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# Whitby Piers Project Appraisal Report

## Benefits Appraisal

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### 1. Coastal Erosion

Whitby is located along a highly active area of coastline, where processes of coastal erosion, cliff and slope instability and both alongshore and onshore-offshore sediment transport are considerable. As such, the risk from coastal erosion over the next 100 years is expected to be significant. The loss of the piers at Whitby Harbour would exacerbate this problem, accelerating the rate of coastal erosion within close proximity to the harbour and resulting in significant economic losses. Sections 1.1 to 1.3 describe the methodologies used to calculate the different types of damages due to coastal erosion, and Section 1.4 describes how the damages specific to the loss of the piers have been derived.

#### 1.1 Property Damages

Values of damages caused by coastal erosion have been calculated using the Multi-Coloured Manual and guidance from Defra and the Environment Agency in order to establish Annual Average Damages (AAD).

The Shoreline Management Plan (SMP2) provides detailed information on the rates of coastal erosion and the projected shoreline position for the next 20, 50 and 100 years within the Study Area, both under a hypothetical No Active Intervention (NAI) policy (although assuming the Whitby Harbour piers remain in place) and with the preferred SMP2 policies in place. This work was expanded during the Further Investigations at Whitby Harbour to provide an additional breakdown of the erosion line in year 75 in areas adjacent to the Harbour. The National Property Dataset has been overlain onto the NAI erosion lines from the SMP2 covering Management Units MU1 to MU9 (Figure 1) and onto the NAI erosion lines from the Further Investigations at Whitby Harbour across Management Units MU10 to MU20 (Figure 2) to determine which properties would be at risk in different future epochs.

Damages have been calculated taking market value for the properties and discounting appropriately according to the period in which the property is lost, using the declining long term discount rate of 3.5% for years 0-30, 3.0% for years 31-75, and 2.5% for years 76-100 as recommended in the 'Green Book'.

#### 1.2 Services Damages

The damages for services have been taken as a cost for relocating the services out of the 100 year erosion zone, based on a rate of £375/m, discounting appropriately according to the period in which the section of service is lost, using the declining long term discount rate of 3.5% for years 0-30, 3.0% for years 31-75, and 2.5% for years 76-100 as recommended in the 'Green Book'.

#### 1.3 Quay Wall Damages

The frontages along the River Esk estuary between the Whitby Harbour piers and the A171 high level road bridge consist of a variety of different quay walls. These quay walls support the ground and infrastructure behind them and provide protection against erosion from fluvial, tidal and wave processes. Without the quay walls, the banks of the River Esk estuary would erode back to a stable angle, resulting in loss of infrastructure and properties immediately behind the quay walls. Along the majority of the river Management Units, roads are located immediately behind the quay wall, with properties just beyond the roads.

The quay walls range in age and type of construction, and it is likely that the vast majority of the quay wall assets will reach the end of their residual lives within the appraisal period of the Strategy.

In order to calculate the damages due to quay wall collapse, it has been assumed that in the Do Nothing scenario the quay walls will fail at the lower end of the residual life period. Damages have been calculated for properties directly at risk of collapse following quay wall failure and the services that additionally would be directly affected. The damages have been discounted according to year loss following Green Book discounting rates.

Properties within RE1, RE2, RW1, and RW2 have been excluded from this calculation to avoid double counting as they are also at risk of coastal erosion propagating from the adjacent coastal frontages due to increased erosion after loss of the piers (Section 1.4). Properties that are also at risk of flooding have had their combined damages, flooding and collapse due to quay wall loss, capped at their market value.

The failure of the quay wall in RE6 will result in the loss of Church Street, which is the only vehicular access route along the east bank of the River Esk estuary to the properties on Church Street and in the historic 'Old Town' area (e.g. Sandside, Henrietta Street). There is an additional key access route across the Swing Bridge. Under the Do Nothing option both of these accesses would be lost, resulting in 548 properties being isolated (Figure 3). It is likely that the majority of services serving these properties will be within Church Street and therefore will become lost as well. Without vehicle access for residents or emergency services, and with no services for the properties, it is likely that the properties affected would be abandoned. Damages under this scenario have therefore been taken as the market value of these properties, discounted to year of loss.

#### **1.4 Increase in Damages due to Loss of Whitby Harbour Piers**

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.

Loss of the piers would clearly have significant implications for the beach and cliffs. Removal of the 'groyne effect' of the West Pier and its extension would prevent sediment from being deposited at Whitby Sands and would result in the rapid lowering of the beach and loss of sand between Upgang Beach and the West Pier.

This lowering of the beach would, in turn, reduce protection to the coastal cliffs west of Whitby Harbour and result in an increase in the rate of coastal cliff recession. This cliff recession would become exacerbated close to the harbour mouth, where the wave-reducing effects of the piers would be lost, resulting in even faster rates of erosion. Increased rates of cliff erosion will also result in the loss of land and property along the cliff top between the harbour and Upgang Beach. The loss of the piers will also result in an increased wave climate within the harbour, reducing the residual life of the quay wall assets in the River Esk.

The damages directly attributable to the presence of the Whitby Harbour piers and extensions within Management Units MU17 and MU18 have been taken as the difference between the damages that would occur should the piers and extensions be lost, and the damages that would occur with the piers and extensions remaining in place (as discussed in Sections 1.1, 1.2 and 1.3), as shown in Table 1. The damages that occur with the piers lost have been calculated following the same methodologies as described in Sections 1.1, 1.2 and 1.3.

**Table 1 - Do Nothing Present Value Damages Attributable to Management Units MU17 & MU18**

Damage Category	PVd with Piers	PVd without Piers	PVd attributable to MU17 & MU18
Properties	£8,989k	£22,492k	£13,503k
Services	£1,609k	£1,772k	£163k
Quay Walls	£22,209k	£26,852k	£4,643k
<b>TOTAL</b>	<b>£32,807k</b>	<b>£51,116k</b>	<b>£18,309k</b>

Erosion lines representing the increased rates of erosion following the loss of the piers have been derived for the frontages that would be affected, namely Management Units 9 to 20 and River Management Units RW1, RW2, RE1 and RE2 (Figure 4). There is an increase in the number of properties at risk of coastal erosion under this scenario, beyond those properties already at risk without the loss of the piers, as shown in Table 2. There will be an additional 362 residential properties and 135 commercial properties at risk of erosion if the piers were to be lost.

**Table 2 - Properties at risk of coastal erosion over the 100 year appraisal period**

MU	Do Nothing with Piers			Do Nothing without Piers			Difference		
	Res.	Com.	Total	Res.	Com.	Total	Res.	Com.	Total
9	0	0	0	22	2	24	22	2	24
10	0	0	0	8	0	8	8	0	8
11	0	0	0	99	11	110	99	11	110
12	0	0	0	97	26	123	97	26	123
13	0	2	2	0	2	2	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	16	16	0	16	16	0	0	0
RW1	1	18	19	27	48	75	26	30	56
RW2	13	10	23	52	26	78	39	16	55
19	32	24	56	32	24	56	0	0	0
20	0	0	0	0	0	0	0	0	0
RE1	37	31	68	63	48	111	26	17	43
RE2	0	0	0	45	33	78	45	33	78
<b>Total</b>	<b>83</b>	<b>101</b>	<b>184</b>	<b>445</b>	<b>236</b>	<b>681</b>	<b>362</b>	<b>135</b>	<b>497</b>

The loss of the piers will result in an increased wave climate within the harbour, which will increase the rate of deterioration of the quay wall assets in the River Esk. The damages have therefore been based on the assumption that the residual life of the quay walls will be reduced by 5 years for the Do Nothing.

Present Value damages over the 100 year appraisal period for the Do Nothing scenario are **£18,309k**.

## 2. Tidal Flooding

### 2.1 Property Damage in Whitby Town Centre

Flood risk in the lower reaches of the River Esk estuary and around Whitby Harbour can come from three sources:

1. High river flows – especially when coinciding with high astronomical spring tides or high sea surge events;
2. High sea surges; or
3. Wave overtopping of quayside walls – especially during high astronomical spring tides or high sea surge events.

Modelling work that was undertaken as part of the original Strategy identified that high river flows are the least significant contributor to flood risk in the lower reaches of the estuary, and that tides and waves are far more significant.

It is recognised that it is the crest elevation level of the quayside walls that is the determining factor in preventing flooding during times of high river flow, high tidal states or high sea surges, but the Whitby Harbour piers play a vital role in reducing wave heights in the harbour and estuary that otherwise could lead to overtopping of quay walls.

Values of damages caused by tidal flooding have been calculated using the Multi-Coloured Manual and guidance from Defra and the Environment Agency in order to establish Annual Average Damages (AAD).

To assess the tidal flood risk in Whitby the following methodology has been applied:

- Flood zone maps have been created to identify the extent of flooding that would occur under tidal events of different 'present climate' return periods, should the quay walls become overtopped. The number, location and type of ground floor properties within these flood zones have been calculated based on a LiDAR-based Digital Ground Model and the National Property Dataset.
- A topographic survey of the quay walls was carried out in July 2011. The information from this survey has been used to carry out a check on the properties identified at risk and adjust threshold levels where appropriate. In addition properties at Whitehall Landing (RE9) have been excluded from the damage assessment as information from the original planning application (2001) shows floor levels are above the 1 in 200 year including climate change (50 years sea level rise) water level.
- Indirect residential damages and health damages have been included.
- This information has been used to calculate annual average damages.
- The above step has been repeated using tidal events of different 'future climate' (2057) return periods, to take into consideration sea level rise.
- The Present Value (PV) damages have been estimated for a period of 100 years with present value taken into account using a declining long term discount rate of 3.5% for years 0-30, 3.0% for years 31-75, and 2.5% for years 76-100 as recommended in the 'Green Book'.
- The residual life of the quay wall assets has been taken into account; where properties are directly at risk due to collapse of quay walls the AAD for flooding have only been taken up to the end of the residual life of the quay wall asset to avoid double counting. This affects properties in RE4, RE7 and RE8.

- The above steps have been repeated with water levels elevated by 110mm; this being a typical increased wave height within the estuary in the absence of the piers as defined by SWAN modelling undertaken during the Further Investigations at Whitby Harbour. The difference in the annual average damages between this and the initial assessments is the 'benefit' of having the harbour piers compared against not having them present.

There are 18 river Management Units within the Study Area; RW1 to RW9 on the west bank and RE1 to RE9 on the east bank. Using the flood zone maps and information from site walkovers the river Management Units have been grouped appropriately into five floodcells, based on the interconnectivity of the areas (Table 3). The damage calculations have been carried out on a floodcell basis.

**Table 3 - Floodcell Descriptions**

Floodcell	Description	Management Units
1	East bank north of Swing Bridge	RE1 & RE2
2	East bank, Swing Bridge to Abraham's Quay	RE4, RE5, RE6 & RE7
3	East Bank, Abraham's Quay to A171 high-level road bridge	RE8 & RE9
4	West Bank, Swing Bridge to A171 high-level road bridge	RW5, RW6, RW7, RW8 & RW9
5	West Bank north of Swing Bridge	RW1 & RW2
Swing Bridge	Swing Bridge abutments on both banks	RE3 & RW4

As flooding predominantly occurs as a result of tidal inundation, a flooding duration of less than 12 hours has been used and an allowance for additional damage due to salty water has been included in the calculation of damages.

Capping values have been applied to all properties, both residential and commercial. The property values that are used for the purpose of residential property capping have been calculated based on data from Land Registry for North Yorkshire County Council for June 2011, as shown in Table 4. For non-residential properties, property values provided within the National Property Database (NPD) data have been used to cap flood damage to these buildings. Where values are missing from the NPD, rateable values from the Valuation Office Agency have been used to derive a market value.

**Table 4 - Average House Prices from Land Registry (June 2011)**

House Type	Whitby	England
Detached houses	£267,881	£253,042
Semi-detached houses	£152,200	£152,797
Terraced houses	£128,432	£121,671
Flats	£122,508	£151,356
All dwellings	£172,156	£160,779

The properties at risk of tidal flooding under a 1 in 200 year return period event, both at the present day and taking into account future sea level rise, are presented in Figure 5. The AAD and PVd for the Do Nothing scenario are summarised in Table 5, and the numbers of properties at risk in each return period are shown in Table 6. For a full breakdown of properties at risk in each floodcell please refer to the accompanying discounting spreadsheets.

**Table 5 - Do Nothing Flood Risk Damage Assessment by Floodcell**

Flood cell	Tide Only Damages (A)			Tide & Wave Damages (B)			Increase in Damages due to Loss of Piers (B minus A)		
	Present Climate AAD	Future Climate AAD	PVd	Present Climate AAD	Future Climate AAD	PVd	Present Climate AAD	Future Climate AAD	PVd
1	£103k	£304k	£2,827k	£176k	£452k	£2,928k	£73k	£148k	£101k
2	£248k	£792k	£7,002k	£391k	£1,128k	£7,870k	£143k	£336k	£868k
3	£608k	£782k	£1,327k	£682k	£843k	£1,330k	£74k	£61k	£3k
4	£780k	£2,085k	£7,647k	£1,104k	£2,596k	£8,474k	£324k	£511k	£827k
5	£2k	£9k	£178k	£2k	£27k	£452k	£0k	£18k	£274k
<b>TOTAL</b>	<b>£1,741k</b>	<b>£3,972k</b>	<b>£18,981k</b>	<b>£2,355k</b>	<b>£5,046k</b>	<b>£21,054k</b>	<b>£614k</b>	<b>£1,074k</b>	<b>£2,073k</b>

**Table 6 - Properties at Risk under Do Nothing Scenario**

Return Period	Tide Only						Tide and Wave					
	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

## 2.2 Wave Run-up at Slipway (MU16)

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.

In order to estimate the economic damages associated with these wave run-up events the following methodology has been followed. As no records of the frequency of this occurrence exist (other than anecdotal statements that it is 'quite frequent') and there are no detailed records of the financial impacts to local businesses and residents, a number of conservative assumptions have been made. For the purposes of the economic appraisal, it has been assumed that such run-up events occur once each year and that they affect only small area, affecting 5 commercial properties (Figure 6). These are Pleasure Land Amusements, Whitby Fisherman's Football Club, The Endeavour Office, The RNLI Museum, and Whitby Yacht Club. These properties are not at risk from tidal flooding due to overtopping of quay walls, and therefore including the damages from wave run-up at the slipway is not double counting.

In order to estimate damage costs associated with these events, the methodologies described within the MCM have been adjusted to assume that the properties identified at risk of flooding due to wave run-up are inundated to a depth of 50mm with a flood duration of less than 12 hours. (A flood depth of 50mm is significantly lower than the average 1 in 1 year flood depth of 539mm so this is considered a reasonable flood depth).

The details of these properties, based on information from the National Property Dataset have been used to calculate a total damage cost of **£168k** per event.

The total PV damage cost of wave run-up events have been estimated for a period of 100 years with present value taken into account using a declining long term discount rate of 3.5% for years 0-30, 3.0% for years 31-75 and 2.5% for years 76-100 as recommended in the 'Green Book'. The damages have been capped at the market value of the commercial properties.

Based on the above average annual damage (AAD) the 100 year Do Nothing PV damage equates to **£1,809k**. The Do Minimum damages would be the same as the Do Nothing.

## 2.3 Wave Overtopping – Coastal Management Units

Wave overtopping causes structural damage to the assets and also deposits sand and debris on the promenades. The damages have been assessed as an annual clean up cost, at a rate of £50/m/year. Based on this rate over the 100 year appraisal period the Do Nothing PV damage equates to **£896k**.

### 3. Tourism & Amenity

A Contingent Valuation Survey (CVS) has been 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 CVS consultants who carried out the survey. The findings of this study suggest that for a significant proportion of visitors to Whitby the town is a unique and priceless destination. The town has a cross-generational appeal and attachment with visitors, creating strong enough memories that generation after generation of the same families will visit the resort, creating lasting emotional connections to the town.

Whitby as a tourist destination is unique with its combination of heritage, culture, character, amenity and tourism facilities (Table 7). The popularity and visitors' attachment to the town has been represented in recent years with a series of awards and accolades:

- 2008: voted Daily Mail 'Country's Best Day Out' by readers;
- 2007: voted No.1 of the '50 Best British Holidays' by the Observer;
- 2006: 'Top Seaside Resort' in New Woman;
- 2006: 'Best Seaside Resort in UK' according to Holiday Which?

**Table 7 - Summary of Features that Contribute to Whitby's Unique Tourist Appeal**

Features of Whitby	
<b>Heritage</b>	<ul style="list-style-type: none"> <li>• Whitby first recorded in 656AD;</li> <li>• Whitby Abbey founded in 664AD;</li> <li>• Major centre for the whaling industry in 1700s-1800s (Whale Bone Arch);</li> <li>• Connections with Captain James Cook (Museum) and the HMS Endeavour;</li> <li>• Whitby Jet industry, at its height in 1800s;</li> <li>• Many historic and listed buildings including St. Mary's Church.</li> </ul>
<b>Culture</b>	<ul style="list-style-type: none"> <li>• Connections with Bram Stoker's Dracula;</li> <li>• Strong literary tradition, visited by and inspiring Elizabeth Gaskell, Lewis Carroll and Charles Dickens, James Russell Lowell, Robin Jarvis;</li> <li>• Seafood reputation;</li> <li>• Whitby Regatta;</li> <li>• Whitby Museum, RNLi Museum, Captain Cook Museum, Pannett Park.</li> </ul>
<b>Character/Setting</b>	<ul style="list-style-type: none"> <li>• Traditional 'Old Town' seaside fishing settlement;</li> <li>• Working harbour right in the heart of the town;</li> <li>• West and East Pier and their extensions and lighthouses;</li> <li>• Swing Bridge;</li> <li>• Proximity to North York Moors National Park;</li> <li>• Conservation Area.</li> </ul>
<b>Amenity</b>	<ul style="list-style-type: none"> <li>• Wide sandy beaches;</li> <li>• Whitby Pavilion Entertainment Complex;</li> <li>• Marina;</li> <li>• Sneaton Castle Conference Centre.</li> </ul>

From the CVS it was estimated that 39% of the estimated revenue of tourism to the local economy was directly related to the beach, coastline and harbour areas of Whitby, this equates to £16,050k. The research also showed that 19% of respondents would no longer visit and a further 40% would visit less if the quality of the beach and coastline were to decline through lack of adequate coastal protection. Assuming the 40% would visit half as often then the total reduction in visitor levels would be 39%. The reduction in revenue from tourism can therefore be estimated as 39% of £16,050k, which is £6,260k per year.

The tourism damages have been split across the Whitby management units (MUs 9 to 20). As the piers are integral to maintaining the beaches, coastline and harbour areas that attract tourists to Whitby the majority of the damages have been apportioned to Management Units 17 and 18 (44% each). Management Units 19 and 20 play an important role in preventing the East Pier being detached from the mainland through erosion at its landward end, therefore 1% of the tourism damages have been assigned to each of these units. West Cliff with its designed landscaped cliffs, beach related amenities such as chalets, and cliff top guest accommodation, also contributes to the tourism appeal of the town, and therefore for the tourist attractions of West

Cliff (excluding the beach which is attributable to the piers) 10% of the tourism damages are assigned in total to Management Units 9 to 16, apportioned according to the length of the management unit.

It has been assumed that the tourism damages assigned to the piers (MUs 17 & 18) only occur over the first 10 years after the piers have breached (Year 10), as over time visitors would develop attachments to other destinations. Therefore the Do Nothing PV damage figure is **£33,613k** over 100 years.

### 3.2 Sensitivity Test

In the assessments it has been assumed that the 19% of visitors who would no longer visit Whitby would also not visit substitute sites because they stated that they specifically visited Whitby on their trip because of the amenity value of its harbour (mainly). Also, the 40% of visitors who would visit Whitby less often would visit only half as often (i.e. a 20% loss) and not go elsewhere for the same reason. However, it is possible that a proportion of those visitors no longer visiting Whitby would go to substitute sites, therefore a sensitivity test which reduces the economic benefits ascribed by various percentages has been carried out (i.e. assuming that 50% of visitors who stay away from Whitby would go to substitute sites).

The sensitivity of the economic case for the preferred option to the value of the tourism damages has been carried out by reducing the tourism benefits to 75%, 50%, 25%, and 0%. The results of the sensitivity are shown in the table below. The sensitivity shows that the economic justification for the scheme remains robust even with the total exclusion of all tourism benefits. However, the total removal of tourism benefits would not be an accurate reflection of the true benefits of the scheme, and would therefore not be a reasonable approach.

The table also shows the impact of changing the tourism benefits on the FDGiA available and value of contributions required from Scarborough Borough Council, as determined from the FDGiA Calculator. Note, in addition to the contribution derived from the FDGiA calculator SBC will also have to underwrite the required additional contingencies for the project (95%ile risk and inflation), which amount to £2,209k. The value of the tourism benefits are therefore influential in determining the amount of FDGiA available for the scheme and the contributions required.

The project team is comfortable with the methodology used to calculate the tourism benefits as presented in this report, and do not feel they are overestimated. Based on the data collected during the visitor surveys, the uniqueness of the town (as represented by Whitby's bid to become a World Heritage Site) and the attachment it generates in repeat and frequent visitors would not be easily and instantaneously transferred to other destinations. The immediate impact of the loss of the piers and physical consequences of this would have an impact on national tourism revenue in the short term as loyal visitors with an emotional connection to Whitby would not transfer immediately to alternative destinations. The tourism damages have been capped to just 10 years following collapse of the piers. This reflects the acknowledgement that over time visitors will disperse to alternative sites, and the loss of tourism income generated at Whitby will over time be regenerated at alternative sites.

Tourism Damages %	Total PVb (£k)	BCR	Total PVb over 20 years (£k)	FDGiA %	SBC Contribution Required (£k)	Increase (£k)
100	128,082	10.25	51,393	73.23	1,760	-
75	119,679	9.58	42,990	66.12	2,226	466
50	111,276	8.91	34,586	58.93	2,699	939
25	102,872	8.24	26,183	51.92	3,160	1,400
0	94,469	7.56	17,779	44.81	3,627	1,867



## 5. Harbour Function

The harbour function at Whitby is dependant on the presence of the piers and their extensions to provide protection from the aggressive wave climate. Under the Do Nothing scenario both the pier extensions and the main piers will be lost. This will result in a more aggressive wave climate within the harbour, resulting in damage to four key receptors:

- Loss of Refuge;
- Relocation of lifeboat station;
- Damage to vessels; and
- Increased dredging.

All of the damages incurred in this category are due to the loss of the piers and their extensions which act together to function as a system. Therefore the damages in this category have been split equally between MU17 West Pier and MU18 East Pier.

The total Do Nothing present value damages over 100 years for the four components within this category are **£13,292k**.

As the current maintenance regime is restricted by budgets it will have a very limited impact on the residual life of the structure. Maintenance will be mainly focused on public health and safety requirements and will not deal with the structural deterioration of the piers. Therefore the Do Minimum scenario is the same as the Do Nothing scenario and the present value damages will be the same.

### 5.1 Loss of Refuge

Whitby Harbour is a well established maritime facility which has been used for over a century to allow safe passage of vessels from the North Sea into the River Esk estuary and to provide shelter to passing vessels during periods of extreme sea conditions. With the effects of climate change projected to result in increasingly severe storm events over the next 50 years, it is anticipated that Whitby Harbour will be increasingly utilised as a port in which vessels can take shelter during such events.

As such, it may be argued that the Harbour has a duty of care for vessels travelling within this area of the North Sea and that this care should be maintained in order to prevent the loss of life and damage to vessels caught in heavy seas off Whitby.

Information provided by the Whitby Harbour Master suggests that between 15 and 20 vessels make unscheduled entry into the harbour each year in order to take shelter from heavy seas. If it is assumed that there is an average of 5 people on each of these vessels, it could be argued that the harbour is directly responsible for the welfare of up to 100 people per year. This is a worst case scenario and does not take into account the actions of the life boat service that would be able to intervene in the event of emergencies.

The value of a single life has been set at £1,480k for economic appraisal purposes; this is taken from the Defra Risk to Life Supplementary Guidance issued in May 2008 (£1,145k at 2000 values, increased for inflation using CPI to £1,480k). It has been assumed that on average in the absence of the Whitby Harbour the loss of life would be 1 death every 5 years, starting in year 10 when the piers first breach.

The Do Nothing PV damages over 100 years are **£6,679k**.

## 5.2 Relocation of Lifeboat Station

The current lifeboat station at Whitby, constructed in 2007, is located on the east bank of the River Esk estuary within a zone that is well sheltered by the piers. The station is also protected by a small secondary pier inside the shelter of the primary piers which provides a second layer of protection to launching rescue vessels.

It is envisaged that if the piers were to be lost, this would have a considerable impact on the condition and operational efficiency of the station. Increased wave energy impacting upon the secondary pier is likely to significantly reduce the expected life span of the structure, increasing the cost of maintenance and inevitably leading to its collapse.

Royal Haskoning works with the RNLI around the UK and therefore has extensive and recent experience in the design and construction of lifeboat stations. Due to this, it has been possible to establish an approximate construction cost of a replacement life boat station of the same specifications as the current station.

An approximate cost of £4 million is provided. This includes the cost of construction on which would bring the facilities up to the standard of new legislative requirements. If this cost is discounted to assume that the lifeboat station is relocated after the piers are completely lost in year 30, a present value damage of **£1,425k** is incurred.

As the coastal defences in Management Unit 19 prevent coastal erosion extending inland along the Esk into RE1 and outflanking the Lifeboat Station, 20% of the damages have been assigned to MU19, with the remaining 80% split equally between the piers (MUs 17 & 18).

## 5.3 Damage to Vessels

The piers protect vessels that are berthed within the harbour, preventing them from damage that may otherwise be caused by incoming waves. As protection from the piers is lost it is anticipated that damage to the fishing fleet itself will be incurred. During 2008, approximately 100 different commercial vessels made entry into the harbour. It is assumed that the majority of these craft are fishing vessels.

It has been estimated that due to the deterioration of the piers, each vessel is likely to sustain an average of £400 worth of damage per year which would previously not occur. This results in an average damage to the commercial fleet of £40,000 per year.

It has been assumed that the vessels would only keep using the harbour for 20 years after the piers first breach in year 10, at which point it would become unsustainable to keep the fleet stationed in Whitby Harbour, this ties in with the assumptions used for the calculation of damages to the fishing business (Section 6). The resulting Do Nothing present value damages over 100 years are **£417k**.

A sensitivity test has been carried out on this assumption, looking at capping the damages to vessels at their market value. The market value of similar vessels of the types found in Whitby harbour varies greatly, from <£20k to >£100k. A conservative assumption of an average market value for the vessels at Whitby of £50k results in a total value of the fleet of £5,000k. This is of an order of magnitude greater than the damage calculated; therefore the assumptions used do not overestimate the damages.

#### 5.4 Increased Dredging

The current cost of dredging the navigation channel at Whitby Harbour in order to allow safe passage of vessels in and out of the River Esk estuary is currently set at approximately £150,000 (2009 budget). It is known that the present piers and extensions trap approximately 60% of the material that is transported along the coast and nearshore. Therefore some of the 40% of sediment that bypasses the piers enters the channel, whilst some moves further offshore carried in suspension in the water column.

If we conservatively assume that the £150k budget is used to dredge all of the 40% of sediment bypassing the pier from the channel, then the pro-rata cost for dredging the whole 100% of sediment is £375k. Therefore the annual damage for increased dredging due to loss of the piers is £225k, this annual damage will initiate in year 10 when the piers first breach.

The resulting Do Nothing present value damages over 100 years are **£4,771k**.

## 6. Loss of Business

There are three key areas of commerce within Whitby; fishing, maritime services, and tourism. Under the Do Nothing scenario all three would be adversely affected, having a significant affect on the local economy. The impacts on fishing and maritime services are discussed below; tourism has been covered under Section 3.

In addition, the impact on the functionality of the harbour through the loss of the piers would have an adverse impact on future business opportunities. In particular the town is currently pursuing opportunities for providing services for survey and service vessels for the offshore wind farms being developed in the North Sea (<http://www.whitbywind.org.uk/>). Whitby is ideally placed to service the Dogger Bank wind farm in particular, which will be the world's largest offshore wind farm.

### 6.1 Fisheries

The piers at Whitby Harbour serve a very important role for the local fishing industry. Primarily, the piers act as breakwaters, allowing fishing vessels safe passage in and out of the River Esk estuary during heavy seas and ultimately allow the delivery of catches. It is anticipated that the loss of the piers would result initially in the gradual decline of the fishing industry at Whitby as the number of trawls that can be carried out will be reduced due to worsening sea conditions in the vicinity of the harbour. (The loss of protection from the piers means that vessels will not be able to go out in conditions that they may have previously been able to).

It is recognised that with this demise, some of the fleet (or its quota) may be transferred to another port, such as Scarborough or Teesside. However, to continue to fish the traditional grounds these vessels would have longer haul distances, and be at greater risk of being damaged or experiencing downtime due to bad weather. By way of a proxy, we have estimated the economic damage to the UK from the additional distances and greater risks as the equivalent of a direct loss of fishing income from Whitby itself.

The present annual fishing income to the UK from Whitby is approximately £141,050 (2007/08). It is anticipated that following the breach of the piers in year 10, the fishing industry would see an annual reduction of 10% for the next 20 years beyond which it would become unsustainable and cease altogether. The resulting Do Nothing present value damages over 100 years are **£2,349k**.

As the current maintenance regime is restricted by budgets it will have a very limited impact on the residual life of the structure. Maintenance will be mainly focused on public health and safety requirements and will not deal with the structural deterioration of the piers. Therefore the Do Minimum scenario is the same as the Do Nothing scenario for the piers and the associated damages will be the same.

### 6.2 Maritime Services

In addition to the damages associated with the impact on the fishing industry, the loss of the local fishing industry is likely to have a number of immeasurable knock on effects to the local economy and businesses. Businesses that are likely to be affected are boat yards and marine repair mechanics, fish wholesale and independent fish mongers and retailers, fish and chips vendors and other local eateries and restaurants. Considering Whitby's fame for seafood establishments, this is likely to have further knock on effects for the tourist industry and the wider local economy. However the maritime service businesses are likely to move with the fishing fleet to other locations and therefore the economic loss is local rather than national and has not been considered further.

## 7. Loss of Historic Environment

The study area for the Strategy contains a large number of sites of historic significance, many of which will become at risk of coastal erosion within the appraisal period under the Do Nothing scenario. The most significant of these are the pier structures, the main parts of which are listed.

### 7.1 Piers – Listed Structures

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. Due to their significance the value of the piers has been derived.

If the main piers were to be allowed to deteriorate, the value derived from their listed status would be lost to the nation. Whilst it would not be possible to directly replicate the antiquity of the structures, efforts could be made to clad a new replacement structure with petrographically similar stone blockwork as an approximate analogue value.

The estimated cost of such replacement works to the main piers only (as the pier extensions are not listed) is £167,241,000. The cost has been split across four management units; the two piers (MUs 17 & 18) and on the east side, MU 19 and 20. Erosion in MU 19 and 20 would isolate the East Pier from the mainland and expose the most landward end of the pier, accelerating deterioration of the structure from the landward end. The split of the costs across the four management units as follows:

- MU 17: West Pier – 50%;
- MU 18: East Pier – 45%;
- MU 19: Haggerlythe – 2.5%; and
- MU 20: Abbey Cliff – 2.5%.

The costs for each management unit are assigned to the end of the residual life period of the existing assets (assuming no maintenance under Do Nothing. For the piers, it is estimated that the first breach would occur by year 10, however it is assumed that the structures of the main piers would not be completely lost until year 30. The discounted PV damages for Do Nothing are therefore **£58,255k** over 100 years.

### 7.2 Other Historic Structures

The Strategy study area contains a large number of sites of historic significance, many of which will become at risk of coastal erosion within the appraisal period under the Do Nothing scenario. Table 9 summarises the heritage assets at risk of coastal erosion in each Management Unit.

In order to assign damage values for the loss of these historic assets specialists in archaeology have been consulted (Northern Archaeological Associates Ltd). The damages have been derived as the cost of surveying and recording the historic assets before they are lost to coastal erosion, as recommended in Environment Agency guidance (Flood and Coastal Erosion Risk Management Appraisal Guidance – Supporting Document for the Appraisal Summary Table, March 2010).

The costs for each management unit have been applied 5 years before the Do Nothing erosion of the frontage in that management unit is due to commence (taking into account existing coastal defence assets with no maintenance). The 5 years is to allow time for the surveying and recording to be carried out before the historic asset becomes directly at risk. The discounted PV damages for Do Nothing are therefore **£84k** over 100 years.

## 8. Loss of Natural Environment

It is known that the present size, type and location of the piers and pier extensions are responsible for the foreshore to the east of the piers being maintained free of sediment. If the piers were lost, sediment would cover the geological interest and its educational value to the nation would be lost.

It has been assumed that should the piers become lost, then the 4ha of the foreshore present in Management Unit 20, which is designated as a geological SSSI, will become totally smothered by marine sediment. Based on the Economic Evaluation of Environmental Effects first cut methodology (eftec, 2007), the damages to the foreshore have been derived using a value of £2,750 per hectare per year (Table 2.2 of the eftec Handbook). The foreshore has a specialist recreational use for geologists, including enthusiasts, recreational, educational and academic. The exposed rock foreshore outcrops are of national significance as recognised by their SSSI protected status.

The annual damages have been applied from year 10 onwards when the piers would first breach and have been discounted to give Do Nothing present value damages over 100 years of **£233k**.

The range of values given in the Economic Evaluation of Environmental Effects Handbook (Table 2.2) is £1,200 to £6,350 per hectare per year. This gives a range of damage values for the recreational loss of the foreshore through sediment accumulation of £102k to £539k, therefore the assumed value of £223k falls suitably within this range.

## 9. Summary

The damage assessment for the Whitby Piers PAR presented in this report is extracted from the Whitby Coastal Strategy 2: Strategic Appraisal report (2012). The base date for the StAR economic appraisal is 4<sup>th</sup> Quarter 2011. The uplift to 1<sup>st</sup> Quarter 2012 using the Consumer Price Index would be less than 1% and therefore is insignificant and has not been applied.

A summary of the Do Nothing and Do Something scenarios is presented in Table 8.

**Table 8 – Summary of Present Value Damages (£k)**

Damage Category		Do Nothing PVd (£k)	Do Something PVd (£k)
<b>1</b>	<b>Coastal Erosion</b>		
1.1	Property	18,145	0
1.2	Other assets (Services)	163	0
<b>2</b>	<b>Tidal Flooding</b>		
2.1	Property	2,073	0
2.2	Wave run-up	1,809	0
2.3	Wave Overtopping	896	896
<b>3</b>	<b>Tourism &amp; Amenity</b>		
3.1	Tourism & Amenity	33,613	0
<b>4</b>	<b>Traffic Disruption</b>		
4.1	Coastal Erosion	Damages not quantified	Damages not quantified
4.2	Flooding	Damages not quantified	Damages not quantified
<b>5</b>	<b>Harbour Function</b>		
5.1	Loss of Refuge	6,679	0
5.2	Relocation of Life Boat Station	1,140	0
5.3	Damage to Vessels	417	0
5.4	Increased Dredging	4,771	0
<b>6</b>	<b>Loss of Business</b>		
6.1	Fisheries	2,349	0
6.2	Maritime	Damages not quantified	Damages not quantified
6.3	Tourism	Damages not quantified	Damages not quantified
6.4	Future Opportunities (e.g. offshore wind farms)	Damages not quantified	Damages not quantified
<b>7</b>	<b>Loss of Historic Environment</b>		
7.1	Piers – Listed Structures	56,605	0
7.2	Other Listed/Historic Structures	84	0
<b>8</b>	<b>Loss of Natural Environment</b>		
8.1	Foreshore rock exposures (Geological interest)	233	0
<b>TOTAL</b>		<b>128,978</b>	<b>896</b>

### 9.1 Do Something Residual Damages

The Do Nothing damages occur due to the collapse of the piers which would result in loss of beaches, reactivation of coastal erosion, sediment transport, and increased wave heights within the harbour causing increased flood risk and loss of harbour functionality. The Do Something options ensure that the piers remain functional over the 100 year appraisal period and therefore avoid all of the Do Nothing damages associated with the failure of the piers. There are therefore no residual damages associated with any of the damage categories with the exception of wave overtopping. The options proposed will not prevent wave overtopping on the pier structures and therefore the annual wave overtopping damages still apply throughout the appraisal period.

## 10. Partnership Funding

The outcome measure score has been calculated using the Partnership Funding (PF) calculator for 2013/14. A copy of the calculator for the first phase of works can be found in Appendix C to this report.

The four components of the Whitby Harbour Piers (East Main Pier, East Pier Extension, West Main Pier, and West Pier Extension) function as an integrated asset system. The flood risk and coast protection benefits derived from the presence of the piers and their extensions come from the system as a whole and cannot be apportioned to the individual pier components. Both the main piers and the pier extensions need to remain in place for the full benefits to be derived over the 100 year appraisal.

The benefit period for the first phase of the scheme (Main Piers) has therefore been capped at 20 years for the PF calculations, despite the works to the main piers having a 100 year design life. The 20 year benefit period is determined by the timing of the capital scheme to the Pier Extensions. The benefits and costs (design, construction and maintenance) have therefore been entered into the Partnership Funding Calculator as the present value prices for the first 20 years of the appraisal period. The benefits for the first 20 years of the scheme are shown in Table 9.

**Table 9 – Summary of Present Value Benefits over first 20 years of appraisal period (£k)**

Damage Category		PV Benefits (£k) – Full 100 Years	PV Benefits (£k) – First 20 Years
<b>1</b>	<b>Coastal Erosion</b>		
1.1	Property	18,145	9,684
1.2	Other assets (Services)	163	15
<b>2</b>	<b>Tidal Flooding</b>		
2.1	Property	2,073	1,369
2.2	Wave run-up	1,809	1,737
2.3	Wave Overtopping	0	
<b>3</b>	<b>Tourism &amp; Amenity</b>		
3.1	Tourism & Amenity	33,613	33,613
<b>4</b>	<b>Traffic Disruption</b>		
4.1	Coastal Erosion	Damages not quantified	Damages not quantified
4.2	Flooding	Damages not quantified	Damages not quantified
<b>5</b>	<b>Harbour Function</b>		
5.1	Loss of Refuge	6,679	2,676
5.2	Relocation of Life Boat Station	1,140	0
5.3	Damage to Vessels	417	264
5.4	Increased Dredging	4,771	1,486
<b>6</b>	<b>Loss of Business</b>		
6.1	Fisheries	2,349	390
6.2	Maritime	Damages not quantified	Damages not quantified
6.3	Tourism	Damages not quantified	Damages not quantified
6.4	Future Opportunities (e.g. offshore wind farms)	Damages not quantified	Damages not quantified
<b>7</b>	<b>Loss of Historic Environment</b>		
7.1	Piers – Listed Structures	56,605	0
7.2	Other Listed/Historic Structures	84	84
<b>8</b>	<b>Loss of Natural Environment</b>		
8.1	Foreshore rock exposures (Geological interest)	233	73
<b>TOTAL</b>		<b>£128,082k</b>	<b>£51,393k</b>

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, the adjusted OM score is 100%.

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



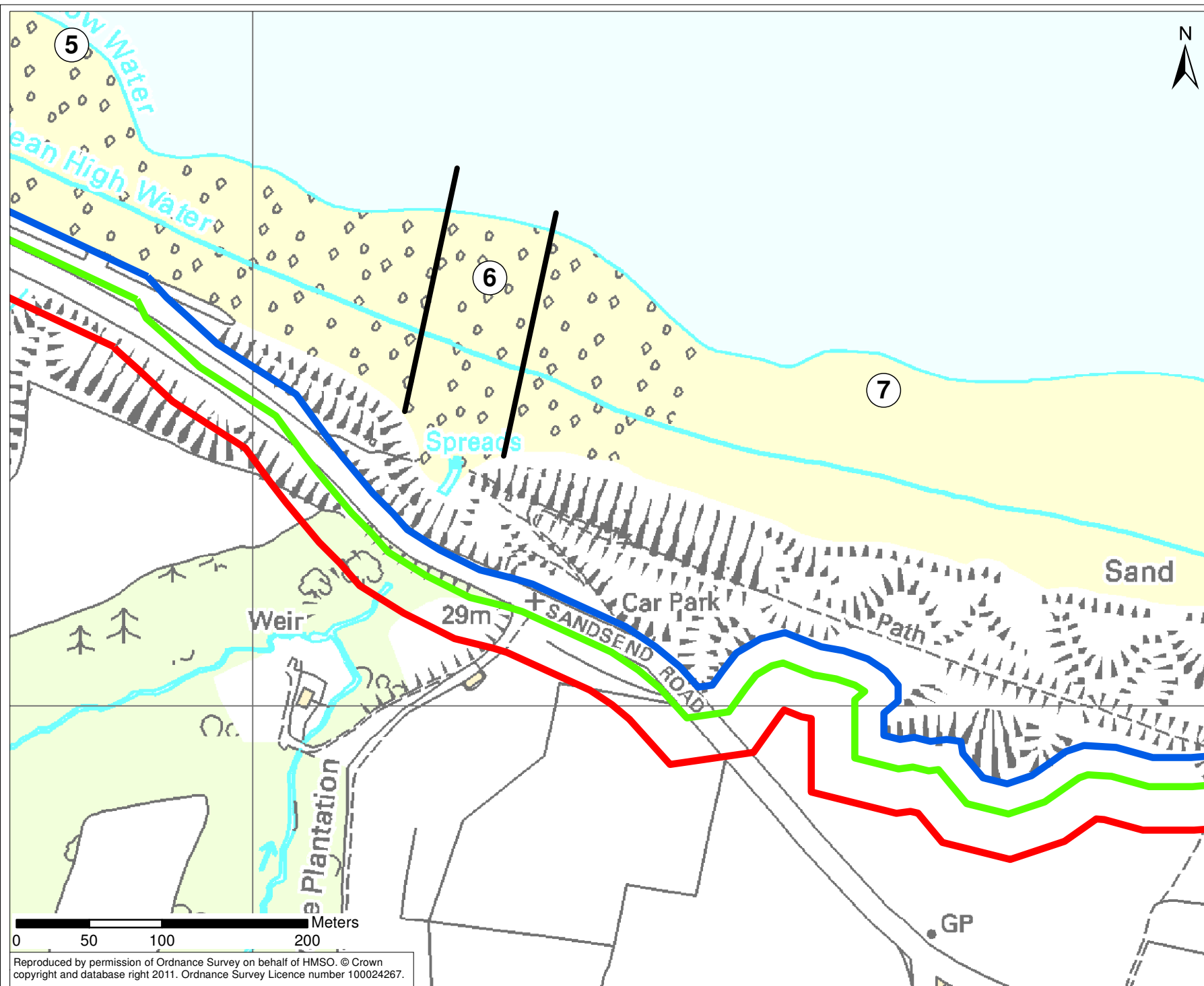
## **Appendix A**

### **Figures**









### SMP Erosion lines

- Do Nothing - 20yrs
- Do Nothing - 50yrs
- Do Nothing - 100yrs

Title:  
SMP Erosion Lines:  
Sandsend, MU1 - MU8

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

Scale on A4:  
1:3,500

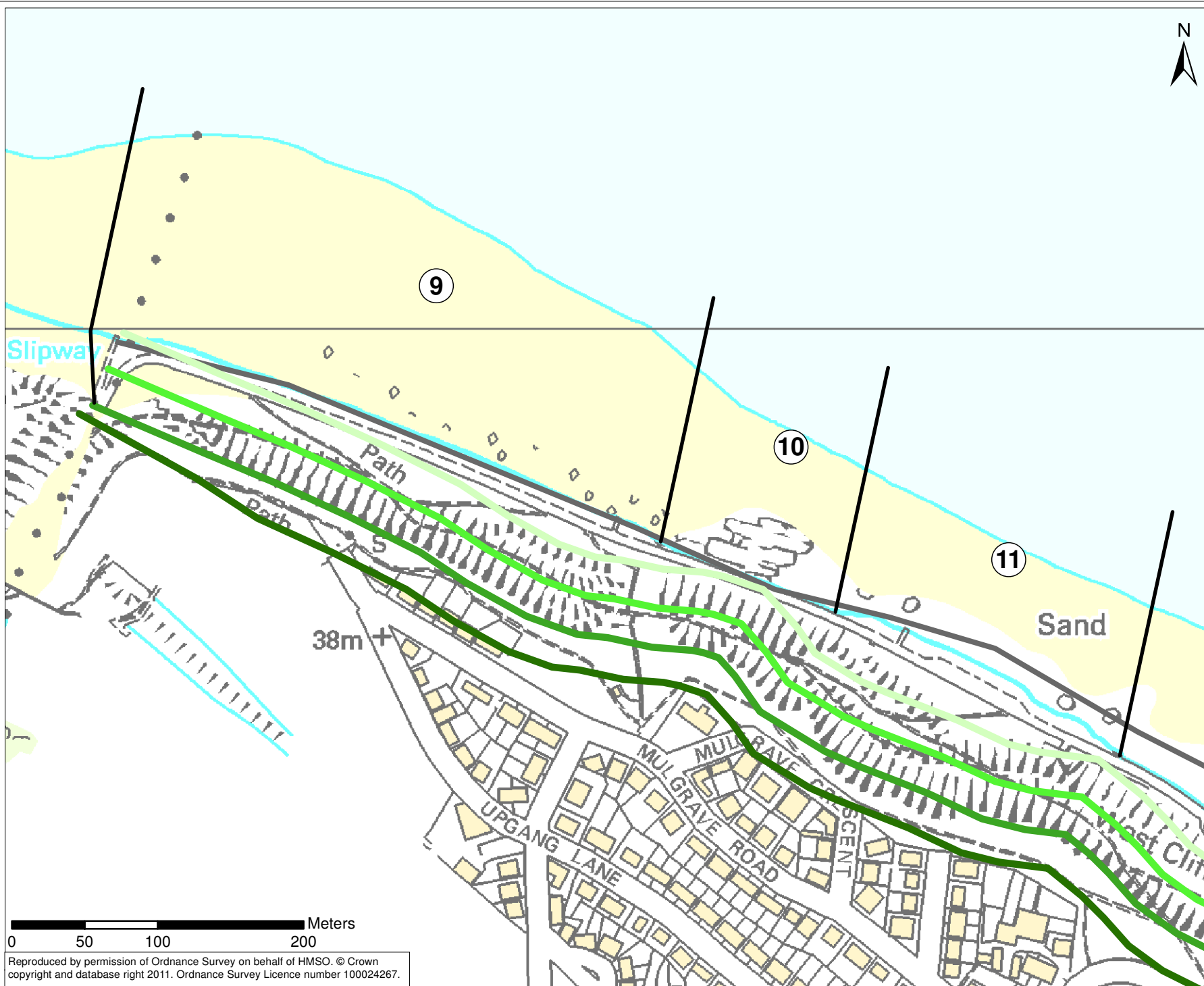
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1c

Drawn:  
TC

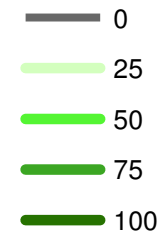
Checked:  
NJC







# **Further Investigation Erosion Lines (with piers)**



Title:  
Further Investigation  
Erosion Lines (with piers):  
MU9 - MU20

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

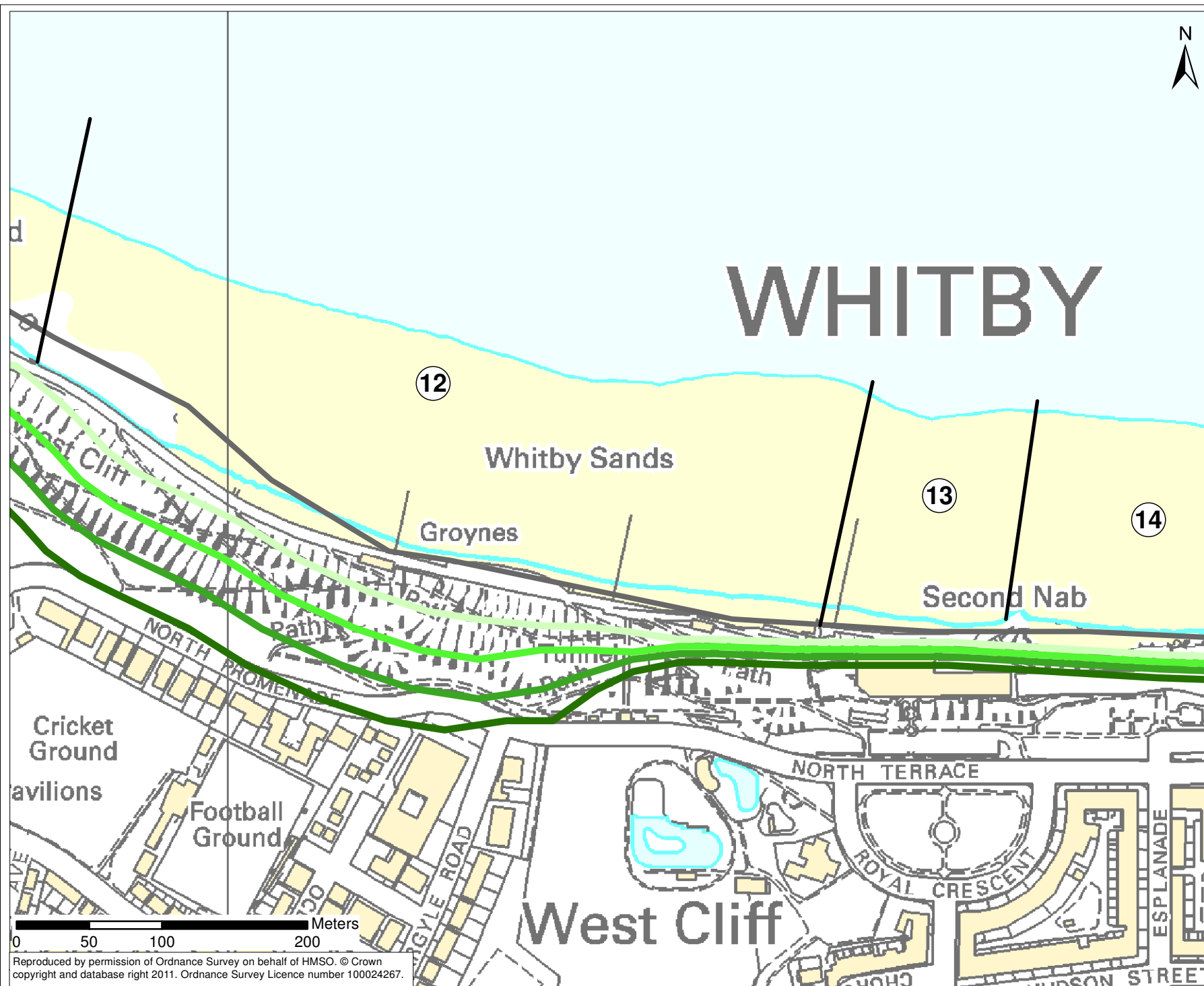
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Figure:  
2a

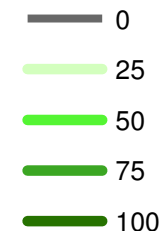
Drawn:  
TC

Checked:  
NJC





# Further Investigation Erosion Lines (with piers)



Title:  
Further Investigation  
Erosion Lines (with piers):  
MU9 - MU20

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

Scale on A4:  
1:3,500

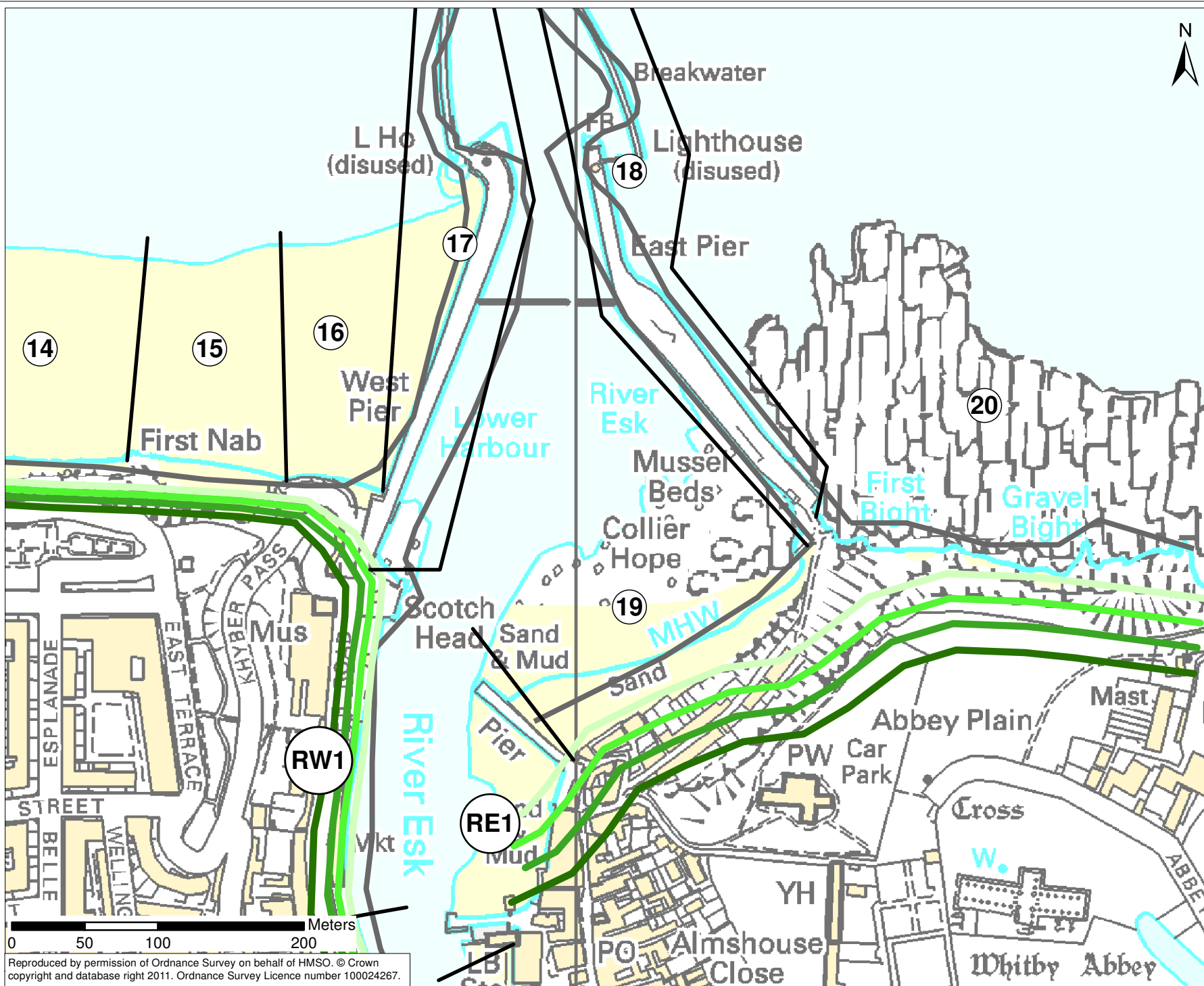
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Drawn:  
TC

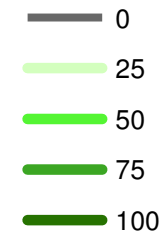
Checked:  
NJC







#### Further Investigation Erosion Lines (with piers)



Title:  
Further Investigation  
Erosion Lines (with piers):  
MU9 - MU20

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

Scale on A4:  
1:3,500

Figure:  
2c

Drawn:  
TC

Checked:  
NJC





Key:

**Properties isolated due to loss of quay wall in RE6**

- Commercial
- Residential
- Non classified

□ Affected Area

Title:  
Properties isolated due to loss of quay wall in RE6

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

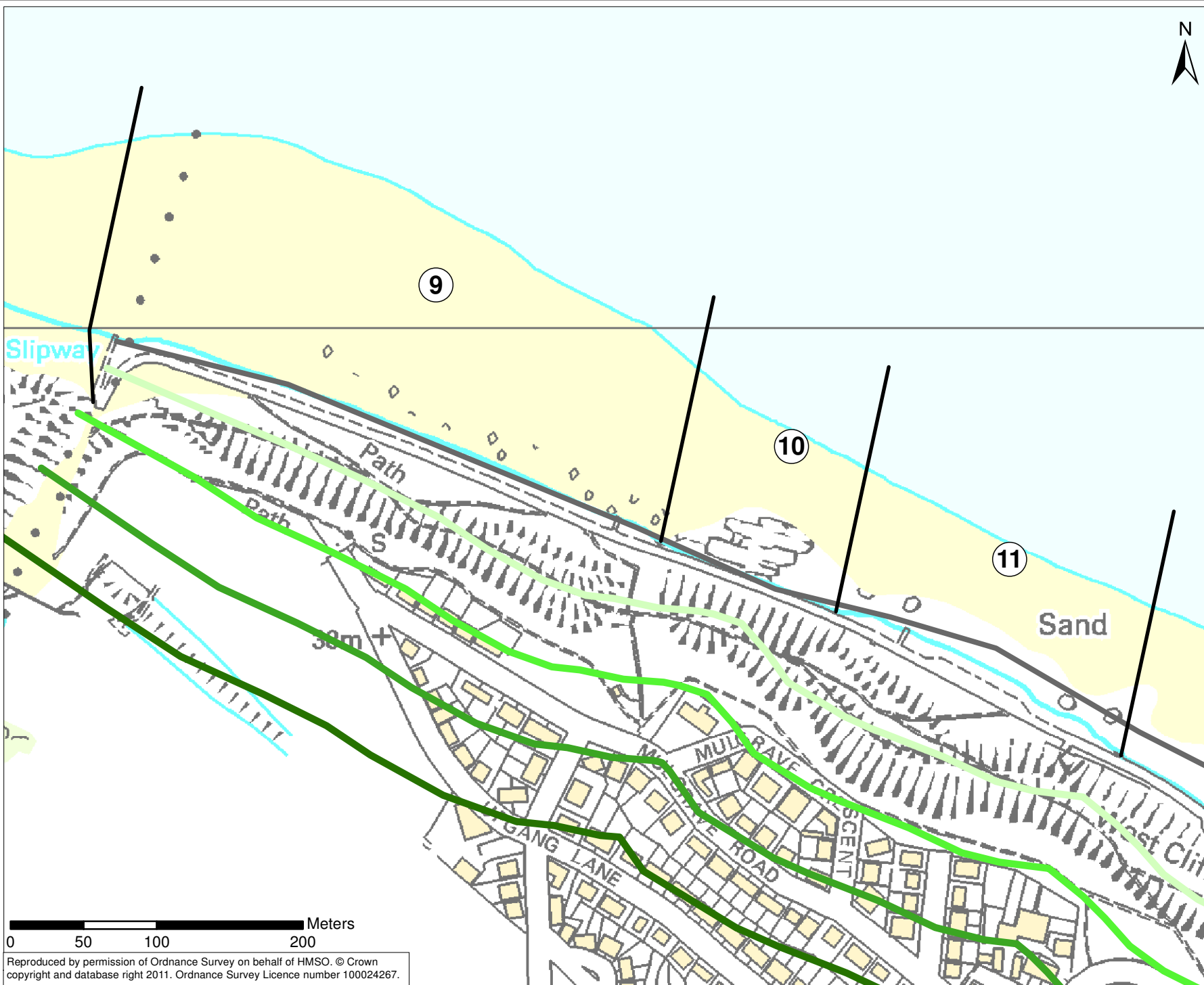
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Figure:  
G3

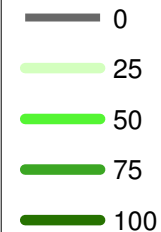
Drawn:  
TC

Checked:  
NJC





# **Further Investigation Erosion Lines (without piers)**



Title:  
Further Investigation  
Erosion Lines (without piers):  
MU9 - MU20

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

Scale on A4:  
1:3,500

Figure:  
4a

Drawn:  
TC

Checked:  
NJC

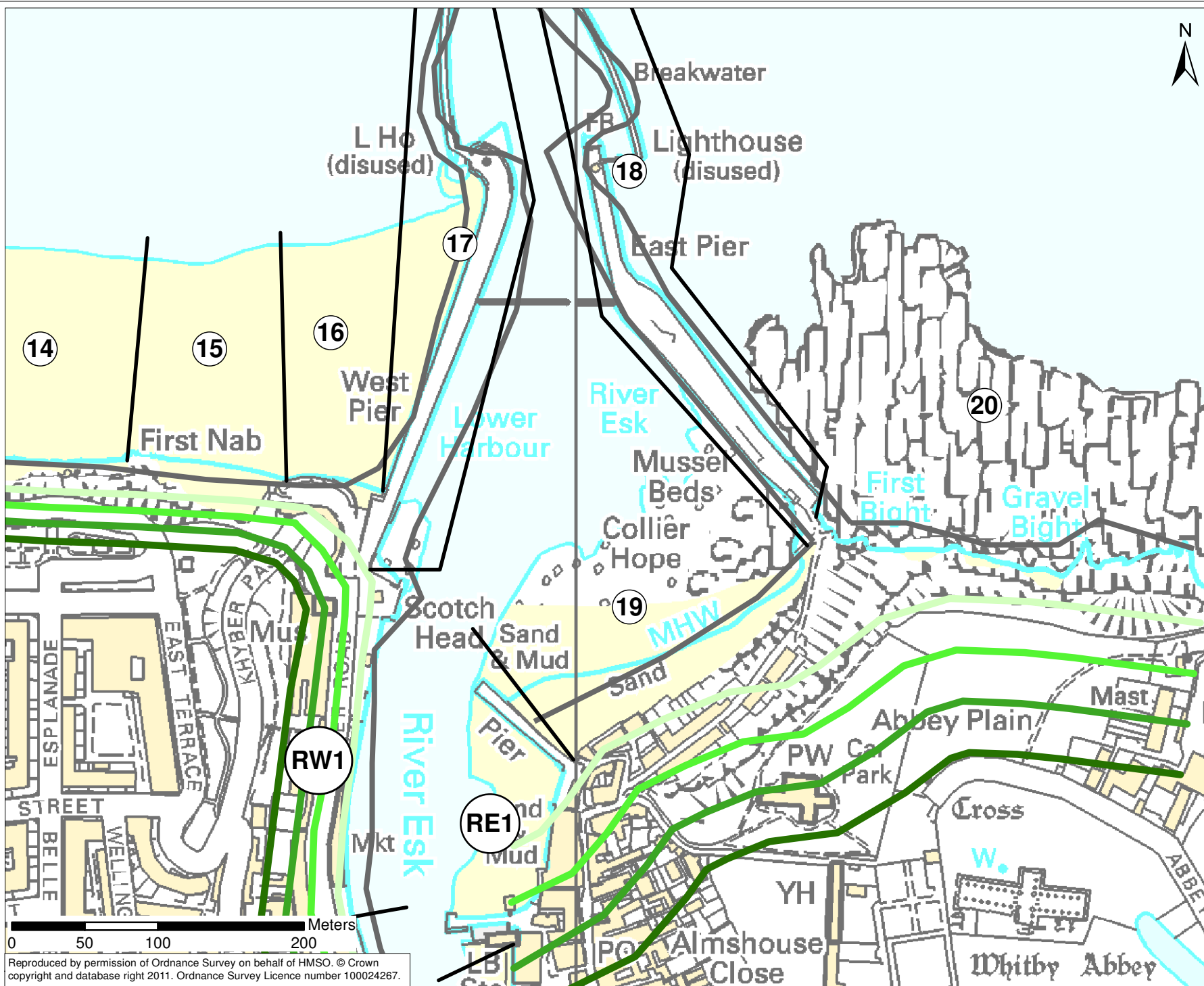


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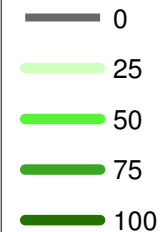
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# **Further Investigation Erosion Lines (without piers)**



Title:  
Further Investigation  
Erosion Lines (without piers):  
MU9 - MU20

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date:  
October 2011

Scale on A4:  
1:3,500

Figure:  
4c

Drawn:  
TC

Checked:  
NJC





Key:

**Properties at Risk of Tidal Flooding**

- RP200
- SLR200

**Flood Extents**

- 2007 - RP200 (4.1mOD)
- SLR 2057 - RP200 (4.38mOD)

Title:  
Properties at Risk of Tidal Flooding

Project:  
Whitby Coastal Strategy 2

Client:  
Scarborough Borough Council

Date: October 2011	Scale at A3: 1:4,000	
Figure: G5	Drawn: TC	Checked: NJC



**ROYAL HASKONING**





Aerial Photography 2010 courtesy of North East Coastal Observatory  
[www.northeastcoastalobservatory.org.uk](http://www.northeastcoastalobservatory.org.uk)

Title:  
 Wave Run-up at Slipway

Project:  
 Whitby Coastal Strategy 2

Client:  
 Scarborough Borough Council

Date:  
 October 2011

Scale on A4:  
 1:1,250

Figure:  
 G6

Drawn:  
 TC

Checked:  
 NJC







## **Appendix B**

### **Summary Spreadsheet**



Category		Management Unit			TOTAL
		MU16	MU17	MU18	
<b>1 Coastal Erosion</b>					
1.1	Property		£9,073	£9,073	<b>£18,145</b>
1.2	Other assets (services)		£81	£81	<b>£163</b>
<b>2 Tidal Flooding</b>					
2.1	Property - Direct & Indirect		£1,037	£1,037	<b>£2,073</b>
2.2	Wave Run-up at Slipway	£1,809			<b>£1,809</b>
2.3	Wave Overtopping		£448	£448	<b>£896</b>
<b>3 Tourism &amp; Amenity</b>					
3.1	Tourism & Amenity		£16,807	£16,807	<b>£33,613</b>
<b>4 Traffic Disruption</b>					
4.1	Coastal Erosion				<b>£0</b>
4.2	Flooding				<b>£0</b>
<b>5 Harbour Function</b>					
5.1	Loss of Refuge		£3,339	£3,339	<b>£6,679</b>
5.2	Relocation of Lifeboat Station		£570	£570	<b>£1,140</b>
5.3	Damage to Vessels		£209	£209	<b>£417</b>
5.4	Increased Dredging		£2,386	£2,386	<b>£4,771</b>
<b>6 Loss of Business</b>					
6.1	Fisheries		£1,175	£1,175	<b>£2,349</b>
6.2	Maritime				<b>£0</b>
6.3	Tourism				<b>£0</b>
<b>7 Loss of Historic Environment</b>					
7.1	Piers - Listed Structures		£29,792	£26,813	<b>£56,605</b>
7.2	Other Listed/Historic Structures		42.1	42.1	<b>£84</b>
<b>8 Loss of Natural Environment</b>					
8.1	Geological SSSI		£117	£117	<b>£233</b>
<b>TOTAL (£k)</b>		<b>£1,809</b>	<b>£65,074</b>	<b>£62,095</b>	<b>£128,978</b>

Damages not quantifiable

Project Summary Sheet					
<b>Client/Authority</b> Scarborough Borough Council			Prepared (date) 31/05/2012		
<b>Project name</b> Whitby Harbour Piers Coast Protection Scheme Project Appraisal Report			Printed 14/06/2012		
<b>Project reference</b> Base date for estimates (year 0) Scaling factor (e.g. £m, £k, £) Year Discount Rate Optimism bias adjustment factor			Prepared by Emma Hick Checked by Checked date		
9W5572					
Q4 2011					
£k (used for all costs, losses and benefits)					
0 30 75					
3.5% 3.00% 2.50%					
variable					
<b>Costs and benefits of options</b>					
<b>Costs and benefits £k</b>					
Option number	Option 1	Option 3	Option 4	Option 5	Option 6
Option name	Do-nothing	M1 + E1	M1 + E2	M1 + E3	M1 + E4
Optimism Bias		40.80%	45.30%	50.50%	39.70%
<b>COSTS:</b>					
PV capital costs	0	8,348	9,097	9,846	8,490
PV operation and maintenance costs	0	460	438	415	438
PV other	0	15	15	15	15
Optimism bias adjustment	0	3,600	4,326	5,189	3,550
PV negative costs (e.g. sales)	0	0	0	0	0
PV contributions					
<b>Total PV Costs £k excluding contributions</b>	0	12,422	13,875	15,465	12,492
<b>Total PV Costs £k taking contributions into account</b>	0	12,422	13,875	15,465	12,492
<b>BENEFITS:</b>					
PV monetised flood damages	4,778	896	896	896	896
PV monetised flood damages avoided		3,882	3,882	3,882	3,882
PV monetised erosion damages	124,200	0	0	0	0
PV monetised erosion damages avoided (protected)		124,200	124,200	124,200	124,200
<b>Total monetised PV damages £k</b>	128,978	896	896	896	896
<b>Total monetised PV benefits £k</b>		128,082	128,082	128,082	128,082
PV damages (from scoring and weighting)					
PV damages avoided/benefits (from scoring and weighting)					
PV benefits from ecosystem services	0	0	0	0	0
<b>Total PV damages £k</b>	128,978	896	896	896	896
<b>Total PV benefits £k</b>		128,082	128,082	128,082	128,082
<b>DECISION-MAKING CRITERIA:</b>					
<b>excluding contributions</b>					
<i>Based on total PV benefits (includes benefits from scoring and weighting and ecosystem services)</i>					
Net Present Value <b>NPV</b>		115,660	114,207	112,617	115,590
Average benefit/cost ratio <b>BCR</b>		10.3	9.2	8.3	10.3
Incremental benefit/cost ratio <b>IBCR</b>			0.0	0.0	0.0
Highest bcr					
<i>Based on monetised PV benefits (excludes benefits from scoring and weighting and ecosystem services)</i>					
Net Present Value <b>NPV</b>		115,660	114,207	112,617	115,590
Average benefit/cost ratio <b>BCR</b>		10.3	9.2	8.3	10.3
Incremental benefit/cost ratio <b>IBCR</b>			0.0	0.0	0.0
Highest bcr					
<b>including contributions</b>					
<i>Taking account of contributions (includes benefits from scoring and weighting and ecosystem services)</i>					
Net Present Value <b>NPV</b>		115,660	114,207	112,617	115,590
Average benefit/cost ratio <b>BCR</b>		10.3	9.2	8.3	10.3
Incremental benefit/cost ratio <b>IBCR</b>			0.0	0.0	0.0
Highest bcr					
<i>Based on monetised PV benefits (excludes benefits from scoring and weighting and ecosystem services)</i>					
Net Present Value <b>NPV</b>		115,660	114,207	112,617	115,590
Average benefit/cost ratio <b>BCR</b>		10.3	9.2	8.3	10.3
Incremental benefit/cost ratio <b>IBCR</b>			-	-	-
Highest bcr					
Best practicable environmental option (WFD)					
<b>Brief description of options:</b>					
Option 1	Do-nothing				
Option 3	M1 + E1				
Option 4	M1 + E2				
Option 5	M1 + E3				
Option 6	M1 + E4				
<b>Comments and assumptions:</b>					

## **Appendix C**

### **FDGiA Partnership Funding Calculator**



PARTNERSHIP FUNDING CALCUATOR

for the 2013/14 Flood and Coastal Risk Management Medium Term Plan

ePublications Catalogue Code -

Project Name

Whitby Harbour Piers Coast Protection Scheme PAR - Preferred Option 6 (M1 + E4) - 1st Phase (Main Piers)

Unique Project Reference

ALL COSTS ARE IN THOUSANDS OF POUNDS (£k)

Key

Input cells

Calculated cells

SUMMARY: prospect of FDGiA funding

PV Maximum FDGiA that the scheme could qualify for = 'FDGiA Contribution'

4,812

Scheme Benefit to Cost Ratio

7.82

to 1

Raw Score

73.23%

Effective return to taxpayer

10.68

to 1

Partnership Funding Score (PF)

77.17%

Effective return to area

198.43

to 1

1. Scheme details

Risk Management Authority type of asset maintainer

LA

Y

Is evidence available that a Strategic Approach has been taken, and that double counting of Benefits has been avoided ?

Duration of Benefits (yrs)

20

PV Appraisal Costs

0

PV Design & Construction Costs

6,313

PV Post Construction Costs

259

PV Total Costs

6,572

All Costs and Contributions must be on a PV Whole-Life basis over the Duration of Benefits; and include Contributions towards future Maintenance

PV Local Levy secured to date

PV Public Contributions secured to date

259

PV Private Contributions secured to date

PV Funding from Other Environment Agency Functions/Sources secured to date

PV Total Contributions secured to date

259

Figures in Blue to be entered onto MTP

PV Total Benefits

51,393

2. Qualifying benefits under Outcome Measure 2: houses better protected against flood risk

Number of houses in:

20% most deprived areas

21-40% most deprived areas

60% least deprived areas

Before

3

6

5

After

5

4

Change due to scheme

0

0

0

2

-2

-5

0

0

0

At: Moderate risk Significant risk Very significant risk

Moderate risk Significant risk Very significant risk

Annual damages avoided, compared with a house at low risk

0.150

0.600

1.350

Change in house damages, in:

20% most deprived areas

21-40% most deprived areas

60% least deprived areas

Per year

0.0

-7.7

0.0

Over lifetime of scheme

0

-153

0

Qual. benefits (discounted)

OM2 (20%)

0

OM2 (21-40%)

116

OM2 (60%)

0

3. Qualifying benefits under Outcome Measure 3: houses better protected against coastal erosion

Number of houses in:

20% most deprived areas

21-40% most deprived areas

60% least deprived areas

Before

162

56

15

122

7

Long-term loss Medium-term loss

Damages per house avoided:

Annual damages avoided (£k)

6.0

6.0

Loss expected in

50

20

Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected) (£k)

1.2

3.0

Long-term loss Medium-term loss

Change in house damages, in:

20% most deprived areas

21-40% most deprived areas

60% least deprived areas

Year 1 loss avoided

-191.7

-111.5

-165.5

Over lifetime of scheme

-3,835

-2,230

-3,310

Qual. benefits (discounted)

OM3 (20%)

2,917

OM3 (21-40%)

1,696

OM3 (60%)

2,518

4. Qualifying benefits under Outcome Measure 4: statutory environmental obligations met

Payments under:

OM4a

Hectares of net water-dependent habitat created

OM4b

Hectares of net intertidal habitat created

OM4c

Kilometres of protected river improved

Assumed benefits per unit

15.0

50.0

80.0

Qualifying benefits

OM4a

0

OM4b

0

OM4c

0

OM4

0

5. Qualifying benefits arising from the overall scheme, for entry into the Medium-Term Plan

OM, deprivation:

Qual. Benefits

Payment rate (p/£)

FDGiA contribution

OM1

44,146

5.56

2,453

OM2

20% most

0

45.0

0

21-40%

116

30.0

35

Least 60%

0

20.0

0

OM3

20% most

2,917

45.0

1,313

21-40%

1,696

30.0

509

Least 60%

2,518

20.0

504

OM4

0

100.0

0

Total

51,393

PVB

4,812

The "FDGiA Contribution" towards the scheme's whole-life benefits

PV CONTRIBUTIONS v PARTNERSHIP FUNDING SCORE

Raw Score

Current PF% if < 100%

PF 100%

Current PF% if > 100%

PV Contribution Scenarios

PV Contributions

0

259

1,760

3,074

4,389

5,703

Partnership Funding Score

73.23%

77.17%

100.00%

120.01%

140.01%

160.01%

PV Contributions yet to be secured to achieve PF Score

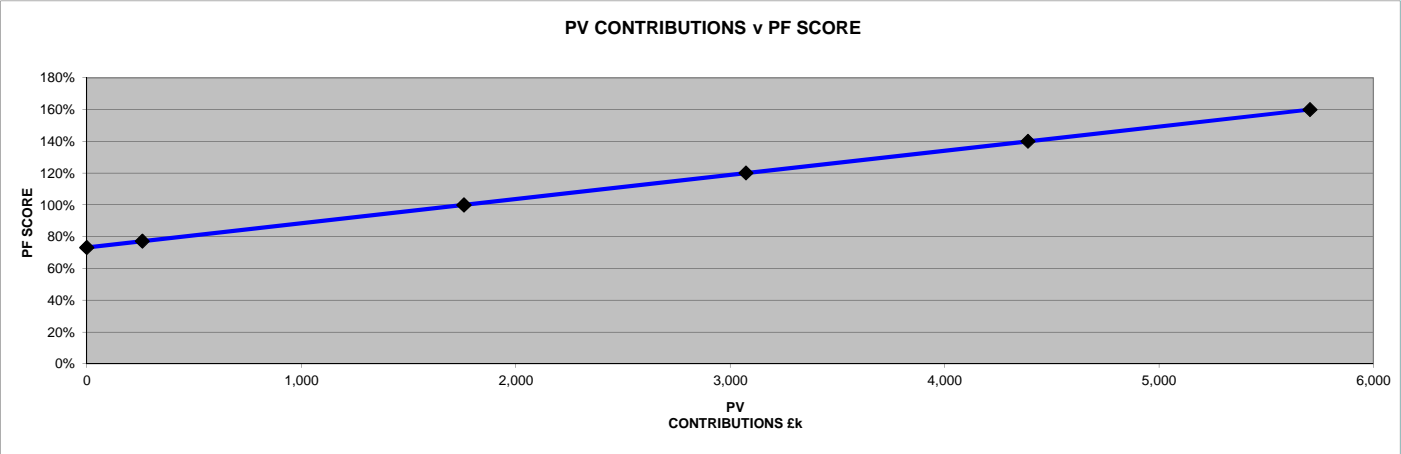
0

1,501

2,815

4,130

5,444



**Sensitivity Testing** . It is important that users of this calculator appreciate the implications on funding from changes to input data which may become necessary as the project develops and better information is available. Three typical tests are provided below. Users should consider how appropriate these are to their project, what other tests may be appropriate and how best to use the information with all those that may be involved in the project.

As above  
Sensitivity 1 - Change in PV Whole Life Cost (25% increase)  
Sensitivity 2 - Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band  
Sensitivity 3 - Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss  
Sensitivity 4 - Increase Duration of Benefits by 25%  
Sensitivity 5 - Reduce Duration of Benefits by 25%

PV FDGiA Contribution	Raw Score	PF Score
4,812	73.23%	77.17%
4,812	58.58%	61.73%
4,805	73.12%	77.06%
4,747	72.24%	76.18%
5,104	77.67%	81.61%
4,466	67.95%	71.89%