



Cell 1 Regional Coastal Monitoring Programme Update Report 4: 'Partial Measures' Survey 2012



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Scarborough Council Final Report

February 2013

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition	
AONB	Area of Outstanding Natural Beauty	
DGM	Digital Ground Model	
HAT	Highest Astronomical Tide	
LAT	Lowest Astronomical Tide	
MHWN	Mean High Water Neap	
MHWS	Mean High Water Spring	
MLWS	Mean Low Water Neap	
MLWS	Mean Low Water Spring	
m	metres	
ODN	Ordnance Datum Newlyn	

Water Levels Used in Interpretation of Changes

	Water Level (m AOD)			
Water Level Parameter	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20
	Water Level (m	AOD)		
Water Level Parameter	Saltwick Nab to Hundale Point	Hundale Point to White Nab	White Nab to Filey Brigg	Filey Brigg to Flamborough Head
1 in 200 year	3.88	3.93	3.93	4.04
HAT	3.10	3.05	3.05	3.10
MHWS	2.60	2.45	2.45	2.50
MLWS	-2.20	-2.35	-2.35	-2.30

Source: *River Tyne to Flamborough Head Shoreline Management Plan 2*. Royal Haskoning, February 2007.

Glossary of Terms

Term	Definition
Beach	Artificial process of replenishing a beach with material from another
nourishment	source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal	The reduction in habitat area which can arise if the natural landward
squeeze	migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1).

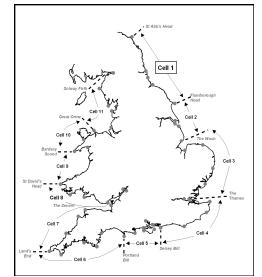


Figure 1 Sediment Cells in England and Wales

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

The beach profile surveys, topographic surveys and cliff top recession surveys are undertaken as a 'Full Measures' survey in autumn/early winter every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

To date the following reports have been produced:

Table 1	Analytical, Update and Overview Reports Produced to Date
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Year		Full Measures		Partial Measures		Cell 1
		Survey	Analytical Report	Survey	Update Report	Overview Report
1	2008/09	Sept-Dec 08	May 09	Mar-May 09	June 2009	-
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Feb 13 (*)	

^(*) The present report is **Update Report 4** and provides an analysis of the 2012 Partial Measures survey for Scarborough Council's frontage.

1. Introduction

1.1 Study Area

Scarborough Council's frontage extends from Staithes Harbour in the north, to Speeton in Filey Bay in the south. For the purposes of this report, it has been sub-divided into eight areas, namely:

- Staithes¹
- Runswick Bay
- Sandsend Beach, Upgang Beach and Whitby Sands
- Robin Hood's Bay
- Scarborough North Bay
- Scarborough South Bay
- Cayton Bay
- Filey Bay

1.2 Methodology

Along Scarborough Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 20 transect lines
 - o Topographic survey at Runswick Bay
 - Topographic survey along the Sandsend to Whitby frontage
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Scarborough North Bay
 - Topographic survey at Scarborough South Bay
 - Topographic survey at Cayton Bay
 - Topographic survey at Filey Bay
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 20 transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Filey Bay (Town coverage)
- Cliff top survey bi-annually at:
 - Staithes
 - Robin Hoods Bay (new addition Spring 2010)
 - Scarborough South Bay (new addition Spring 2010)
 - Cayton Bay
 - \circ Filey

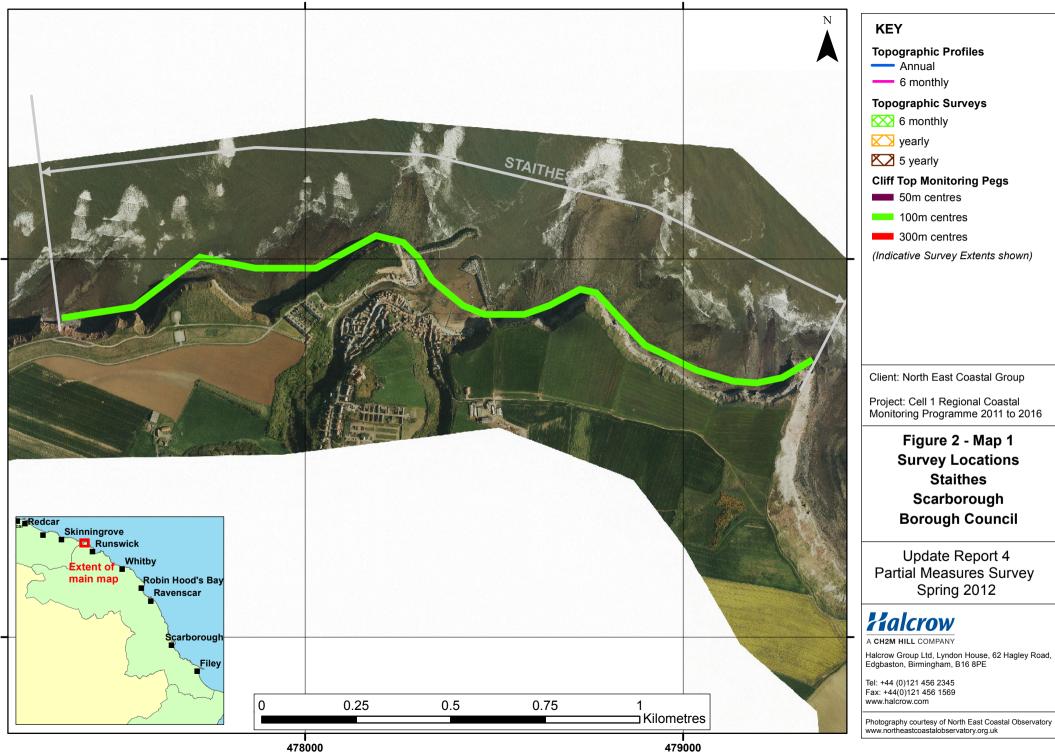
The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 22nd and 29th March 2012. During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

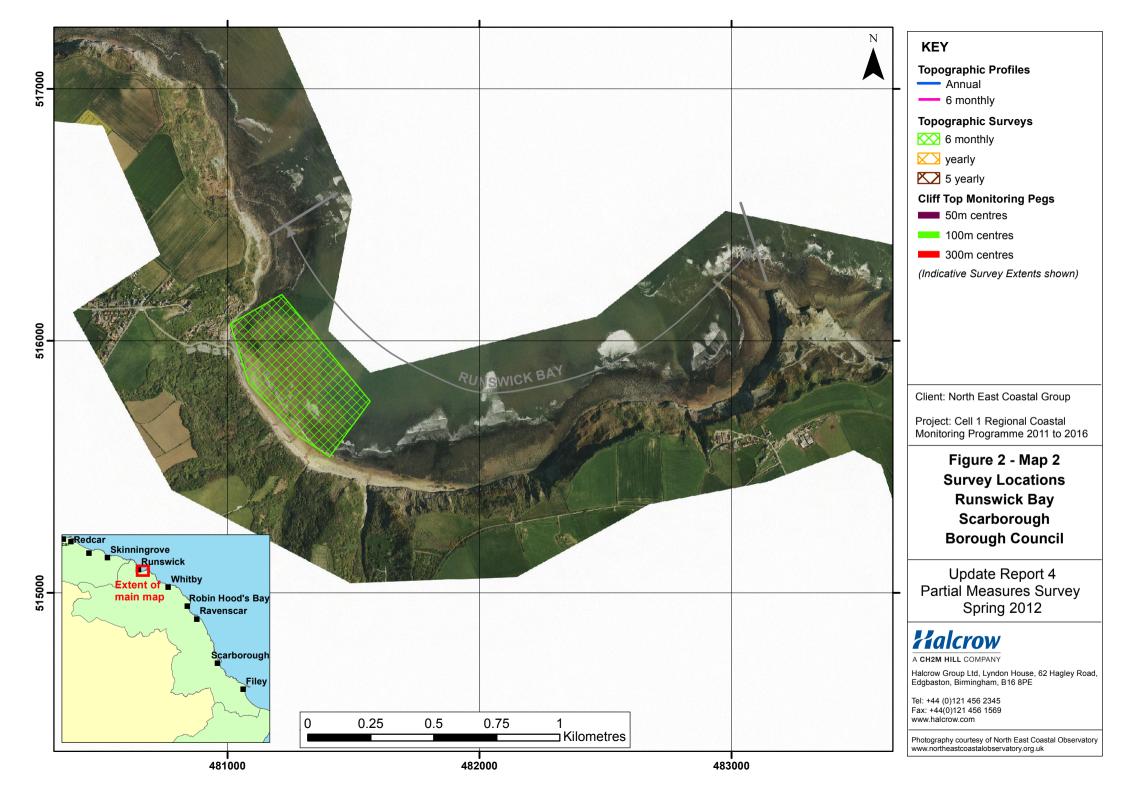
The Update Report presents the following:

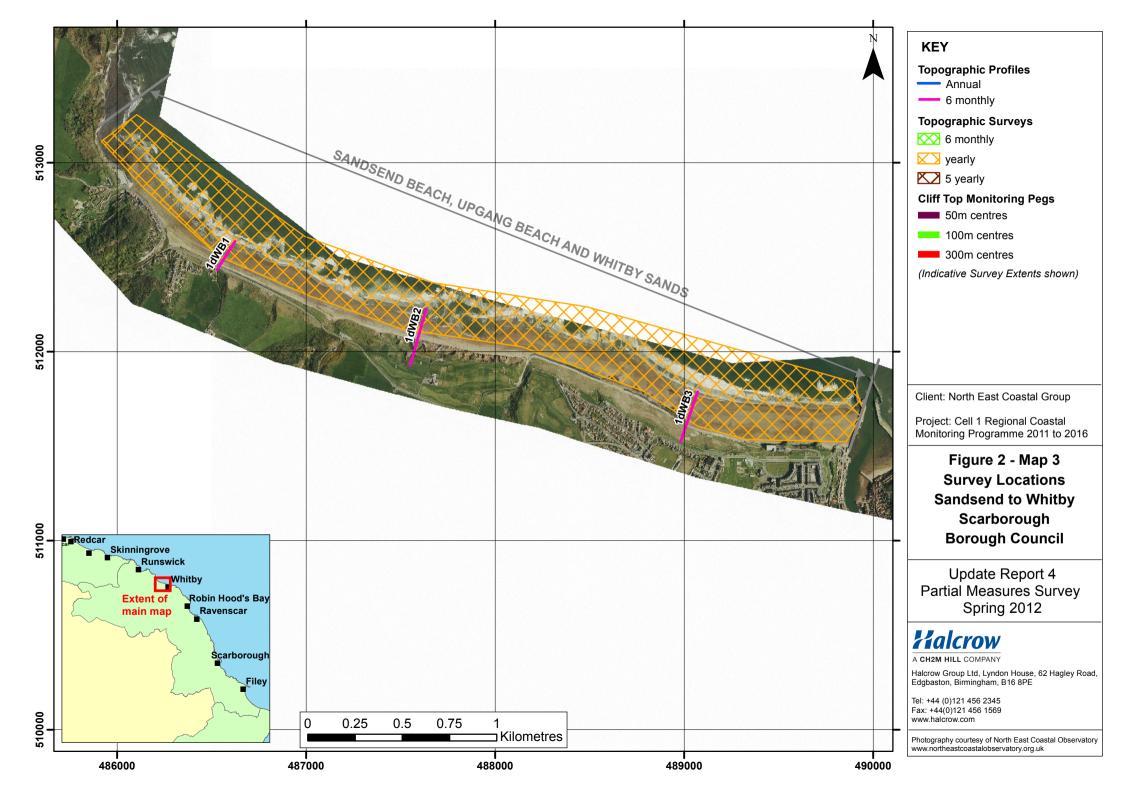
- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

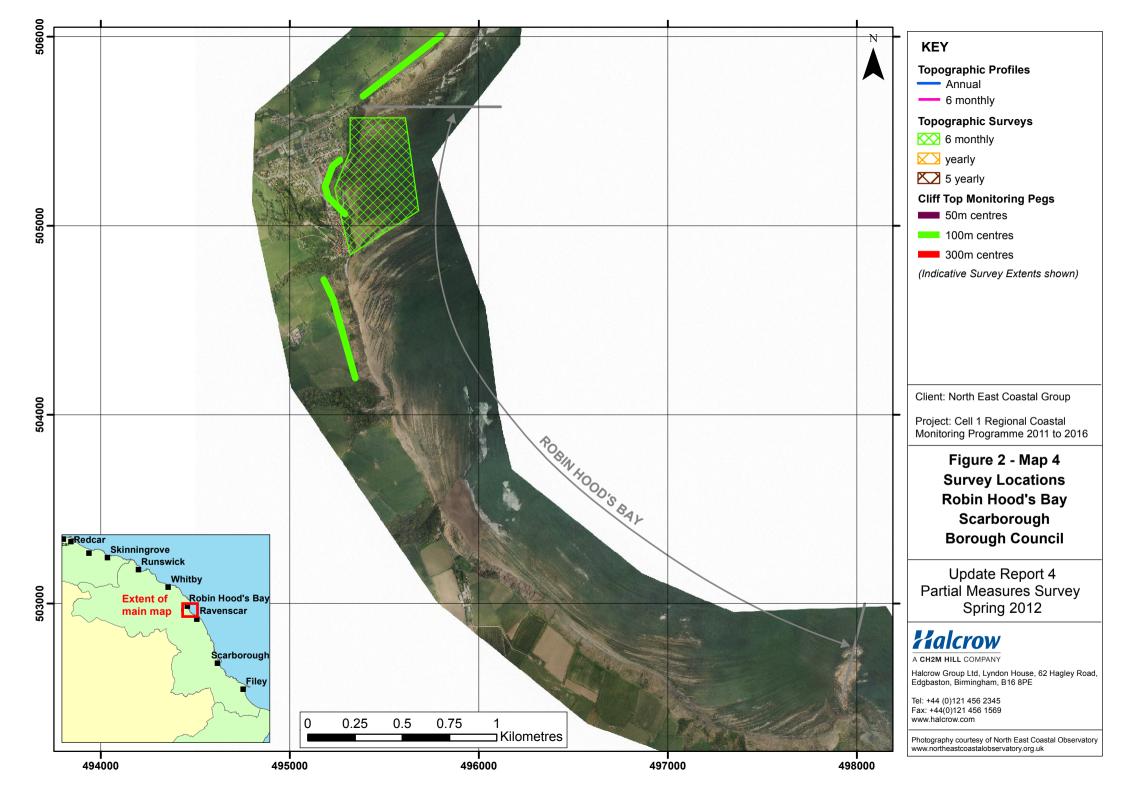
Data from the present survey are presented in a processed form in the Appendices.

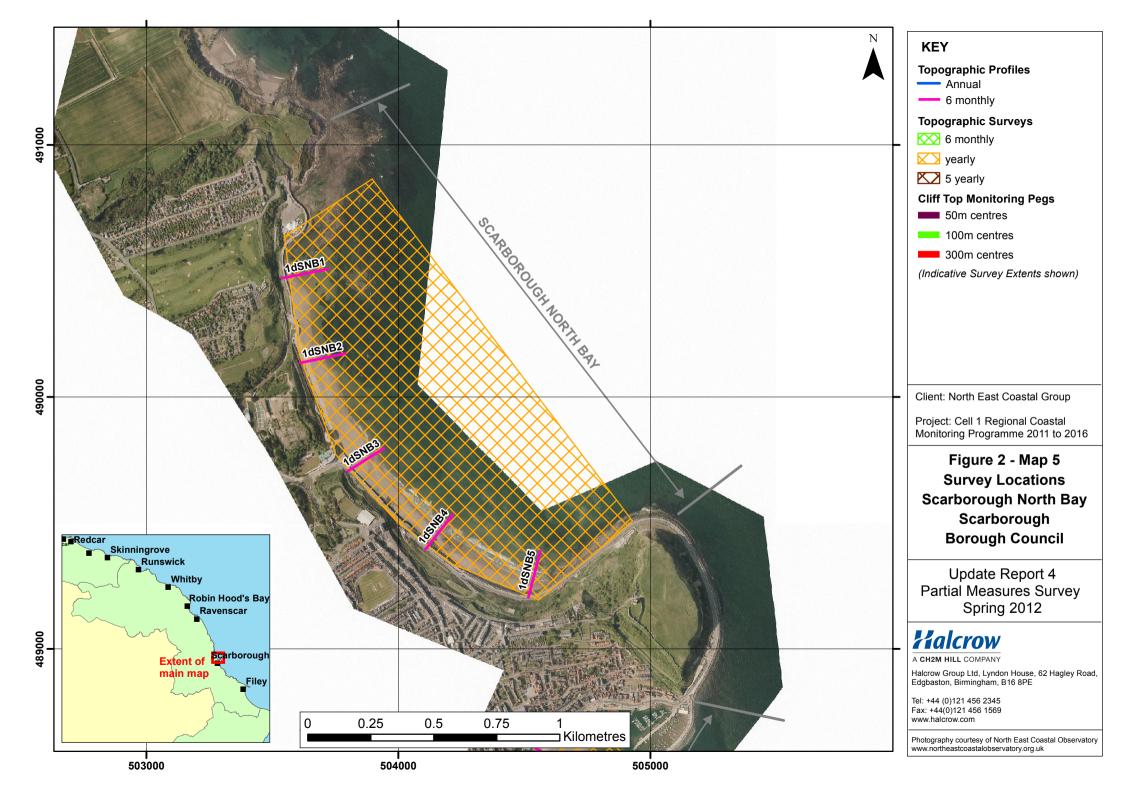
¹ The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland & Scarborough Borough Councils.

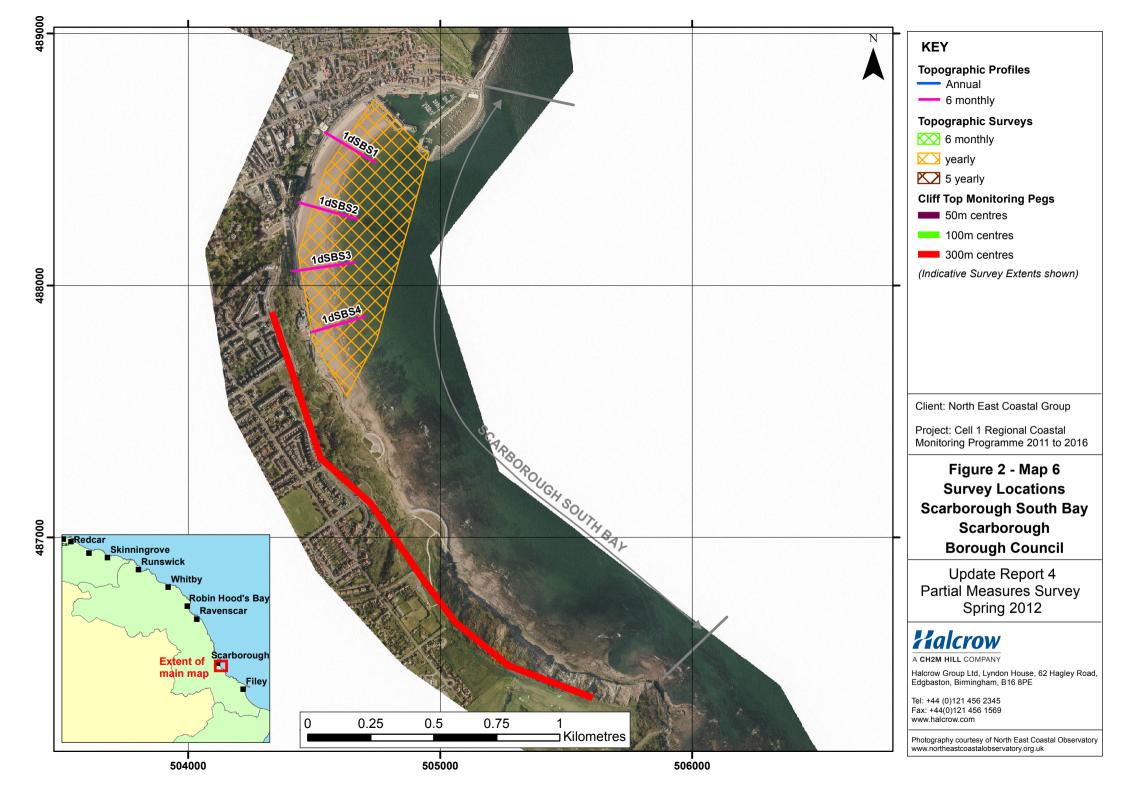


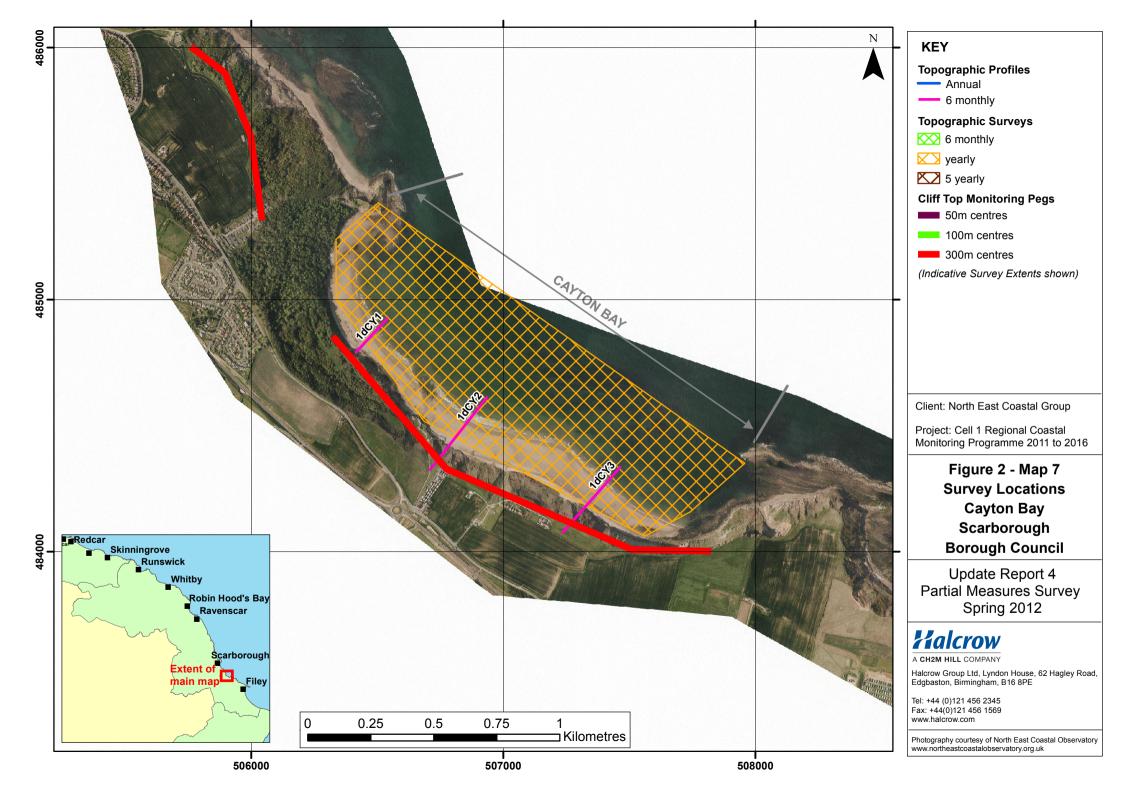


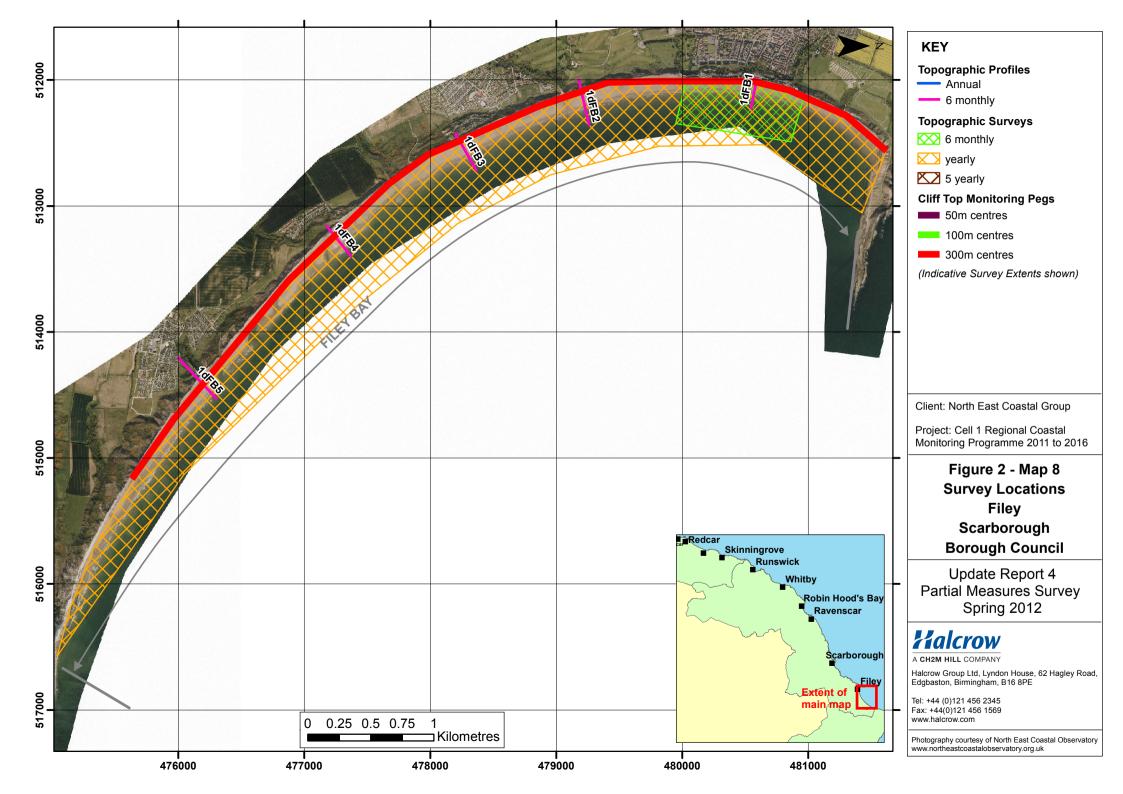












2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
March 2012	 Cliff-top Survey: Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is a nominal 100 m. The cliff top surveys at Staithes are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the March 2012 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous September 2010 survey. The results provided in Appendix C show that 18 of the 20 control points showed change of ±0.1m, which is within the likely error of measurement. The four remaining control points all show advance of the cliff line, which suggests errors in identification of the cliff edge has occurred. The long-term data, covering the period 2008 to present, are also hard to interpret. Most monitoring points show rates of change within the range of expected error, some show advance of the cliff of up to 0.4m/yr, which is presumably an error in the identification of the cliff edge, and others show a small erosion rate. Point 13 shows the highest rate of erosion of 0.7m/yr. The widespread occurrence of erroneous data make any meaningful interpretation of these data difficult. 	The recorded change between October 2011 and March 2012 are very small. Longer term trends: Table C1 in Appendix C presents the erosion rate calculated from the data collected from 2008. The table shows that only three of the 20 control points indicate cliff erosion. Nine of the 20 control points have a rate of change close to zero. The remaining eight control points show growth, which is thought to relate to error in the definition of the cliff top.

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
23 rd March 2012	Topographic Survey: Data from the most recent topographic survey (partial measures, spring 2012) have been used to create a digital ground model (DGM) (Appendix B – Map 1a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last produced topographic survey (full measures, winter 2011) and the present survey, to identify areas of net erosion and accretion. Appendix B - Map 1b shows two predominant areas of erosion and accretion in Runswick Bay. Close to the shore and in the north of the bay there has been erosion. Overall around 0.25m in level has been lost from the beach but there has been erosion of up to 1m in some places. Lower down the beach and in the southern half of the bay there has been deposition between Autumn 2011 and Spring 2012. Most of the beach had accreted by over 0.5m and the largest gains were around 1m in the south of the bay. There was very little change in the centre of the bay, where a rocky shore platform is present.	The majority of the bay has accreted over the winter with the erosion being limited to the shoreline in the north of the Bay Longer term trends: The trend of accretion in the south of the bay continued. There was also a repeat of the erosion observed in the previous year in front of the rock armour defence in the north of the bay.

Survey Date	Description of Changes Since Last Survey	Interpretation
29 th March 2012	 Beach Profiles: The Sandsend, Upgang and Whitby frontage is covered by three beach profile lines for the Partial Measures survey (Appendix A). The profiles were last surveyed in September 2011. Profile 1dWB1 is located around 400m south of Sandsend village. Over the winter the beach has become much steeper, with a net transfer of sediment towards the back of the beach. Profile 1dWB2 is located in the centre of Upgang beach. The part of the profile above 4m OD has changed very little. Around the level of HAT the level of the beach has eroded by 0.5m. The berm which had been present in the last survey has been eroded by March 2012. There is now a steep mid-beach at this location, although the middle of this profile was not accessible due to soft mud and a deep fissure. The rest of the beach has eroded by around 0.25m. Profile 1dWB3 is located on Whitby Sands and showed no significant changes above MHWS. The beach has steepened between since the last survey. The beach at the toe of the defence appears to have accreted by 0.5m over the winter. However, the remainder of the beach has eroded by up to 0.25m in two places as the summer berms have been eroded from the profile. 	All three of the beaches have steepened, to a varying degree, over the winter months. This is likely to be due to the erosion of the foreshore, which, when coupled with strong long period swell waves that act to throw material up the beach during storms, leads to deposition at the back of the beach. Longer term trends: At WB1 the beach has steepened but the March 2012 profile is closer to the norm for this frontage. Only the 2011 profiles show a flat beach, the rest since 2008 are steep. There is no evidence of progressive erosion of the beach. When compared to the past profiles both WB2 and WB3 show the beach level in March 2012 was close to the centre of the spread of previous results.

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

2.4 Robin Hoods Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
22 nd March 2012	Topographic Survey: Data from the most recent topographic survey (partial measures, spring 2012) have been used to create a digital ground model (DGM) (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 2b) from the last topographic survey (full measures, winter 2011) and the present survey. There have been minimal changes on the beach at Robin Hoods Bay between September 2011 and March 2012. The pattern of change is spatially variable and majority of change recorded is within a range of ±0.25m. The greatest erosion recorded was just north of Robin Hoods Bay village where 0.75m of lowering was recorded. Adjacent to the patch of erosion was an area of accretion where up to 1.5m of material was deposited.	Little change was recorded over the winter of 2011/12. The extensive wave cut platform at this location is likely to be the reason for the small recorded changes. Longer term trends: The present survey results confirm the pattern of little change in the bay overall with the largest changes being close to the shore. The localised significant changes are probably related to sand bar migration with no net change in the volume of sediment stored on the beach.
March 2012	 Cliff-top Survey: Thirteen ground control points have been established at Robin Hood's Bay (since 3rd March 2010) to monitor the cliff top The separation between any two points is around 200m. The cliff top surveys at Robin Hood's Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the March 2012 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 2) and changes in position since the last survey in September 2011 and the baseline survey in March 2010. Taking into account the survey accuracy of +/-0.1m, seven of the thirteen markers show no change in cliff top position since the last survey in September 2011. Of the other six markers, three show cliff recession. Markers 5 and 10 show recession of 1.1m while one shows less significant recession of 0.2m (Marker 1). The remaining three markers show cliff top advance (Markers 4, 8 and 11), which is assumed to be error in recognition of the clifftop. 	There appears to have been two significant changes in cliff position, with Markers 5 and 10 both showing recession of 1.1m over the winter of 2011/12. Longer term trends: The erosion rates calculated from the observed changes since March 2010 show a low erosion rate for most of the cliff points. Two of the markers have significant recession rates; markers 1 and 5 have rates of 1.6m/yr and 0.7m/yr respectively. The data has not been collected over a long time span and as a result there is not a high confidence in the recession rates. More data collected over future years will help to clarify cliff behaviour at Robin Hoods Bay.

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
27 th March	Beach Profiles:	At Profile SBN1 the March 2012 profile is similar to the profiles recorded previously showing stability overall.
2012	Scarborough North Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A). Profile 1dSBN1 is located around 200m south of the Sea Life Centre. The beach profile has changed very little since September 2011. Throughout the whole profile the changes recorded over the winter are within a range of ±0.1m. At the lowest extent of the profile close to MLWS there was the largest recorded change, which was 0.2m of accretion.	At profile SBN2 the beach level was close to the average. Profile SBN3 the upper and lower beach was relatively high while the med- beach had been eroded. At SBN4 the level of the upper beach is high and the lower beach has dropped.
	Profile 1dSBN2 is located close to the former chair lift and the profile has show erosion overall. Between HAT and MHWS the beach has eroded by 0.6m, the remainder of the upper beach has eroded by around 0.4m. Between 60 and 70m chainage there was negligible change, while from 70m chainage onwards there was slight accretion. Overall the profile flattened.	Profile at SBN5 has an upper beach which is low compared to the previous profiles. The rest of the beach is relatively high. The beach overall has flattened.
	Profile 1dSBN3 is located near Royal Albert Drive. Overall the profile has been subject to accretion. The upper beach, close to the sea wall has accumulated around 1m of material. A section of the central beach has eroded by 0.2m while the remainder of the beach has accreted by 0.2m. The beach has changed shape with an accumulation of sediment against the defence and on the lower beach.	The pattern of change shown by the March 2012 is spatially variable, with some profiles flattening and others steeping.
	Profile 1dSBN4 is located at the northern end of Clarence Gardens. The upper beach (between 25m and 50m chainage) has accreted by 0.1m between September 2011 and March 2012. From 50m chainage down to the extent of the survey the level of the beach has dropped. In the March 2012 survey the jagged parts of the survey at around 50m reappear, the beach has lowered by around 0.25m.	Longer term trends: The fluctuation of beach levels continues. There is no evidence for progressive recession or accretion.
	Profile 1dSBN4 is located on the southern side of Clarence Gardens from the start of the survey to 0.2m OD the profile has changed very little. Below 0.2m chainage the beach has accreted by 0.2m from September 2011 to March 2012.	

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
27 th March	Beach Profiles:	SBS1 and SBS2 have steepened due to the accumulation of material on the top of the beach and
2012	Scarborough South Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A).	erosion at the bottom of the beach.
	Profile 1dSBS1 is located around 250m south of the West Pier. The upper part of the beach from has accreted by around 0.15m from 10m to 80m chainage. From 80m chainage to 120m chainage a berm which had been present in September 2011 had eroded by March 2012. The remainder of the March 2012 profile the beach has accreted by up to 0.2m.	SBS3 has a profile in the mid-range of recorded levels and a typical gradient. At SBS4 the March 2012 survey has the highest profile recorded although the gradient of the beach is typical.
	Profile 1dSBS2 is located on the shore in front of St Nicolas cliff. From 5m chainage to 35m chainage the beach has accreted by up to 0.4m. Further down the beach between 85m and 175m chainage the beach has eroded by 0.2m over the winter of 2011/12.	Additional profiles were carried out before and after some beach profiling works in April and May 2012. The analysis of the profiles will be provided in the Full
	Profile 1dSBS3 is located 250m north of the Scarborough Spa complex. The profile has changed very little down to MHWS. Below that level the beach has flattened. The upper beach from 10m to 60m chainage has eroded by 0.2m. From 60m chainage to 130m chainage the centre of the beach has changed very little. From 130m chainage a small mound has appeared which means accretion of around 0.2m.	Measures 2012 Report, which will describe the changes observed during the summer of 2012. Longer term trends: The observed changes in South Bay are consistent with the seasonal fluctuations of addiment with a here contained which had
	Profile 1dSBS4 is located on the beach in front of the Scarborough Spa Complex. The profile has remained stable overall with the largest change being 0.2m of accretion at around 10m chainage. From 80m to 180m chainage the beach has accreted by around 0.1m	sediment with a bay system. The material which had been moved northwards by natural processes is likely to have been altered subsequently by beach management.
March 2012	Cliff-top Survey: Thirteen ground cliff top monitoring control points have been established at Scarborough South Bay and	The recession rates show that there has been little recession along this frontage. Nine of the thirteen survey points have a recession rate of around
	in Cornelian Bay and Knipe Point at Cayton Bay. The separation between points is around 300m. The cliff top surveys at Scarborough South Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing.	± 0.1 m/yr. The four markers with significant recession rates of between 0.1m/year and 0.2m/year are Markers 3.6.11 and 12.
	Appendix C provides results from the March 2010 baseline survey through to the most recent March 2012 survey, showing the distance from the ground control point to the edge of the cliff top along the	Longer term trends: Eight of the thirteen points have a recession rate of 0m. Three have a rate of 0.1m and

Survey Date	Description of Changes Since Last Survey	Interpretation
	defined bearing (Appendix C- Map 3). The recoded changes between February 2011 and March 2012 show that of the 13 survey points, seven show no change in cliff top position outside of the +/-0.1m error bands. Five of the points show advance of the cliff, which is likely to be a result of errors in the method. The remaining point is the only marker where significant erosion (0.3m) was recorded.	two have a rate of 0.2m. The cliff recession data has been collected over a short time span, as a result there is a low confidence in the rates which have been calculated. The rate of recession on this coast will be clarified with a longer duration of data collection. There are concerns about the accuracy of the method, the appearance of positive recession readings shows that there are large errors in the data set. The errors will become less significant in a longer-term dataset.

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Date 28 th March 2012	 Beach Profiles: Cayton Bay is covered by three beach profile lines for the Partial Measures survey (Appendix A). Profile 1dCY1 is located on the beach in front of Tenants' Cliff in the north of the Bay. There is low confidence in accuracy of the upper profile at this location due to the dense vegetation encountered by the surveyor. At 20m chainage there is a large mound on the profile which could be due to accretion, vegetation or debris being washed onto the beach. From 25m to 65m chainage there has been little change in the beach. From 65m to 100m chainage the beach has accreted by 0.5m. The rest of the profile shows minimal change. Profile 1dCY2 is close to the former pumping station in the middle of Cayton Bay. The middle of the cliff part of the section was not surveyed due to the ground makeup, soft mud flows, unstable grass and landslips. Between HAT and MHWS the beach has accreted by 0.5m. The rest of the beach has eroded by 0.5m over the winter of 2011/12. 	There is a small accretion of sediment at the base of the cliff on each one of the Cayton Bay profiles. The material which is being moved on the beach is likely to be derived from cliff erosion and landslides. Longer term trends: The part of the profiles which represent the beach show seasonal variation. Each of the profile plots illustrate that the beach level and gradient were well within the previous range of results. Profile CY2 and CY3 appear to show progressive recession of the cliff, which is to be expected on an undefended section of coast.
	Profile 1dCY3 is located around 600m SE of the pumping station. The middle of the cliff section could not be surveyed due to unstable ground. Between the base of the cliff at 120m chainage to 200m chainage there has been little change over the winter. From 205m chainage to 240m chainage the beach has accreted by 0.75m. For the remainder of the profile the September 2011 and March 2012 profiles are similar.	
	The middle of sections 2 and 3 could not be measured due to the ground conditions, which included soft ground and landslips.	
March 2012	Cliff-top Survey: Eight ground control points have been established within Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is typically around 300m. The cliff top surveys at Cayton Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the March 2012 survey showing the distance from the ground control	There has been very little change over the winter of 2011/12 and as a result the recession rates have not changed a great deal. Longer term trends: The recession rates show that overall the cliff top has changed very little during the last four years. There are areas where the cliff has eroded, Markers 1, and 2 have recession rates of

Survey Date	Description of Changes Since Last Survey	Interpretation
	point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous September 2011 survey. Considering the survey accuracy of +/-0.1m, two of the eight marker points shows no change between the baseline survey and the most recent March 2012 survey. Four marker points have exhibited an advance in cliff top position by between 0.3m and 1.3m and two points have shown a recession of the cliff top by 0.5m and 5m.	0.2m/yr and 1.5m/yr respectively. The results from Markers 1 and 2 show a lot of variation along 300m of coast, which is likely to be due to the short time span that data is collected over. If data continues to be collected for a much longer time it is likely the recession rates will be more similar throughout the bay and that there will be more confidence in the calculated rate if it is based on a longer data set.

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
28 th March	Beach Profiles:	All of the profiles show that there is a mound of material on the upper beach, which has either been
March 2012	 Beach Profiles: Filey Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A). Profile 1dFB1 is located in front of Filey town in the north of the bay. From 15m chainage (around the level of MHWS) to 80m chainage the beach has accreted by 0.2m between September 2011 and March 2012. The middle of the beach has remained stable over the winter. Between 120m and 200m chainage the beach has eroded by 0.2m. Profile 1dFB2 is located on the shore, just north of Primrose Valley Holiday Village. The changes in the profile are similar to FB1. Just below MHWS the beach has accreted by 0.5m The profile from 90m onwards is reasonably stable with little recorded change between September 2011 and March 2012. Profile 1dFB3 is located in front of Flat Cliffs .Between 40m (around the HAT level) and 70m chainage the beach has accreted a mound of material 0.1m high. From 70m to 140m chainage the beach has eroded by 0.25m. From 140m to 170m chainage the beach has accreted by 0.1m. From 170m to 250m chainage the beach has eroded by 0.2m. Profile 1dFB4 is located near Humanby Gap. The profile shows very little change down to the HAT level. From 40m to 155m chainage the beach has eroded by 0.5m. Between 60m and 240m chainage there was a 0.5m high mound of material present in March 2012 where the beach had been flat in September 2011. Profile 1dFB5 is located close to Reighton Gap. Above HAT there is very little recorded change. From 225m (near the intersection of the beach and HAT) to 240m chainage a 0.2m high mound of material 	
	has accreted on the beach. From 240m to 340m the beach has eroded by 0.3m. Further down the beach there was very little change in the beach profile over the winter of 2011/12.	

Survey Date	Description of Changes Since Last Survey	Interpretation
28 th March	Topographic Survey:	Very little change was observed over the winter of 2011/12
2012	Data from the most recent topographic survey (partial measures, spring 2012) have been used to create a digital ground model (DGM) (Appendix B – Map 3a) using a Geographical Information System (GIS). The topographic plot shows the shore parallel bathymetry in front of Filey town. A difference plot has also been produced using the DGM (Appendix B – Map 3b) comparing the last topographic survey (full measures, winter 2011) to the present survey. The difference plot shows that there was slight accretion close to the shore and slight erosion further down the beach. The majority of these changes were within the error of the analysis which is ±0.1m. The largest change is in the north, close to Cobble Landing where the beach had accreted by up to 0.75m between Autumn 2011 and Spring 2012.	Longer term trends: The beach level in front of Filey Seawall does not appear to change much over a six monthly period. When the difference plots going back to 2009 are reviewed it is apparent that the largest changes tend to be close to the shoreline, but that there is little change overall.
March 2012	 Cliff-top Survey: Twenty-three ground control points were established within Filey Bay for the purposes of cliff top monitoring in November 2008. Additional points were added in September 2010 and March 2011 (as shown in Appendix C – Maps 5a and 5b) taking the total number of ground control points within Filey Bay to twenty-eight. The maximum separation between any two points is nominally 300m. The cliff top surveys at Filey Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the March 2012 survey showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous September 2010 survey. Between the last survey in September 2011 and the current survey twenty of the twenty-eight ground control markers in Filey Bay showed recession within the ±0.1m of error in the method. Two of the points showed advance of the cliff, which suggests there are errors in the data set. The remaining six markers showed recession of between 0.2m/yr and 0.6m/yr over the winter of 2011/12. 	Over the winter of 2011/12 the marker points show stability overall, with the majority of change observed in the centre of the bay. Longer term trends: The average annual recorded rate of change tends to be low for the majority of the frontage. Markers 5, 7 and 14 have recession rates of 1.7m, 0.5m and 0.2m respectively. The recession rates will become clearer as the more data is collected on the erosion rates.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

At Whitby the middle of section WB2 was not accessible due to soft mud and a deep fissure.

At Cayton the top of section FB1 can not be measured due to dense vegetation. The middle of sections FB2 and FB3 can not be measured due to the ground conditions of soft mud and landslips.

Cliff Top Surveys

The aim of cliff monitoring data is to gain a reliable record of the frequency and magnitude of cliff top failures. Data are collected every six months, but previous surveys have had a low accuracy, meaning that survey error is typically greater than any measured short term change. It is possible that a more reliable pattern of change will be determined over the longer term. However, in the short term, more reliable assessments of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey will be completed in late 2012 and a second repeat survey is planned for 2014. These data will be analysed to give more accurate information on the behaviour of the cliffs.

4. Recommendations for 'Fine-tuning' the Monitoring Programme

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Staithes the cliff-top survey shows that there have been no large losses from the cliff line over the winter of 2011/12. The cliff is likely to continue to erode and could potentially pose a hazard, but there are no causes for concern related to the data collected.
- At Runswick Bay the topographic survey shows that the bay has accreted overall over the winter with the erosion being concentrated in close to the shore in the north of the Bay. As a result there are no causes for concern.
- At Sandsend Beach, Upgang Beach and Whitby Sands the beach profiles show that the beach has steepened over the winter months, which is to be expected. The beach profiles present no cause for concern.
- At Robin Hoods Bay the topographic survey shows little change in the beach level. The cliff survey points show that there have been two significant changes in cliff position, both showing recession of 1.1m. However, at this location there are no immediate causes for concern.
- At Scarborough North Bay the beach profiles show that the fluctuation of the beach at each of the profiles continues. There is no cause for concern at North Bay.
- At Scarborough South Bay the observed changes in Beach Profiles are consistent with the seasonal fluctuations of sediment with the bay system. The material which had been moved northwards by natural processes is likely to have been altered subsequently by beach management. There has been little change in beach position. There is no cause for concern based on the beach profiles and cliff-top survey results.
- At Cayton Bay There is a small accretion of sediment at the base of the cliff on each one of the Cayton Bay profiles. The material which is being moved on the beach is likely to be material which is eroded from the cliff. Although the cliff survey data shows that there have been no large failures affecting the cliff top. The beach profile and cliff-top survey provide no cause for concern.
- At Filey Bay the beach profiles show an accumulation of material on the upper beach, whereas the topographic survey shows little change. The cliff-top survey data shows that over the winter of 2011/12 the marker points present a picture of overall stability, with the

majority of change observed in the centre of the bay. The data collected present no causes for concern.

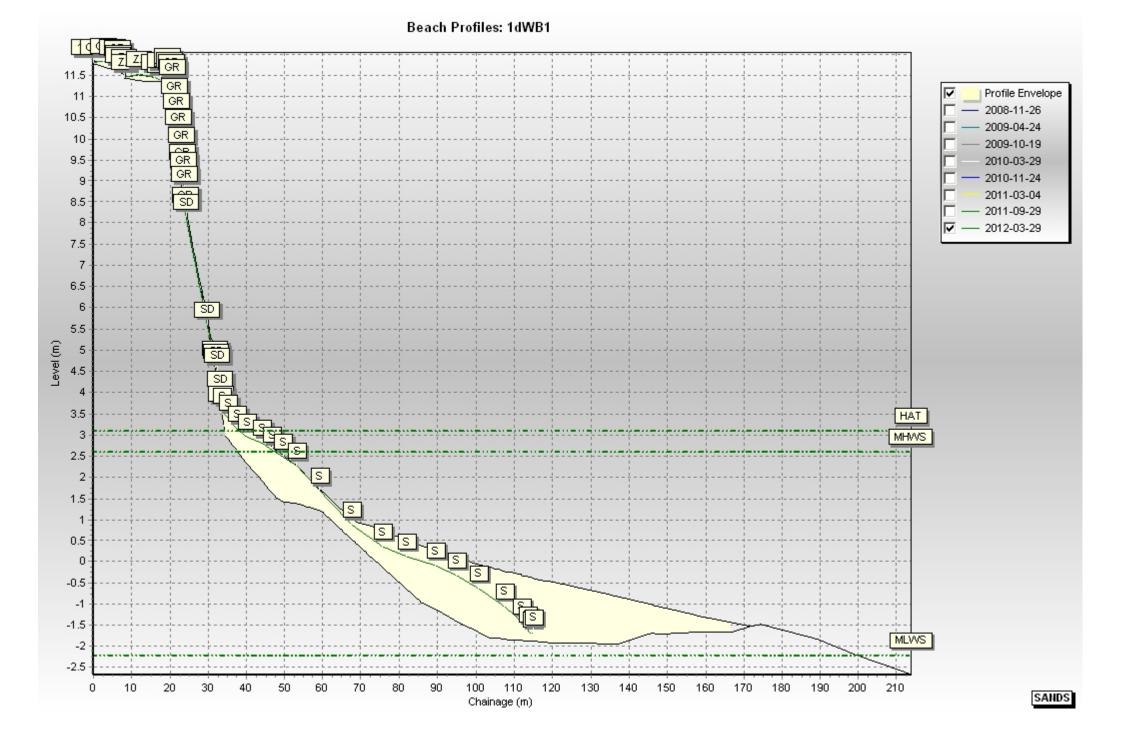
Appendices

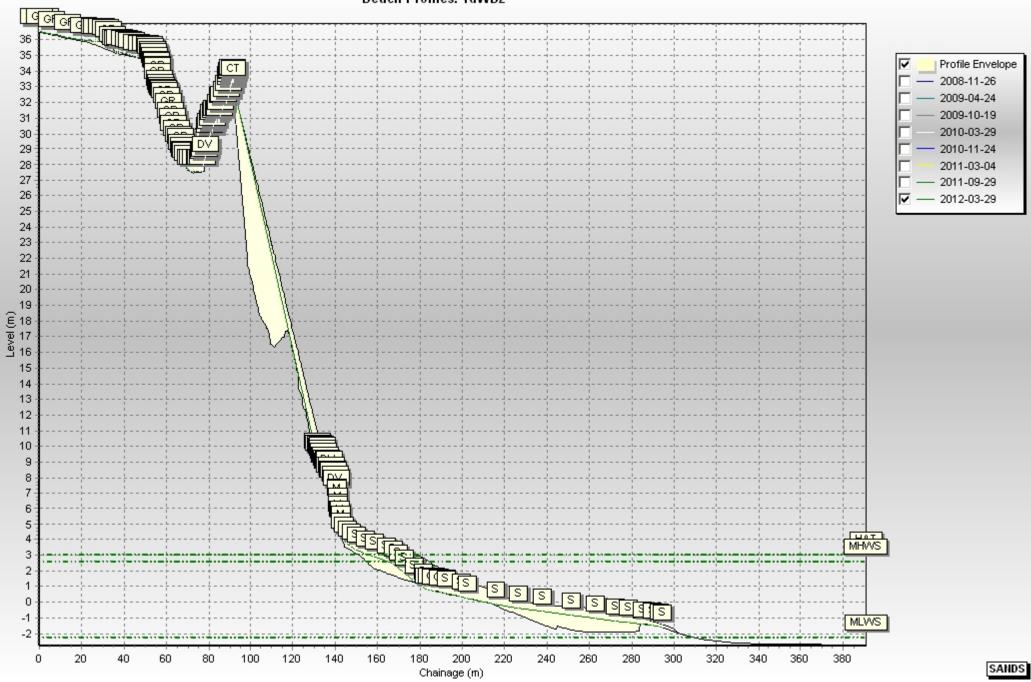
Appendix A

Beach Profiles

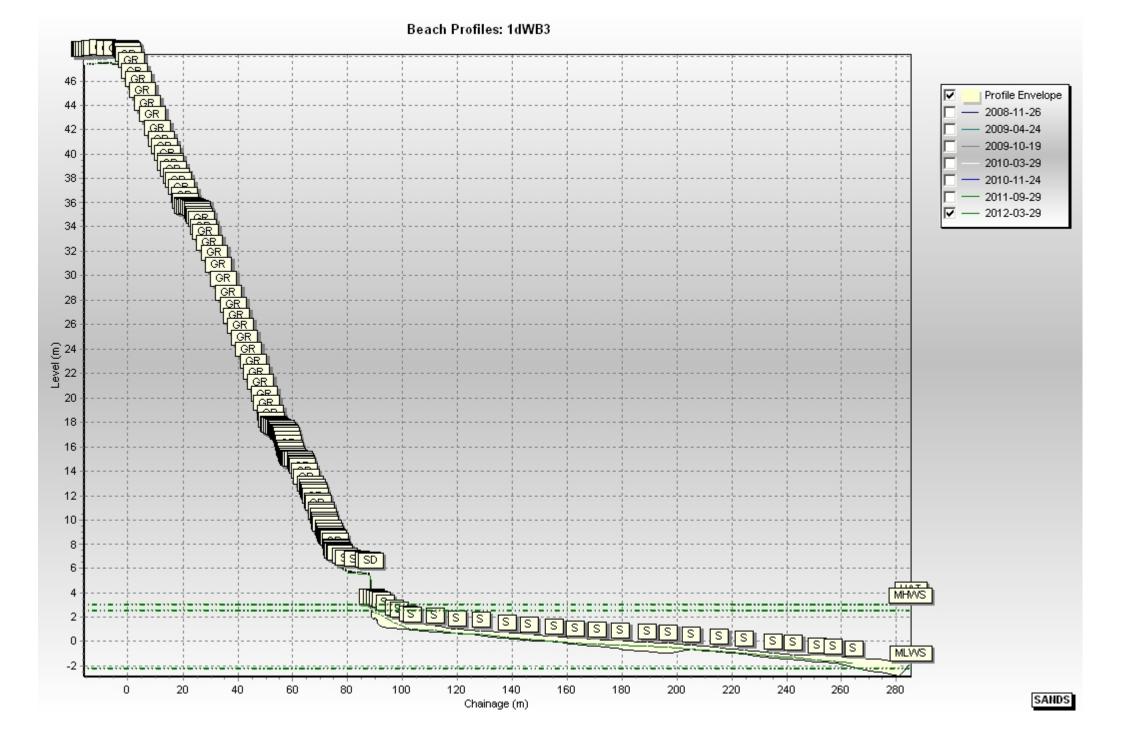
Code	Description
S	Sand
М	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
В	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
Х	Mixture
FB	Obstruction
СТ	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown

The following sediment feature codes are used on some profile plots:

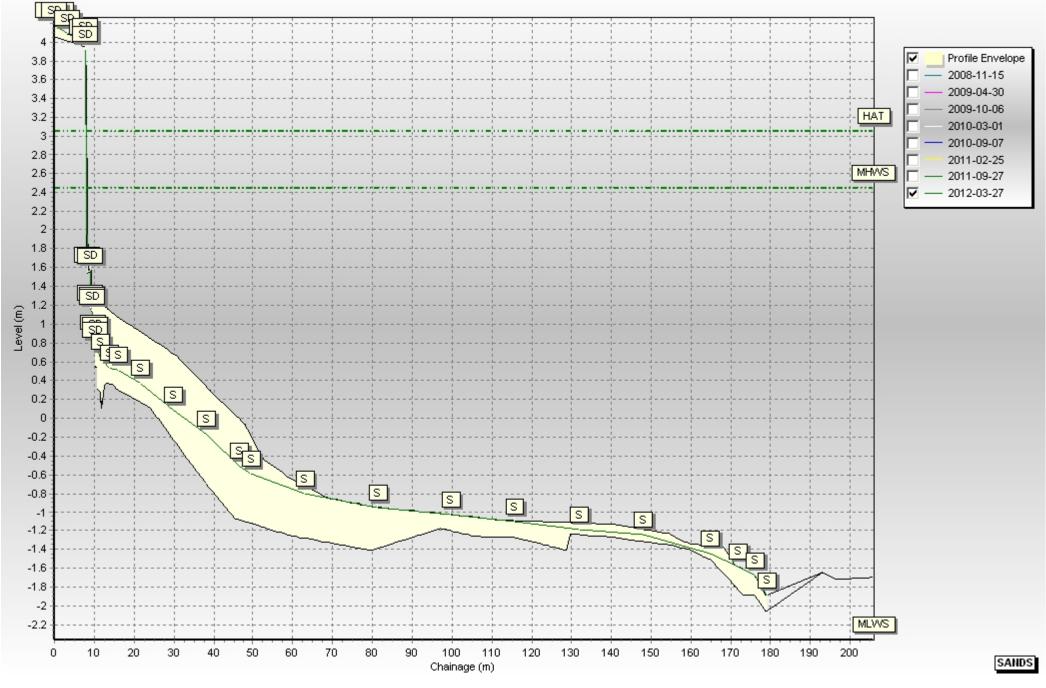




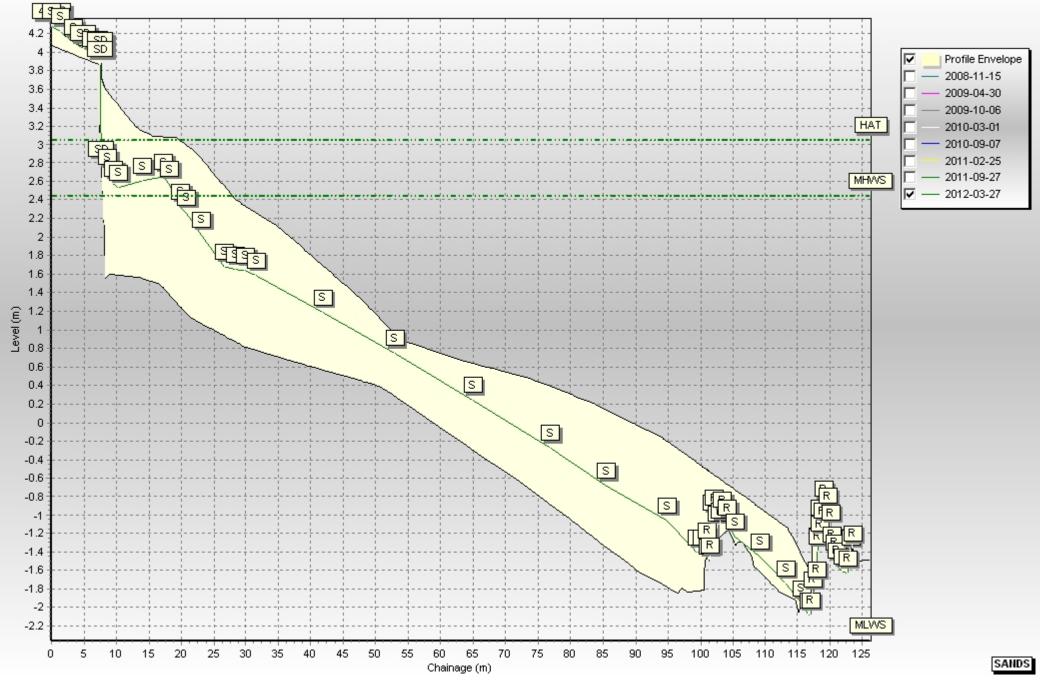
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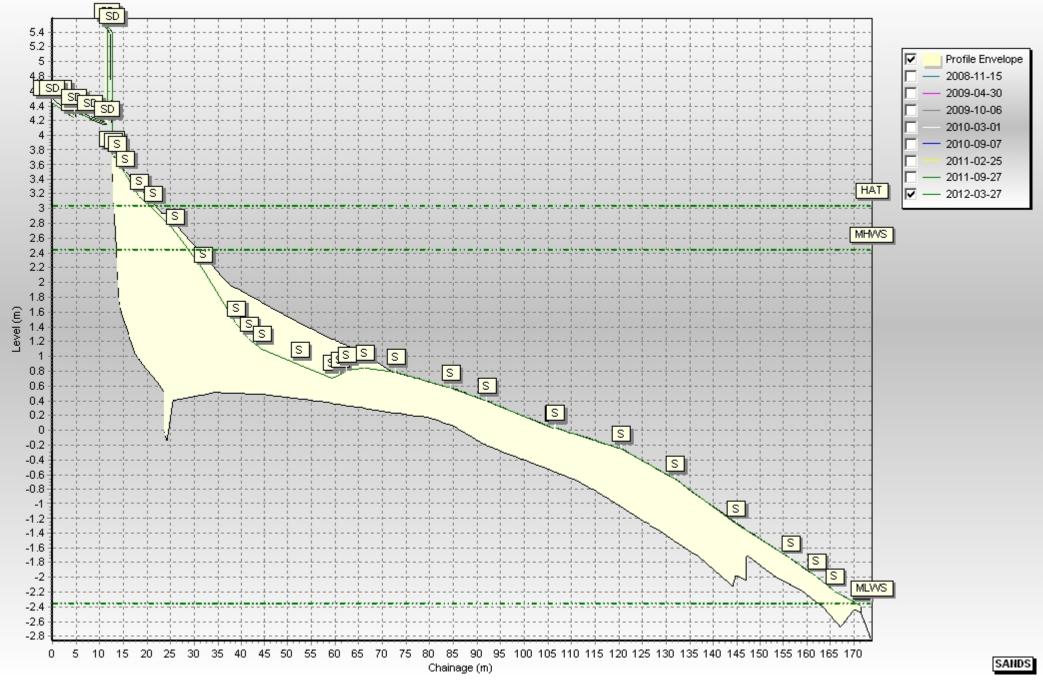


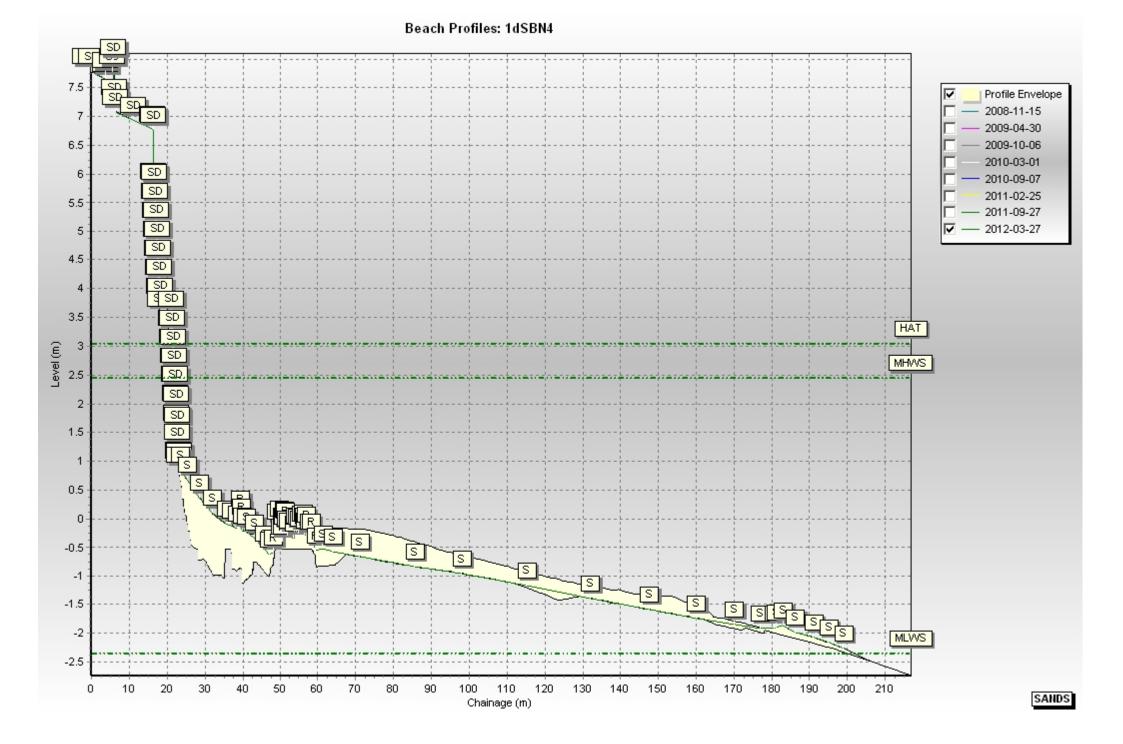
Beach Profiles: 1dSBN1

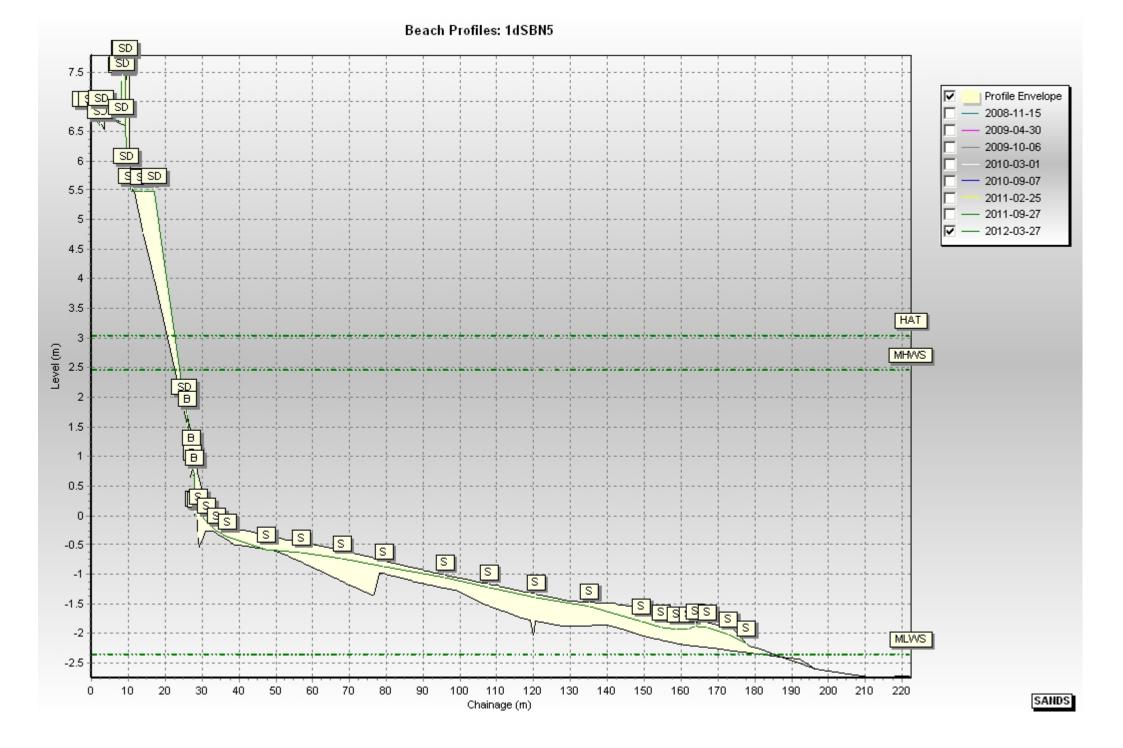


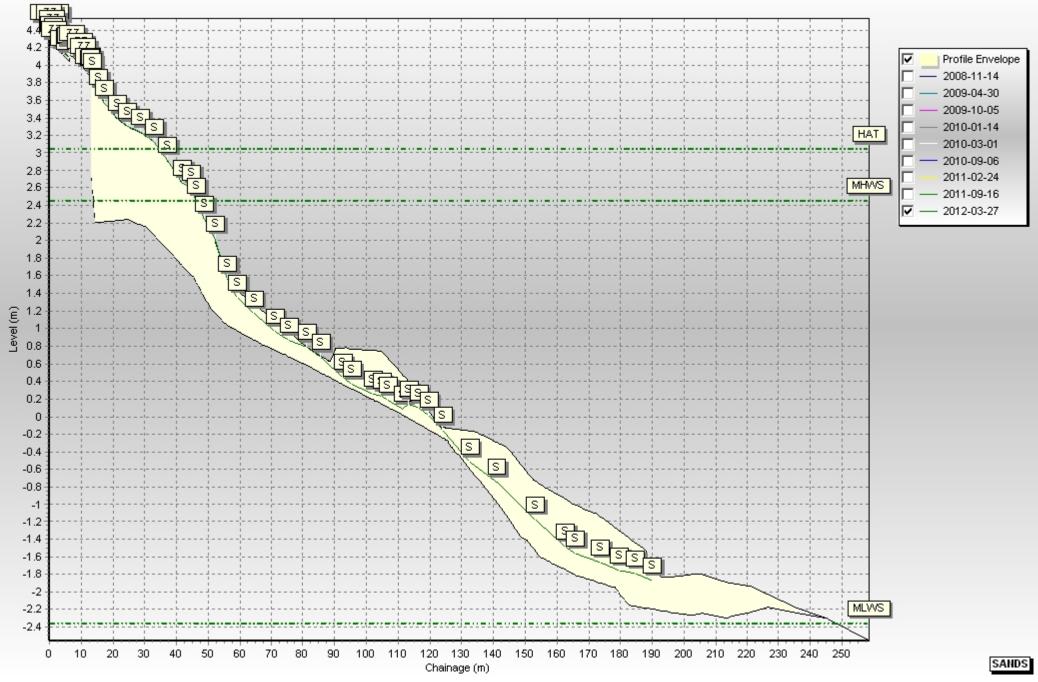
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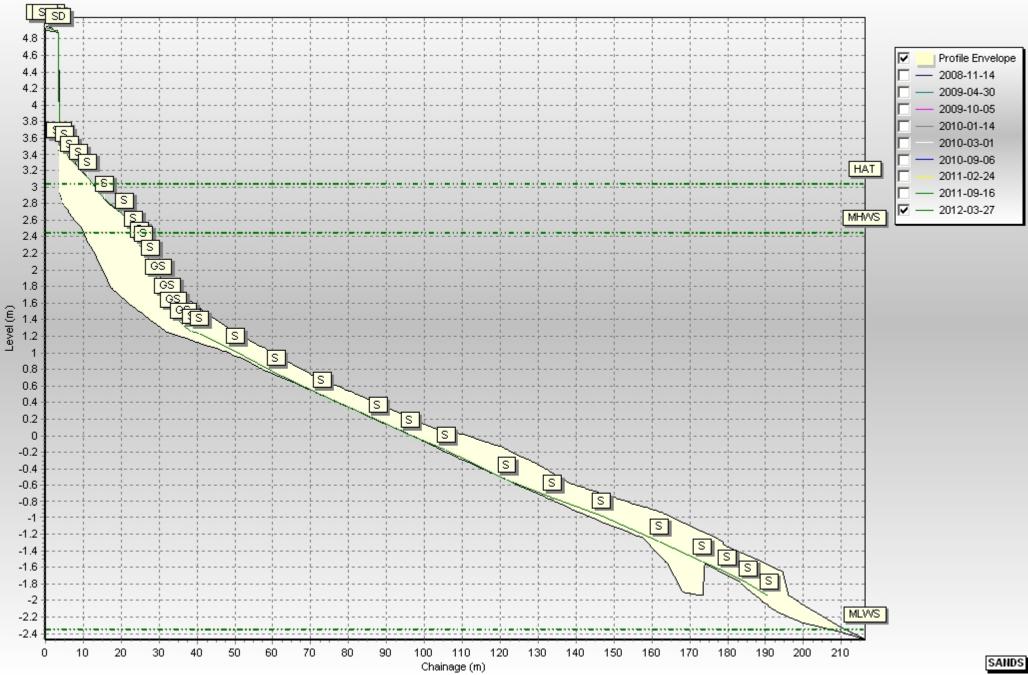


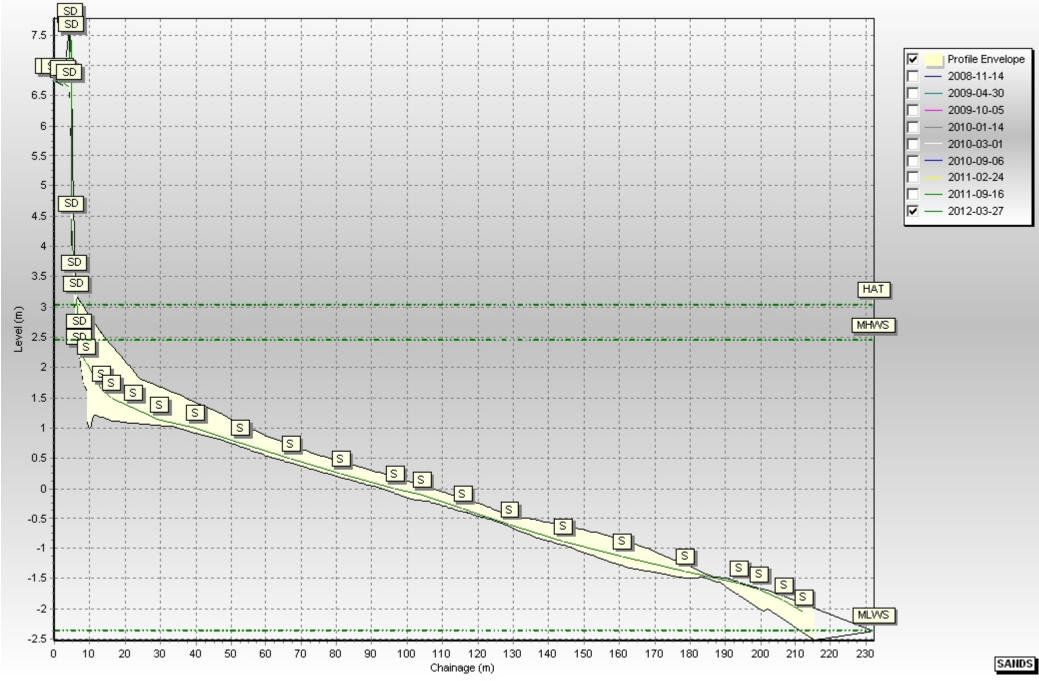


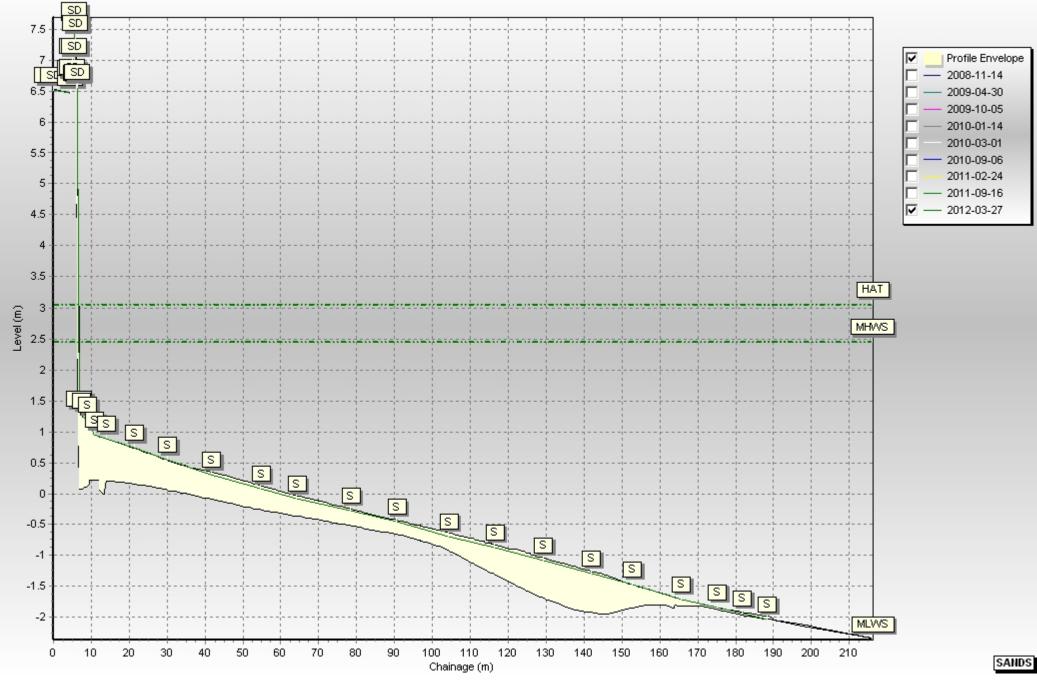




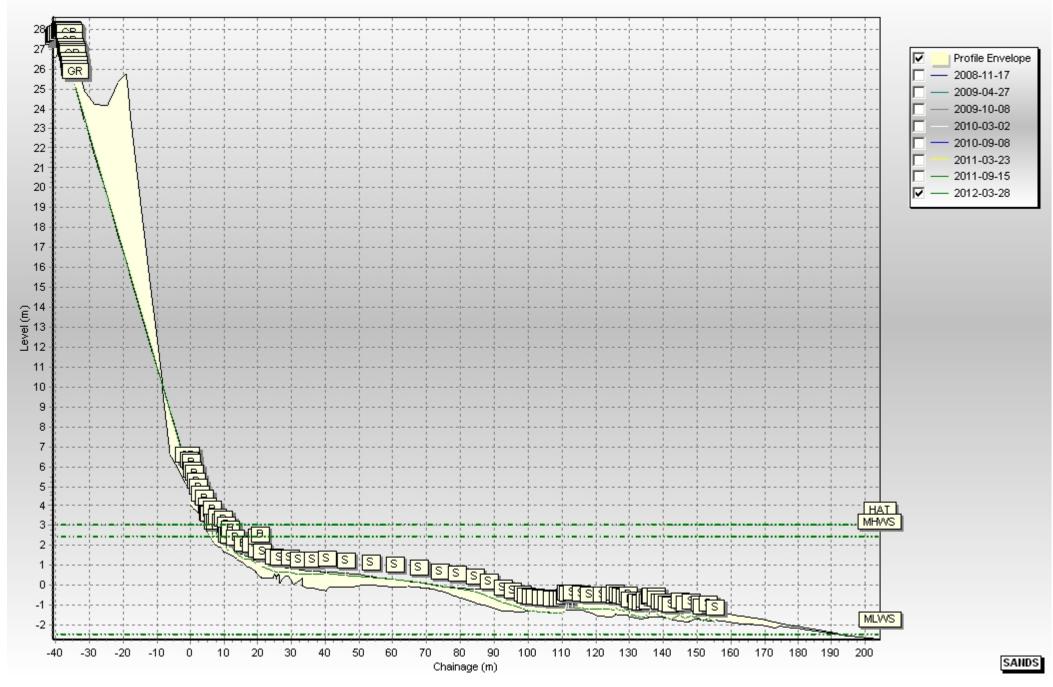




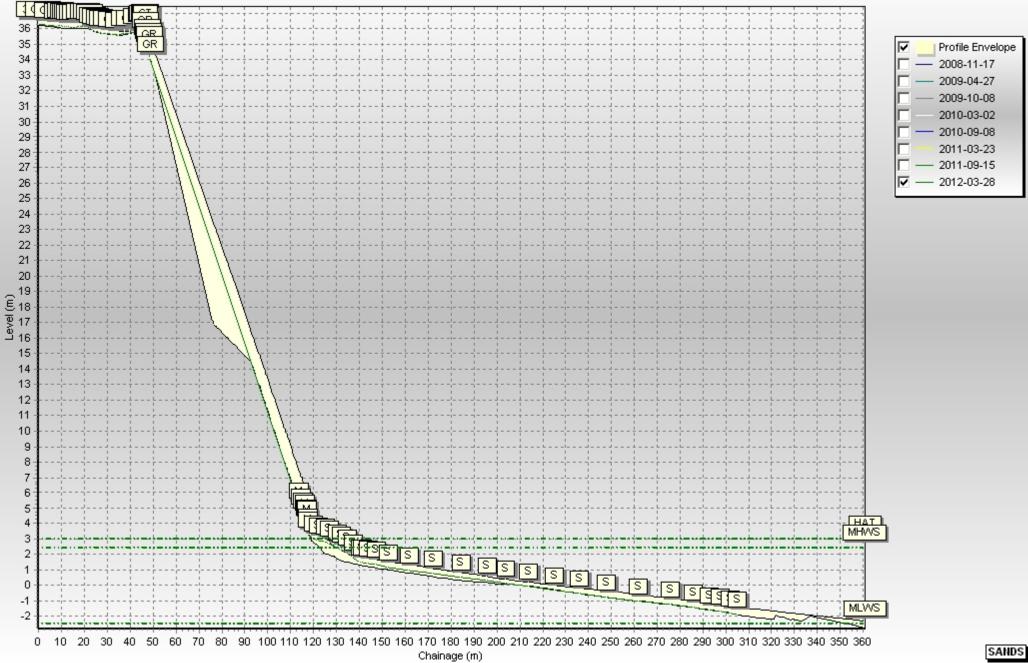




Beach Profiles: 1dCY1



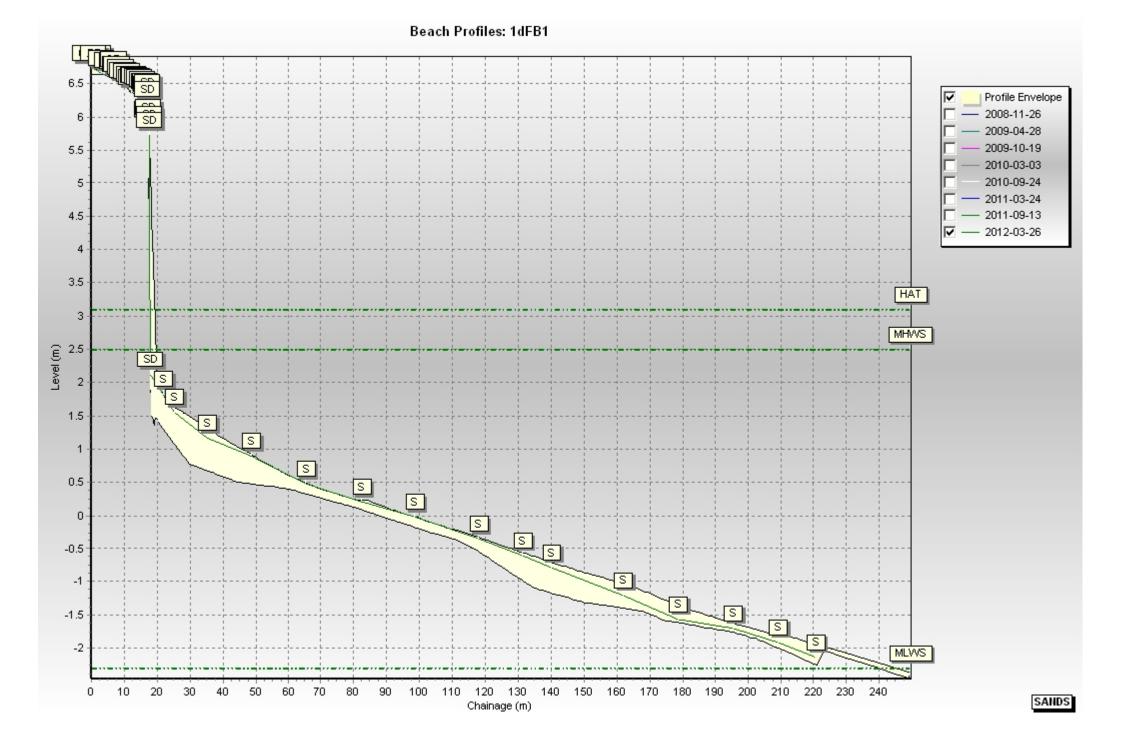
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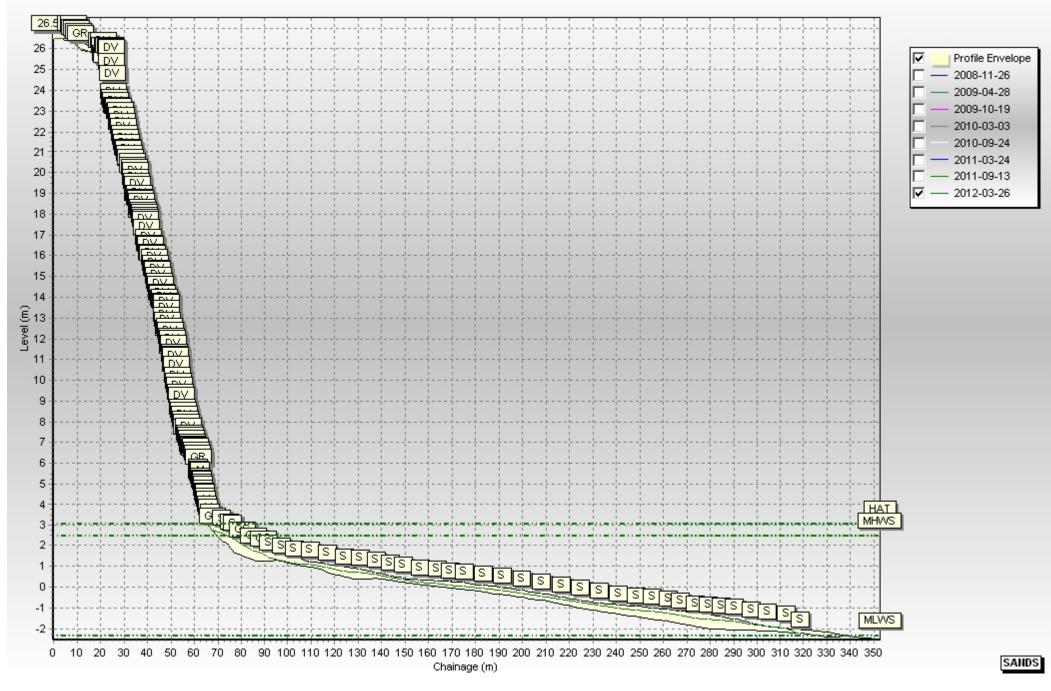


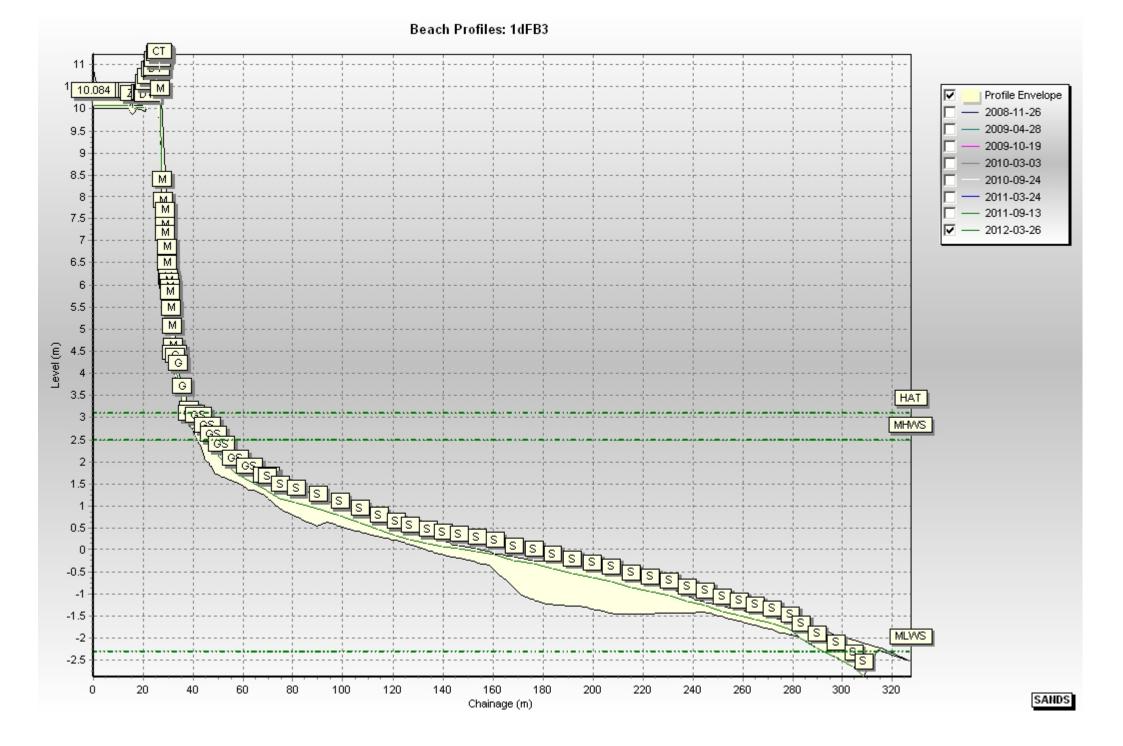
M Profile Envelope - 2008-11-17 2009-04-27 2009-10-08 2010-03-02 - 2010-09-08 2011-03-23 - 2011-09-15 ---- 2012-03-28 (E) 24 [evel 22 M MHWS MLWS -2 Chainage (m)

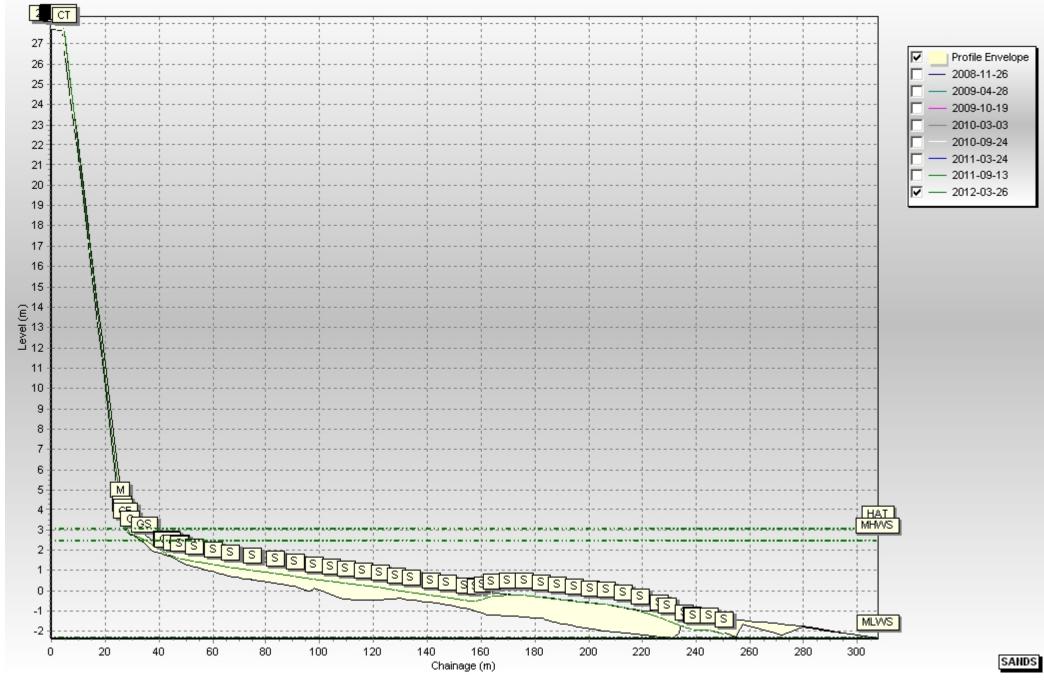
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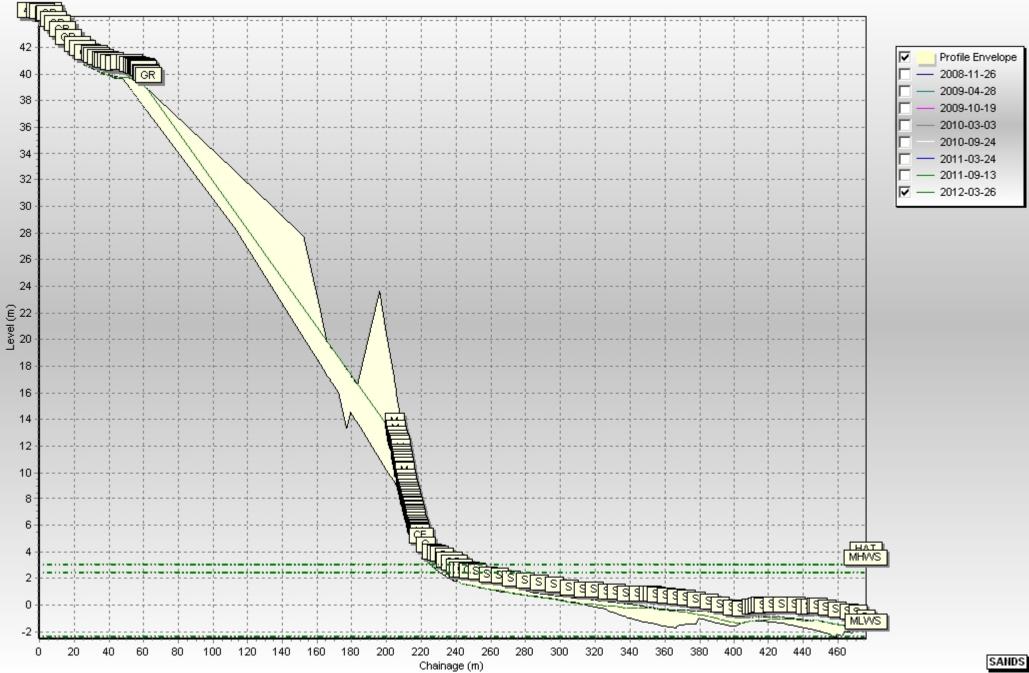
SANDS





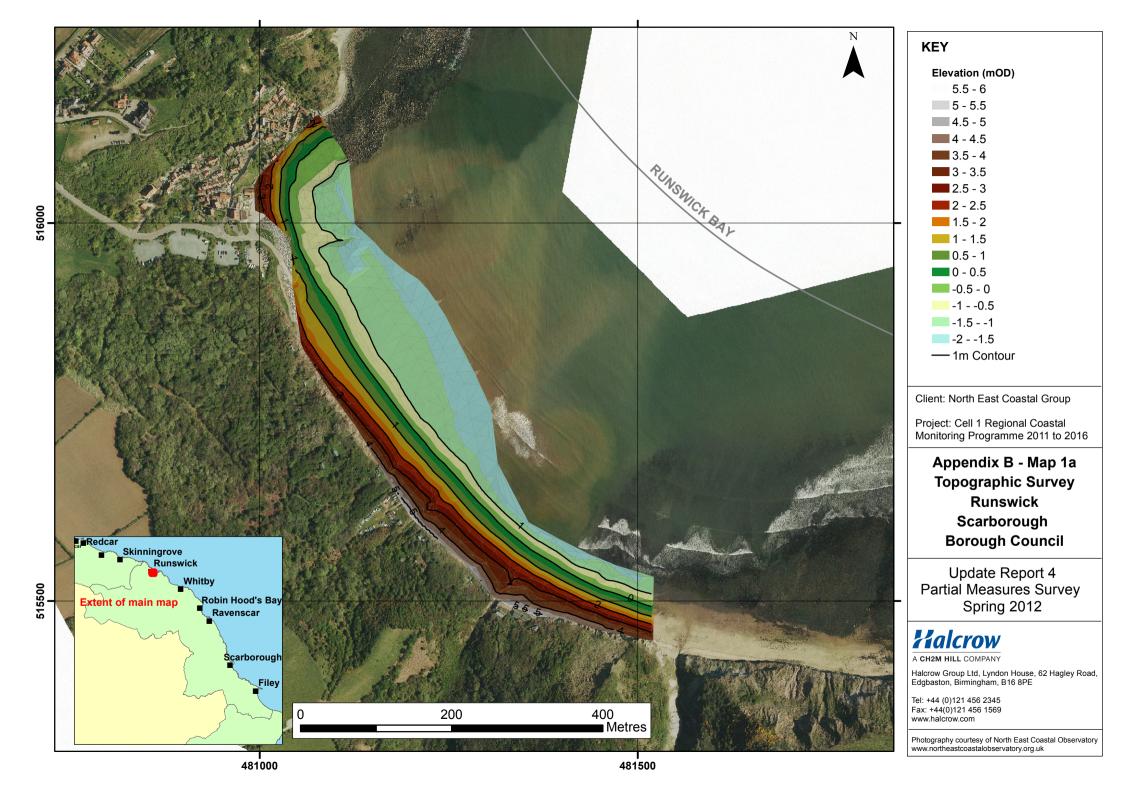


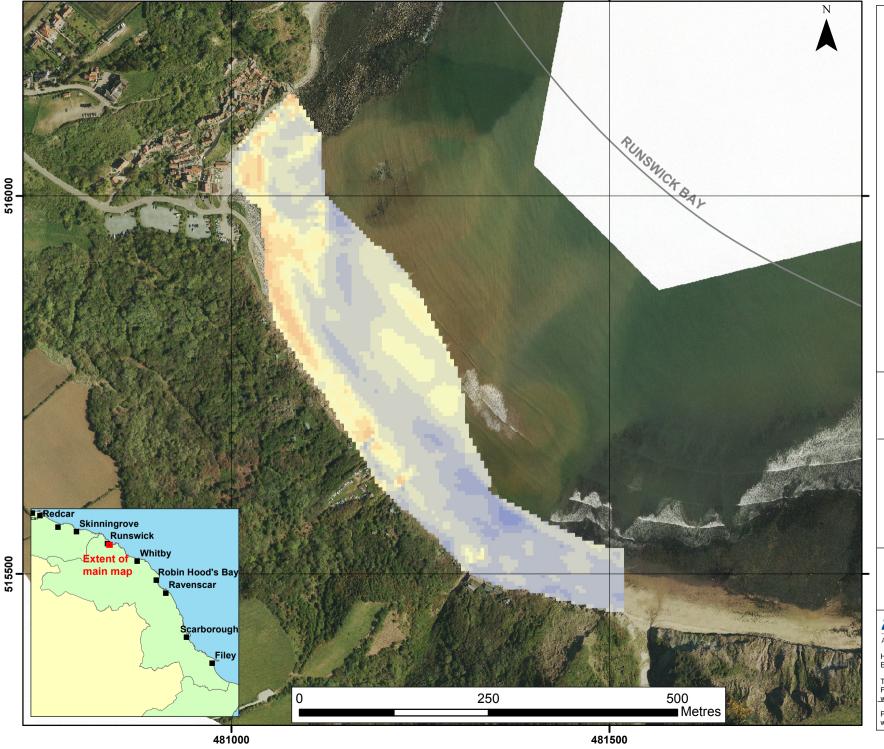


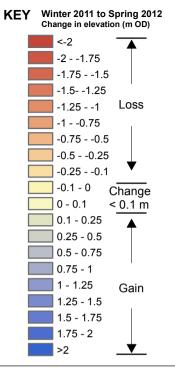


Appendix B

Topographic Survey







Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1b **Topographic Difference** Runswick Scarborough **Borough Council**

Update Report 4 Partial Measures Survey Spring 2012

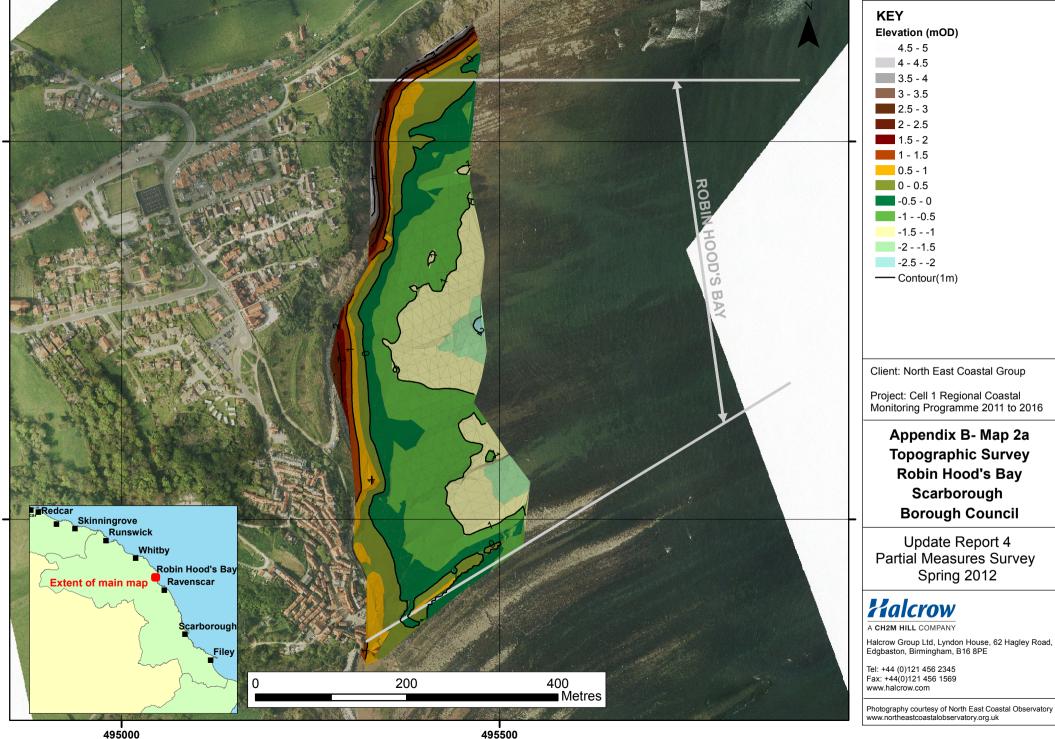
Kalcrow

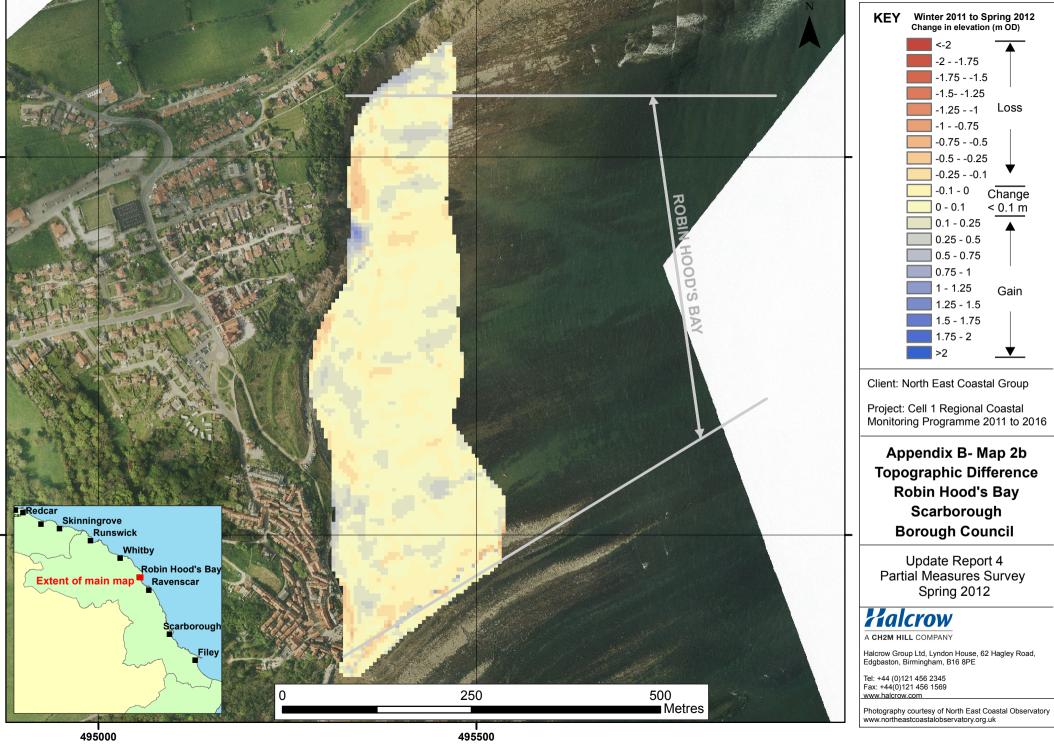
A CH2M HILL COMPANY

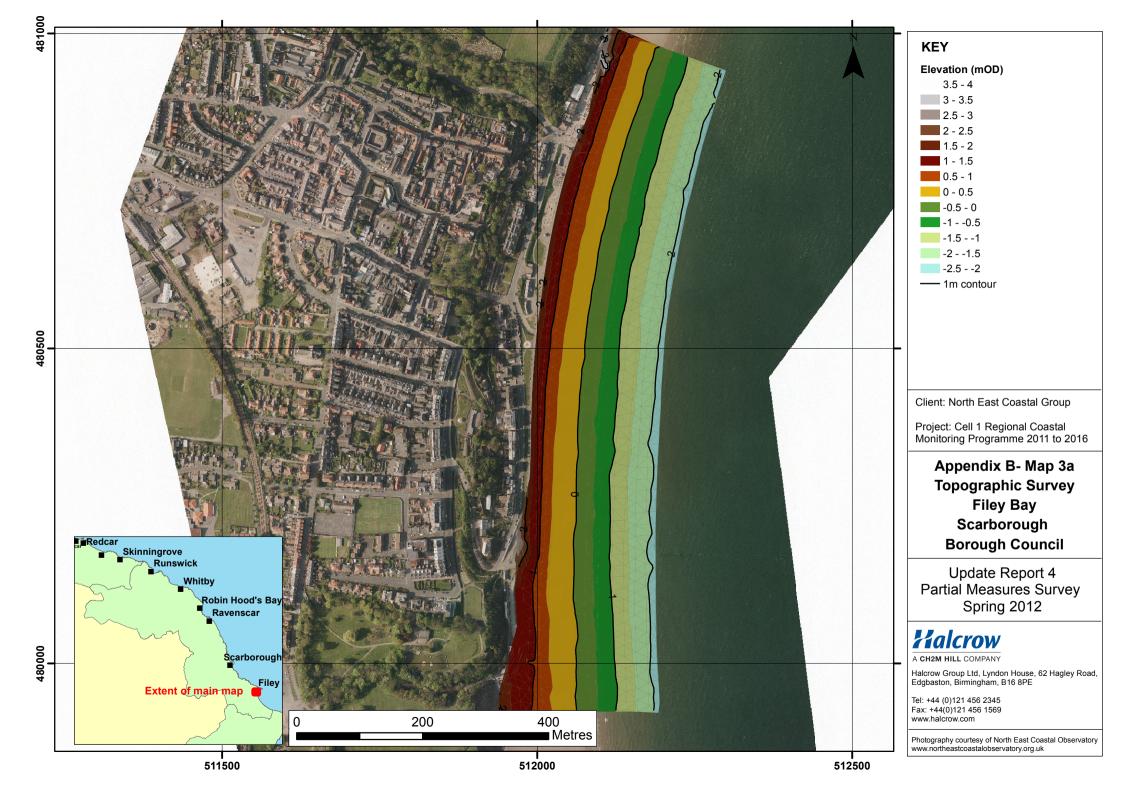
Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

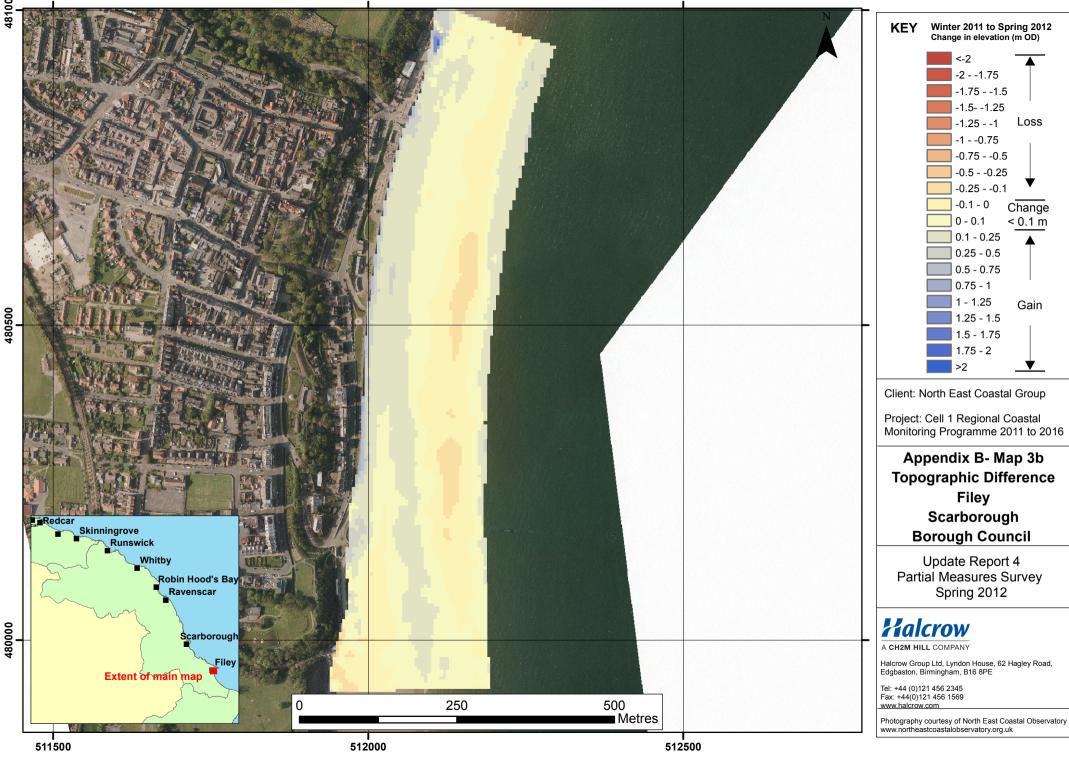
Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com

Photography courtesy of North East Coastal Observatory www.northeastcoastalobservatory.org.uk









Appendix C

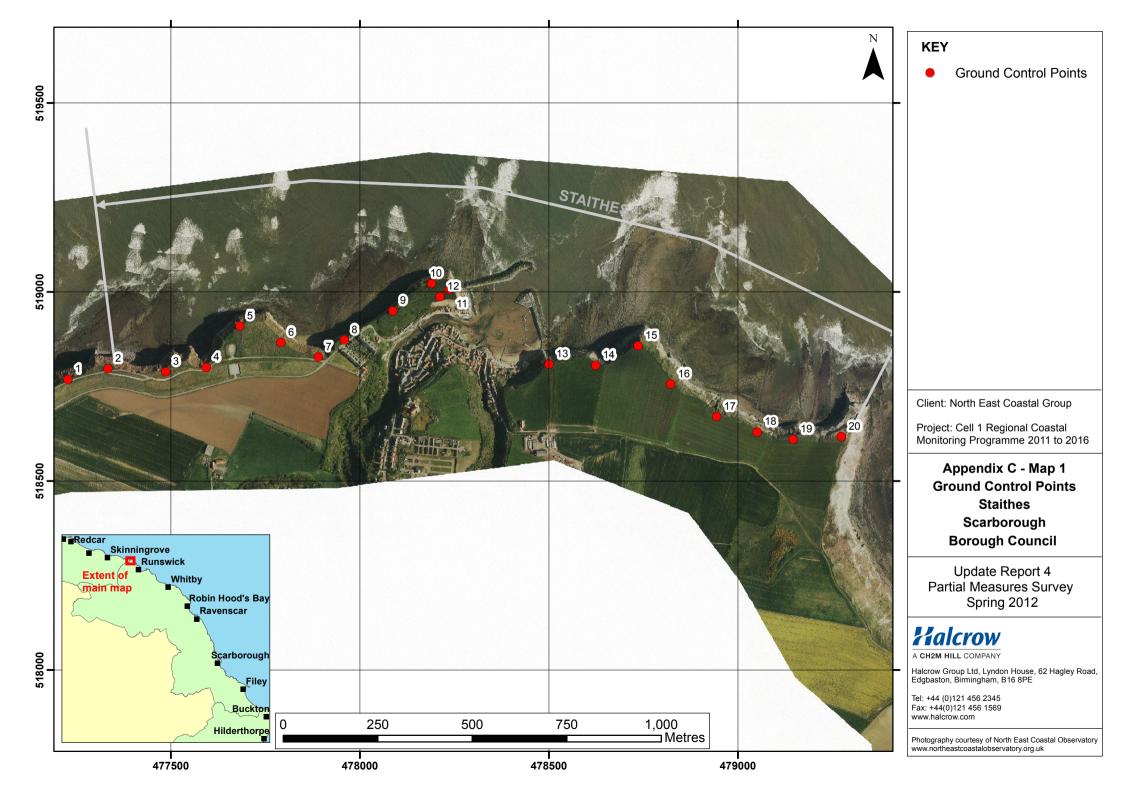
Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Figure C1). The maximum separation between any two points is nominally 100m.

The cliff top surveys at Staithes are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.



	-	rol Point De		Dista	nce to Cliff To	o (m)*	Total Erc	Erosion Rate (m/year)*	
Ref	Easting	Northing	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (Oct 2011)	Present Survey (March 2012)	Baseline (Nov 2008) to Present (March 2012)	Previous (Oct 2011) to Present (March 2012)	Baseline (Nov 2008) to Present (March 2012)
1	477228	518769	320	1.9	1.6	1.7	-0.2	0.1	-0.1
2	477334	518798	0	10.9	10.6	10.8	-0.1	0.2	0.0
3	477487	518789	350	7.1	8.2	8.4	1.3	0.2	0.4
4	477594	518801	340	5.9	5.2	5.2	-0.7	0.0	-0.2
5	477683	518911	350	8.4	9.4	9.3	0.9	0.0	0.3
6	477792	518867	30	8.6	8.5	8.5	-0.1	0.0	0.0
7	477891	518828	60	7.7	7.5	7.6	-0.1	0.1	0.0
8	477959	518873	350	8.7	9.6	9.8	1.1	0.1	0.3
9	478088	518950	350	7.6	8.0	8.3	0.7	0.3	0.2
10	478191	519023	340	8.4	8.7	8.8	0.4	0.1	0.1
11	478237	519007	60	6.9	6.7	6.8	-0.1	0.1	0.0
12	478213	518988	150	6.1	6.5	6.5	0.4	0.0	0.1
13	478501	518809	15	11.4	9.2	9.1	-2.3	-0.1	-0.7
14	478624	518807	20	7.5	7.5	7.5	0.0	0.0	0.0
15	478737	518858	60	6.1	6.4	6.4	0.3	0.0	0.1
16	478823	518757	60	8	8.4	9.0	1.0	0.7	0.3
17	478944	518671	30	9.3	9.4	9.5	0.2	0.1	0.0
18	479052	518630	20	9.2	9.3	9.3	0.1	0.0	0.0
19	479147	518610	0	14.2	14.3	14.4	0.2	0.1	0.1
20	479274	518618	20	11.4	11.2	11.4	0.0	0.1	0.0

Table C1 – Cliff Top Surveys at Staithes

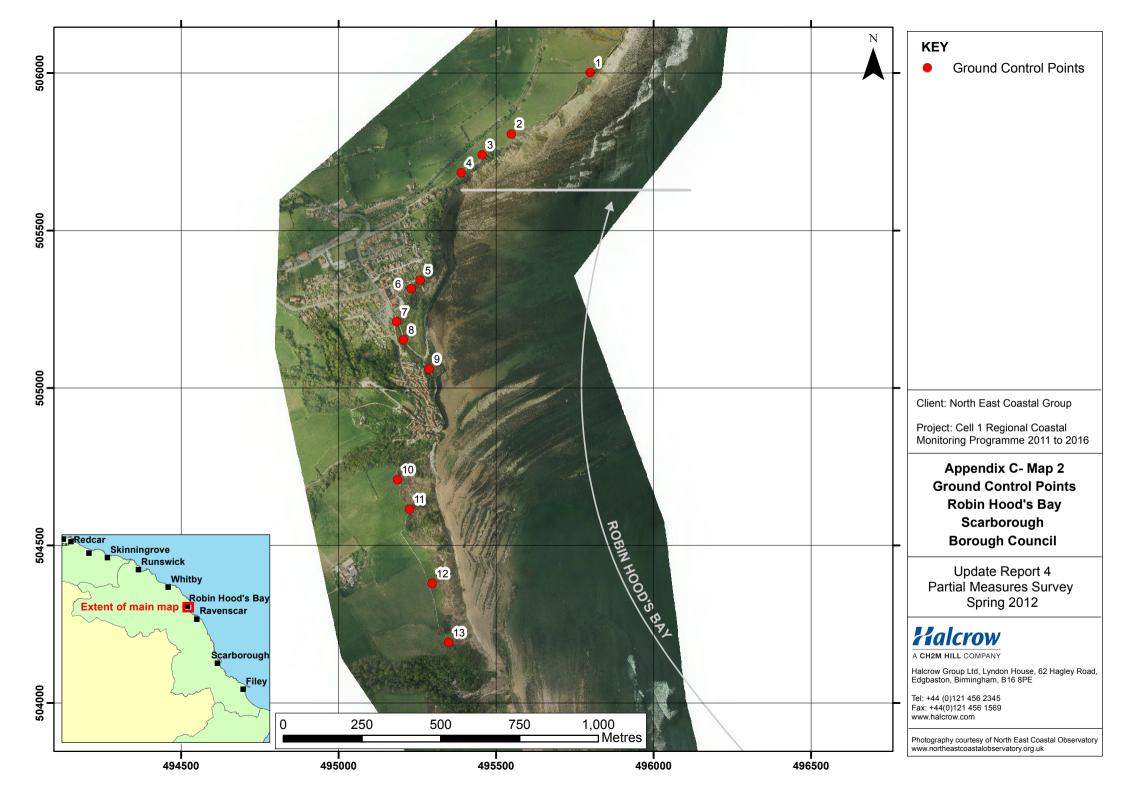
Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Figure C2). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Robin Hoods Bay are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C2 provides baseline information about these ground control points and results from the 2010 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C2 – Cliff Top Surveys at Robin Hoods Bay

Ground Control Point Details				Dista	nce to Cliff Top	(m)	Total Er	Erosion Rate (m/year)	
Ref	Easting	Northing	Bearing (⁰)	Baseline Survey (March 2010)	Previous Survey (Sept 2011)	Present Survey (March 2012)	Baseline (March 2010) to Present (March 2012)	Previous (Sept 2011) to Present (March 2012)	Baseline (March 2010) to Present (March 2012)
1	495799.5	506002.2	130	11.6	8.3	8.1	-3.5	-0.2	-1.63
2	495549.2	505807.3	135	9.3	9.3	9.2	-0.1	-0.1	-0.03
3	495456.3	505740	130	5	5.1	5.2	0.2	0.0	0.07
4	495389.9	505683.7	140	6.3	6.2	6.3	0.0	0.1	-0.01
5	495259.4	505342.5	130	11.3	10.8	9.7	-1.6	-1.1	-0.73
6	495231.2	505315.7	95	5.9	5.9	5.8	-0.1	0.0	-0.04
7	495184.8	505210.7	85	6.4	6.3	6.2	-0.2	-0.1	-0.08
8	495206.5	505153	75	5	5.2	5.4	0.4	0.2	0.17
9	495287.8	505060.5	80	4.3	4.6	4.5	0.2	-0.1	0.10
10	495187.8	504708.8	70	3.1	3.7	2.5	-0.6	-1.1	-0.27
11	495226.2	504615.7	120	3.8	3.6	3.8	0.0	0.2	-0.02
12	495297.5	504380.2	80	11	10.9	11.0	0.0	0.1	-0.01
13	495350.4	504193	55	3.7	3.6	3.7	0.0	0.0	-0.02



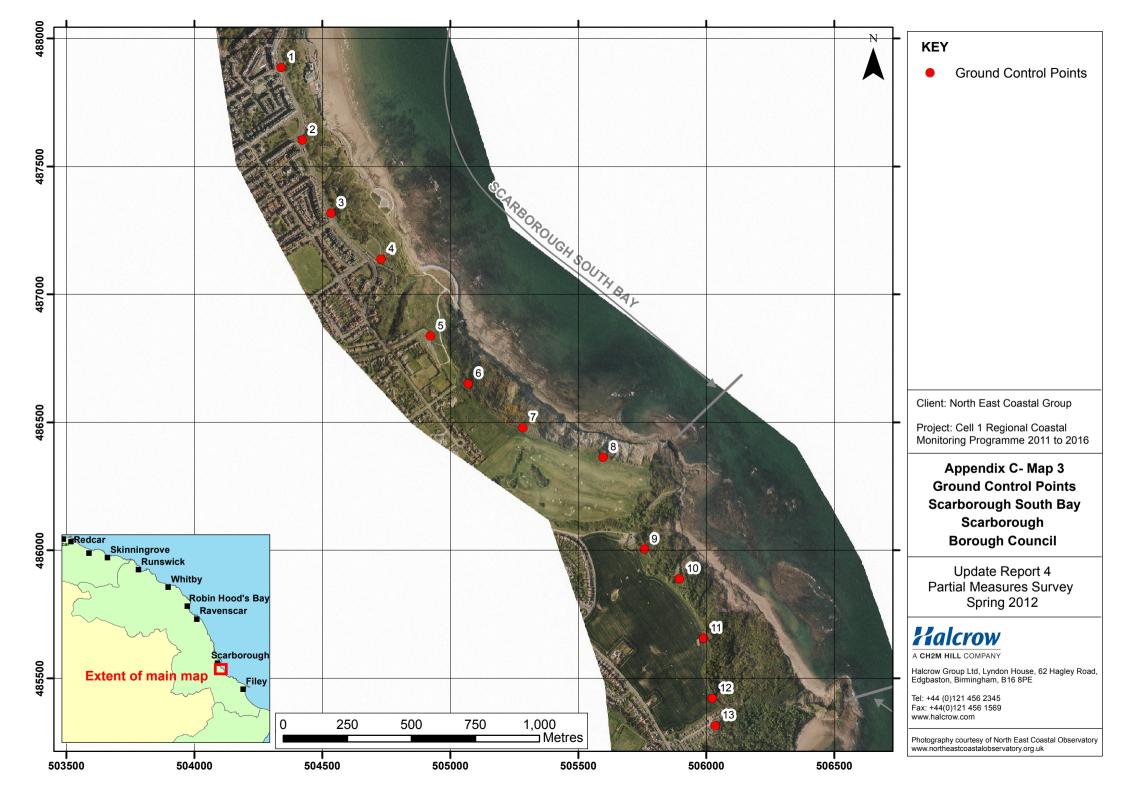
Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Figure C3). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Scarborough South Bay are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C3 provides baseline information about these ground control points and results from the 2010 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Gi	Ground Control Point Details			Dista	nce to Cliff Top	o (m)*	Total Erosion (m)*		Erosion Rate (m/year)*
			Bearing			Present Survey	Baseline (March 2010) to	Previous (Feb 2011)	Baseline (March 2010) to
Ref	Easting	Northing	(°)	Survey (March 2010)	Previous Survey (Sept 2011)	(March 2012)	Present (March 2012)	to Present (March 2012)	Present (March 2012)
1	504339.5	487887.3	70	7.0	7.0	7.0	0.0	0.0	0.0
2	504422.3	487603.7	80	4.8	4.8	4.9	0.1	0.0	0.0
3	504534.8	487318.3	40	15.1	15.1	14.9	-0.2	-0.3	-0.1
4	504730.2	487137.9	55	9.6	9.5	9.6	0.0	0.1	0.0
5	504922.9	486837.8	60	8.8	8.5	8.7	-0.1	0.2	-0.1
6	505071.1	486652.1	75	3.8	3.4	3.5	-0.3	0.2	-0.1
7	505284.3	486480	35	7.0	7.0	7.0	0.0	0.0	0.0
8	505597.9	486363.4	30	8.6	8.6	8.6	0.0	0.0	0.0
9	505758.6	486005.1	45	9.1	9.1	9.0	-0.1	0.0	0.0
10	505896	485889.6	15	14.8	14.2	14.8	0.0	0.6	0.0
11	505990	485657.1	80	4.7	4.3	4.3	-0.4	0.0	-0.2
12	506024.9	485421.8	55	6.1	5.7	5.8	-0.3	0.0	-0.2
13	506036	485315.3	90	7.0	5.9	7.0	0.0	1.1	0.0

Table C3 – Cliff Top Surveys at Scarborough South Bay



Cayton Bay

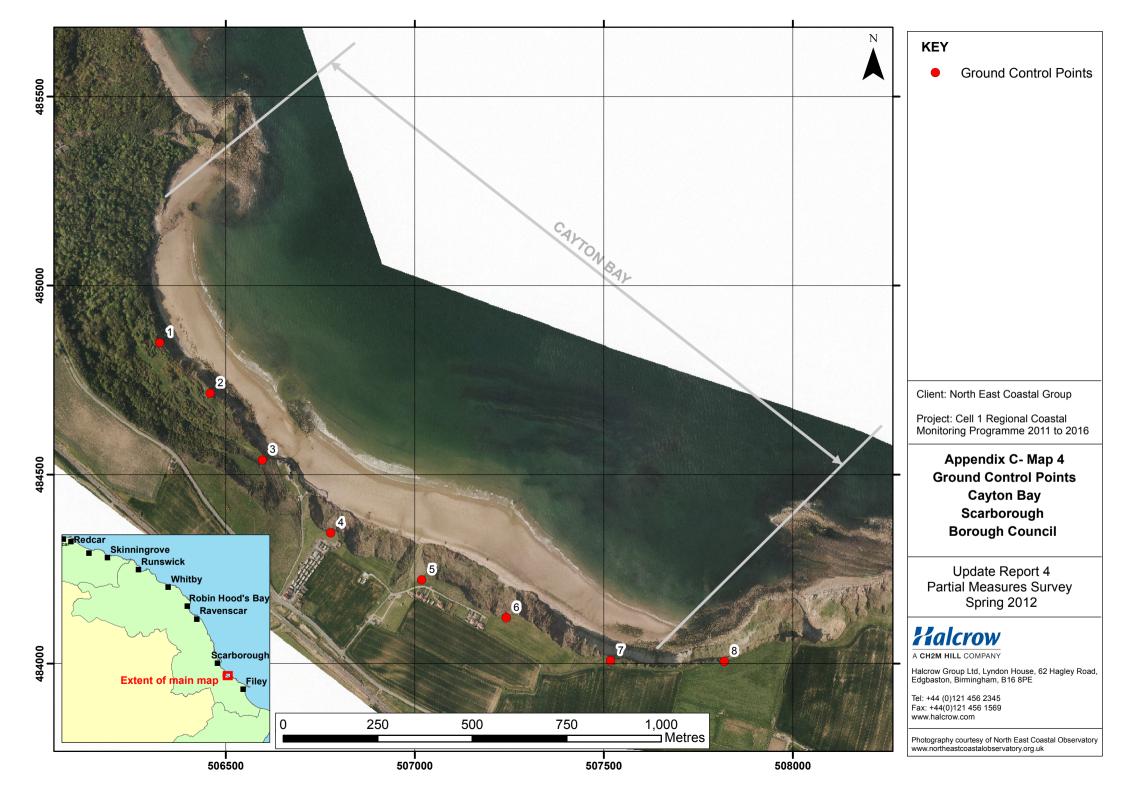
Eight ground control points have been established at Cayton Bay (Figure C4). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Cayton Bay are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C4 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C4 – Cliff Top Surveys at Cayton Bay

Gr	round Contr	ol Point De	etails	Dista	nce to Cliff To	p (m)	Total Er	Erosion Rate (m/year)	
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2011)	Present Survey (March 2012)	Baseline (Nov 2008) to Present (March 2012)	Previous (Sept 2011) to Present (March 2012)	Baseline (Nov 2008) to Present (March 2012)
1	506325.5	484849.7	50	4	3.4	3.5	-0.5	0.0	-0.2
2	506459.4	484715.9	65	5	0.2	0.0	-5.0	-0.2	-1.5
3	506597.4	484538.6	65	5	6.6	6.3	1.3	-0.3	0.4
4	506778.1	484345.5	21	9	9.0	9.0	0.0	0.0	0.0
5	507018.6	484221.6	342	7.7	8.2	8.0	0.3	-0.2	0.1
6	507242.3	484121.7	2	7.4	7.5	7.5	0.1	0.0	0.0
7	507518.2	484008.2	25	7.5	7.9	7.9	0.4	0.0	0.1
8	507818.7	484006	1	5.5	5.3	5.9	0.4	0.7	0.1



Filey Bay

Twenty-three ground control points have been established in Filey Bay (Figure C5 and C6). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Filey Bay are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C5 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C5 – Cliff Top Surveys in Filey Bay

Ground Control Point Details			Dista	nce to Cliff To	op (m)	Total Er	Erosion Rate (m/year)		
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2011)	Present Survey (March 2012)	Baseline (Nov 2008) to Present (March 2012)	Previous (March 2011) to Present (Sept 2011)	Baseline (Nov 2008) to Present (March 2012)
1	512444.9	481630.9	130	8.7	8.8	8.9	0.2	0.1	0.0
2	512306.7	481490.3	144	7.6	7.7	7.8	0.2	0.1	0.0
3	512153.6	481234.6	122	8.3	8.5	8.4	0.1	0.0	0.0
4	512029.2	480959.9	115	7.4	7.5	7.5	0.1	0.0	0.0
5	511895.4	479888	89	7.1	1.4	1.4	-5.7	0.0	-1.7
6	511908.5	479597.1	48	6.7	6.9	6.9	0.2	-0.1	0.0
7	511991.4	479310.4	69	6.7	5.1	5.0	-1.7	0.0	-0.5
8	512083.4	478981.5	66	10.2	10.4	10.3	0.1	0.0	0.0
9	512121.3	478786.3	76	8.3	8.3	8.4	0.0	0.1	0.0
10	512226.2	478547.9	74	7.5	7.3	7.2	-0.3	-0.1	-0.1
11	512471.4	478153.5	53	6.6	6.4	6.5	-0.1	0.1	0.0

12	512558.9	477901.9	66	7.7	8.4	7.7	0.0	-0.6	0.0
12A*	512655.8	477822.4	67	13.9	13.7	13.9	-0.1	0.2	-0.1
13	512697.6	477719	34	4.2	4.4	4.2	0.0	-0.2	0.0
14	512939.4	477400.9	66	8	7.3	7.3	-0.8	0.0	-0.2
15	513157	477192.7	51	5.2	5.3	5.2	0.0	-0.2	0.0
16	513299.5	477024.6	30	7.7	7.7	7.8	0.0	0.0	0.0
17	513507.7	476821.1	34	10.7	10.7	10.9	0.2	0.2	0.1
18	513721	476602.3	31	7.2	7.3	7.1	-0.2	-0.3	0.0
19	513916.6	476354.1	51	6.6	6.7	6.2	-0.4	-0.4	-0.1
20	514174.8	476179.4	32	7	7.2	7.3	0.3	0.0	0.1
21	514471.5	475965.7	66	7.6	7.5	7.5	-0.1	0.0	0.0
22	514656.2	475728.8	101	8.1	8.1	8.1	0.0	0.0	0.0
23	514889.5	475537.6	60	9.1	9.1	9.0	-0.1	-0.1	0.0
24*	512603.7	481665.9	14	19.9	19.8	19.8	-0.1	0.0	-0.1
25*	512607.1	481648.9	184	17.2	17.3	17.2	0.0	-0.2	0.0
26*	512301.9	481825.5	18	11	11.0	11.0	0.0	0.0	0.0
27*	512475.8	481712.1	20	11.6	11.6	11.6	0.0	0.0	0.0

