



## **Cell 1 Monitoring: Scarborough Asset Inspections**

Scarborough Borough Council

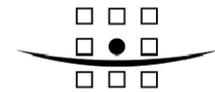
29th September 2010

Final Report

9T6403



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## 1 INTRODUCTION

The Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, March 2010) identified several assets within the Scarborough Borough Council region that are in 'urgent' need of repair. Scarborough Borough Council has commissioned Royal Haskoning to undertake further inspections of these assets to determine a more detailed repair schedule.

As part of this study all assets assessed as being in 'urgent' need of repair have been inspected in detail to produce the following information; a description of any defects, the exact location of the defects within the asset, proposals for recommended repairs and a breakdown of any costs associated with the repairs.

The assets included within this study are within the following Management Units:

- Management unit 4 – Staithes;
- Management Unit 7 - Runswick Bay;
- Management Unit 20- Scarborough North Bay;
- Management Unit 22- Scarborough South Bay;
- Management unit 24 - Cayton Bay; and
- Management unit 29 - Filey.

The inspections have been carried out between the 31<sup>st</sup> August and 15<sup>th</sup> September 2010.

In addition to the above assets, SBC requested that Royal Haskoning also undertake an assessment of the concrete revetment at Sandsend, north of Whitby, which had been recently damaged by storms.

- Management unit 9 – Sandsend.

Details of this inspection and the recommendations are included within this report.

## 2 STAITHES

### 2.1 Asset Description

Asset Ref. 1221D901D0402C22 is an older wall section located towards the west side of the harbour in Management Unit 4. The wall consists essentially of 5 separate sections made from concrete, masonry blockwork and stonework. Large areas of the wall are exterior walls of private properties and the wall also supports roads above. The five sections of wall are as follows:

1. Concrete wall which supports a road through;
2. Masonry mix of stonework at the bottom and blockwork at the top, which supports private property
3. Concrete wall, which supports private property; and
4. The final two sections are made up of masonry blockwork then stonework which support a private road.

### 2.2 Past Condition Report

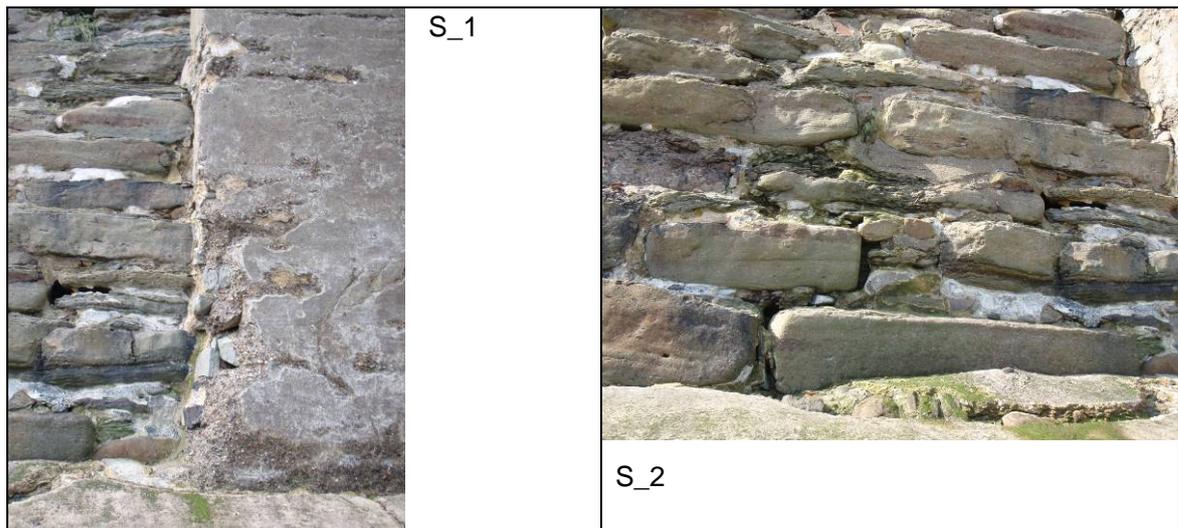
The Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, March 2010) identified 'older sections of harbour wall in need of regular maintenance' along the asset. Undercutting at the toe was also identified and it was suggested this was due to dynamic movement of sand. The report described evidence of repair work and suggested as the wall was in need of regular repair work perhaps replacement of structure should be considered.

### 2.3 Current Asset Condition

As an illustration of the defects found in during the recent asset inspection a table is provided below:

Chainage	Wall Type	Defect	Photo Reference
2	Masonry with Concrete cover wall	Section of concrete surface missing	S_1
2	Stone masonry wall and Masonry with Concrete cover wall	Void at the construction joint, 65mm at construction joint	S_11
3	Stone Masonry wall	Mortar missing and voids in masonry	S_2
5-10	Block masonry wall	Some vegetation at cope of the wall, loss of mortar in block masonry in this area	S_3
15	Block Masonry wall	Displaced block masonry and loss of mortar at top of wall	S_4
15-17	Concrete toe	Reinforcement mesh exposed	S_5
15	Concrete toe	Minor erosion of 250mm width, 180mm depth	S_6
17	Concrete toe	Minor erosion depth 0.1m	S_7

12 & 16	Block masonry wall	Slight bulge	-
17	Construction joint between brickwork with concrete surface wall and block masonry wall	Vertical cracking	S_8
17-20	Brickwork with concrete surface wall	Diagonal cracking from cope to construction joint	S_9
24	Concrete toe	Slight crack at top of toe	S_10
15	Concrete	Section of old masonry wall exposed	S_12
28-29	Brickwork with concrete surface wall	Diagonal crack from construction joint to cope of wall	S_13
28-30	Concrete toe	Undercutting varying in depth 300-500mm, length 2m	S_14
33-34	Stone masonry wall	Evidence of patchwork	S_15
34-40	Stone masonry	Missing mortar and several voids	S_16
34	Concrete toe	Localised patch of undercutting, 400mm depth	S_17
37	Concrete toe	100mm undercutting off rock foreshore	S_18
41-42	Concrete toe and wall	Strip of wall and toe showing evidence of repair work	S_19
42	Concrete wall	Horizontal cracking from construction joint	S_19
41-42	Concrete toe	300mm undercutting	S_20
42-50	Concrete toe	Eroded off surface	S_21
45-47	Concrete toe	2m long undercut of 250mm depth	S_22





S\_3



S\_4



S\_5



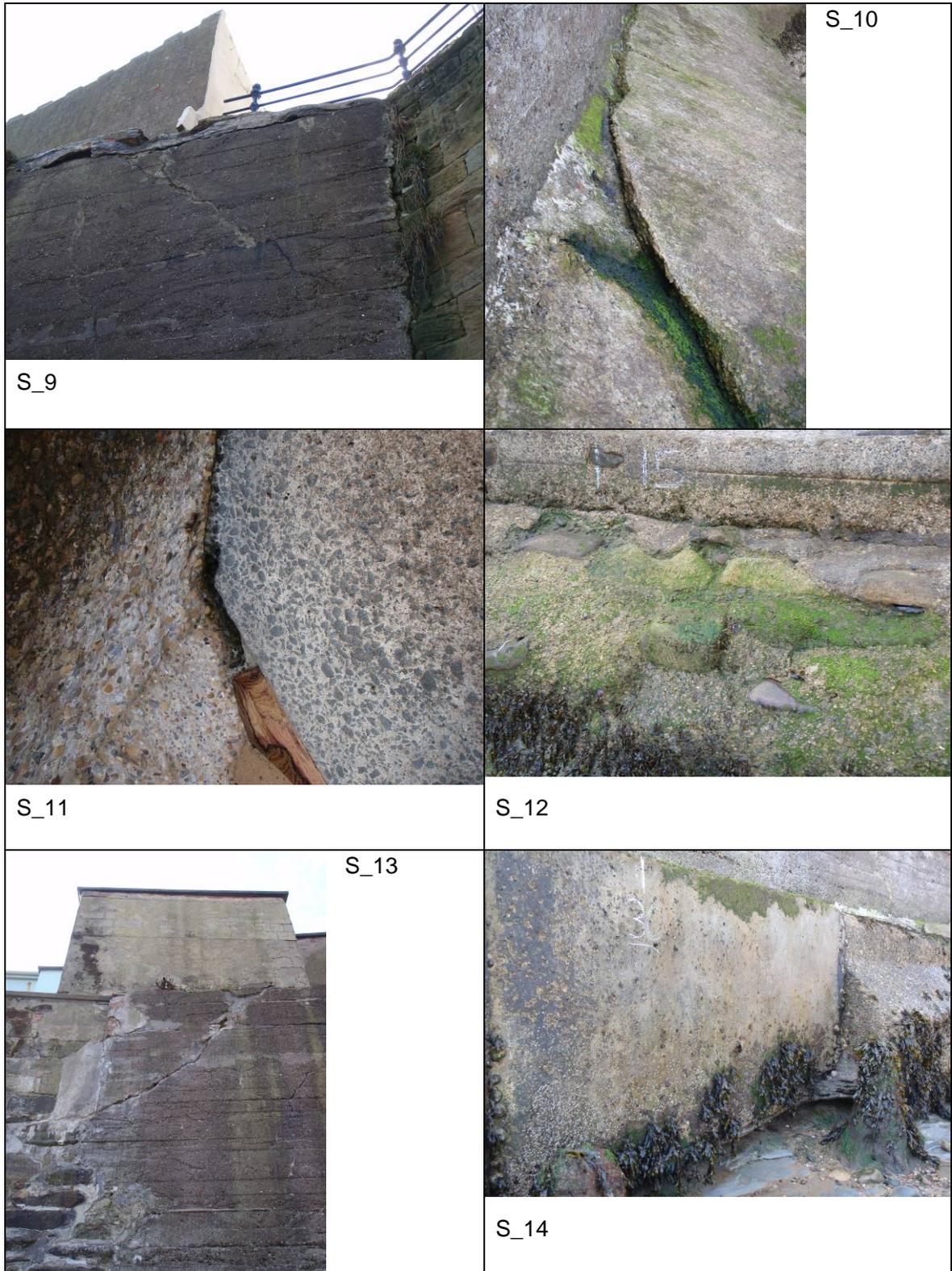
S\_6



S\_7



S\_8





S\_15



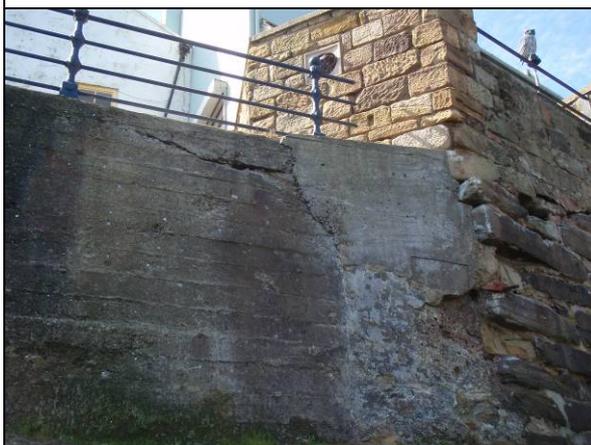
S\_16



S\_17



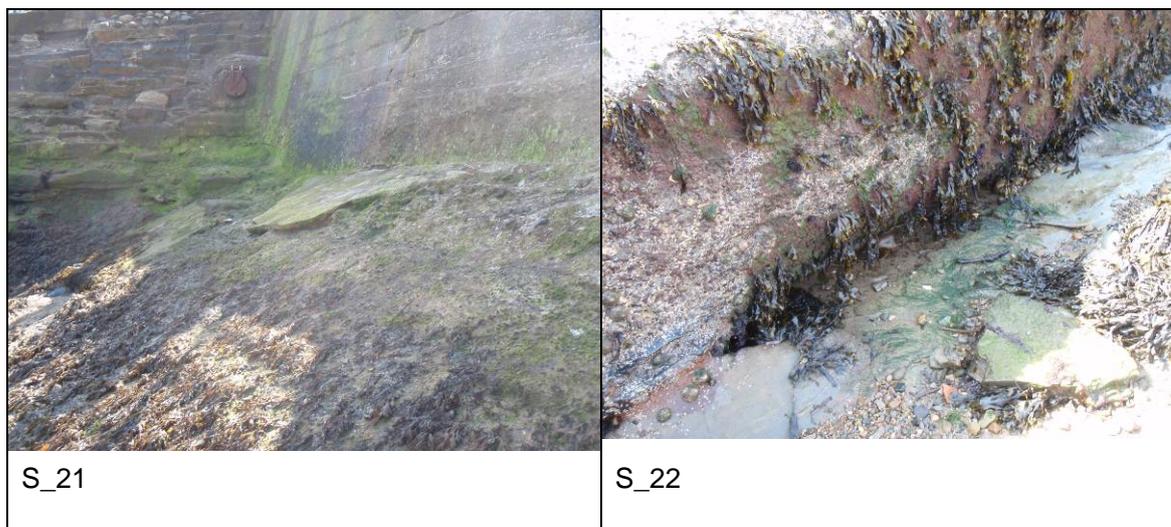
S\_18



S\_19



S\_20



## 2.4 Recommendations for Repair Work

The structural inspection did not highlight any major instabilities of the wall it is considered that the structures can be 'patch' repaired to continue the current standard of defence for the medium term future. The repair works will be spilt into sections for each wall construction type working from the north to the south.

### Chainage 0-2m

The first section of concrete rendered masonry wall (approximately 2m) should be repaired using a marine repair grout to fill in any voids and cracking and to reform the broken edge. Possibly remove existing render and apply a new finish, current render appears to contain beach aggregate.

### Chainage 2-5m

The short 3m section of random coursed stone wall requires re pointing, all vegetation from the top of the wall should be removed, any loose mortar should also be removed and any poor quality (fractured or eroded blocks be replaced) prior to repointing.

### Chainage 5-17m

The dressed masonry wall (Chainage 5 - 17m) should be cleared of vegetation and minor repointing works are required at the top of the wall where vegetation and water has damaged the existing mortar. The small area of exposed reinforcement mesh at the base of the wall should be ground down to a smooth surface to remove the risk the public.

### Chainage 17-30

The rendered wall from chainage 17m to 30m should have the vegetation removed from the cope and any loose blocks along the cope should be secured in place with mortar. There are three main options to treat the cracked render, the first would be to remove the cracked render and replace. The second option would be to remove the render and if the masonry wall behind the existing render is in a satisfactory condition then it may be possible to undertake minor repointing works and leave the wall as masonry like the

remaining walls. The third option could involve encasing the existing wall in a thin layer of reinforced concrete (approximately 300mm thick). Dowels could be drilled and fixed to the existing wall and reinforcement mesh could then be fixed.

The short section of undercutting that occurs at the southern end of this section of wall could be repaired by the use of concrete bag work. Although this would not provide a long term solution the bag work would significantly reduce the rate of undercutting. It is likely that the bag work would require maintenance/replacement every 10 years. If a more long term solution is required then it is recommended that the concrete toe is part demolished and extended down via a small trench cut in the bed rock using a rock cutter attached to the arm of an excavator. This would provide increased protection from future undercutting.

#### Chainage 30-40m

The next section of random stone masonry wall (chainage 30-40m) has few small defects and requires only a small amount of repointing to localised areas. The localised undercutting is currently very minor and it would be difficult to repair these with bag work due to the small nature. Short term repairs could be undertaken by filling the voids with a marine repair mortar or a long term option could involve cutting a new toe into the bed rock.

#### Chainage 40-50m

The final section of wall (Chainage 40-50m) requires a minor repair to a crack in the render at chainage 40m; this crack should be filled in with a repair mortar. The concrete toe along this section requires repairs to the undercutting, at present the undercutting is very minor and could be repaired by the use of a marine repair mortar or if a longer term option is required then like in previous sections the concrete toe could be part demolished and reconstructed with a new toe cut into the bedrock.

## 2.5 Estimated Cost

The repairs to the walls investigated in Staithes as part of this focused study are likely to be owned by the riparian land owners and therefore they should be routinely repaired by the land owner. SBC should therefore make enquires into the legal ownership of the walls prior to undertaking any works. If the walls are owner by the private land owner then the landowners could be legal obliged to undertake the repairs or the council may volunteer to undertake the works with contributions from the landowners for the repairs.

Cost estimates for the works for repair works are provided below.

Description	Cost (£k)
Construction Costs (inc plant and labour)	
Chainage 0-2m (Patch)	0.9
Chainage 0-2m (Remove render and point masonry)	1.7
Chainage 0-2m (Remove render and replace render)	<b>2.0*</b>
Chainage 2-5m (point masonry)	1.0

Chainage 5-17m	1.0
Chainage 17-35m (remove and replace render)	6
Chainage 17-35m (remove and point masonry wall)	<b>8*</b>
Chainage 30-40m (pointing to masonry wall + toe repairs)	1.5
Chainage 40-50m (patch repair + toe repairs)	1.5
<b>Total (*chosen option for cost purposes)</b>	<b>15</b>
Overhead & Profit Mark-up @ 12%	1.8
Preliminaries at 15%	2.25
Contingency at 25%	3.75
Design / Works Information Costs	
• Concrete mix design and specification	-
• Works Information and Pre-Construction Information (inc service enquiries etc)	-
• Site investigation (SBC plant and labour ½ day plus RH attendance).	-
Site Supervision	1
Other Costs – not used	
<b>Total Cost</b>	<b>23.8</b>

## 2.6 Way Forward

It is recommended that Scarborough Borough Council undertake enquires into the legal ownership of the walls and following discussions with the landowners regarding their responsibility as riparian owners in applicable. If landowners are willing to undertake the works themselves then no further involvement would be required from Scarborough Borough Council with the exception of a post repair work inspections. It is however considered unlikely that the landowners will undertake the works and provisions should be made for funding so that Scarborough Borough Council can undertake the works to restrict the deterioration of the assets.

Discussions should be held with regarding the preferred option as the costs vary for the options. The options that have been priced are likely to provide protection for the medium term future however with the increase pressure from sea level rise and erosion of the foreshore larger engineered options are likely to be required in the future.

### 3 RUNSWICK

#### 3.1 Asset Description

Asset Ref. 1221D901D0601C02 is located in Management Unit 7 in Runswick Bay. The asset is a breakwater which is believed to provide protection to the adjacent RNLI Life Boat Station for launching the Life Boat. The asset is 28 metres in length, ranging from 1.3m to 1.5m in height on each side and is approximately 1.2m wide. It has an overall volume of 47m<sup>3</sup>. The breakwater is believed to be constructed from mass concrete. The breakwater emerges at 90° from the adjacent sea wall to the north of the adjacent Life Boat Station. At Chainage 11m, the breakwater angles northward towards the sea.

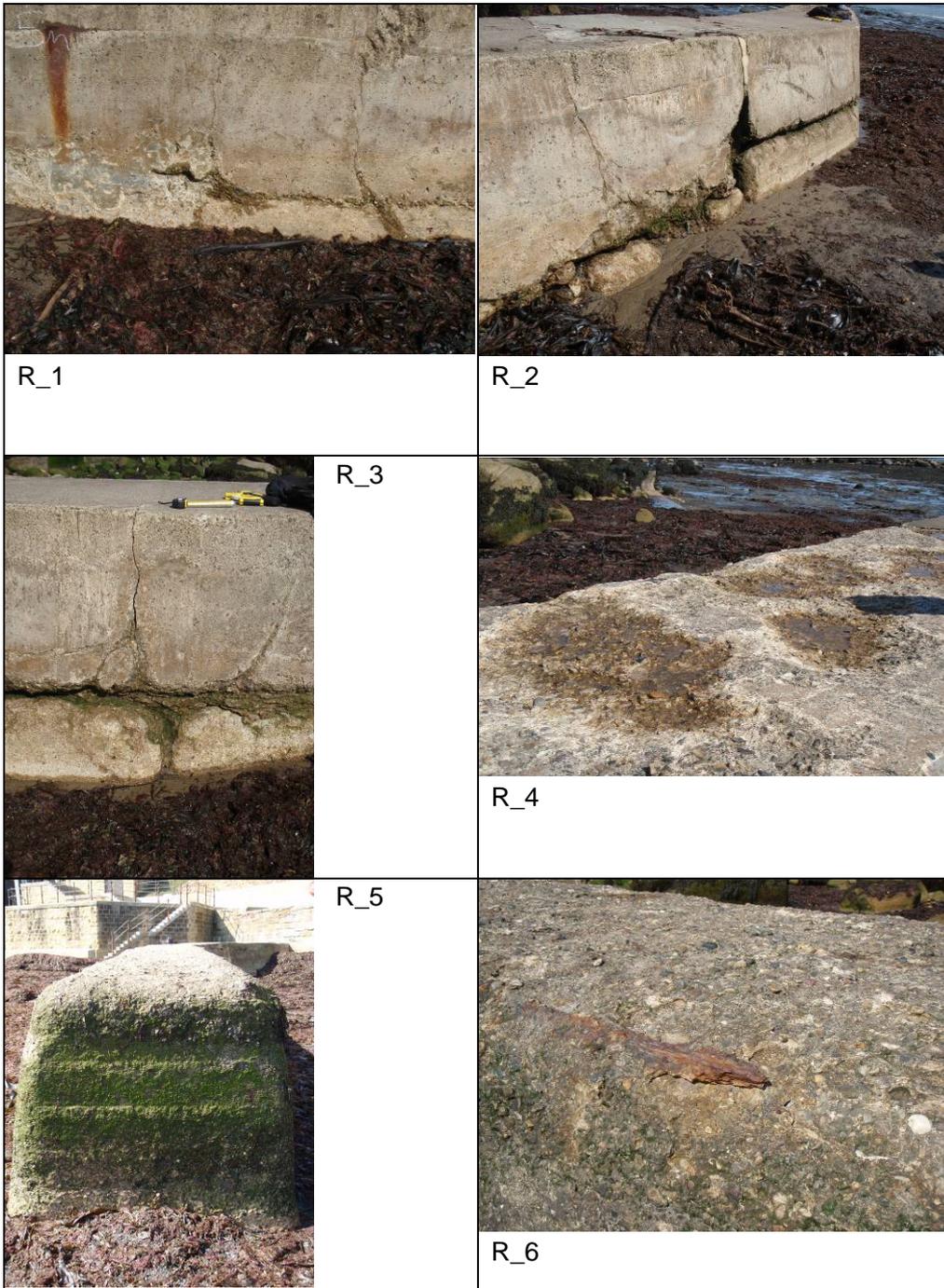
#### 3.2 Past Condition Report

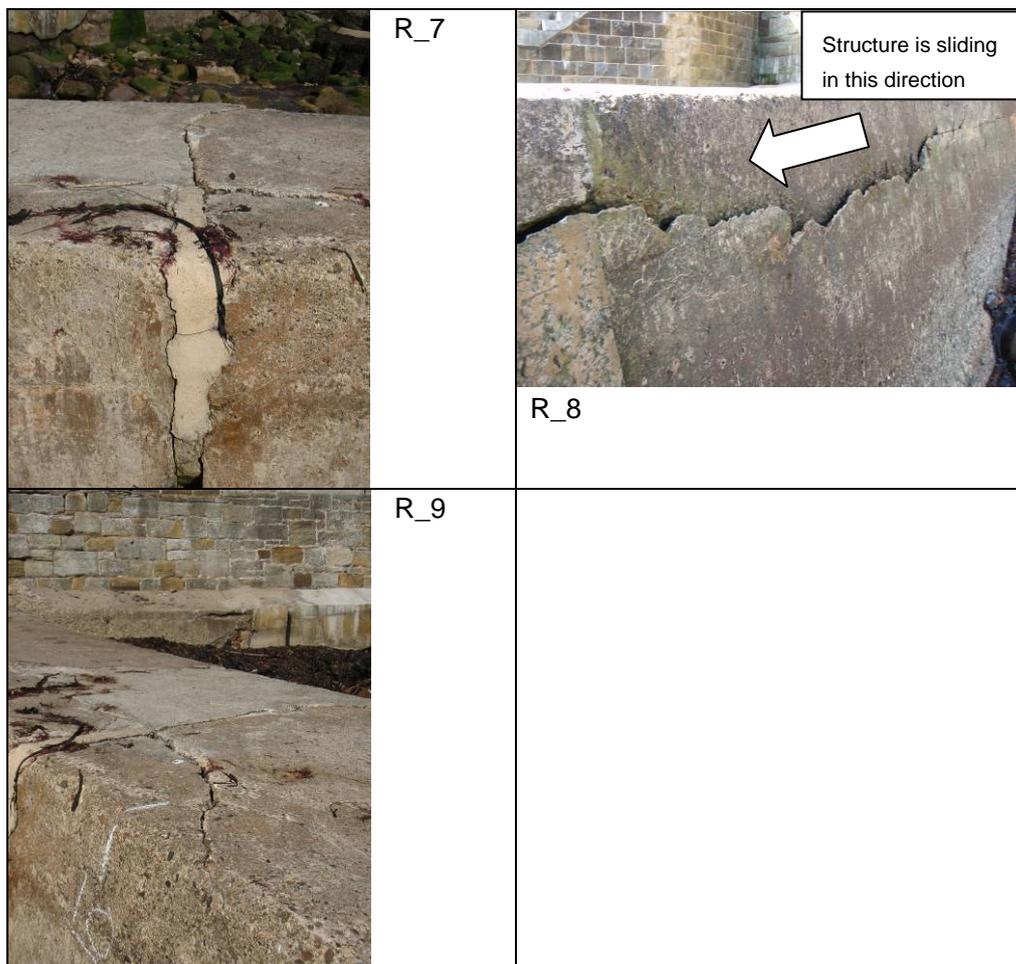
In the Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, March 2010), the report described clear evidence the breakwater is in need of repair. Large horizontal and vertical cracks were seen as the major defaults of the breakwater, this asset was flagged as needing urgent repairs.

#### 3.3 Current Asset Condition

An illustration of the defects found are provided below;

Chainage	Side	Defect	Photo Reference
5-8	South	Area of undercutting just off ground level	R_1
8	South	Vertical cracking at construction joint 0.05m width, very weak concrete in between breakable by hand	R_2, R_7
8	South	Void from ground to 0.85m height, some reinforcement on show in void	R_2
8-15	South	Mid-height horizontal undercutting depth 200mm	R_3
14-18	Top	Concrete top missing, rough concrete surface exposed	R_4
25	South	Exposed Steel	R_6
18	South and North	Evidence of repair work on past vertical and horizontal cracks	R_7
5-12	North	Horizontal cracking 0.08m width	R_8
9	North	Void in concrete 0.15m depth	R_10
10	Top	Cracking along topside perpendicular from construction joint	R_9
23-28	All	Smooth outer layer of concrete removed, rough concrete exposed	R_5





The asset is suffering from surface erosion and also significant cracking. Of most concern is the failure of the whole section from Chainage 5 to 8, which is failing in sliding as can be seen in Photograph R\_8.

### 3.4 Recommendation for Repair Works

There are two repair options;

Option 1 – Partial Repair: this would involve the partial demolition of the structure between Chainage 5 to Chainage 18. A new section of breakwater would then be cast using plastic fibre reinforced mass concrete. This would ensure the replaced section has an asset life of >75 years. The existing sections are likely to have a residual asset life of between 10 to 30 years and would require additional future works.

Option 2 – Complete Replacement: this would require the complete demolition and replacement of the asset. Although initial more costly, there are likely to be longer term cost savings as the whole structure would have an asset life of 75 to 100 years/

Estimated costs for both options have been provided.

### 3.5 Estimated Cost

#### Option 1

Description	Cost (£k)
Construction Costs (inc plant and labour)	15
Overhead & Profit Mark-up @ 12%	1.8
Preliminaries at 15%	2.52
Contingency at 25%	4.2
Design / Works Information Costs <ul style="list-style-type: none"> <li>Concrete mix design and specification</li> <li>Works Information and Pre-Construction Information (inc service enquiries etc)</li> <li>Site investigation (SBC plant and labour ½ day plus RH attendance).</li> </ul>	0.6 2.0 1.0
Site Supervision	2.0
Other Costs – not used	0.0
<b>Total Cost</b>	<b>29.12</b>

Note – this is the present day cost for partial replacement only and does not include any factoring for future replacement of existing sections. Therefore this cannot be used as a direct comparison cost for Option 2.

#### Option 2:

Description	Cost (£k)
Construction Costs (inc plant and labour)	28
Overhead & Profit Mark-up @ 12%	3.36
Preliminaries at 15%	4.7
Contingency at 25%	7.84
Design / Works Information Costs <ul style="list-style-type: none"> <li>Concrete mix design and specification.</li> <li>Works Information and Pre-Construction Information (inc service enquiries etc).</li> <li>Site investigation (SBC plant and labour ½ day plus RH attendance).</li> </ul>	0.6 2.0 10
Site Supervision	2.8
Other Costs – not used	0.0
<b>Total Cost</b>	<b>59.3</b>

### **3.6 Way forward**

- 3.6.1 Scarborough Borough Council to determine functionality of breakwater. If it serves no coastal or RNL benefit, then the option to abandon the asset is recommended.
- 3.6.2 If the asset has functionality, then it is recommended that the whole asset be replaced. The replacement asset could include integrated seating detail or other aesthetic details/features. It is recommended that the asset be replaced immediately due to the apparent existing failure.

## 4 SCARBOROUGH - NORTH BAY

### 4.1 Asset Description

In Scarborough North Bay, Management Unit 20, there are seven assets described to be in need of 'urgent' repair in the Coast Protection and Coastal Slope Condition Analysis report (Halcrow, March 2010).

Two of these assets are located in the northern part of the bay near the Scarborough Sea Life Centre:

- **Asset 1221D901D1201C02** is a sea wall mainly made up of in situ concrete which provides protection for the Yorkshire Water sewage treatment works, the Sea Life Centre visitor attraction, as well as acting as a retaining wall for the promenade. The asset is made up of concrete blockwork below a concrete crest wall which runs along the edge of a promenade made from concrete slabs. There are steel sheet piles filled with concrete at the toe of the wall. The asset starts at the base of the access steps at the Old Scalby Mills pub, and continues round to the first set of access steps south of the slipway. The change in asset is also marked by the change from the concrete crest wall on the edge of the promenade to the steel hand railing of asset 1221D901D1201C03; and
- **Asset 1221D901D1201C03** acts as a retaining sea wall for the promenade as well as acting as a defence for the cliffs from sea erosion. The asset is made up entirely of concrete, as is the promenade it retains which has a steel railing at the cope. The asset starts at the access steps where asset 1221D901D1201C02 ends, and continues to the next set of access steps, which is where the steel hand railing on the promenade ends.

Four of the assets are located consecutively in the southern part of the North Bay. These assets are all sea walls that act as retaining walls for the promenade, and also function as protection from sea erosion. All four walls are located between the 'Sands Development' and the Castle Cliff headland in Scarborough's North Bay.

- **Asset 1221D901D1201C07** is located just south of the 'Sands Development'; its starting point is the bottom of the slipway where the steel handrailing begins on the promenade. This sea wall is made up of mainly blockwork masonry and concrete slabs at the cope. The wall has an angled blockwork apron at the toe. At the southern end of the defence there is a large concrete flat apron at the toe of the wall. The end point of the asset is the set of access steps. Southwards asset 1221D901D1201C07 is connected to asset 1221D901D1201C21;
- **Asset 1221D901D1201C21** is made from block masonry; apart from the southern part of the wall has a concrete toe. This asset ends at the large buttress in the wall at the bottom of the closed off large slipway where 1221D901D1201C21 meets asset 1221D901D1201C08;
- **Asset 1221D901D1201C08** is a stepped concrete blockwork sea wall structure constructed with several buttresses/bastions which protrude out onto the beach. This sea wall is essentially made up of two tiers of walls; one on top of another rising from beach level to the promenade. Asset 1221D901D1201C08 also includes a secondary wall to the back of the promenade which supports the highway, this is also made from stepped blockwork masonry; and

- **Asset 1221D901D1202C23** is a 20m long sea wall which is located between asset 1221D901D1201C08 and the rock armour section of sea defence which runs around the Castle Cliff headland. This asset includes a sea wall and a secondary wall to the back of the promenade which supports the highway. Both walls of asset 1221D901D1202C23 are formed of stepped blockwork.

Asset 1221D901D1202C02 was also identified as in need of 'urgent' repair in the Coast Protection Assets and Coastal Slope Condition Analysis Report. However this asset is part of the Castle Headland scheme constructed in 2005. The defects noted in the 2010 report were cracking in the splash wall on the promenade and it was recommended that monitoring be carried out. Therefore in agreement with Scarborough Borough Council this asset has not been included in the inspections for this report.

## 4.2 Past Condition Report

In the Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, Match 2010) it was identified that assets **1221D901D1201C02** and **1221D901D1201C03** had several large vertical cracks running the full height of the sea wall. Halcrow identified there is clear evidence of past repair work however it was concluded that the cracks that have not been repaired have worsened since they were last looked at; due to the worsening of these cracks it was suggested that additional repair work is required.

The report goes on to describe how the front face of blockwork making up the asset **1221D901D1201C03** shows degradation and past repair work has failed; which was concluded when exposed reinforcement bars were identified.

Asset **1221D901D1201C02** has undergone beach erosion, which can be seen at the northern parts of the wall where the steel sheet pile toe has been exposed and is corroded. The exposure of the steel sheet pile in this asset presents a health and safety risk as in parts the exposed steel is sharp and hazardous.

The southern North Bay walls contain cracking along joints and loss of material in several parts.

Assets **1221D901D1201C07** and **1221D901D1201C21** have vertical cracks the full height of the wall with some partly repaired. The promenade also shows cracking with additional cracks between coping stones and promenade in places. The slipway to the south of asset **1221D901D1201C21** is highlighted as showing several structural cracks running the full height of the structure, it is suggested that these particular cracks represent significant damage and therefore need to be addressed. When referring to asset **1221D901D1201C07** the report highlights exposed lateral joints, cracking through and beneath capping near the southern end of defence and seepage through wall, with visible open joints. Asset **1221D901D1201C21** shows erosion at joints and repairs to the promenade, with damage to the coping visible, and the concrete toe is exposed in sections.

Asset **1221D901D1201C08** to the south of asset 1221D901D1201C21 has suffered severe erosion to the toe as well as severe cracking to outbuilt sections in particular to the north of the wall. The report indicates there are localised signs of repair to eroded faces of blockwork and to buttresses, however it is suggested that additional repair

works are required. Above the sea wall, the promenade and second wall at the back of the promenade show cracking.

In the report asset **1221D901D1202C23** was seen to have two large vertical cracks, with one of these extending through the capping beam. There is also missing blockwork in localised areas as well as erosion exposing the aggregate towards the bottom of the wall. The secondary wall beyond the promenade, as well as the promenade, also shows cracking.

### 4.3 Current Condition Report

#### Asset Reference 1221D901D1201C02

Chainage	Defects	Photo Reference
0	Small cracks in capping beam.	NB02_2
10	Corner of wall, where it returns around the access steps has a fracture line from approximately 500mm above the piles to 2.5m above.	NB02_1
15-20	Slight cracking of wave return concrete base.	NB02_2
28	Crack from wave return wall to approximately 1m above sheet piles.	NB02_2
42-50	Repair to wave return wall has been carried out.	
52	Small crack or possible cold joint	NB02_2
65	Small crack through wave return wall base	NB02_2
80	Loss of blockwork facing	NB02_3
87	Sheet piles at base of wall step out from wall, no obvious reason for change in alignment	NB02_4
98	Joint	NB02_2
135	Small crack developing along block joints	NB02_2
168	Crack from wave return wall running through blockwork to lower stepped apron. Repointing required.	NB02_2
176	Displacement through blocks	
183	Joint	NB02_2
242	Displacement of blocks resulting in open joints approximately 6mm wide. Repointing required.	NB02_5
258	At the corner of the slipway there is a full height crack with evidence of movement of whole corner unit.	NB02_6
261	Missing block and displacement on opposite side of corner.	NB02_7
334	Loss of beach material has exposed base of slipway, leaving it unusable.	NB02_8
End of asset	The coping of the access steps at the end of the asset are badly abraded.	NB02_9
Full length of asset, landward side	The splash wall on the promenade shows regular stress cracks at joints, likely to be due to initial settlement on placement. There is some breaking out of concrete at the edges of the joints, which is possibly due to weathering damage.	NB02_10



NB02\_1 Fracture line at corner of access steps (Chainage 10)



NB02\_2 Example of stress cracks at joints



NB02\_3 Abrasion of blockwork surface



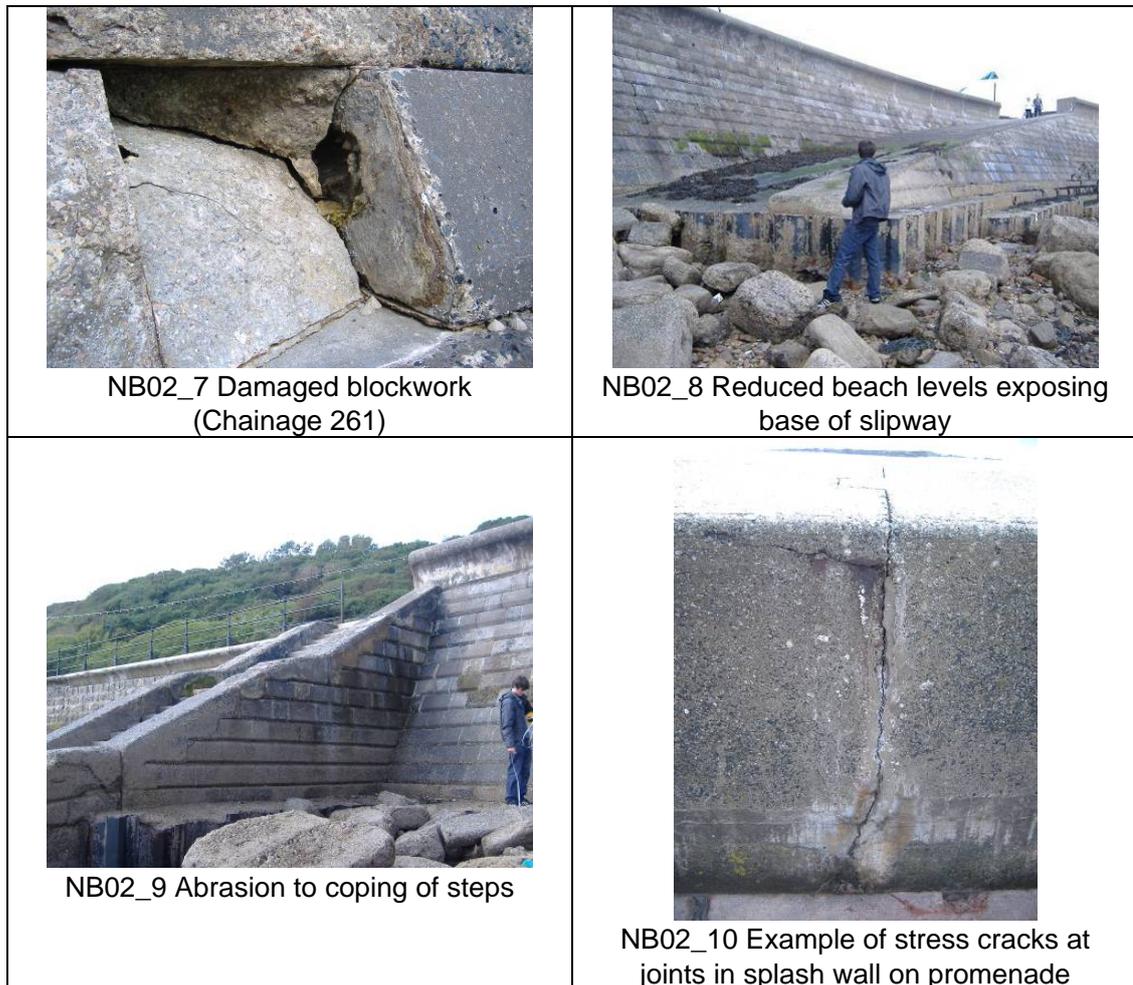
NB02\_4 Change in alignment of exposed sheet piles



NB02\_5 Open joint 6mm wide (Chainage 242)



NB02\_6 Full height crack at corner of slipway (Chainage 258)



**Asset Reference 1221D901D1201C03**

Chainage	Defects	Photo Reference
0	Severe abrasion of blockwork faces adjacent to steps. Some steel bars protruding from blockwork face, do not appear to be reinforcement of the wall, possibly remnants of a historic structure that was attached to wall at this location.	NB03_1
30	Crack through upper blockwork wall.	NB03_2
45-60	Mass concrete footing exposed.	
66	Crack through upper blockwork wall.	NB03_2
81	Crack through upper blockwork wall.	NB03_2
95	Crack through upper blockwork wall.	NB03_2
110	Crack through upper blockwork wall.	NB03_2
End	Corner of the steps at the end of the asset is cracked.	NB03_3

 <p>NB03_1 Abrasion of blockwork surfaces and remnants of steel work from a historic structure</p>	 <p>NB03_2 Example of cracking found along full length of asset</p>
 <p>NB03_3 Cracking on south face of steps at southern end of asset</p>	

#### Asset Reference 1221D901D1201C24

This asset is located immediately to the south of asset 1221D901D1201C03; it runs from the set of access steps at the southern end of 1221D901D1201C03 to the next set of access steps. Although this asset was not included in the list of assets identified as being in 'urgent' need of repair in the Coast Protection and Coastal Slope Condition Analysis Report (Halcrow, March 2010) it was noted on site that this asset had some major defects. The asset is severely undercut along most of its length (see photos NB24\_1, NB24\_2 and NB24\_3). The access steps at the southern end of the asset appear to be particularly badly affected (see photos NB24\_4 and NB24\_5). Along the promenade there is a long continuous crack parallel to the wall along a significant proportion of the asset, this indicates the possible early signs of failure of the asset.



NB24\_1 Undercutting of asset looking north



NB24\_2 Undercutting of asset looking south



NB24\_3 Close up of undercutting



NB24\_4 Undercut north face of access steps at south end of asset



NB24\_5 Undercut access steps at south end of asset



NB24\_6 Crack on promenade running parallel to front face of wall

**Asset Reference 1221D901D1201C07**

Chainage	Defects	Photo Reference
Full length of asset	Loss of mortar between blocks, mainly horizontal joints	NB07_1
5	Abrasion of surface of toe blocks	NB07_2
25	Previous repairs to horizontal joints have been carried out	
45	There is the start of a vertical crack	NB07_3
55	Previous repairs to a vertical crack	NB07_4
65	Abrasion of surface of toe blocks	NB07_5
70	Start of (north) later addition concrete toe protection	
85	Reduction in sand levels at concrete toe protection, starting to expose vertical edge	NB07_6
90	Previous repairs to a vertical crack	NB07_7
95	Undercutting of the concrete toe protection	NB07_8
125	Bed rock exposed on foreshore	
125-182 (end)	Repairs to horizontal joint near top of the wall	NB07_9
125-130	Severe abrasion of the surface toe blocks and concrete toe protection	NB07_10
135-182 (end)	Large flat concrete apron at toe of wall – severe undercutting on the northern end , undercutting carries on around the front face of the structure however sheet piles are visible set back from front edge, it is unclear whether the sheet piles continue around the northern face of the apron.	NB07_11, NB07_12, NB07_13
182 (end)	Large exposure of bedrock on foreshore and at base of wall	
182 (end)	Location of access steps 1221D901D1201C07001. There is previous repair work to the walls supporting the steps to the north and south. On the northern wall there is severe erosion of the joints at the top of the wall and a vertical crack from the coping of the mid-point of the steps. There is also a full height crack in the wall supporting the promenade at the rear of the steps. There is loss of beach material at the base of the steps.	NB07_14, NB07_15, NB07_16, NB07_17



NB07\_1 Example of loss of mortar between joints



NB07\_2 Abrasion of surface of toe blocks (Chainage 5)



NB07\_3 First signs of vertical crack appearing (Chainage 45)



NB07\_4 Vertical crack which has been previously repaired (Chainage 55)



NB07\_5 Surface abrasion of toe blocks (Chainage 65)



NB07\_6 Exposure of vertical edge of concrete toe protection (Chainage 85)



NB07\_7 Vertical crack which has previously been repaired (Chainage 90)



NB07\_8 Undercutting of concrete toe protection (Chainage 95)



NB07\_9 Repairs to horizontal joint  
(Chainage 125-182)



NB07\_10 Abrasion of toe blocks and  
concrete toe protection (Chainage 125-  
130)



NB07\_11 Overview of concrete apron



NB07\_12 Undercutting on north face of  
concrete apron (Chainage 135)



NB07\_13 Undercutting at corner of front  
with north face exposing sheet piles  
(Chainage 135)



NB07\_14 Repair work to northern wall of  
access steps (Chainage 182)

 <p>NB07_15 Northern and back walls of access steps showing vertical cracks (Chainage 182)</p>	 <p>NB07_16 Southern wall of access steps showing previous repair works and abraded coping (Chainage 182)</p>
 <p>NB07_17 Bottom of access steps showing reduction in beach level (Chainage 182)</p>	

**Asset Reference 1221D901D1201C21**

Chainage	Defects	Photo Reference
0-24	Some severe surface abrasion of blocks. There is erosion at the toe, leaving a vertical face with the loss of some blocks from the toe. There are signs the toe is beginning to be undercut towards chainage 24.	NB21_1 NB21_2
24	There is a step out in the toe of the wall, with the toe to the south being approximately 900mm extended. The step in the toe marks a change in the construction of the toe in terms of the type of blocks used. The step in the toe occurs roughly where exposure of the bed rock on the foreshore close to the seawall disappears.	NB21_3
24-44	Toe is being undercut, and the blocks of the toe apron are showing signs of abrasion.	NB21_4
47	Coping stones is showing signs of erosion	NB21_5
95	At the start of the curved section of wall there appears to be deep undercutting of the toe (could not be fully examined due to depth of pool in front of toe). There appears to have been some previous repairs carried out to the toe;	NB21_6

	additional concrete toe protection.	
97	Previous repairs to a large vertical crack including coping stones. A new smaller vertical crack is developing to the left of the upper section of repair work.	NB21_7
97-114	Beach levels are higher around this section of wall, covering the toe, with no signs of undercutting. The coping stones around this section show signs of surface abrasion.	
114	Large vertical crack which has previously been repaired. There is another smaller vertical crack to the left which has been partially repaired.	NB21_8
114-180	Toe is starting to be undercut and there is severe abrasion of the toe blocks.	NB21-9
125	Large vertical crack in the spillway support wall, it appears to be an old crack as the edges have become rounded. Crack goes from coping stone to toe and forks towards the top. The blocks just below the coping stone in the vicinity of the crack appear to have had severe mortar loss and potentially could be loose.	NB21_10
135	Vertical crack in spillway support wall, again has rounded edges so potentially is an old crack.	NB21_11
180-185	The large buttress at the bottom of the slipway shows several defects: <ul style="list-style-type: none"> <li>• Surface of blocks especially at the toe are severely abraded;</li> <li>• Voids are starting to form in some of the joints where material has been washed out;</li> <li>• There are signs that the front face is starting to be undercut;</li> <li>• The corner of the front and north face is showing signs of cracking;</li> <li>• There are several large vertical cracks forming on the front face from the corner with the south face;</li> <li>• There are several large vertical cracks on the south face of the buttress, and the coping stone at the corner of the south and front faces has a large crack running through it. The surfaces of the blocks are abraded;</li> <li>• At the base of the front face of the buttress in the left corner where it meets the first of the buttresses of asset 1221D901D1201C08 there is a void developing. At the face of the wall the void is approximately 500mm high and 200mm wide, the dimensions reduce as the void goes back into the structure. The void is approximately 300mm deep and there is a small stream of water flowing out of the void, the source of which is unknown.</li> </ul>	NB21_12 NB21_13 NB21_14 NB21_15 NB21_16 NB21_17, NB21_18 NB21_19



NB21\_1 Abrasion of surface of apron and loss of blocks from toe (Chainage 0-24)



NB21\_2 Exposure and undercutting of toe (Chainage 0-24)



NB21\_3 Change in alignment of toe (Chainage 24)



NB21\_4 Undercutting of toe (Chainage 24-44)



NB21\_5 Abrasion of coping stones (Chainage 47)



NB21\_6 Undercutting of toe with signs of possible previous repair work (Chainage 95)



NB21\_7 Previous repair work to large vertical crack (Chainage 97)



NB21\_8 Previous repair work to large vertical crack (Chainage 114)



NB21\_9 Undercutting of toe (Chainage 114-180)



NB21\_10 Vertical crack in slipway support wall (Chainage 125)



NB21\_11 Vertical crack in slipway support wall (Chainage 135)



NB21\_12 Overview of buttress showing abrasion of blockwork (Chainage 180-185)



NB21\_13 Close up of an example of a void developing between blocks



NB21\_14 Beginnings of undercutting at toe of buttress



NB21\_15 Cracks on north face of buttress



NB21\_16 Cracks on front face of buttress at corner with south face



NB21\_17 Cracks in south face of buttress, at join with next asset



NB21\_18 Cracks in south face of buttress at corner with front face

 <p>NB21_19 Large void in corner of front face of buttress</p>	
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**Asset Reference 1221D901D1201C08**

Chainage	Defects	Photo Reference
0	1 <sup>st</sup> Buttress: northern end of asset. Superficial surface abrasion of blocks, no undercutting.	NB08_1
3	Horizontal crack through middle of blocks on 5 <sup>th</sup> row down of lower level.	NB08_2
5	Loss of material in some joints between blocks in lower rows.	
10	Horizontal crack through middle of blocks on 3 <sup>rd</sup> row down of lower level.	NB08_2
25	2 <sup>nd</sup> Buttress: superficial surface abrasion of blocks on north and front face. Toe is starting to be exposed but no undercutting.	NB08_1
30	Severe abrasion of apron of wall.	NB08_3
48	Horizontal cracks through middle of blocks on 2 <sup>nd</sup> and 3 <sup>rd</sup> rows down of lower level.	NB08_2
50	3 <sup>rd</sup> Buttress: superficial surface abrasion of blocks on north face. The front face is starting to be undercut along the right half (north), the left half (south) has some additional concrete toe protection in place.	NB08_1
55	There are two large cracks along the concrete berm between the upper and lower sections of the wall. One crack runs parallel to the wall and is approximately 2m long, the other crack runs diagonally across the berm and is approximately 2.5m long. On the promenade above the upper section of wall there are corresponding parallel cracks.	NB08_4 NB08_5
65	Horizontal crack through middle of blocks on 2 <sup>nd</sup> row down of lower level, the surface of the blocks in that row has been lost below the crack. Directly below this crack	NB08_6

	there is a smaller horizontal crack developing in the 4 <sup>th</sup> row down.	
70	Horizontal crack through middle of blocks on 4 <sup>th</sup> row down of lower level. There has been some replacement of blocks in the second row down of the lower level.	NB08_2
75	4 <sup>th</sup> Buttress: superficial surface abrasion of blocks on north face and south face.	NB08_1
85	There is a large crack along the concrete berm between the upper and lower sections of the wall, running parallel to the wall, approximately 3m long. On the promenade above the upper section of wall there are corresponding parallel cracks.	NB08_4 NB08_5
90	Horizontal crack through middle of blocks on 5 <sup>th</sup> row down of lower level.	NB08_2
95	There is a small crack along the concrete berm between the upper and lower sections of the wall, running parallel to the wall, approximately 2m long. On the promenade above the upper section of wall there are corresponding parallel cracks.	NB08_4 NB08_5
100	5 <sup>th</sup> Buttress: superficial surface abrasion of north face. The toe is being exposed around the front face but there is no undercutting yet.	NB08_1
110	There is a large crack along the concrete berm between the upper and lower sections of the wall, running parallel to the wall, approximately 3m long. On the promenade above the upper section of wall there are corresponding parallel cracks.	NB08_4 NB08_5
115	There is a small crack along the concrete berm between the upper and lower sections of the wall, running parallel to the wall, approximately 1m long.	NB08_4
120	Horizontal crack through middle of blocks on 2 <sup>nd</sup> row down of lower level.	NB08_2
125	6 <sup>th</sup> Buttress: some slight superficial surface abrasion on north face. Undercutting around toe.	NB08_7
130	Horizontal crack through middle of blocks on 2 <sup>nd</sup> row down of lower level. The blocks show a lot of abrasion. There is a fractured block in the upper level of the wall.	NB08_2
150	7 <sup>th</sup> Buttress: the toe is exposed but no signs of undercutting.	
160	Some of the blocks in the 5 <sup>th</sup> row down of the lower level have been replaced.	NB08_8
175	8 <sup>th</sup> Buttress: the toe is starting to be undercut and the southern face shows some superficial surface abrasion.	
195	9 <sup>th</sup> Buttress: southern end of asset.	
Secondary wall	The secondary wall behind the promenade which supports the highway also shows signs of cracking.	NB08_9



NB08\_1 Example of superficial surface abrasion of blockwork on buttresses



NB08\_2 Example of horizontal cracks in lower level of blockwork



NB08\_3 Abrasion and loss of blocks from toe apron



NB08\_4 Example of cracks in berm between upper and lower sections of wall



NB08\_5 Example of crack in promenade



NB08\_6 Horizontal crack through blockwork with loss of surface material below crack (Chainage 65)

 <p>NB08_7 Undercutting of toe on 6<sup>th</sup> buttress</p>	 <p>NB08_8 Previous replacement of blockwork in lower level of wall (Chainage 160)</p>
 <p>NB08_9 Example of cracking in secondary wall behind promenade</p>	

**Asset Reference 1221D901D1201C23**

Chainage	Defects	Photo Reference
Front Face	The corner between the front and north faces appears to be moving, there are large cracks on both faces.	NB23_1, NB23_2
	There is a fractured block close to the corner with the north face, approximately half way up the wall.	NB23_3
	Several of the joints are showing significant loss of material, leaving gaps large enough for barnacles to grow.	NB23_3
	There is a large vertical crack from the coping stone to the horizontal joint below the 6 <sup>th</sup> row of blocks; one of the blocks adjacent to the crack is fractured.	NB23_4
	The surfaces of the blocks show signs of abrasion.	
North Face	There are a lot of cracks, horizontal and vertical; in particular the corner with the front face appears to be moving. The back corner with asset 1221D901D1201C08 shows a significant amount of cracking.	NB23_5

<p>Secondary Wall &amp; Access Steps</p>	<p>The secondary wall behind the promenade which supports the access steps and highway has several large full height vertical cracks. The promenade in this location also shows several large cracks. There is also abrasion to the coping stones on the access steps.</p>	<p>NB23_6, NB23_7, NB23_8, NB23_9</p>
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NB23\_1 Corner of front face with north face



NB23\_2 Corner of north face with front face



NB23\_3 Fractured blockwork on front face



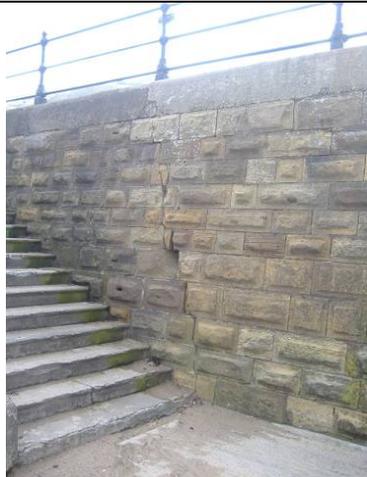
NB23\_4 Vertical crack in front face



NB23\_5 North face showing severe cracking



NB23\_6 Vertical crack in secondary wall behind promenade



NB23\_7 Vertical crack in secondary wall behind promenade at access steps



NB23\_8 Vertical crack in secondary wall behind promenade (between two sets of steps)



NB23\_9 Cracked and abraded coping of secondary wall behind promenade at access steps

#### 4.4 Recommendation for Repair Works

See items 4.5 and 4.6 below.

#### 4.5 Estimated Cost

It is recommended that a PAR be carried out to obtain funding for a scheme to provide scour protection to the walls in North Bay that currently have exposed or even undercut footings. The proposed PAR should also include costs for repair and stabilisation works to the walls where works are required outside of the scope of routine maintenance – and are not considered to be urgent. An estimated cost for outline design for scour protection and asset refurbishment activities and the production of the PAR is shown below.

Description	Cost (£k)
Outline Design	65
PAR	35
<b>Total Cost</b>	<b>100</b>

#### 4.6 Way forward

4.6.1 Urgent emergency works should be carried out to stabilise the under-cut steps to prevent them failing and causing a breach in the sea wall.

4.6.2 It is recommended that a PAR be prepared to obtain funding for a scheme to provide scour protection to the walls in North Bay that currently have exposed or even undercut footings. The proposed PAR should also include costs for repair and stabilisation works to the walls where works are required outside of the scope of routine maintenance – and are not considered to be urgent.

The PAR shall take into account the findings of ongoing assessments for optimising and enhancing the capital investment programme and give consideration to an integrated construction programme, to commence following the completion of any proposed works in South Bay (the Spa).

4.6.3 Monitoring of defects that pose a potential H&S risk to the public should be carried out. Tell-tells should be installed on the corners of buttresses and other similar features where movement has been identified – until such time as funding is available to carry out repairs.

## 5 SCARBOROUGH - SOUTH BAY

### 5.1 Asset Description

In the Scarborough south bay; management unit 22 there are two assets described to be in need of 'urgent' repair in the Halcrow Coast Protection and Coastal Slope Condition Analysis report, March 2010. The two assets are asset 1221D901D1303C02 and asset 1221D901D1304C02 which are both located south of south bay.

Asset 1221D901D1303C02 previously acted as a retaining wall for the south bay open air swimming pool, however now that the swimming pool is no longer in use and has been filled with concrete the wall's main purpose is to provide protection for the toe of the cliff behind the wall. The sea wall is made from stepped masonry blockwork, as well as a concrete slabs at the cope.

Asset 1221D901D1304C02 is located further south of asset 1221D901D1303C02. Asset 1221D901D1304C02 is a two tiered sea wall which also provides protection to the south cliff as well as offering easy access to the beach for the public. The first tier of the wall is a concrete retain wall this tier also acts as a retaining wall for the walkway in front of the second tier. The second tier is made up of stone masonry and concrete; this sea wall functions as a retaining wall for the promenade as well.

### 5.2 Past Condition Report

In the Halcrow's March 2010 Coast Protection Assets and Coastal Slope Condition Analysis Report it was identified that the blockwork in asset 1221D901D1303C02 is in poor condition and that areas of the wall have deeply washed out joints.

When referring to asset 1221D901D1304C02 the report highlighted that there is a section of concrete rebar that is exposed on the capping beam. The report goes on to mention there are many large cracks in the back wall and the capping beam. The report describes how replacement of the capping beam and wall is evident mid section of the wall. Finally the report goes on to indicate that there is significant surface erosion exposing aggregate throughout the lower section of the concrete wall and capping beam. The report recommends the wall needs resurfacing.

### 5.3 Current Asset Condition

As an illustration of the defects found in breakwater a table is provided below;

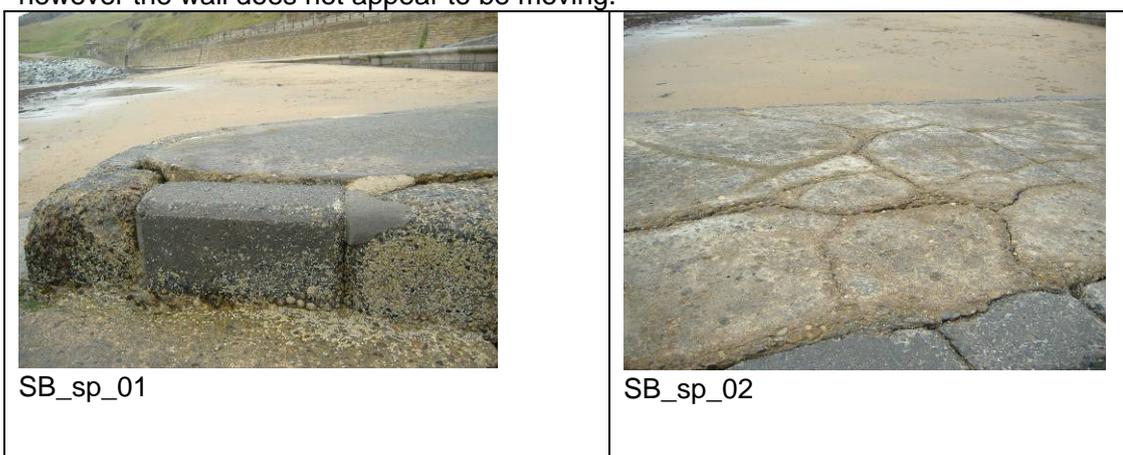
#### 1221D901D1303C02 (Swimming Pool (SP), Sea Wall)

Chainage starting from tip of southern breakwater

Chainage	Defect	Picture Reference
8m	Some missing mortar to blocks on tier of breakwater	SB_sp_01
15m	Slight surface damage	SB_sp_02
18m	Missing/loose mortar	SB_sp_03
28	Mortar Missing	SB_sp_04
32	Loss of surface to capping beam	SB_sp_05

40	Missing mortar	SB_sp_06
40-50	Minor damaged/missing mortar	SB_sp_07
General	Slight loss of surface to capping beam, no repair required.	SB_sp_08
78-90	Minor cracking to mortar/loss	SB_sp_09
90-93	Cracking to capping beam	SB_sp_10
98-110	Mortar loss from top joint	SB_sp_11
117	Missing mortar and broken pipe	SB_sp_12
120	Damaged mortar	SB_sp_13
125	Missing Flap, fine/sand discharge, minor undercutting	SB_sp_14
135	Water 'jetting' from joint, approximately 1.5m above foreshore level	SB_sp_15
137	Sand discharge from weephole	SB_sp_16
140-150	Missing mortar, water seepage approximately 2m above foreshore level.	SB_sp_17
155	Missing Mortar (deep)	SB_sp_18
160	Outfall pipe in poor condition undercut/suspended	SB_sp_19
160	Minor undercutting of wall	SB_sp_20
General	Constant minor surface loss from capping beam, some rust staining	
170-200	Top two courses missing mortar	SB_sp_21
200-300	Missing mortar in patches	SB_sp_22
305	Outfall possibly missing flap	

No major defects, concern over the level of water the wall is retaining every tide cycle, wall has weep holes but seepage was noted at 2m above foreshore level. I don't think the wall would have been designed to retain this level of water for long periods - however the wall does not appear to be moving.



 <p>SB_sp_03</p>	 <p>SB_sp_04</p>
 <p>SB_sp_05</p>	 <p>SB_sp_06</p>
 <p>SB_sp_07</p>	 <p>SB_sp_08</p>



SB\_sp\_09



SB\_sp\_10



SB\_sp\_11



SB\_sp\_12

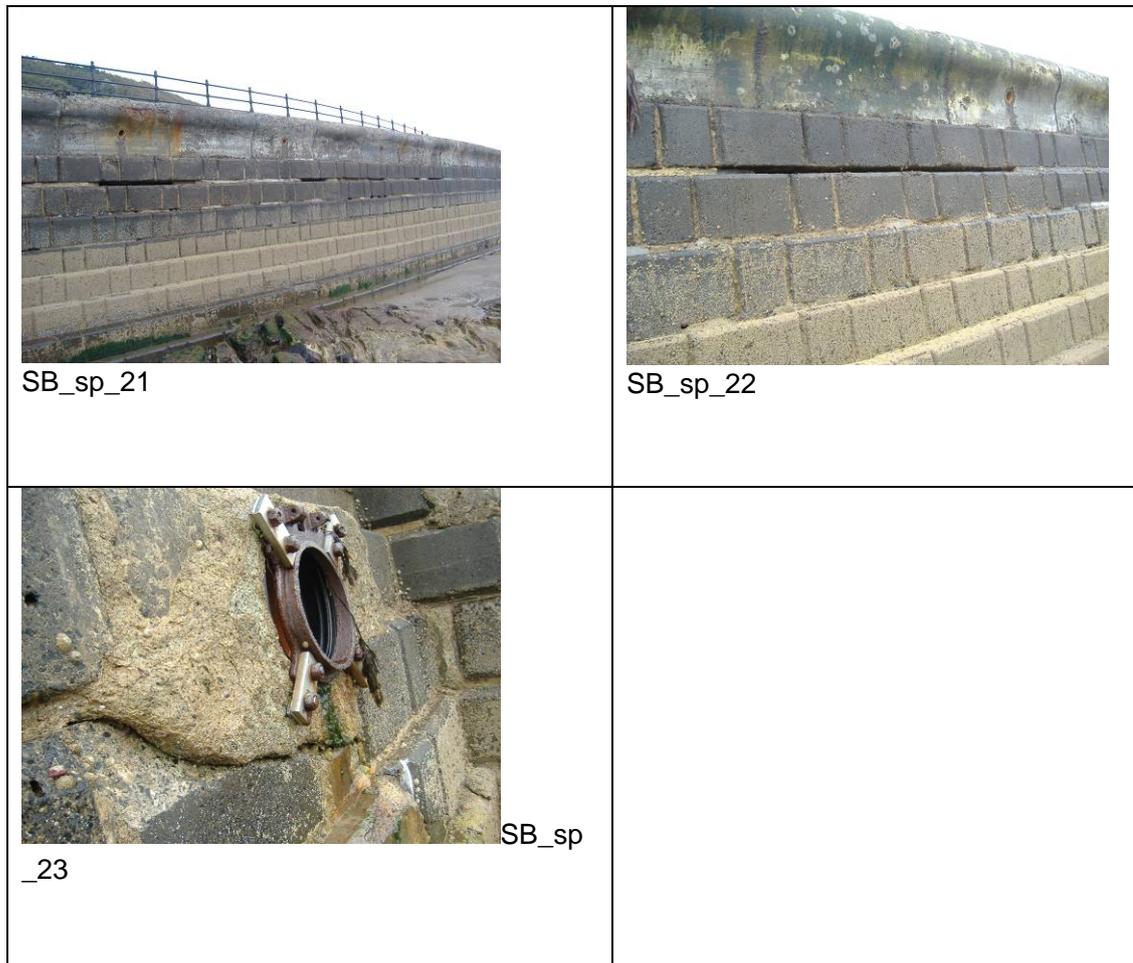


SB\_sp\_13



SB\_sp\_14





1221D901D1304C02 (Two Tiered Sea Wall)

Chainage starting from top of stair case by rock revetment.

Chainage	Upper or Lower	Defect	Picture Reference
-20	U	Horizontal construction joint/missing mortar, diagonal crack to concrete	SB_01
-10	U	Spanning capping beam, cracked at both joints, spalling to underside.	SB_02
-5	U	Damaged block/missing mortar at old repair construction joint	SB_03
0	U	Missing mortar at construction joint	SB_04
0	L	Minor missing mortar/loss of material at base of steps	SB_05
0-110	U	Hand railing in very poor condition	SB_06
32	L	Poor construction joint	SB_07
33	L	Minor loss of material from wall surface	SB_08
62	U	Part of block eroded	SB_09

63	U	3 No. Screw in wall - remove for H&S	SB_10
60-70	U	Minor patch of missing mortar	SB_11
70-80	U	Capping beam in poor condition	SB_12
90	U	Diagonal crack at corner, old.	SB_13
80	L	Minor loss of material, past repair ok condition	SB_14



SB\_01



SB\_02



SB\_03



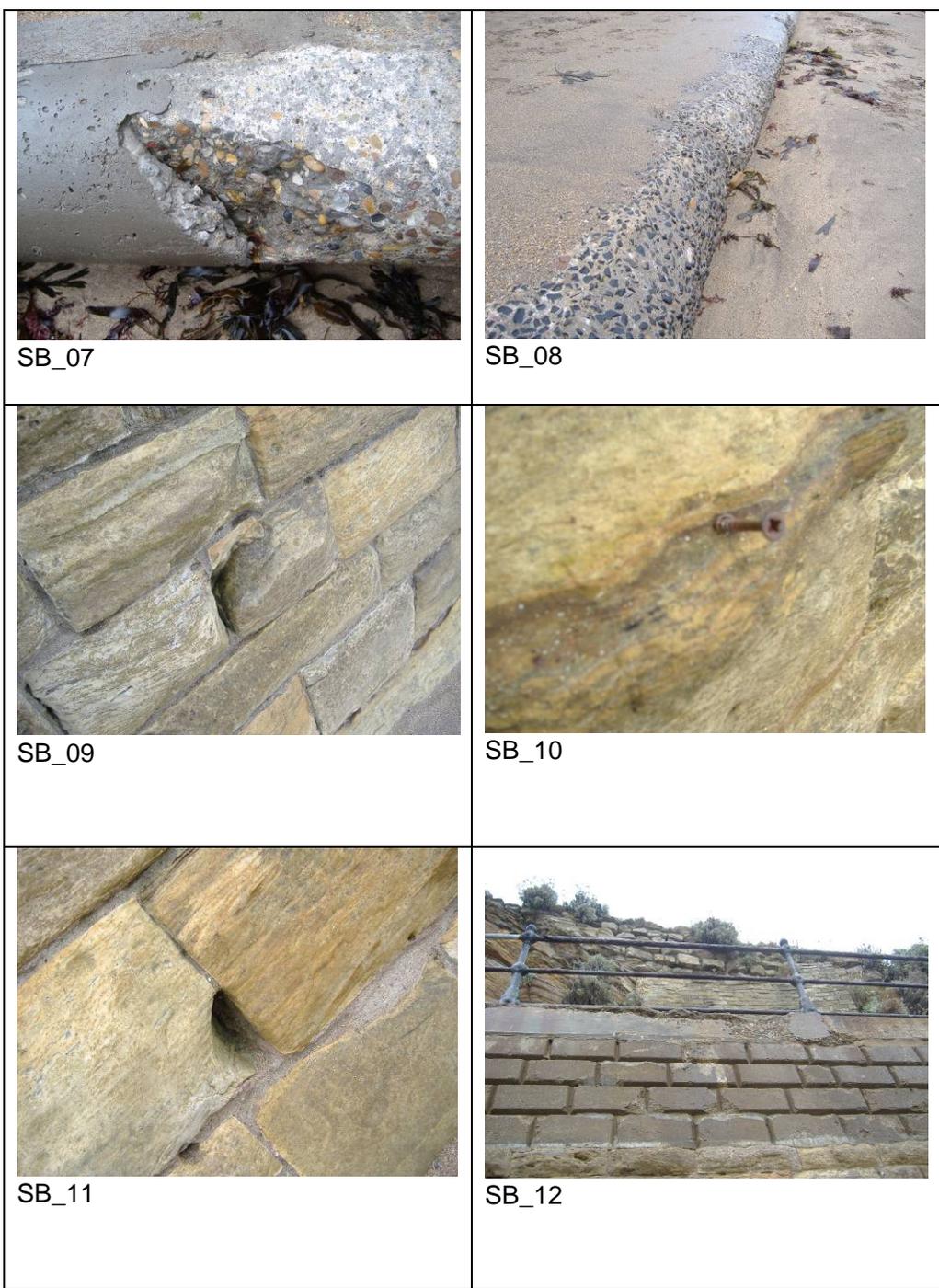
SB\_04



SB\_05



SB\_06





## 5.4 Recommendation for Repair Works

### 1221D901D1303C02 (Swimming Pool (SP), Sea Wall)

The repair options for seawall in front of the swimming pool are typically pointing to the areas of missing mortar. It is not considered necessary to re-point the full structure as the large majority of the mortar is in good condition. It has been estimated that approximately 260m of pointing is required and a contingency of 30% has been added to this.

In addition to the re-pointing costs there works required to repair two outfall pipes. The first requires a short section of encasement where the pipe surround has been fully undercut and the pipe is now 'bridging' the gap (SB\_sp\_19). The second requires the replacement of a pipe section that has broken off inside the wall (SB\_sp\_12). The existing surround should be broken out and a new pipe inserted and a new surround formed to secure the pipe.

During the inspections it was noted that the water was retaining a significant level of water after the tide had fallen. Due to the presence of weepholes long the base of the wall it is considered that the wall was designed to drain. The wall is currently not free draining and therefore could be under greater than design loads. However there are no visible signs of movement of the wall and it appears stable. If routine monitoring of the wall identifies movements then design calculations should be undertaken to assess the stability of the structure and works maybe required to improve the drainage or increase the strength of the structure.

### 1221D901D1304C02 (Two Tiered Sea Wall)

The repair works for the higher and lower walls are limited both walls are in a good condition and only feature very minor defects with the exception of the handrail along the top level wall, an area of poor quality repair to the capping beam and spalling to one short section of the bridging capping beam at the access steps.

The level of mortar loss across the upper wall is very small and it is hard to justify mobilising a stone mason to undertake repairs along this asset. However if works commence at the sea wall in front of the old swimming pool then it is recommended that a day is spent undertaking small areas of repairs to this asset.

The section of the capping beam that spans the access steps has spalling to the underside. The purpose of this beam is unknown as the route is not wide enough for pedestrian access. The purpose of this beam should be reviewed as at present it is not clear. The spalling material could be broken out and patch repaired or it may be possible to remove the short section. Costs will be provided for a patch repair however if it is decided to remove this beam then its role as a possible support to the walls should be reviewed.

It is recommended that the current hand rail is removed and replaced, the current system has been repaired in places but it is now at a point where it will become increasingly difficult to repair, a number of the replacement horizontal bars have already failed and full replacement is likely in the short to medium term. At a small number of locations vertical cracks can be seen in the capping beam where vertical supports are located, the corrosion of the metal could be causing damage to the capping beam.

During the removal and replacement of the hand rail a 5m section of capping beam requires localised breakout of loose/spalling material and the section recast. During the inspection the current fixing technique was not seen from below and to enable removal of the hand rail localised breakout of the capping beam may be required at each vertical support which could result in damage to the capping beam and a large number of small repairs carried out. It shall be assumed for costing purposes that the existing handrail can be removed without major damage to the capping beam.

## 5.5 Estimated Cost

### 1221D901D1303C02 (Swimming Pool (SP), Sea Wall)

Description	Cost (£k)
Construction Costs (inc plant and labour)	8
Overhead & Profit Mark-up @ 12%	0.84
Preliminaries at 15%	1.05
Contingency at 25%	1.75
Design / Works Information Costs <ul style="list-style-type: none"> <li>• Mortar Specification</li> <li>• Works Information and Pre-Construction Information (inc service enquiries etc).</li> <li>• Site investigation (SBC plant and labour ½ day plus RH attendance).</li> </ul>	0.5 - -
Site Supervision	1
Other Costs – not used	0.0
<b>Total Cost</b>	<b>13.14</b>

### 1221D901D1304C02 (Two Tiered Sea Wall)

Description	Cost (£k)
Construction Costs (inc plant and labour)	30
Overhead & Profit Mark-up @ 12%	3.6
Preliminaries at 15%	4.5
Contingency at 25%	7.5
Design / Works Information Costs <ul style="list-style-type: none"> <li>• Design of capping beam and handrail replacement</li> <li>• Works Information and Pre-Construction Information (inc service enquiries etc).</li> <li>• Site investigation (SBC plant and labour ½ day plus RH attendance).</li> </ul>	5 1 -
Site Supervision	1
Other Costs – not used	0.0
<b>Total Cost</b>	<b>52.6</b>

## 5.6 Way Forward

The works for the sea wall in front of the old swimming pool are largely re-pointing and it is recommended that the SBC appoint a stone mason to undertake the repair works. It is likely that the stone mason would be able to undertake the repairs the outfall pipes as well as the works are relatively straight forward.

For the two tiered wall there are no major repairs required to the lower wall. However the upper wall hand rail and capping beam requires urgent works. It is recommended that the hand rail is replaced in the near future. The costs provided for the repairs to this asset come mostly from the handrail and it is therefore advised that SBC invite a specialist handrail contractor to the site to review the system and advise if the existing vertical supports are suitable for reuse as this may provide a cost saving and also keep the historical form of the handrails.

The capping beam requires localised patch repairs in a number of locations, there is evidence of past repairs and similar repairs should be undertaken for the areas which have now failed.

## **6 CAYTON BAY**

### **6.1 Asset Description**

In Cayton Bay, Management Unit 24, there is one asset (ref. 1221D901D1402C04) that was identified as in need of 'urgent' repair in the Coast Protection and Coastal Slope Condition Analysis Report (Halcrow, March 2010). The asset is part of a sea wall defence structure for the private pumping station located in Cayton Bay. This asset is located at the southern end of the sea wall defences. The wall is made from several different types of masonry and concrete.

In addition to the wall, there is a mass concrete structure which forms the northern end of the asset, the functionality of which is to provide stepped access to the beach.

The assets are to the south of a former pumping station, now privately owned residential property (pending planning permission), and abut the masonry walls protect the building frontage from erosion and act as retaining walls. The walls in front of this building are separate assets in NFCDD and have not been assessed during this inspection.

### **6.2 Past Condition Report**

In the Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, March 2010) the asset 1221D901D1402C04 is described as consisting of a 'patchwork of makeshift additions which lack any unity.' The lack of unity in the wall is explained to be the cause of major undercutting, blockwork washout, parts of upper wall are missing and the wall has withstood significant damage.

### **6.3 Current Asset Condition**

The length of seawall and revetment to the north of the mass concrete access steps/structure is severely undercut and in poor condition. This has led to the structural failure of the revetment in one location, where a large void has washed out the material under the revetment causing the mass concrete upper surface to fracture and collapse.

The remainder of this asset is also undercut and is eroding due to the ad-hoc construction and repairs that have been carried out.

With no further maintenance or repairs it is likely that this asset will fail in 1 or 2 years, resulting in direct wave action on the soft cliff material behind.

The mass concrete structure is in very poor condition. Is it undermined to such an extent that elements of the structure are moving apart, cracking, rotating and leaving large voids. There are significant health and safety implications as a result of this, including a large void where children can climb underneath the asset. As this is the only access to the beach, it is recommended that SBC consider the H&S implications resulting from the condition of this asset.

The soft boulder clay cliff, immediately to the south of the mass concrete structure, is eroding behind the asset. If this continues then the defences will be outflanked by the eroding cliff and will cease to perform a functional role.



CB\_01 – Defences have failed where indicated.



CB\_02 – Undermining and voids to mass concrete step unit. Note erosion to cliff face at the rear of the unit.



CB\_03 – Failure of mass concrete revetment immediately to north of step unit.



CB\_04 – General view along failed revetment.



CB\_05 – Health & Safety issue with large void beneath failed slab on mass concrete step units (note A4 size clipboard for scale).



CB\_06 – Cracking and failure of top slab on mass concrete step unit.

## 6.4 Recommendations for Repair Work

The asset performs two functions;

- 1 – providing access to the beach, which is popular with surfers.
- 2 – preventing erosion of the cliff in front of the pumping station building.

Access to the beach can be provided with new timber steps rather than replacing the failed concrete structure, which could be demolished and removed – or made safe and abandoned.

Given the SMP policy for this area of coast, no repair works are recommended – other than those to make safe any structures for which SBC may have liability. See Section 6.6 below.

## **6.5 Estimated Cost**

Cost estimates have not been provided as a result of the recommended Way Forward below.

## **6.6 Way Forward**

The current SMP policy for Cayton Bay Access (Policy Unit 29.3) is ‘Managed Realignment.’ Given that the seawall/revetment is only protecting the pumping station building and the desired MR policy, it is recommended that;

1. The asset is not repaired and discussions are held with the owner of the pumping stat
2. The existing concrete structure is made safe and abandoned.
3. New steps are installed to continue to provide access to the beach.

## **7 FILEY**

### **7.1 Asset Description**

In Filey Bay, Management Unit 28, there is one asset (ref. 1221D901D1602C03) that was identified as being in need of 'urgent' repair in the Coast Protection and Coastal Slope Condition Analysis Report (Halcrow, March 2010). The asset is a section of sea wall that protects Filey frontage as well as acting as a retaining wall for the promenade which runs adjacent to The Beach Road. The wall is made from concrete blockwork and concrete slabs.

A slipway creates a 'breach' in the wall at Chainage 369 to 378. An access bridge spans the slipway, providing pedestrian and vehicular access to the south. The sea wall ties into the brickwork bridge abutments, and the continues beyond them to tie into high ground.

### **7.2 Past Condition Report**

In the Coast Protection and Coastal Slope Condition Analysis Report (Halcrow, March 2010) the asset 1221D901D1602C03 was described to have missing blockwork. However the report describes the overall condition of the wall as fair, with some repair work needed to the poor sections of the capping beam. The main issue highlighted in the report was the assets hand railing on the promenade. The hand railing was said to be corroded and loose; posing a public risk to health and safety. This hand railing is seen as the only fault in the asset which is in need of urgent repair.

### **7.3 Current Asset Condition**

The seawall has surface spalling (abrasion) in numerous locations. The wave return coping and the area of seawall immediately below are suffering from abrasion and damage in various locations, with often sections of missing mortar and damage to the joints.

The upper surface of the concrete coping is damaged towards the northern end of the asset.

The seawall is generally in a fair condition and requires routine maintenance to ensure continued performance and public safety, with particular consideration to the stability of damaged copings.

The handrails are corroded and are suffering from loss of thickness. The extent of corrosion varies. The handrails appeared to be serviceable and regularly painted. The replacement of the handrails is not considered to be urgent, provided that they continue to be routinely painted and inspected.

The brickwork abutments of the access bridge have vertical cracks, of a significant width at the base of the walls. These have been repaired and in filled with a flexible filler – although this has fallen out. In addition, the crack has been 'controlled' by the upper section of wall being deliberately cut with an angle grinder.

There are numerous outfalls which do not have non-return valves.

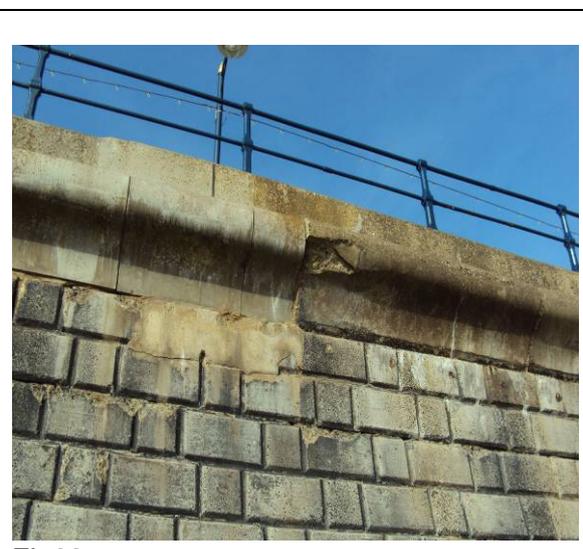
**Asset Reference 11221D901D1602C03**

Chainage 0 commencing at southern end of asset.

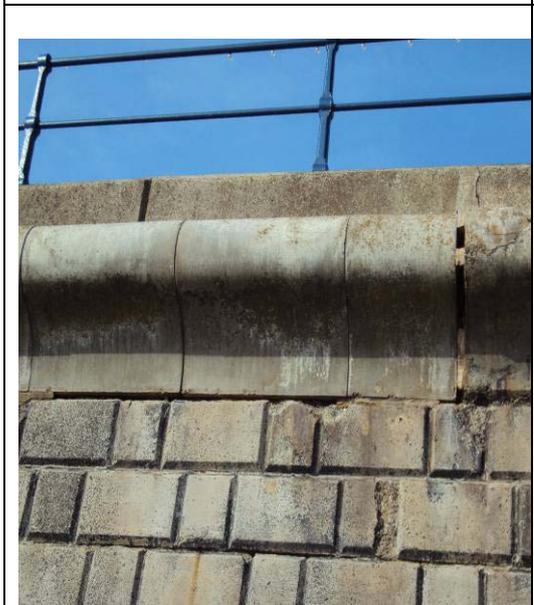
<b>Chainage</b>	<b>Defect</b>	<b>Photo Reference</b>
11	Surface spalling.	
37	Surface spalling.	
81	Surface spalling.	
112	Damaged wave return coping.	FI_02
129	Void between wave return coping units where repair has failed.	FI_03
158	Surface spalling.	FI_01
167	Open joint between repaired wave return coping units.	
299	Vertical crack through blockwork.	
361	Missing mortar below copings.	
369 to 378	Large vertical cracks in brickwork bridge abutments.	FI_04 & FI_05
427	Damage to upper capping beam.	
582	Damage to wave return coping.	
612	Damage to wave return coping.	
648	Damage to upper surface of concrete coping.	
657	Damage to wave return coping at joint.	FI_06
668	Damage to wave return coping.	
688	Damage to wave return coping.	
696	Patch repair to wave return wall coping. No return 'shape'.	FI_07
719	Horizontal cracking along upper capping beam.	FI_08
775	Horizontal cracking to stonework wall at the end of the slipway.	



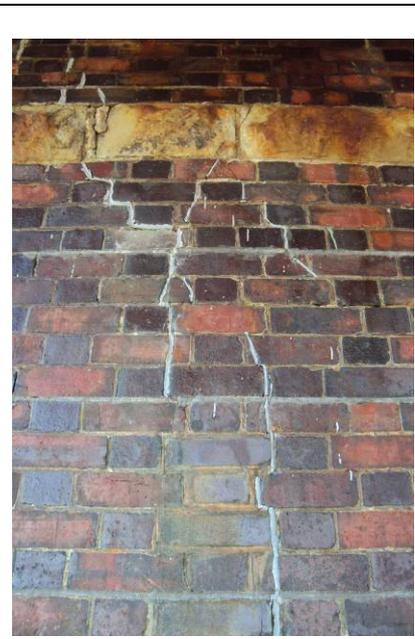
FI\_01



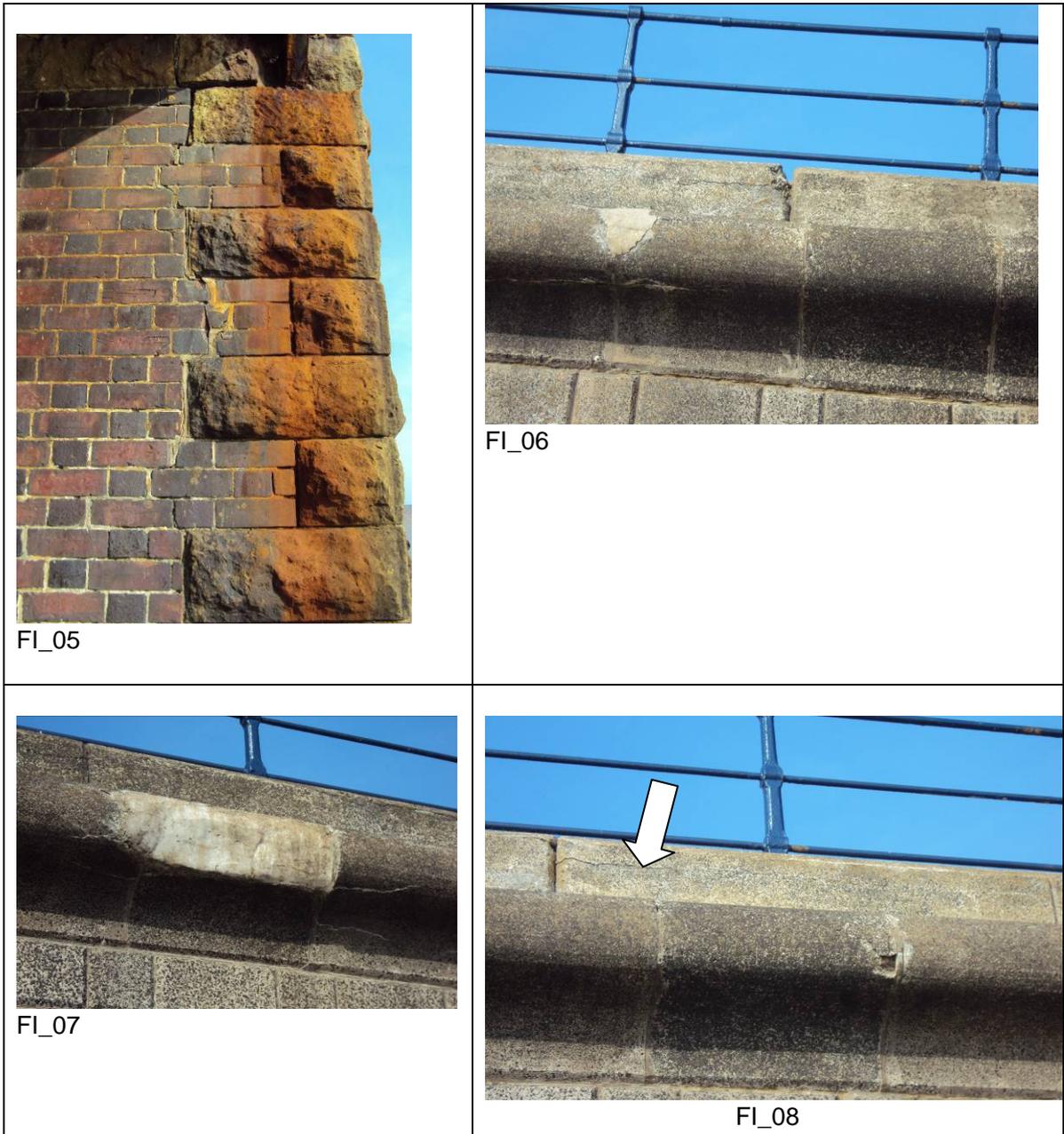
FI\_02



FI\_03



FI\_04



#### 7.4 Recommendations for Repair Work

- 1) Proactively remove loose/cracked wave return wall coping and recast new sections using framework contractor and in-house supervision.
- 2) Routine maintenance repairs to seawall.
- 3) Allow future budget planning for replacement of handrails.
- 4) Monitor cracks on bridge abutments and obtain structural report for identifying issues regarding safe load limits.
- 5) Confirm that non return valves are not required.

## 7.5 Estimated Cost

Cost estimates for the works for repair works are provided below.

Description	Cost (£k)
<b>Repairs to Copes</b>	
Removal of damaged wave return copings and replacement.	10
Overhead & Profit Mark-up @ 12%	1.2
Preliminaries at 15%	1.7
Contingency at 25%	2.8
Design / Works Information Costs <ul style="list-style-type: none"> <li>Works Information and Pre-Construction Information (inc service enquiries etc)</li> </ul>	0.5
Site Supervision	0.0
Other Costs – not used	0.0
<b>Total Cost</b>	<b>16.2</b>
<b>Handrails</b>	
Purchase price (cast iron) = £120 per linear metre.	
Based on a price of £150 per linear metre installed.	
Total replacement length estimated as 1.0km.	150
Overhead & Profit Mark-up @ 12%	18
Preliminaries at 15%	25.2
Contingency at 25%	42
<b>Total Cost</b>	<b>235.2</b>

## 7.6 Way Forward

It is recommended that works to remove and replace wave return copes that are cracked / damaged are prioritised, as these pose a potential risk to the public.

Routine maintenance works to repair damage to joints and replace washed out pointing should continue.

Regular monitoring of the wave return copes should be carried out, to identify further cracking or other damage that may pose a risk to the public.

The handrails need not be replaced. It is only the horizontal bars that are corroding and these can be replaced on an 'as required' basis. The cost estimate for complete replacement shows that this is not a desirable option and therefore it is recommended that the handrails continue to be; inspected, painted and the horizontal bars replaced as an when required.

## 8 SANDSEND

### 8.1 Asset Description

Mu9C – East Sandsend is protected by an 800m length concrete revetment, covering light weight rock armour, running parallel to the coast road. This is identified as asset 1221D901D0702C02. The asset is protecting the coast road.

The defence is formed from mass concrete poured over light weight rock armour, with an additional concrete pour applied to the upper surface. This upper concrete layer varies from 30mm to 100mm in thickness at various locations. The upper concrete layer is unreinforced.

### 8.2 Past Condition Report

In the Coast Protection Assets and Coastal Slope Condition Analysis Report (Halcrow, March 2010) it was identified that the defence had many significant defects throughout. The most common of these being surface cracking and localised spalling. The most significant being major undercutting and erosion of the toe. Repair works were advised, with an Urgency of Routine.

### 8.3 Current Asset Condition

The asset can be assessed as consisting of four specific lengths, with the condition varying in each.

Chainage 0 to 226 – the revetment is weathered and has surface abrasion, with some areas of exposed rock armour that need patch repairs. With maintenance this asset has an estimated residual life of 5 to 10 years, before significant areas of rock armour are exposed. The beach levels here are relatively high, resulting in little or no scour at the toe.

Chainage 226 to 356 – the upper concrete skin has not bonded to the lower mass concrete/rock armour layer and is falling away in sheets as it is affected by waves and weather. There are serious Health & Safety issues associated with this and it is recommended that consideration be given to make this area safe. There are some areas of surface abrasion and exposed rock armour, which can be repaired through routine maintenance works. This length has an estimated residual life of 5 to 10 years, even though it appears to be of more recent construction than the first length (due to the almost complete loss of the upper concrete layer).

Chainage 356 to 543 – significant loss of revetment as a result of scour, undercutting and failure of the toe of the asset over this length. This requires urgent emergency works to protect the exposed rock armour and prevent further losses. It should be noted that beach levels are locally low over this length, which has contributed to the undercutting and failure – the reasons for this localised low spot should be investigated, as it appears to coincide with an area of unstable cliff/ground on the landward side of the highway. It is also recommended that funding be obtained to carry out significant repairs and replacement works for this length of the asset – or indeed the whole length of the

asset. Residual life is estimated to be <1 year if no emergency repair works are carried out.

Chainage 543 to 826 (end) – this length has some areas of exposed rock armour, cracking, loss of toe cover and exposed rock armour on the upper surfaces in some locations. The severity of the defects is less significant than the previous section and can be dealt with through planned maintenance or as part of a refurbishment project. The beach levels are higher along this section than for Chainage 356 to 543. Residual life, if repaired and maintained 5 to 10 years.

An illustration of the defects found is provided below;

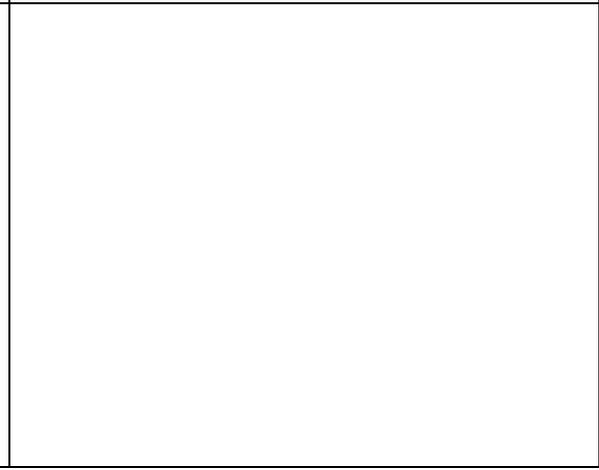
**Asset Reference 1221D901D0702C02 (Swimming Pool (SP), Sea Wall)**

Chainage commencing at the Sandside Café and running to the south.

Chainage	Defect	Photo Reference
0 to 19	Good sand coverage. No issues. Gabion defences.	
19>	Concrete revetment overlaying light weight rock armour.	
31	Concrete surface is eroded and rock armour exposed around outfall.	SE_01
130	Loss of concrete surface at joint above toe.	
149	Exposed rock armour in an area approx 1m <sup>2</sup> .	SE_03
164	Exposed rock armour in an area approx 1m <sup>2</sup> .	
164 to 188	Loss of upper concrete surface exposing rock armour stone.	
188 to 226	Loss of upper concrete surface exposing rock armour stone.	
226	Loss of toe cover and voiding in upper and lower concrete layers.	
248	Almost complete loss of upper concrete layer.	SE_02
283	Rock armour stone exposed ¾ of the way of the revetment for approximately 5m length.	
290 to 356	Loss of concrete cover at toe, voids, exposed rock armour stone, upper concrete layer failing.	
356 to 543	Condition is very poor, with toe failing completely in some areas. Beach levels low.	SE_05
358	Rock exposed on upper revetment.	SE_04
384	Rock exposed on upper revetment.	
407 to 446	Significant scour at toe – failure of upper concrete surfaces, no concrete cover at toe, loss of rock armour stone, large voids at toe.	
437 to 442	Revetment has collapsed at toe – 3 to 4m loss of slope distance of revetment. Vertical	SE_05

	step formed approximately 800mm high.	
446 to 461	Slight scour at toe. Possible recent repair.	
461 to 543	Loss of concrete cover at toe and exposed rock armour stone.	SE_06
501	Upper revetment is cracked/fracture exposing armour stone.	
520	Area of toe washed out.	SE_07
542	Large outfall. Is this outfall causing beach levels to be locally lower?	
543 to 569	Upper concrete revetment eroded exposing rock armour stone.	
595 to 600	Rock armour stone exposed at toe.	
654	Damage at toe at location of cast iron pipe outfall. Note – flow is not running from the pipe, but underneath it.	
682	Loss of concrete at toe where revetment changes direction.	
742	Exposed rock armour stone due to loss of concrete cover.	
759	Damage to concrete at toe.	
816 to 826	Numerous fracture lines.	





## 8.4 Recommendations for Repair Work

There are a number of issues and repair options to be considered, these are listed below.

- 1) Emergency works – to stabilise eroded toe section.
- 2) Repairs to damaged sections + continue with routine maintenance.
- 3) Refurbishment of the asset – reinstate toe/slope profile, cast anti-scour toe beam and pour new reinforced concrete revetment.
- 4) Do Nothing – move road back.
- 5) Geotechnical investigation and discussions with Highways Authority.

## 8.5 Estimated Cost

Cost estimates for a project to fully repair and refurbish the revetment, including a rc toe beam and a new 200mm thick rc revetment are shown below;

Description	Cost (£k)
PAR, Design Costs, Specification & Works Information	75
Geotechnical Investigations	25
Licences, Applications & Consultation	10
Construction Costs	800
Site Supervision	50
Other Costs – not used	
<b>Total Cost</b>	<b>960</b>

(A full cost estimate has been prepared by RH Quantity Surveyors for the construction costs estimate and can be made available if required.)

## 8.6 Way Forward

Emergency works to prevent further loss of the revetment where the toe has been scoured out are essential and should be carried out immediately.

Given the poor condition of large sections of this asset, and the limited residual life of the remaining sections, it is recommended that a scheme be implemented to replace the whole asset. A PAR would be required to identify options and assess the economics of proposed options.

It is understood that the option of moving back the road is not considered viable by the highways authority.

It is also clear that there are geotechnical issues relating to the lowered beach profiles which need further investigation and discussion with the highways authority before any option selection is carried out.