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Note / Memo

HaskoningDHV UK Ltd.
Water & Maritime

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Subject: **Sidmouth Breakwater - Optimisation Potential**

1 Introduction

1.1 Background

Following a risk workshop held in January 2022 and revised construction costs for the preparation of the Outline Business Case for Sidmouth coastal defence scheme, concerns have been raised related to the level of available Grant in Aid funding and thus the economic feasibility of the project.

To assess whether project savings could be obtained by reducing the overall standard of protection (SoP), RHDHV has been asked to revisit the design of the main elements of the scheme, namely the offshore breakwater at Frontage 4 and the splash wall behind the promenade, from 1 in 200 years return period SoP to 1 in 75 and 1 in 100 years for the present day and 50 years horizon. No changes to the quantities of beach nourishment (and associated East Beach groyne) were included in the assessment, as these would require detailed modelling to fully appreciate their impact on flooding and erosion rates.

Figure 1—1: Frontage Locations

2 Offshore breakwater analysis

2.1 Cross Section

The breakwater design used for the cost estimates comprises a simple rock type structure with no core and all rock armour. The structure has a slope of 1:3 on the seaside and 1:2.5 on the leeside and the armour size is 6-10t. The crest level fixed at +3.75mOD.

The breakwaters is located at ~70m in front of the beach at Frontage 4. This may need to be revised at detailed design stage.

A sketch of the structure's cross section can be seen in Figure 2—1.

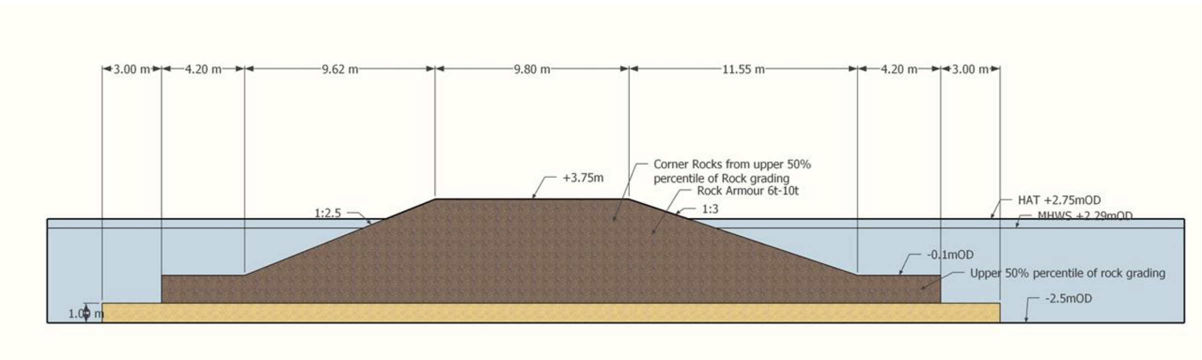

Figure 2—1: Sketch of preferred breakwater structure

2.2 Original Design Conditions

RHDHV has reviewed the design conditions used for the previous design. The original design used the 1 in 200 year event, with a theoretical offshore wave height of 4.44m. However, due to the location of the breakwater relatively close onshore (~5.1m water depth), waves are likely to be depth-limited and thus a lower incident wave height should be used in the assessment. The maximum wave height for a given depth of water is determined using the widely accepted rule of thumb:

Maximum wave height = 0.78~0.80 * water depth; where

water depth = 5.1m (bathymetry -2.5mOD and design water level +2.6m)

In the location of the breakwater, a maximum wave height of ~4m would develop which was used in the assessment.

3 Potential for Optimisation

RHDHV has analysed the potential for decreasing the dimensions of the breakwater by reducing the design standards from 1 in 200 years to 1 in 75 or 1 in 100 years. Also, a shorter duration of benefit was considered from 100 years to 50 years.

As explained above, given its location, a smaller breakwater which does not compromise the required SoP would only be possible if the design wave height is below 4.0m, i.e. below the depth-limited wave height.

Table 3—1 shows the theoretical offshore wave heights at the breakwater location for Frontage 4 for both the 50 years (2067) and the 100 years (2117) epochs. It is immediately apparent that all wave heights are ~4m or greater and thus the revised breakwater would need to have the same dimensions as per the original design. Offshore wave heights greater than 4m would not develop at the breakwater location but be capped at ~4m.

Table 3—1: Wave Heights at Frontage 4 for different design standards

Time Epoch	Return Period (Years)	Wave Height Value (m)
Present Day	75	3.98
	100	4.02
	200	4.06
2067	75	4.53
	100	4.55
	200	4.57
2117	75	4.67
	100	4.70
	200	4.71

4 Splash Wall

At this stage of the project, a high-level assessment has been undertaken for the splash wall optimisation, assuming a maximum reduction in wall height of ~200mm during a 1 in 75 year return period present day event. Given the fact that the wall foundation are likely to remain the same to allow for potential future raising, it is unlikely that cost savings would be greater than around £10,000. Moreover, given the model uncertainties related to the height of the wall, it is considered more prudent to keep the original cost estimates.

5 Conclusion

RHDHV has concluded that at this stage of the project, without further costly and time consuming detailed analysis and modelling, there is no opportunity to optimise costs by reducing the SoP of the scheme to 1 in 100 years or 1 in 75 years return periods events. This is due to the fact that the incoming waves for the above storm events at the toe of the structure are greater than 4m, i.e. greater than the maximum allowed depth-limited wave height which can be experienced at the chosen location. Therefore, given that the same incoming wave height would be used, the breakwater would need to maintain the same dimensions.

Similar observations as for the breakwater can be drawn for the raised wall at the back of the promenade. Further detailed modelling would confirm exact dimensions of the wall. However, this analysis is not considered appropriate for the stage of the project.

However, potential optimisation in the design could be obtained at a later stage of the project, following further detailed modelling and / or if new information that allows for a change on the design wave heights becomes available.

Having determined that no savings can be made in the construction costs by reducing the SoP nor the duration of benefits, there is no need to reassess the cost / benefit analysis, as this would only result in smaller benefits being realised thus decreasing the cost / benefit ratio and available funding.

It is our recommendation that the current construction costs are used for calculating the maximum Grant in Aid funding available the scheme with further refinement at detailed design stage.