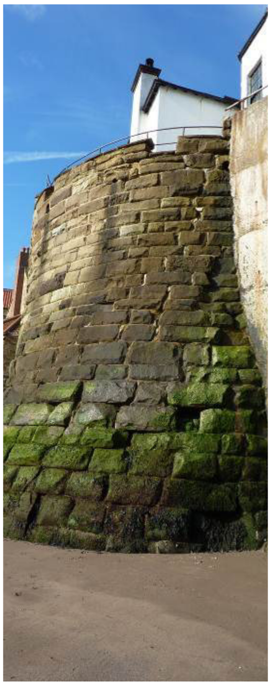

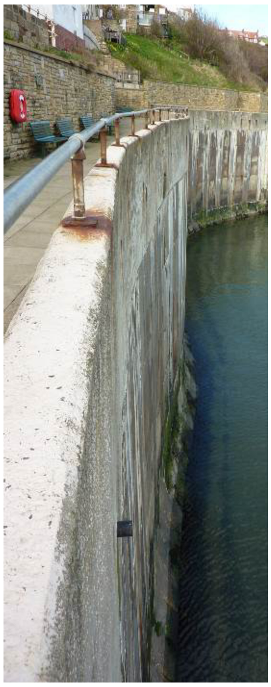

Robin Hood's Bay
Coastal Defence Condition Survey

May 2014

Scarborough Borough Council

Mott MacDonald

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
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Content

Executive Summary

A condition assessment of the coastal defences along the Robin Hood's Bay sea wall, which forms part of the '2007, River Tyne to Flanborough Head Shoreline Management Plan (SMP2)' was carried out by representatives of Mott MacDonald on behalf of Scarborough Borough Council on 10th April 2014.

The Robin Hood's Bay sea wall is a 12m tall concrete sea wall which is abutted by a masonry sea wall at the southern end and a natural shale cliff at the north. Previous surveys by CRL (2007), Royal Haskoning (2011) and CH2M HILL (2012) have highlighted this sea wall as in poor condition and in need of repair. This defence condition assessment aims to confirm the condition of the sea wall using the latest Environment Agency Guidance and determine an approximate residual life for the structure. This will aid Mott MacDonald in recommending potential options to maintain protection along the frontage.

The conclusions of the assessment is that the majority of the sea wall is in fair condition, although further investigation is required to understand the structural implications of the rust and white staining present on the surface. The principal areas of concern are at either end of the structure at the interface between the masonry sea wall and cliff face. The previous detailed inspection report (Royal Haskoning, 2011) classed the main section of the sea wall as in poor condition. This was largely due to extensive rust staining, indicating corrosion of reinforcement. This has been changed to fair as from a visual inspection the defects noted on the sea wall do not appear to be affecting the structural performance of the defence. This is in accordance with the Environment Agency's Condition Assessment Manual (2006). For other sections of defence the condition compares well with previous assessments.

This report has determined residual life of the structures based on the 'Practical guidance on determining asset deterioration and the use of condition grade deterioration curves: Revision 1 (2013)'. Based on these curves the residual life of the main structure is 10 years, however the interfaces at either end pose a risk to the structure and are in need of further assessment.

1. Introduction

1.1 History

Robin Hood's Bay is a coastal bay and historic village situated between Scarborough and Whitby on the North Yorkshire coastline. The village of Robin Hood's Bay is a popular tourist destination and marks the end of the coast to coast walk form West Cumbria to the East Coast.

There is a long history of coastal erosion at Robin Hood's Bay. Since a large landslide in 1780 which destroyed much of the original road into the village (King Street), over 200 properties have been lost to cliff erosion. The south part of the village is protected from erosion by a concrete sea wall which is approximately 12m tall and 160m long built circa 1973. This sea wall is abutted by a masonry sea wall at the southern end and a natural shale cliff at the northern end. Following the construction of the sea wall no signs of instability have been reported.

The area surrounding Robin Hood's Bay is also of high environmental importance and sit within the Maw Wyke to Beast Cliff Site of Special Scientific Interest and Special Area of Conservation (SAC). This area is designated for it's geological, geomorphological and vegetation interest.

Robin Hood's Bay lies within management area 25.2 of the '2007, River Tyne to Flanborough Head Shoreline Management Plan 2 (SMP2)' which recommends a policy of Hold the Line for Robin Hood's Bay for the next 100 years. The sea wall was constructed in 1973 and is expected to reach the end of its design life within the next 20 years. It protects 44 properties which would be lost to erosion with the next 100 years.

In 2007 Concrete Repairs Limited (CRL) was commissioned by Scarborough Borough Council to investigate the current condition of the wall and recommend any required repairs. Due to funding constraints these repairs were not carried out. In 2011 Royal Haskoning carried out an asset assessment for the frontage which included a review of the CRL report. The 2011 report recommended that further study is done to investigate the structural condition of the wall and to look at whole life cost of Do Minimum, enhanced repairs and replacement options.

In 2012 Scarborough Borough Council produced a Coastal Strategy Appraisal Report covering 24km between Whitby's Abbey Cliff and Hundale Point. This recommended an option of Active Intervention in order to maintain the current line of defence and recommends that a Project Appraisal Report (PAR) is commissioned in order to seek funding for investigation, design and delivery of a capital scheme.

Mott MacDonald has been commission by Scarborough Borough Council (SBC) to produce a PAR to develop a list of options for the sea wall and propose a preferred solution. This defence condition assessment will form part of the PAR and be used as a basis for the planning of future work and maintenance regimes.

1.2 Purpose of the Defence Condition Assessment

The main purpose of the condition assessment is to establish the current condition of the concrete sea wall at Robin Hood's Bay to establish the residual life of the defence and to identify any increased deterioration since the previous inspection. This includes an analysis of the function and construction of the sea wall. Assessment of the current condition of the Sea Defence will aid Mott MacDonald in appraising and developing options for the sea wall including advanced maintenance, strengthening and full replacement. This will form the basis of a PAR to recommend a preferred option for the sea wall.

As confirmed by SBC during the site visit on 10/04/2014 the condition assessment covers the concrete sea wall, associated drainage and promenade only. The masonry sea wall and shale cliffs at either end of the sea wall are included in this assessment solely for their interface and effect on the sea wall. During the survey the sea wall was broken into its constituent elements: seaward face, parapet wall and the interface at each end. Each element is summarised in Section 4 providing an overall assessment of the condition of each incorporating the details from all assessed elements. Section 4 of this condition assessment also includes:

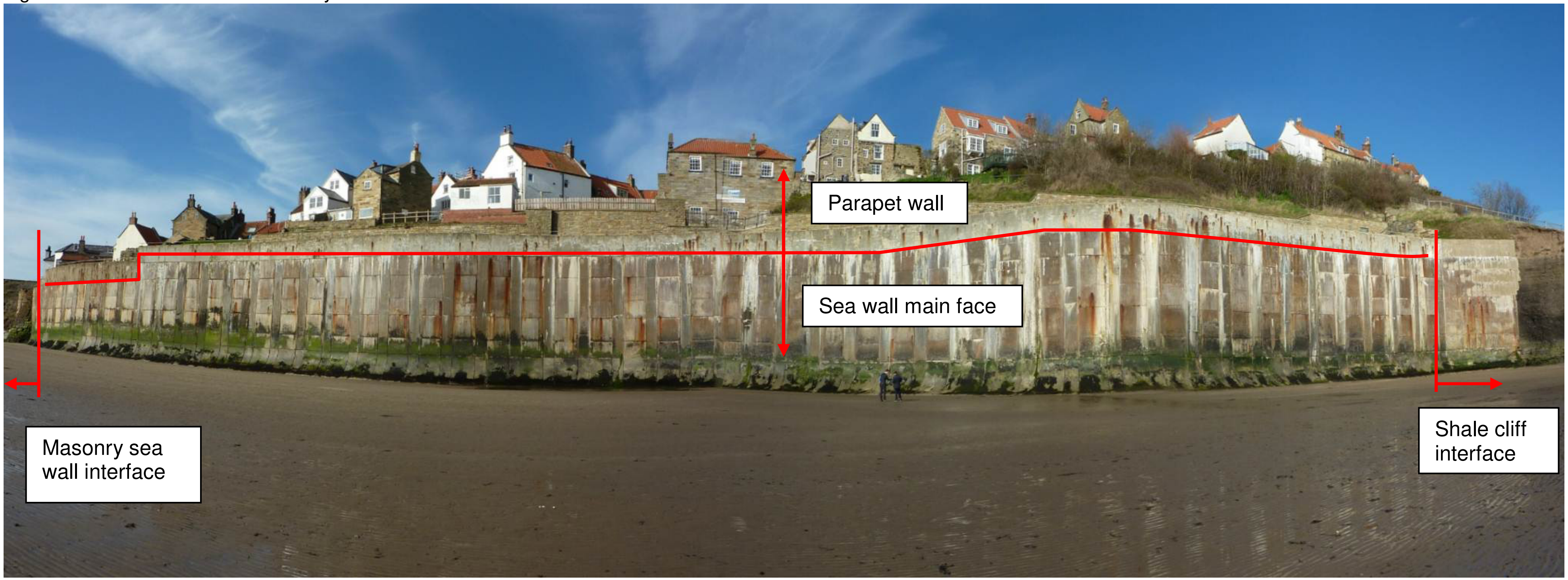
- Estimated length of section.
- Overview of the assets protected.
- Residual life.

2. Coastal Defence Asset Summary

This section of the report provides a general overview of Robin Hood's Bay, identifying how the frontage has been divided up for the conditions assessment and it also provides as overview of the composition of the defences present in Robin Hood's Bay.

The bay has been broken up into four sections: the interface between the masonry and concrete sea walls, the main face of sea wall, the parapet wall and promenade and the interface between the sea wall and the cliff. The survey sections are presented in Figure 2.1.

Figure 2.1: Panoramic view and survey sections



2.1 Structure description

The following general observations were made with respect to the assets along the frontage.

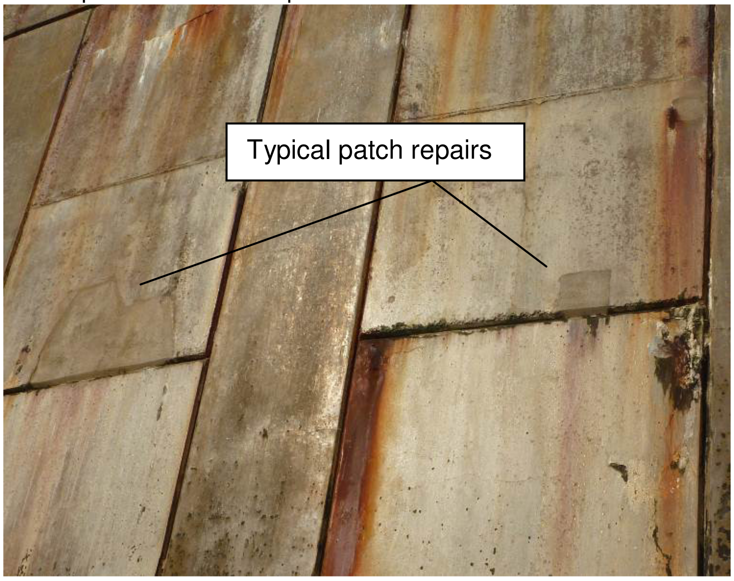
2.1.1 Concrete Sea Wall

The concrete sea wall is constructed from precast concrete columns and curved base units. There are concrete panels between the columns which act as permanent shuttering for mass concrete backfill. The drawings provided by SBC indicate that there are rock anchors which run from the front of the wall into the underlying cliff. There is a parapet wall along the top of the main face of the sea wall which is backed by a promenade. At the ends of the sea wall the panels and columns finish and the final section is cast in situ.

There are drainage pipes present in the structure at promenade level and just above the base blocks. The lower drainage outlets are spaced every 12m and there are 13 in total. From a review of construction drawings these connect to a rubble drain set back from the front surface of the wall which is in turn linked the drains along the promenade. SBC do not believe these drains to be functioning.

There are several surface repairs on the face of the structure as presented in Figure 2.2. From discussion with SBC at the site visit it was confirmed that no major repair work has been undertaken since the 2007 CRL report. Any repairs have been as a result on removing loose material for safety reasons.

Figure 2.2: Detail of two patch repairs on the centre panels



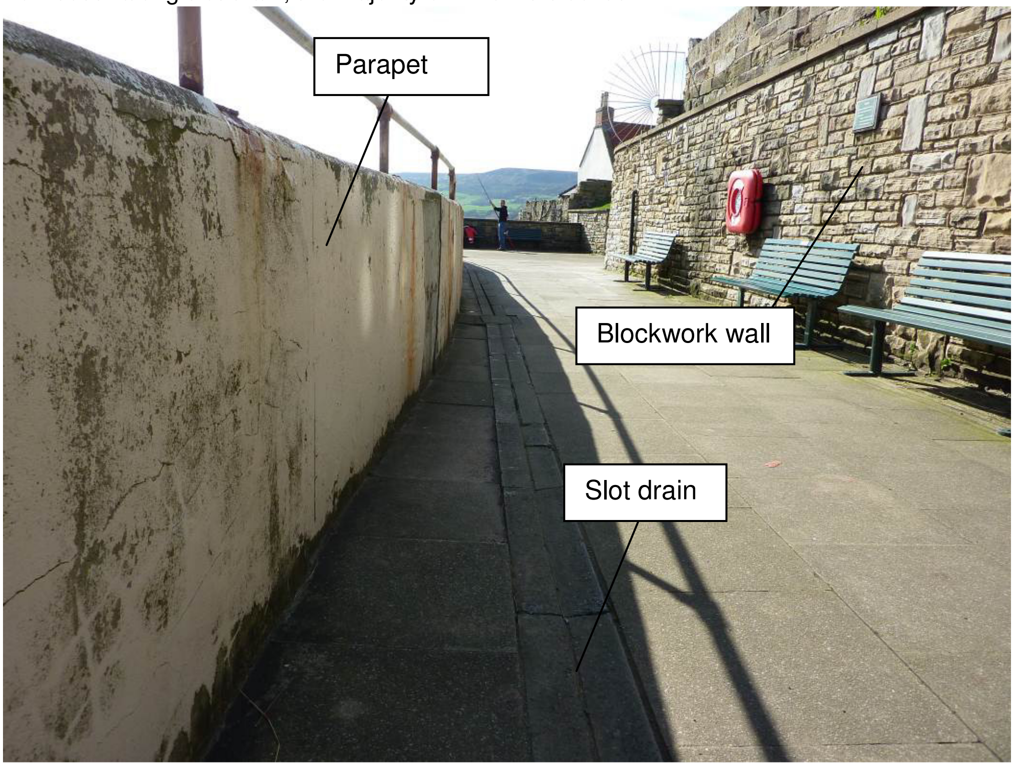
There is extensive rust staining on the surface of the sea wall (see Figure 2.3) it is not known what the source of this is. It has been suggested in CRL (2007) that iron ore is present in the aggregate which is a likely cause of staining in some areas. This is likely to relate to the dark circular rust spots.

Figure 2.3: View looking south along concrete sea wall

2.1.2 Promenade

There is a paved promenade behind the parapet wall. This is backed by a blockwork wall above which are several properties. It was confirmed by SBC on site that this PAR will not consider the blockwork wall. The promenade is drained by a slot drain which runs along the majority of the seaward edge of the promenade and several gullies which are located either in the centre or the rear of the promenade. A large proportion of the slot drain is blocked (see Figure 2.4).

Figure 2.4: View south along slot drain, the majority of which is blocked.

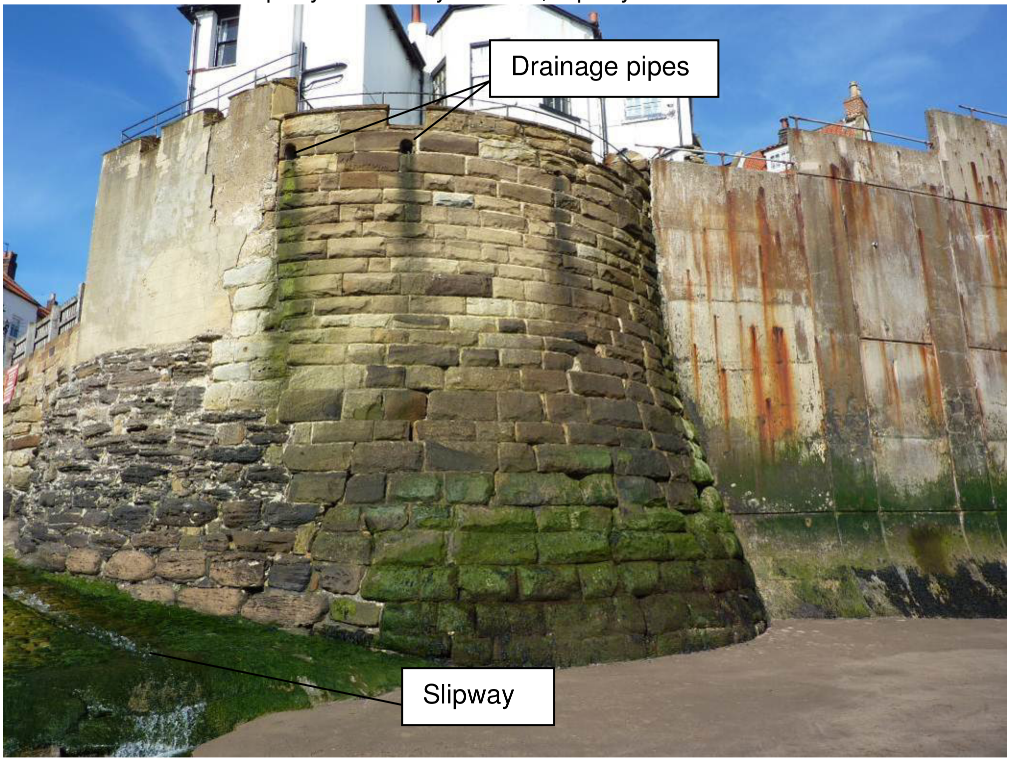


2.1.3 Masonry Sea Wall

The masonry sea wall joins the concrete sea wall at the southern end. The last 2-4m on the sea wall is mass concrete and joins directly to the masonry wall structure. There is a slipway on the other side of the masonry sea wall which provides beach access from the town. A stream outlet runs down the slipway, adjacent to the wall.

The crest of the masonry sea wall is lower than the main crest of the concrete sea wall. The masonry blocks are irregular in size but generally reduce in size higher up the wall. There is minimal drainage provided in the wall; the only drainage which is visible is at promenade level (see Figure 2.5). During the start-up meeting representatives from SBC commented that following heavy rainfall water can be seen running through the structure between the blocks. SBC also stated that regular maintenance is done on the wall filling voids that appear between the blocks.

Figure 2.5: View from end of the slipway of masonry sea wall, slipway and concrete sea wall



2.1.4 Cliff

At the northern end the sea wall joins a natural shale cliff. The cliff face is protected by rock armour on the corner which may provide some shelter to the section which joins the wall (see Figure 2.6). From the site meeting with Robin Siddle and Martin Lloyd (SBC) on 10/04/2014 it was discussed that the cliff face continues to erode at low tide when not exposed to wave action. Erosion appears to be accelerated close to the sea wall. A recent patch has been made to the wall it is assumed that this was to try and reduce outflanking at this corner (see Figure 2.7). During the site visit SBC stated that at this end of the wall outflanking and refilling with mass concrete is a regular process.

Figure 2.6: View of northern end of wall showing cliff face and rock armour

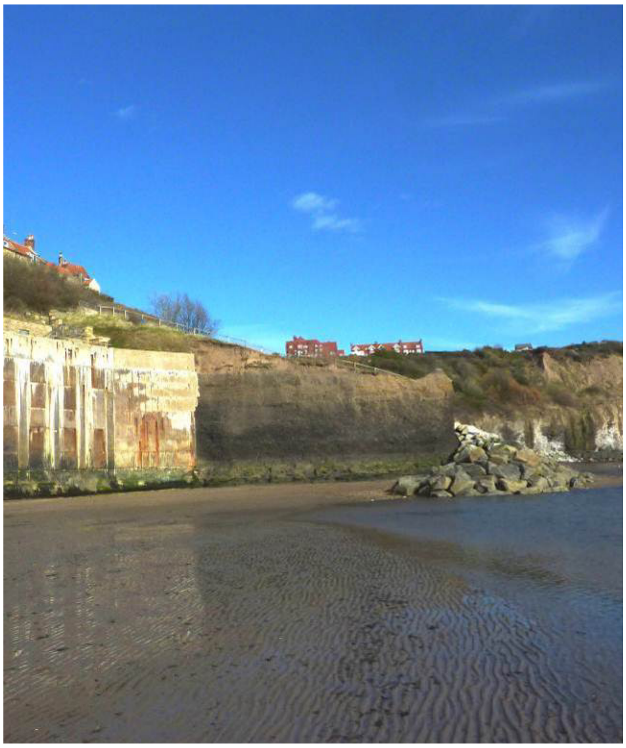
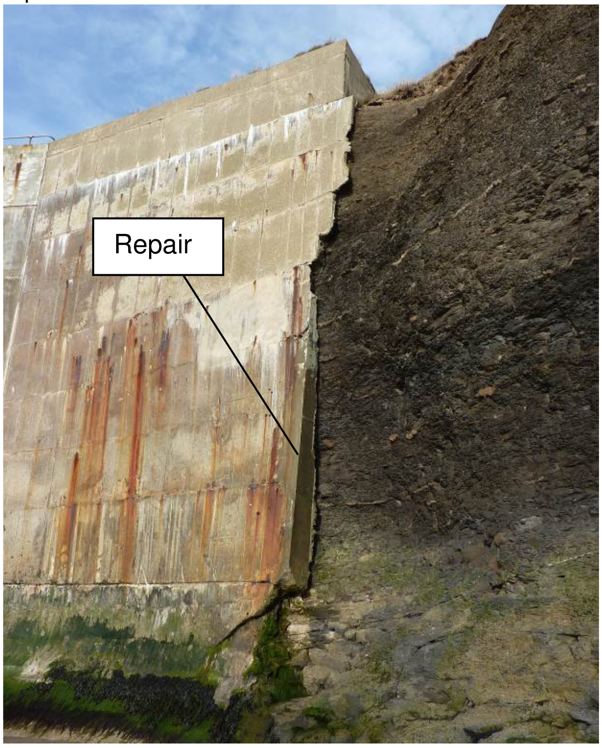


Figure 2.7: View of northern end of wall showing recent repair



3. Baseline Understanding on Sea Wall Composition

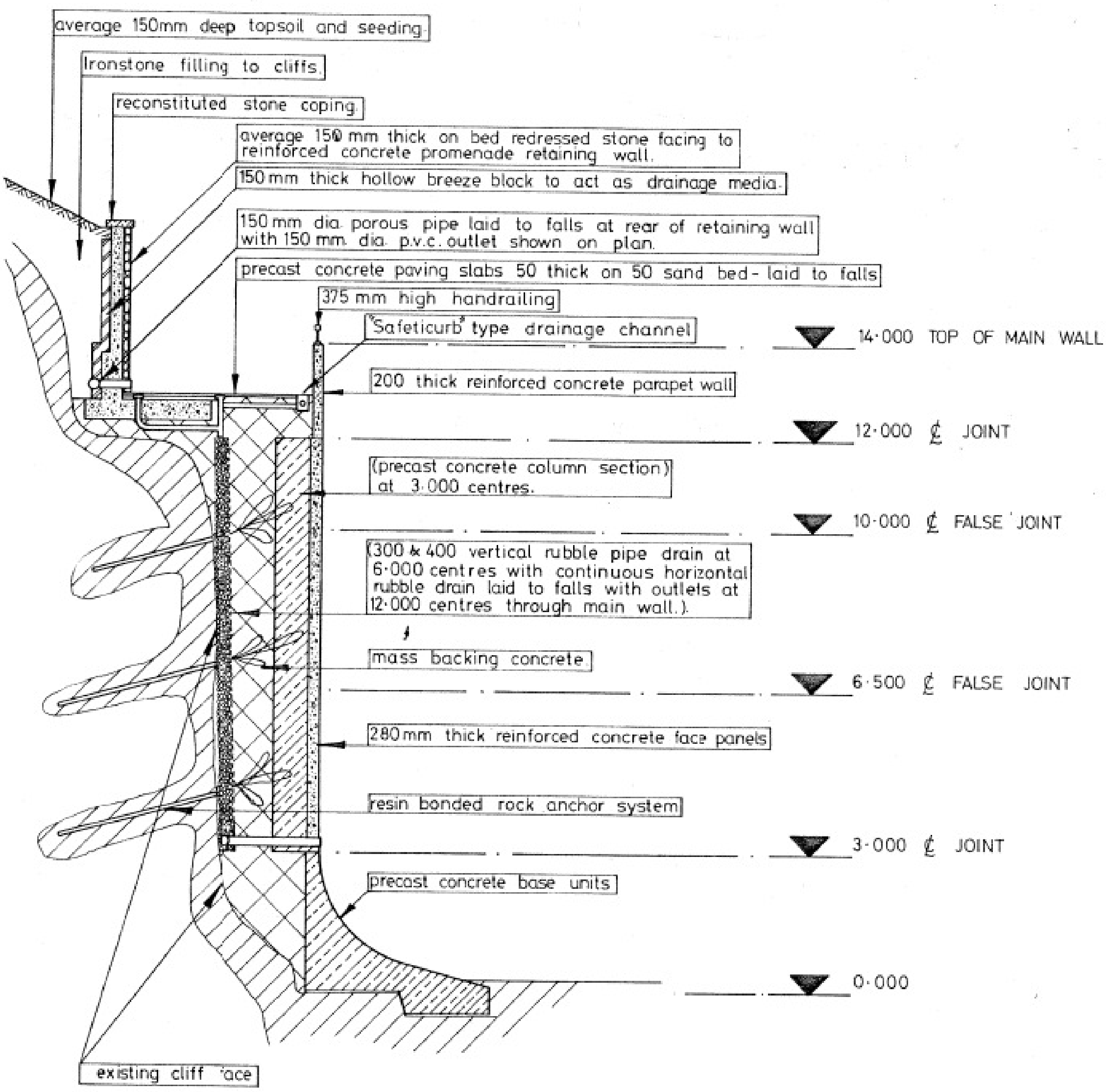
3.1 Introduction

This Section sets out Mott MacDonald's understanding of the purpose and composition of the sea wall. This aids in identification of potential failure mechanisms and allows assessment of whether damage to individual elements in likely to affect the performance of the asset. Information about the composition of the sea wall is limited the following conclusions are based on the site visit, design drawings supplied and photographs of the sea wall during construction. As only one of the construction drawings has been marked as As Built it is difficult to confirm the actual construction of the wall.

3.2 Structural Elements

A typical cross-section of the sea wall is presented in Figure 3.1

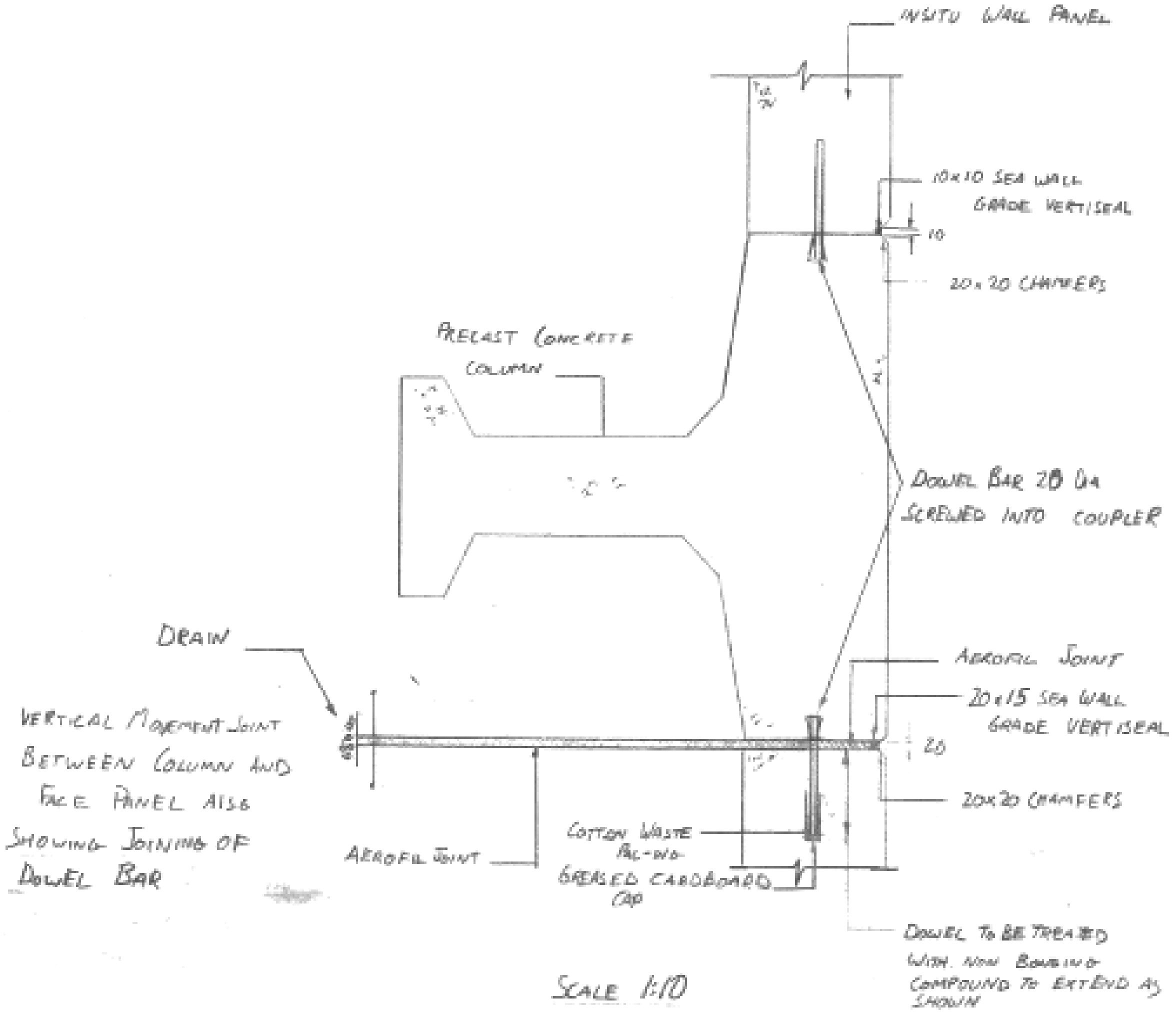
Figure 3.1: Typical cross-section through sea wall



Source: Construction drawing provided by SBC, John H. Haste & Partners(1974) Sea Wall (As Built)

The sea wall is founded on precast concrete base units the toe of which is buried in the beach. These base units have a curved seaward face. The top edge of these base units is the same width as the face panels. I-beam shaped precast concrete columns are slotted into the top of the base units. The columns are single span sections are run from the base units to the bottom of a parapet wall. These columns are tied to cast in situ reinforced concrete face panels with 20mm diameter dowel bars (see Figure 3.2 and Figure 3.3). The precast columns and cast in place panels form the face of the sea wall.

Figure 3.2: Typical cross-section through column showing joint details



Source: Construction drawing provided by SBC, John H. Haste & Partners(1974) Elevation and Sections of Wall (redrawn)

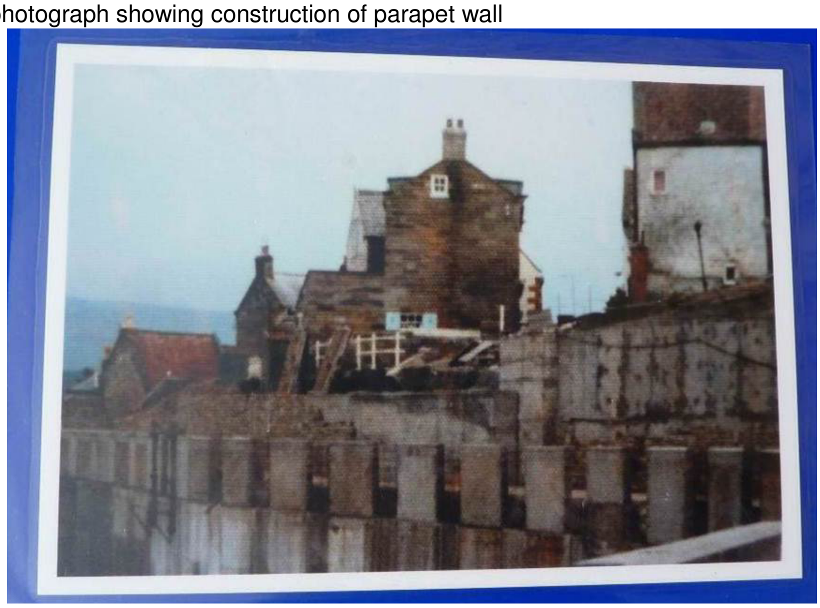
Figure 3.3: Historic photograph of wall during construction showing casting of face panels between precast columns

Source: Robin Hood's Bay Resident

Between the face of the sea wall and natural cliff is mass concrete fill. The structure (i.e. columns, panels and mass concrete) is tied to the cliff face with rock anchors which are fixed into the natural cliff.

The shape of the column provides a geometric key to bond the mass concrete to the front of the structure. The concrete fill, behind the face, is likely to have been done in stages pouring to the depth of the lowest face panel first before installing the next layer. This would create construction joints in the structure. There were no specific drawings provided for the anchor detail however a drawing for nearby sea wall at Gurney Hole (which was designed as part of the same scheme) suggests that these extend 3700mm into the cliff face. As there are no visible connection plates shown in the design drawings it is assumed that these are embedded solely within the mass concrete. From the As Built drawing in Figure 3.1, the anchors are probably connected to the mass concrete by loops formed at their end. The sea wall is topped with a precast reinforced parapet wall which fronts a promenade. A photo of the construction of the parapet wall is provided in Figure 3.4.

Figure 3.4: Historic photograph showing construction of parapet wall



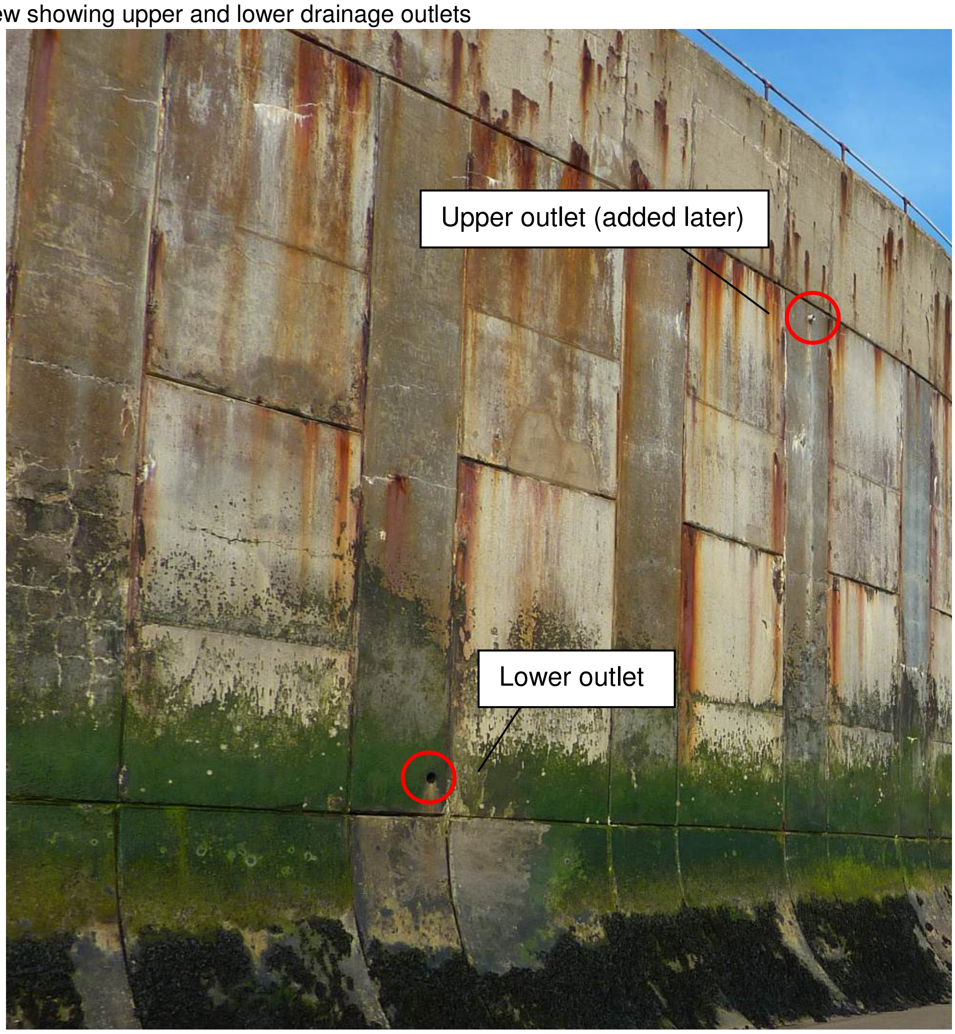
Source: Robin Hood's Bay Resident

3.3 Drainage

The promenade is drained by a series of gullies, pipe drains and a slot drain which runs along the majority of the promenade. These feed into a longitudinal drainage network and then to vertical rubble drains located at the back of the wall between the mass concrete and the cliff face (believed to be at 6m intervals). The vertical rubble drains connect to a continuous horizontal rubble drain which runs just above the base units and connects to pipe outlets which exit through the wall every forth column (approximately 12m). The cross section drawing (Figure 3.1) suggests that the vertical rubble drains were originally designed to take both the surface water from the promenade and to prevent pore water pressures building behind the wall.

Several years after the wall's construction it was realised that the drainage system was not working effectively as there was ponding on the promenade so a high level drainage system was installed. This involved modifying the original high level chambers and connecting to pipes through the seawall at a higher level than before (see Figure 3.5). From discussion with SBC the promenade no longer floods which indicates that the upper drainage system now functions. This suggests that the predominant drainage issue is now the rubble drain or lower drainage system.

Figure 3.5: View showing upper and lower drainage outlets



3.4 Assumed Function of the Sea Wall

As discussed in the previous sections the main part of the sea wall comprises of the following elements:

- concrete base
- precast reinforced concrete columns
- cast in place reinforced concrete panels
- mass concrete
- rock anchors.

In order to understand the impact of corrosion and deterioration of each element on the performance and stability of the wall, which will assist in the prioritisation of maintenance and remedial works, the function of the structure should be understood.

The sea wall may serve the following purposes:

- provide stability against active earth pressures
- provide slope stability against global failure mechanisms
- provide erosion protection against wave action and climate

While no ground investigation information directly behind the sea wall is available, the exposed vertical cliff north of the wall (see Figure 2.6 and Figure 2.7) and the available drawings and archive photos suggest that the geology at the back of the wall comprises a hard shale stratum. The hard shale is unlikely to impose active earth pressures of considerable magnitude on the wall and the wall is therefore not required to provide earth support. In addition, the short fixed length of the rock anchors suggests that the wall was not designed to prevent any potential global, deep seated, instability of the cliff side should it occur. Therefore, provision of slope stability is not considered as a plausible function of the sea wall,

From discussion on site with SBC and review of the available information it can be assumed that the principal function of the sea wall is deemed to be erosion protection, protecting the cliff from wave action and climate. Unless evidence is found which suggest otherwise this assessment and future assessments will be based on this conclusion.

A possible source of forces, which could induce stress on the wall, is the potential pore water pressure built up behind the wall. However, as no deformation of the wall has been recoded to date, it can be assumed that either the low permeability of the shale in conjunction with the presence of the rubble drain on the back of the wall mitigates the risk of pore water pressure built-up or that the structure is currently able to withstand the stresses. Given these uncertainties the potential for pore water pressure built-up constitutes a residual risk which needs to be addressed through inspection and testing of the existing drainage and possibly construction of additional weep holes along the wall if deemed necessary.

Since the wall is unlikely to function as a retaining structure, it is reasonable to assume that the anchors' principal function is to pin the wall to the rock and support the wall form toppling or sliding under the action of pore water pressures or under the action of its own weight due to its irregular shape and slenderness. Given that the anchors are encapsulated with the mass concrete and their location and geometry is uncertain it is impractical to assess their condition and performance therefore they are not accounted for in this assessment. As no deformation of the structure has been recoded to date, it can be assumed that the anchor-wall system has so far performed adequately. However, the anchors are a primary element for the wall stability and therefore uncertainty on their conditions constitutes an additional residual risk which needs to be considered in any future assessment.

The structural composition of the face panels and columns as well as the understood construction sequence indicates that the principal structural element of the sea wall is the mass concrete fill which is connected to the anchors. The I-beam shaped columns interlock to the mass concrete for their stability and the stability of the interlocked panels. Their function is to provide a robust shuttering, which enabled concrete pouring in exposed intertidal conditions during construction, and to provide a smooth and robust reinforced surface to reduce damage to the mass concrete from wave action. The concrete base also provides erosion protection and possibly functioned as a shuttering during construction and as foundation of the wall thereafter. Based on the assumption that the anchors are connected to the mass concrete only and that the structural function of the columns and of the face panels is limited to what discussed above, the structural impact of corrosion damage to the columns and the panels may be low.

4. Summary Condition Survey

4.1 Introduction

This section contains a summary of each section of the defence along Robins Hood's Bay (sections defined in Figure 2.1). Each section is detailed in a summary table, accompanied by a selection of photographs identifying structures and highlighting significant defects. The assessment tables include; the condition grade and estimated residual life for each structure, level of exposure, information on the assets protected and estimated length.

The defence condition assessment contained within this report is based upon the visual inspection of the coastal defences within the defined duration. No intrusive investigations or structural testing have been carried out to confirm the structural condition of structures.

4.1.1 Condition Grade

The condition grade of each part of the structure has been assessed using the Environment Agency 'Condition Assessment Manual (CAM), 2006'. The CAM guidance presents text descriptions that cover five Condition Grades for various assets. The grades range from Grade 1 ("Very Good") to Grade 5 ("Very Poor"). The defence types for the assessed structures are present in Table 4.1 to Table 4.3.

4.1.2 Residual Life

Residual life is defined as the estimated duration that a defence is able to fulfil a minimum level of performance in terms of its function or structural strength. The residual life has been estimated based on the Environment Agency's 'Technical report – FCRM assets: deterioration modelling and WLC analysis', 2013.

The residual life of structures has been determined for a medium maintenance scenario. This indicates that whilst targeted maintenance is carried out to repair significant defects a strict maintenance programme responding to all damage including superficial damage is not carried out as standard across the frontage.

A threshold grading is required to determine the residual life and defines the minimum condition a structure should be allowed to deteriorate to prior to maintenance or remedial works being undertaken. A threshold grade of 4 (poor) has been set for the sea wall. This grade is defined by the Environment Agency as the grade where defects have reached a level that would significantly reduce the performance of an asset (Environment Agency, 2006). It is assumed that this is the point where SBC would want to conduct major reactive repairs.

Residual life is also dependant on the level of exposure of the structure. As Robin Hood's Bay is on the open coast and high tide reaches the sea wall exposure has been taken as high.

Table 4.1: Interface between Concrete Sea Wall and Masonry Sea Wall

Asset Location			
Defence Structure	Sea Wall	**Location:**	End of New Road
Survey Date	10/04/2014		
Coastal Defence Condition			
Defence Type:	Masonry Sea Wall and Mass Concrete Sea Wall		
Coastal Defence Length:	10m	**Year Built:**	Unknown
Principal Assets Protected:	The Bay Hotel		
Exposure:	High	**Threshold Grade**	Poor
Condition Grade:	**Masonry Wall**	Poor	
	Concrete Tie In	Fair	
Residual Life	10 Years		
Description			

Masonry Wall

A blockwork wall extends from the slipway round to the concrete sea wall. The majority of the joint material is missing in the intertidal section of the wall and several blocks have been displaced. Voids were observed where joint material has been lost. There is also localised cracking of blocks. The condition of the wall improves above the marine zone.

The toe of the structure is buried and there is no sign of slumping, heave or displacement of the structure.

Concrete Sea Wall Tie In

The last 2-4m of the concrete sea wall is cast against the masonry wall. There is widespread rust staining on the surface of the wall and multiple shallow horizontal cracks. The tie in with the masonry wall is good with no significant signs of breaking away or outflanking.

Interface between Concrete Sea Wall and Masonry Sea Wall

View south showing the interface between the concrete sea wall and the masonry sea wall, several blocks have been displaced.

View north of the masonry sea wall showing substantial loss of joint material in the intertidal section.

Table 4.2: Concrete Sea Wall

Asset Location			
Defence Structure	Sea Wall	**Location:**	Between Masonry Wall and Cliff
Survey Date	10/04/2014		
Coastal Defence Condition			
Defence Type:	Concrete Sea Wall		
Coastal Defence Length:	160m	**Year Built:**	1973
Principal Assets Protected:	Promenade and properties along King Street		
Exposure:	High	**Threshold Grade:**	Poor
Condition Grade:	**Main Face**	Fair	
	Parapet Wall	Fair	
Residual Life	10 Years		
Description			

Main Face
Localised spalling is visible across the whole of the surface. There is extensive rust staining which is also present across the whole surface but is worse in some areas. Although widespread rust staining is generally concentrated in localised spots. The source of this staining is uncertain. There are multiple horizontal cracks these are present in the majority of columns. These cracks are in a similar vertical position across the wall. There is a general loss of cover over the wall surface and some localised areas where the outer surface has been removed. It was not possible to see from the ground but there are a couple of areas where surface rebar is potentially exposed. There are some signs of patch repair to the surface of the structure.

There is extensive loss of vertical joint material, in some locations exposing the underlying mass concrete. There are no viable signs of movement or slumping or heave of the ground. The toe is well covered along the majority of the section however there is one spot where water was pooling indicating that the beach may be lower in that section.

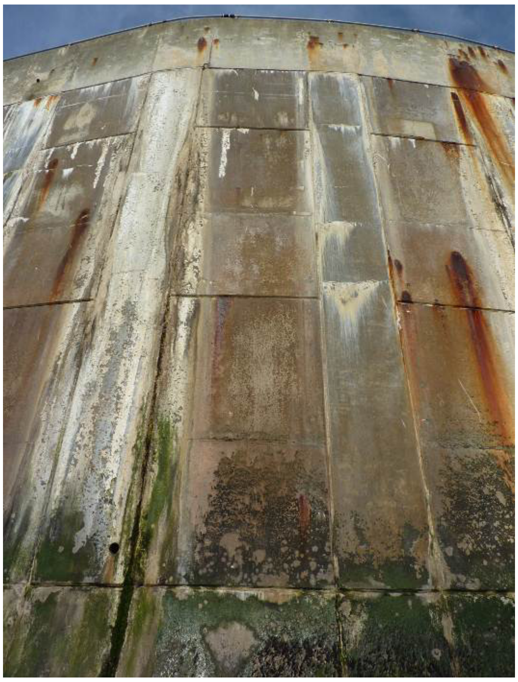
There is white staining present across the whole of the structure which worsens at the northern end. The majority begins either at a horizontal crack or at the interface between the main face and the parapet wall. This could be an indication of leakage through the structure.

Parapet Wall
The seaward face shows extensive rust staining and horizontal cracking. The landward face is heavily cracked and the surface has been removed in multiple locations exposing the underlying concrete wall. The landward face is also rust stained although the majority of this is as a result of the handrail. There are no signs of movement of the wall

Concrete Sea Wall
between Masonry Wall and Cliff

View of northern end of concrete sea wall showing rust staining and white staining

View of concrete see wall showing extensive white staining around horizontal cracks and loss of vertical joint material



Detail of toe of concrete sea wall showing extensive loss of joint material and loss of concrete surface

View south along rear of parapet wall showing cracks, rust staining and loss of surface.

Table 4.3: Interface between concrete sea wall and cliff

Asset Location			
Defence Structure	Sea Wall	**Location:**	Northern End of Sea Wall
Survey Date	10/04/2014		
Coastal Defence Condition			
Defence Type:	Concrete Sea Wall		
Coastal Defence Length:	10m	**Year Built:**	1973
Principal Assets Protected:	Promenade and properties The Square		
Exposure:	High	**Threshold Grade:**	Poor
Condition Grade:	Poor		
Residual Life	0 Years		
Description			

Concrete Sea Wall
The northern most 10m of sea wall in mass concrete which ties directly into the shale cliff. The edge of the sea wall is exposed and heavily cracked there is a large repair to the lower half of the wall. The erosion of the cliff face next to the wall edge has led to outflanking and loss off back fill. If this continues it could present a risk to the structural integrity of the wall.

There is spalling in multiple areas across the surface of the wall. There are also several short surface cracks and extensive rust and white staining. There is extensive damage to the last toe block if this deteriorates further it could pose a structural risk to the wall. The toe is buried and there is no sign of movement or heave.

The parapet section appears to be in better condition than the main face as there is no staining and fewer cracks.

Interface between
Concrete Sea Wall and Natural Cliff

View of intersection between cliff and sea wall showing rust and white staining

Detailed view of damaged toe block. The recent edge repair can also be seen above this block

View South of the interface between the cliff and the sea walls showing erosion of the cliff leading to outflanking of the sea wall and damage to the edge of the wall. The edge repair is visible on the lower half of the wall.

5 Summary of Residual Life

5.1 Residual Life Based on Visual Assessment

Table 5.1 summarises the condition grading of the sea wall elements and gives a comparison of the findings of this assessment and studies undertaken in 2011 (Royal Haskoning) and 2012 (CH2M HILL).

Table 5.1: Summary of condition grades from current and historic surveys.

Legend
Condition Grade
V Poor
Poor
Fair
Good

Section Reference	Length (m)	2011Condition Grade (Royal Haskoning)	2012 Condition Grade (CH2M HILL)	2014 Condition Grade	Estimated Residual Life (yrs.) 2014
Masonry Sea Wall	10	V Poor	Poor	Poor	0
Concrete Sea Wall, Masonry Sea Wall Interface	3	Good	Fair	Fair	10
Concrete Sea Wall (Main Face)	160	Poor	Poor	Fair	10
Parapet Wall	160	Fair	V Poor	Fair	10
Concrete Sea Wall, Natural Cliff Interface	10	Poor	Poor	Poor	0

Comparison of this assessment with previous studies indicates that the condition of the wall has not significantly deteriorated. This assessment suggests an improvement in the condition of the main face of the concrete sea wall when compared to the 2011 and 2012 studies. The last detailed inspection (Royal Haskoning, 2011) considered the main face to be in Poor condition, this was largely due to extensive rust staining indicating corrosion of the reinforcement. However, this does not yet appear to be affecting the structural condition of the sea wall as there are no obvious signs of movement of deformation. The grade assigned is based on a visual inspection following the Environment Agency Condition Assessment Manual (2006). The Condition Assessment Manual defines poor condition as "*Defects that would significantly reduce the performance of the asset*" (EA, 2006). From a visual inspection this does not appear to be the case.

In addition to this, as discussed in Section 3.4, it is believed that the main structural component of the wall is the mass concrete which suggests that the structural impact of corrosion to the panels and columns may be low.

The rock anchors and encapsulated in the mass concrete so their inspection was impractical at the time of Mott MacDonald's survey. Therefore, the estimated residual life in Table 5.1 does not

account for the condition of the rock anchors and the current assessment relies on the absence of signs of deformation over the last 40 years to assess the underlying structural condition.

6 References

Conditions Assessment Manual, Environment Agency 2006

Technical report – FCRM assets: deterioration modelling and WLC analysis, Environment Agency, 2013,

Condition Assessment of Robin Hood's Bay Sea Wall, Concrete Repairs Ltd, 2007

Robin Hood's Bay Asset Inspection, Royal Haskoning, 2011

Walk-over Visual Inspections of Assets including Coastal Slopes, CH2M HILL, 2013