an overview of the location of the proposed new breakwater within Holyhead New Harbour.

1.2 Purpose of this note

This note outlines our proposed approach to the numerical modelling for the Proposed Scheme. It provides details of the models we propose to run, and outlines how we propose to use the model outputs in our assessment of the effects of the Proposed Scheme. It also provides information on our approach to assessing water flushing rates within the newly enclosed marina. We request that NRW's technical experts provide comment and confirm that the proposed approach is appropriate to inform the EIA.

Figure 1 – Proposed layout of the Holyhead Waterfront Regeneration Scheme

2 Proposed scope of numerical modelling

2.1 Hydrodynamic and wave modelling

Hydrodynamic, wave transformation and wave penetration modelling has already been undertaken to support the design of the Proposed Scheme. Royal HaskoningDHV's 2D Irish Sea Regional Model, built in MIKE21-FMHD software, was used for the assessment of hydrodynamics. Wave transformation modelling and wave penetration modelling were completed using MIKE21-SW and MIKE21-BW, respectively. The MIKE modelling software suite was developed by DHI and has been used world-wide with a solid track record.

Our regional hydrodynamic model was calibrated against both predicted astronomic tidal elevation data and measured tidal elevation, and current data around the Irish Sea. The model was further refined and updated around the study site and inside the proposed new marina development to create the 2D Conygar model.

With the output from this modelling already available, it is proposed that further hydrodynamic and wave modelling will not be required, and the coastal processes assessment will be informed by the existing modelling output.

2.2 Sediment dispersion modelling

Should it be determined that capital dredging is required, we propose to use our established MIKE21/3 model to simulate suspended sediment dispersion arising from the proposed dredging and offshore disposal. This MIKE21/3 model covers the entire Holyhead Harbour and the Holyhead coast, including Holyhead North offshore disposal site. The MIKE21/3 model has been calibrated and verified by both astronomic and measured tidal data. The model includes a hydrodynamic module (MIKE21/3-HD) and sediment transport module (MIKE21/3-MT).

It is proposed that the model will be run in 3D for the entire dredging period to capture the full extent of the sediment plume and the peak concentration of suspended sediment. The stirring effect of waves will be considered by applying upper-limit wave conditions, i.e. those that dredging can be undertaken safely in during inshore dredging and offshore disposal.

In the event that the capital dredging is not required, we propose to instead assess the potential impacts of rock placement on a mobile seabed using expert geomorphological assessment. In this scenario, the use of numerical modelling to predict sediment dispersion is considered to be disproportionate to the potential impacts, because the release of sediment into the water column would be very small. Disturbance of sediment into the water column is likely to be low concentration and localised to each rock placement. The low tidal currents would mean it would settle quickly back to the bed, with very little change to the distribution of sediment particle sizes.

3 Proposed use of Model Outputs in the EIA

3.1 Hydrodynamic model

The presence of the new breakwater would have the potential to alter the baseline tidal regime, particularly tidal currents. Any changes in the tidal regime may have the potential to contribute to changes in seabed morphology due to alteration of sediment transport patterns.

The existing hydrodynamic modelling is fit-for-purpose to predict the impacts of the Proposed Scheme on the surrounding tidal current regime. The model was run for both the baseline and proposed scenarios. The hydrodynamic model was first run for the baseline scenario using water levels and tidal current velocities over one month, i.e. two spring-neap cycles. The model was then re-run over the same time period with the breakwater included.

Current conditions for two hours before and after high tide, for spring tides and neap tides near the study site, will be presented in the environmental assessment for both scenarios. The differences in current flows between the two scenarios will be presented to show the location and magnitude of any potential changes in tidal current velocities directly arising from the Proposed Scheme. Bed shear stresses for the two scenarios will be derived from the model outputs to define potential for sediment transport and changes to erosion / accretion patterns.

3.2 Wave models

The presence of the new breakwater has the potential to alter the baseline wave regime, particularly in respect of wave heights and directions. Any changes in the wave regime may have the potential to contribute to changes in the seabed morphology due to alteration of sediment transport patterns.

The existing wave models are fit-for-purpose to predict the impacts of the Proposed Scheme on the wave regime. The wave transformation model was run for the baseline condition and the wave penetration model was run for the proposed scenario (i.e. the breakwater in place). The results from both sets of model simulations will be compared in the assessment to predict the pre- and post-scheme wave regimes.

3.3 Sediment dispersion model

During capital dredging, there is the potential for the activities to disturb sediment, potentially resulting in changes in suspended sediment concentrations. The increased suspended sediment concentrations associated with capital dredging then have the potential to deposit sediment elsewhere.

The outputs of the sediment dispersion model will be used to support the environmental assessment of increases in suspended sediment and sediment deposition due to dredging activities. The results of the modelling will be presented as a series of maps showing suspended sediment concentration and sediment deposition on the seabed from the plume at any time over the simulation period, using the following statistical measures:

- the maximum values and maximum extent over which the effects are predicted; and,
- maximum predicted deposition from the plume.

These data will provide a basis to predict the worst-case impacts in the EIA.

4 Water flushing

With the proposed new breakwater in place in Holyhead New Harbour, there is the potential for tidal flushing of the newly enclosed marina area to be limited. If the flushing time is impaired, it could potentially lead to deterioration in water quality.

We propose to use the water quality assessment methods outlined in PIANC report 98, *'Protecting Water Quality in Marinas'* (2008). A measure for achieving acceptable water quality is the flushing time, calculated as the time required to reduce initial pollutant concentrations within a semi-enclosed waterbody to a prescribed value. In the report, methods are presented that predict flushing time based on various, easily-measurable input parameters, including tidal prism, water depth and basin area. These empirical methods are deemed proportionate and robust enough to determine flushing time, with the proposed breakwater in place, for the purposes of the EIA. Once determined, we would use the predictions to assess the effects on water quality and subsequent impacts on marine species.

Note

HaskoningDHV UK Ltd.
Industry & Buildings

To:	Natural Resources Wales
From:	Ben Hughes
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Copy:	
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Checked by:	Jamie Gardiner

Subject: **Holyhead Waterfront Regeneration Scheme EIA – Response to NRW's comments raised on proposed modelling specification**

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1 Introduction

A modelling specification (PB8908-RHD-ZZ-ZZ-FN-Z-0033_modelling specification.pdf) detailing the proposed approach to the numerical modelling for the Holyhead Waterfront Regeneration Scheme ('the Proposed Scheme') was submitted to NRW on 7 December 2020. A response was provided by NRW on 25 January 2021 (ref. RV0540-029), which included a number of comments requesting clarification or further information on elements of the specification.

2 Purpose of this note

This note sets out our responses to the comments provided by NRW in their response RV0540-029. With the information provided in this note, we are seeking to get final confirmation from NRW's technical experts that the proposed approach is appropriate to inform the Environmental Impact Assessment (EIA) for the Proposed Scheme.

3 Responses

Our responses to the comments provided by NRW are presented in Table 1 on the following page.

Royal HaskoningDHV
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Table 1 Response to NRW comments

NRW comment no.	Comment refers to Section:	NRW Comment	RHDHV response
1	2.1: Proposed scope of hydrodynamic and wave modelling	Before we can agree on whether the 2D 'Conygar model' is fit for purpose, we need to see evidence of the calibration and validation outputs of the regional scale hydrodynamic model and the model mesh size, type and model domain spatial extent chosen.	The 2D hydrodynamic model to be used is the same as that used for the Holyhead Port Expansion project; the model has been further refined and updated inside the New Harbour. As NRW has access to the Port Expansion application, please refer to that project for details on the calibration and validation outputs and further details of the model (we can provide the relevant documents if necessary). No additional calibration and validation of the model is considered necessary.
2		We cannot agree that further hydrodynamic and wave modelling will not be required until we have had the opportunity to review the efficacy of the existing modelling outputs.	The hydrodynamic model is now going to be rerun to take account of the latest configuration of the proposed marine works. This will include the presence of land reclaims / revetment, breakwater and a potential dredged berth pocket for the RNLI vessel. The model scenario will be run for a period of 1 month, since this will cover a full spring-neap tidal cycle. The wave transformation and wave penetration modelling were completed using MIKE21-SW and MIKE21-BW, respectively. The wave transformation model was run for the baseline condition and the wave penetration model was run for the Proposed Development scenario (i.e. with the new breakwater and land reclaims in place). The results from the baseline and proposed scenario model simulations will be visually compared in the EIA to predict the differences between the pre- and post-development wave regimes.
3	2.2: Proposed scope of sediment dispersion modelling	What is the anticipated dredge period and working pattern of the dredger given the estimated amount to be removed (125,000m^3)? What are the proposed dredge spill rates and volumes? What is the percentage size distribution of the sediment being dredged and	The proposed dredge spill rates and volumes are still to be determined, as are the dredge period and working pattern. A marine vibrocore survey has been undertaken in 2020 and included collection of 10 vibrocores. They recovered (typically) very

NRW comment no.	Comment refers to Section:	NRW Comment	RHDHV response
		will the sediment dispersion modelling factor in the different sediment size fractions?	soft to soft, clayey silt with occasional lenses of silty sand underlain by mudstone bedrock. Only two of the vibrocores penetrated into weathered bedrock. The remaining vibrocores penetrated between 0.3m and 1.5m of the clayey silt. Thirteen sub-samples were recovered from the vibrocores and particle size analysis undertaken. The dominant sediment types are silt (53-68% in all samples) and clay (18-38%). Sand (0-7%) and gravel (0-3%) are minor components. The median particle sizes of the samples are between 0.0058mm and 0.0077mm (silt). The gradient curve of sediment particle size will be represented in the model. The model will be run for the entire dredging programme and the maximum suspended sediment concentration value will be presented.
		Can you please clarify that “potential impacts of rock placement on a mobile seabed” refers to the positioning of the new breakwater rock armour and not to the disposal of capital dredged rock material at the Holyhead North disposal site?	Section 2.2 of the modelling specification refers to expert geomorphological assessment of the impacts of placement of breakwater rock material onto the existing seabed within the footprint of the new breakwater, an approach which would be taken should dredging in the footprint of the breakwater not be required. However, we now anticipate the requirement for dredging therefore we do not anticipate the need to take this alternative approach.
5	3.1 Proposed use of hydrodynamic model outputs	Can you please clarify if you will produce depth averaged tidal current vectors showing magnitude and direction over each spring and neap tidal cycle for baseline characterisation over the full extent of the study area and whether the ‘proposed scenario’ includes all the proposed marine engineering works?	Depth-averaged tidal current vectors showing magnitude and direction over each spring/neap tidal cycle will be presented for baseline characterisation. As stated above, the hydrodynamic model will be rerun based on the latest configuration of the marine works.
6		Can you please clarify if the “two hours before and after high tide” [when current conditions are proposed to be presented] are representative of maximum flow conditions during ebb and flood tides?	We will compare the time series and select the time when ebb and flood currents are at their highest for the purposes of comparison. This will allow us to represent maximum flow conditions and may not necessarily be exactly two hours before and after high tide.
7 & 8		The bed shear stresses derived from the hydrodynamic modelling of currents will be for current only conditions. How are you going to relate the bed shear stress calculations to the seabed sediment	Bed shear stresses derived from the hydrodynamic modelling will be for current-only conditions. Relating the change in bed shear stresses to the seabed sediment type (and hence potential for

NRW comment no.	Comment refers to Section:	NRW Comment	RHDHV response
		type and show the changes to sediment transport patterns and areas of accretion and erosion? Will you be using the Mike21 sediment transport module to simulate bed load transport and suspended load transport of non-cohesive and cohesive material that is representative of the mobile sediments at the study site? Will bed shear stresses be calculated for wave and current conditions using wave heights that represent typical, storm waves and extreme wave conditions? A comparison of current only bed shear stresses to wave-current bed shear stresses will allow for an assessment of the sensitivity of bed shear stress to waves, particularly, inshore where waves can be an important influence on bed shear stresses.	transport) will be completed conceptually and using empirical data on critical bed shear stresses for sediment movement. Comparing bed shear stress derived from a hydrodynamic model can demonstrate areas of accretion and erosion. It is expected (and the hydrodynamic model would demonstrate) that the affected area is limited to the proposed marina. It is expected the marina area will suffer from some degree of sedimentation. It is a confined space and the longshore sediment drift is limited to this confined space. The coast would only receive waves more or less perpendicular to the coast.
9	3.2: Proposed use of wave model outputs	What wave regimes will be modelled given that waves may come from different directions with differing wave heights over the year. It is best practice to choose wave conditions that represent typical wave conditions, storm winter waves and extreme waves all of which are dependent on the wind speed and direction, duration and fetch length.	The wave transformation modelling assessed 1 in 1-year waves for operational conditions, and 1 in 100 year, 1 in 200 year and 1,000 year for survival conditions during extreme storm events with offshore waves approaching from a range of 30-degree sectors.
10	General comment	There is no consideration given to the impacts of global warming. The potential effect of sea level rise should, depending on the assessment, be included in the modelling programme.	We have considered climate change in the wave modelling. Although we need to address flood risk due to climate change, it is unlikely that this development would worsen the effect of climate change by other means. With regard to flood risk, it is likely that the proposed development would provide some protection to the coast from waves.