JBA consulting

Isle of Man Flooding and Wave Overtopping Study

Concept Design Report

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Department of Infrastructure
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Revision History

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Contract

This report describes work undertaken by JBA Consulting, on behalf of Isle of Man, Department of Infrastructure, by contract documentation issued 11 July 2014. Department of Infrastructure's representative for the contract is Jeffrey Robinson. Alexander Dane and Graham Kenn of JBA Consulting completed this work element.

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Purpose

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Acknowledgements

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Executive Summary

This report summarises the design of a number of coastal defence options for reducing the risk of coastal processes at seven sites on the Isle of Man:

- Castletown
- Douglas
- Laxey
- Ramsey
- Peel
- Port St Mary
- Gansey.

The defences have been designed to reduce the risk of coastal processes during the design storm event, specified as the 1 in 200-year event (including climate change to the year 2115), by the project team. The coastal risk mechanisms experienced at these sites can largely be split into those experiencing wave overtopping, so called open coast frontages, and those experiencing still water level flooding, named harbour frontages for this report.

A number of different design options have been proposed, to reduce the risk from these mechanisms. As part of the options development process, each option has been reviewed against key design criteria in the form of a Multi-Criteria Analysis (MCA). These criteria include the technical capabilities, impact on landscape, environment and heritage and the capital and maintenance costs. A summary of the findings are provided below on a site-by-site basis, detailing the existing standard of protection, the options proposed, the highest scoring option identified from the multi-criteria analysis and the cheapest option. This will allow the Department of Infrastructure (DoI) to make an informed decision about whether investment can be justified, and which option represents the best defence solution.

Castletown Harbour

Flood risk mechanism: Still water level flooding

Existing standard of protection: 1 in 10-year present day, 1 in 1-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
CH1 – Raised harbour wall	1 in 200-year	2.1	64
CH2 – Set back wall	1 in 200-year	1.5	65
CH3 – Tidal gate	<1 in 20-year	6.0	48

Highest scoring option: CH2 - Set back wall

Cheapest option: CH2 - Set back wall

Discussion items: In reality, the best defence solution within Castletown Harbour is likely to be a combination of a raised harbour wall in some places and a set back wall in others. The harbour can be effectively split into discrete frontages, where on an individual basis, the most appropriate defence option should be selected. The tidal gate significantly increases the risk of fluvial flooding during gate closure so can be effectively discounted from the options appraisal.

Castletown Open Coast

Flood risk mechanism: Wave overtopping

Existing standard of protection: 1 in 100-year present day, 1 in 20-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
COC1 – Raised sea wall	1 in 50-year	0.5	67
COC2 – Set back wall	1 in 200-year	1.2	76
COC3 - Rock revetment	1 in 200-year	2.8	66

Highest scoring option: COC2 - Set back wall

Cheapest option: COC1 - Raised sea wall

Discussion items: COC1 is the cheapest option, but only offers a standard of protection of 1 in 50-years in 2115, suggesting it may not be appropriate for the future. While COC2 scores highest in the MCA, it does so with a considerable risk in its ability to function as a coastal defence. If this option were to be taken forward to detailed design, it would require extensive physical modelling to prove its ability to meet the design criteria. More information on this risk is provided in Section 5.2.2. For these reasons, COC3 provides the least technical risks and so could be considered the preferred option for this frontage.

Douglas Harbour

Flood risk mechanism: Still water level flooding

Existing standard of protection: 1 in 50-year present day, 1 in 1-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
DH1 – Raised harbour wall	1 in 200-year	1.6	68
DH2 – Set back wall	1 in 200-year	1.3	76
DH3 – Tidal gate	<1 in 20-year	15.0	36

Highest scoring option: DH2 - Set back wall

Cheapest option: DH2 - Set back wall

Discussion items: The set back wall option is both the highest scoring and the cheapest option so can be considered to be the most suitable option within Douglas Harbour. The tidal gate option significantly increases fluvial flood risk so does not seem feasible after an initial assessment.

Douglas Open Coast Area A (Central and Queens Promenade)

Flood risk mechanism: Wave overtopping and still water level flooding

Existing standard of protection: Wave overtopping - 1 in 20-year present day, 1 in 5-year 2115
Still water level flooding - 1 in 200-year present day, 1 in 10-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
DOCA1 – Set back wall	1 in 200-year	4.4	77
DOCA2 – Raised sea wall	1 in 200-year	4.3	68
DOCA3 - Beach recharge	1 in 200-year (1 in 10-year SWL)	10.5	60

Highest scoring option: DOCA1 - Set back wall

Cheapest option: DOCA2/DOCA1 (limited price difference)

Discussion items: While the raised sea wall is marginally cheaper, the set back wall out performs the raised sea wall on the majority of scoring criteria so can be considered the most appropriate out of the hard defence solutions proposed. The beach recharge is expensive but could provide the opportunity to increase tourism footfall to Douglas Bay, so may provide other benefits in its implementation. The implementation of a beach recharge scheme would likely involve significantly more risk than the set back wall option and also a greater maintenance liability.

Douglas Open Coast Area B (King Edward Road)

Flood risk mechanism: Wave overtopping

Existing standard of protection: 1 in 10-year present day, 1 in 5-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
DOCB1 – Rock revetment	1 in 200-year	3.7	63
DOCB2 – Xbloc revetment	1 in 200-year	4.4	53

Highest scoring option: DOCB1 - Rock revetment

Cheapest option: DOCB1 - Rock revetment

Discussion items: Unless there are issues associated with sourcing the rock armour for the revetment, DOCB1 looks to be the most suitable option at this location. The concrete armour unit revetment would be more difficult to construct and have a higher cost than the rock armour revetment option.

Laxey Harbour

Flood risk mechanism: Still water level flooding

Existing standard of protection: 1 in 100-year present day*, 1 in 1-year 2115

* Laxey Harbour flood risk mechanism has been anecdotally described as being a combination of high still water levels and waves propagating into the harbour so this value is likely to be an underestimation

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
LH1 – Raised harbour wall	1 in 200-year	0.9	68

Discussion items: Only one defence solution was proposed at Laxey, due to the confined nature of the streets surrounding the harbour. It is acknowledged that there would need to be significant 'defence softening' measures developed during detailed design, in order to ensure the defences are in-keeping with their surroundings.

Laxey Open Coast

Flood risk mechanism: Wave overtopping

Existing standard of protection: 1 in 50-year present day, 1 in 5-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
LOC1 – Set back wall	1 in 100-year	0.8	77
LOC2 – Raised sea wall	1 in 10-year	0.4	66
LOC3 - Rock revetment	1 in 200-year	1.5	66

Highest scoring option: LOC1 - Set back wall

Cheapest option: LOC2 - Raised sea wall

Discussion items: While LOC2 is the cheapest option, the standard of protection offered does not fall within recommended guidance so can be effectively discounted from the options appraisal. LOC1 does not conform to the 200-year design standard, but the volume of overtopping experienced could be considered appropriate providing sufficient control measures are in place.

The rock revetment is the only option that conforms to the design standard, but may significantly alter the coastal environment in Laxey.

Ramsey Harbour

Flood risk mechanism: Still water level flooding

Existing standard of protection: 1 in 2-year present day, 1 in 1-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
RH1 – Raised harbour wall	1 in 200-year	1.6	66
RH2 – Set back wall	1 in 200-year	1.3	73
RH3 – Tidal gate	<1 in 20-year	15.0	41

Highest scoring option: RH2 - Set back wall

Cheapest option: RH2 - Set back wall

Discussion items: RH2 is both the cheapest and highest scoring option so represents the best defence solution. RH1 has greater technical risk and the possibility to remove the connectivity between the working harbour and promenade so is less favourable than the set back wall option. The tidal gate option significantly increases fluvial flood risk during gate closure, so does not appear viable after initial assessment.

Ramsey Open Coast

Flood risk mechanism: Wave overtopping and still water level flooding

Existing standard of protection: Wave overtopping - 1 in 50-year present day, 1 in 5-year 2115
Still water level flooding - 1 in 200-year present day, 1 in 100-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
ROC1 – Set back wall	1 in 100-year	1.0	77
ROC2 – Rock revetment	1 in 200-year	2.3	61

Highest scoring option: ROC1 - Set back wall

Cheapest option: ROC2 - Rock revetment

Discussion items: The set back wall option is both the highest scoring and cheapest option. However, it does not offer the full 1 in 200-year standard of protection in 2115. The overtopping rate experienced is not significantly higher than the intended tolerable threshold so could still be viable if the situation could be efficiently managed. The other option, the rock revetment, achieves the required standard, but does so at a large environmental and visual cost. This scheme would likely negatively impact upon the dune system, which may cause it to be rejected during the Environment Impact Assessment (EIA) stage. Therefore, this option may not be suitable at this location.

Peel Harbour

Flood risk mechanism: Still water level flooding

Existing standard of protection: 1 in 100-year present day, 1 in 1-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
PH1 – Raised harbour wall	1 in 200-year	1.0	69
PH2 – Set back wall	1 in 200-year	0.8	75

Highest scoring option: PH2 - Set back wall

Cheapest option: PH2 - Set back wall

Discussion items: The set back wall option scores highest and is the cheapest so appears to be the best defence solution. However the wall is set back behind East Quay road which would have to be closed during a storm event. If the DoI consider maintaining the access through East Quay road to be critical, this option may have to be discounted and the raised harbour wall option taken forward.

Peel Open Coast

Flood risk mechanism: Wave overtopping

Existing standard of protection: 1 in 20-year present day, 1 in 1-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
POC1 – Rock revetment	1 in 200-year	7.0	63
POC2 – Set back wall	1 in 200-year	1.3	77

Highest scoring option: POC2 - Set back wall

Cheapest option: POC2 - Set back wall

Discussion items: The rock armour revetment option is considerably more expensive than the set back wall option. Coupled with the lower cost, the set back wall option performs better against the key design criteria, suggesting that the set back wall option is the most suitable at this location.

Port St Mary Harbour

Flood risk mechanism: Wave overtopping and still water level flooding

Existing standard of protection: Wave overtopping - 1 in 20-year present day, 1 in 5-year 2115
Still water level flooding - 1 in 100-year present day, 1 in 50-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
PSM1 – Set back wall	1 in 100-year	0.9	76
PSM2 – Rock revetment	1 in 200-year	1.5	71

Highest scoring option: PSM1 - Set back wall

Cheapest option: PSM1 - Set back wall

Discussion items: While PSM1 is both the cheapest and highest scoring solution, it only offers a 1 in 100-year standard of protection. Having said this, the calculated wave overtopping rates are not significantly higher than the threshold and so this still represents a viable option. However, the existing concrete revetment in front of the defence is in poor condition and would likely need replacing in the next 10-20 years. This option is therefore likely to have a higher whole life cycle cost than PSM2 which addresses the poor condition of the revetment through the design of a rock armour revetment. For these reasons, PSM2 is the recommended option to be taken forward.

Gansey Open Coast

Flood risk mechanism: Wave overtopping

Existing standard of protection: 1 in 50-year present day, 1 in 5-year 2115

Proposed defence options:

Defence option	Standard of protection offered (2115)	Cost (£M)	Multi-criteria analysis score (%)
GOC1 – Rock revetment	1 in 200-year	8.3	63
GOC2 – Xbloc revetment	1 in 200-year	9.4	56
GOC3 - Raised sea wall	1 in 200-year	1.0	62

Highest scoring option: GOC1 - Rock revetment

Cheapest option: GOC3 - Raised sea wall

Discussion items: The low price of GOC3 makes it an attractive option. However, the magnitude of this wall would have a significant detrimental impact on the landscape, blocking out the view from the road and the property behind. It also does nothing to address the current problem with the existing rock armour becoming mobile during large storm events. For these reasons, GOC1 is recommended as the most suitable option at this location, being the cheapest and easiest to construct out of the two revetment options, it would also address the issue of existing armour stability.

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