



A great place to live, work & play

Project Appraisal Report

Authority scheme
reference

Defra/WAG LDW
number

Promoting
authority

Scarborough Borough Council

Scheme
name

Whitby Harbour Piers Coast Protection Scheme Phase 1



Date

November 2012

Version

3

PAR for *Whitby Harbour Piers Coast Protection Scheme Phase I*

Version	Status	Signed off by:	Date signed	Date issued
1	Submission to LPRG			
2	Updates for LPRG comments prior to meeting	Stewart Rowe	2/11/2012	5/11/2012
3	Updates after LPRG meeting on November 7 th 2012	Stewart Rowe	16/11/2012	

Template version – April 2011

CONTENTS

	Approval history sheet	iii
1	EXECUTIVE SUMMARY	1
1.1	Introduction and background.....	1
1.2	Problem	2
1.3	Options considered for implementing the FCRM strategy	2
1.4	Preferred option	3
1.5	Recommendation.....	6
1.6	Director's briefing paper	7
1.7	Key plan.....	8
2	INTRODUCTION AND BACKGROUND	9
2.1	Purpose of this report.....	9
2.2	Background.....	9
2.3	Current approach to flood risk management	12
3	PROBLEM DEFINITION AND OBJECTIVES	13
3.1	Outline of the problem.....	13
3.2	Details of approved strategy.....	13
3.3	Consequences of doing nothing.....	15
4	OPTIONS FOR IMPLEMENTING THE APPROVED STRATEGY.....	17
4.1	Options considered	17
4.2	Technical details	18
4.3	Environmental assessment	21
4.4	Option costs.....	23
4.5	Options benefits	25
5	SELECTION AND DETAILS OF THE PREFERRED OPTION.....	28
5.1	Selecting the preferred option	28
5.2	Sensitivity testing	29
5.3	Details of the preferred option	30
6	IMPLEMENTATION	37
6.1	Project planning	37
6.2	Procurement strategy.....	38
6.3	Delivery risks	38

TABLES

Table 1.1	Options Considered	2
Table 1.2	Project costs (£k)	4
Table 1.3	Benefit-cost ratios and outcome measures	5
Table 1.4	Risks and mitigation	5
Table 4.1	Options Considered	18
Table 4.2	Key environmental impacts, mitigation and opportunities	21
Table 4.3	Summary of options costs	23
Table 4.4	Summary of present value (PV) damages and benefits (£k)	26
Table 5.1	Benefit-cost assessment	28
Table 5.2	Comparison of whole life costs for phasing sensitivity	29
Table 5.3	Project costs for preferred option (£k?)	34
Table 5.4	Updated cost of strategy for whole cell/frontage	34
Table 6.1	Key dates	37
Table 6.2	Annualised spend profile	38
Table 6.3	High level risk schedule and mitigation	38

APPENDICES

Appendix A	Project appraisal data sheet
Appendix B	List of reports produced
Appendix C	Photographs
Appendix D	Figures
Appendix E	Details of proposed works
Appendix F	Indicative landscape plans
Appendix G	Economic appraisal
Appendix H	Cost breakdown
Appendix I	Expenditure profile
Appendix J	Project programme
Appendix K	Technical report
Appendix L	Risk register
Appendix M	List of consultees
Appendix N	Environmental reports
Appendix O	Natural England letter of support

Approval history sheet

APPROVAL HISTORY SHEET (AHS)			
1. Review (to be completed by promoting Authority)			
Project Title: Whitby Harbour Piers Coast Protection Scheme Phase 1 PAR			
Authority Project Code:		Date of PAR: June 2012	
Lead Authority: Scarborough Borough Council			
Consultant: Royal Haskoning		Version No: 1	
Position	Name	Signature	Date
"I have reviewed this document and confirm that this project meets our quality assurance requirements, satisfies all the required environmental obligations and meets Defra investment appraisal criteria. I confirm that all internal approvals including member approval have been completed for this project and recommend submission to the Environment Agency for eligible capital grant approval in the sum of £ "			
Authority Project Executive			
"I have reviewed this document and confirm that it complies with the current PAR guidelines for Local Authority and IDB submissions"			
PAR Reviewer			
"I confirm that I have consulted with the Head of FCRM & Business Finance and that the project is ready for submission to PAB/LPRG"			
Area Flood Risk Manager			
PAB – Project Assessment Board <input type="checkbox"/> (Projects less than £2 million) (Check box to indicate which is appropriate)		LPRG – Large Project Review Group <input type="checkbox"/> (Projects greater than £2 million)	
Date of Meeting(s):		Chairman:	
Recommended for approval: In the capital grant eligible sum of £:		Date:	Version No:
3. Project approval Officers in accordance with the FSoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Agency Board			
Version No:		Date:	
Capital Grant sum Approval	By: In the sum of: £ <i>(if different from above)</i>	Date:	
Breakdown of approved costs			
4. Defra approval			
Submitted to Defra or Not Applicable (as appropriate)		Date:	
Version No. (if different):			
Defra Approval: or Not applicable (as appropriate)		Date:	
Comments:			

1 Executive summary

1.1 Introduction and background

- 1.1.1 This Project Appraisal Report (PAR) seeks investment approval for the detailed design, modelling, environmental surveys, and delivery of a major capital scheme to upgrade the aged pier structures at Whitby Harbour to improve their structural condition and overtopping performance into the future in accordance with the recommendations of the River Tyne to Flamborough Head Shoreline Management Plan and the Whitby Coastal Strategy 2.

Location and background

- 1.1.2 Whitby Harbour is situated at the mouth of the River Esk in the centre Whitby, North Yorkshire. The harbour is on a north facing coastline and is protected by two parallel listed masonry piers (East Pier and West Pier) and their concrete extensions.
- 1.1.3 The piers form an integral part of the coastal defences for the Whitby frontage, and are important in terms of their historical significance in the development of the town and the role they play in the tourist appeal of the resort. The old town of Whitby is covered by a Conservation Area, including both the main piers and their extensions. The area immediately to the east of the piers is a geological SSSI, designated for its rock outcrops on the foreshore. The Heritage Coast covers this stretch of coastline, including the SSSI.
- 1.1.4 The piers are in poor structural condition as a result of loss of inner core material and are at risk of breaching should further structural degradation continue. The pier extensions are being undermined at the toe of the structures through a combination of sea bed erosion and deterioration of the toe material. The development of a significant void beneath the pier extension would pose the risk of a breach and lead to accelerated deterioration in the associated assets.
- 1.1.5 The aim of the Whitby Coastal Strategy 2 is to manage the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal instability over the next 100 years. The specific aims for this project are:
- To extend the life of the existing assets as far as is economically practical;
 - To reduce future maintenance requirements;
 - To reduce the risk of flooding to Pier Road from the slipway at Battery Parade;
 - To improve public safety whilst using the piers.
- 1.1.6 The project will be carried out under the powers of the Coast Protection Act 1949.

Approved FCRM strategy

- 1.1.7 The Whitby Coastal Strategy, originally produced in 2002, has been updated, and submitted for approval in September 2012. It covers approximately 5km of North Yorkshire's coastline from Sandsend to Abbey Cliff and extends 2km upstream the River Esk estuary.
- 1.1.8 The Strategy recognises the critical importance of the Whitby Harbour structures to the overall flood and coastal defence system across the wider Strategy frontage, as well as directly to the harbour itself. This view is supported by the approved River Tyne to Flamborough Head Shoreline Management Plan 2.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 1

- 1.1.9 One of the most significant findings of the Strategy is the identification of the 'poor' (Grade 4) or 'very poor' (Grade 5) structural condition and the present-day and future overtopping performance of the structures at Whitby Harbour. The Strategy concluded that both main piers had a residual life of less than 10 years.
- 1.1.10 The Strategic option is to improve the structural condition of the main piers, manage overtopping performance issues on the main piers through restricting public access and to improve the structural condition and overtopping performance of the pier extensions.

1.2 Problem

- 1.2.1 The structural condition of the piers will continue to worsen ultimately leading to total failure. This would result in loss of the beaches and re-activation of recessional processes along the cliffs along both the western and eastern frontages and within the inner harbour area. Higher waves would propagate further upstream and increase flood risk in the estuary. Beach sediment presently retained by the West Pier and its extension would be mobilised and the majority transported into the harbour causing siltation of the channel. This would reduce the channel's ability to convey fluvial and tidal flows and hence provide another mechanism of increasing flood risk to the town.
- 1.2.2 Failure of the pier structures would result in 497 properties (of which 362 are residential) which would otherwise not be at risk from coastal erosion within the 100 year appraisal period becoming at risk. In addition 184 properties would suffer accelerated erosion rates. Loss of piers would result in more severe wave climate within harbour, increasing the damages from flooding to the 148 properties at risk in the 1 in 200 year event; 11 additional properties would also become at risk.
- 1.2.3 Overtopping discharges are in excess of target thresholds for serviceability on the main piers, presenting a significant hazard to members of the public using the piers. On the extensions the overtopping discharges are in excess of target thresholds for avoidance of structural damage. The overtopping will worsen over time due to sea level rise.

1.3 Options considered for implementing the FCRM strategy

- 1.3.1 As the structural issues for the various sections of the pier system are different the options considered for each vary accordingly. To improve the structural condition of the main piers there is only one technically viable solution, M1. For the pier extensions a range of four 'E' options for structural and performance improvements are viable.

Table 1.1 Options Considered (Option 1 = Do Nothing (baseline), Option 2 = Do Minimum)

Option*		Description
3	M1 + E1	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Sheet pile and concrete backfill scour protection to all four faces, with concrete repairs to all faces.
4	M1 + E2	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to outside face of east extension, and sheet pile and concrete backfill scour protection to other three faces, with concrete repairs to all faces.
5	M1 + E3	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to the two outside faces of the extensions, and sheet pile and concrete backfill scour protection to two inside faces, with concrete repairs to all faces.
6	M1 + E4	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to outside face of east extension, sheet pile and concrete backfill scour protection to inside face of west extension, and void in-filling with concrete bagwork to two remaining faces, with concrete repairs to all faces.

1.4 Preferred option

Description

- 1.4.1 The preferred option is Option 6: M1 + E4. The option will sustain the current threshold against flooding and delay the onset of coastal erosion. Economically there were only insignificant differences between Options 3 and 6; both were deemed acceptable. Based on technical and environmental reasons Option 6 was selected as the preferred option. Environmentally Option 6 is preferred as the extension works have the shortest programme and the least potential for releasing potential contaminants during pre-auguring for piling operations.
- 1.4.2 The preferred option has a phased approach, with two main initial capital work phases and two subsequent phases:
1. Main Piers – Year 1: Stabilise the external sandstone facing blocks and fill in any voids using grout. Repairs to top surface of the piers to prevent water ingress during overtopping resulting in wash-out of core material creating future voids.
 2. Pier Extensions – Year 21: Install a rock revetment on the outer face of the East Pier Extension, sheet piles and concrete backfill scour protection on the inner face of the West Pier Extension and around the northern bullnoses for both Extensions. Localised repairs and infilling voids on the west faces of the Pier Extensions.
 3. West Main Pier Bullnose – Year 52: Replacement of the scour protection works.
 4. Pier Extensions – Year 61: Install scour protection on west faces of both extensions.
- 1.4.3 As part of Phase 1, works to improve the performance of the piers in terms of overtopping/flood risk to the public will be carried out. A flood gate is proposed at Battery Parade Slipway (adjacent to the West Pier) to prevent tidal run-up flooding Pier Road. Safety barriers and warning signs will be installed on the Main Pier entrances. An operational procedure will be implemented for the Harbour Master's staff to prevent public access to the piers at times when overtopping would put them at risk.

Environmental considerations

- 1.4.4 Environmentally Option 6 is preferred as the extension works have the shortest programme and the least potential for releasing potential contaminants during pre-auguring for piling operations. A detailed assessment of the potential effects of the proposed scheme and proposed mitigation measures can be found in the Environmental Report (Appendix N) and Indicative Landscape Plan (Appendix F).
- 1.4.5 The proposed works are considered to have a negligible effect on coastal processes, and roosting and foraging birds. Potential impacts during construction to tourism, landscape / seascape character, migratory fish, and from the effects of noise and vibration can be minimised by adhering to best practice methods. During and after construction, risks and impacts will be managed through implementation of the Environmental Action Plan, and Site Waste Management Plan.
- 1.4.6 Consultation has been carried out with Scarborough Borough Council, North Yorkshire County Council, Environment Agency, Marine Management Organisation, Natural England and English Heritage. An Environmental Screening Opinion has been received and can be found in Appendix M. An Environmental Impact Assessment is not required. A letter of support has been received from Natural England and is Appendix O.

Benefits

- 1.4.7 The economic assessment for this PAR is based on the assessment carried out for the Whitby Coastal Strategy 2. The major contributors to the damages are property, tourism

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 3

& amenity, loss of historic environment, and loss of harbour function. The damages have been calculated in accordance with the MCM, Defra and Environment Agency guidance.

- 1.4.8 The damages directly attributable to the presence of the Whitby Harbour piers and extensions have been taken as the difference between the damages that would occur over the study area of the Whitby Coastal Strategy 2 should the piers and extensions fail, and the damages that would occur if the piers and extensions remain in place.
- 1.4.9 The total present value damages for the Do Nothing scenario are £128,978k. The preferred option would avoid the majority of these damages resulting in present value benefits of £128,082k.

Costs

- 1.4.10 The construction costs have been estimated with input from three contractors to develop a robust budget. Environmental enhancement costs have been included for interpretation boards and an artist's involvement in the design of the floodgate and pedestrian safety barriers. The environmental mitigation measures outlined in Table 4.2 can be accomplished within construction best practice methodologies without any additional costs. Compensation will not be required as the piers are owned by SBC and there are no properties which will be directly affected by the working area.
- 1.4.11 A Monte Carlo risk assessment has been carried out for the Preferred Option (Appendix L). Inflation has been calculated in accordance with the Environment Agency's standard methodology. Inflation for 24 months has been included at a rate of 2.5%.

Table 1.2 Project costs (£k)

	Economic appraisal	Whole life cash cost	EA FSoD approval
Costs to PAR	N/A – sunk costs	22	22
Costs post PAR			
Local Authority staff	97	106	106
Consultant fees	150	161	161
Early Contractor Involvement (ECI)	27	29	29
Cost consultant fees	89	96	96
Site investigation & survey	130	139	139
Construction	4,282	4,830	4,830
Environmental mitigation	0	0	0
Environmental enhancement	24	27	27
Site supervision	284	320	320
Compensation	0	0	0
Risk contingency			
95%ile			2,378
50%ile	1,230	1,230	
Inflation (at 2.5%)	N/A	N/A	436
Future costs (const. + maintenance)	5,150	13,421	N/A
Contributions - Scheme			-1,501
Contributions – Risk & Inflation			-2,209
Total	11,463	20,381	4,812

Economic summary, outcome measures and priority

- 1.4.12 The first phase (Main Piers) of the scheme has a 100 year design life, but the benefit period, PV benefits and costs are capped at 20 years as this is when the second phase (Pier Extensions) of the scheme will be required. The raw OM score for the Phase 1 repair works is 73.23%. With contributions from SBC the adjusted OM score is 100%.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 4

Table 1.3 Benefit-cost ratios and outcome measures

Outcome Measures		Number	Qualifying Benefits	FDGiA Contribution
OM1 (Economic Benefit)			44,146	2,453
OM2 (Households better protected against flooding)	20% most deprived areas			
	21-40% most deprived areas	14	116	35
	60% least deprived areas			
OM3 (Households better protected against coastal erosion)	20% most deprived areas	162	2,917	1,313
	21-40% most deprived areas	71	1,696	509
	60% least deprived areas	129	2,518	504
OM4 (Statutory Environmental Obligations Met)				
TOTAL FDGiA Contribution				4,812
Raw OM Score				73.23%
Cost saving and/or external contribution required				1,760
Scheme Contributions Secured				1,760
Adjusted OM Score				100%

Funding and contributions

- 1.4.13 The scheme will be funded under the Partnership Funding system by a combination of Flood Defence Grant in Aid funding and a major contribution from SBC. SBC have secured a contribution of £1,501k for the design and construction of the first phase of the scheme (Main Piers). SBC have also allocated an additional £2,209k for inflation, and to cover the risk contingency above the 50%ile level.
- 1.4.14 In addition SBC will be responsible for the on-going maintenance costs (£259k). Costs to SBC associated with loss of revenue from car parking and wharf rental during the construction have not been included; these costs are a contribution in kind and will be in the region of £240k.
- 1.4.15 The future phases of the scheme will be funded according to the requirements and allocation process applicable at the time of application of the future phases. SBC are committed to the overall scheme to ensure the long term stability of the main piers and their extensions and are conscious that future contributions are likely to be required.

Key delivery risks (economic, social and environmental)

Table 1.4 Risks and mitigation

Key project risk	Adopted mitigation measure
Extent of voiding in Main Piers is greater than anticipated.	Design consideration and construction methodology to assess whether the amount of grouting required can be limited to only areas at risk of tidal ingress and surface water ingress to reduce the overall quantity required.
Proportion of sandstone blocks requiring replacement is greater than anticipated.	Final inspection and review to be carried out during the Design phase to confirm the condition and to inform the requirements for the contract.
Tidal conditions result in delays to programme for works on the 100m length scour protection works on the bull-nose of the West Main Pier.	Ensure that Contractor's method statements consider ways in which the risk of downtime can be minimised - i.e. timing of the works, method selected, plant selected. Ensure that Contractor's price includes an allowance for downtime and an agreed day-rate for additional standing time. Contingency sum to be allowed for Marine Plant standing time.
English Heritage include a Planning Requirement for removing concrete repairs on East Pier deck surface and replacing with Sandstone Blocks.	Further consultation with English Heritage will be carried out post PAR, prior to submission of Planning Application.
Compensation claims for loss of earnings or for damage due to plant movement from local residents and businesses.	Carry out pre-condition surveys of properties and businesses along plant access routes and adjacent to the works. Communicate with local businesses and assess ways in which to minimise the disruption to businesses through programme timings.
Extent of scour at toe of Main Piers and/or bull noses has increased resulting in the need for additional lengths of sheet pile and concrete backfill.	Final inspection and review to be carried out during the Design phase to confirm the condition and to inform the detailed design and proposed construction methodology.

1.5 Recommendation

- 1.5.1 It is recommended that technical and financial approval be given to Phase 1 (Main Piers) of the Whitby Harbour Piers Coast Protection Scheme, for the preferred option, Option 6: M1 + E4. The approval sum being sought is £4,812k. The total cost of Phase 1 (Main Piers) of the scheme is £8,522k including £2,378k risk allowance at the 95%ile, and £436k inflation allowance (2.5%).
- 1.5.2 The scheme will be funded by £4,812k of FDGiA funding and £1,501k contribution from SBC to the design and construction of Phase 1, and £2,209k allowance from SBC to cover the inflation and provide a risk contingency allowance above the 50%ile.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 6

1.6 Director's briefing paper

Authority:	Scarborough Borough Council	Project Executive:			
Project Title:	Whitby Harbour Piers Coast Protection Scheme Phase 1		Code:		
Consultant:	Royal Haskoning	Contractor:	n/a	Cost Consultant:	n/a
The Problem:	<p>The piers at Whitby Harbour are in a very poor condition and will continue to worsen ultimately leading to total failure. This would result in loss of the beaches and re-activation of recessional processes along the cliffs along both the western and eastern frontages and within the inner harbour area. Higher waves would propagate further upstream and increase flood risk in the estuary.</p> <p>Overtopping discharges are in excess of target thresholds for serviceability on the main piers, presenting a significant hazard to members of the public using the piers. On the extensions the overtopping discharges are in excess of target thresholds for avoidance of structural damage. The overtopping will worsen over time due to sea level rise.</p>				
Assets at risk from flooding:	Failure of the pier structures would result in 497 properties (of which 362 are residential) which would otherwise not be at risk from coastal erosion within the 100 year appraisal period becoming at risk. In addition 184 properties would suffer accelerated erosion rates. Loss of piers would result in more severe wave climate within harbour, increasing the damages from flooding to the 148 properties at risk in the 1 in 200 year event; 11 additional properties would also become at risk.				
Existing standard of flood protection:	10 year asset residual life	Proposed standard of flood protection:	100 year design life		
Description of proposed scheme:	<p>Phase 1 (Year 1): structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures.</p> <p>Phase 2 (Year 20): Half-height rock revetment to outside face of east extension, sheet pile and concrete backfill scour protection to inside face of west extension, and void in-filling with concrete bagwork to two remaining faces, with concrete repairs to all faces.</p>				
Costs (PVC): (100 year life inc. maintenance)	£11,463	Benefits: (PVb)	£ 128,082	Ave. B: C ratio: (PVb/PVc)	11.17
NPV:	£ 116,619	Incremental B: C ratio:	n/a	Whole life cost (cash value):	£20,381
Choice of Preferred Option:	Preferred Option 6 was selected on technical and environmental grounds. Economically, it is indistinguishable from Option 3.				
Total eligible cost for which capital grant approval is sought:	£ 4,812k (incl. £0k inflation & £901k contingency)				
Delivery programme:	<p>Planning Approval: February 2015 (if required)</p> <p>Award Construction Contract: March 2015</p> <p>Construction Start: April 2015</p> <p>Construction end: May 2017</p> <p>End of Project: May 2017</p>				
Are funds available for the delivery of this project?			Yes		
External approvals:	Planning permission – tbc, Marine licence and all other consents required to be obtained by February 2015				
Outcome measures	<p>OM2: 14 households better protected against flooding (21-40% most deprived)</p> <p>OM3: 162 (20% most deprived), 71 (21-40% most deprived), and 129 (60% least deprived) households better protected against coastal erosion</p> <p>Raw OM Score = 73.23%</p> <p>Adjusted OM Score = 100%</p>				

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 7

1.7 Key plan



Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 8

2 Introduction and background

2.1 Purpose of this report

- 2.1.1 This Project Appraisal Report (PAR) seeks investment approval from the Project Approval Board (PAB) for the detailed design, modelling, environmental surveys, Environmental Impact Assessment and delivery of a major capital scheme to upgrade the aged pier structures at Whitby Harbour to improve their condition and overtopping performance into the future in accordance with the recommendations of the River Tyne to Flamborough Head Shoreline Management Plan, the Whitby Coastal Strategy 2 and the Further Investigations at Whitby Harbour.
- 2.1.2 This PAR presents the business case for the scheme to best implement the approved strategic option for the Whitby Harbour Piers (Management Units 17 and 18). The appraisal has been carried out in accordance with the Defra Flood and Coastal Erosion Risk Management Appraisal Guidance and associated Environment Agency procedures and policies.

2.2 Background The approved FCRM strategy

- 2.2.1 The Whitby Coastal Strategy was originally produced in 2002 (High-Point Rendel) and covers approximately 5km of North Yorkshire's coastline from Sandsend to Abbey Cliff (Appendix D, Figure D1) and also extends approximately 2km upstream in the River Esk estuary. The Strategy has been subsequently reviewed and updated, and the Whitby Coastal Strategy 2 (Royal Haskoning) was submitted for approval in September 2012.
- 2.2.2 The main communities within the Strategy area reside in the town of Whitby and at Sandsend village. The River Esk flows through Whitby and discharges into the harbour. Within the Strategy area there are 517 residential and 261 commercial properties at risk of coastal erosion over the next 100 years, and 83 residential and 65 commercial properties at risk of tidal flooding in the 0.5% annual probability event, increasing to 97 residential and 88 commercial with sea level rise.
- 2.2.3 The Strategy recognises the critical importance of the Whitby Harbour structures (both the main piers and their extensions – see Key Plan) to the overall flood and coastal defence system across the wider Strategy frontage, as well as directly to the harbour itself. This view is supported by the approved River Tyne to Flamborough Head Shoreline Management Plan 2 (Royal Haskoning, 2007) which states that “the overall defence system works with the Piers providing essential protection to the Harbour and also supporting a more sustainable defence to the Whitby sea front. For the Whitby frontage the SMP can confirm the policy for holding the line both to the open coast and within the entrance to the Harbour”.
- 2.2.4 One of the most significant findings of the Strategy is the identification of the ‘poor’ (Grade 4) or ‘very poor’ (Grade 5) structural condition and overtopping performance of the structures at Whitby Harbour. The Strategy concluded that both main piers had a residual life of less than 10 years.
- 2.2.5 The strategy recommended that for the Whitby Harbour Piers frontage a capital coastal defence scheme should be carried out to significantly improve the flood and coastal defence performance of the harbour structures.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 9

Legislative framework

2.2.6 The project will be carried out under the powers of the Coast Protection Act 1949.

Previous studies

2.2.7 The original 2002 Strategy made recommendations for a capital coastal defence scheme to significantly improve the coastal defence performance of the harbour. However, under the national funding prioritisation mechanisms that were current at that time, implementation was not possible within the desired timescales.

2.2.8 Instead, funding was made available in 2008/09 for undertaking a series of further investigations at Whitby Harbour to better characterise the extent and nature of the structural problems and to help better define the capital works required and associated costs and timescales for their implementation.

2.2.9 The further investigations at Whitby Harbour included:

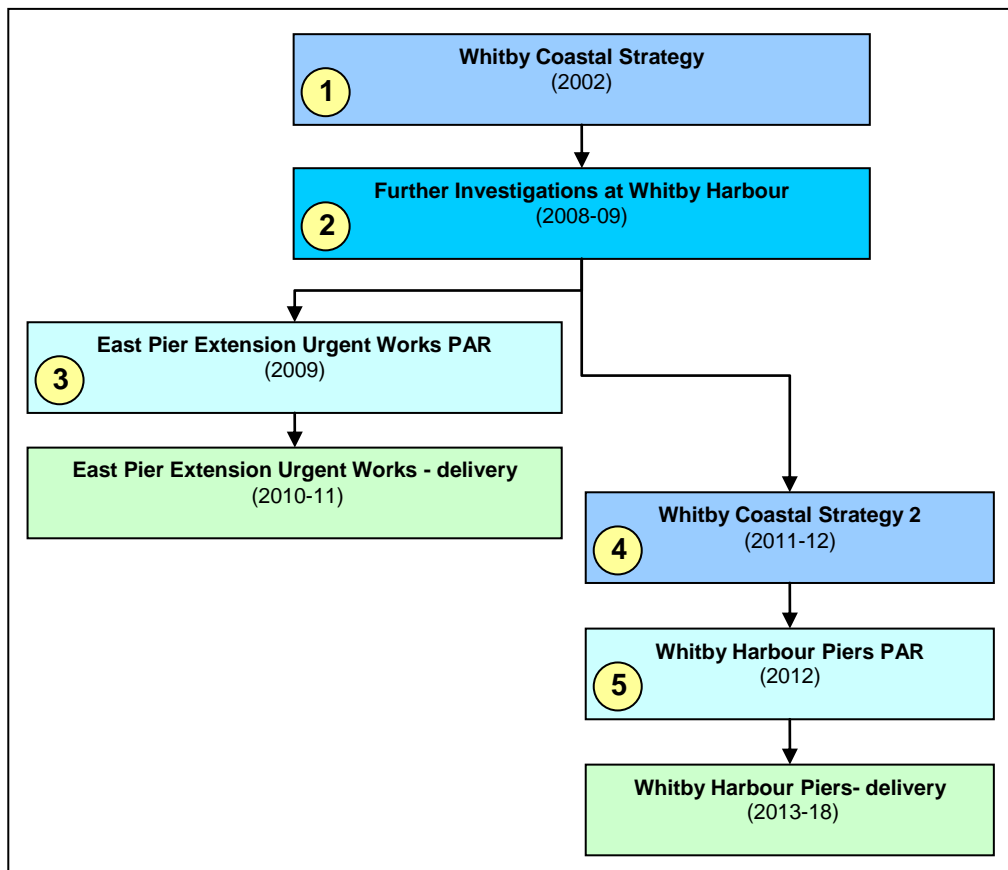
- Topographic, digital measured and photographic surveys
- Dive survey and visual inspections
- Ground probing radar and microgravity surveys
- Ground investigation
- Hydrographic, geophysical and seismic surveys
- Wave climate modelling and water level assessments
- Beach behaviour and sediment budget qualitative analysis
- Overtopping assessments
- Flood level assessments along the River Esk estuary
- Coastal erosion assessments

2.2.10 These further investigations on the Whitby Harbour structures were undertaken in 2008-09 (Appendix K). Resulting information has led to a review of the concept schemes that were proposed for the harbour structures in the original Whitby Coastal Strategy. The review has been undertaken in accordance with changes since the original Strategy was published, including new scheme prioritisation and assessment procedures, and changes in guidance relating to sea level rise.

2.2.11 Critically, the further investigations also revealed that a section at the south-east corner of the East Pier Extension was severely voided and undermined and, at the time, only remained attached to the main body of the structure by a cantilevering action. There was a real and imminent risk of failure of this section which would have led to increased exposure and accelerated deterioration of other structures within the harbour and increased exposure to flooding and erosion risk. Consequently, a PAR was prepared for funding approval by the Regional Project Appraisal Board (PAB) to undertake the detailed design and delivery of Urgent Works on the East Pier Extension in advance of the main Whitby Harbour scheme, so as to prevent its collapse.

2.2.12 The diagram below shows the main stages of project development, involving the original Whitby Coastal Strategy (item 1), the Further Investigations at Whitby Harbour (item 2), the East Pier Extension Urgent Works PAR (item 3), the Whitby Coastal Strategy 2 review (item 4) and the Whitby Harbour PAR (this document; item 5).

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 10



Location and designations

- 2.2.13 Whitby Harbour is situated at the mouth of the River Esk in the centre of the town of Whitby. The piers and their extensions protect the mouth of the harbour on the north facing coastline. The piers form Management Units 17 and 18 of the Whitby Coastal Strategy 2. Although the piers and their extensions function as an integrated system, they can be considered as four components of that system; East Pier Main, East Pier Extension, West Pier Main, and West Pier Extension.
- 2.2.14 The main Whitby Harbour piers are both listed structures and form an integral part of the coastal defences for the Whitby frontage. The piers are also important in terms of their historical significance in the development of the town and the role they play in the tourist appeal of the resort. The West Pier dates back to the 1500s and the East Pier to the 1700s. The old town of Whitby is covered by a Conservation Area, this includes both the main piers and their extensions.
- 2.2.15 The area immediately to the east of the piers is a geological SSSI, designated for its outcrops of rock on the foreshore. The Heritage Coast covers the coastline to east and west of Whitby, including the SSSI rocky foreshore immediately adjacent to the East Pier.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 11

2.3 Current approach to flood risk management

Measures to manage the probability of coastal erosion risk

- 2.3.1 The probability of coastal erosion and the severity of tidal flooding are managed due to the presence of the harbour piers and their extensions.
- 2.3.2 The piers at Whitby Harbour act to protect the local coastline in two distinct ways. Primarily, Whitby West Pier and its extension act as a large groyne, trapping sediment which moves west to east along the coast and in the nearshore zone, and helping to maintain the healthy beach at Whitby Sands, which in turn then protects the cliffs along that section of frontage. Secondly, the piers act as breakwaters, intercepting waves travelling towards the coast and therefore reducing the wave energy which impacts upon the beach, coastal cliffs and frontages within the harbour area.

Measures to manage the consequences of coastal erosion risk

- 2.3.3 The study area is served by the Environment Agency's North East Tidal Flood Forecasting Service and operational alerts are raised by the Environment Agency to Scarborough Borough Council when trigger thresholds that may lead to significant overtopping or sea flooding are exceeded. A wave buoy deployed off Whitby Harbour as part of the Cell 1 Regional Coastal Monitoring Programme feeds real-time data into this operational system (buoy present 2010-11 for 1 year and is being redeployed in 2012 until 2016).
- 2.3.4 As and when necessary, access along the West Pier Extension is controlled temporarily by gates, or prohibited if risks to public safety are identified due to overtopping or poor structural condition. These gates are currently closed by the Harbour Master's Watch Keepers, who monitor tide data on a 24/7 basis and are locally based in the Harbour Master's office.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 12

3 Problem definition and objectives

3.1 Outline of the problem

- 3.1.1 The Whitby Harbour Further Investigations (2008-09) (FIR 2009) have led to the identification of a number of structural condition and overtopping performance issues associated with the coastal defence structures at Whitby Harbour (Appendix K).
- 3.1.2 Main West Pier – The overall condition is poor (Grade 4), with movement of sandstone blocks, opening of joints, scour at sea bed level, cracking and chipping of blocks, and voiding behind facing blocks. Overtopping discharges are in excess of target thresholds for serviceability and will worsen over time due to sea level rise.
- 3.1.3 West Pier Extension – The overall condition is poor (Grade 4), with opening of concrete joints and extensive voiding in the protective steel sheet piling. Overtopping discharges are likely to be in excess of target thresholds for avoidance of structural damage.
- 3.1.4 East Pier - The overall condition is poor (Grade 4), with cracking, chipping, displacement and settlement of sandstone blocks, opening of joints, and voids behind facing blocks. There is evidence of the onset of accelerated low-water corrosion to sections of protective sheet piling. There are a series of three hollows in the sea bed adjacent to the pier wall which could lead to wall collapse. Overtopping discharges are in excess of target thresholds for serviceability and are greatest at the landward end of the pier. Overtopping will worsen over time due to sea level rise.
- 3.1.5 East Pier Extension – Following the completion of the emergency repairs works the conditions has been improved from very poor (Grade 5) to poor (grade 4). The emergency works targeted a specific defect and there remain numerous voids in the sheet piles caused by corrosion of the steel and loss of backing concrete. Overtopping discharges are great along this structure and well in excess of target thresholds for avoidance of structural damage.

3.2 Details of approved strategy

Details of the approved option

- 3.2.1 The approved options from the Whitby Coastal Strategy 2 for the four components of the pier system (Management Units 17 and 18) are:
- **East Pier Main:** improve the condition of the structure using sheet piles, with grouting and re-pointing, and managing the public safety aspects of the overtopping risk through an access gate. This is presently preferred over a rock revetment despite rock armour providing stability and protection to the highly exposed outer face of the structure and therefore increasing the longevity of the capital refurbishment, as there would also be some undesirable impact on the heritage status of the East Pier and on the SSSI foreshore to its immediate east.
 - **East Pier Extension:** improve the condition of the structure using sheet piles with backfill, concrete repairs, and managing the risk of structural damage from overtopping using rock armour on the outer face.
 - **West Pier Main:** improve the condition of the structure using sheet piles, with grouting and re-pointing, and managing the public safety aspects of the overtopping risk through an access gate. This is preferred to an alternative option of using rock armour due to the amenity value of the Whitby Sands and the heritage value of the Grade II listed West Pier.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 13

- **West Pier Extension:** improve the condition of the structure using sheet piles with backfill, concrete repairs, and managing the risk of structural damage from overtopping through on-going maintenance of the structure.

Key constraints

- 3.2.2 The main piers are Grade II listed, as are the lighthouse structures situated on the Main Piers. Although the pier extensions are not listed, they need to be treated as if they were due to the curtilage of the adjacent listed main piers. The piers fall within the Whitby Conservation Area designation.
- 3.2.3 The foreshore extending eastwards from the Whitby Harbour East Pier is nationally designated as the Whitby to Saltwick SSSI for its geological interest.
- 3.2.4 The study area is of immensely high amenity value and attracts a large number of day-visiting and long-stay tourists. Any options must be sensitive to the value placed on the harbour and beaches by residents and tourists.
- 3.2.5 Whitby Harbour remains a functional harbour, with a duty of care to provide refuge to vessels that face navigational difficulties. It has a full time Harbour Master and its management is overseen by the Whitby Harbour Board. There is an operational RNLI lifeboat station, as well as a RNLI lifeboat museum.
- 3.2.6 The River Esk is locally designated as a SINCE. In addition, UK BAP habitats are present within the study area, including maritime cliff and slope, mudflat and saltmarsh habitats. The river is also important habitat for migratory fish including sea trout and salmon; whilst the harbour provides foraging areas for bird species of European and national importance. The piers provide high tide roosts for these species.

Objectives

- 3.2.7 The aim of the Whitby Coastal Strategy 2 is to manage the risks to people and the developed, natural and historic environments from sea flooding, coastal erosion and coastal instability over the next 100 years.
- 3.2.8 In pursuance of this aim, the specific objectives of the Strategy 2 are:
- To ensure that the risks from sea flooding, coastal erosion and coastal slope instability are identified and fully understood over the next 100 years;
 - To ensure that a full range of management options has been considered, at appropriate levels of detail, to address these risks, taking on board latest guidance and advice on appraisal and selection of options;
 - To ensure that the preferred management options are technically feasible, environmentally and socially acceptable, and economically viable and represent a robust and sustainable investment strategy for the study area;
 - To ensure that there is appropriate organisational and public consultation on the findings and recommendations of the Strategy 2 and that feedback is appropriately considered;
 - To ensure that, where possible, opportunities for environmental and economic enhancement have been considered;
 - To ensure that a collaborative approach between the respective organisations is adopted throughout development of the Strategy 2, seeking to secure funding contributions and maximise 'win-win' outcomes.
- 3.2.9 These objectives were set by the Whitby Coastal Strategy 2 Project Steering Group (PSG), which comprised representatives from; Scarborough Borough Council, North Yorkshire County Council, Whitby Town Council, Whitby Harbour Board, Environment

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 14

Agency, and Natural England. In setting the objectives views from a wider range of organisations such as English Heritage and members of the public, were also taken on board by the PSG.

3.2.10 The specific aims for this project within the strategy are:

- To extend the life of the existing assets as far as is economically practical;
- To reduce future maintenance requirements;
- To reduce the risk of flooding to Pier Road from the slipway at Battery Parade; and
- To improve public safety whilst using the piers.

3.3 Consequences of doing nothing

3.3.1 Under this option, the present structural condition of the piers would continue to worsen. This deterioration would lead to further settlement, undermining, voiding, damage such as cracking, abrasion and spalling, and ultimately collapse and breach of the most vulnerable sections. Whilst the residual structures would initially remain in situ, they would experience greater loading forces due to the waves penetrating through the breach and hence would also deteriorate further over time. Also, the breached area would progressively widen and over time the standard of protection offered by the derelict structures would significantly reduce.

3.3.2 The initial breach mechanism is most likely to occur at locations on the Main Piers where voiding has already occurred and tidal ingress has resulted in washing out of the central core material. The 2002 Strategy identified a residual life for the Main Piers of 10 years, however the FIR 2009 concluded that this was a conservative estimate based on the additional information gained from the investigations. Based on the findings of the FIR 2009 it has been assumed that a breach will occur in 2022 (year 10). It would involve displacement of the stone facing blocks in areas where there are presently cavities forming behind the outer facing on the sides and deck. The facing blocks would collapse due to wave impact. With continual impact from the sea, the core of the structure would collapse, forming the breach. Further storm damage would unravel the structure and then propagate the breach along the structure, so widening it and reducing its effectiveness to provide coastal protection. This would continue to develop until the whole structure had collapsed or some self-regulating stability had been (temporarily) achieved. During this process, the exposure to wave activity of the lower estuary would increase, resulting in mobilisation of sediment from the spending beach and destabilisation of the inner estuary jetties.

3.3.3 The mostly likely failure mechanism for the mass concrete pier extensions would be structural failure as a result of large voids undermining the toe of the structure. The voids would develop as a combination of erosion of the seabed at the toe of the structures, and also as a result of loss of concrete at the toe as the sheet piles fail and the weak concrete mix retained behind the piles is lost. The concrete structures would then crack and collapse on to the sea bed and continue to break up and deteriorate.

3.3.4 These scenarios would ultimately lead to total failure of the structures, resulting in loss of the beaches and re-activation of recessional processes along the cliffs at the harbour mouth along both the western and eastern frontages and within the inner harbour area. Higher waves would also propagate further upstream and hence increase flood risk in the estuary. Beach sediment presently retained by the West Pier and its extension would become mobilised and much of this would be transported into the harbour causing siltation of the channel and hence a reduction in channel capacity. This would reduce the channel's ability to convey fluvial and tidal flows and hence provide another mechanism of increasing flood risk to the town.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 15

- 3.3.5 Failure of the pier structures would result in 497 properties (of which 362 are residential) which would otherwise not be at risk from coastal erosion within the appraisal period becoming at risk. In addition 184 properties would suffer accelerated erosion rates due to the loss of the piers. Of the 681 total properties at risk of coastal erosion following failure of the piers 59 are expected to be lost by year 20, an additional 388 properties would be lost by year 50, and the remaining 234 lost by year 100. Loss of piers would result in more severe wave climate within harbour, increasing the damages from flooding to the 148 properties at risk in the 1 in 200 year event; 11 additional properties would also become at risk. There are currently no flood alleviation measures in place in Whitby and consequently the standard of protection of properties varies widely, with some properties at risk in events as low as the 1 in 1 year event. The change in flood risk is shown in Table 3.1.

Table 3.1 Flood risk to properties in Whitby

Return Period	Existing Situation						Following Failure of Piers					
	Present Climate			Future Climate			Present Climate			Future Climate		
	Res	Com	Tot	Res	Com	Tot	Res	Com	Tot	Res	Com	Tot
1 in 1 year	26	7	33	58	38	96	45	12	57	73	49	122
1 in 3 years	54	30	84	74	51	125	57	37	94	80	57	137
1 in 10 years	58	39	97	81	60	141	73	51	124	81	62	143
1 in 50 years	80	58	138	85	68	153	81	60	141	90	71	161
1 in 100 years	81	62	143	93	84	177	83	65	148	97	88	185
1 in 200 years	83	65	148	97	88	185	90	69	159	103	91	194
1 in 1,000 years	95	85	180	107	96	203	97	88	185	132	134	266

Note: Res = Residential, Com = Commercial, Tot = Total

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 16

4 Options for implementing the approved strategy

4.1 Options considered

4.1.1 The Strategic option is to improve the structural condition of the main piers, manage overtopping performance issues on the main piers through restricting public access and to improve the structural condition and performance of the pier extensions. As the structural issues for the various sections of the pier system are different the options considered for each vary accordingly.

4.1.2 To improve the structural condition of the main piers the Preferred Option selected from the option screening process in the FIR 2009 has been adopted, as this meets the project objectives and sustains the character of the assets. Therefore one solution, M1, has been considered.. The works would include:

- Sealing up any voids in the outer faces using mortar, concrete, sandstone insets or other temporary solutions.
- Stabilise any un-bound areas of outer blockwork using tie rods/plates.
- Use a cementitious grouting technique to infill voids immediately behind the wall face and beneath the upper surfaces, from bed rock level to below the surface level. Grout tubes to be installed through the walls and also the upper surface at spacings to suit the technique and product used.
- Replacing badly eroded/weathered sandstone blocks and copings.
- Repairs to the concrete promenade surface of the west Pier.
- Sealing and repairs to the sandstone promenade surface of the east Pier.
- Refurbishment of the handrails on the west Pier.

4.1.3 Performance improvements for the Main Piers are proposed in the form of a number of Safety Management actions and activities, to prevent public access onto the Piers when overtopping is likely to occur.

- Installation of access barriers at the entrance to both piers and at the entrance to the West Pier Extension access bridge.
- Installation of a flood gate at the Battery Parade Slipway.
- Installation of warning signs at the access gates and flood gate locations.
- Implementing a new operational procedure for the piers whereby the Harbour Master's staff are responsible for the operation and maintenance of the access barriers and flood gate.

4.1.4 For the pier extensions, however, a range of solutions for structural and performance improvements are technically viable and these have all been considered, and are described in detail in the Whitby PAR Options Appraisal Report included in Appendix K.

4.1.5 The potential solutions considered for each face were shortlisted to the following;

- Infilling of voids with concrete bagwork or similar.
- Half height rock revetment.
- Sheet pile revetment with concrete backfill.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 17

4.1.6 In addition, common elements for each Pier Extension option include;

- Concrete repairs to faces and top of Pier Extensions.
- Installation of scour protection to Pier Extension bull noses.

4.1.7 Four Pier Extension Options were derived from the potential solutions for the Pier Extension faces and the common repair elements proposed. These four 'E' options are described in combination with the Main Pier Option 'M1' in Table 4.1 below. Do Nothing and Do Minimum are also summarised in this table.

Table 4.1 Options Considered

Option		Description
1	Do Nothing	Walk-away option; no maintenance, repairs, management activities, or emergency works would be carried out. Piers and their extensions would be allowed to deteriorate and fail. This is the baseline option.
2	Do Minimum	Existing maintenance regime would continue, but would be insufficient to prevent the further deterioration and inevitable failure of the main piers and their extensions. This option was rejected at the Strategy stage and will not be considered further in this PAR.
3	M1 + E1	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Sheet pile and concrete backfill scour protection to all four faces, with concrete repairs to all faces.
4	M1 + E2	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to outside face of east extension, and sheet pile and concrete backfill scour protection to other three faces, with concrete repairs to all faces.
5	M1 + E3	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to the two outside faces of the extensions, and sheet pile and concrete backfill scour protection to two inside faces, with concrete repairs to all faces.
6	M1 + E4	Main Piers: M1 structural repairs to main piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Extensions: Half-height rock revetment to outside face of east extension, sheet pile and concrete backfill scour protection to inside face of west extension, and void in-filling with concrete bagwork to two remaining faces, with concrete repairs to all faces.

4.1.8 The Do Minimum option was considered at the Strategy level and was assessed against various Do Something options. The Do Minimum was not the economically preferred option, and was also rejected on technical, environmental, social, and strategic merit. The Do Minimum option will therefore not be considered any further in this PAR.

4.2 Technical details

Phasing of the works

4.2.1 The timing of the works for options 3 to 6 has been considered by taking into account;

- The current condition of the assets as reported in the FIR 2009,
- The potential failure mode and
- The likelihood of failure.

4.2.2 It has been concluded that the works should be carried out in two phases; the first phase being the works to the Main Piers and the second phase being the works to the Pier Extensions.

4.2.3 The Main Piers are in poor condition as a result of wash-out of the central granular core material and due to instability of the external sandstone block facing that has occurred where toe support has been lost due to erosion/undermining. The Strategy estimated they have a residual life of less than 10 years.

4.2.4 The Pier Extensions are undercut and the mass concrete faces are eroded by tidal action. However, for the structures to fail a large void would have to develop underneath

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 18

them or the eroded faces would need to deteriorate such that they were unable to support the timber superstructure of the upper walkway.

- 4.2.5 For the above reasons the Main Piers have been prioritised as requiring capital works as soon as possible to prevent further loss of core material and to stabilise the outer sandstone wall faces.
- 4.2.6 The works for the Pier Extensions have been delayed for 20 years to maximise the existing asset residual life, this takes account of the likely failure mechanisms and timescales for the Pier Extensions. Costs have been included within the economic assessment for diving surveys every 5 years to monitor the condition of the toe of the structure and for further investigations to be carried out on the nature and condition of the concrete at the toe.
- 4.2.7 Following the initial capital works phases on the Main Piers (Phase 1) and Pier Extensions (Phase 2), additional works will be required at intervals to ensure that the 100 year design life of the scheme is achieved. These works will be smaller in scope than the initial capital phases.

Technical description of options

- 4.2.8 Options 3,4,5 & 6 include the following common elements;
- All Main Pier Option M1 elements.
 - Concrete repairs to all faces of the Pier Extensions.
 - Scour protection to Pier Extension Bull Noses.
- 4.2.9 Option 3 proposes to surround all faces of the Pier Extensions with a vertical sheet pile revetment installed into pre-augured trenches. The void between the sheet piles and the structure will be backfilled with concrete. Any voids that exist at the toe of the structure will be filled and the sheet piles will prevent undermining of the toe. It has been assumed that the sheet pile/concrete backfill solution has a residual life of 50 years, and will therefore need replacing within the appraisal period.
- 4.2.10 Option 4 varies from Option 3 in that it assesses the cost impact of installing a rock revetment to the outer face of the East Pier Extension, whilst retaining the sheet revetment and concrete backfill on the remaining three faces. This option has the advantage of providing a revetment solution on the exposed outer face of the East Pier Extension which has a 100 year design life, in comparison to an anticipated design life of 50 years for the sheet pile revetments. Thus the initial capital cost is increased, but the costs at the next intervention are decreased.
- 4.2.11 In addition, the outer face of the East Pier Extension is subject to the most aggressive wave climate and the placement of a rock revetment on this face will reduce the rate of erosion of the exposed faces of the mass concrete structure. This performance benefit has been represented by reducing the annual maintenance cost for this face. The reduced number of interventions required is a benefit given that it is the most exposed and difficult face to work on.
- 4.2.12 Option 5 assesses the cost advantages of installing rock revetments to the two outer faces. Rock revetments on the inner faces would be a navigation hazard and therefore scour protection works for these faces are in the form of sheet pile revetments and concrete backfill.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 19

- 4.2.13 The initial capital costs are increased in comparison to Options 3 and 4, but the costs at the next intervention and the annual maintenance costs are reduced.
- 4.2.14 Options 3, 4 & 5 include scour protection works to all four Pier Extension faces. These options therefore present the greatest risk in terms of capital construction costs due to their reliance on marine plant and the known risk of standing-time as a result of the local wave climate. The FIR 2009 identified significant defects to the east faces of the Pier Extensions only.
- 4.2.15 Option 6 therefore assesses the advantages of only carrying out scour protection works to the east faces of the Pier Extensions as an initial capital scheme, with an assumption that the two faces that have received no works will require sheet pile and concrete backfill scour protection 40 years after the capital works are completed (it has also been assumed that the sheet pile works carried out on the east face of the West Pier Extension will also be replaced at this time). Option 6 also includes a rock revetment to the east face of the East Pier Extension and initial localised void infilling and repairs to the sheet piles on the west faces.
- 4.2.16 All four Do Something options achieve the project objectives of extending the asset life of the existing structure to ensure that it continues to function as a coastal defence asset, whilst managing the overtopping performance by introducing a more formalised approach to public safety management and preventing flooding to Pier Road.
- 4.2.17 The technical aspects of the options considered are derived from the extensive information collected by the FIR 2009 and as developments of the options put forwards in that report. The FIR2009 is included in Appendix K.
- 4.2.18 The technical (and economic) development of the FIR2009 options is described in detail in the Whitby PAR Options Appraisal Report (2012), which has been included in Appendix K.

Climate change consideration

- 4.2.19 The Piers protect the town centre of Whitby from tidal flooding by reducing the wave climate in the harbour and in the Esk estuary. By ensuring the continuity of the pier assets through the proposed capital scheme options, the current standard of protection from tidal flooding will be maintained.
- 4.2.20 Due to the nature of the assets it is not possible, as part of a capital scheme option, to mitigate against future rises in still water levels as a result of climate change. Therefore the increased tidal flood risk to properties adjacent to the Esk cannot be managed through improvements or modifications to the Piers. The flood risk to properties within Whitby from climate change has been assessed in the Whitby Coastal Strategy 2 and recommendations made for works to alleviate the risk. This includes the Church Street Flood Alleviation Scheme which is being progressed as a separate scheme. At the 1% annual probability event (1 in 100 year) the number of properties at risk in Whitby will increase from 143 to 177 with climate change by 2050.
- 4.2.21 The West Pier and Extension act as a groyne, retaining sand on the Whitby Sands beach and thereby creating a natural erosion protection asset for the cliffs. By reducing the wave climate in the harbour the piers also provide erosion protection to the Haggerlythe and Abbey Cliffs areas, as well as the inner harbour and town.
- 4.2.22 The proposed options do not enhance the piers' function as an erosion protection asset or offset any future impacts from climate change. The modelling undertaken during the

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 20

FIR 2009 assessed that current overtopping rates are sufficient to result in structural integrity issues for the extensions and public safety issues for the main piers. The proposed options include public safety management actions (and assets) to deal with the latter and have assessed that the structural issue is not a significant risk and does not impact on its performance as a coastal defence asset.

- 4.2.23 Climate change impacts are likely to result in increased overtopping rates, the modelling carried out to assess overtopping of the structure in the FIR 2009 takes into account climate change predictions. The increase in overtopping will result in more frequent closures of the piers for public safety reasons and an increase in the rate of erosion of the mass concrete pier extension structure, requiring more frequent repairs to protect the timber superstructure supporting the walkways.

4.3 Environmental assessment

- 4.3.1 All options have the potential to affect navigation, foraging and roosting overwintering birds, and tourism and recreation during the construction works. Over-topping issues to the main piers are to be managed through the use of warning signs and barrier gates; these have the potential to affect the character and appearance of the Conservation Area. It should be noted that English Heritage was consulted to inform the optioneering process. Their requirements have been used to inform the design of the proposed works and to identify suitable mitigation measures, where required.
- 4.3.2 It is understood that where sheet piling is to be installed that the method of installation would be through pre-augured trenches rather than percussive piling methods. This method generates significantly lower levels of airborne and underwater noise than percussive methods. In order to prevent damage to the pier extension during the construction of the rock revetment, where proposed, it is assumed that the rock will be placed using, for example, a long reach excavator, rather than being tipped from a barge. This also reduces the noise and vibration impacts, both airborne and underwater, that could arise from tipping activities and also minimises the potential to injure and kill fish, in particular migratory fish, during placement.
- 4.3.3 The potential key positive and negative environmental impacts of the detailed options being considered are presented in Table 4.2. Only the potential impacts that differ between the options are presented here allowing for a comparison of each option's positive and negative impacts against each other. Mitigation measures and enhancement opportunities have also been proposed, where required.

Table 4.2 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/enhancement opportunity
Option 3 – Do Something M1 + E1		
No rock revetment on the west face of the West Pier, whose visibility could affect the character and appearance of the Conservation Area.	Works have no potential to reduce over topping issues. This issue is to be managed using warning signs and closing the piers.	Construction works should follow industry best practice guidance (i.e. CIRIA).
No rock temporarily stored on the beach.	All four faces of the Pier Extensions have an estimated residual life of only 50 years.	Works should be undertaken so as to be considerate of sensitive periods for tourism, migratory fish and birds.
	This option requires the most pre-auguring to place the sheet piling, extending the programme of around four years.	Production of a construction method statements will ensure suitable mitigation for construction works (e.g. materials to be used, timing of works, prevention of pollution, prevention etc.).
	Pre-auguring works will disturb sediments, which may have associated contaminants. This potential issue is considered to be the highest for this option.	A SWMP will be implemented prior to the commencement of works.

Key positive impacts		Key negative impacts	Mitigation/enhancement opportunity
		Pre-auguring works will result in arisings. Beneficial use will need to be considered or, if this is not possible, disposal options. Should the sediments be contaminated, this will affect the cost and the beneficial use and disposal options that can be considered. This option would produce the most arisings.	Liaise with harbour master to avoid / mitigate any effects to navigation.
Option 4 – Do Something M1 + E2			
Reduced overtopping to East Pier Extension resulting from the placement of rock revetments.		This option involves more sheet piling, and associated pre-auguring, than Option 6, extending the programme to around three years.	As for Option 3,
The east face of the East Pier Extension will have an estimated residual life of 100 years, thus reducing the level of intervention required to maintain this side of the pier.		Rock to be used for the revetment may need to be unloaded on the beach prior to being put in place.	Works should be designed so as to minimise the visibility of the rock revetment.
No rock revetment on the west face of the West Pier Extension, whose visibility would affect the character and appearance of the Conservation Area.		Works have no potential to reduce overtopping to West Pier Extension. This issue is to be managed using warning signs and closing the piers.	
		Pre-auguring works will disturb sediments, which may have associated contaminants.	
		Pre-auguring works will result in arisings. Beneficial use will need to be considered or, if this is not possible, disposal options. Should the sediments be contaminated, this will affect the cost and the beneficial use and disposal options that can be considered.	
Option 5 – Do Something M1 + E3			
Reduced overtopping to East and West Pier Extensions resulting from the placement of rock revetments		Rock on outer face of West Pier considered to be unsuitable by English Heritage due to the visibility of the rock affecting the character and appearance of the Conservation Area.	As for Option 4.
The outer faces of the Pier Extensions will have an estimated residual life of 100 years, thus reducing the level of intervention required to maintain these sides of the piers.		Rock revetment along the seaward face of the West Pier Extension would affect local anglers.	
		Rock to be used for the revetment may need to be unloaded on the beach prior to being put in place.	
		Pre-auguring works will disturb sediments, which may have associated contaminants.	
		Pre-auguring works will result in arisings. Beneficial use will need to be considered or, if this is not possible, disposal options. Should the sediments be contaminated, this will affect the cost and the beneficial use and disposal options that can be considered.	
Option 6 – Do Something M1 + E4			
Reduced overtopping to East Pier Extension resulting from the placement of rock revetments.		Rock to be used for the revetment may need to be unloaded on the beach prior to being put in place.	As for Option 4.
The east face of the East Pier Extension will have an estimated residual life of 100 years, thus reducing the level of intervention required to maintain this side of the pier.		The proposed approach of localised infilling of voids would, whilst reducing the level of capital works required for year 2, reduce the time for the next capital works are required by 10 years (to Year 60), compared to the other three options (year 70).	
No rock revetment on the west face of the West Pier Extension, whose visibility would affect the character and appearance of the Conservation Area.		Works have no potential to reduce overtopping to West Pier Extension. This issue is to be managed using warning signs and closing the piers.	
Anticipated shortest construction programme of around two years.			
Pre-auguring works will disturb sediments, which may have associated contaminants. This potential issue is considered to be the lowest for this option.			

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 22

Key positive impacts	Key negative impacts	Mitigation/enhancement opportunity
Pre-auguring works will result in arisings. Beneficial use will need to be considered or, if this is not possible, disposal options. Should the sediments be contaminated, this will affect the cost and the beneficial use and disposal options that can be considered. This option would produce the least arisings.		

4.4 Option costs

4.4.1 The costs are to a Q1 2012 price date. The uplift to Q2 2012 would be less than 1% and is therefore insignificant. The costs have been robustly developed by requesting quotes from three contractors for the construction works identified following development of the options. In addition, lessons learnt from the East Pier Extension Emergency Works have been incorporated into the cost estimation process.

4.4.2 A summary of the costs for the short listed options considered is shown in Table 4.3. Full details of the cost build-ups for the options can be found in Appendix H.

Table 4.3 Summary of options costs

	Option 3: M1 + E1	Option 4: M1 + E2	Option 5: M1 + E3	Option 6: M1 + E4
Local Authority Staff	£87k	£87k	£87k	£87k
Consultant Fees	£146k	£146k	£146k	£146k
Early Contractor Involvement (ECI)	£37k	£37k	£37k	£37k
Cost Consultant Fees	£87k	£87k	£87k	£87k
Site investigation & survey	£91k	£91k	£91k	£91k
Construction	£4,432k	£4,432k	£4,432k	£4,432k
Environmental mitigation	£0k	£0k	£0k	£0k
Environmental enhancement	£27k	£27k	£27k	£27k
Site supervision	£348k	£348k	£348k	£348k
Compensation	£0k	£0k	£0k	£0k
Risk contingency (variable%)	£2,144k (40.8%)	£2,381k (45.3%)	£2,654k (50.5%)	£2,086k (39.7%)
Sub Total	£7,399k	£7,636k	£7,909k	£7,341k
Future costs (Const. + maintenance)	£5,023k	£6,239k	£7,556k	£5,150k
Total PV cost	£12,422k	£13,875k	£15,465k	£12,491k

PAR to Construction

4.4.3 The PAR to Construction costs have been estimated as a percentage of the construction costs. As all the options have the same first phase of works (Main Pier) the PAR to Construction costs will be the same for all options, and will therefore not differentiate between the options. A percentage basis is therefore a sufficient level of detail for the option appraisal.

4.4.4 The design costs were taken as 5% of the construction works and the site investigation costs were taken as 2.5% of the construction works. The design costs cover consultant, cost consultant, CDM-C, ECI, and SBC staff. This results in a cash cost of £284k for this phase of the scheme.

Construction

4.4.5 A cost certainty assessment exercise was carried out by requesting quotes from three contractors for the construction works identified following development of the options. The full cost comparison information from the three contractors can be found in the Options Appraisal Report in Appendix K.

4.4.6 The site supervision costs have been estimated as 10% of the construction costs, this gives a cash cost of £379k across the two year construction period for the initial phase of

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 23

the scheme (Main Piers). An allowance of 5% of the construction costs (£189k) has been made to cover the costs of SBC, ECC Project Manager, cost consultant and consultant fees during the construction period.

- 4.4.7 A budget of £30k has been included for environmental enhancements; this is for providing artwork for the floodgate at Battery Parade and barrier gates at entrances to the piers, and to install interpretation boards along the piers. It is not anticipated that any significant mitigation measures will be required. There will be no mitigation measures that are not normal best practice for construction, and therefore no additional costs will be required.
- 4.4.8 It is not envisaged that any compensation payments will be required. The piers are owned by SBC and there are no businesses or residential properties which will be directly affected by the working area. The construction works will not impact on the functionality of the harbour either during or following construction. The construction works will be programmed to avoid having both piers closed at the same time; this is to mitigate any potential impacts on tourism. No compensation payments were made for the East Pier Extension Emergency Works.
- 4.4.9 Costs to Scarborough Borough Council associated with loss of revenue during the construction have not been included; these costs are a contribution in kind. It is estimated that there will be a loss of approximately £180k of car park revenue due to the location of the site compound in the Endeavour Wharf car park; in addition there will be a loss of wharf rental revenue of approximately £60k due to the berthing of marine plant in the harbour. These costs are based on the loss of revenue that occurred during the East Pier Extension Emergency Works.

Future Costs

- 4.4.10 The future costs include inspection and maintenance, strategic costs, and future phases of capital investment for the Main Piers and the Pier Extensions.
- 4.4.11 Inspection and maintenance costs are based on recent experience on similar projects, and rates from SPONS for general labour based on likely maintenance activities required. The options for the future Pier Extension works will require different levels of maintenance due to the materials and solutions used. This is reflected in the option costs.
- 4.4.12 The future construction costs have been derived using the pricing information gathered during the cost certainty exercise with contractors and vary according to the options for the future Pier Extension capital works. The future construction costs include:
- Replacement of the flood gate at Battery Parade and overtopping warning barriers at the entrances to the Main Piers every 20 years;
 - Capital scheme for the Pier Extensions in years 21-24 to improve their structural condition;
 - Replacement of the scour protection works on the West Pier (Main) Bull Nose in year 52; and
 - Additional investments for the Pier Extensions in either years 61 or 71 dependant on option.

Risk Contingency

- 4.4.13 A typical starting (upper bound) optimism bias factor for a scheme at Pre-Feasibility Stage is 60% and for a Detailed Design stage 30%. The Whitby PAR has been

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 24

developed to an Outline Design stage and it has been assumed that the starting point for the initial assessment is 45%, as the scope of works is significantly developed from the initial Strategy stage, but not to a level of cost/risk certainty that could be determined at a Detailed Design stage as part of a Design and Build contract.

- 4.4.14 Each of the options has been considered to evaluate how the risk elements vary, depending upon the solutions proposed, and the resulting optimism bias allowances vary between 39.7% and 50.5%. A detailed explanation of the adjustments made to the average % risk components is provided in the Options Appraisal Report in Appendix K.

4.5 Options benefits

- 4.5.1 Damages have been calculated using the Multi Coloured Manual (MCM) and the Green Book (HM Treasury, 2003). These documents have been used in combination with the Defra FCERM-AG series and Supplementary Guidance Notes. Figures in the Multi Coloured Manual have been updated to 2nd Quarter 2011 using the Consumer Price Index. Damages have been calculated for the 100 year appraisal period and discount rates starting at 3.5% and reducing to 2.5% have been applied.
- 4.5.2 The economic assessment for this PAR is based on the economic assessment carried out for the Whitby Coastal Strategy 2. The base date for the StAR economic appraisal is 4th Quarter 2011. The uplift to 2nd Quarter 2012 using the Consumer Price Index would be 1% and therefore is considered to be insignificant and has not been applied.
- 4.5.3 The piers at Whitby Harbour act to protect the local coastline in two distinct ways. Primarily, Whitby West Pier and its extension act as a large groyne, trapping sediment which moves west to east along the coast and in the nearshore zone, and helping to maintain the healthy beach at Whitby Sands, which in turn then protects the cliffs along that section of frontage. Secondly, the piers act as breakwaters, intercepting waves travelling towards the coast and therefore reducing the wave energy which impacts upon the beach, coastal cliffs and frontages within the harbour area.
- 4.5.4 The damages attributable to the piers are derived from a range of sources, including damages to the built, social, natural and historic environment. A full description of the damages included within the assessment and how they have been derived is in Appendix G.
- 4.5.5 As the main piers and extensions function as an integrated system it is not possible to apportion the damages between the different components of the pier system in a systematic way. Therefore the system has been assessed as a whole, with the costs of the works for all four sections of the piers being compared to the total benefits.

Do Nothing

- 4.5.6 The damages directly attributable to the presence of the Whitby Harbour piers and extensions have been taken as the difference between the damages that would occur over the study area of the Whitby Coastal Strategy 2 should the piers and extensions fail, and the damages that would occur if the piers and extensions remain in place.
- 4.5.7 The major contributors to the overall damages come from property, tourism & amenity, loss of historic environment, and loss of harbour function. The damages have been calculated in accordance with the MCM, Defra and Environment Agency guidance. The loss of tourism and amenity value has been calculated based on data from a Contingent Valuation Survey (CVS) which was carried out in 2011 as part of the development of the Whitby Coastal Strategy 2. The CVS was based on an equivalent proxy enjoyment value approach, rather than a willingness to pay approach, as recommended by the specialist

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 25

CVS consultants who carried out the survey. The loss of historic environment has been based on a reasonable rebuild cost for the structures. The different damages within the loss of harbour function category have been derived based on information provided by SBC and Whitby Harbour Master on the current functionality of the harbour.

- 4.5.8 Risk to life from tidal flooding was not considered to be a major risk in Whitby due to the flood warning available, short duration of flooding, type of property at risk, availability of escape routes, and the large area of commercial properties which can be easily closed to the public. Compared with the other benefit categories considered, risk to life from tidal flooding would not have contributed a significant damage value, and therefore it was felt it was not proportional to carry out a damage assessment on this category.
- 4.5.9 A summary of the Do Nothing damages is presented in Table 4.3, showing the contribution from the different categories of damages. The total present value damages for the Do Nothing scenario are £128,978k.

Table 4.4 Summary of present value (PV) damages and benefits (£k)

Damage Category		Do Nothing PV Damages (£k)	Do Something Options	
			PV Damages (£k)	PV Benefits (£k)
1	Coastal Erosion			
1.1	Property	18,145	0	18,145
1.2	Other assets (Services)	163	0	163
2	Tidal Flooding			
2.1	Property	2,073	0	2,073
2.2	Wave run-up	1,809	0	1,809
2.3	Wave Overtopping	896	896	0
3	Tourism & Amenity			
3.1	Tourism & Amenity	33,613	0	33,613
4	Traffic Disruption			
4.1	Coastal Erosion	DNQ*	DNQ*	DNQ*
4.2	Flooding	DNQ*	DNQ*	DNQ*
5	Harbour Function			
5.1	Loss of Refuge	6,679	0	6,679
5.2	Relocation of Life Boat Station	1,140	0	1,140
5.3	Damage to Vessels	417	0	417
5.4	Increased Dredging	4,771	0	4,771
6	Loss of Business			
6.1	Fisheries	2,349	0	2,349
6.2	Maritime	DNQ*	DNQ*	DNQ*
6.3	Tourism	DNQ*	DNQ*	DNQ*
6.4	Future Opportunities (e.g. offshore wind farms)	DNQ*	DNQ*	DNQ*
7	Loss of Historic Environment			
7.1	Piers – Listed Structures	56,605	0	56,605
7.2	Other Listed/Historic Structures	84	0	84
8	Loss of Natural Environment			
8.1	Foreshore rock exposures (Geological interest)	233	0	233
TOTAL		£128,978k	£896k	£128,082k

* DNQ = Damages not quantified

Wave Run-Up at Pier Road

- 4.5.10 Discussions with the Whitby Harbour Master have highlighted that significant amounts of flooding can occur to properties at the southern end of the West Pier as a result of waves breaking onto Whitby Sands. During heavy storm events, waves have been known to break onto the highest point of the beach and run-up the lifeboat access ramp on the west side of the pier causing localised, but considerable, disruption.
- 4.5.11 The damages have been assessed using the methodologies in the MCM, based on anecdotal evidence and conservative assumptions. The 100 year Do Nothing PV damage equates to £1,809k. This brings the total Do Nothing PV damages to £128,978k.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 26

Do Something

- 4.5.12 The options being considered will ensure the presence of the main piers and their extensions into the future, avoiding the vast majority of the damages associated with the Do Nothing scenario. There will be some residual damages associated with clean up costs following overtopping events on the main piers as the Strategic option for the main piers is to improve the condition of the structures but not the performance. The risks to people associated with overtopping will be managed through warning signs and an access gate.
- 4.5.13 The residual PV damages for the Do Something options would be £896k, giving total PV benefits of £128,082k.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 27

5 Selection and details of the preferred option

5.1 Selecting the preferred option

- 5.1.1 All the Do Something options have the same initial phase of works on the main piers, and therefore they have the same initial design, post-PAR, and construction costs. The difference in the whole life costs between the options derive from the differences in the future works to the pier extensions, maintenance required, and the level of risk contingency.
- 5.1.2 Option 3 has the lowest present value whole life costs of £13,422k. However Option 6 is only marginally more expensive, by £69k, this is just 0.6% of the overall whole life cost, and can therefore be considered insignificant. Option 3 and Option 6 have similar benefit-cost ratios of greater than 10. Options 4 and 5 are significantly more expensive, by £1.5M and £3.0M respectively, and can therefore be eliminated.
- 5.1.3 All the Do Something options sustain the current threshold of flooding and delay coastal erosion by the 100 year appraisal period. As all the options have the same standard of protection the use of incremental benefit-cost ratios is not required.
- 5.1.4 As the difference between Option 3 and Option 6 in benefit-cost ratio and whole life costs is negligible both options are considered to be economically acceptable. The choice of preferred option between Option 3 and 6 should therefore be made on a technical and environmental basis.

Table 5.1 Benefit-cost assessment

Option	Cash Costs (£k)	PV Costs (£k)	PV Benefits (£k)	Av. Benefit/Cost Ratio	Net Present Value
Option 3: M1 + E1	18,623	12,422	128,082	10.31	115,660
Option 4: M1 + E2	19,322	13,875	128,082	9.23	114,207
Option 5: M1 + E3	20,021	15,465	128,082	8.28	112,617
Option 6: M1 + E4	17,669	12,491	128,082	10.25	115,591

- 5.1.5 Whilst Option 3 does not include a rock revetment, with its associated effects, this option is considered to have the longest programme, at around four years, as a result of the sheet piling works that are required. These works would result in the largest amount of arisings produced during the pre-auguring works, which would need to be suitably disposed of and which have the potential to be contaminated. Option 3 would require the highest level of capital intervention (cash cost) as all four faces of the Pier Extensions would have residual lives of only 50 years. Furthermore, Option 3 does not provide any reduction to the effects of wave overtopping of the Pier Extensions, resulting in the requirement for higher levels of maintenance works, should over-topping damage the surface of the piers.
- 5.1.6 The preferred Technical Option is Option 6: M1 + E4. Option 6 is technically preferred to Option 3 as; it maximises the residual life of the existing pier extension assets, offers a solution with greater residual life and better buildability in terms of the east pier extension rock revetment (which also reduces overtopping and future maintenance costs), is safer to construct as it requires less diving work and also has significantly less risk of marine plant standing time (which was a major cost over-run factor in the emergency works that were carried out).
- 5.1.7 Option 5 is considered to be environmentally unacceptable due to the presence of rock along the outer face of the West Pier Extension, which would affect the character and appearance of the Conservation Area.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 28

- 5.1.8 Option 4 involves significantly more sheet piling works compared to Option 6, which would extend the programme by an estimated 12 months. This option would also result in more arisings as a result of the pre-auguring works, which have the potential to be contaminated. As such, Option 6 is preferred over Option 4 and is the environmentally preferred option.
- 5.1.9 As there is no single preferred economic option, Option 6: M1 + E4 is the recommended Preferred Option on technical and environmental grounds.

5.2 Sensitivity testing

- 5.2.1 All of the Do Something options have the same first phase of works for the Main Piers. Therefore any changes to the M1 section of the works (Main Pier) would affect all the options same and would have no impact on the choice of preferred option.
- 5.2.2 As the future works to the Pier Extensions are all different between the Do Something options any changes to the costs for this portion of the scheme could impact on the choice of preferred option. However the Pier Extension works are delayed until year 20 and are not included within the request for funding approval. An additional PAR would need to be prepared and submitted at the appropriate time for funding approval for the Pier Extension works and the preferred option would need to be confirmed at that point in light of any technological advances or changes in market prices.
- 5.2.3 A sensitivity analysis has been carried out on the phasing of the scheme. The preferred option proposes to phase the scheme with the Main Pier works starting in year 1 and the Pier Extension works starting in year 21. The proposed phasing is based on the urgency of the works for each section of the pier system and the principle of maximising the previous investments in the assets by prolonging the residual life of the asset. Therefore it is not possible to delay investment for either the Main Piers or the Pier Extensions any further than proposed in the preferred option.
- 5.2.4 The sensitivity has been carried out on bringing forward the Pier Extension works into the same phase as the Main Piers. The results of this sensitivity for all four of the Do Something options are shown in Table 5.2. Bringing the Pier Extension works forward does not change the choice of preferred option; Options 3 and 6 are still close enough in PV costs to be an insignificant difference. Despite the increase in costs due to having only one phase of works the scheme is still economically robust with a benefit-cost ratio of around 8.

Table 5.2 Comparison of whole life costs for phasing sensitivity

Option	Proposed Phasing (Main Year 1, Extensions Year 21)		Phasing Sensitivity (Main Year 1, Extensions Year 1)	
	PV Costs (£k)	Av. Benefit-Cost ratio	PV Costs (£k)	Av. Benefit-Cost ratio
Option 3: M1 + E1	12,422	10.31	15,942	8.04
Option 4: M1 + E2	13,875	9.23	18,458	6.94
Option 5: M1 + E3	15,465	8.28	21,196	6.04
Option 6: M1 + E4	12,491	10.25	16,153	7.93

- 5.2.5 In order for the benefit-cost ratio to drop below 5 the costs of the preferred option would have to increase by £13M to £25.6M, a factor of 106%. This is extremely unlikely to occur, especially within the first phase of the scheme (Main Piers) where an increase in costs to £25.6M represents a factor of 349%.

5.3 Details of the preferred option

Technical aspects

5.3.1 The preferred option, Option 6: M1 + E4, has a phased approach, with two main initial capital work phases and two subsequent phases:

1. Main Piers – Year 1: Stabilise the external sandstone facing blocks and fill in any voids using grout that exist as a result of settlement, erosion or tidal wash-out. Repairs to surfaces of the top of the piers to prevent water ingress during overtopping resulting in wash-out of core material creating future voids.
2. Pier Extensions – Year 21: Install a rock revetment on the outer face of the East Pier Extension, sheet piles and concrete backfill scour protection on the inner face of the West Pier Extension and also around the northern bullnoses for both Pier Extensions. Localised repairs and infilling localised voids on the west faces of the Pier Extensions.
3. West Main Pier Bullnose – Year 52: Replacement of the scour protection works on the West Pier (Main) Bull Nose (less than 20% of cost of Phase 1 capital scheme).
4. Pier Extensions – Year 61: Install scour protection on west faces of both pier extensions.

5.3.2 The Main Piers works (Option M1) are recommended to ensure that the structures are returned to a good structural condition. The works proposed would; prevent further losses of inner granular core material, stabilise the external sandstone facing blocks and fill in any voids that exist as a result of settlement, erosion or tidal wash-out.

5.3.3 Voiding is known to be present up to 500mm behind the face of the sandstone blocks and beneath the decking. It is proposed that cementitious grout will be poured into the voids to infill them. Preparatory works to seal any gaps around the sandstone blocks will be required to ensure grout is not lost onto the beach or into the sea. It is anticipated that voids at the toe of the main piers can also be infilled with grout thus avoiding the need to install sheet piles (or similar).

5.3.4 M1 also includes works to improve the performance of the structure, in terms of overtopping/flood risk. A flood gate is proposed at Battery Parade Slipway (adjacent to the West Pier) to prevent tidal run-up flooding Pier Road. Safety barriers and warning signs are proposed to be installed on the Main Pier entrances and at the entrance to the West Pier Extensions access bridge. An operational procedure will be implemented for the Harbour Master's staff (the Watch Keepers) to operate and maintain the barriers and signs, to prevent public access to the piers at times when overtopping would put them at risk and also to close the flood gate at Battery Parade. The operational procedure to close the gate would be agreed during the detailed design stage but should be based on planned and responsive criteria. Planned closures would be based on an assessment of the predicted height of tides (and surge) in comparison to the gate cill level. In this case the warning time would be initially months in advance, with updates on a daily basis through monitoring tide data, wind and surge predictions. With the Watch Keepers based at the Harbour Master's Office the response time to close the gates is minutes. Responsive closures should be carried out by the Watch Keepers if local conditions are deemed to pose a flood risk, regardless of predicted tides, wind and surge data. The response time to close the gate again will be minutes due to the close proximity of the operational staff.

5.3.5 Repairs to the existing concrete surface on the West Pier and sealing of the sandstone block surface of the East Pier are proposed to ensure that tidal (and surface water) ingress is prevented into the core of the structure which may result in washing out of granular material and voiding.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 30

- 5.3.6 Repairs to the existing safety railings on the West Pier are also included within the project scope, as integral safety management assets.
- 5.3.7 Option E4 proposes to initially install a rock revetment on the outer face of the East Pier Extension, sheet piles and concrete backfill scour protection on the inner face of the West Pier Extension and also around the northern bullnoses for both Pier Extensions.
- 5.3.8 The rock revetment will provide an asset with a 100 year residual life that reduces the rate of erosion on the faces of the mass concrete structures and provides a solution with better buildability for an area of the piers where access to deliver concrete would be difficult and costly. Initial filling of any large voids using concrete filled textile bags would be carried out prior to placement of the rock armour.
- 5.3.9 The sheet pile and concrete backfill revetment on the West Pier Extension inner face will infill any existing voids and provide scour protection to the structure with an anticipated residual life of 50 years.
- 5.3.10 Option E4 includes costs for carrying out localised repairs and infilling localised voids on the west faces of the Pier Extensions. The FIR 2009 did not indicate any significant defects for these two faces. Option E4 has assumed that 40 years after the initial Pier Extensions capital works have been carried out, that a capital scheme to install scour protection on these faces will be required.
- 5.3.11 Repairs of the exposed concrete faces of the mass concrete Pier Extensions have been included within the scope and costs for Option E4, to ensure that the integrity of the timber superstructure that supports the walkways is maintained and to increase the residual life of the assets themselves.

Environmental aspects

- 5.3.12 A detailed assessment of the potential effects of the proposed scheme can be found in the Environmental Report in Appendix N. In addition, the key environmental constraints, potential effects of the scheme and proposed mitigation measures are presented on an Indicative Landscape Plan in Appendix F.
- 5.3.13 All works should adhere to best practice guidance, in particular:
- Pollution Prevention Guidelines - Works in, near water: PPG 5 (Environment Agency 2007); and,
 - CIRIA Coastal and Marine Environmental Management Site Guide (CIRIA report C584) (CIRIA 2003).
- 5.3.14 The proposed works are considered to have a negligible effect on coastal process, and roosting and foraging birds (as long as no percussive piling methods are used).
- 5.3.15 A marine sediment quality survey is recommended to determine the physical and chemical quality of the sediments that have the potential to be disturbed during the pre-auguring for the sheet piling works. This information should be used to inform further assessment for the potential effects to water quality, migratory fish and estuarine ecology, and also to inform the beneficial use and disposal options for any arisings from the pre-auguring works. It is also proposed that the findings of the survey should be used to inform a more detailed Water Framework Compliance Assessment. The findings of the sediment quality survey and the identification of any mitigation measures, if required, should be discussed and agreed with local EA Fisheries Enforcement Officer and NYCC Ecologist.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 31

- 5.3.16 Should construction plant and machinery to be located within the SSSI boundary in order to carry out the repair works to the main piers, measures will need to be put in place to ensure that the SSSI is not damaged. Assent will be required from Natural England for any works likely to damage the SSSI.
- 5.3.17 As salmonid and lamprey migration mostly takes place during the night, scour protection works should be undertaken during daylight hours only.
- 5.3.18 In order to minimise potential noise and vibration impacts and temporary effects to tourism, local landscape / seascape character and amenity value, best practice measures are recommended.
- 5.3.19 Consultation with NYCC Archaeologist and English Heritage confirmed that the preferred option will not have an adverse effect on the character or appearance of the Conservation Area (and therefore also the landscape / seascape character), providing the following recommendations are followed:
- Regarding the placement of an access barrier and warning signs at the entrances to the east and west piers, the design and siting will be critical. With regard to the east pier, it was proposed that any gate is sited at the bottom of the concrete slope so as to be kept free from the pier. There is a need for the warning signs on the pier complex, as a whole, to be brought into a uniform design and this design to be used for any new signage and the replacement of the old.
 - Regarding the repairs to the surface of the east main pier, it was suggested that re-pointing (in a suitable mortar) is undertaken with selective cutting out of old repairs which had been carried out in concrete, or inappropriate repairs in stone, and the re-instatement of appropriate new stone (Aislaby or Lowther Cragg). The surface should be fully recorded.
 - Railings along the full length of the east pier would adversely impact upon its simplicity of form and detract from its historic significance. Replacement of the existing railings should be to a simple robust design not a replication of the promenade railings on the west pier.
 - Site flood gate at Battery Parade slipway between the end of the parapet walls, having as little physical impact on the historic stonework as possible and kept as low as possible consistent with the prevention of water inundation.
- 5.3.20 With the exception of the replacement of the existing signs (point one) and of the concrete repairs, point two, these recommendations have been incorporated into the design of the proposed scheme. Method statements for all works to the piers should be discussed and agreed with NYCC Archaeologist and English Heritage.
- 5.3.21 The replacement of the concrete and signs does not materially affect the management of flood and erosion risk and therefore this must be considered as enhancing the historic environment of the harbour.
- 5.3.22 A WFD compliance assessment was undertaken to determine the scheme's potential to affect the Environmental Objectives of the WFD, as presented in the Environmental Report in Appendix N. There are three water bodies that have the potential to be affected by the proposed scheme: the Yorkshire North coastal, Esk transitional and Esk & Yorkshire Coast Ravenscar groundwater water bodies. A summary of the assessment is provided below.
- 5.3.23 Due to the limited nature of the proposed works, the groundwater water body is not considered to have the potential to be affected.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 32

- 5.3.24 The proposed installation of scour protection will extend the existing defence line seaward by a maximum of approximately 2m. This change to the coastal water body's geomorphology is considered to be negligible.
- 5.3.25 Potential adverse effects to the coastal and transitional water bodies could result through accidental spills and leakages and through the release of contaminants from material used for the repair works and during the pre-auguring for the sheet piling works.
- 5.3.26 In addition to adhering to best practice and pollution prevention guidance, only material approved for use in the marine environment will be used for the repair works. The potential for the water bodies to be affected by the potential release of sediment and associated contaminants during the pre-auguring works would be determined by a marine sediment quality survey (see Section 5.3.15). This survey will help inform the proposed scheme's potential to affect the chemical and biological potential of the two water bodies, and to identify suitable mitigation measures where appropriate. The WFD compliance assessment would be revisited once the findings of the marine sediment survey are known and discussed and agreed with the Environment Agency.

With adherence to the above, the proposed scheme is considered to be compliant with the WFD.Costs for the preferred option

- 5.3.27 The costs for the preferred option have been refined from the option appraisal stage to improve the confidence in the cost estimate. Where items were estimated on a percentage basis at the option appraisal stage, such as design, site investigation, and Local Authority costs, they have been developed to a more robust estimate based on the likely activities and durations required for each item. A full breakdown of the preferred option costs can be found in Appendix H.
- 5.3.28 Environmental enhancement costs are for the placement of interpretation boards at appropriate locations in the vicinity of the main piers to educate residents and tourists on the historical significance of the piers in the development of Whitby, and educate them on the wildlife of the harbour. An allowance has also been included for an artist's involvement in the design of the floodgate at Battery Parade and the barrier gates at the entrances to the main piers to prevent public access during overtopping events. These costs have been based on the cost of the existing safety gate on the West Pier Extension footbridge that was designed and fabricated by a local artist in 2005 to commemorate Whitby seafarers.
- 5.3.29 The environmental mitigation measures outlined in Table 4.2 can be accomplished within construction best practice methodologies and therefore there is not expected to be any additional costs over and above the construction costs required for mitigation measures.
- 5.3.30 It is not envisaged that any compensation payments will be required. The piers are owned by SBC and there are no businesses or residential properties which will be directly affected by the working area. The construction works will not impact on the functionality of the harbour either during or following construction. The construction works will be programmed to avoid having both piers closed at the same time; this is to mitigate any potential impacts on tourism. No compensation payments were made for the East Pier Extension Emergency Works.
- 5.3.31 A Monte Carlo risk assessment has been carried out for the Preferred Option and is included in Appendix L. The key risks and the proposed mitigation measures are outlined in Section 6.3.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 33

- 5.3.32 Inflation has been calculated in accordance with the Environment Agency's standard methodology. Inflation for 24 months has been included at a rate of 2.5%.
- 5.3.33 The contribution from Scarborough Borough Council is £1,385k for the design and construction of the scheme, and an additional £2,209k to cover inflation and risk contingencies above the 50%ile, and has been included within the 'Contribution' row for the EA FSoD approval amount.

Table 5.3 Project costs for preferred option (£k)

	Cost for economic appraisal (PV)	Whole life cash cost	EA FSoD approval project cost
Costs to PAR:			
Local Authority staff	Sunk Costs		
Site investigation & survey	Sunk Costs		
Consultant fees	Sunk Costs	22	
Early Contractor Involvement (ECI)	Sunk Costs		
Cost consultant fees	Sunk Costs		
Sub-total	Sunk Costs	22	22
PAR to Construction:			
Local Authority staff	50	53	53
Site investigation & survey	130	139	139
Consultant fees	150	161	161
Early Contractor Involvement (ECI)	27	29	29
Cost consultant fees	46	48	48
Sub-total	403	430	430
Construction:			
Construction costs	4,282	4,830	4,830
Inflation allowance for 24 months			436
Environmental enhancement	24	27	27
Environmental mitigation	0	0	0
Local Authority staff	47	53	53
Consultant fees	0	0	0
Site supervision	284	320	320
Cost consultant fees	43	48	48
Compensation	0	0	0
Sub-total	4,680	5,278	5,714
Future Costs:			
Maintenance	611	1,491	
Future construction	4,539	11,930	
Risk Contingency:			
Monte Carlo 95% or similar			2,378
Monte Carlo 50% or similar	1,230	1,230	
Contributions – Scheme			-1,501
Contributions – Risk & Inflation			-2,209
TOTAL	11,463	20,381	4,812

* Note: this is the revised cost estimate of the preferred option following outline design development and the reassessment of the risk contingency, and is therefore reduced from the cost presented in Table 4.3 for Option 6 for the option appraisal comparison.

- 5.3.34 The present value costs in the Whitby Coastal Strategy 2 StAR for Management Units 17 (West Pier) and 18 (East Pier) are £16,166k, and the cash cost expenditure profile is shown in Table 5.3. These costs include 60% optimism bias. The current forecast of the Strategy present value cost for Management Units 17 and 18 is £11,463k, which is within the approved strategic costs.

Table 5.4 Updated cost of strategy for whole cell/frontage

Cost	2013/14 (£k)	2014/15 (£k)	2015/16 (£k)	2016/17 (£k)	2017/18 (£k)	Future Years (£k)	Total (£k)
Latest Approved Strategy Implementation Cost (£m)							
Capital	378	378	4,166	4,166	0	20,669	29,757
Non-Capital	93	16	16	16	102	1,752	1,995
Total	471	394	4,215	4,215	102	22,451	31,752
Current Forecast of Strategy Implementation Cost (£m)							
Capital	81	479	3,175	3,203	0	14,782	21,720
Non-Capital	20	13	13	57	20	1,804	1,927
Total	101	492	3,188	3,260	20	16,586	23,627

* Note: these are the cash costs including risk allowances, but excluding inflation.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 34

Contributions and funding

- 5.3.35 The scheme will be funded under the Partnership Funding system by a combination of Flood Defence Grant in Aid funding and a major contribution from Scarborough Borough Council (SBC). SBC have secured a contribution of £1,501k for the design and construction of the first phase of the scheme (Main Piers initial capital scheme). SBC have also allocated an additional £2,209k for inflation, and to cover the risk contingency above the 50%ile level.
- 5.3.36 Costs to SBC associated with loss of revenue due to the construction have not been included; these costs are a contribution in kind. It is estimated that there will be a loss of approximately £180k of car park revenue due to the likely location of the site compound in the Endeavour Wharf car park; in addition there will be a loss of wharf rental revenue of approximately £60k due to the berthing of marine plant in the harbour. These costs are based on the loss of revenue that occurred during the East Pier Extension Emergency Works.
- 5.3.37 SBC will be responsible for the on-going maintenance of the piers, and will fund the estimated £611k PV cost over the 100 year appraisal period.
- 5.3.38 The future phases of the scheme will be funded according to the requirements and allocation process applicable at the time of application of the future phases. SBC are committed to the overall scheme to ensure the long term stability of the main piers and their extensions and are conscious that future contributions are likely to be required.

Outcome measures and funding priority

- 5.3.39 The profile of outcome measure delivery and contributions is shown in Table 5.4, as calculated using the FDGiA Partnership funding Calculator for 2013/14. (see Appendix G).
- 5.3.40 The first phase of works which are the initial Main Piers capital scheme is shown in 2015/16 (Table 5.4a), as this is the year when construction will be completed. The outcome measures for the remaining phases of the scheme are shown in the future years (Table 5.4b).
- 5.3.41 Although the first phase (Main Piers) of the scheme will have a 100 year design life, the benefit period is capped at 20 years. This is when the second phase (Pier Extensions) of the scheme is expected to be required, and as the main piers and the pier extensions function as an asset system, all components are needed to deliver the full benefits over the 100 year appraisal period. Therefore the benefits and costs (design, construction and maintenance) have been entered into the Partnership Funding Calculator as the present value prices for the first 20 years of the appraisal period.
- 5.3.42 The raw OM score for the Phase 1 repair works is 73.23%, equivalent to FDGiA funding of 4,812k. With the SBC contribution of £1,501k to the design and construction of the first phase of the project and £259k to the maintenance for the 20 year benefit period until the second phase of the scheme is required (total SBC contribution of £1,760k), the adjusted OM score is 100%.
- 5.3.43 To achieve an adjusted OM score of 120% a contribution to the design and construction of the first phase of the scheme of £2,815k would be required, and a contribution of £4,130k would be required to achieve 140%. However a contribution greater than the £1,501k already agreed by SBC is unlikely to be viable due to current financial savings that the council has to make in line with government policy and the financial burden from

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 35

contributions to other on-going flood and coastal erosion risk management projects in the SBC area.

Table 5.4a Outcome measures contributions and prioritisation score for Phase 1 (Main Piers) in 2015/16

Outcome Measures		Number	Qualifying Benefits	FDGiA Contribution
OM1 (Economic Benefit)			44,146	2,453
OM2 (Households better protected against flooding)	20% most deprived areas			
	21-40% most deprived areas	14	116	35
	60% least deprived areas			
OM3 (Households better protected against coastal erosion)	20% most deprived areas	162	2,917	1,313
	21-40% most deprived areas	71	1,696	509
	60% least deprived areas	129	2,518	504
OM4 (Statutory Environmental Obligations Met)				
TOTAL FDGiA Contribution				4,812
Raw OM Score				73.23%
Cost saving and/or external contribution required				1,760
Scheme Contributions Secured				1,760
Adjusted OM Score				100%

Table 5.4b Outcome measures contributions and prioritisation score for future works

Outcome Measures		Number	Qualifying Benefits	FDGiA Contribution
OM1 (Economic Benefit)			63,080	3,504
OM2 (Households better protected against flooding)	20% most deprived areas			
	21-40% most deprived areas	14	219	66
	60% least deprived areas			
OM3 (Households better protected against coastal erosion)	20% most deprived areas	162	5,477	2,465
	21-40% most deprived areas	71	3,185	956
	60% least deprived areas	129	4,728	946
OM4 (Statutory Environmental Obligations Met)				
TOTAL FDGiA Contribution				7,936
Raw OM Score				100%
Cost saving and/or external contribution required				0
Scheme Contributions Secured				0
Adjusted OM Score				100%

6 Implementation

6.1 Project planning Phasing and approach

- 6.1.1 The preferred option, Option 6: M1 + E4, has a phased approach, with two main initial capital work phases and two subsequent phases:
1. Main Piers – Year 1: Stabilise the external sandstone facing blocks and fill in any voids using grout that exist as a result of settlement, erosion or tidal wash-out. Repairs to surfaces of the top of the piers to prevent water ingress during overtopping resulting in wash-out of core material creating future voids.
 2. Pier Extensions – Year 21: Install a rock revetment on the outer face of the East Pier Extension, sheet piles and concrete backfill scour protection on the inner face of the West Pier Extension and also around the northern bullnoses for both Pier Extensions. Localised repairs and infilling localised voids on the west faces of the Pier Extensions.
 3. West Main Pier Bullnose – Year 52: Replacement of the scour protection works (less than 20% of cost of Phase 1 capital scheme).
 4. Pier Extensions – Year 61: Install scour protection on west faces of both extensions.
- 6.1.2 Funding is being sought for Phase 1 (Main Piers) of the scheme. There is no phasing for the construction within the initial capital works (Phase 1).

Programme and spend profile

- 6.1.3 Phase 1 (Main Piers) of the scheme has a 4 year programme, a detailed programme can be found in Appendix J:
- 2013/14: Procurement of Employer's Agent, ECC Project Manager & Site Supervisor using YorConsult framework. Procurement of Design & Build Contractor using YorCivilis framework;
 - 2014/15: Site Investigation and Detailed Design, and applications for consents, licences and permissions (including Planning Permission);
 - 2015/16: Mobilisation and first year of construction; and
 - 2016/17: Second year of construction and demobilisation.
- 6.1.4 Construction will be carried out over a 2 year period, commencing in April 2015. Works will be programmed to minimise disruption to the public and tourism industry by keeping at least one of the main piers open throughout the construction period as far as possible. There are no major constraints on the programme.
- 6.1.5 The annualised spend profile is shown in Table 6.2, including risk contingencies and inflation at 2.5%. This profile has been submitted to the Medium Term Plan.

Table 6.1 Key dates

Activity	Date
Planning permission received	February 2015
Target price agreed by	March 2015
Works start on site on	April 2015
Works substantially complete by	May 2017

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 37

Table 6.2 Annualised spend profile

	2013/14	2014/15	2015/16	2016/17	2017/18	Future Years	Total
Local Authority staff	26	26	26	27		349	454
Fees	24	353	184	184		1,220	1,965
Construction			2,601	2,666		9,012	14,279
Environmental mitigation							
Environmental enhancement				28			28
Compensation							
Other							
Risk contingency	30	100	550	550		4,200	5,430
Total*	80	479	3,361	3,455		14,781	22,156

6.2 Procurement strategy

6.2.1 A procurement review has been carried out by SBC and the procurement strategy agreed as follows:

- Employer's Agent to be appointed using the YorConsult framework to assist with producing the procurement documents (Invitation to Tender) and assess the tenders;
- Contractor to be appointed on a Design & Build contract using the YorCivils framework;
- ECC Project Manager to be appointed using the YorConsult framework; and
- CDM-C to be appointed using the YorConsult framework as part of the Employer's Agent contract.

6.2.2 The East Pier Emergency Works which were completed in 2011 can be used for benchmarking as part of a target setting exercise.

6.3 Delivery risks

High level risk register

6.3.1 The key risks are outlined in Table 6.3 below along with the proposed mitigation measures. The full Monte Carlo risk register is in Appendix L. The risk register was developed during the outline design of the preferred option and is based on the findings of the FIR (2009), recent asset inspections (2012) and taking into account the lessons learned from the East Pier Emergency Works in 2010/11. The risk register was developed by the Project Team, including discussions with the members of the project team for the East Pier Emergency Works.

Table 6.3 – High level risk schedule and mitigation

Key project risk	Adopted mitigation measure
Extent of voiding in Main Piers is greater than anticipated.	Design consideration and construction methodology to assess whether the amount of grouting required can be limited to only areas at risk of tidal ingress and surface water ingress to reduce the overall quantity required.
Proportion of sandstone blocks requiring replacement is greater than anticipated.	Final inspection and review to be carried out during the Design phase to confirm the condition and to inform the requirements for the contract.
Tidal conditions result in delays to programme for works on the 100m length scour protection works on the bull-nose of the West Main Pier.	Ensure that Contractor's method statements consider ways in which the risk of downtime can be minimised - i.e. timing of the works, method selected, plant selected. Ensure that Contractor's price includes an allowance for downtime and an agreed day-rate for additional standing time. Contingency sum to be allowed for Marine Plant standing time.
English Heritage include a Planning Requirement for removing concrete repairs on East Pier deck surface and replacing with Sandstone Blocks.	Further consultation with English Heritage will be carried out post PAR, prior to submission of Planning Application.
Compensation claims for loss of earnings or for damage due to plant movement from local residents and businesses.	Carry out pre-condition surveys of properties and businesses along plant access routes and adjacent to the works. Communicate with local businesses and assess ways in which to minimise the disruption to businesses through programme timings.
Extent of scour at toe of Main Piers and/or bull noses has increased resulting in the need for additional lengths of sheet pile and concrete backfill.	Final inspection and review to be carried out during the Design phase to confirm the condition and to inform the detailed design and proposed construction methodology.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 38

Safety plan

6.3.2 The key roles under CDM are as follows:

- CDM-Co-ordinator To be appointed using YorConsult framework
- Client Scarborough Borough Council
- Principal Contractor To be appointed using YorCivils framework

6.3.3 Public safety will be assessed in line with Scarborough Borough Council's procedures prior to the start of construction of the works.

Title	Whitby Harbour Piers Coast Protection Scheme Phase 1					
No.	Enter ref. no.	Status:	Version No. 3	Issue Date:	November 2012	Page 39

Appendix A**Project report data sheet**

Entries required in clear boxes, as appropriate.

GENERAL DETAILS

Authority Project Ref. (as in forward plan):

Project Name
(60 characters
max.):

Whitby Harbour Piers Coast Protection Scheme Phase 1

Promoting Authority: Defra ref (if known)
Name

Scarborough Borough Council

Emergency Works:

No

Yes/No

Strategy Plan Reference:

Whitby Coastal Strategy 2

River Basin Management Plan

System Asset Management Plan

Shoreline Management Plan:

River Tyne to Flamborough Head SMP2

Project Type:

Project within Strategy. Coast Protection.

Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project/
Strategy Implementation/Sustain SOS. Coast Protection/Sea Defence/Tidal Flood Defence/Non-Tidal Flood Defence/Flood Warning
Tidal/Flood Warning - Fluvial/Special**CONTRACT DETAILS**

Estimated start date of works/study:

April 2013

Estimated duration in months:

48

Contract type*

Design/Construct

(*Direct labour, Framework, Non Framework, Design/Construct)

COSTS

Appraisal:

APPLICATION (£000's)

22

Costs for Agency approval:

4,812

Total Whole Life Costs (cash):

20,381

For breakdown of costs see Table in Section 2.4

CONTRIBUTIONS

Windfall Contributions:

Deductible Contributions:

ERDF Grant:

Other Ineligible Items:

LOCATION - to be completed for all projects

EA Region/Area of project site (all projects):

North-East Region

Name of watercourse (fluvial projects only):

n/a

District Council Area of project (all projects):

Scarborough Borough Council

EA Asset Management System Reference:

Grid Reference (all projects):

NZ899489

(OS Grid reference of typical mid point of project in form ST064055)

DESCRIPTION

Specific town/district to benefit:

Whitby

Brief project description including essential elements of proposed project/study
(Maximum 3 lines each of 80 characters)

A major capital scheme to upgrade the aged pier structures at Whitby Harbour to improve their structural condition and overtopping performance into the future in accordance with the recommendations of the River Tyne to Flamborough Head Shoreline Management Plan and the Whitby Coastal Strategy 2.

Phase 1 of scheme involves structural repairs to the Main Piers, concrete pile and panel scour protection to West Pier bullnose, and overtopping safety management measures. Phase 2 of scheme is structural repairs to the Pier Extensions in 20 years time.

DETAILS

Design standard (chance per year):

100 year design life

yrs

Existing standard of protection (chance per year)

10 years structural residual life

yrs

Design life of project:

100

yrs

Fluvial design flow (fluvial projects only):

n/a

m³/s

Tidal design level (coastal/tidal projects only):

4.38

m

Length of river bank or shoreline improved:

2300

m

Number of groynes (coastal projects only):

0

Total length of groynes* (coastal projects only):

0

m

Beach Management Project?

No

Yes/No

Water Level Management (Env) Project?

No

Yes/No

Defence type (embankment, walls, storage etc)

Breakwater (Piers)

* i.e. total length of all groynes added together, ignore any river training groynes

ADDITIONAL AGREEMENTS:

Maintenance Agreement(s):

n/a

Not Applicable/Received/Awaited

EA Region Consent (LA Projects only):

Not Applicable/Received/Awaited

Non Statutory Objectors:

No

Yes/No

Date Objections Cleared:

Other:

Not Applicable/Received/Awaited

ENVIRONMENTAL CONSIDERATIONS

Natural England (or equivalent) letter:

Received

Not Applicable/Received/Awaited

Date received

16/8/2012

SITES OF INTERNATIONAL IMPORTANCE

(Answer Y if project is within, adjacent to or potentially affects the designated site)

Special Protection Area (SPA):

No

Yes/No

Special Area of Conservation (SAC):

No

Yes/No

Ramsar Site

No

Yes/No

World Heritage Site

No

Yes/No

Other (Biosphere Reserve etc)

No

Yes/No

SITES OF NATIONAL IMPORTANCE (Answer Y if project is within, adjacent to or potentially affects the designated site)

Environmentally Sensitive Area (ESA):	No	Yes/No
Site of Special Scientific Interest (SSSI):	Yes	Yes/No
National/Regional Landscape Designation:	No	Yes/No
National Park/The Broads	No	Yes/No
National Nature Reserve	No	Yes/No
AONB, RSA, RSC, other	No	Yes/No
Scheduled Ancient Monument	No	Yes/No
Other designated heritage sites	Yes	Yes/No

OTHER ENVIRONMENTAL CONSIDERATIONS

Listed structure consent	tbc	Not Applicable/Received/Awaited
Water Level Management Plan Prepared?	No	Yes/No
FEPA licence required?	tbc	Not Applicable/Received/Awaited
Statutory Planning Approval Required	tbc	Yes/No/Not Applicable

COMPATIBILITY WITH OTHER PLANS

Shoreline Management Plan	Yes	Yes/No/Not Applicable
River Basin Management Plan	n/a	Yes/No/Not Applicable
Catchment Flood Management Plan	n/a	Yes/No/Not Applicable
Water Level Management Plan	n/a	Yes/No/Not Applicable
Local Environment Agency Plan	n/a	Yes/No/Not Applicable

SEA/ENVIRONMENTAL IMPACT ASSESSMENT

SEA	n/a	Statutory required/Agency voluntary/not applicable
EIA	Not required	Yes (schedule 1); Yes (schedule 2); SI1217; not applicable
SEA/EIA status	Screening report	Scoping report prepared/draft/draft advertised/final

Other agreements	Detail	Result	(Not Applicable/Received/Awaited for each)

Costs, benefits & scoring data

(Apportion to this phase if part of a strategy)

Local authorities only: For projects done under Coast Protection Act 1949, please separately identify: FRM = Benefits from reduction of asset flooding risk; CERM = Benefits from reduction of asset erosion risk**Benefit type** (DEF: reduces risk (contributes to Defra SDA 27); CM: capital maintenance; FW: improves flood warning; ST: study; OTH: other projects)

DEF

LAND AREA

Total area of land to benefit:		Ha
of which present use is:	FRM	CERM
Agricultural:		Ha
Developed:		Ha
Environmental/Amenity:		Ha
Scheduled for development		Ha

PROPERTY & INFRASTRUCTURE PROTECTED

	Number		Value (£'000s)	
	FRM	CERM	FRM	CERM
¹ Residential	7	362	7,240	60,809
Commercial/industrial	9	135	881	17,544
Critical Infrastructure				
Key Civic Sites				
Other (description below):		2		158,879
Description:	Historic Piers			

costs and Benefits

¹ Present value of total project whole life costs (£'000s):	11,463	
Project to meet statutory requirement? Y/N	N	
	Value (£'000s)	
	FRM	CERM
Present value of residential benefits:	858	13,228
Present value of commercial/industrial benefits:	3,024	4,917
Present value of public infrastructure benefits:	0	15,519
Present value of agricultural benefits:	0	0
Present value of environmental/amenity benefits:	0	90,536
¹ Present value of total benefits (FRM & CERM)	128,082	
Net present value:	116,619	
Benefit/cost ratio:	11.17	
Base date for estimate:	Q4 2011	
PAG Decision Rule stage 3 applied	No	Yes/No
PAG Decision Rule stage 4 applied	No	Yes/No

OTHER OUTCOME MEASURE SCORING DETAILS

Super Output Area No*:	3,375 7,906 13,922 17,568	Indicate if deprived:	Yes	Yes/No
(*as ranked by Indices of Multiple Deprivation)				
Risk:		VH, H or N/A		
Net gain of BAP habitat:		Wetland	Saltmarsh/ Mudflat	Ha
	0	0		
SSSI protected:	4	Ha		
Other Habitat:	0	Ha		
Heritage Sites:	II or other	"I or II" , "II or other" or "N/A"		

Exemption Details (if exempt from OM scoring system)

Exempt from Scoring: **No** Yes/No

Reason (max 100 chars):

Appendix B

List of reports produced

The following reports were produced as part of this PAR and can be found in the appendices:

- Whitby Piers PAR: Option Appraisal Report (Royal Haskoning, May 2012)
- Whitby Harbour PAR Environmental Report (Royal Haskoning, May 2012)

Other reports used during development of the PAR:

- River Tyne to Flamborough Head Shoreline Management Plan 2 (2007)
- Whitby Coastal Strategy: Sandsend to Abbey Cliff – High Point Rendell (2002)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategy Appraisal Report – Royal Haskoning (2012)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategy Appraisal Report Appendices – Royal Haskoning (2012):
 - Historic Environment Desk Based Assessment
 - Geological Walkover Survey
 - Coastal Cliffs and Slopes Inspections
 - Coastal Defence Inspection
 - Wave Overtopping Overview
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategic Environmental Assessment Scoping Consultation Document – Royal Haskoning (2012)
- Whitby Coastal Strategy 2: Sandsend to Abbey Cliff – Strategic Environmental Assessment Environmental Report – Royal Haskoning (2012)
- Cell 1 Monitoring: Scarborough Asset Inspection 2010 – Royal Haskoning (2010)
- Whitby Harbour: Further Investigations Report (Royal Haskoning, 2009)