ROYAL HASKONING

Halcrow

Cell 1 Regional Coastal Monitoring Programme Update Report 3: 'Partial Measures' Survey 2011

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Scarborough Borough Council
Draft Report

August 2011

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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
m	metres
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWN	Mean Low Water Neap
MLWS	Mean Low Water Spring
MSL	Mean Sea Level
AOD	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

	Water Level (m AOD)			
Water Level Parameter	**River Tyne to Frenchman's Bay**	**Frenchman's Bay to Souter Point**	**Souter Point to Chourdon Point**	**Chourdon Point to Hartlepool Headland**
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90
	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 nourishment	Artificial process of replenishing a beach with material from another 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 squeeze	The reduction in habitat area which can arise if the natural landward 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 inter-tidal 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 long shore 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 300 km of the northeast coastline of England, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire.

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. Reports produced to date are summarised in Table 1.

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09	June 09	-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	July 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-April 11	August 11(*)	-

(*) The present report is **Update Report 3** and provides an analysis of the 2011 Partial Measures survey for Scarborough Borough Council's frontage. It is intended as a brief update of the key findings from this survey to maintain an understanding of ongoing changes.

1. Introduction

1.1 Study Area

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

- Staithes[1]
- 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 no. transect lines
  - 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
  - Filey

The location of these surveys is shown in Figure 1, Maps 1-8. This information has also previously been provided in a digital file, which can be viewed in Google Earth.

The current Partial Measures survey was undertaken between February and April 2011. In addition to the planned topographic surveys undertaken at Runswick Bay, Robin Hood's Bay and Filey Town, surveys were also carried out along the Sandsend to Whitby frontage and within Scarborough's North and South Bays. Additional data were collected at Sandsend-Whitby following concerns about exceptionally low beach levels fronting the cliff toe revetments observed in January 2011. Additional data were also collected at Scarborough to support potential project appraisal reports (PARs) in north and south bays. For further details refer to Note 9T6403 from Royal Haskoning 29 March 2011.

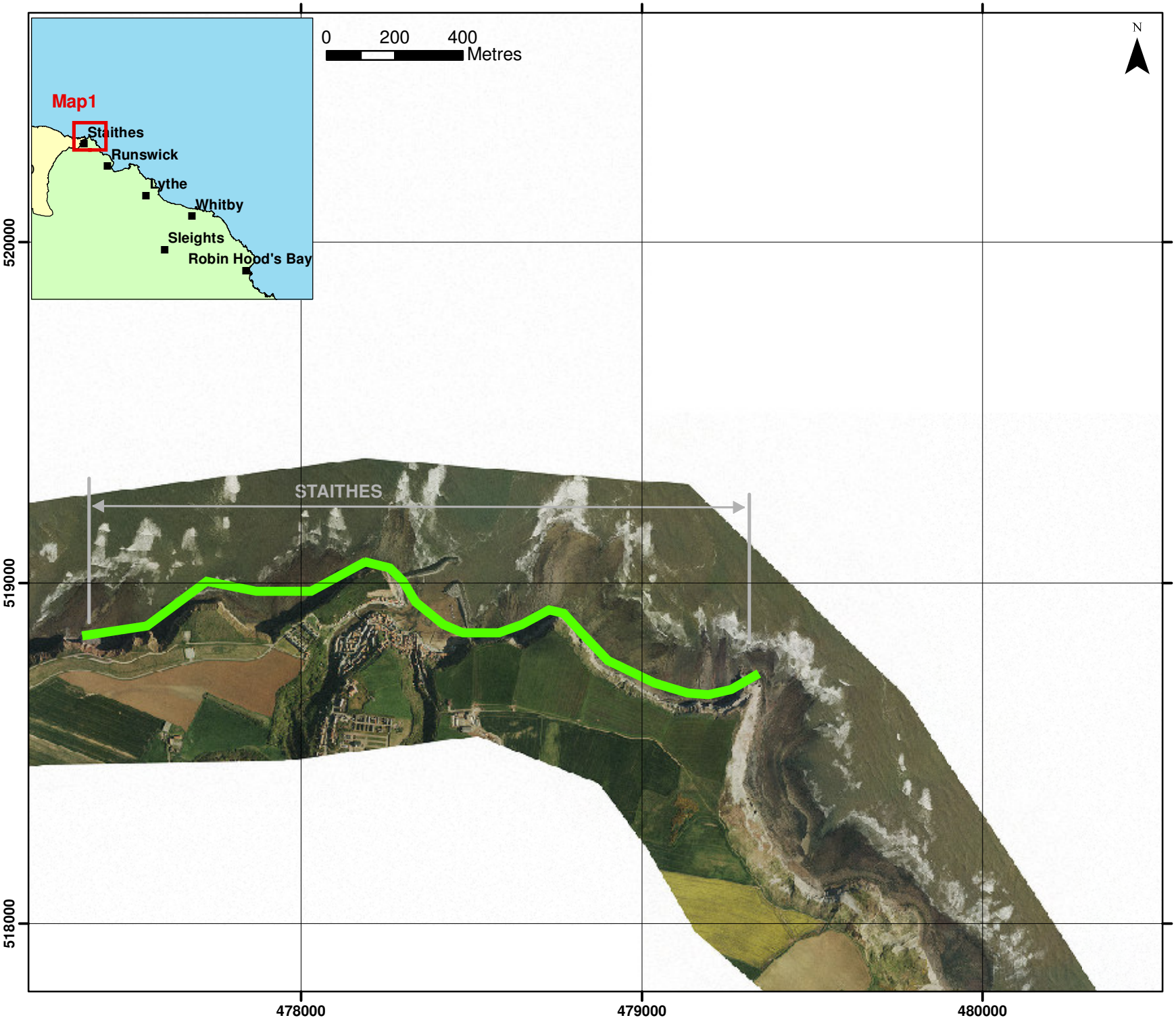
[1] The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland & Scarborough Borough Councils.

The weather was fine and dry, with a calm sea state in all areas except for Scarborough North Bay when conditions were overcast and breezy.

This 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
- conclusions that highlight any areas of concern (Section 5).

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



SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 1 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:15,000 at A4

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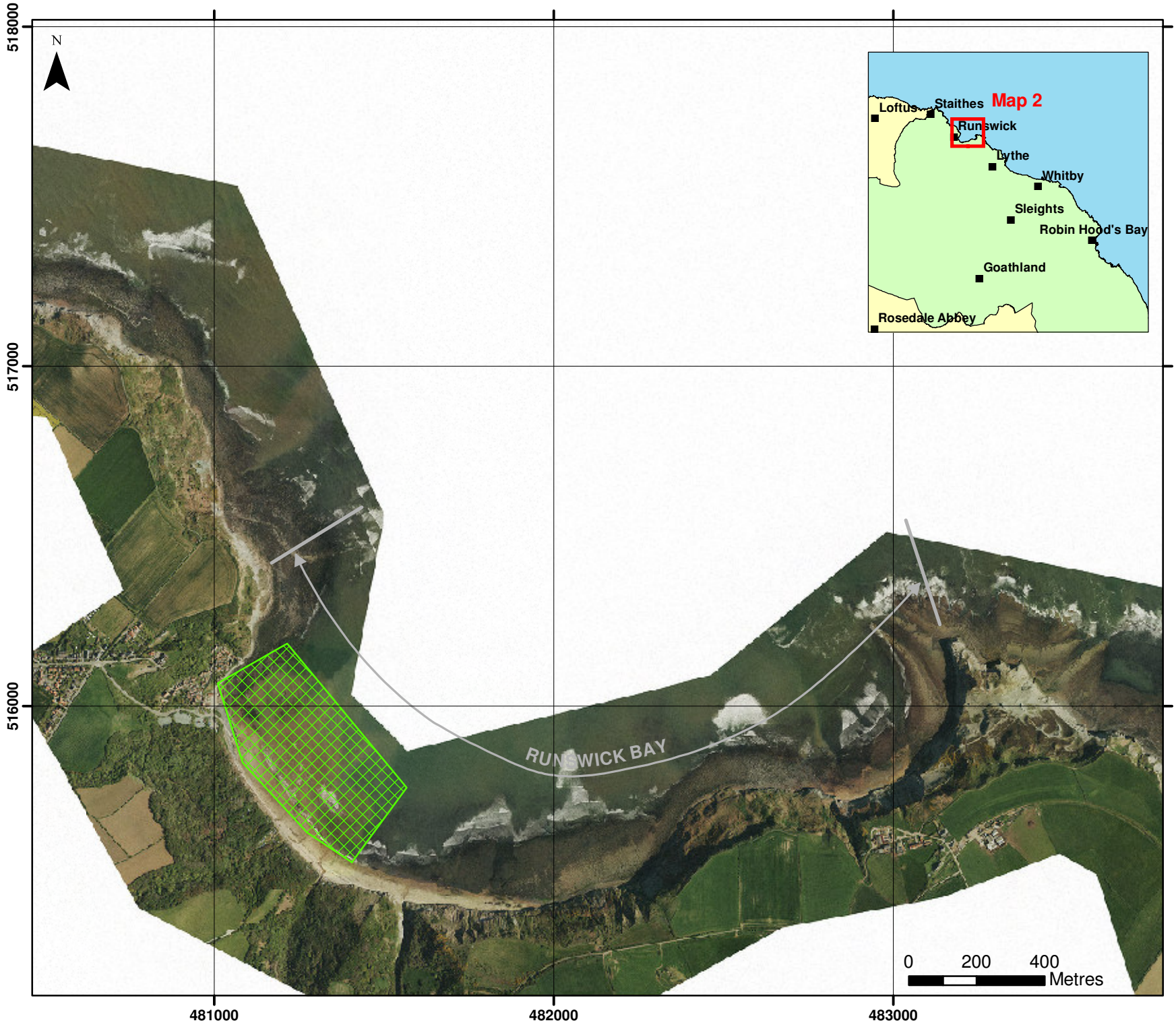

SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 2 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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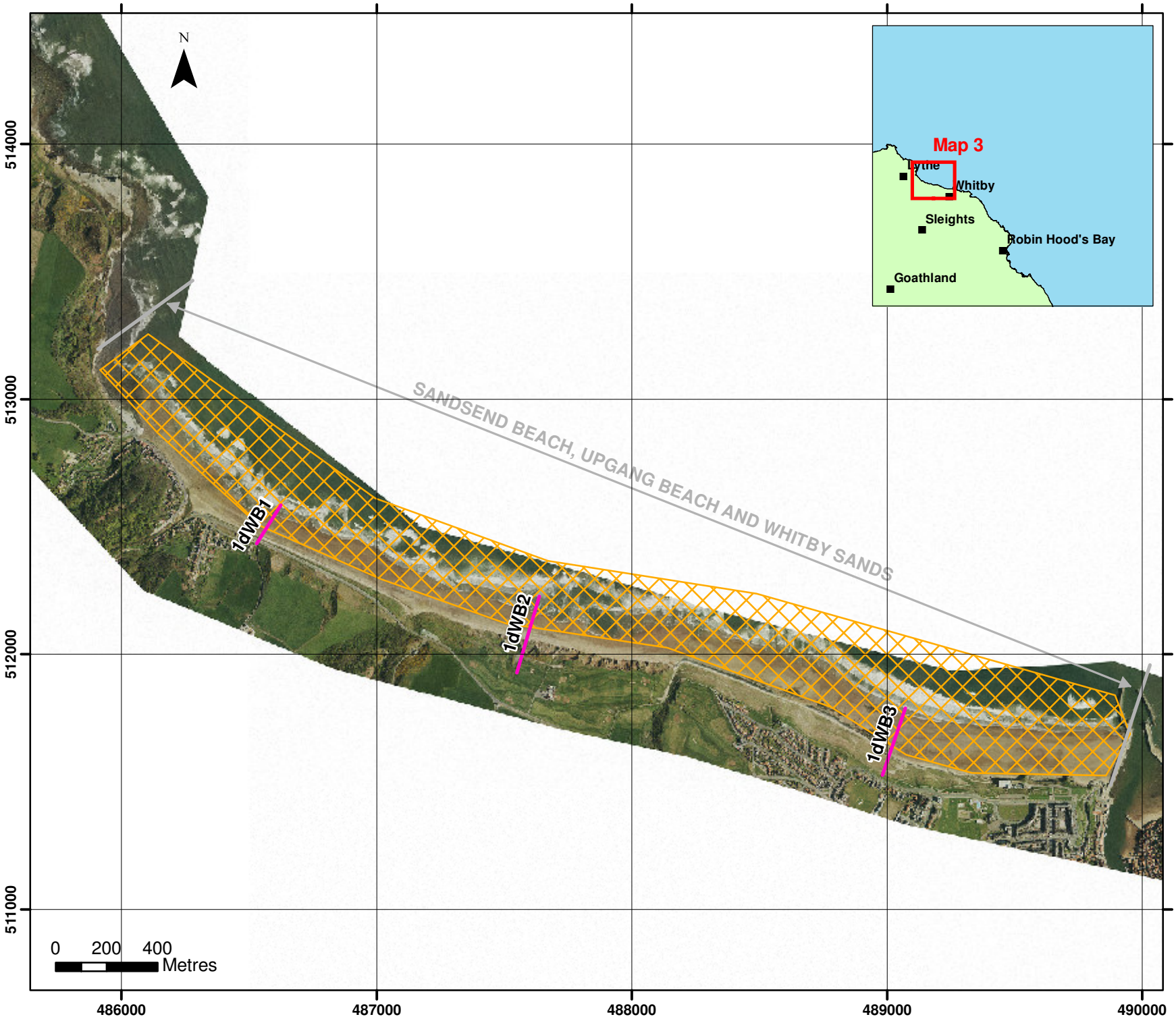

SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 3 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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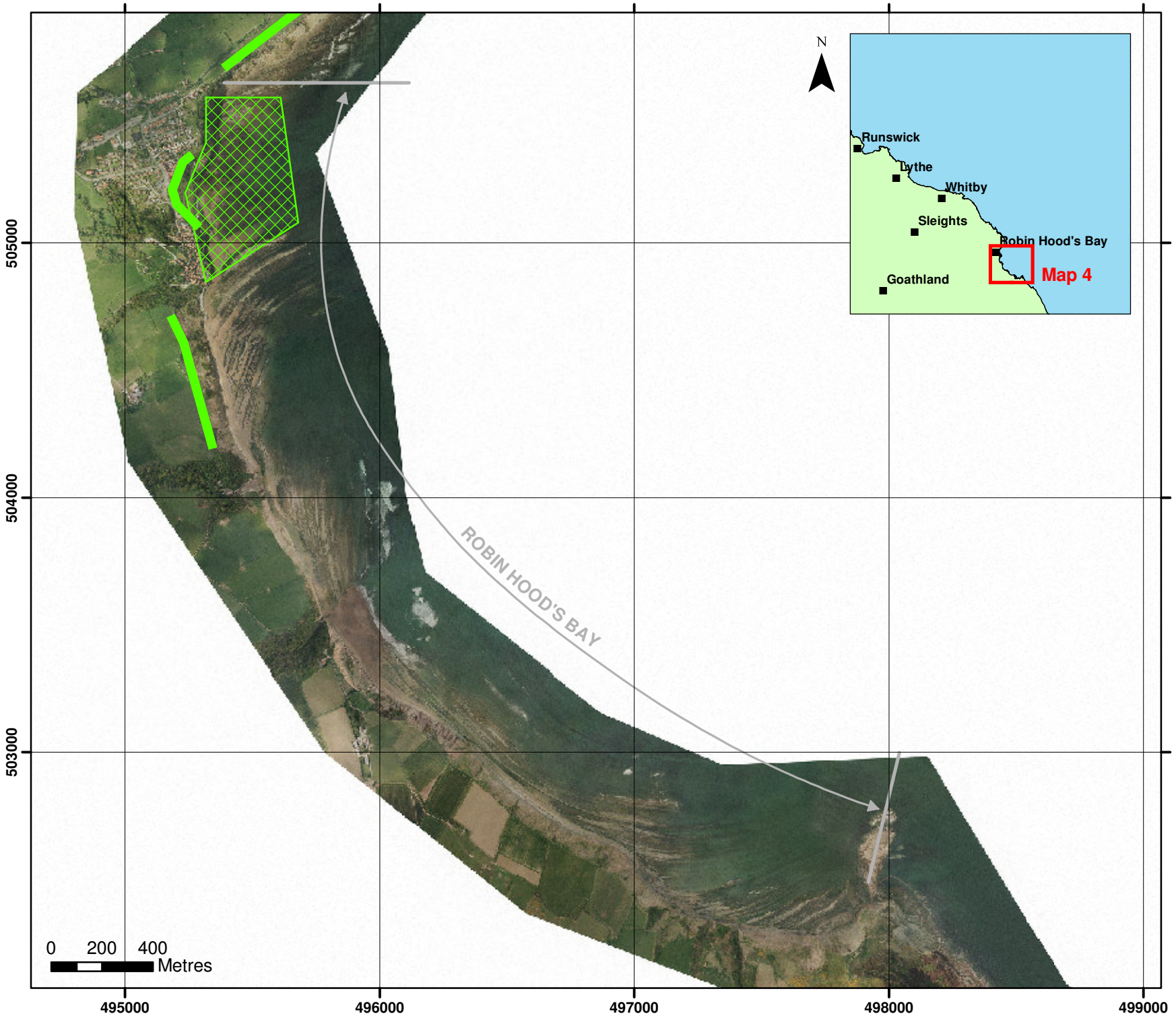

SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 4 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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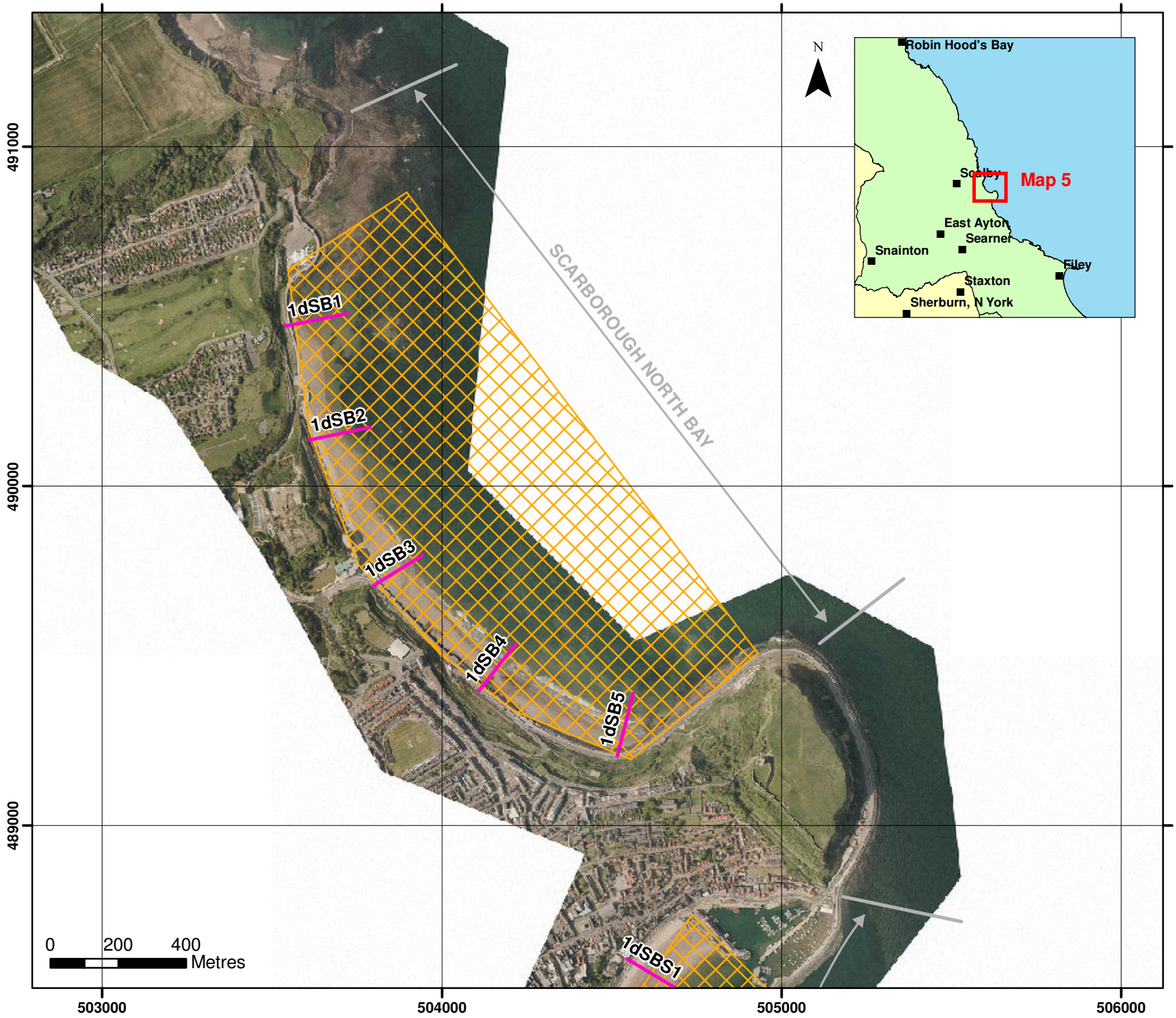

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 5 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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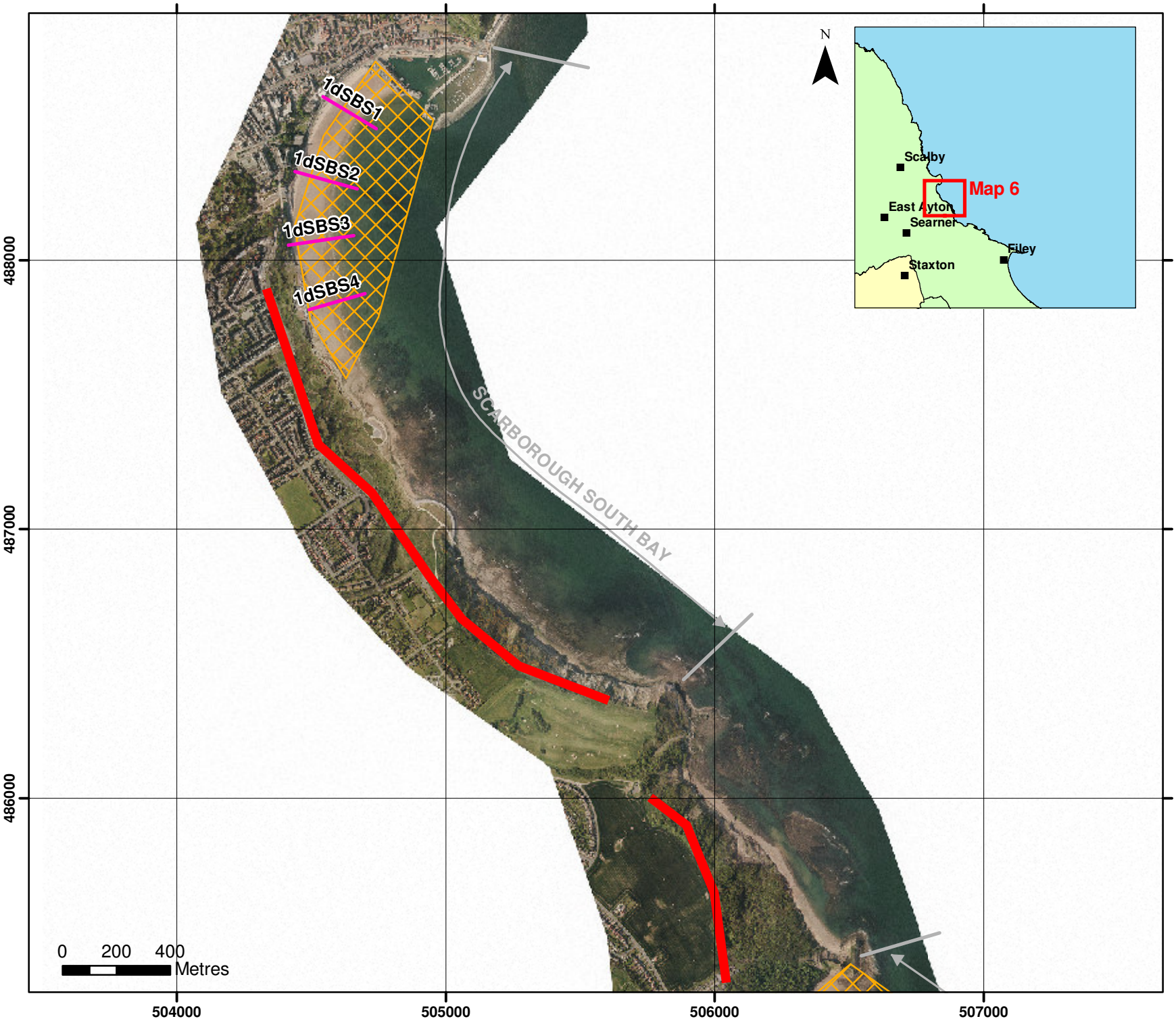

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 6 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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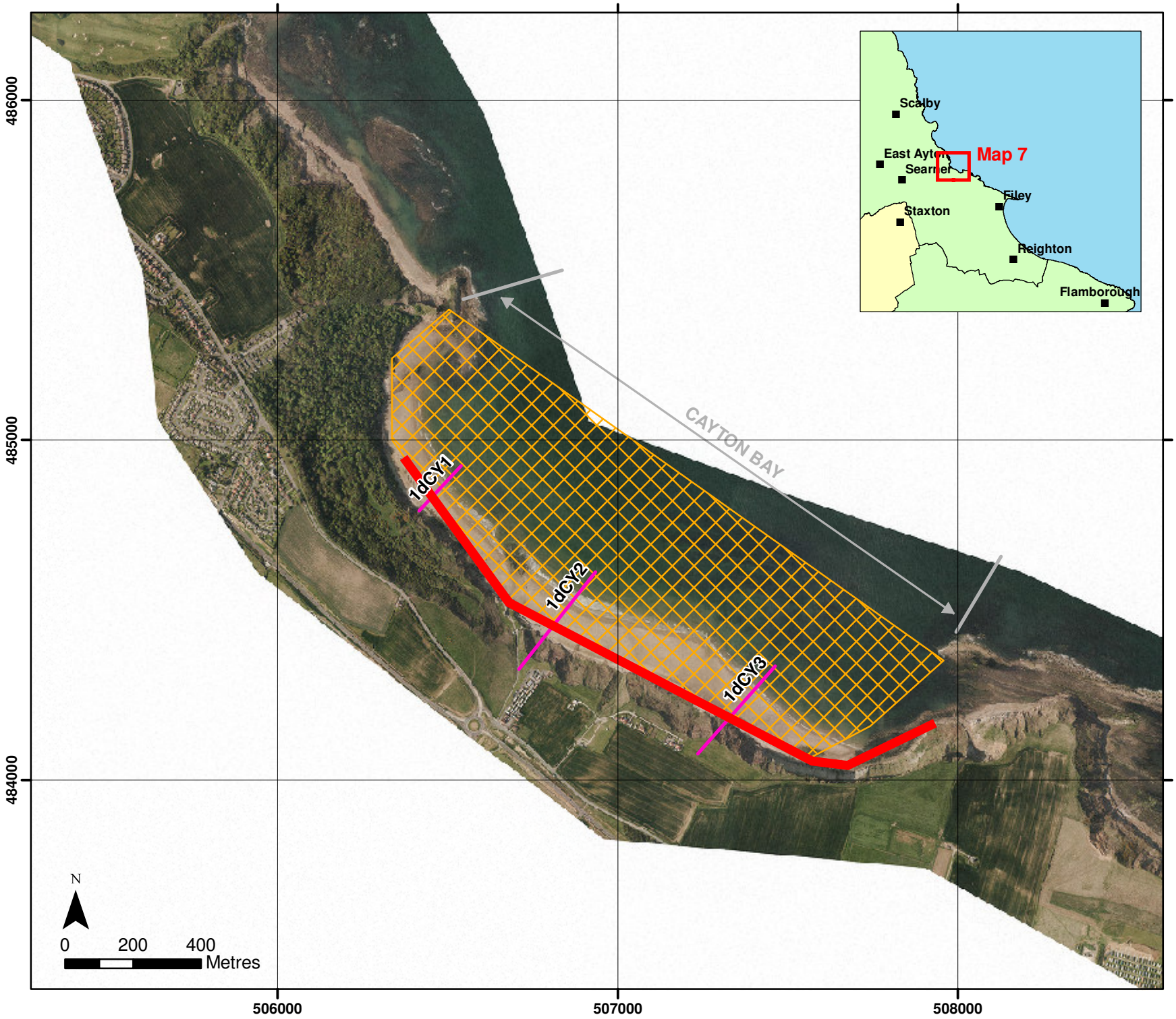

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 7 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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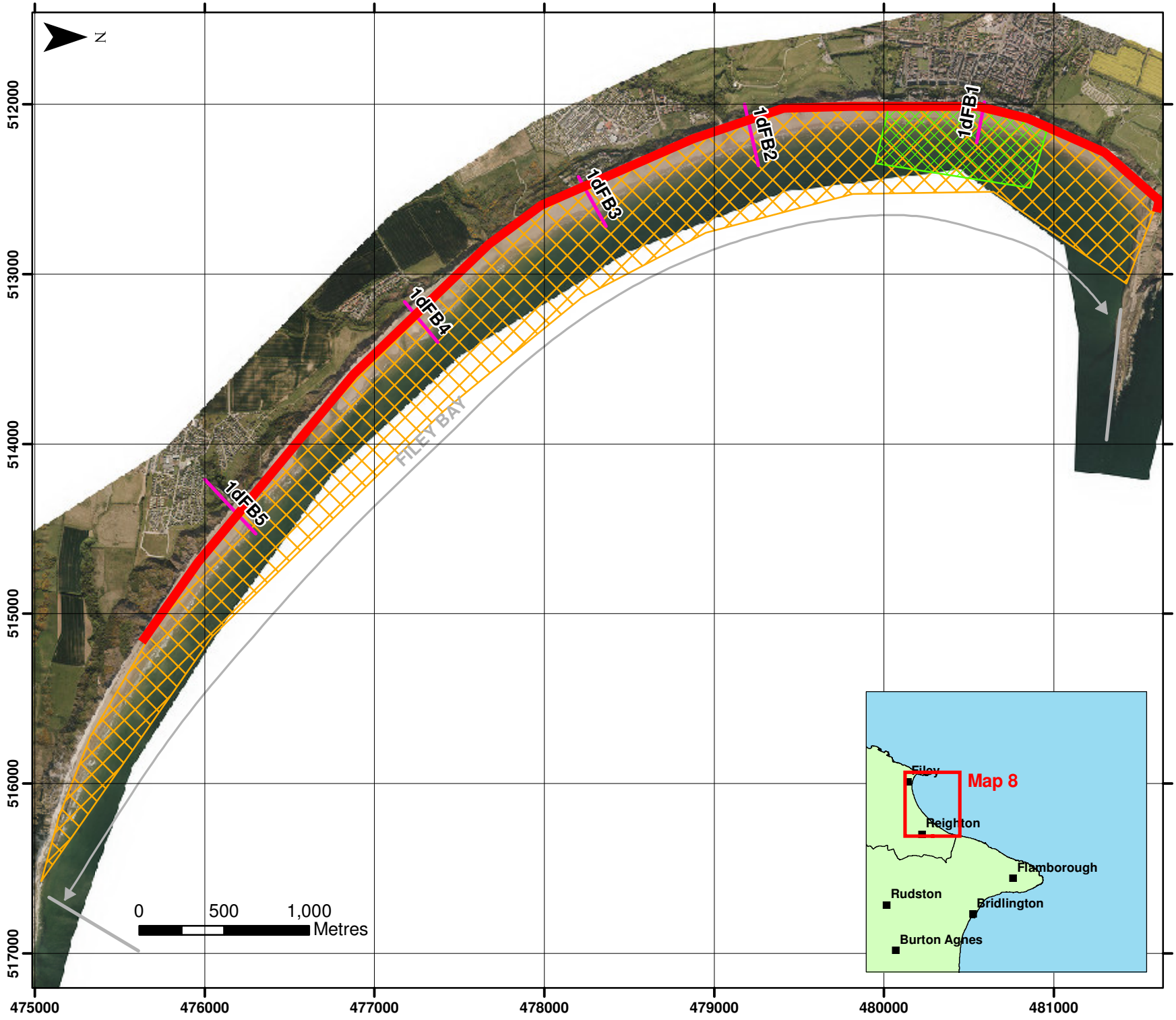

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 8 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2011	**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 typically around 100m (although occasionally less). 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 April 2011 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. When survey accuracy is taken into consideration, eight of the twenty points have shown no change in cliff top position between the November 2008 and April 2011 surveys (i.e. the measured change in cliff position is less than the survey error). Only two locations (points 4 and 13) have shown recession of the cliff line by 0.6 and 1.9m respectively since the baseline survey (±0.1m due to survey accuracy). This equates to erosion rates of 0.2m/yr and 0.8m/yr respectively. Ten locations (points 3, 5, 8, 9, 10, 12, 16, 17, 18, 19) have shown an increase in distance to the cliff edge of between 0.2 and 1.4m, suggesting that the cliff top has advanced. It is noted that points 3 and 12 (all to the west of Staithes) have consistently shown an increase in distance from the control point to the cliff edge.	The markers which have shown no change since the baseline survey suggest a relatively stable local cliff face in these locations (points 1, 2, 6, 7, 11, 14, 15, 20). Cliff top recession was observed at points 4 and 13. Point 4 is located to the west of Staithes, along Cowbar Lane, a well known site of cliff top recession. Point 13 is located above Staithes harbour itself. The specific processes responsible for this recession would need to be determined by a dedicated field inspection. Ten of the surveyed locations show an increase in distance to the cliff edge. It is possible that these data represent an extension of the cliff top due to a progressive toppling failure but this is not supported by field observations. These data are therefore considered to be erroneous and resulting from differing interpretation of the exact position of the cliff edge between surveys. This suggests that a review of the survey technique including a site visit would be beneficial in order to consider how the data collection could be made more reliable.

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2011	**Topographic Survey:** Runswick Bay is covered by a 6-monthly topographic survey. Data have been used to create a digital ground model (DGM) (Appendix B - Map 1) using a Geographic Information System (GIS) computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (April 2011) and the earlier topographic survey DGM (August 2010), which are presented as 5m resolution raster grids (as shown in Appendix B – Map 2), to identify areas of net erosion and accretion. Appendix B - Map 2 shows a linear band of deposition at the back of the beach which extends along most of the survey length except for the beach area fronting the rock armour defences. This deposition is particularly marked (>1m) immediately to the north and south of the rock armour. A clear erosional band runs parallel to the band of deposition in the middle of the survey area suggesting a net increase in beach angle in this area. The pattern of change in the south of the survey area is generally dominated by minor deposition, with occasional pockets of minor erosion such as near the Sailing Club.	The beach at Runswick Bay appears to have experienced landward transport of material and some shore parallel erosion mid-beach over the 2010-2011 winter period. This is a similar pattern of beach change as that recorded over the preceding 2010 summer period, albeit less pronounced. However, it is in contrast to the observations at the same time period in 2010 where offshore movement of material was recorded over the last winter period (2009-2010). This suggests a departure from the previously observed seasonal cycle of onshore swell dominated movement of beach material in the summer and offshore storm dominated movement in the winter.

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2011	**Beach Profiles:** The frontage spanning Sandsend Beach, Upgang Beach and Whitby Sands is covered by three beach	WB 1- Erosion at the back of the beach has increased resulting in increased exposure of the cliff toe and defences. Should this trend continue, the risk to the road above should be considered.

Survey Date	Description of Changes Since Last Survey	Interpretation
	profile lines, spaced between Sandsend and Whitby West Cliff (Figure 1 – Map 2). WB 1 - The beach level has risen since the last survey (November 2010) by up to 1m at the seaward extent of the profile (from a chainage of c. 70m onwards). This has resulted in a beach level higher than that recorded during any other previous survey. Further landwards, this pattern is reversed with the beach level at the back of the beach (beneath the road) being lower than during the last survey by c.0.75m. As a result, the beach gradient has become shallower. This pattern of beach change is also shown in the difference between the November 2010 and March 2011 topographic surveys (see Appendix B – Map 4a). WB 2 - There has been negligible change along the face of the cliff since the last survey, although the photographs appear to show ongoing activity within the mudslides from the cliffs that back this frontage. The back of the beach appears to have experienced significant accretion of up to 2m between chainage 145 and 195m. The beach elevation at this location (3.8m AOD at chainage of c.155m) is in excess of MHWS (2.6m AOD), and therefore acts to provide some protection to the cliff toe. From c.200m seawards, the March 2011 survey shows there has been erosion of up to c. 0.5m since November 2010. Consequently there is an increase in the overall beach gradient. This pattern of beach change matches that shown in the comparison of the November 2010 and March 2011 topographic surveys (see Appendix B – Map 4a). WB 3 - The March 2011 survey for this profile shows a distinctive 'stepped' cliff profile which is markedly different from any previous surveys. This has resulted in significant changes in elevation down the cliff face since the last survey – in places up to 8m erosion is observed and elsewhere up to 5m of accretion. It is not clear whether this represents a real change to the cliff face (possibly resulting from cut/fill activities) or whether some error has occurred. Given that the top and base of the cliff have remained in the same place it is suggested that this data does not represent natural cliff change. The profile of the beach section (from c.90m chainage onwards) is initially slightly higher than the previous survey but reduces in elevation with distance seaward so that by a chainage of c.105m it is lower than previous surveys by up to 2m. This does not match the difference DGM shown on Appendix B – Map 4b which shows deposition on the beach along most of the profile length. This suggests an error in the cliff profile	WB 2- The accumulation of material at the back of the beach has afforded some additional protection to the cliff toe. WB 3- Significant change to the cliff and beach profiles are shown by the data and it is not certain whether this represents real change or an error within the data. The pattern of change on the beach does not appear to match that recorded by the full topographic survey. The pattern of change from profiles WB1 and WB2 suggest that there may have been some transfer of sediment from the northwest towards the southeast (i.e. from Sandsend towards Whitby). This matches the net south easterly sediment transfer reported in the March 2010 Full Measures report, but it should be noted that this observation relates to information from only a small number of beach profiles and therefore may not give the full picture of beach change.

Survey Date	Description of Changes Since Last Survey	Interpretation
	data or perhaps that it was not measured in the correct location.	
	Topographic Survey: The Sandsend to Whitby frontage was surveyed as an additional task due to concern about the exceptionally low beach levels fronting the toe defences at Sandsend Beach (for further details refer to Note 9T6403 from Royal Haskoning 29 March 2011). Data have been used to create a DGM (Appendix B – Map 3a and 3b) using a Geographic Information System (GIS) computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (March 2011) and the earlier topographic survey DGM (November 2010), with 5m raster grids (as shown in Appendix B – Map 4a and 4b), to identify areas of erosion and accretion. Appendix B – Map 4a shows areas of erosion and deposition generally distributed as linear shore-parallel strips across the survey area. The pattern of change is more complex fronting Sandsend Beck and the beach to the north, where the impact of fluvial discharge may have interacted with the coastal system. Further south, from Sandsend village to Upgang, the beach is characterised by linear bands of erosion and deposition that are aligned approximately NW to SE, and is slightly different to the WNW to ESE alignment of the coastline. This means the pattern of change at back of the beach alternates from erosion to deposition. In this area, the magnitude of change between surveys is significant and often exceeds 1m. The concern for exceptionally low beach levels at the back of Sandsend Beach is confirmed by the presence of a band of significant erosion of up to 1.3m. Appendix B – Map 4b shows a similar pattern of change at Whitby Sands. The pattern of alternating linear strips of erosion and deposition is repeated, but here the alignment better reflects that of the coastline. The back of the beach is therefore characterised by a broad zone of deposition of up to 1m, while the seaward part of the beach is characterised erosion of a similar magnitude. This pattern continues towards Whitby, although the magnitude of change is more limited, with change greater than 0.5m rarely being seen, the pattern is slightly complicated by the harbour groyne and the back of the beach fronting Whitby west town is characterised by a thin band of erosion.	This frontage exhibits a complicated pattern of beach change between November 2010 and March 2011 that may reflect movement of sand bars across the beach. The beaches at East Sandsend and Upgang appear to show a combination of both landward and seaward movement of materials, and notable erosion is evident beneath the road at Sandsend Beach. The pattern observed between Sandsend and the westerly extent of the Upgang mudslides is broadly opposite to that observed previously, between Oct 2009 and Nov 2010. Yet deposition beneath the western extent of the Upgang mudslides is present in both datasets and may relate to slumping and sliding of material from the cliffs onto the beach. This deposition is also shown by profile WB2 between November 2010 and March 2011 At Whitby Sands the previous trend to erosion at the back of the beach is reversed in this survey. It is likely that these overall patterns of change along this frontage reflect the migration of sand bars.

2.4 Robin Hood's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2011	**Topographic Survey:** Robin Hood's Bay is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B - Map 5) using a GIS computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (April 2011) and the earlier topographic survey DGM (September 2010), with 5m raster grids (Appendix B – Map 6), to identify areas of erosion and accretion. Appendix B - Map 6 highlights that the majority of the foreshore has experienced very limited change, with small strips of erosion and deposition of under 0.5m that appear to be aligned with outcrops of bedrock on the shore platform. Change is more apparent along the back of the beach, where deposition is common, particularly at Dungeon Hole and West Scar. There is localised erosion at the back of beach at the area protected by rock armour. **Cliff Top Survey:** Thirteen ground control points have been established at Robin Hood's Bay (since 3 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 April 2011 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 2010 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 baseline March 2010 survey. Of the other six markers, four show cliff recession of 0.3 to 0.4m/yr, one shows more significant recession of 3.3m (Marker 1) and one shows cliff top advance (Marker 10).	Areas of minor erosion & deposition are located throughout the bay, with no clear overall pattern. This most likely relates to the limited supply of sediment to the bay and the resistant rocky shore platform. During the last survey period (March 2010-Sept 2010) the general observation of little change was also made, with the areas below Dungeon Hole and West Scar exhibiting erosion rather than accretion. A number of profiles show no change in position suggesting the cliffs at these locations have been stable over this time period. Elsewhere, some markers (Numbers 5, 7, 8, 11) show recession of the cliffs which may relate to ongoing erosion. Marker 1 shows a significant amount of cliff recession over a short timescale. Marker 10 shows cliff top advance - which may relate to toppling and cliff top extension or measurement error. Further surveys are required to identify reliable patterns of cliff top recession.

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2011	**Beach Profiles:** Scarborough North Bay is covered by five beach profile lines, located between the Sea Life Centre at Scalby Mills to Clarence Gardens (Figure 1 – Map 5). SBN 1- The whole profile lies below MHWS (2.45m AOD). Comparison of the profile data from September 2010 (the previous survey) and February 2011 indicates that the back of the beach has experienced accretion between 10-70 m chainage by up to 1m so that it is now at a higher elevation than any previous surveys undertaken since spring 2009. There has been little change further seawards. The upper and middle beach has therefore steepened. The survey did not extend as far seaward as previous surveys. This pattern of change matches that shown by the topographic surveys in this area. SBN 2- The profile indicates that the back of the beach adjoining the seawall, between c. 8 and 25 m chainage has experienced erosion of up to 0.5m. As a result the top of beach elevation (2.4m) is below MHWS (2.45m AOD). Seaward of the 25 m chainage mark the beach has accreted since the last survey, by up to 1.0m. This pattern matches that shown by the DGM of difference (Appendix B – Map 8). SBN 3- Compared with the previous survey, this profile has experienced some lowering, with the back of the beach showing erosion of up to 0.4m at c. 22m chainage distance. This will have helped to further expose the seawall at the back of the beach to marine action. The beach elevation in this location (c.1.2m) is below MHWS (2.45m AOD). Further seaward, between chainage c.30m and c.70m, there has been little change in beach elevation. After 70m chainage there has been further erosion of up to 0.5m. This pattern of change is strongly correlated with that shown on the DGM of difference in Appendix B – Map 8 for this location. SBN 4- This beach profile shows a net gain of material since the last survey. The uneven topography of the rock platform and boulder deposits remains largely unchanged but there has been notable deposition of materials between rock ridges. This includes the areas between chainage c. 25m and 35m and between c.40m and c.48m. Further seaward there has been negligible change in the beach profile. This pattern broadly matches that observed from the DGM of difference shown in Appendix B – Map 8. SBN 5- This beach profile shows mostly subtle changes in elevation since the previous survey. At the	SBN 1- Shows some beach accretion fronting the seawall, and little change elsewhere. This change provides some degree of extra protection to the seawall and promenade. SBN 2- This profile shows a reduction in beach profile with erosion noted near the seawall. Overall however, the entire profile shows that beach elevation is notably higher (by up to 1m) than it was during the baseline survey of November 2008. SBN 3- Shows minor erosion in front of the seawall, and on the lower beach, but otherwise there is little change. SBN 4- Net gain of material overall. This represents a departure from the typical winter beach profile adjustment. SBN 5- Indicates a subtle landward transfer of beach sediments, which may act to provide additional protection to structures at the back of the beach. These profiles largely match the patterns of change shown by the topographic surveys.

Survey Date	Description of Changes Since Last Survey	Interpretation
	very back of the beach between chainage c.30m and c.40m there has been some minor deposition of less than 0.5m. Beyond c.40m chainage there is a trend towards erosion which increases with distance seaward, so that by chainage c.75m the graph shows erosion of 0.5m. This broadly matches the pattern of change shown on the DGM of difference in Appendix B – Map 8. The profile does not extend as far as MLWS and therefore comparison of the seaward part of the beach with previous surveys is not possible. **Topographic Survey:** Data were collected from the Scarborough North Bay frontage to support a potential PAR scheme (for further details refer to Note 9T6403 from Royal Haskoning 29 March 2011). Data have been used to create a DGM (Appendix B – Map 7) using a Geographic Information System (GIS) computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (February 2011) and the earlier topographic survey DGM (September 2010), with 5m raster grids (as shown in Appendix B – Map 8), to identify areas of erosion and accretion. Appendix B – Map 8 shows that change to the beach within North Bay has been mostly minor. The northern part of the survey area shows two linear, shore parallel bands of deposition. The middle section of the survey is dominated by erosion which is particularly intense at the back of the beach near Peasholm Gap where over 1m beach reduction was recorded. Further to the southeast, accretion prevails at the back of the beach with little change shown further seaward, with the exception of a small pocket of erosion at the southerly extent of the survey, adjacent to the rock armour protecting Marine Drive.	Areas of minor erosion & deposition are located within North Bay, with no clear overall pattern of beach growth or loss. In contrast, the previous survey indicated a general movement of material seawards.

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2011	**Beach Profiles:** Scarborough South Bay is covered by four beach profile lines, situated between the Old Harbour in the north and The Spa Complex in the south (Figure 1 – Map 6). SBS 1- The previous survey revealed an undulating profile which has now been flattened out – this is typical of a storm response, leading to bands of accretion or erosion of up to 0.75m. The overall gradient of the resulting beach profile has not changed significantly. SBS 2- This profile shows erosion of the beach surface along most of its length. This is particularly marked near the back of the beach and seawall (up to 0.75m erosion). At the seaward end of the profile (beyond chainage c.160m) there is some deposition shown on both the profile graph and the corresponding DGM of difference. SBS 3- The beach fronting the seawall has been eroded by c.0.5m since the last beach survey (up to chainage length of c.50m) resulting in the lowest levels recorded during the current monitoring programme. Consequently the beach level (c.1.1m AOD) remains below MHWS of 2.45m AOD. Between c.50 and c.130 m chainage there is little change. Further seaward however, there is another band of erosion, but this is generally less than 0.5m. This pattern of change is clearly reflected in the DGM of difference shown in Appendix B – Map 10. SBS 4- This profile shows a subtle change in beach elevations since the previous survey. At the base of the seawall there has been erosion of up to 0.75m which is concentrated to within 2-3m of the wall itself. Further seaward (between c.10m and c.90m chainage) there has also been some minor erosion of the order of c.0.1m. However, this is not so great as to expose the previously noted rock platform beneath the sand (noted in the March 2010 survey). Beyond c.90m chainage there is little change since the last survey. The DGM of difference clearly shows the same pattern of change, as displayed in Appendix B – Map 10.	SBS 1- There has been little overall change in the beach profile. SBS 2- There has been a notable lowering of the beach along this section, especially fronting the seawall. SBS 3- There has been a notable lowering of the beach fronting the seawall. Reference to past surveys indicates this may be a seasonal trend related to winter storm activity. SBS 4- Beach levels in front of the seawall have been lowered and there has also been minor erosion mid-beach. Elsewhere there has been little change. Taken together these profiles suggest there has been an overall loss of beach materials, especially in the centre and south of the Bay (SBS 2- 4). There is no evidence to suggest a clear direction of long-shore sediment movement.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Cliff Top Survey: Thirteen ground control points have been established at Scarborough South Bay- extending through Cornelian Bay and to Knipe Point within Cayton Bay for the purposes of cliff top monitoring. The separation between any two 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. Appendix C provides results from the March 2010 baseline survey, the subsequent September 2010 and the most recent February 2011 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 3). Of the 13 survey points, seven show no change in cliff top position outside of the +/-0.1m error bands (between March 2010 and February 2011). No measurement was taken for Point 2 during the February 2011 survey. The remaining five point markers show recession of the cliff edge by between 0.2m and 0.9m since March 2010.	No change can be currently reported from point markers 1, 3, 4, 7, 8, 9 and 10. These are located throughout the Bay (as shown on Appendix C – Map 3) and indicate relatively stability of the cliff face in these locations. Point markers 5, 6, 11, 12 and 13 show recession of the cliff top outside the bounds of measurement error. Points 5 and 6 are located immediately southeast of the Holbeck landslide lobe and points 11-13 are located in the south of Cornelian Bay and around Knipe Point. The latter have all shown consistent cliff top recession since the baseline survey of March 2010. The largest amount of recession (0.9m) is observed for point 13 at Knipe Point. It is highly likely that this recession relates to the landslide activity in the north of Cayton Bay that began in April 2008.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Topographic Survey: The Scarborough South frontage was included during the Spring 2011 survey to support works at the Spa Complex (for further detail refer to Note 9T6403 from Royal Haskoning 29 March 2011). Data have been used to create a DGM (Appendix B – Map 9) using a Geographic Information System (GIS) computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (February 2011) and the earlier topographic survey DGM (September 2010), with 5m raster grids (as shown in Appendix B – Map 10), to identify areas of erosion and accretion. Appendix B – Map 10 shows that the northern part of the survey area is characterised by a number of shore parallel linear bands of change in beach elevation. This includes a strip of erosion along the back of the beach which extends from the Harbour to the Clock Café near the southern extent of the survey. Heading seaward, this erosion band is followed by a small band of deposition, another band of less intense erosion and finally another band of deposition extending southwards from the Harbour wall. The southern part of the survey area shows a more complex pattern of change, with pockets of erosion and deposition present within an area characterised by rocky outcrops on the beach. The beach fronting the Spa Complex shows erosion of up to 1m in places.	The Scarborough South topographic survey shows an overall pattern of erosion at the back of beach and a complex pattern elsewhere. This generally suggests that there has been a seaward movement of material between September 2010 and February 2011. This change is considered to reflect beach responses to seasonal wave types, where beach materials move onshore in the summer during periods of swell dominance and offshore in the winter during periods of storm dominance.

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2011	**Beach Profiles:** Cayton Bay is covered by three beach profile lines, located between Tenants' Cliff and the south of Cayton Sands (Figure 1 – Map 7). CY 1- The cliff face is largely vegetated at this location and shows no change since the previous survey. The back of the beach also shows very little change, with some minor erosion (0.25m or less) between chainage c.30m and c.50m. Further seaward there is a greater trend towards erosion, with a maximum beach lowering of approximately 1m at c.100m chainage. The beach profile in this location is rough and undulating suggesting that the underlying rock platform may have been exposed. CY 2- The cliff top position is unchanged since the last survey though there has been some change on the cliff face. Between chainage c.50m and c.95m, the cliff face appears to have been eroded by up to 4m. However, this is related to access constraints during the comparative surveys leading to different interpolations of the cliff slope and it does not represent real change. There has been some minor erosion at the very back of the beach (max 0.5m) and the cliff toe appears to have been eroded by about 2m since the last survey. There has been little change elsewhere. CY 3- The cliff toe appears to have advanced by about 2m (from chainage c.123m to 125m). Between chainage c.150m and c.180m there has been minor accretion of the beach surface by a maximum of 0.2m. Further seaward this trend is reversed so that from chainage c.200m onwards there has been erosion of up to 0.7m. This means that the beach elevation here is now the lowest it has been during the current monitoring programme.	CY 1- Shows erosion of the middle of beach (seaward extent) but little change elsewhere. This erosion may be related to winter storm activity. CY 2- Erosion at the back of the beach is evident, likely related to winter storm activity. There has been little change elsewhere on the cliffs or beach. CY 3- Shows no change to the cliff profile. A band of accretion is evident towards the back of the beach and a band of erosion towards the front. Taken together these profiles suggest that there has been a seaward transfer of beach materials since the last survey, as might be expected under a winter storm system.

Survey Date	Description of Changes Since Last Survey	Interpretation
	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 2011 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. Considering the survey accuracy of +/-0.1m, one of the eight marker points shows no change between the baseline survey and the most recent March 2011 survey. Five marker points have exhibited an advance in cliff top position by between 0.2 and 1.0m and two points have shown a recession of the cliff top by 0.5 and 5.1m.	General stability of the cliff face is expected in the vicinity of marker point 6 where no change is observed outside the bounds of error. In contrast marker points 3, 4, 5, 7 and 8 have shown an apparent advance of the cliff top. Whilst this may be a result of cliff toppling activity it is more likely a consequence of measurement error or an inconsistent interpretation of the true cliff edge between surveys. Marker points 1 and 2 have shown cliff top recession of 0.5m and 5.1m respectively since the baseline survey. These markers are located at Tenants Cliff, in the northern part of Cayton Bay, where rockfalls have been observed previously. A site inspection is required to determine whether rockfalls are responsible for the observed cliff recession.

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2011	**Beach Profiles:** Filey Bay is covered by five beach profile lines, spaced between Filey Sands and Speeton Sands (Figure 1 – Map 8). FB 1- The back of the beach has experienced erosion of up to 0.5m between chainage c.20m and c.50m, so that this part of the beach is now at the lowest level it has been during this monitoring programme. Further seaward the amount of erosion reduces gradually down to chainage c.130m. Beyond this point there has been very little change in beach elevation. As a result, there has been a slight reduction of the beach gradient. FB 2- The cliff face has shown little change since the previous survey, although the data resolution is greater from this survey than previously, lending more detail to the cliff face. The back of the beach between chainage c.70m and c.100m shows some minor erosion; this does not exceed 0.2m. Between c.100m and c.225m there is no change in beach elevation. Further seaward however there is another band of erosion of typically 0.3m. FB 3- The change in beach elevation shown for this profile strongly reflects that shown for profile FB 2. This includes little change to the cliff face and two bands of minor erosion on the beach – one at the cliff toe (chainage c.40m to c.100m) of magnitude 0.1 to 0.2m and one further seaward (chainage c. 220m onwards) also of magnitude 0.1 to 0.2m. FB 4- For the most part, the beach survey shows deposition which is relatively low at the cliff end (c.0.1m) and increases gradually with distance seaward (to c.0.2m) so that from a chainage of about 130m there are record high beach levels. At the very back of the beach (at the cliff toe) there is a small pocket of greater deposition – this is located at chainage distance c.30m and represents an elevation of beach levels by up to 0.6m. FB 5- The survey of the cliff face is interpolated between survey points at the cliff top and cliff	FB 1- The profile shows erosion at the back of the beach as is typical following the winter storm season. This results in reduced protection to the seawall. There has been little change elsewhere. FB 2- This profile shows two bands of minor erosion, one at the cliff toe and one further seaward. Otherwise there has been little change. FB 3- Minor erosion of the beach surface is observed in two bands, including one at the back of the beach resulting in reduced protection to the cliff toe. FB 4- Shows accretion of beach materials, which increase in thickness with distance seaward. This is does not match the usual winter storm pattern of beach erosion. FB 5- The beach shows a pattern of undulating change, with the exception of the very back of the beach which has experienced little change.

Survey Date	Description of Changes Since Last Survey	Interpretation
	bottom, and therefore no real changes in cliff profile can be observed. The back of the beach (between chainage c.220m and 310m) shows very little change in elevation since the last survey. Between c. 310m and c.380m is a pocket of erosion as great as 1m which is then followed by a pocket of deposition (between c. 380m and 415m chainage) of up to 0.9m. Beyond this there is another patch of erosion which is up to 0.7m.	The back of the beach fronting Filey town has experienced erosion with little change observed elsewhere. This pattern of elevation change supports the findings shown by the beach profile FB1 and may represent the recognised offshore movement of material during winter wave conditions.
	Topographic Survey (Filey Town): In addition to the annual full topographic survey of Filey Bay, a smaller sub-section fronting Filey Town was also surveyed during the partial measures programme allowing bi-annual analysis of beach change. Data have been used to create a DGM (Appendix B - Map 11) using a Geographic Information System (GIS) computer software package. The GIS has also been used to calculate the differences between the current topographic survey DGM (March 2011) and the earlier topographic survey DGM (September 2010) with 5m raster grids to identify areas of erosion and accretion. Appendix B - Map 12 shows a linear, shore parallel band of minor erosion (under 0.5m change) running along of the beach, immediately beneath the seawall. Elsewhere, the survey suggests that there has been little significant change in beach elevation.	The nine points which have shown no clear change in cliff top position since the baseline survey suggest that there has been general stability of the cliff face at these locations (9, 11, 15, 16, 17, 18, 19, 21 and 23). These points are mostly situated in the southern part of Filey Bay between Flat Cliffs and Speeton Sands.
	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	The ten markers showing an apparent advance of the cliff line are numbered 1, 2, 3, 4, 6, 8, 12, 13, 20 and 22 and show advance between 0.2m and 0.4m since November 2008. The markers are scattered through the Bay, with a noticeable cluster between the Brigg and Filey Town itself. Whilst these advances may result from cliff toppling activity, they are more likely a consequence of measurement error or an inconsistent

Survey Date	Description of Changes Since Last Survey	Interpretation
	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 2011 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. Four of the twenty-eight ground control markers in Filey Bay show recession of the cliff line between November 2008 and March 2011. Of the remaining points, five were not established in 2008, nine show no apparent change in cliff top position (given consideration of survey accuracy) and ten points show an advance in the cliff top position by between 0.2m and 0.4m.	interpretation of the true cliff edge between surveys. The four ground control point markers which do appear to be showing cliff top recession are numbered 5, 7, 10 and 14, all located to the south of Filey town. The amount of recession recorded varies from 0.2m at points 7 and 10 to 5.5m at point 5. This marker is located immediately south of the seawall at Filey town and has shown consistent cliff top retreat between the baseline survey of November 2008 and March 2010, although there has been little change since then. It is likely that activity relates to outflanking of the Filey seawall. Such activity is currently being examined in the Filey Coastal Stability and Outflanking Study.

3. Problems Encountered and Uncertainty in Analysis

Topographic survey
As outlined in Analytical Reports 2 (March 2010) and 3 (February 2011).

Survey accuracy of beach/ cliff profiles
Determining the amount of change on cliff faces from the beach profile data is difficult in steep and inaccessible locations. This is because the profile represents interpolation between survey data at the top and bottom of the cliff. Survey photographs can provide information on the nature of change on the cliff, but do not allow the change to be measured. As a result, further consideration to improving data capture for steep and unstable cliff locations would assist interpretation and reporting.

The length of the beach profiles often varies between surveys. This means that some extend much further seaward than others. As a result, it is not always possible to assess beach change down the entire length of the beach or around the MLW mark.

Cliff top erosion errors & data capture techniques
The cliff top surveys are assumed to have an accuracy of ± 0.1m due to the techniques used. However, at a large number of locations apparent advance of the cliff top position has been calculated. This result may represent toppling failures that lead to extension of the cliff top, but this interpretation is not supported by site inspections. It is more likely that the result is due to differing interpretations of the cliff edge which can be hampered by seasonal vegetation cover. This problem is most evident at Staithes, Cayton Bay and Filey Bay. Analysis of orthorectified aerial imagery is likely to be a more reliable method for determining long-term cliff recession rates. Repeat terrestrial laser scan surveys of cliff faces would allow the precise volumes of sediment produced by cliff recession to be quantified. GPS measurements collected in a line along the cliff edge also offer an alternative method of measuring cliff top change with a more continuous spatial coverage.

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

The following recommendations are suggested:

- Consider measures to improve the accuracy of cliff top and cliff face survey data capture. This could include a site visit by a cliff geomorphologist to confirm failure mechanisms, or analysis of repeat aerial survey data. A programme of targeted terrestrial laser scanning would provide very detailed information on the mechanism and rates of cliff recession.

- Further consideration could be given to analysis and reporting of the longer term beach behaviours as shown by the earliest and most recent topographic survey data. For example, this could include the calculation of change in relative beach volumes or the calculation of cross sectional area change using beach profile data..

5. Conclusions and Areas of Concern

The majority of the patterns of beach change along the Cell One frontage reflect seasonal movements of sediment both on- and off-shore that match previous years' observations. Areas where there has been significant erosion, which may reflect a long-term trend rather than a seasonal cycle, include beaches fronting sea defences at Robin Hoods Bay and Scarborough North Bay. Generally there is good agreement between the beach profiles and the DGMs.

The measurements of cliff top change are frequently erroneous. This is an issue that relates to mis-interpretation of the true cliff top position. Some data suggests that typical recession rates are 0.2 to 0.3m/yr with maximum values reaching 2.2m/yr and 3.3m/yr in soft till cliffs immediately south of Filey town and at the northern end of Robin Hoods Bay respectively.

Site specific conclusions are:

- The cliff top markers along the Staithes frontage show a mixed pattern of retreat and no change. Hotspots of cliff top retreat are located to the west of Staithes adjacent to Cowbar Lane and above Staithes Harbour.

- The Runswick Bay topographic survey indicates a band of deposition running along the back of the beach suggesting that there has been a landward migration of beach materials since the previous survey. This is not typical of the usual winter storm type system.

- The Sandsend to Whitby frontage shows dynamic shifts in the beach profile with laterally extensive bands of both accretion and erosion. The beach profiles suggest there may have been some movement of material eastwards towards Whitby. There has been an accumulation of material at the back of the beach beneath the Upgang mudslides.

- Robin Hood's Bay shows a largely stable foreshore, especially in areas dominated by rock platforms. Cliff top markers show a mixed pattern of no change and recession at one location in the north of the Bay.

- The topographic survey for Scarborough North Bay shows a mixed pattern of beach elevation change, with deposition dominating the northern section and erosion more prevalent in the middle section of the Bay. This erosion is particularly intense in the area of Peasholm Gap. However there is no clear overall pattern of beach growth or loss.

- At Scarborough South Bay there has been notable erosion at the back of the beach, thereby reducing protection of the base of the seawall. There also been some deposition further seaward, to the southwest of the Harbour. Hotspots of cliff top recession are located just south of the Holbeck Hall landslide run out lobe and in the vicinity of Knipe Point. The latter is most likely related to recent landslide activity at the northern end of Cayton Bay.

- The overall pattern of change observed within Cayton Bay suggests there has been a seaward migration of beach materials, with erosion observed at the back of the beach. The cliff top markers show little movement of the cliff edge position, with the exception of a couple of markers located within Tenants Cliff.

- Erosion of the back of the beach is notable from the topographic survey within Filey Bay, suggesting that there has been seaward movement of materials. The cliff top marker survey indicates that the cliff face is relatively stable in most places, with the exception of a few locations to the south of Filey town. Of particular note is the large amount of recession recorded by marker 5, immediately south of Filey itself. This marker is located just south of where the Filey seawall ends and therefore probably represents ongoing outflanking activity at this location.

Appendices

Appendix A

Beach Profiles

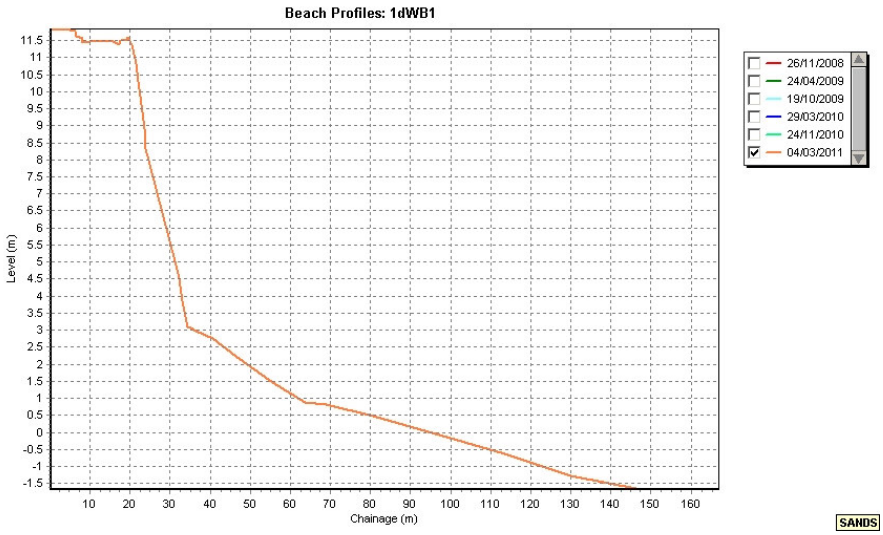
Beach Profile

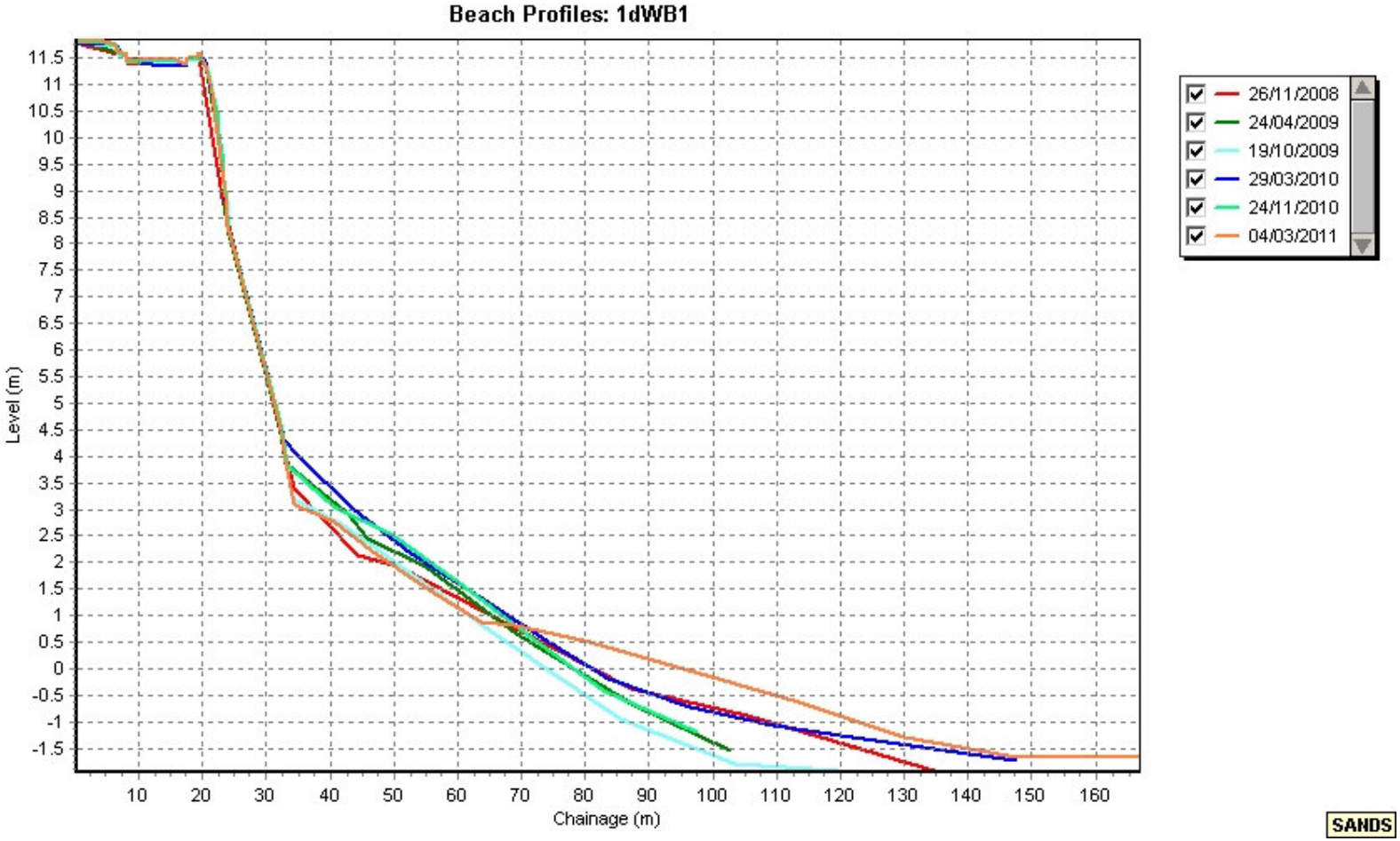
1dWB1

Date 04/03/2011 **Wind** **Summary** Slight Breeze	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 09:00 to 10:00. **Rain** No
Easting 486535.075	**Northing** 512437.797	**Bearing** 47	

Chainage (from base station)	Level AOD (m)
0	11.819
0.019	11.819
3.638	11.841
6.305	11.767
6.635	11.616
8.025	11.567
8.084	11.449
11.946	11.488
15.765	11.458
17.41	11.386
17.47	11.5
19.199	11.506
19.411	11.604
19.868	11.508
20.44	11.391
21.45	10.84
22.123	10.312
22.919	9.618
23.671	8.902
23.857	8.326
24.18	8.221
31.861	4.661
32.209	4.511
33.081	3.882
34.341	3.11
35.099	3.06
36.528	2.981
40.541	2.765
46.452	2.231
55.549	1.475
63.797	0.894
68.918	0.819

79.568	0.523
93.637	0.052
113.377	-0.634
129.935	-1.281
146.264	-1.648
156.652	-1.675
166.671	-1.675



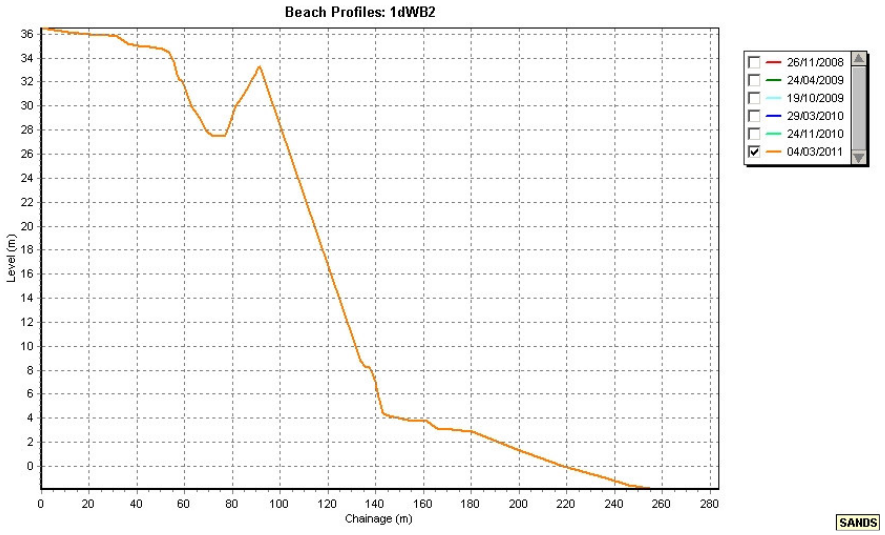

Beach Profiles: 1dWB1
Level (m)
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Chainage (m)
26/11/2008
24/04/2009
19/10/2009
29/03/2010
24/11/2010
04/03/2011
SANDS

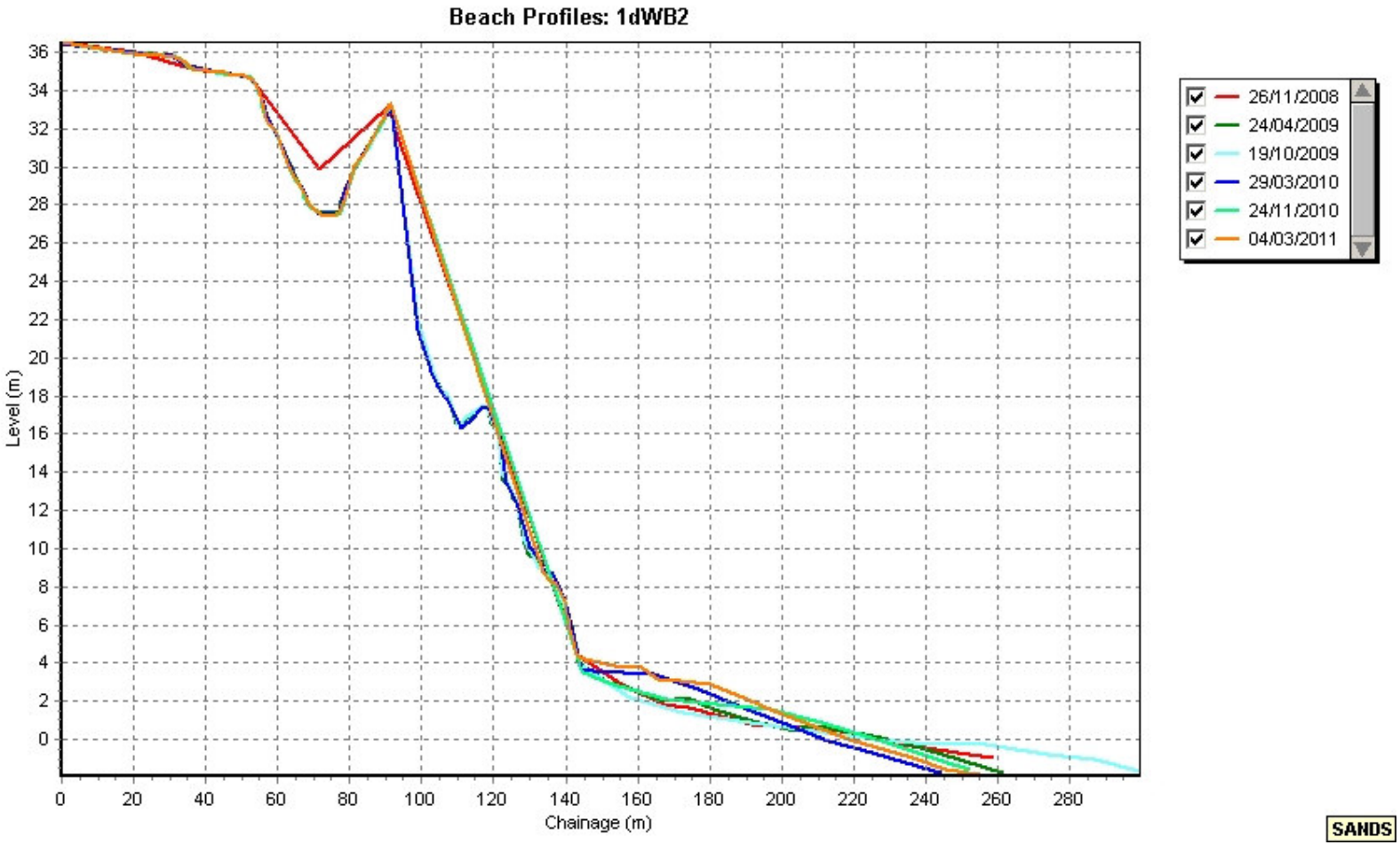
Beach Profile

1dWB2

Date 04/03/2011 **Wind** **Summary** Slight Breeze **Easting** 487550.221	**Inspector** **Sea State** Calm **Northing** 511927.902	**Low Tide (m)** **Visibility** - **Bearing** 16	**Low Tide Time** 09:00 to 10:00. **Rain** No

Chainage (from base station)	Level AOD (m)
0	36.505
0.193	36.505
11.09	36.165
20.142	35.947
27.975	35.862
31.54	35.768
34.279	35.465
35.988	35.173
40.247	35.047
45.182	34.915
47.98	34.803
50.645	34.787
53.297	34.497
53.716	34.372
55.341	33.693
56.696	32.624
57.634	32.244
58.529	32.088
59.313	31.882
61.514	30.665
63.033	29.96
65.158	29.323
66.81	28.829
68.081	28.234
69.009	27.905
71.837	27.471
74.362	27.451
76.343	27.512
77.138	27.569
78.932	28.442
81.346	30.051
83.67	30.597
85.237	31.198
85.693	31.353
86.766	31.588
88.522	32.3
89.859	32.685
90.049	32.931
90.807	33.08
91.01	33.284
91.341	33.301
133.818	8.787
135.815	8.21
136.565	8.273
137.458	8.106
138.476	7.759
139.555	7.269
140.122	6.925
140.31	6.541
140.917	6.219
141.356	5.754
142.081	5.203
142.906	4.443
144.128	4.3
147.271	4.128
153.62	3.872
161.303	3.724
166.099	3.053
168.69	3.054
171.836	3.036
180.292	2.929
190.216	2.111
197.863	1.476
218.598	-0.031
236.094	-0.984
245.748	-1.547
254.749	-1.86
268.018	-1.929
279.064	-1.91
283.652	-1.833



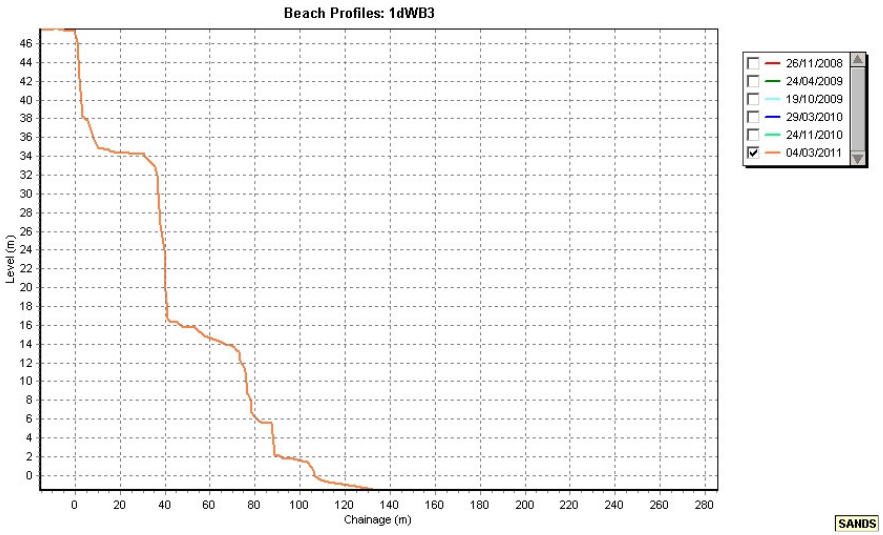

Beach Profiles: 1dWB2
Level (m)
Chainage (m)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
26/11/2008
24/04/2009
19/10/2009
29/03/2010
24/11/2010
04/03/2011
SANDS

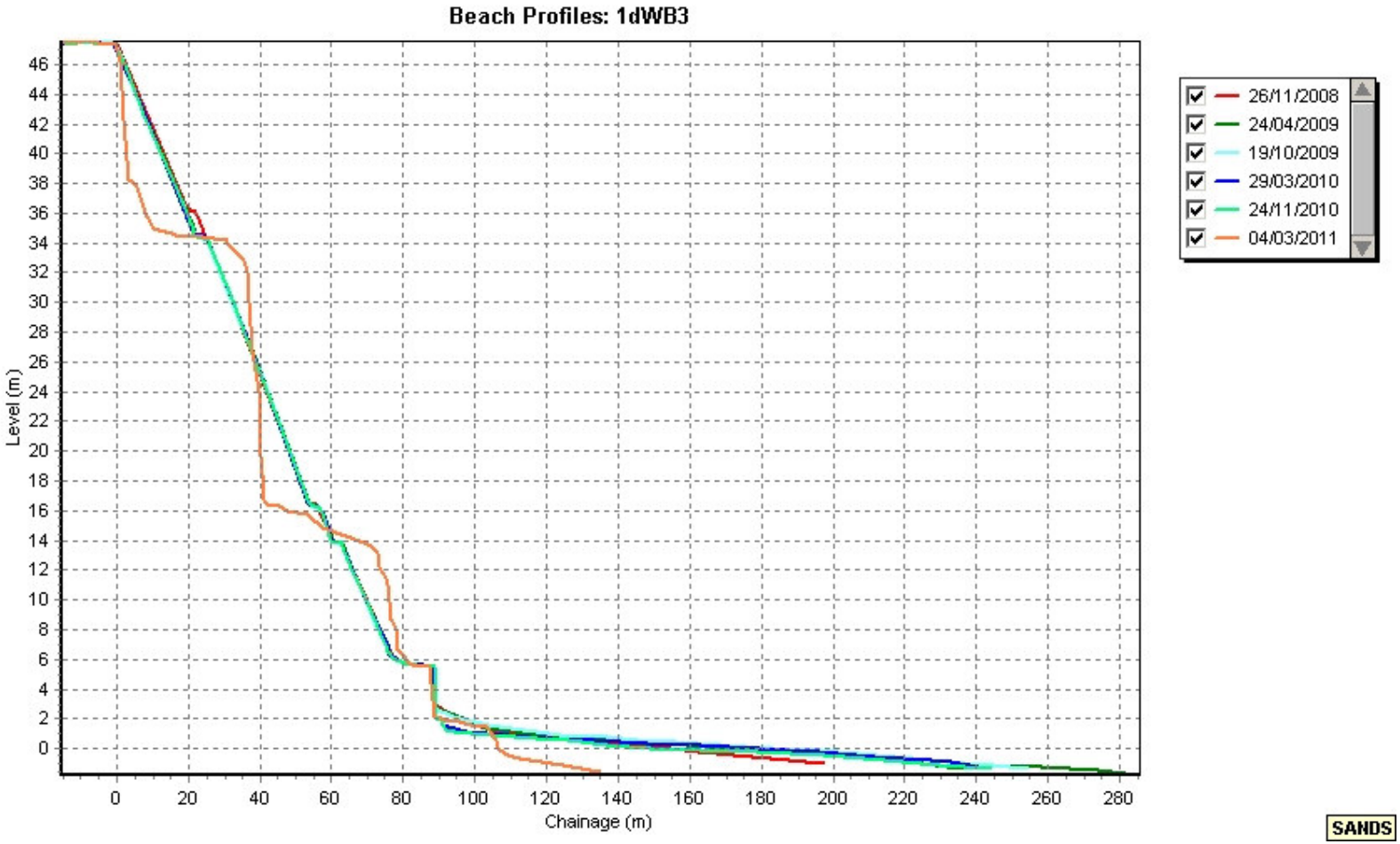
Beach Profile

1dWB3

Date 04/03/2011 **Wind** **Summary** Slight Breeze **Easting** 488983.57	**Inspector** **Sea State** Calm **Northing** 511527.047	**Low Tide (m)** **Visibility** - **Bearing** 19	**Low Tide Time** 09:00 to 10:00. **Rain** No

Chainage (from base station)	Level AOD (m)
-15.554	47.424
-14.393	47.457
-13.415	47.421
-12.326	47.5
-11.299	47.478
-9.821	47.566
-7.229	47.544
-5.282	47.472
-0.451	47.348
1.161	46.235
2.139	42.296
3.228	38.284
4.255	38.09
5.733	37.832
8.325	35.777
10.272	34.958
15.103	34.679
15.554	34.587
17.156	34.444
23.91	34.379
30.908	34.2
31.011	33.973
31.793	33.75
35.557	32.862
36.76	31.575
37.035	30.062
37.69	26.772
39.5	24.045
40.206	19.655
40.924	17.146
41.005	16.758
41.66	16.553
43.034	16.339
45.208	16.316
47.754	15.934
53.199	15.759
57.44	14.837
64.174	14.316
67.746	13.907
68.579	13.828
69.275	13.829
71.115	13.651
71.392	13.466
72.785	13.208
73.232	12.277
74.213	11.807
74.975	11.5
75.805	11.09
76.459	8.721
78.204	7.878
78.278	7.106
78.616	6.672
79.232	6.386
80.529	6.18
81.503	5.767
82.508	5.674
83.174	5.571
87.083	5.553
88.749	2.167
90.721	2.09
91.194	1.951
91.698	1.957
92.566	1.814
95.766	1.827
98.849	1.634
103.086	1.433
103.862	1.253
104.421	1.028
105.098	0.823
106.141	0.566
106.227	0.336
106.366	0.006
106.72	-0.107
109.18	-0.416
112.343	-0.669
124.723	-1.11
134.833	-1.589



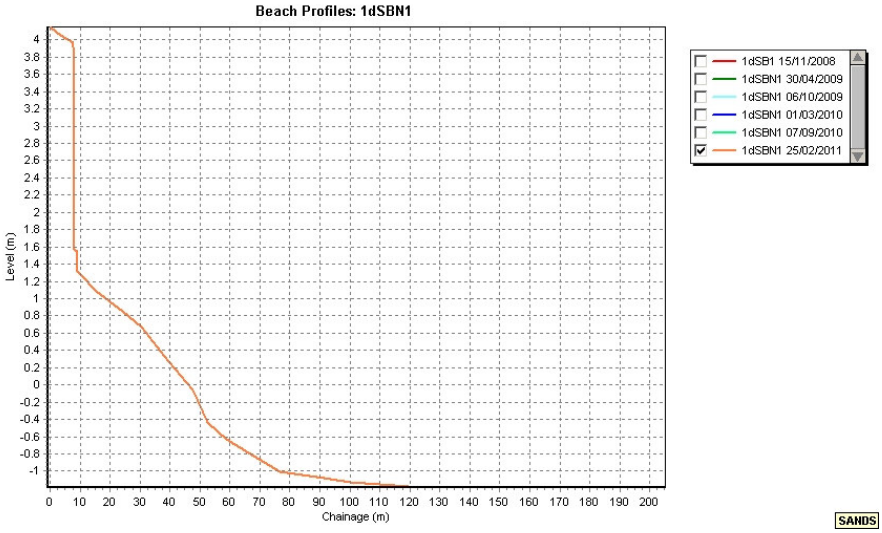

Beach Profiles: 1dWB3
Level (m)
Chainage (m)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
26/11/2008
24/04/2009
19/10/2009
29/03/2010
24/11/2010
04/03/2011
SANDS

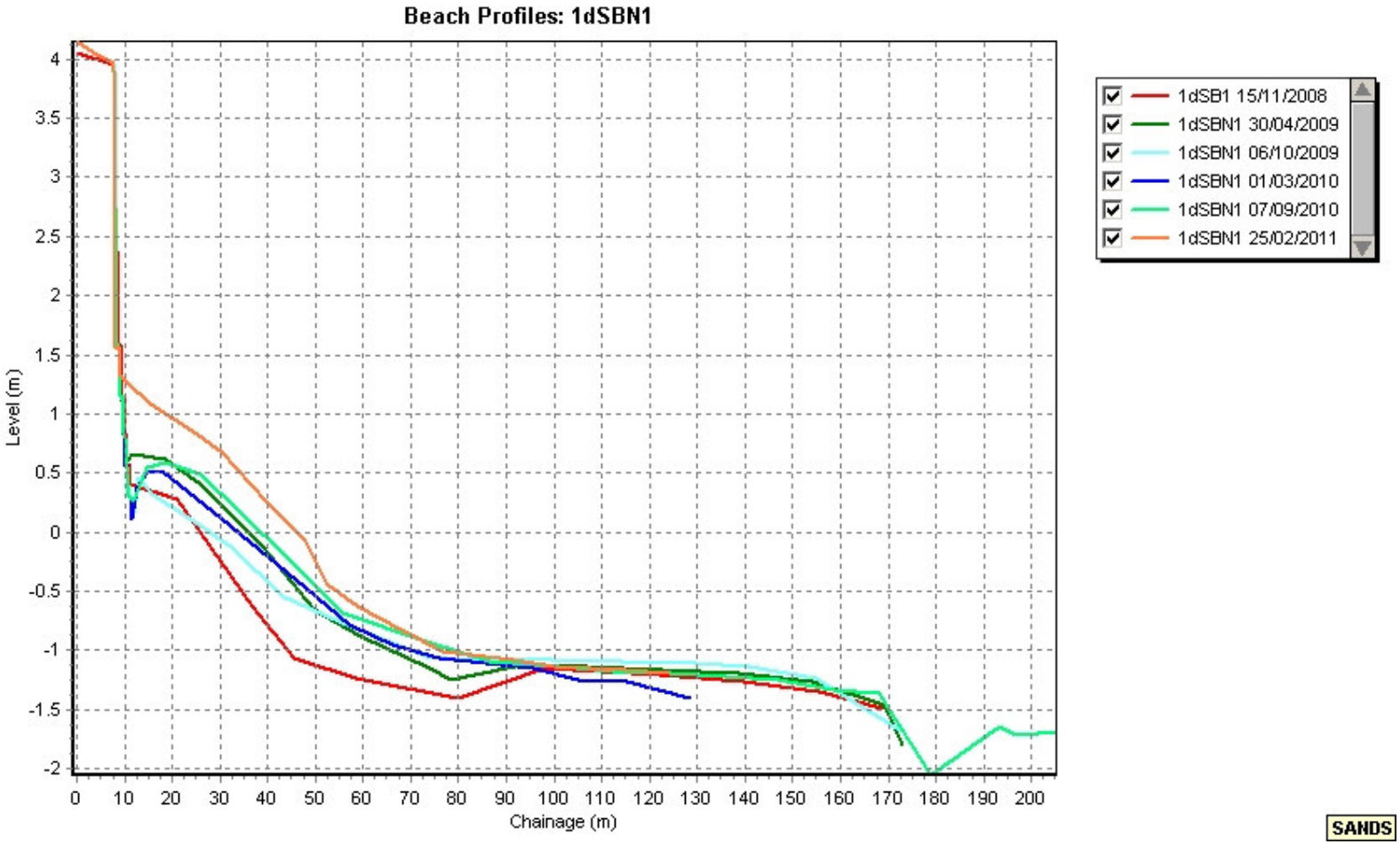
Beach Profile

1dSBN1

Date 25/02/2011 **Wind** **Summary** Breezy **Easting** 503543.363	**Inspector** **Sea State** Calm **Northing** 490470.74	**Low Tide (m)** **Visibility** - **Bearing** 79	**Low Tide Time** 14.45 **Rain** No

Chainage (from base station)	Level AOD (m)
0	4.151
0.082	4.151
3.664	4.05
7.746	3.964
7.813	3.915
8.217	1.57
8.952	1.55
8.953	1.321
10.181	1.278
15.361	1.09
24.016	0.851
30.479	0.668
39.636	0.267
47.698	-0.057
52.676	-0.441
58.885	-0.629
68.056	-0.831
76.821	-1.012
91.357	-1.086
99.974	-1.131
114.968	-1.165
124.012	-1.19



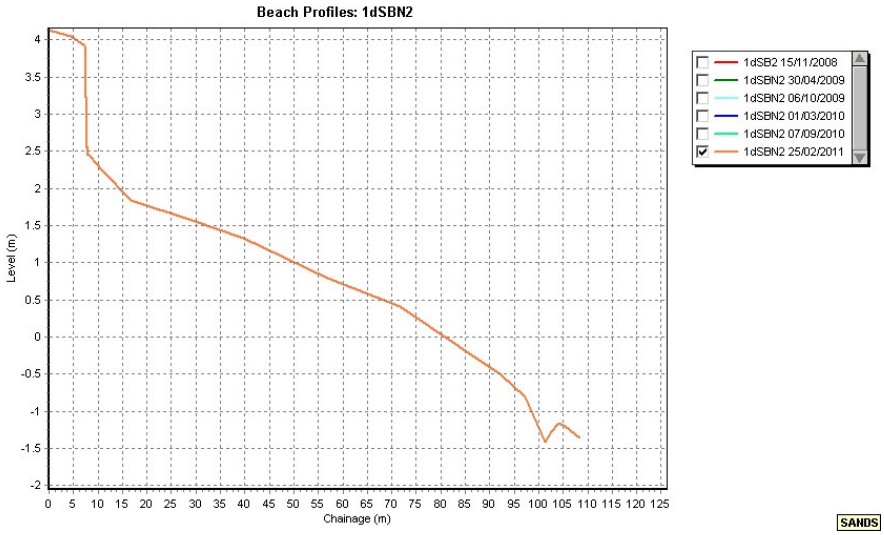

Beach Profiles: 1dSBN1
Level (m)
Chainage (m)
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
1dSB1 15/11/2008
1dSBN1 30/04/2009
1dSBN1 06/10/2009
1dSBN1 01/03/2010
1dSBN1 07/09/2010
1dSBN1 25/02/2011
SANDS

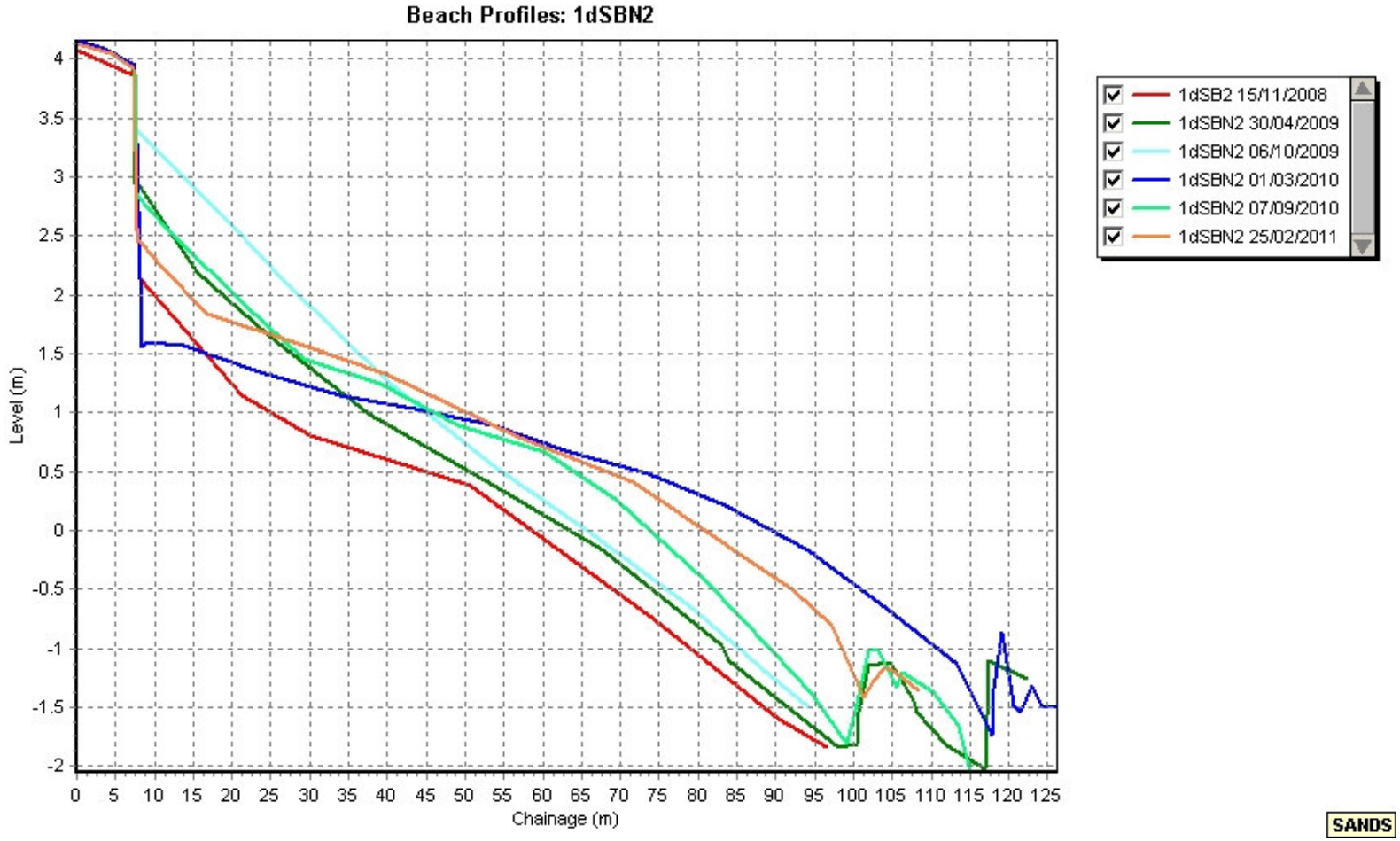
Beach Profile

1dSBN2

Date 25/02/2011	**Inspector**	**Low Tide (m)**	**Low Tide Time**
Wind	**Sea State** Calm	**Visibility** -	14.45
Summary Breezy			**Rain** No
Easting 503616.346	**Northing** 490135.674	**Bearing** 78	

Chainage (from base station)	Level AOD (m)
0	4.137
0.072	4.137
4.588	4.042
7.366	3.916
7.539	3.868
7.554	3.23
7.64	3.21
7.66	2.888
7.755	2.874
7.771	2.544
7.899	2.542
7.937	2.447
8.01	2.465
8.335	2.435
10.988	2.23
16.809	1.84
29.222	1.567
39.61	1.326
47.898	1.07
56.872	0.797
71.744	0.417
83.766	-0.128
92.32	-0.51
97.183	-0.801
101.343	-1.419
102.492	-1.273
104.187	-1.162
105.309	-1.205
108.435	-1.353



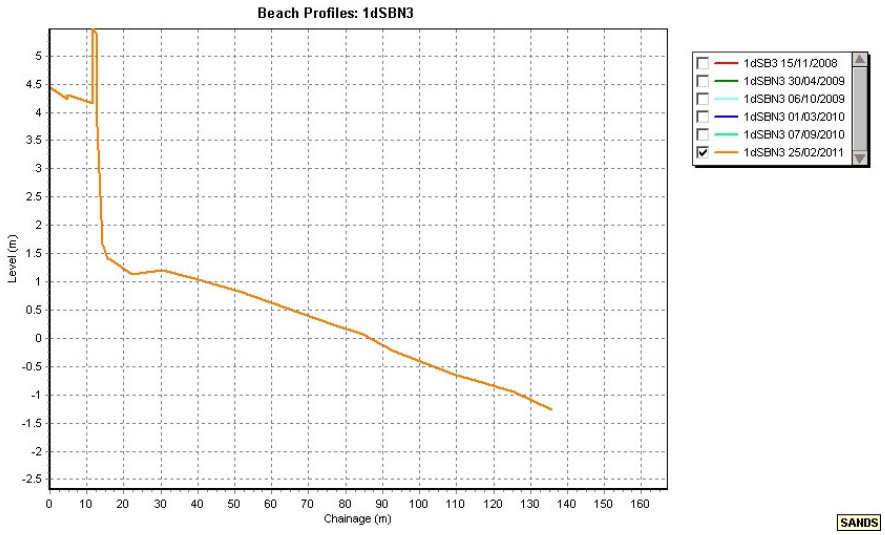

Beach Profiles: 1dSBN2
Level (m)
Chainage (m)
1dSB2 15/11/2008
1dSBN2 30/04/2009
1dSBN2 06/10/2009
1dSBN2 01/03/2010
1dSBN2 07/09/2010
1dSBN2 25/02/2011
SANDS

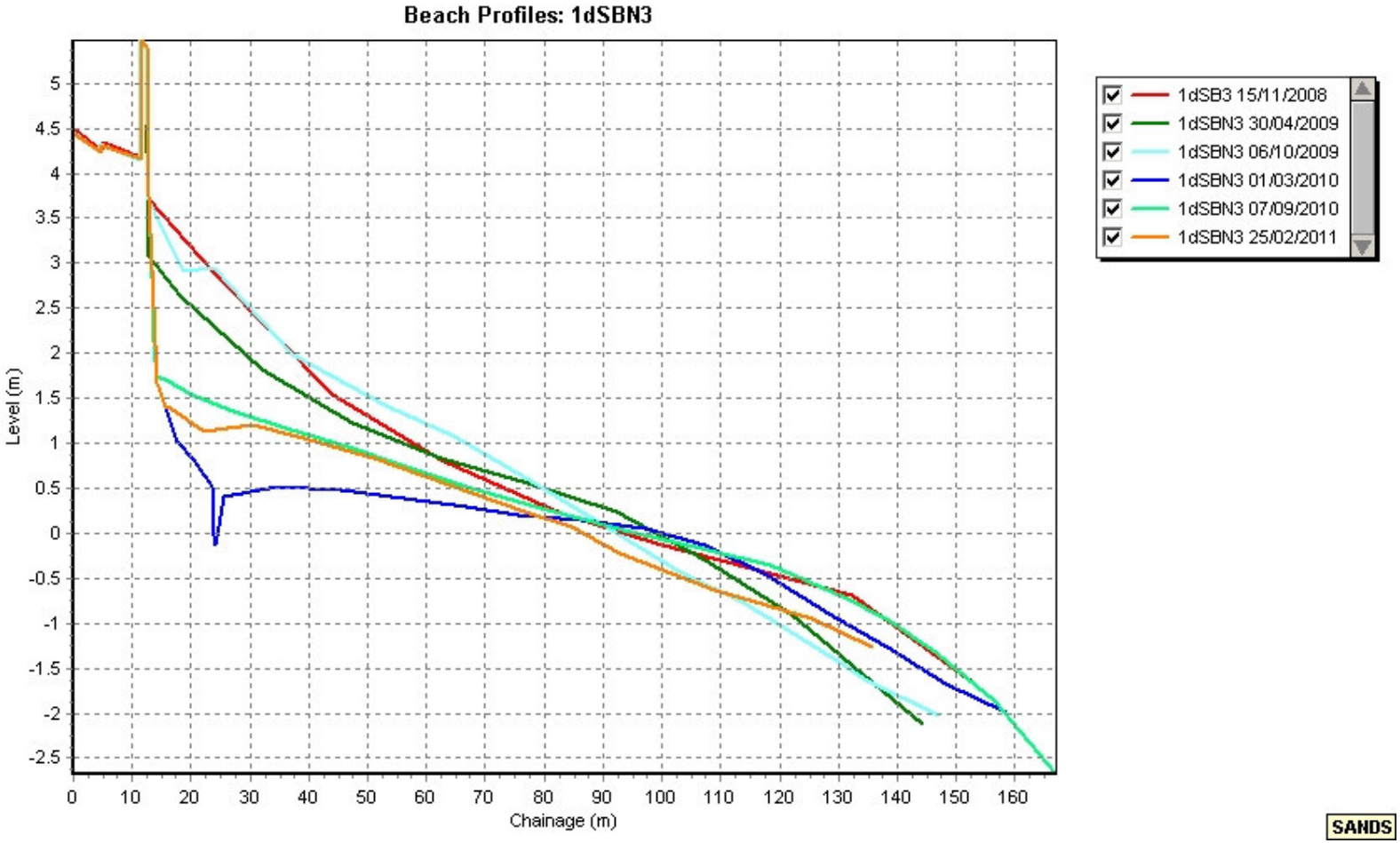
Beach Profile

1dSBN3

Date 25/02/2011 **Wind** **Summary** Breezy	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 14.45 **Rain** No
Easting 503803.958	**Northing** 489708.316	**Bearing** 58	

Chainage (from base station)	Level AOD (m)
0	4.442
4.713	4.228
4.73	4.315
8.118	4.229
11.574	4.156
11.645	5.475
12.621	5.406
12.668	3.753
14.293	1.671
15.611	1.405
16.342	1.389
22.165	1.126
30.448	1.2
39.091	1.053
50.994	0.834
63.974	0.533
76.714	0.236
84.594	0.067
92.774	-0.232
109.052	-0.63
117.92	-0.803
125.474	-0.946
135.627	-1.271




Beach Profiles: 1dSBN3
Level (m)
Chainage (m)
1dSB3 15/11/2008
1dSBN3 30/04/2009
1dSBN3 06/10/2009
1dSBN3 01/03/2010
1dSBN3 07/09/2010
1dSBN3 25/02/2011
SANDS

Beach Profile

1dSBN4

Date 25/02/2011
Wind
Summary Breezy

Easting 504111.79

Inspector
Sea State Calm

Northing 489397.699

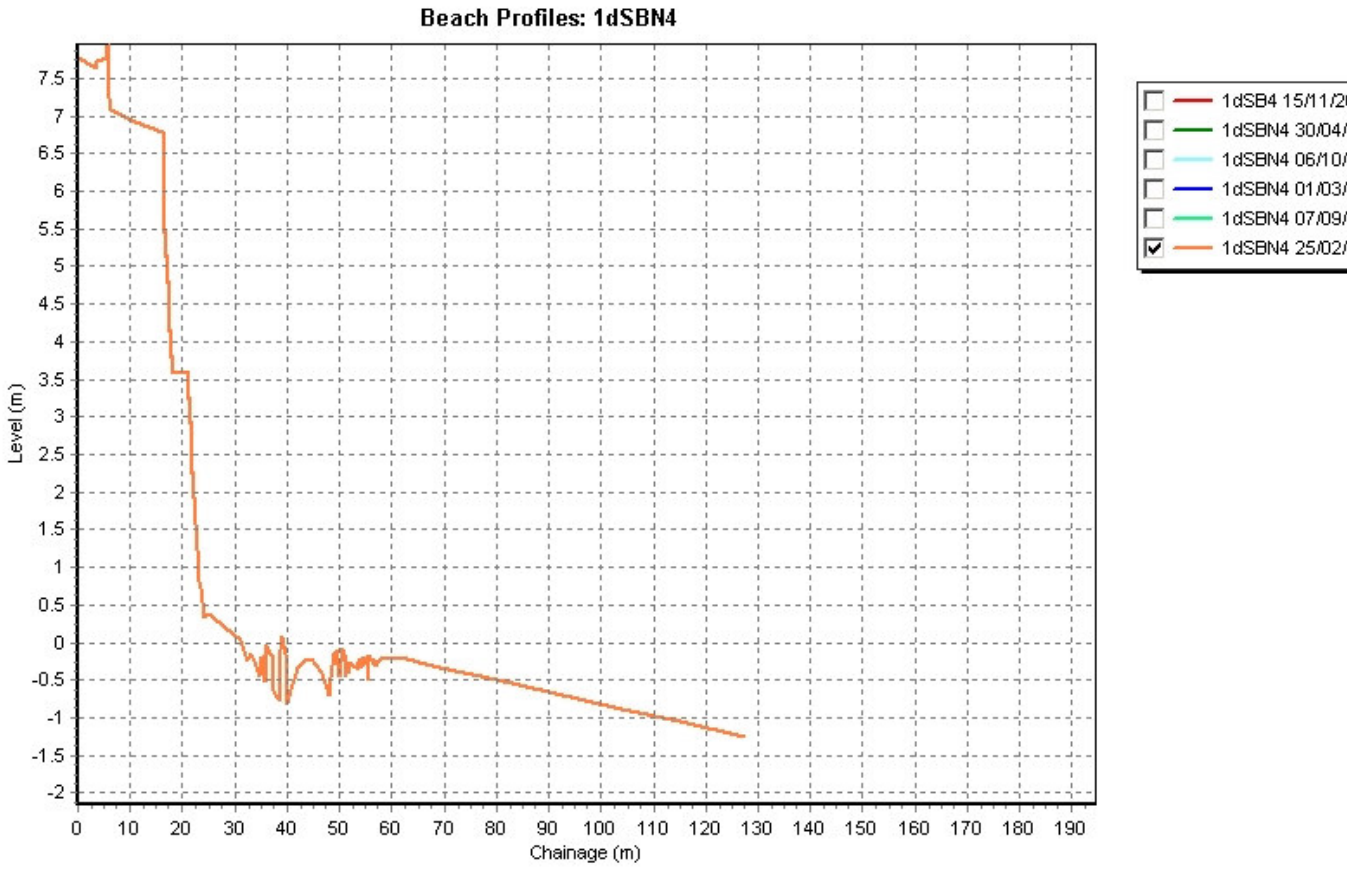
Low Tide (m)
Visibility -

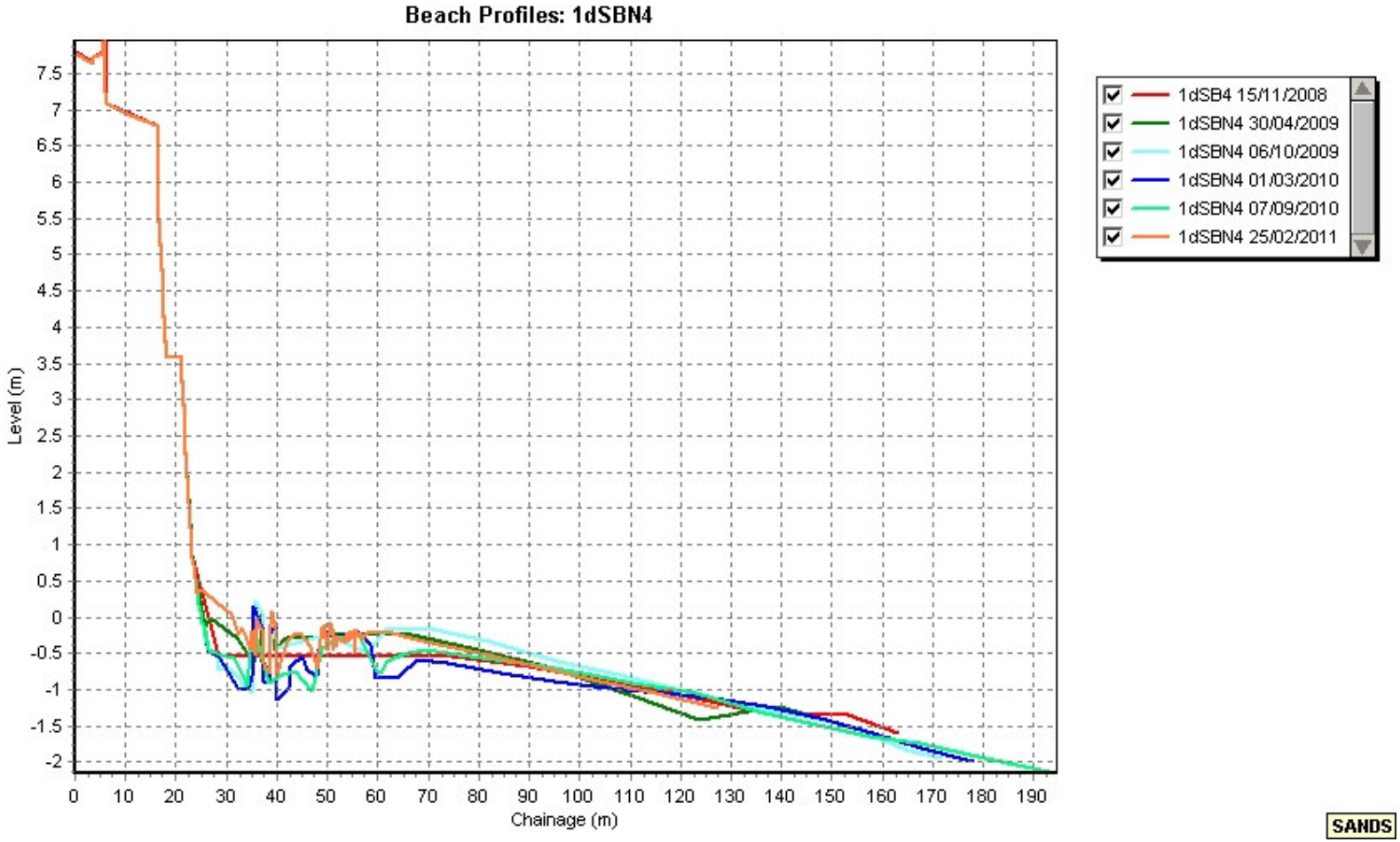
Bearing 38

Low Tide Time
14.45

Rain No

Chainage (from base station)	Level AOD (m)
0	7.781
0.007	7.781
3.744	7.638
3.785	7.717
5.615	7.784
5.69	7.945
5.915	7.94
6.03	7.239
6.115	7.246
6.22	7.072
11.017	6.929
16.156	6.776
16.474	6.757
16.479	5.781
16.678	5.78
16.678	5.45
16.927	5.45
16.928	5.12
17.178	5.12
17.178	4.79
17.428	4.79
17.428	4.46
17.678	4.46
17.679	4.13
17.928	4.13
17.929	3.8
18.178	3.8
18.178	3.57
21.228	3.57
21.229	3.24
21.476	3.24
21.478	2.91
21.727	2.91
21.729	2.58
21.977	2.58
21.979	2.25
22.227	2.25
22.266	1.924
22.482	1.898
22.54	1.584
22.782	1.54
22.79	1.242
22.945	1.229
23.129	0.906
23.29	0.896
23.301	0.826
23.635	0.726
24.102	0.339
25.01	0.373
28.214	0.194
31.062	0.025
32.539	-0.238
33.054	-0.159
33.38	-0.196
34.388	-0.379
34.854	-0.439
35.091	-0.196
35.647	-0.188
35.749	-0.511
35.926	-0.499
36.016	-0.133
36.131	-0.023
36.79	-0.15
37.331	-0.188
37.472	-0.632
38.037	-0.714
38.568	-0.767
38.599	-0.093
38.898	0.075
39.516	-0.03
40.036	-0.279
40.066	-0.809
40.085	-0.808
40.704	-0.641
42.035	-0.329
43.313	-0.246
44.499	-0.21
46.589	-0.401
47.851	-0.708
48.244	-0.698
48.309	-0.483
48.786	-0.317
48.932	-0.151
49.479	-0.108
49.6	-0.206
49.692	-0.296
49.915	-0.444
50.181	-0.418
50.23	-0.242
50.561	-0.239
50.649	-0.077
51.097	-0.151
51.186	-0.423
51.282	-0.444
51.425	-0.267
52.083	-0.396
52.103	-0.257
53.56	-0.367
53.616	-0.316
53.727	-0.322
53.734	-0.261
53.962	-0.222
54.333	-0.332
54.477	-0.257
54.664	-0.194
54.925	-0.294
55.372	-0.189
55.523	-0.312
55.568	-0.504
55.667	-0.491
55.678	-0.18
56.421	-0.284
56.464	-0.212
56.621	-0.214
56.748	-0.307
57.036	-0.32
58.055	-0.225
61.475	-0.204
69.141	-0.324
79.899	-0.497
89.991	-0.652
104.014	-0.875
115.098	-1.05
127.381	-1.253


Beach Profiles: 1dSBN4
Level (m)
Chainage (m)
1dSB4 15/11/2
1dSBN4 30/04/
1dSBN4 06/10/
1dSBN4 01/03/
1dSBN4 07/09/
1dSBN4 25/02/

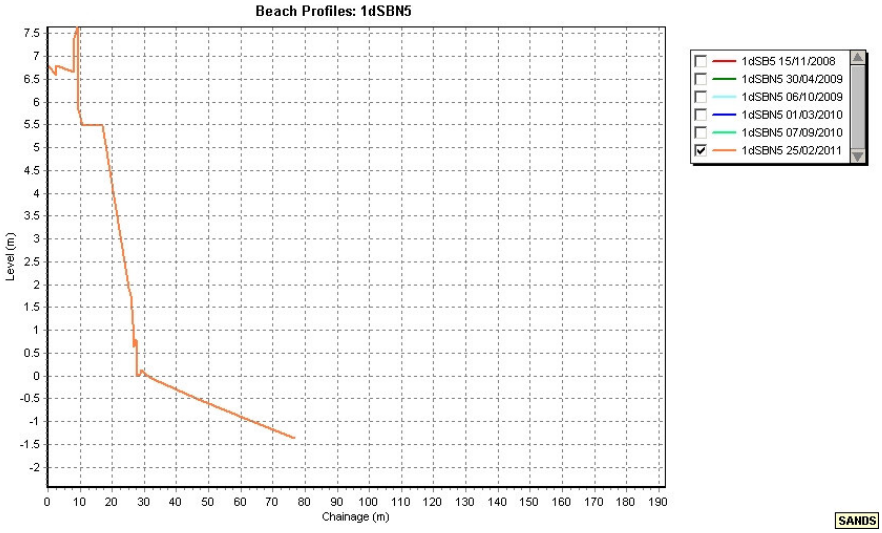

Beach Profiles: 1dSBN4
Level (m)
Chainage (m)
1dSB4 15/11/2008
1dSBN4 30/04/2009
1dSBN4 06/10/2009
1dSBN4 01/03/2010
1dSBN4 07/09/2010
1dSBN4 25/02/2011
SANDS

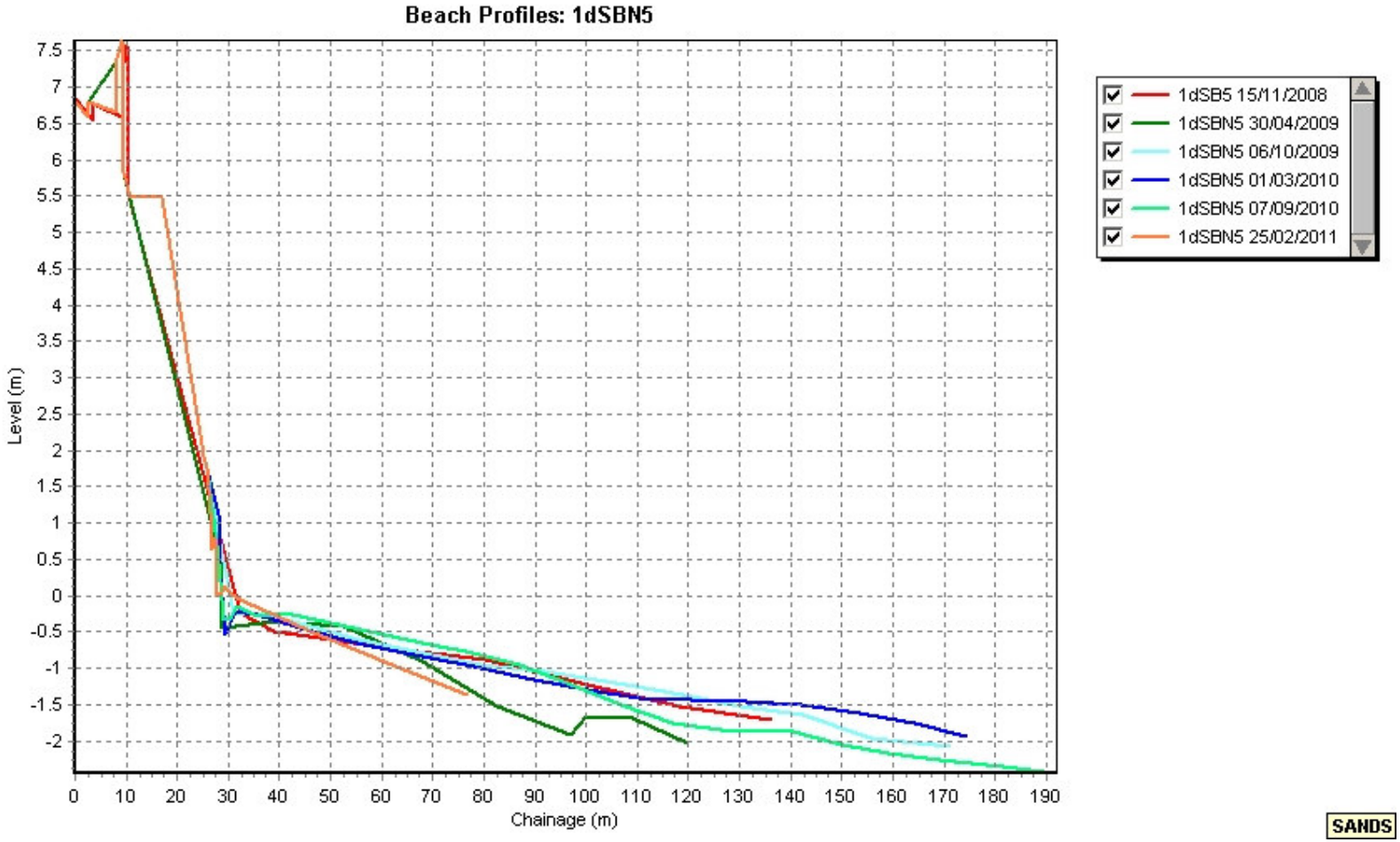
Beach Profile

1dSBN5

Date 25/02/2011 **Wind** **Summary** Breezy	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 14.45 **Rain** No
Easting 504515.599	**Northing** 489205.723	**Bearing** 14	

Chainage (from base station)	Level AOD (m)
0	6.793
0.001	6.793
2.504	6.58
2.576	6.796
8.228	6.646
8.231	6.652
8.235	7.361
8.283	7.397
8.986	7.645
9.164	7.645
9.489	5.833
10.856	5.495
14.148	5.474
16.925	5.496
25.081	1.919
25.892	1.765
26.575	1.146
26.699	0.687
26.794	0.635
27.43	0.788
27.766	0.674
27.906	0.002
28.665	0.049
29.028	0.12
30.672	0.023
32.94	-0.07
46.098	-0.495
51.699	-0.642
65.84	-1.055
76.679	-1.362



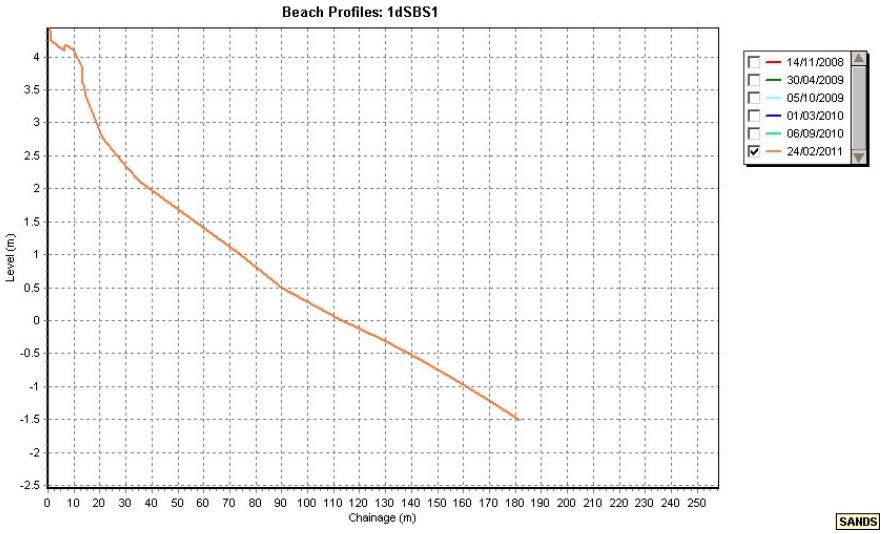

Beach Profiles: 1dSBN5
Level (m)
Chainage (m)
1dSB5 15/11/2008
1dSBN5 30/04/2009
1dSBN5 06/10/2009
1dSBN5 01/03/2010
1dSBN5 07/09/2010
1dSBN5 25/02/2011
SANDS

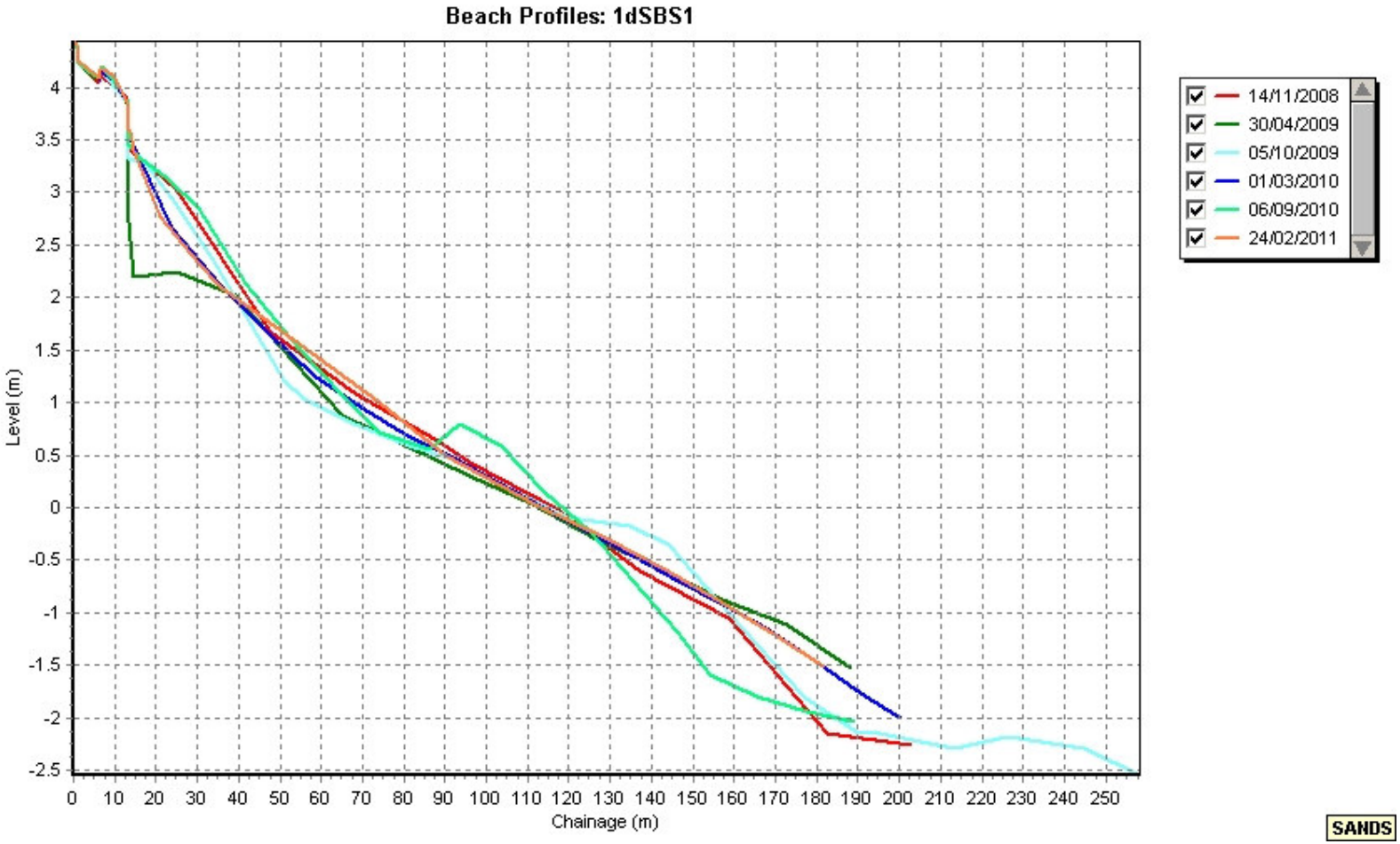
Beach Profile

1dSBS1

Date 24/02/2011 **Wind** **Summary** Strong Wind	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 13.42 **Rain** No
Easting 504544.727	**Northing** 488604.814	**Bearing** 120	

Chainage (from base station)	Level AOD (m)
0	4.44
0.016	4.44
0.593	4.422
1.101	4.377
1.14	4.248
3.47	4.168
6.342	4.093
6.347	4.165
6.682	4.186
9.639	4.098
12.533	3.901
13.108	3.871
13.264	3.832
13.277	3.6
13.646	3.578
14.598	3.401
21.139	2.776
30.232	2.316
35.5	2.103
54.56	1.561
73.946	1.009
90.448	0.498
111.814	0.035
129.434	-0.298
143.301	-0.595
155.641	-0.87
168.979	-1.195
181.865	-1.514



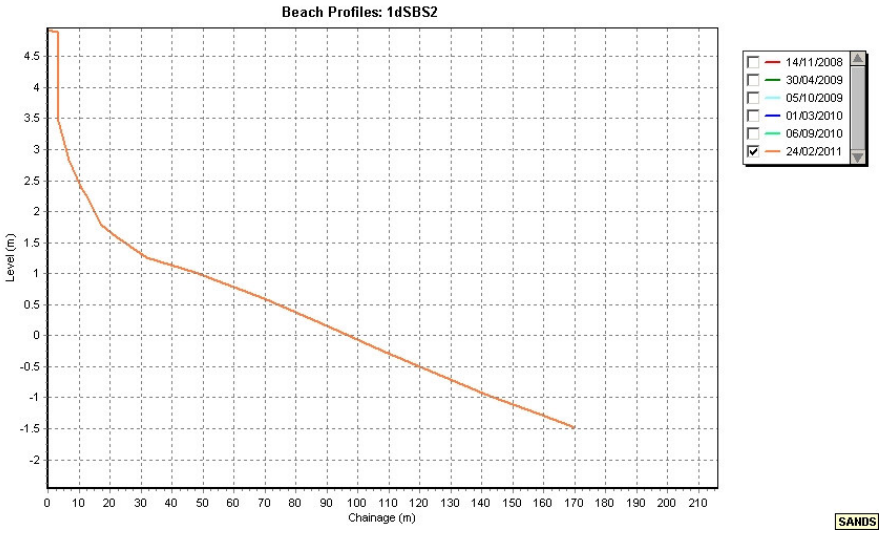

Beach Profiles: 1dSBS1
Level (m)
Chainage (m)
14/11/2008
30/04/2009
05/10/2009
01/03/2010
06/09/2010
24/02/2011
SANDS

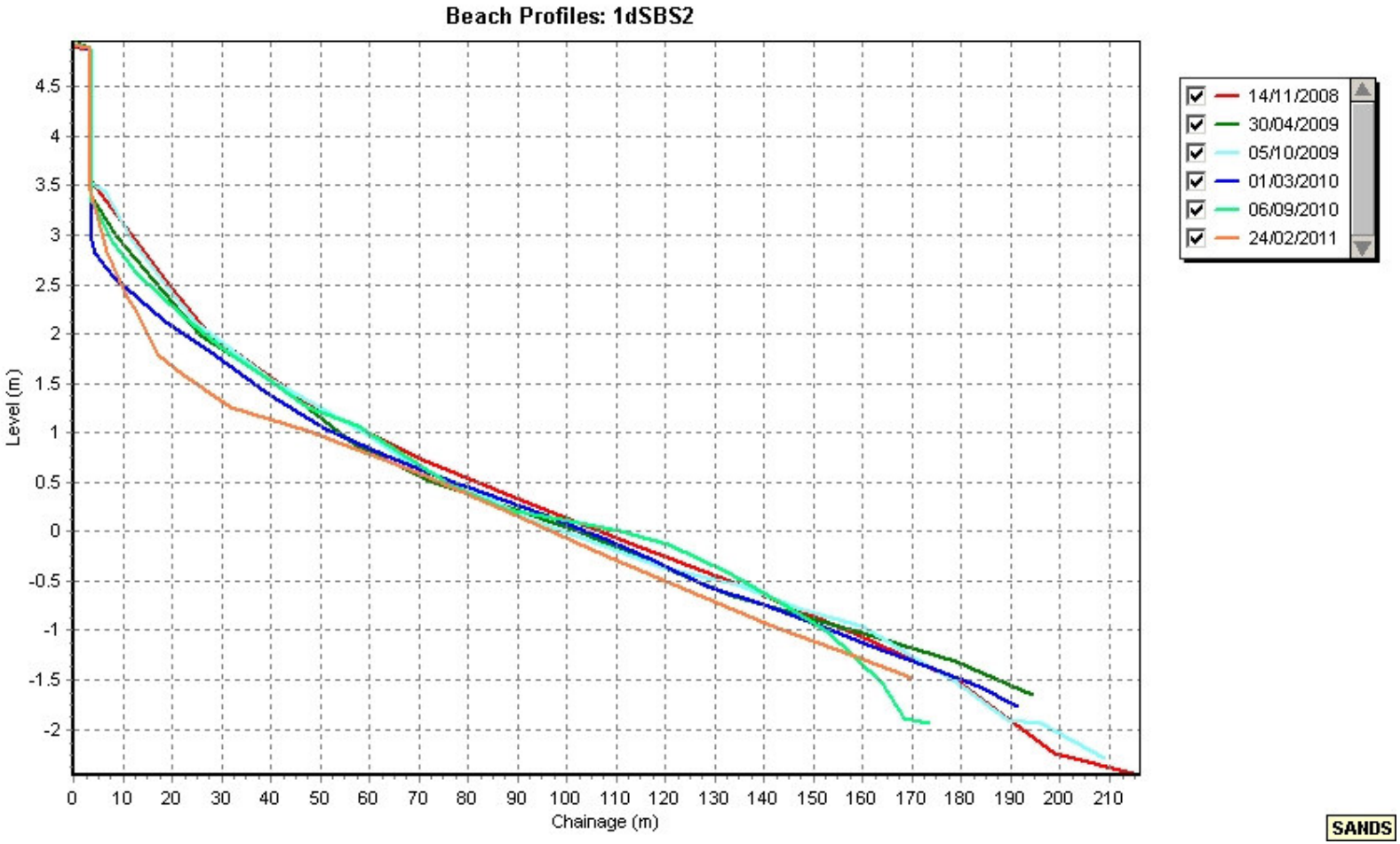
Beach Profile

1dSBS2

Date 24/02/2011 **Wind** **Summary** Strong Wind	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 13.42 **Rain** No
Easting 504443.218	**Northing** 488326.371	**Bearing** 105	

Chainage (from base station)	Level AOD (m)
0	4.93
0.028	4.93
2.896	4.901
3.461	4.885
3.5	3.456
6.713	2.829
10.688	2.38
12.809	2.213
17.447	1.78
21.923	1.6
31.857	1.253
47.451	1.016
69.64	0.593
90.826	0.134
107.985	-0.25
125.669	-0.615
142.801	-0.97
158.71	-1.26
170.192	-1.486



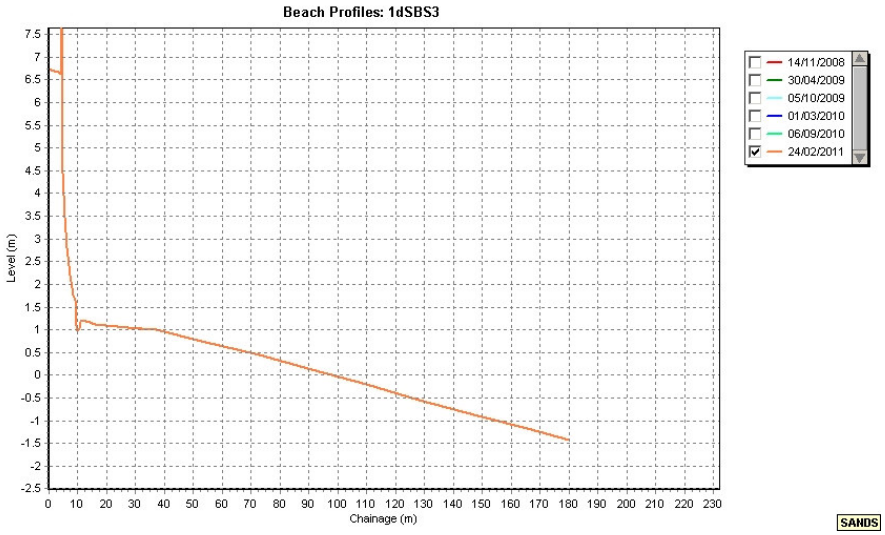

Beach Profiles: 1dSBS2
Level (m)
Chainage (m)
14/11/2008
30/04/2009
05/10/2009
01/03/2010
06/09/2010
24/02/2011
SANDS

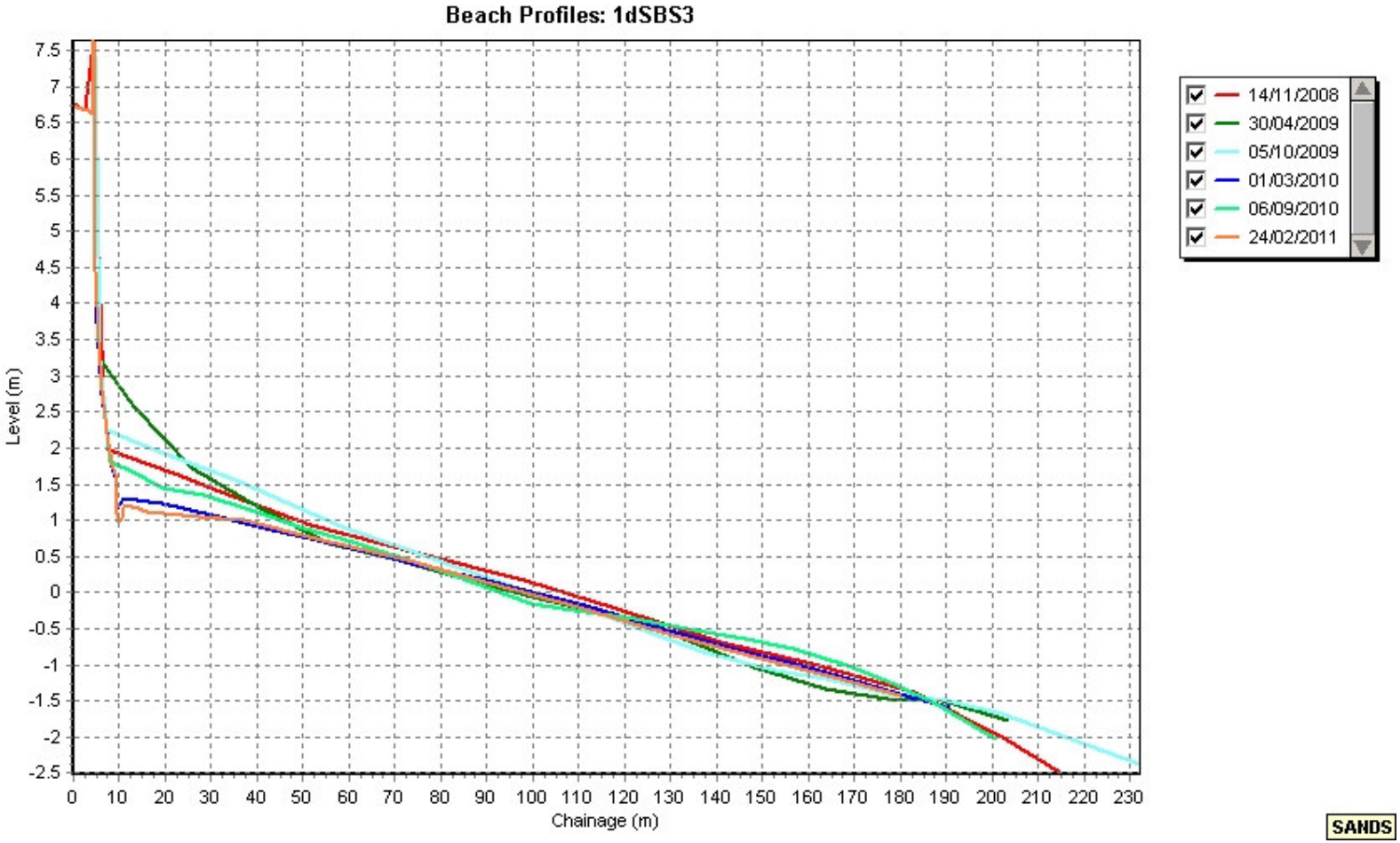
Beach Profile

1dSBS3

Date 24/02/2011 **Wind** **Summary** Strong Wind	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 13.42 **Rain** No
Easting 504423.086	**Northing** 488057.66	**Bearing** 83	

Chainage (from base station)	Level AOD (m)
0	6.745
0.012	6.745
2.456	6.673
2.493	6.698
4.287	6.633
4.434	7.579
4.516	7.644
4.773	7.425
4.81	4.46
5.624	3.487
6.363	2.811
7.213	2.206
8.216	1.759
9.271	1.645
9.424	1.1
9.812	0.975
10.372	1.034
10.764	1.153
11.202	1.205
14.149	1.161
16.086	1.111
27.432	1.054
37.075	1.002
52.854	0.754
72.728	0.455
91.025	0.12
109.719	-0.201
128.175	-0.545
149.888	-0.928
165.346	-1.179
179.955	-1.418



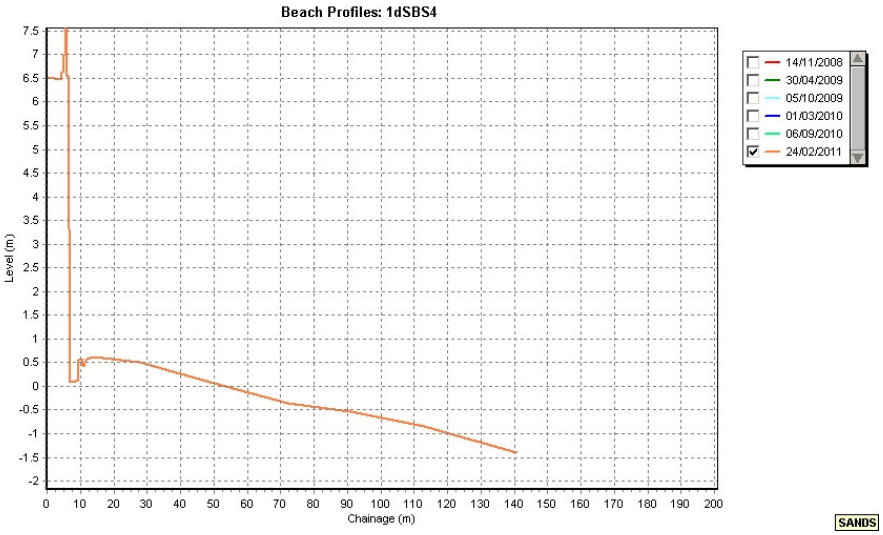

Beach Profiles: 1dSBS3
Level (m)
Chainage (m)
14/11/2008
30/04/2009
05/10/2009
01/03/2010
06/09/2010
24/02/2011
SANDS

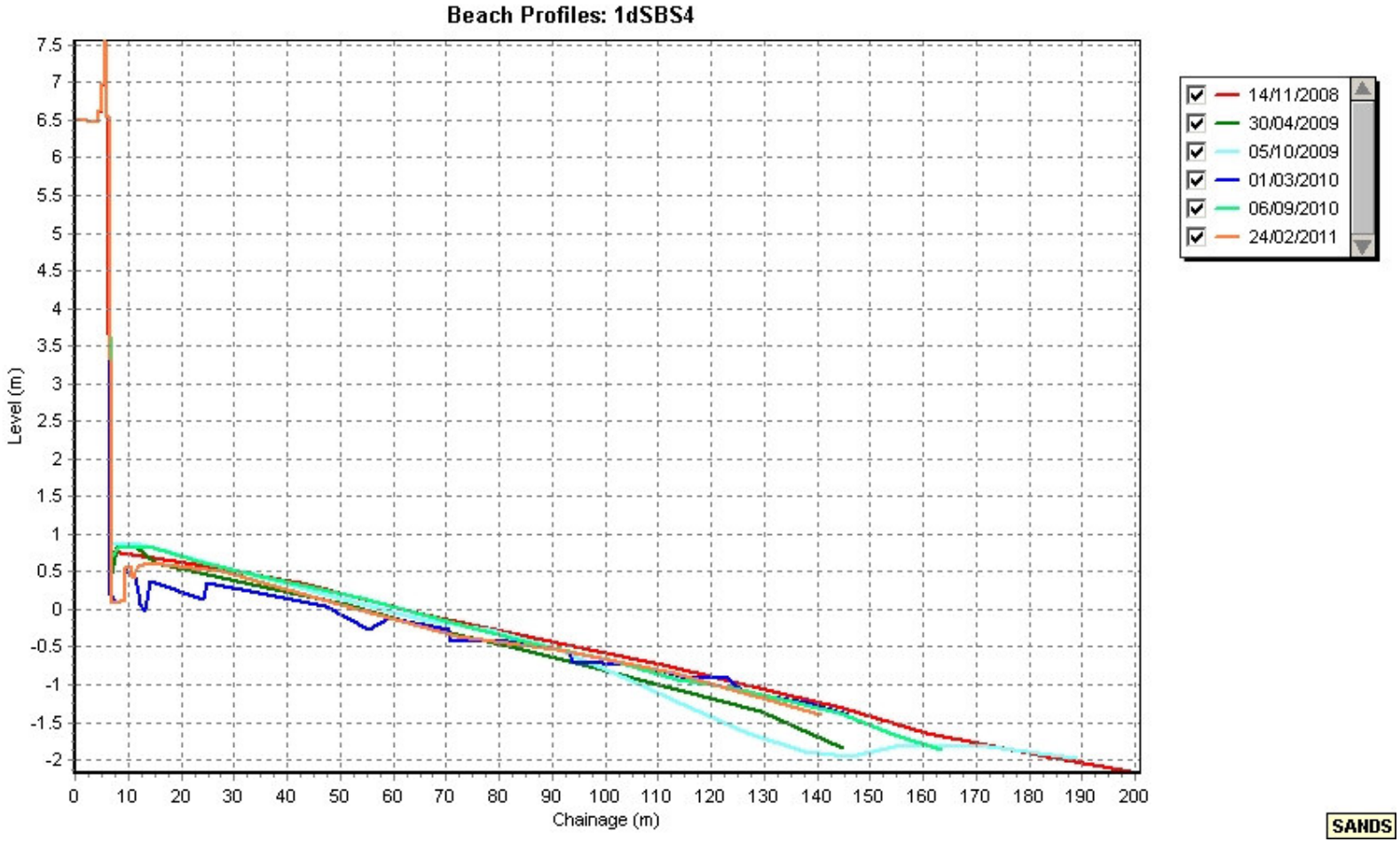
Beach Profile

1dSBS4

Date 24/02/2011 **Wind** **Summary** Strong Wind	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 13.42 **Rain** No
Easting 504494.785	**Northing** 484816.983	**Bearing** 74	

Chainage (from base station)	Level AOD (m)
0	6.523
0.017	6.523
4.441	6.474
4.489	6.627
5.084	6.64
5.12	6.979
5.525	6.982
5.556	7.51
5.632	7.563
5.914	7.359
5.975	6.552
6.211	6.56
6.936	0.083
7.881	0.081
9.349	0.14
9.402	0.243
9.451	0.462
9.485	0.474
9.552	0.549
10.403	0.58
10.6	0.557
10.821	0.453
11.214	0.422
11.449	0.493
11.99	0.58
13.847	0.618
27.58	0.508
49.983	0.065
72.032	-0.345
90.857	-0.523
113.206	-0.851
128.503	-1.15
140.856	-1.398




Beach Profiles: 1dSBS4
Level (m)
Chainage (m)
14/11/2008
30/04/2009
05/10/2009
01/03/2010
06/09/2010
24/02/2011
SANDS

Beach Profile

1dCY1

Date 23/03/2011
Wind
Summary Fine

Inspector
Sea State Calm

Low Tide (m)
Visibility -

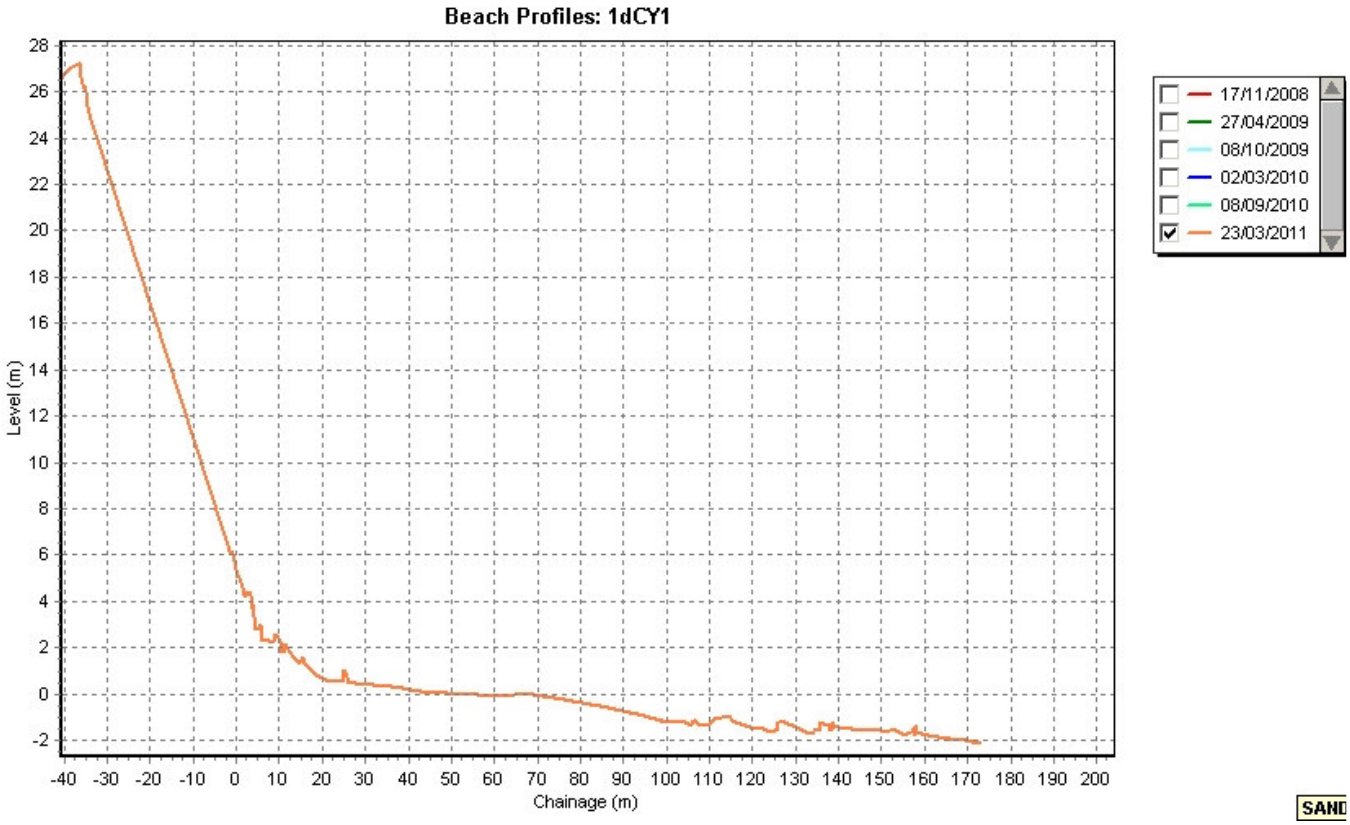
Low Tide Time
11:51
Rain No

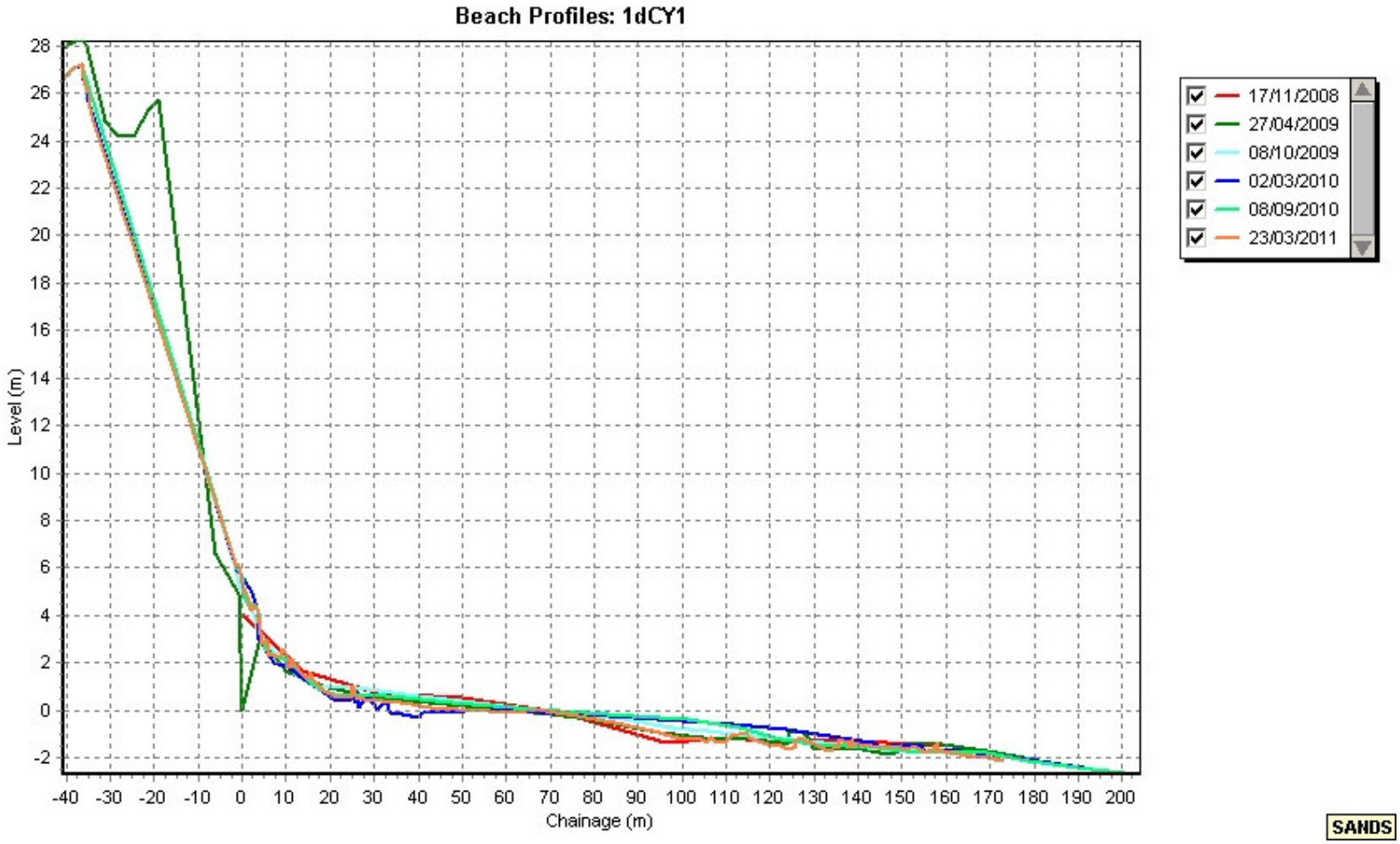
Easting 506420.411

Northing 484793.941

Bearing 43

Chainage (from base station)	Level AOD (m)
-40.44	26.581
-39.472	26.87
-39.204	26.942
-38.823	26.982
-38.465	27.04
-37.81	27.068
-37.615	27.138
-37.124	27.143
-36.722	27.226
-36.393	27.211
-36.174	27.166
-35.98	27.068
-35.926	26.653
-35.79	26.433
-35.654	26.336
-35.409	26.136
-35.073	26.206
-34.893	26.122
-34.782	26.04
-34.567	25.585
-34.549	25.371
-33.597	24.836
-1.482	6.164
-0.844	6.119
0.186	5.01
0.866	5.039
1.516	4.631
1.693	4.254
2.418	4.175
2.523	4.382
3.271	4.319
3.29	4.299
3.766	3.721
3.889	3.885
4.415	2.823
5.43	2.771
5.767	2.978
5.982	2.294
7.335	2.352
8.42	2.217
8.568	2.256
9.069	2.586
9.924	2.462
10.206	2.328
10.628	1.773
11.323	1.779
11.503	2.135
13.142	1.62
14.836	1.329
15.489	1.593
16.071	1.291
18.115	0.921
19.387	0.738
20.908	0.62
22.189	0.539
23.338	0.528
24.115	0.58
24.984	0.566
25.177	1.028
25.415	0.985
26.301	0.49
27.578	0.465
31.865	0.391
35.832	0.335
38.534	0.279
42.92	0.151
48.814	0.067
55.951	-0.023
62.042	-0.108
64.115	-0.105
64.41	-0.023
69.162	0.005
76.313	-0.261
84.758	-0.517
93.275	-0.868
99.033	-1.181
99.063	-1.194
104.116	-1.251
105.911	-1.356
106.297	-1.172
106.709	-1.133
107.897	-1.341
109.483	-1.359
111.126	-1.112
112.466	-0.998
114.982	-1.021
115.263	-1.13
117.276	-1.324
119.465	-1.421
120.846	-1.522
122.559	-1.524
124.48	-1.616
125.734	-1.472
125.938	-1.247
127.616	-1.21
130.068	-1.449
131.558	-1.598
133.526	-1.707
134.435	-1.626
134.653	-1.469
135.817	-1.559
135.884	-1.225
137.42	-1.339
138.114	-1.316
138.23	-1.546
138.503	-1.581
138.717	-1.235
138.931	-1.347
141.071	-1.516
143.086	-1.533
145.768	-1.536
147.157	-1.541
148.582	-1.524
149.659	-1.557
151.252	-1.653
151.737	-1.583
153.156	-1.571
154.903	-1.687
155.567	-1.763
156.623	-1.629
157.25	-1.622
157.32	-1.511
157.706	-1.768
157.806	-1.428
158.226	-1.336
158.267	-1.695
159.154	-1.739
159.655	-1.783
160.976	-1.78
165.622	-1.899
169.556	-2.007
173.077	-2.139


Beach Profiles: 1dCY1
Level (m)
Chainage (m)
17/11/2008
27/04/2009
08/10/2009
02/03/2010
08/09/2010
23/03/2011
SAND

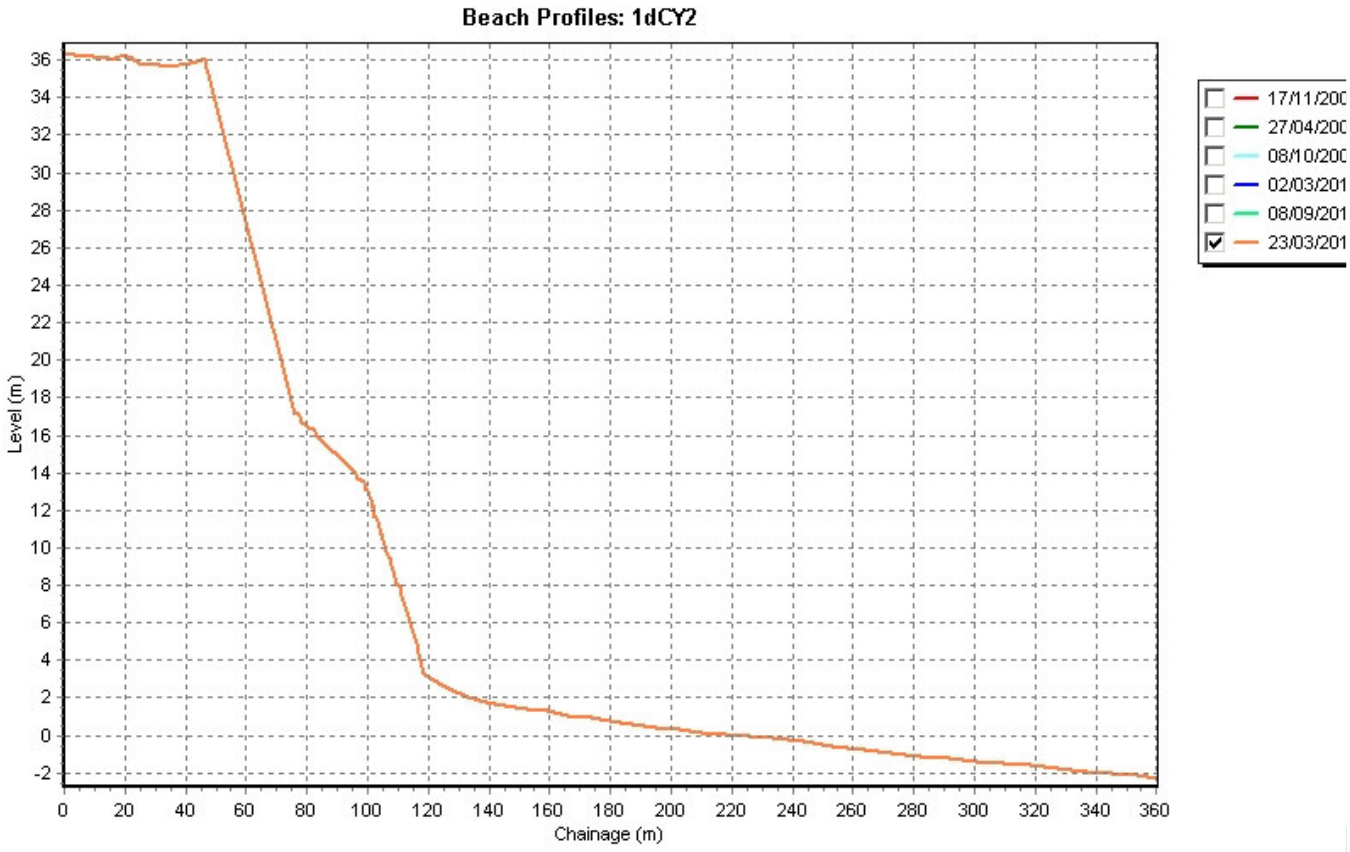

Beach Profiles: 1dCY1
Level (m)
Chainage (m)
17/11/2008
27/04/2009
08/10/2009
02/03/2010
08/09/2010
23/03/2011
SANDS

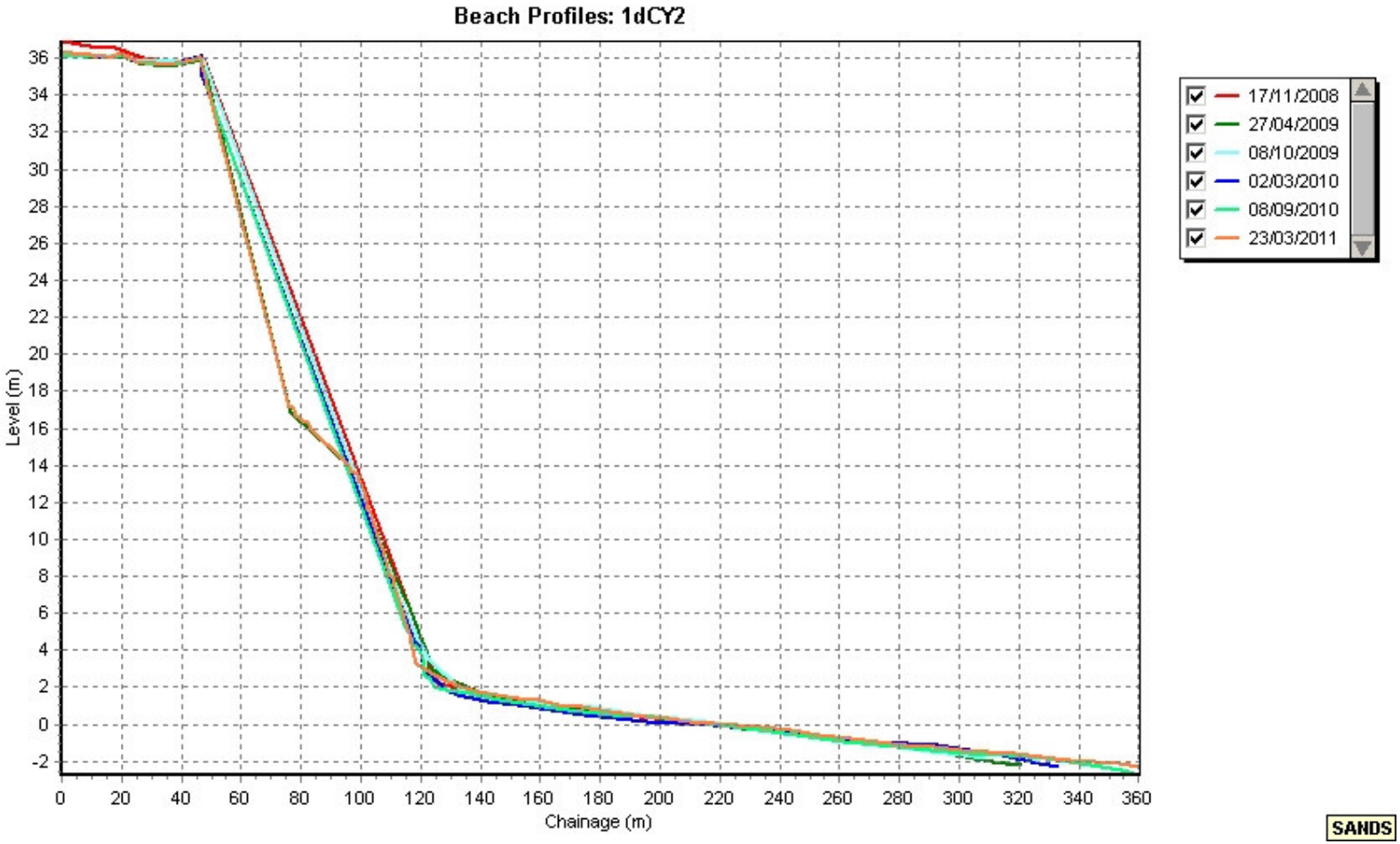
Beach Profile

1dCY2

Date 23/03/2011 **Wind** **Summary** Fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 11:51 **Rain** No
Easting 506712.583	**Northing** 484325.966	**Bearing** 38	

Chainage (from base station)	Level AOD (m)
0	36.31
0.023	36.31
3.355	36.261
7.509	36.177
9.375	36.22
11.025	36.138
12.41	36.191
14.522	36.104
15.561	36.063
18.046	36.2
20.425	36.216
22.273	36.103
24.581	35.828
28.09	35.751
31.269	35.721
35.288	35.698
37.39	35.731
39.589	35.757
41.333	35.858
43.557	35.934
45.047	36.008
46.095	36.085
46.329	36.102
46.596	36.073
46.749	35.572
46.91	35.611
75.792	17.131
76.368	17.145
76.703	17.223
77.384	17.002
77.891	17.036
78.232	16.696
79.536	16.586
80.658	16.418
82.122	16.298
82.594	16.201
83.242	15.963
94.53	14.25
95.883	13.99
96.93	13.713
97.947	13.602
98.66	13.478
99.209	13.351
99.217	13.307
99.356	13.087
99.488	13.22
100.45	12.921
100.474	12.767
101.014	12.577
101.536	12.401
101.543	12.275
101.751	12.136
102.042	12.147
102.383	11.619
102.968	11.655
103.412	11.417
103.54	11.418
104.443	10.755
104.81	10.61
104.92	10.46
105.44	10.206
106.285	9.826
107.22	9.468
107.296	9.54
108.03	9.052
108.223	8.853
108.878	8.61
109.116	8.448
109.552	8.114
109.976	8.038
111.042	7.885
111.08	7.428
116.64	4.534
116.662	4.389
118.475	3.279
120.813	3.059
126.547	2.494
132.856	2.037
139.381	1.78
145.535	1.586
152.431	1.401
159.202	1.295
166.067	1.07
173.516	0.928
179.653	0.794
187.382	0.602
194.933	0.442
202.806	0.322
210.33	0.164
217.822	0.09
225.923	-0.049
233.807	-0.172
243.693	-0.357
253.291	-0.547
263.529	-0.765
272.814	-0.929
281.872	-1.089
291.709	-1.23
300.741	-1.367
309.635	-1.486
318.341	-1.617
327.433	-1.761
336.831	-1.928
345.262	-2.056
353.503	-2.151
360.349	-2.325


Beach Profiles: 1dCY2
Level (m)
Chainage (m)
17/11/200
27/04/200
08/10/200
02/03/201
08/09/201
23/03/201

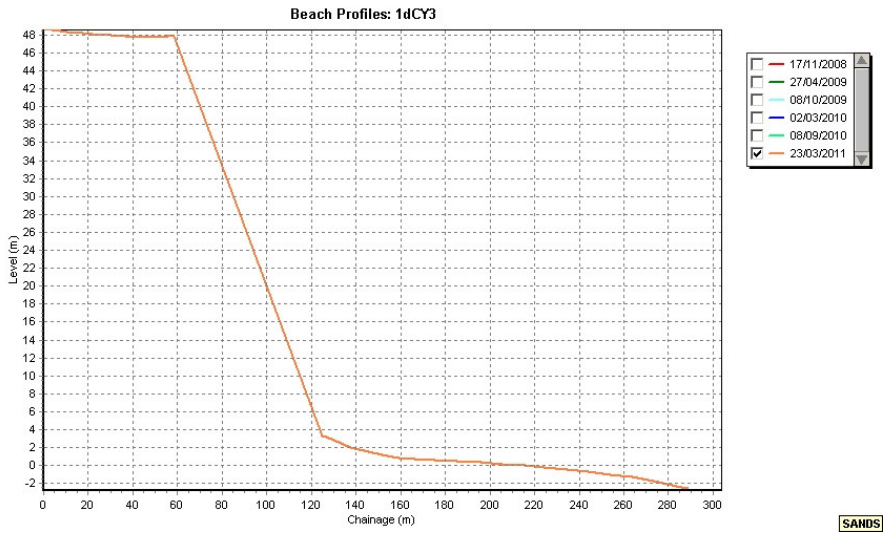

Beach Profiles: 1dCY2
Level (m)
Chainage (m)
17/11/2008
27/04/2009
08/10/2009
02/03/2010
08/09/2010
23/03/2011
SANDS

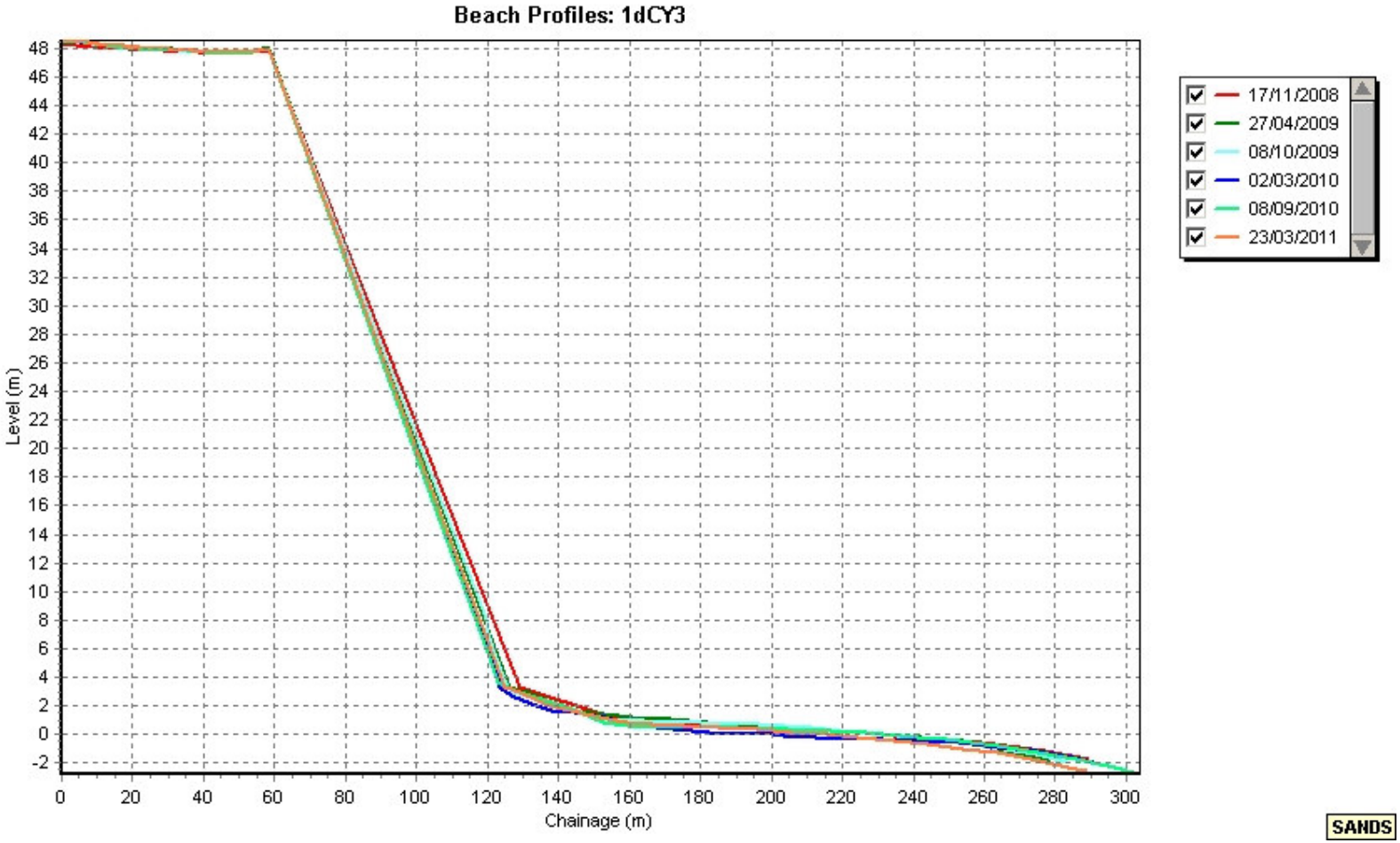
Beach Profile

1dCY3

Date 23/03/2011 **Wind** **Summary** Fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 11:51 **Rain** No
Easting 507242.203	**Northing** 484080.896	**Bearing** 42	

Chainage (from base station)	Level AOD (m)
0	48.558
0.052	48.558
3.594	48.523
5.141	48.472
7.331	48.4
10.384	48.298
13.508	48.189
17.261	48.16
19.533	48.11
21.596	48.063
24.004	48.029
26.915	47.963
29.941	47.935
33.251	47.911
36.648	47.817
39.508	47.764
43.059	47.705
45.223	47.695
46.872	47.715
49.298	47.699
51.003	47.698
52.281	47.701
53.726	47.737
55.336	47.783
56.196	47.964
57.074	47.823
57.117	47.819
57.132	47.818
57.783	47.894
58.078	47.902
58.428	47.853
125.005	3.315
126.598	3.174
129.925	2.807
137.718	2.012
145.771	1.51
154.043	1.043
159.102	0.862
166.332	0.777
175.004	0.678
185.31	0.52
196.033	0.353
205.421	0.162
215.78	-0.014
224.437	-0.15
234.42	-0.382
244.064	-0.69
253.944	-0.996
263.777	-1.251
275.345	-1.787
283.723	-2.247
288.924	-2.525



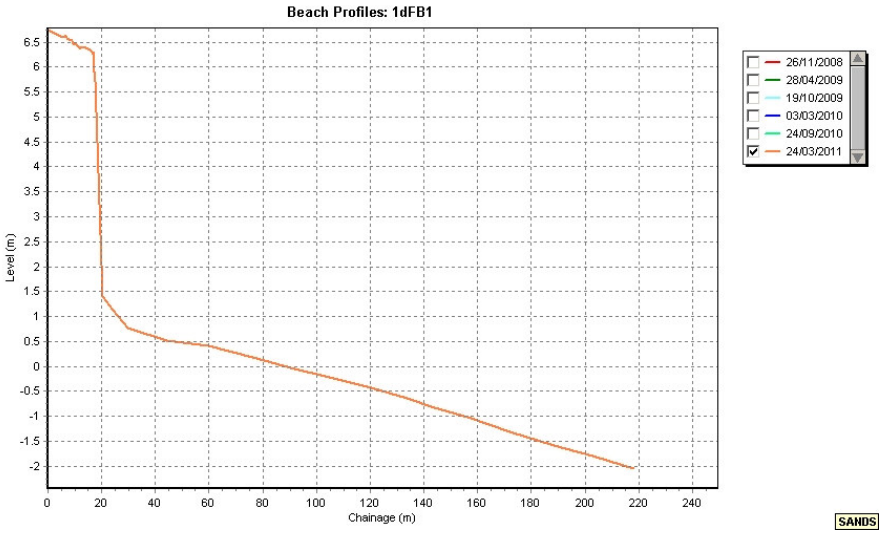

Beach Profiles: 1dCY3
Level (m)
Chainage (m)
17/11/2008
27/04/2009
08/10/2009
02/03/2010
08/09/2010
23/03/2011
SANDS

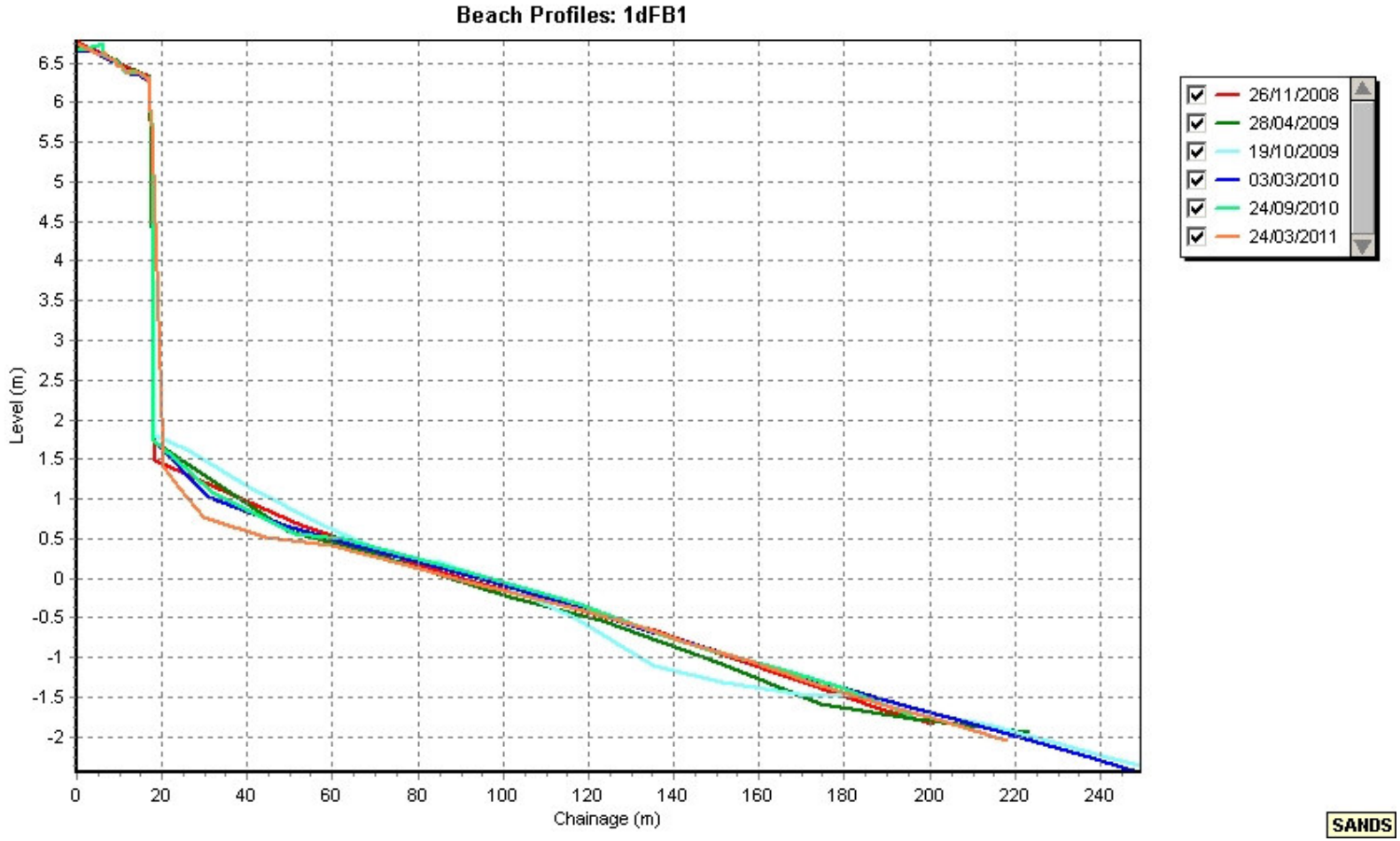
Beach Profile

1dFB1

Date 24/03/2011 **Wind** **Summary** fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 12.36 to 13.36 **Rain** No
Easting 511989.528	**Northing** 480590.964	**Bearing** 100	

Chainage (from base station)	Level AOD (m)
0	6.728
0.667	6.728
3.018	6.652
4.751	6.62
6.228	6.609
6.615	6.643
7.27	6.566
7.68	6.558
8.868	6.525
9.333	6.473
10.594	6.455
11.458	6.41
12.175	6.373
12.642	6.404
12.642	6.416
13.07	6.398
14.01	6.379
14.706	6.371
15.525	6.338
16.245	6.313
16.365	6.308
16.673	6.267
17.052	6.296
17.148	6.186
17.16	5.895
17.313	5.915
17.51	5.808
17.586	5.717
20.28	1.407
24.381	1.132
29.764	0.777
44.111	0.507
59.655	0.402
76.331	0.174
91.829	-0.044
103.07	-0.199
120.365	-0.437
133.59	-0.648
144.028	-0.827
156.49	-1.026
171.829	-1.318
188.305	-1.583
202.879	-1.808
218.025	-2.047




Beach Profiles: 1dFB1
Level (m)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
20
40
60
80
100
120
140
160
180
200
220
240
Chainage (m)
26/11/2008
28/04/2009
19/10/2009
03/03/2010
24/09/2010
24/03/2011
SANDS

Beach Profile

1dFB2

Date 24/03/2011
Wind
Summary fine

Inspector
Sea State Calm

Low Tide (m)
Visibility -

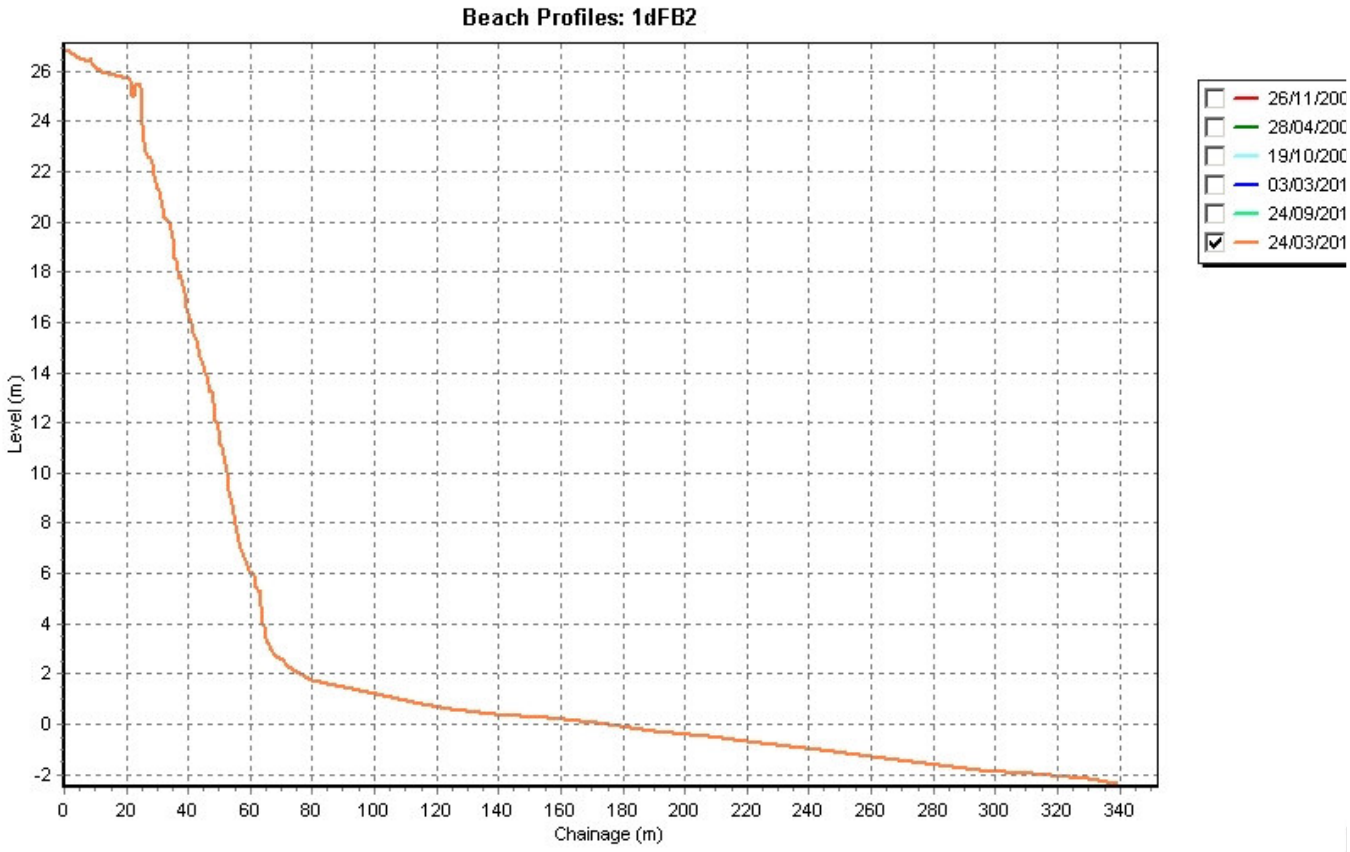
Low Tide Time
12.36 to 13.36
Rain No

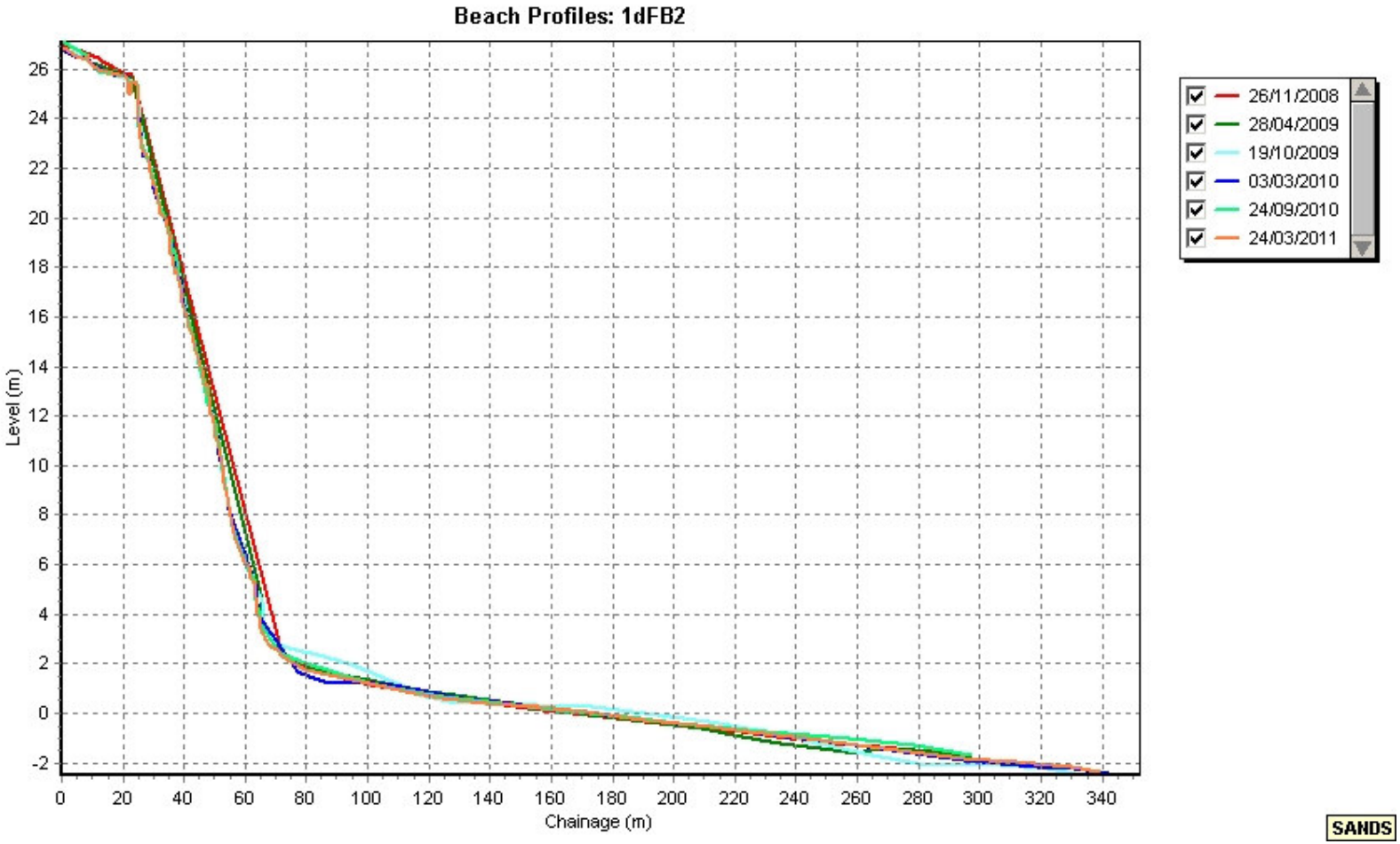
Easting 512005.564

Northing 479181.575

Bearing 77

Chainage (from base station)	Level AOD (m)
0	26.833
0.181	26.833
1.423	26.761
3.561	26.598
4.906	26.522
6.602	26.445
8.042	26.413
8.684	26.531
8.921	26.398
9.464	26.286
10.429	26.137
11.287	26.066
11.968	26.002
20.58	25.733
21.35	25.671
21.751	25.386
21.916	25.066
22.493	24.954
22.808	25.472
23.755	25.509
24.306	25.471
24.557	25.401
25.046	23.921
25.805	23.217
26.477	22.818
27.049	22.534
27.637	22.518
28.24	22.339
28.823	22.104
29.048	21.868
29.936	21.357
30.371	21.262
31.46	20.551
32.069	20.443
32.479	20.196
33.27	20.014
34.212	19.808
34.53	19.672
34.982	19.344
35.36	19.008
35.497	18.581
36.375	18.345
36.797	18.217
36.864	18.099
37.225	17.781
37.321	17.786
37.454	17.889
37.931	17.72
38.308	17.455
38.806	17.225
39.252	16.855
39.564	16.571
41.046	16.018
41.622	15.554
42.38	15.326
43.276	14.976
43.809	14.661
44.503	14.486
45.247	14.068
46.144	13.909
47.012	13.237
47.153	13.339
47.44	13.212
47.446	13.292
48.367	12.284
48.876	12.089
49.282	12.033
50.283	11.37
50.392	11.163
50.922	11.084
52.396	10.084
53.162	9.316
53.991	8.753
55.098	7.986
56.449	7.256
56.949	7.004
57.678	6.683
58.785	6.335
59.405	6.155
60.187	6.022
60.484	6.102
61.001	5.911
61.861	5.435
62.619	5.275
62.984	5.33
63.232	5.232
63.284	4.694
63.293	4.7
63.905	4.409
64.102	4.024
64.719	3.78
65.074	3.46
65.664	3.261
65.824	3.138
66.787	2.991
68.508	2.712
70.316	2.576
72.107	2.311
72.17	2.266
79.543	1.777
90.101	1.461
100.621	1.189
112.53	0.891
124.711	0.619
138.484	0.407
155.737	0.237
171.591	0.058
190.145	-0.269
207.378	-0.509
224.467	-0.725
243.39	-0.99
264.237	-1.329
281.752	-1.619
294.77	-1.818
311.936	-1.976
330.075	-2.158
339.184	-2.373


Beach Profiles: 1dFB2
Level (m)
Chainage (m)
26/11/200
28/04/200
19/10/200
03/03/201
24/09/201
24/03/201

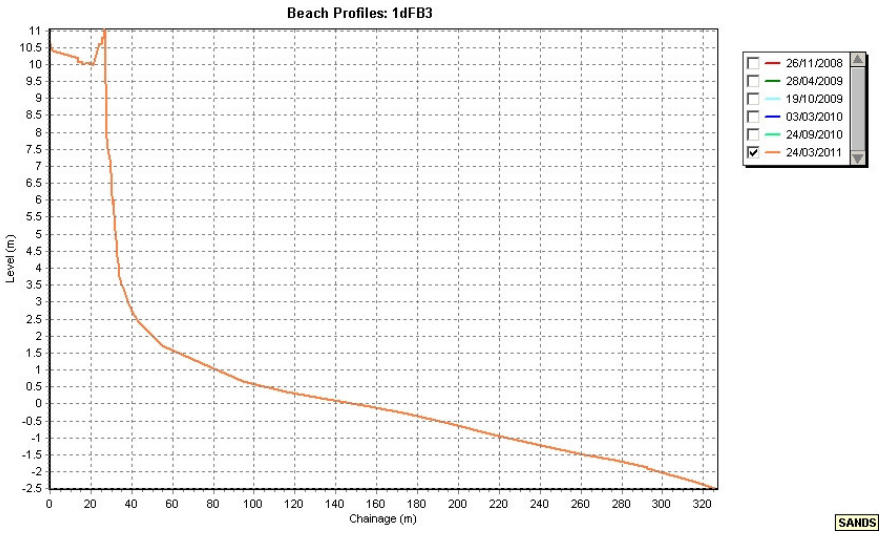

Beach Profiles: 1dFB2
Level (m)
Chainage (m)
26/11/2008
28/04/2009
19/10/2009
03/03/2010
24/09/2010
24/03/2011
SANDS

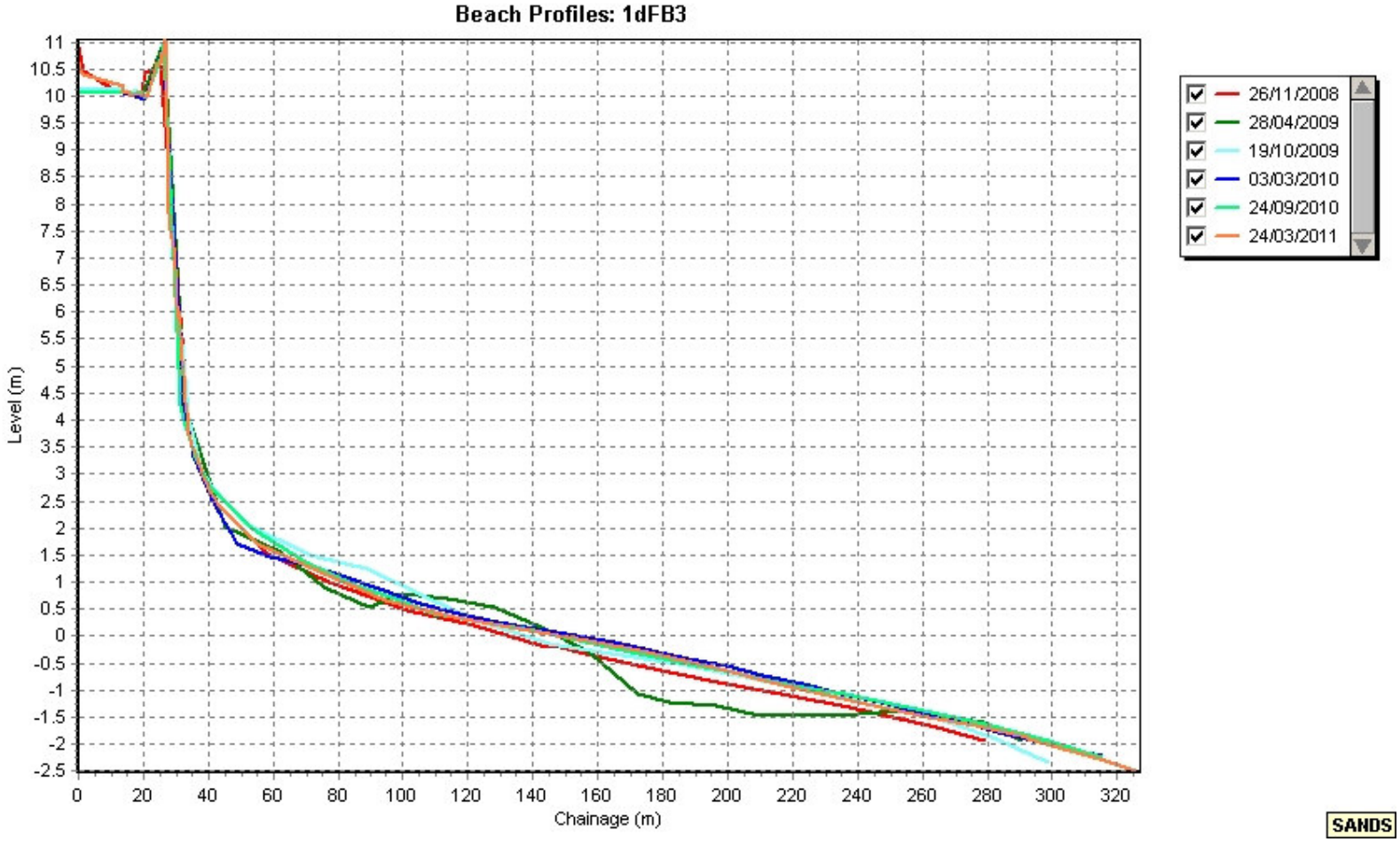
Beach Profile

1dFB3

Date 24/03/2011 **Wind** **Summary** fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 12.36 to 13.36 **Rain** No
Easting 512429.303	**Northing** 478202.148	**Bearing** 61	

Chainage (from base station)	Level AOD (m)
0	10.649
0.077	10.649
0.764	10.511
1.065	10.445
1.532	10.385
1.721	10.396
13.975	10.188
14.013	10.194
14.064	10.164
14.068	10.065
14.612	10.093
14.953	10.071
15.423	10.05
15.788	10.053
15.915	10.034
15.999	10.004
16.927	10.022
17.82	10.035
18.571	10.041
19.516	10.031
20.073	10.032
20.546	10.002
21.222	9.978
24.412	10.603
25.29	10.591
25.754	10.791
26.296	10.777
26.495	11.048
27.612	7.835
28.342	7.509
28.365	7.521
29.139	7.206
29.783	6.802
30.539	6.133
30.887	5.901
30.899	6.048
31.371	5.569
31.982	5.346
32.082	5.119
32.95	4.513
33.117	4.407
33.15	4.341
33.727	3.946
33.929	3.756
35.135	3.547
36.569	3.33
38.124	3.011
40.07	2.723
42.979	2.431
54.784	1.723
74.324	1.197
94.418	0.668
115.772	0.339
135.659	0.144
156.57	-0.093
175.336	-0.309
195.263	-0.574
217.286	-0.922
237.971	-1.201
261.499	-1.488
276.874	-1.658
292.695	-1.878
292.723	-1.909
314.817	-2.283
327.013	-2.522



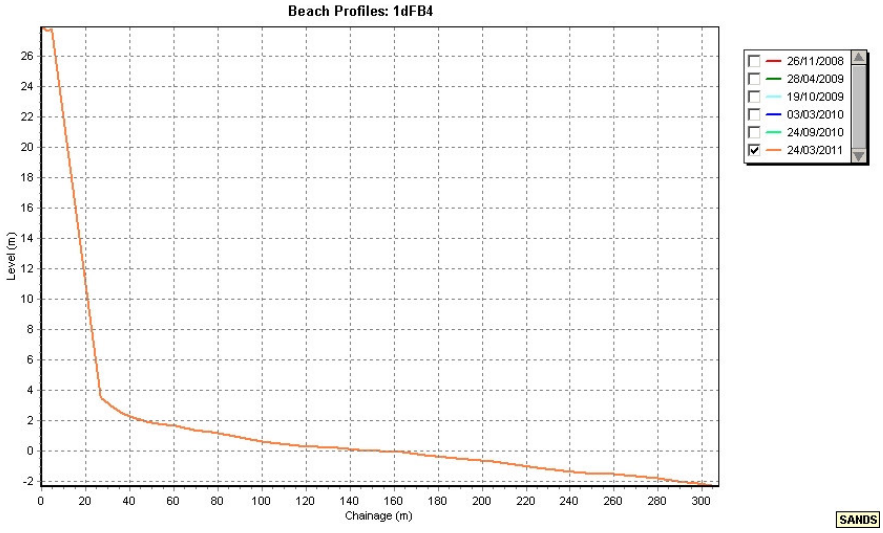

Beach Profiles: 1dFB3
Level (m)
Chainage (m)
26/11/2008
28/04/2009
19/10/2009
03/03/2010
24/09/2010
24/03/2011
SANDS

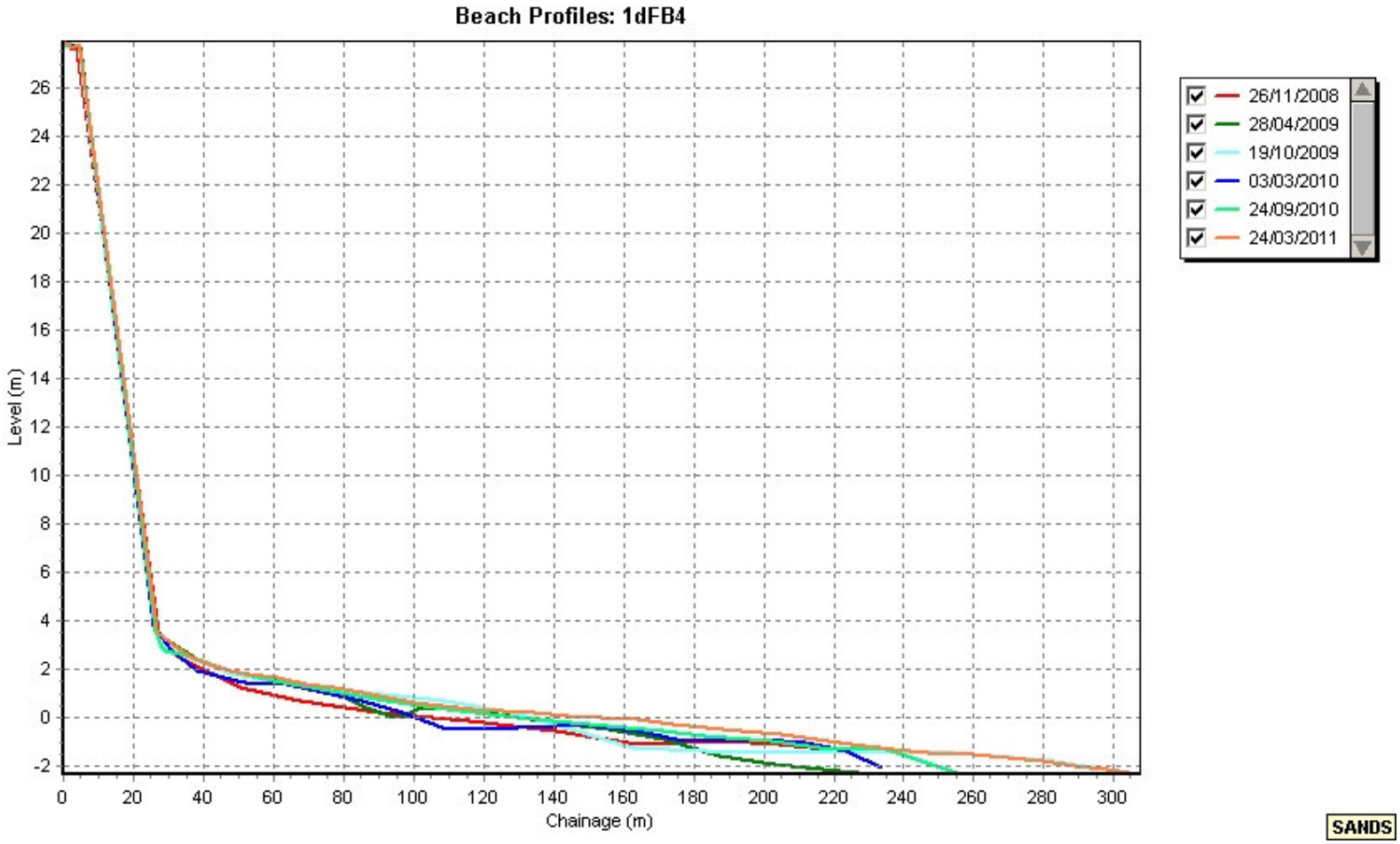
Beach Profile

1dFB4

Date 24/03/2011 **Wind** **Summary** fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility** -	**Low Tide Time** 12.36 to 13.36 **Rain** No
Easting 513165.53	**Northing** 477182.418	**Bearing** 51	

Chainage (from base station)	Level AOD (m)
0	27.799
0.4	27.799
0.839	27.811
1.362	27.816
1.735	27.765
1.982	27.725
2.271	27.696
2.519	27.684
2.799	27.709
3.217	27.758
3.499	27.783
3.902	27.762
4.312	27.794
4.658	27.745
4.928	27.593
26.86	3.671
27.262	3.536
27.647	3.407
28.218	3.376
31.101	3.041
35.593	2.582
39.956	2.263
47.705	1.951
52.814	1.825
60.921	1.647
69.35	1.42
77.131	1.236
85.321	1.031
92.653	0.813
100.022	0.666
108.018	0.512
116.555	0.367
125.171	0.301
134.189	0.19
143.97	0.094
153.546	0.041
163.761	-0.087
173.817	-0.233
183.407	-0.379
193.736	-0.512
205.037	-0.682
215.135	-0.886
225.041	-1.066
237.017	-1.282
246.738	-1.403
259.711	-1.476
269.593	-1.621
279.657	-1.784
288.802	-1.979
298.123	-2.13
307.461	-2.327

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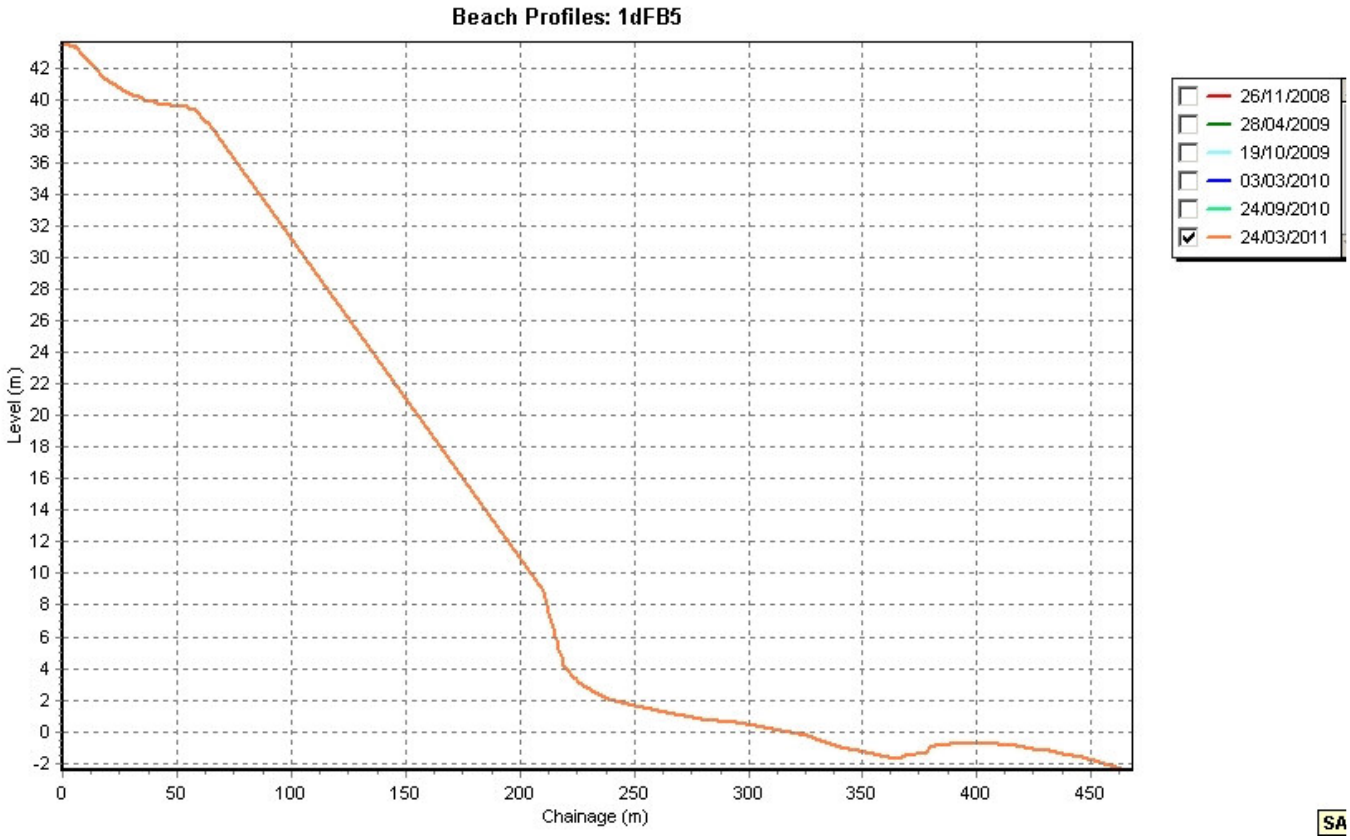
Level (m)
Chainage (m)
26/11/2008
28/04/2009
19/10/2009
03/03/2010
24/09/2010
24/03/2011
SANDS

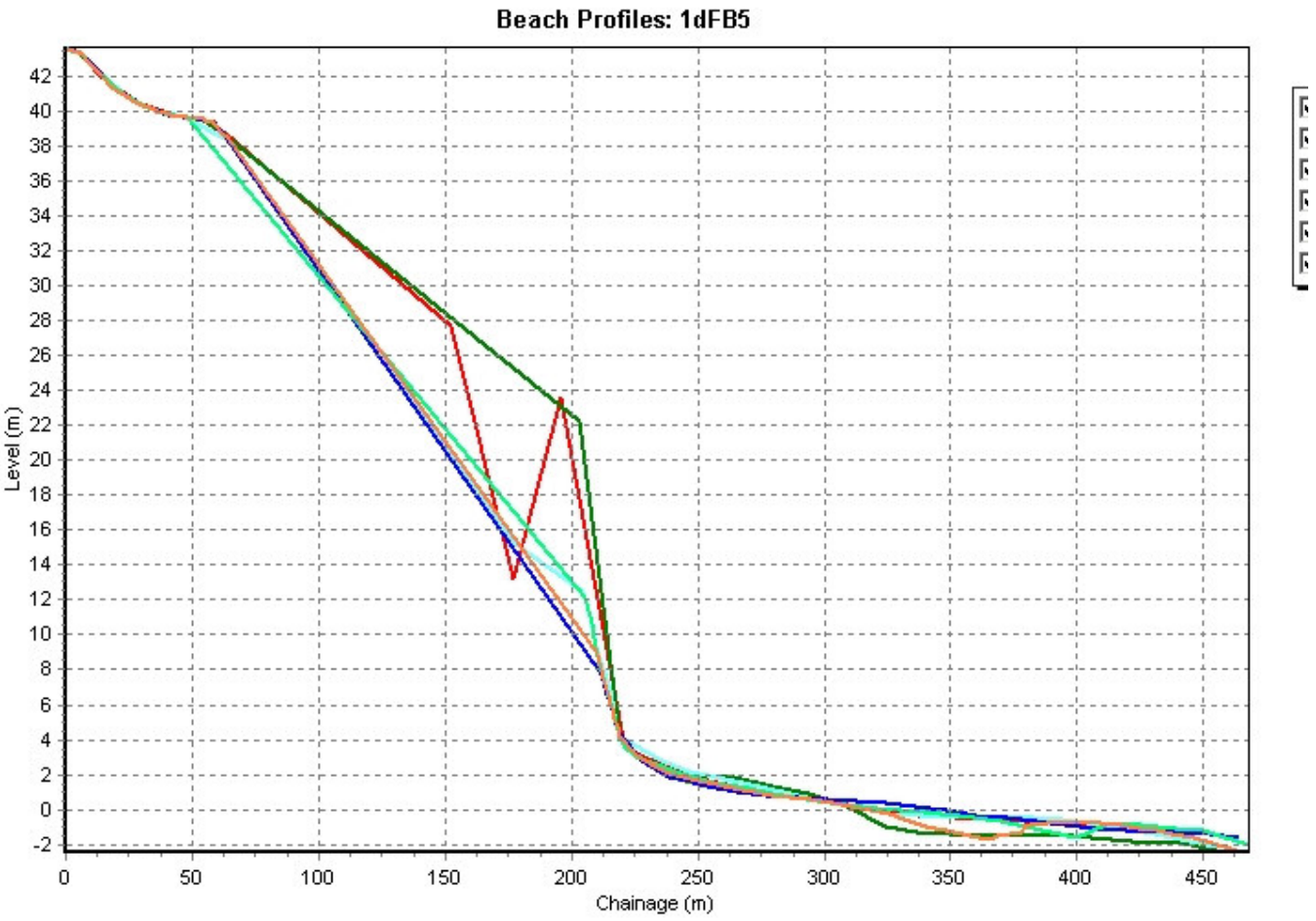
Beach Profile

1dFB5

Date 24/03/2011 **Wind** **Summary** fine	**Inspector** **Sea State** Calm	**Low Tide (m)** **Visibility -**	**Low Tide Time** 12.36 to 13.36 **Rain** No
Easting 514207.792	**Northing** 476001.334	**Bearing** 47	

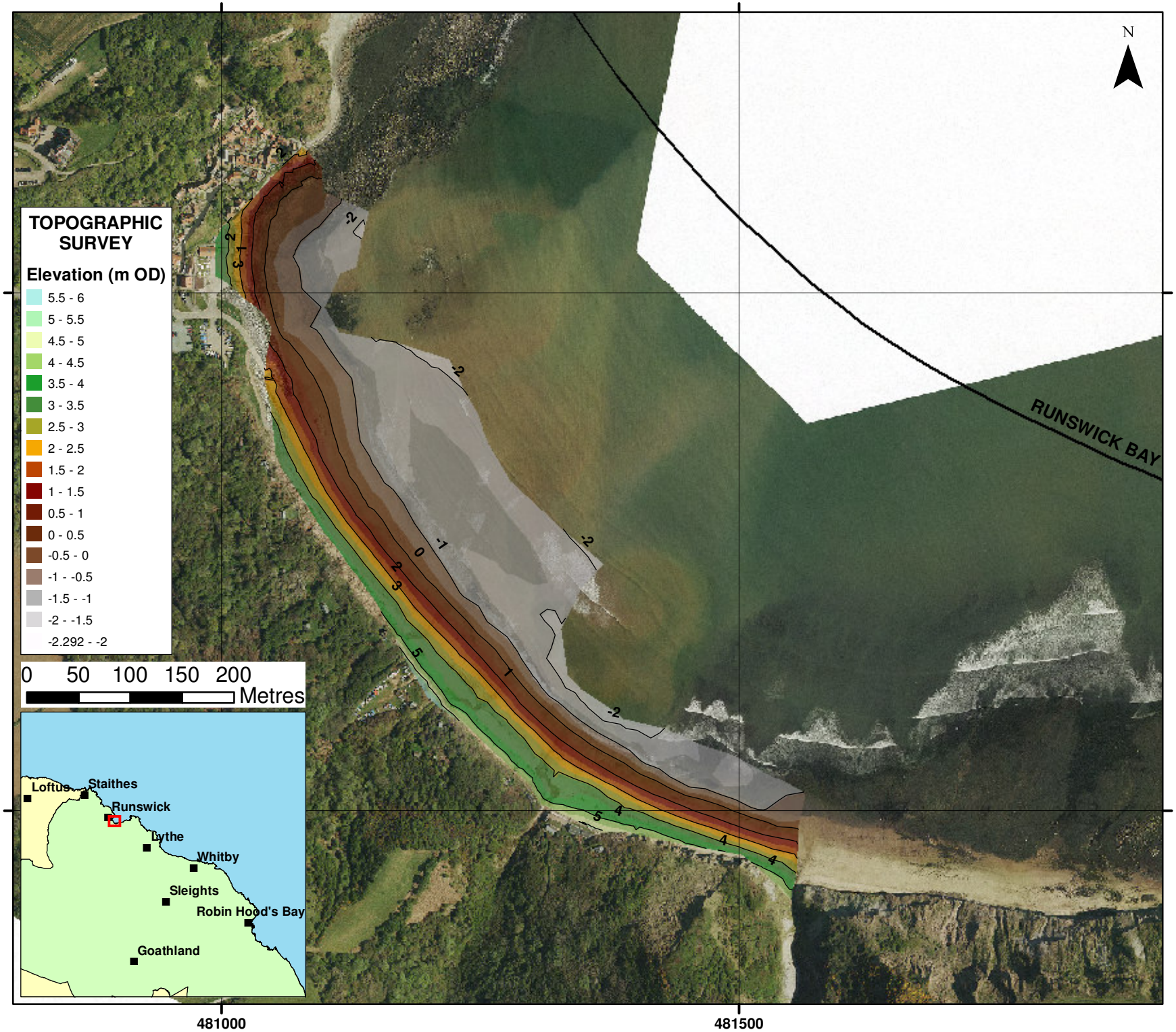
Chainage (from base station)	Level AOD (m)
0	43.657
0.129	43.657
2.76	43.482
4.953	43.362
5.248	43.364
5.487	43.351
5.986	43.341
6.534	43.256
8.574	42.88
11.175	42.537
13.418	42.197
15.538	41.874
17.308	41.549
20.48	41.216
22.934	41.001
26.445	40.631
30.649	40.392
33.441	40.238
36.999	39.978
39.773	39.927
41.413	39.815
43.057	39.697
45.771	39.697
46.967	39.702
51.947	39.661
53.581	39.636
54.056	39.573
55.185	39.489
56.577	39.452
57.778	39.354
58.889	39.343
59.975	39.123
61.285	38.879
62.539	38.714
63.583	38.52
210.602	8.859
211.115	8.421
212.698	7.523
214.448	6.567
215.567	6.026
216.651	5.499
217.112	5.256
217.59	4.957
218.218	4.762
218.89	4.462
219.103	4.357
219.407	4.117
220.572	3.912
223.345	3.43
225.198	3.296
225.829	3.122
229.307	2.777
234.045	2.41
238.759	2.083
244.644	1.836
250.095	1.646
257.436	1.409
264.356	1.214
272.073	1.022
279.074	0.834
286.405	0.703
294.909	0.554
303.097	0.402
310.748	0.212
318.35	-0.011
326.063	-0.305
333.426	-0.681
340.374	-0.974
348.231	-1.244
355.097	-1.435
361.1	-1.612
366.641	-1.692
367.175	-1.594
368.662	-1.527
373.15	-1.409
377.881	-1.399
379.72	-0.991
381.4	-0.849
387.929	-0.755
394.957	-0.731
402.251	-0.734
409.388	-0.803
416.851	-0.928
424.314	-1.085
431.378	-1.222
437.811	-1.377
445.958	-1.662
453.105	-1.905
460.933	-2.274
462.582	-2.351


Beach Profiles: 1dFB5
Level (m)
Chainage (m)
0
50
100
150
200
250
300
350
400
450
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
26/11/2008
28/04/2009
19/10/2009
03/03/2010
24/09/2010
24/03/2011


Beach Profiles: 1dFB5
Level (m)
Chainage (m)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
0
50
100
150
200
250
300
350
400
450

Appendix B

Topographic Survey



Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:5,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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www.halcrow.com

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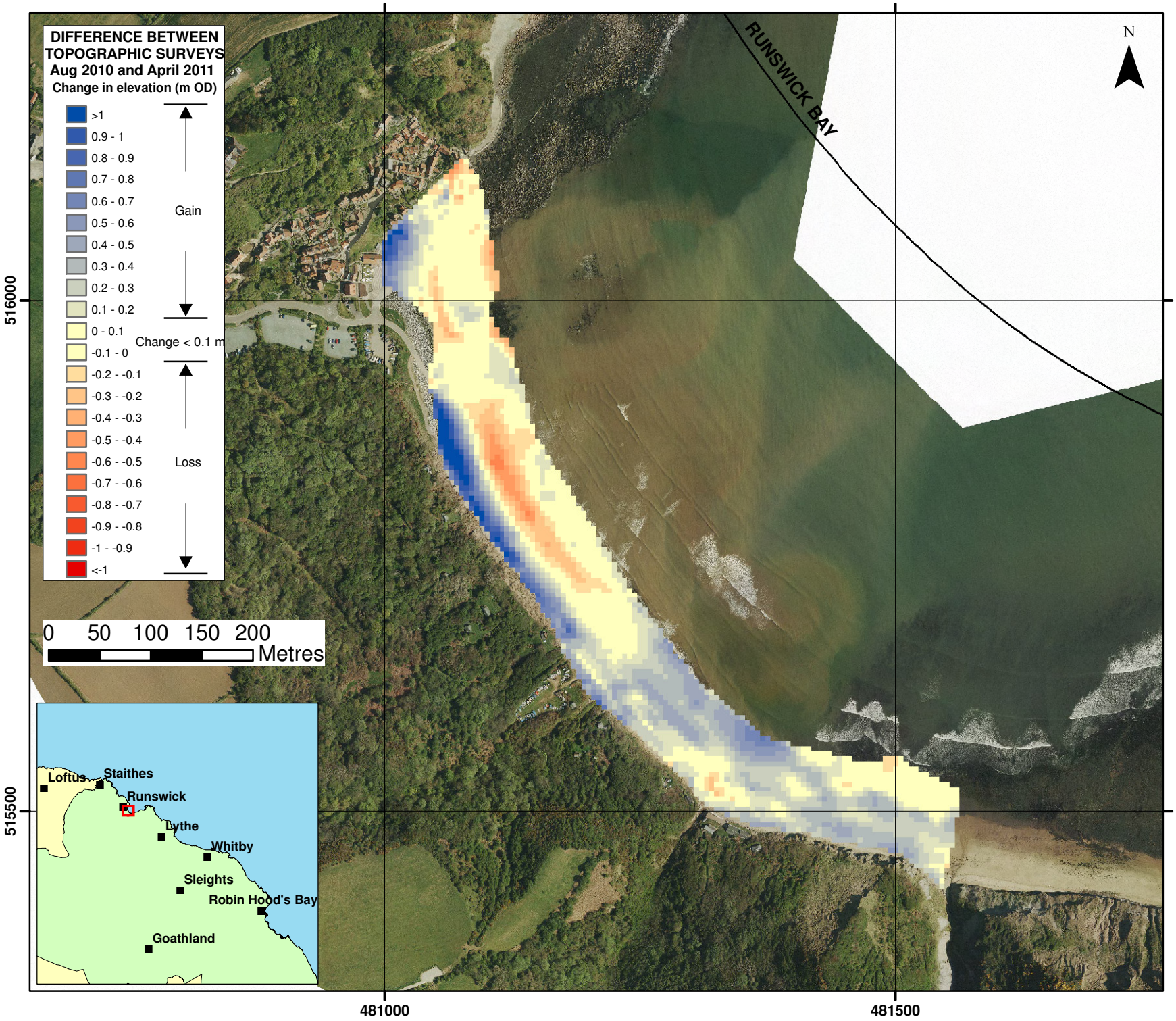
www.northeastcoastalobservatory.org.uk



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:5,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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www.halcrow.com

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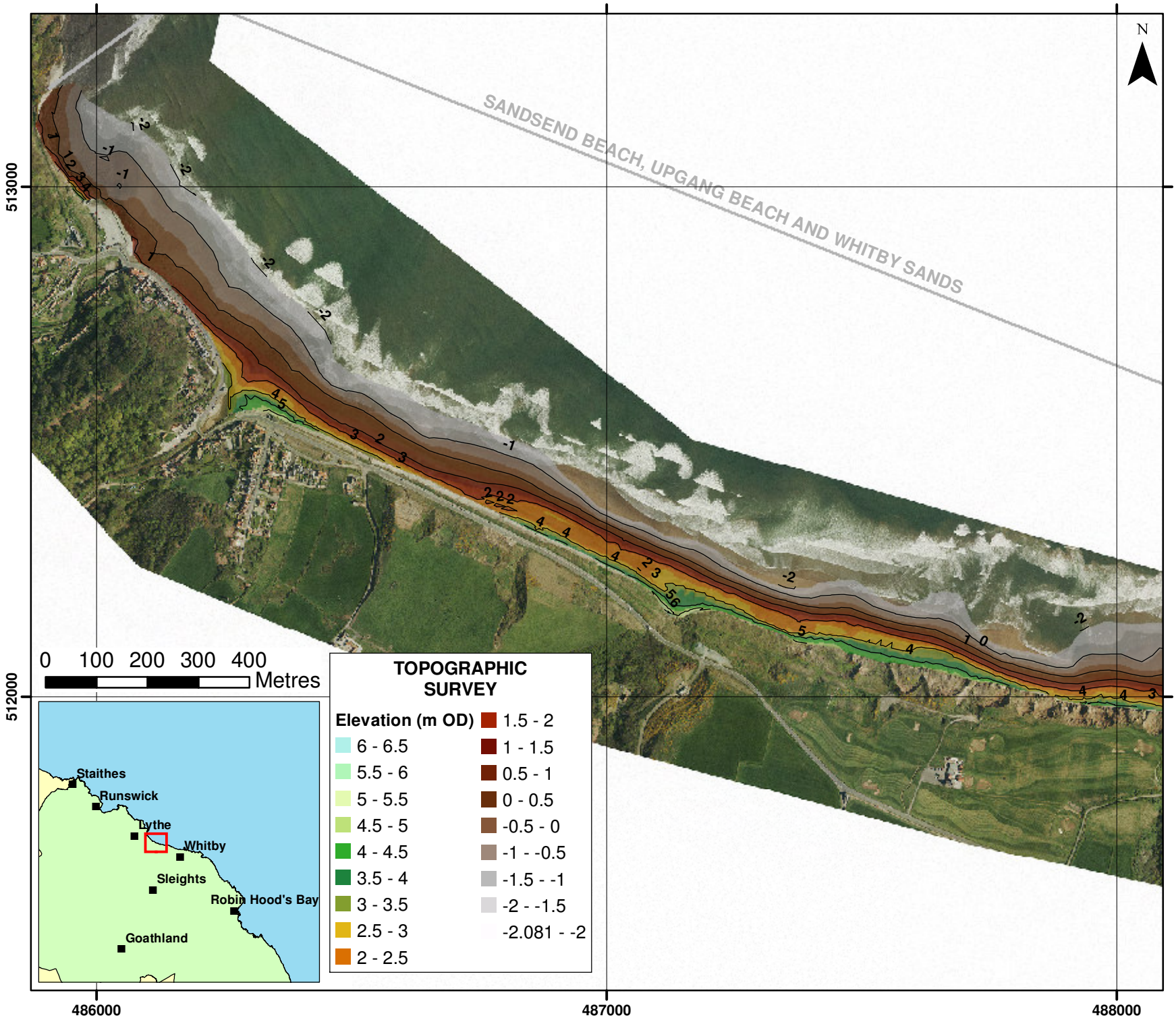
www.northeastcoastalobservatory.org.uk



Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3a Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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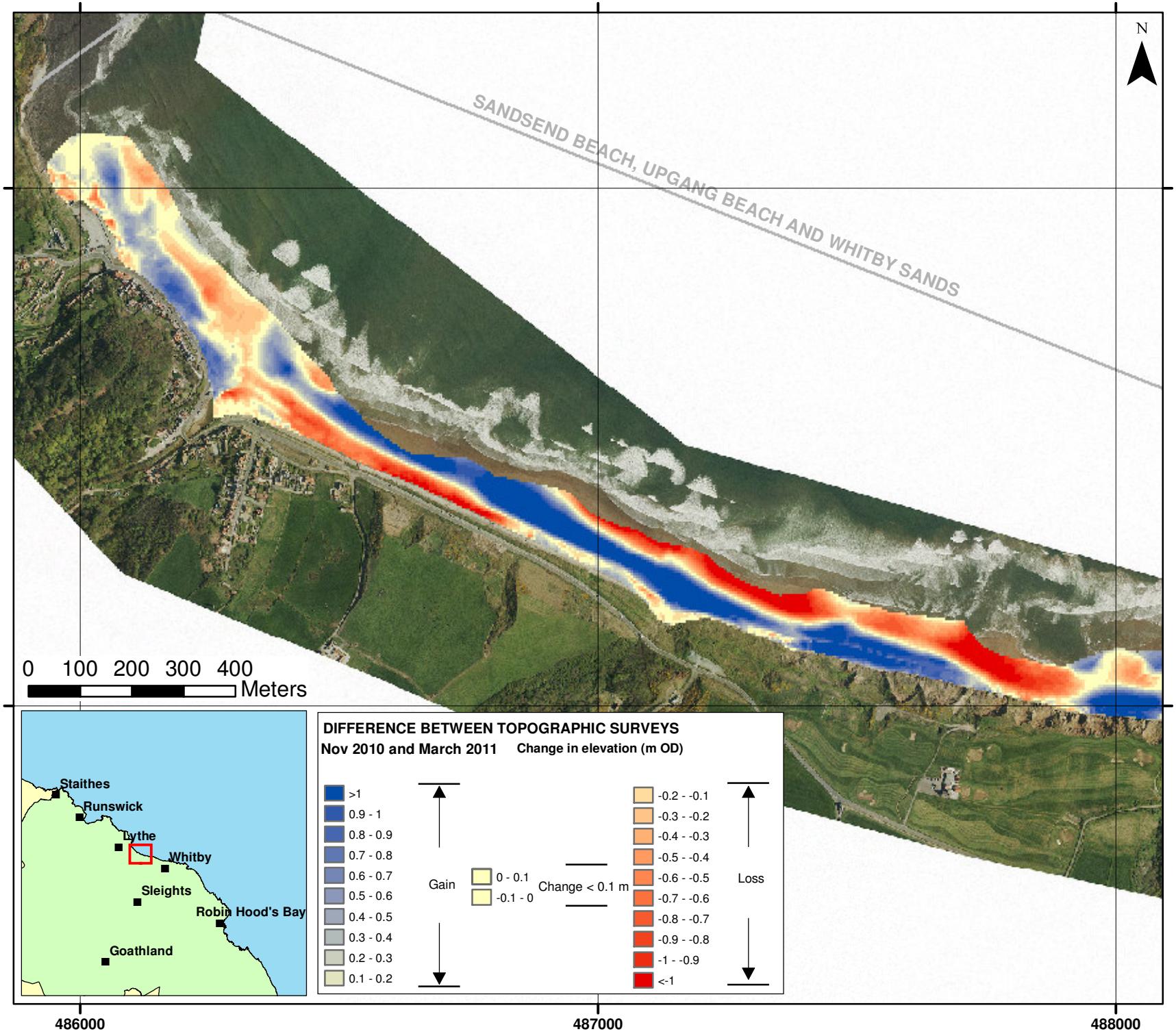

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4a Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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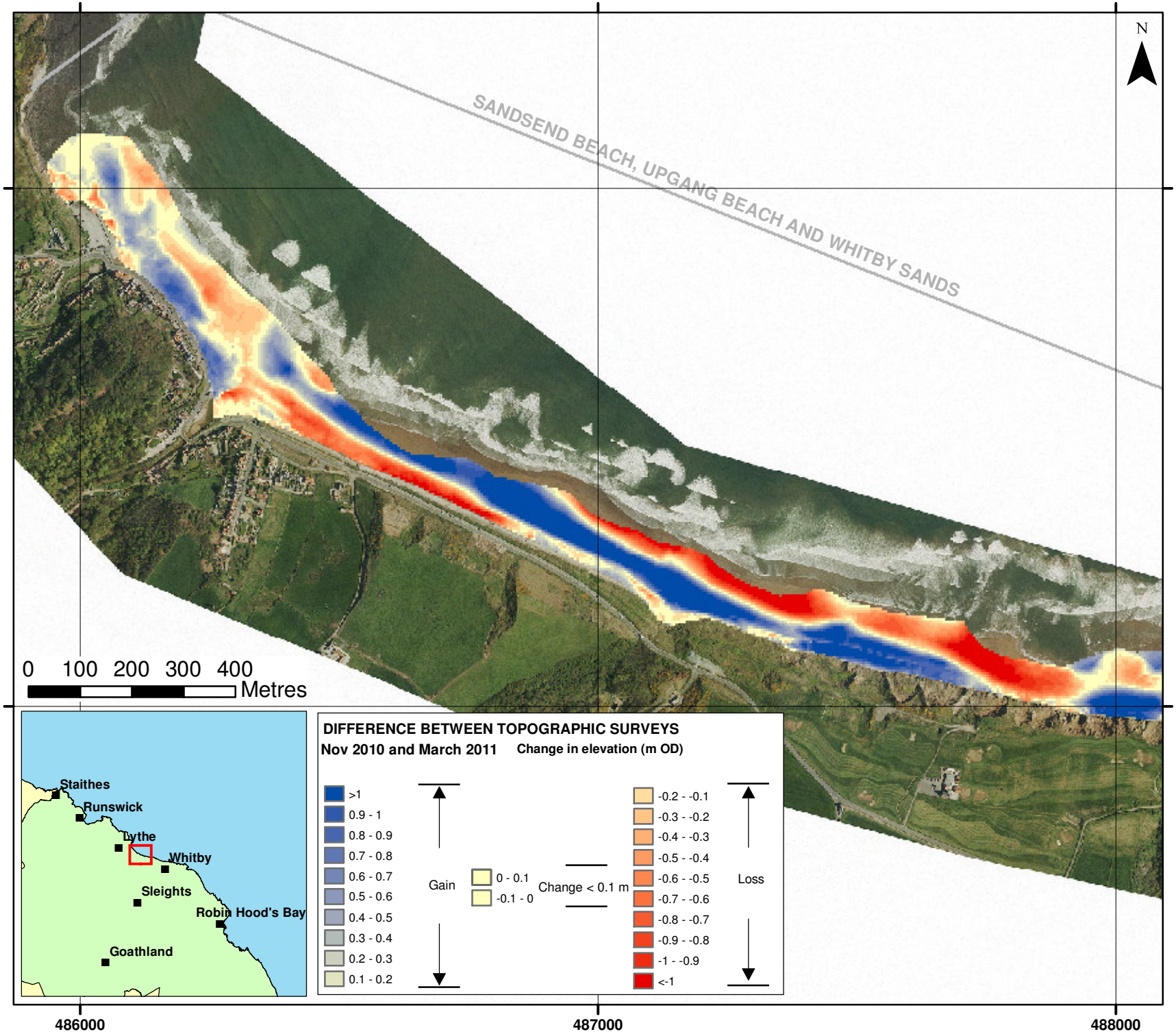

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4a Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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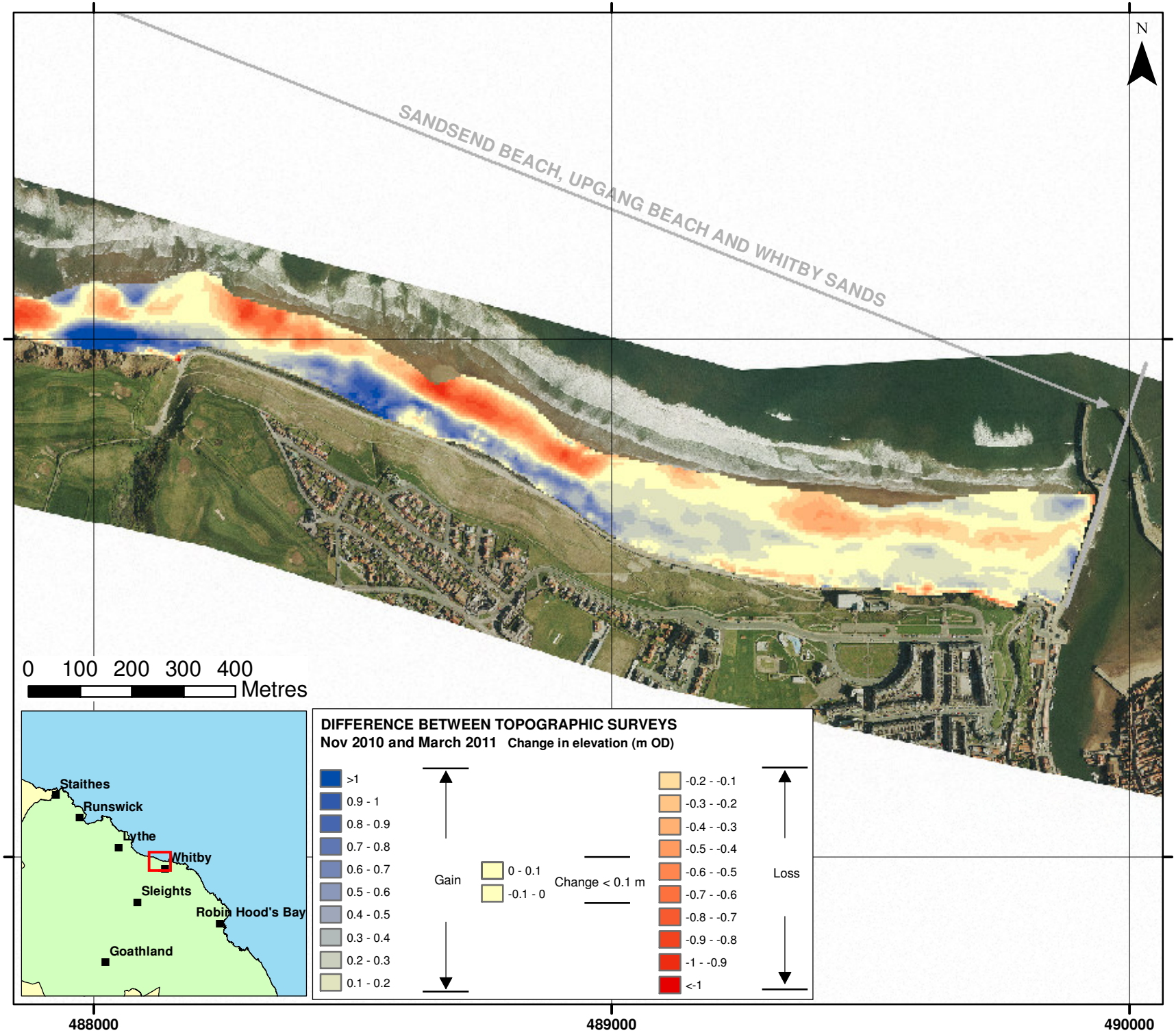

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4b Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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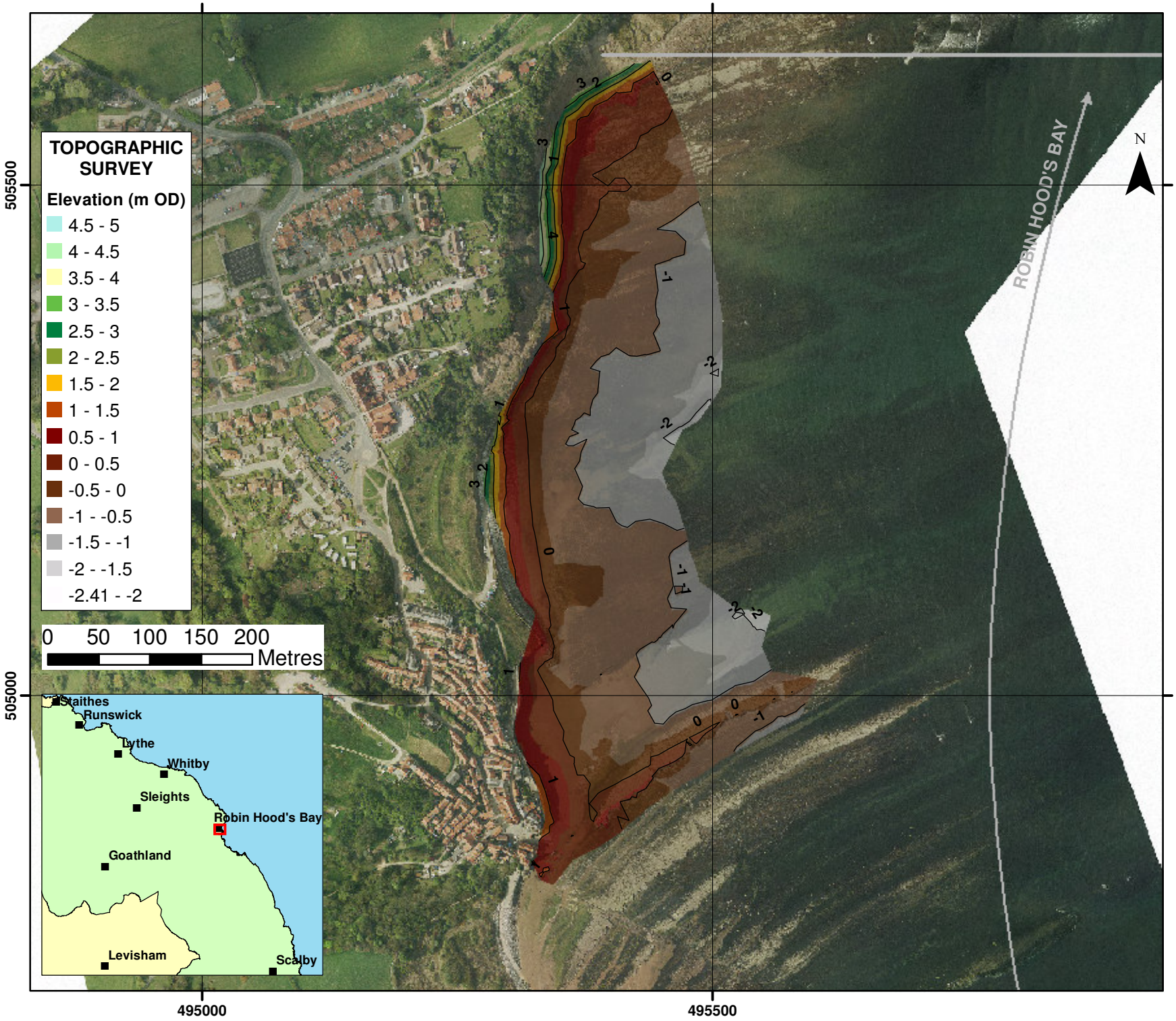

Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 5
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:5,000 at A4

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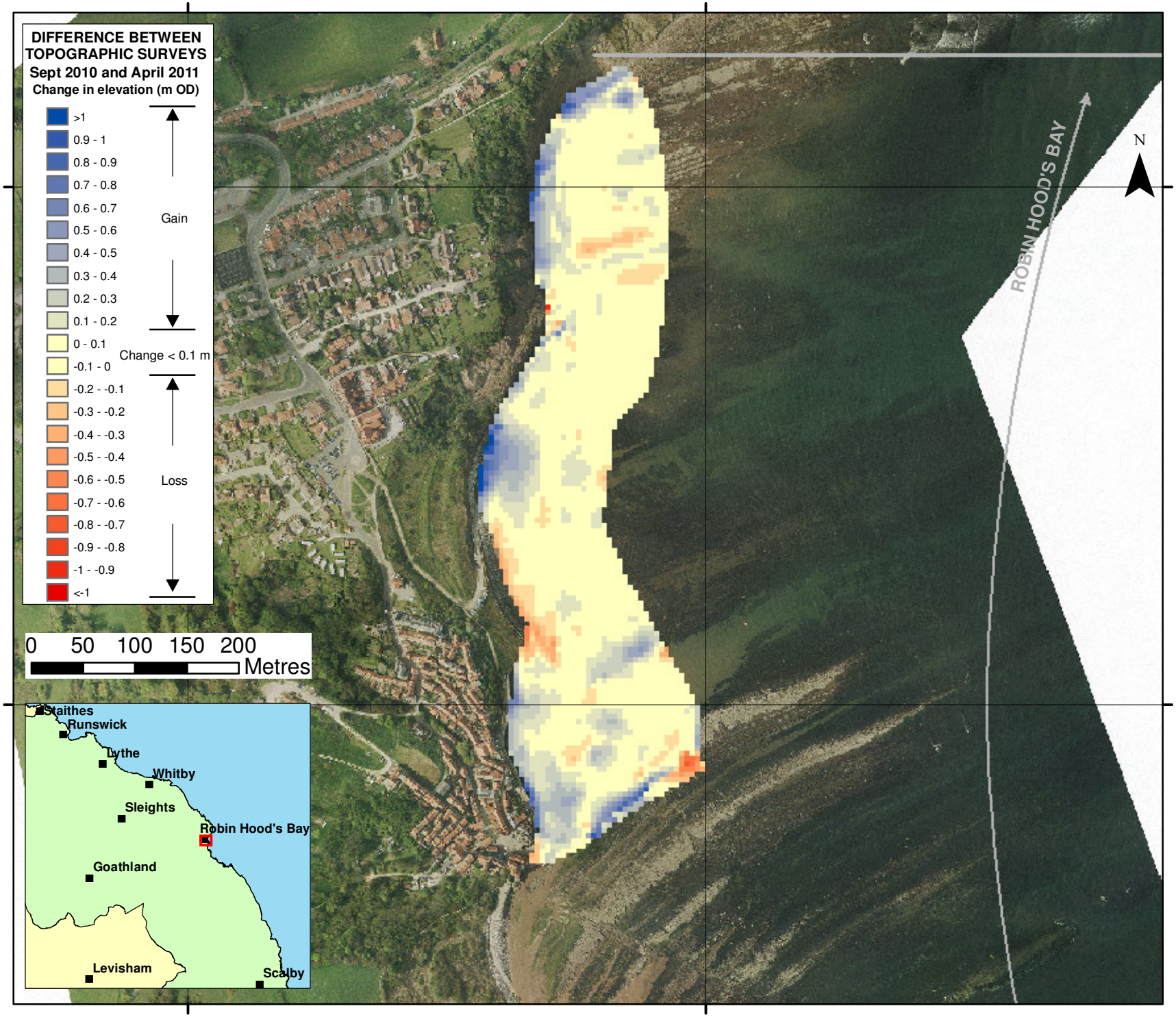

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 6
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:5,000 at A4

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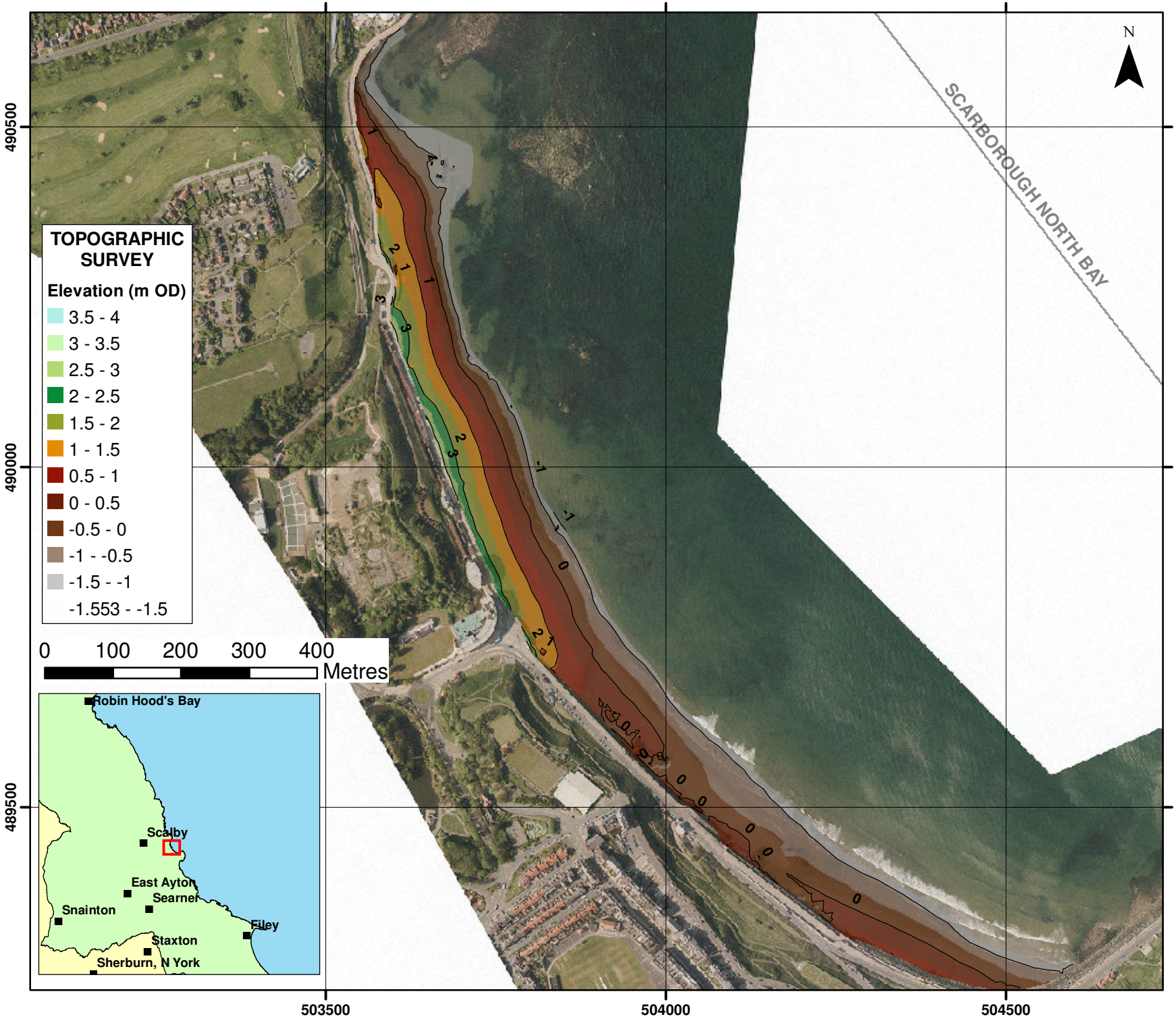

Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 7 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:7,500 at A4

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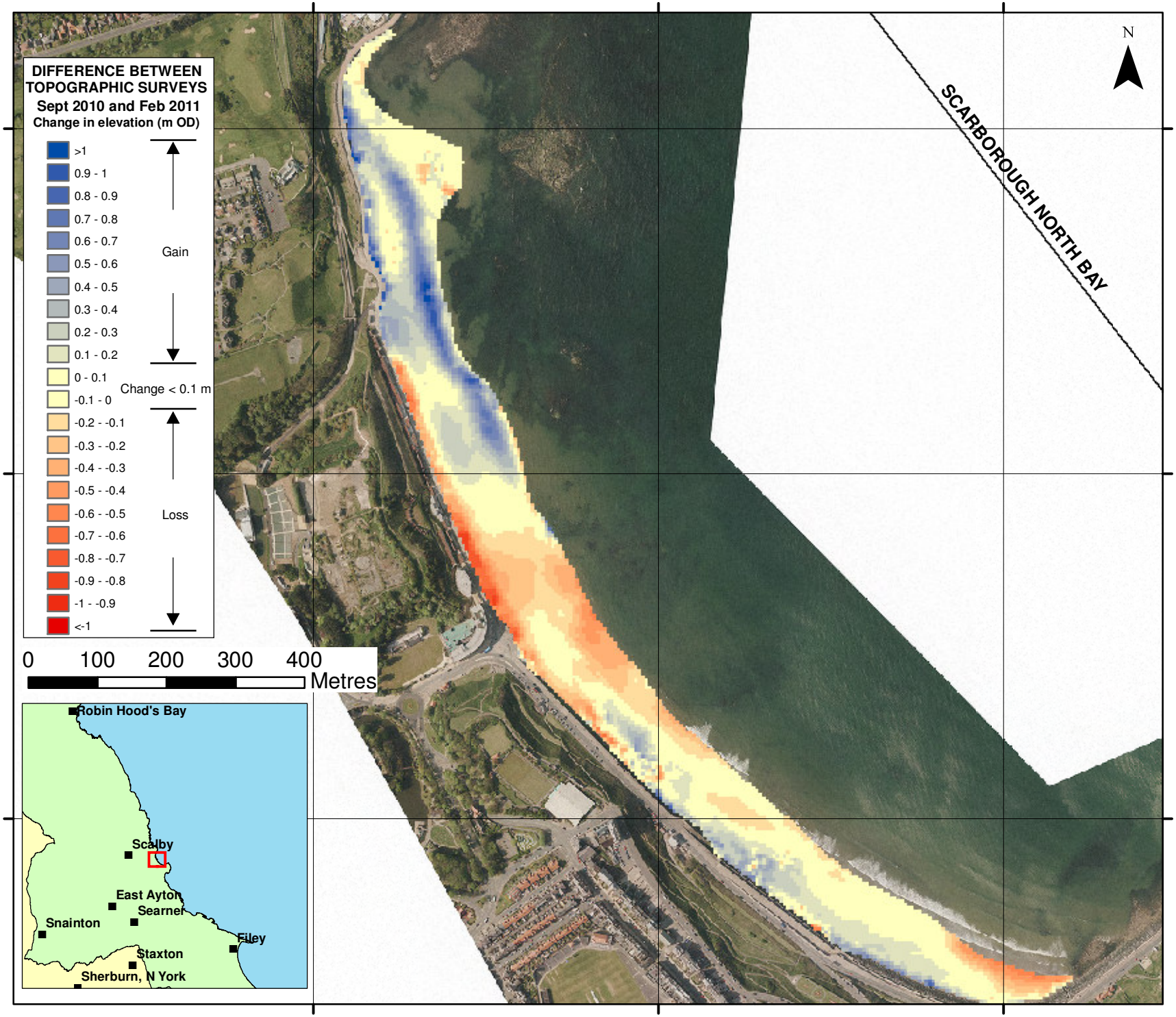

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 8
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:7,500 at A4

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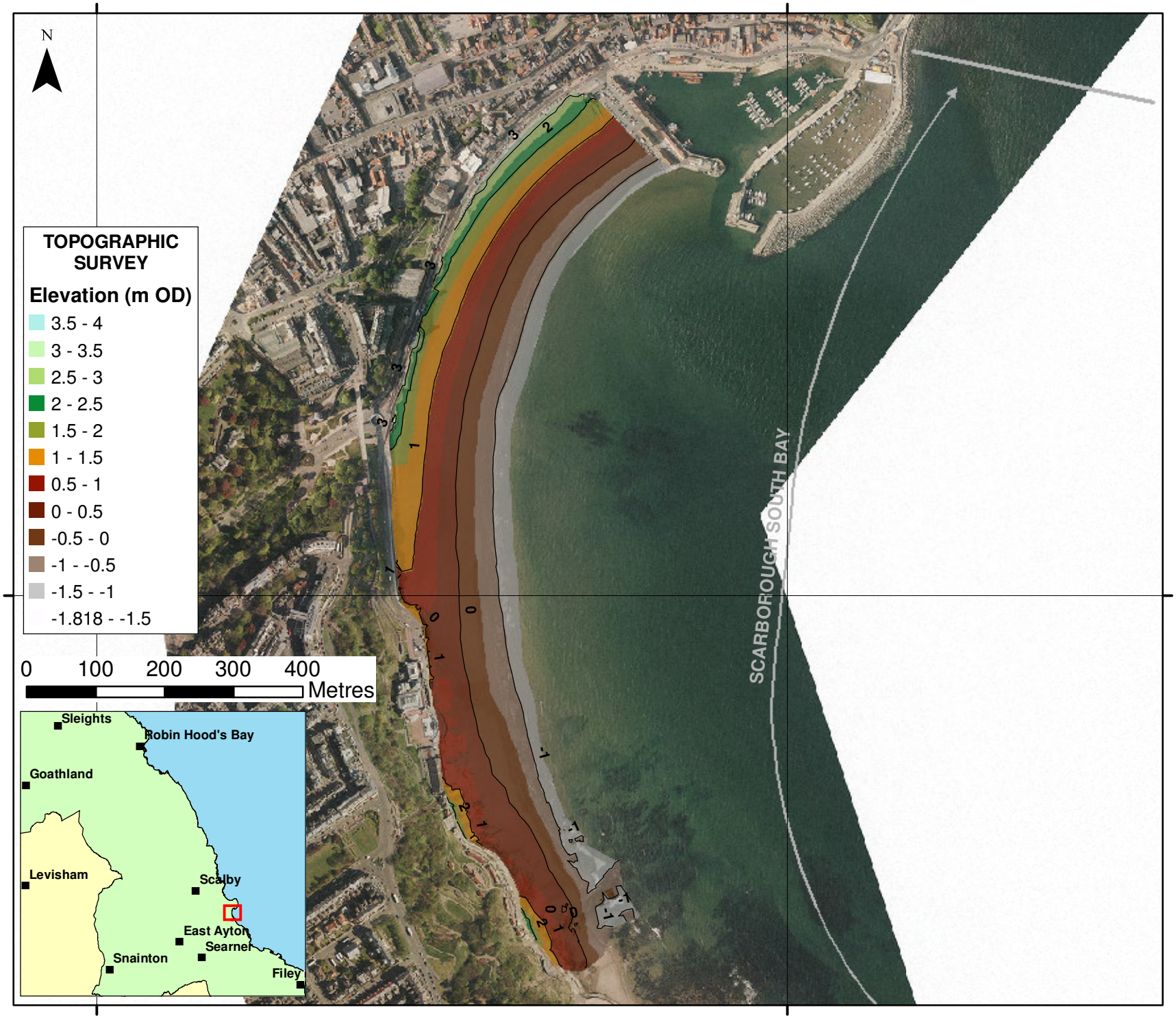

Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 9
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:7,500 at A4

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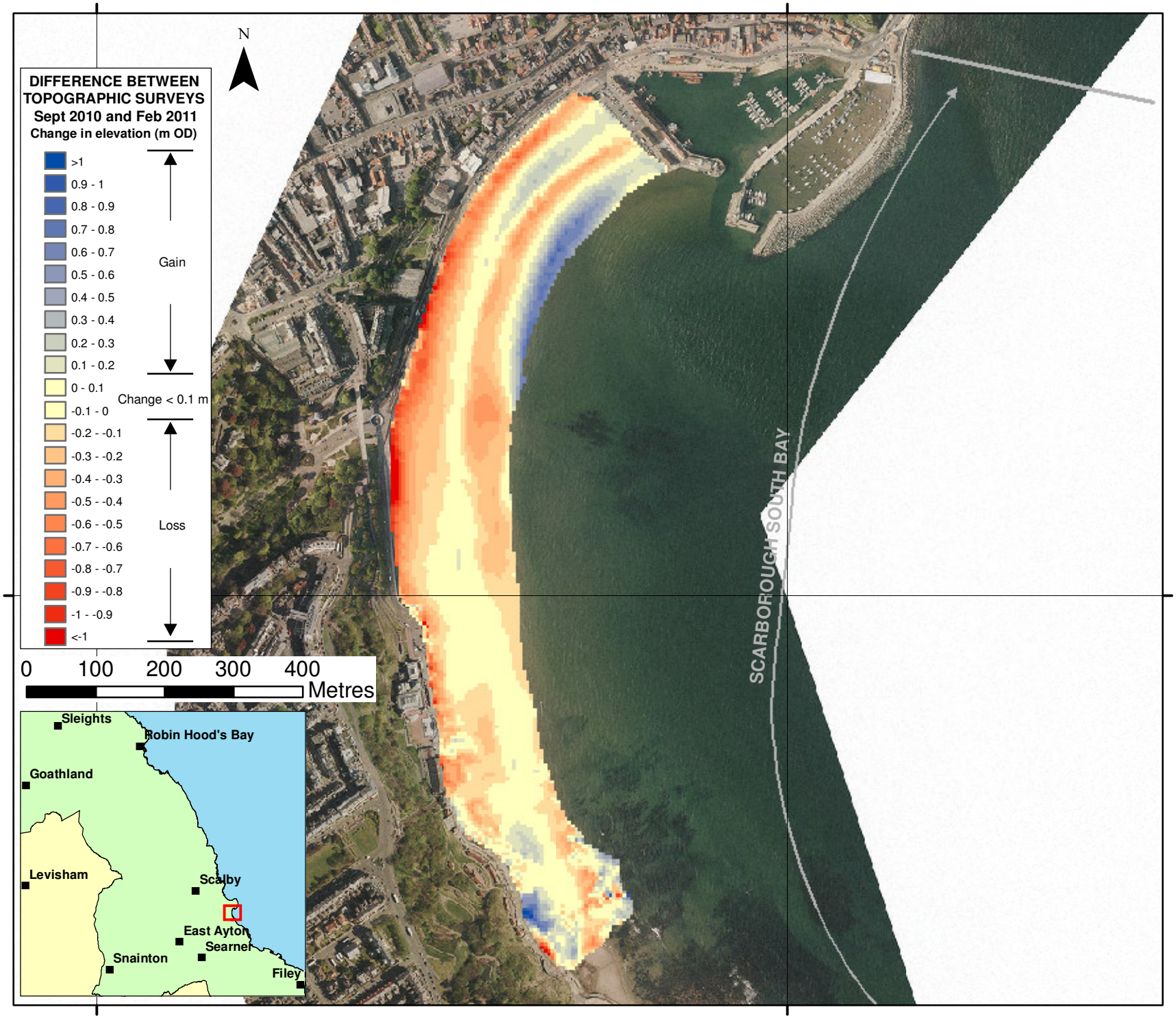

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 10
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:7,500 at A4

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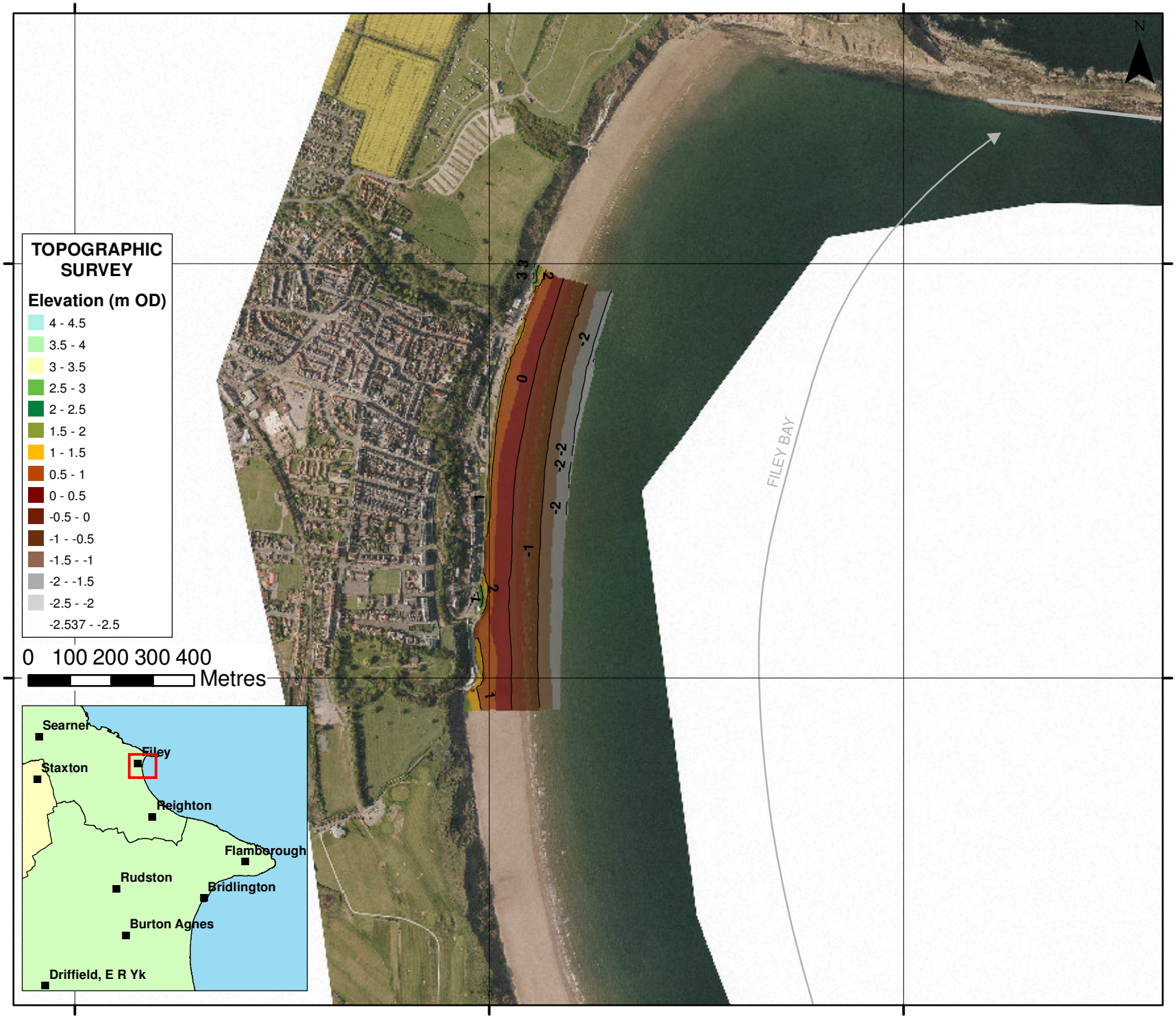

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 11 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:12,500 at A4

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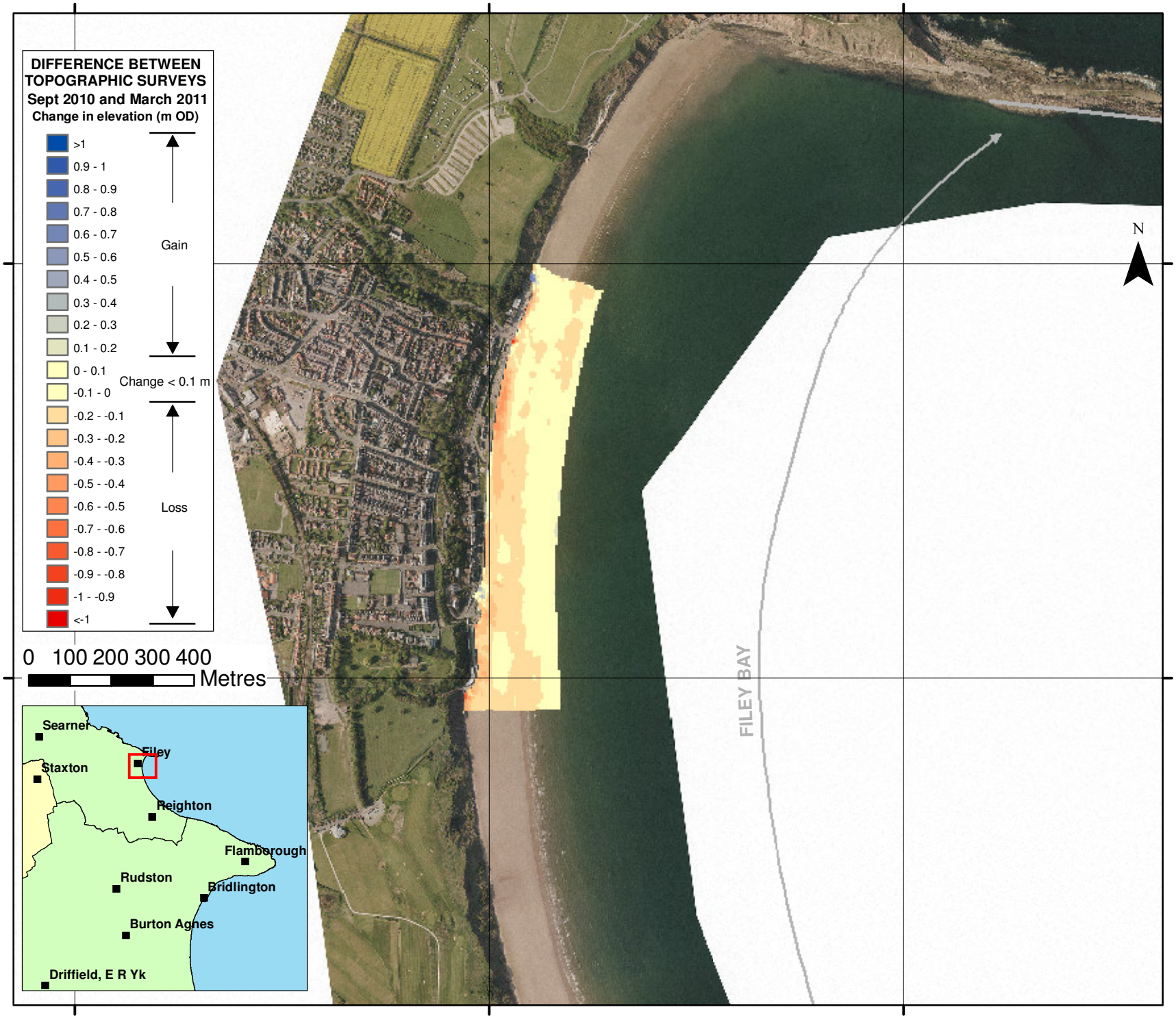

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 12
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:12,500 at A4

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Appendix C

Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Appendix C- Map 1). 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 April 2011 survey showing the position 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.

Table C1 – Cliff Top Surveys at Staithes

Ground Control Point Details					Distance to Cliff Top (m)*			Total Erosion (m)*		Erosion Rate (m/year)*
Ref	Easting	Northing	Level (mAON)	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2010)	Present Survey (April 2011)	Baseline (Nov 2008) to Present (April 2011)	Previous (Sept 2010) to Present (April 2011)	Baseline (Nov 2008) to Present (April 2011)
1	477228	518769	60.587	320	1.9	1.7	1.7	-0.1	0.0	0.0
2	477334	518798	57.543	0	10.9	10.8	10.8	-0.1	0.0	0.0
3	477487	518789	54.861	350	7.1	8.3	8.5	1.4	0.2	0.6
4	477594	518801	53.636	340	5.9	5.3	5.4	-0.6	0.1	-0.2
5	477683	518911	48.371	350	8.4	8.3	9.7	1.3	1.4	0.5
6	477792	518867	47.422	30	8.6	8.5	8.5	0.0	0.0	0.0
7	477891	518828	44.602	60	7.7	7.6	7.7	0.0	0.0	0.0
8	477959	518873	39.974	350	8.7	8.7	9.8	1.1	1.1	0.4
9	478088	518950	37.281	350	7.6	8.4	8.4	0.8	0.1	0.3
10	478191	519023	42.655	340	8.4	9.9	8.9	0.5	-1.0	0.2
11	478237	519007	39.990	60	6.9	6.8	6.8	0.0	0.0	0.0
12	478213	518988	37.169	150	6.1	6.5	6.5	0.4	-0.1	0.1
13	478501	518809	50.260	15	11.4	9.3	9.4	-1.9	0.1	-0.8

14	478624	518807	55.345	20	7.5	7.5	7.5	0.0	0.0	0.0
15	478737	518858	56.017	60	6.1	6.1	6.2	0.1	0.2	0.0
16	478823	518757	50.237	60	8.0	8.8	8.4	0.4	-0.4	0.2
17	478944	518671	46.764	30	9.3	9.7	9.9	0.6	0.2	0.2
18	479052	518630	47.026	20	9.2	9.1	9.4	0.2	0.4	0.1
19	479147	518610	47.108	0	14.2	14.4	14.5	0.3	0.1	0.1
20	479274	518618	44.243	20	11.4	11.5	11.5	0.1	0.1	0.0

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Where the cliff line shows advance this is likely to be the product of differing survey interpretation, and less likely to be a toppling cliff edge. *Note that all values have been rounded to 1 decimal place.

Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Appendix C- Map 2). The maximum separation between any two points is nominally 100m.

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 previous and present surveys showing the position from the ground control point to the edge of the cliff top along the defined bearing.

Table C2 – Cliff Top Surveys at Robin Hoods Bay

Ground Control Point Details					Distance to Cliff Top (m)*			Total Erosion (m)*		Erosion Rate (m/year)*
Ref	Easting	Northing	Level (mAOD)	Bearing (º)	Baseline Survey (Mar 2010)	Previous Survey (Sept 2010)	Present Survey (April 2011)	Baseline (Mar 2010) to Present (April 2011)	Previous (Sept 2010) to Present (April 2011)	Baseline (Mar 2010) to Present (April 2011)
1	495799	506002	65.437	130	11.6	11.4	8.3	-3.3	-3.1	-3.3
2	495549	505807	77.314	135	9.3	9.3	9.3	0.0	0.0	0.0
3	495456	505739	76.778	130	5.0	5.1	4.9	-0.1	-0.2	-0.1
4	495389	505683	73.900	140	6.3	6.2	6.2	-0.1	0.0	-0.1
5	495259	505342	55.041	130	11.3	11.1	11.0	-0.3	-0.1	-0.3
6	495231	505315	53.693	95	5.9	5.8	5.8	-0.1	0.0	-0.1
7	495184	505210	44.946	85	6.4	6.2	6.1	-0.3	-0.1	-0.3
8	495206	505153	34.093	75	5.0	4.9	4.7	-0.4	-0.3	-0.4
9	495287	505060	20.932	80	4.3	4.4	4.3	0.0	-0.1	0.0
10	495187	504708	43.446	70	3.1	3.3	3.3	0.2	0.0	0.2
11	495226	504615	44.665	120	3.8	3.6	3.6	-0.3	-0.1	-0.3
12	495297	504380	44.859	80	11.0	10.9	11.0	-0.1	0.0	-0.1
13	495350	504193	45.630	55	3.7	3.7	3.8	0.0	0.0	0.0

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Where the cliff line shows advance this is likely to be the product of differing survey interpretation, and less likely to be a toppling cliff edge. *Note that all values have been rounded to 1 decimal place.

Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Appendix C- Map 3). The maximum separation between any two points is nominally 300m.

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 most recent February 2011 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.

Table C3 – Cliff Top Surveys at Scarborough South Bay

Ground Control Point Details					Distance to Cliff Top (m)*			Total Erosion (m)*		Erosion Rate (m/year)*
Ref	Easting	Northing	Level (mAOD)	Bearing (º)	Baseline Survey (Mar 2010)	Previous Survey (Sept 2010)	Present Survey (Feb 2011)	Baseline (Mar 2010) to Present (Feb 2011)	Previous (Sept 2010) to Present (Feb 2011)	Baseline (Mar 2010) to Present (Feb 2011)
1	504339	487887	53.707	70	7.0	7.0	7.0	0.0	0.0	0.0
2	504422	487603	52.670	80	4.8	4.9		-	-	-
3	504534	487318	64.346	40	15.1	15.2	15.2	0.1	0.0	0.1
4	504730	487137	56.299	55	9.6	9.6	9.6	0.0	0.0	0.0
5	504922	486837	61.272	60	8.8	8.3	8.6	-0.2	0.3	-0.2
6	505071	486652	68.935	75	3.8	3.8	3.6	-0.2	-0.1	-0.2
7	505284	486479	68.091	35	7.0	6.9	7.1	0.1	0.2	0.1
8	505597	486363	56.836	30	8.6	8.5	8.7	0.1	0.3	0.1
9	505758	486005	61.483	45	9.1	9.1	9.1	0.0	0.0	0.0
10	505895	485889	60.324	15	14.8	14.7	14.8	0.0	0.1	0.0
11	505990	485657	60.520	80	4.7	4.6	4.3	-0.4	-0.3	-0.4
12	506024	485421	69.863	55	6.1	6.0	5.9	-0.2	-0.1	-0.2
13	506035	485315	78.327	90	7.0	6.2	6.1	-0.9	0.0	-0.9

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Where the cliff line shows advance this is likely to be the product of differing survey interpretation, and less likely to be a toppling cliff edge. *Note that all values have been rounded to 1 decimal place.

Cliff Top Survey

Cayton Bay

Eight ground control points have been established within Cayton Bay (Appendix C- Map 4). The maximum separation between any two points is nominally 300m.

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 March 2011 survey showing the position 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.

Table C4 – Cliff Top Surveys at Cayton Bay

Ground Control Point Details					Distance to Cliff Top (m)*			Total Erosion (m)*		Erosion Rate (m/year)*
Ref	Easting	Northing	Level (m AOD)	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2010)	Present Survey (Mar 2011)	Baseline (Nov 2008) to Present (Mar 2011)	Previous (Sept 2010) to Present (Mar 2011)	Baseline (Nov 2008) to Present (Mar 2011)
1	506325	484850	32.079	50	4.0	3.3	3.5	-0.5	0.2	-0.2
2	506459	484716	28.227	65	5.0	-0.2	-0.1	-5.1	0.1	-2.0
3	506597	484539	28.204	65	5.0	6.2	6.0	1.0	-0.2	0.4
4	506778	484345	38.944	21	9.0	9.0	9.2	0.2	0.2	0.1
5	507019	484222	38.816	342	7.7	8.0	8.1	0.4	0.0	0.1
6	507242	484122	46.544	2	7.4	7.4	7.3	-0.1	-0.1	0.0
7	507518	484008	69.549	25	7.5	7.3	7.7	0.2	0.4	0.1
8	507819	484006	80.135	1	5.5	5.9	5.8	0.3	0.0	0.1

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Where the cliff line shows advance this is likely to be the product of differing survey interpretation, and less likely to be a toppling cliff edge. *Note that all values have been rounded to 1 decimal place.

Cliff Top Survey

Filey Bay

Twenty-three ground control points were established within Filey Bay (Appendix C- Maps 5a and 5b) for the baseline survey in November 2008. The maximum separation between any two points is nominally 300m. 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.

Additional ground control points were established in September 2010 and March 2011, taking the total number of locations up to 28. Ground control point 12a was established in September 2010 as a replacement for point 13 as it was inaccessible at this time. New points 24 and 25 were also established in September 2010. In March 2011, new points 26 and 27 were added to the monitoring programme and both points 12a and 13 were accessible at this time.

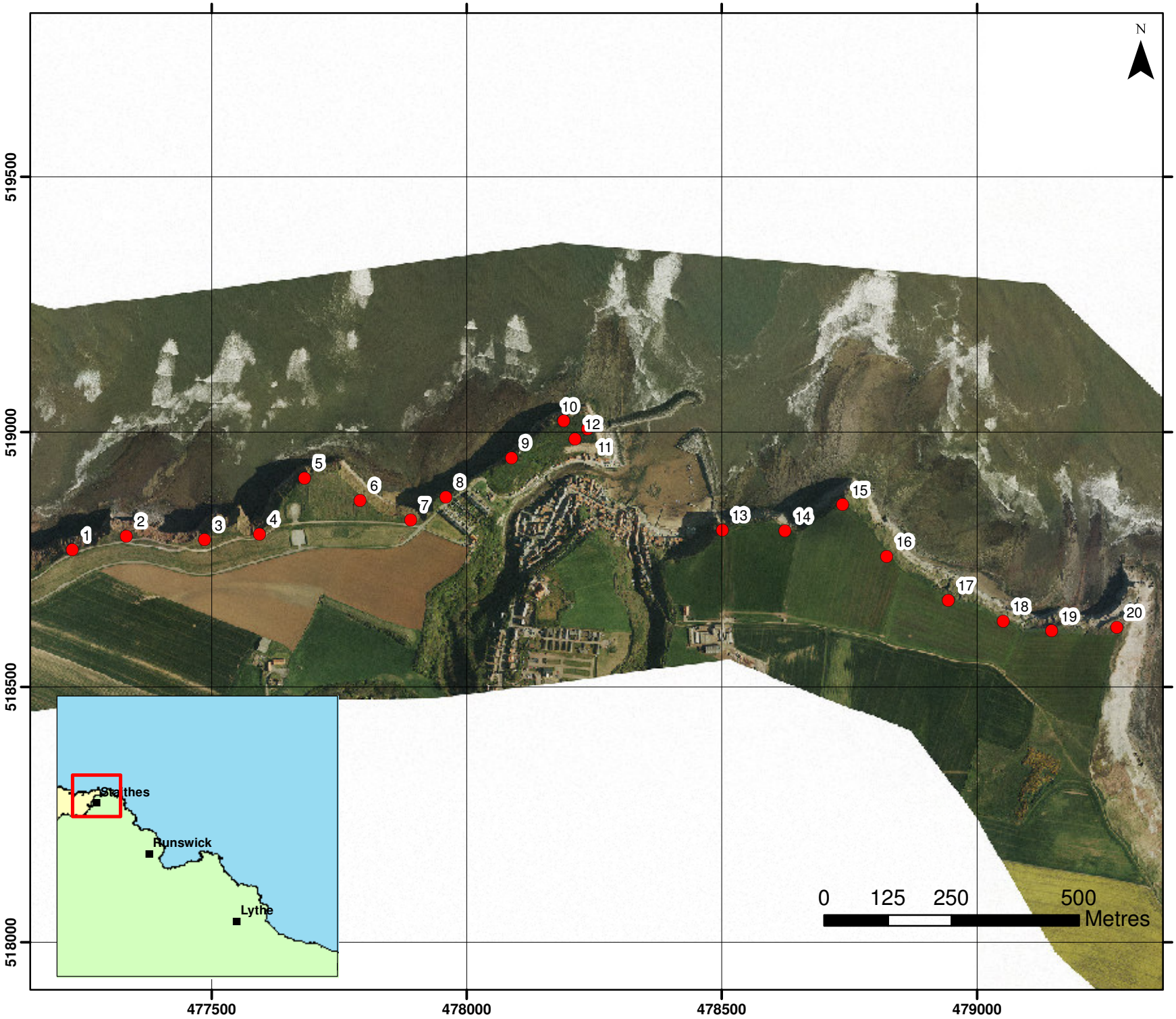
Table C5 provides baseline information about these ground control points and results from the March 2011 survey showing the position from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey.

Table C5 – Cliff Top Surveys at Filey Bay

Ground Control Point Details					Distance to Cliff Top (m)*			Total Erosion (m)*		Erosion Rate (m/year)*
Ref	Easting	Northing	Level (m AOD)	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2010)	Present Survey (Mar 2011)	Baseline (Nov 2008) to Present (Mar 2011)	Previous (Sept 2010) to Present (Mar 2011)	Baseline (Nov 2008) to Present (Mar 2011)
1	512445	481631	42.54	130	8.7	8.8	9.0	0.3	0.2	0.1
2	512307	481490	37.54	144	7.6	7.6	7.8	0.2	0.1	0.1
3	512154	481235	34.61	122	8.3	8.5	8.5	0.2	0.1	0.1
4	512029	480960	33.03	112	7.4	7.6	7.8	0.4	0.2	0.1
5	511895	479888	28.76	89	7.1	1.6	1.6	-5.5	0.0	-2.2
6	511908	479597	31.80	48	6.7	6.9	7.1	0.4	0.2	0.2
7	511991	479310	29.20	69	6.7	6.5	6.5	-0.2	0.0	-0.1
8	512083	478981	27.18	66	10.2	10.4	10.5	0.3	0.1	0.1
9	512121	478786	30.90	76	8.3	8.5	8.5	0.1	-0.1	0.1

10	512226	478548	32.96	74	7.5	7.3	7.3	-0.2	0.0	-0.1
11	512471	478153	11.30	53	6.6	6.3	6.6	0.0	0.3	0.0
12	512559	477902	20.25	66	7.7	7.8	7.9	0.2	0.1	0.1
12a	512656	477822	11.34	67	-	13.7	13.9	-	0.2	-
13	512698	477719	20.22	34	4.2	Unable to measure	4.4	0.2	-	0.1
14	512939	477401	31.74	66	8.0	7.4	7.3	-0.7	-0.1	-0.3
15	513157	477193	27.61	51	5.2	5.1	5.4	0.1	0.2	0.1
16	513299	477025	27.97	30	7.7	7.8	7.7	0.0	0.0	0.0
17	513508	476821	36.78	34	10.7	10.8	10.7	0.0	-0.1	0.0
18	513721	476602	39.68	31	7.2	7.3	7.3	0.1	0.0	0.0
19	513917	476354	48.85	51	6.6	6.7	6.6	0.0	-0.1	0.0
20	514175	476179	41.83	32	7.0	7.1	7.3	0.3	0.2	0.1
21	514472	475966	43.23	66	7.6	7.6	7.6	0.0	0.0	0.0
22	514656	475729	56.55	101	8.1	8.2	8.3	0.2	0.1	0.1
23	514889	475538	68.50	60	9.1	9.1	9.1	0.0	0.0	0.0
24	512604	481666	41.90	14	-	19.8	19.9	-	0.1	-
25	512607	481649	42.51	184	-	17.2	17.2	-	0.1	-
26	512302	481826	50.48	18	-	-	11.0	-	-	-
27	512476	481712	44.63	20	-	-	11.6	-	-	-

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Where the cliff line shows advance this is likely to be the product of differing survey interpretation, and less likely to be a toppling cliff edge. *Note that all values have been rounded to 1 decimal place.



Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 1 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

Drawn by:	AW	Date:	June 2011
Checked by:	PF	Date:	June 2011
Approved by:	PF	Date:	June 2011

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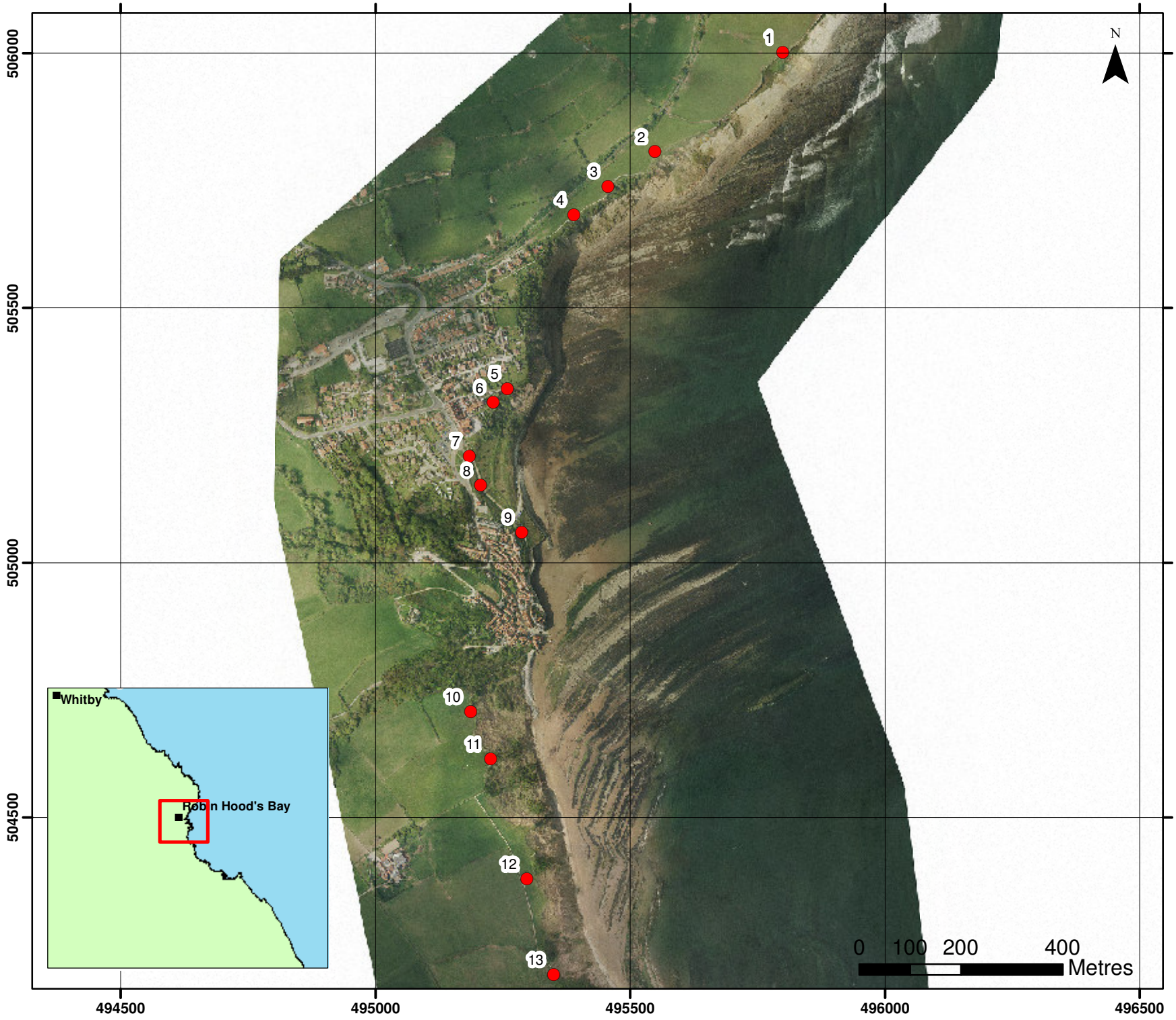

Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 2
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

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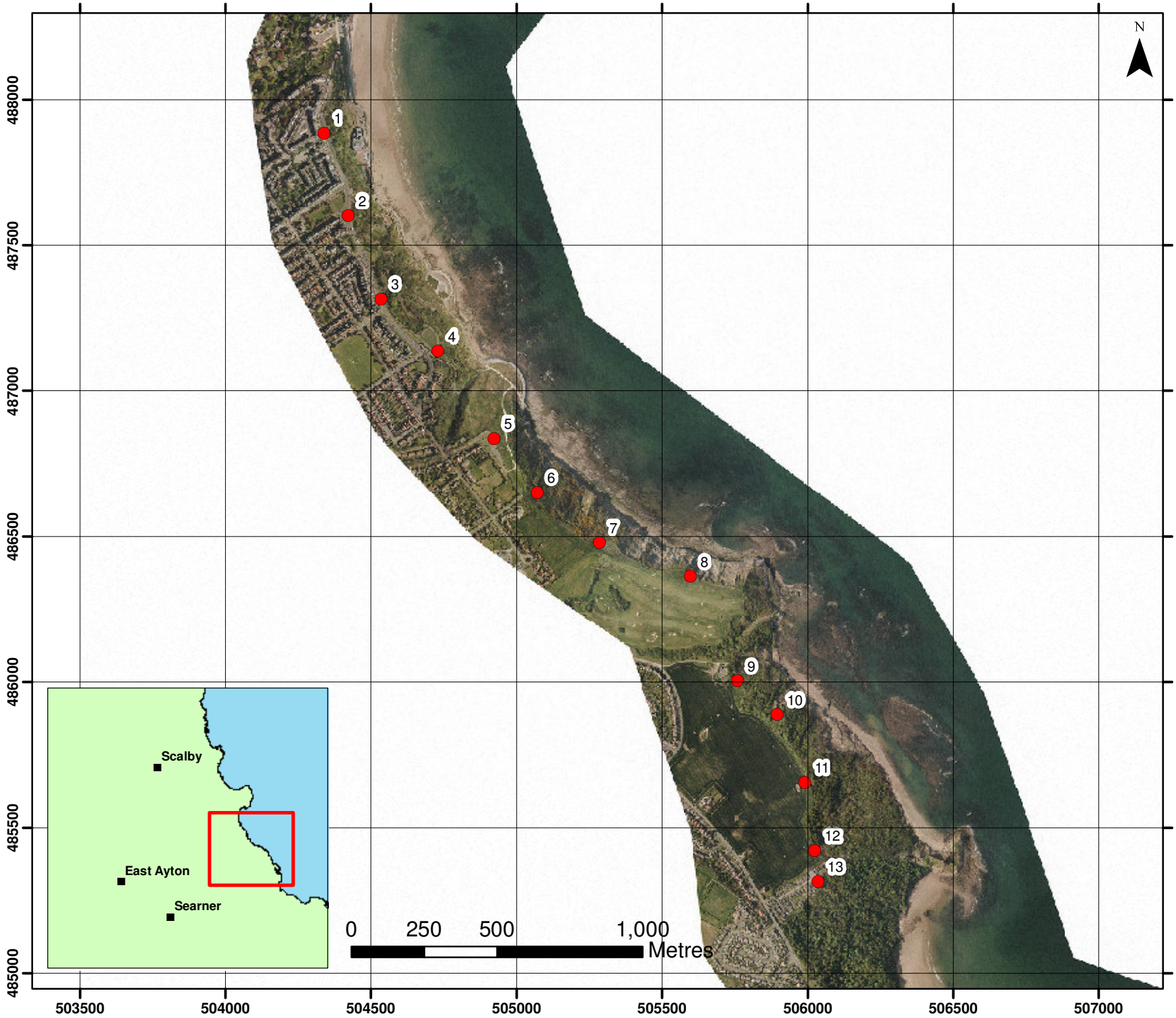

Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 3 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:17,500 at A4

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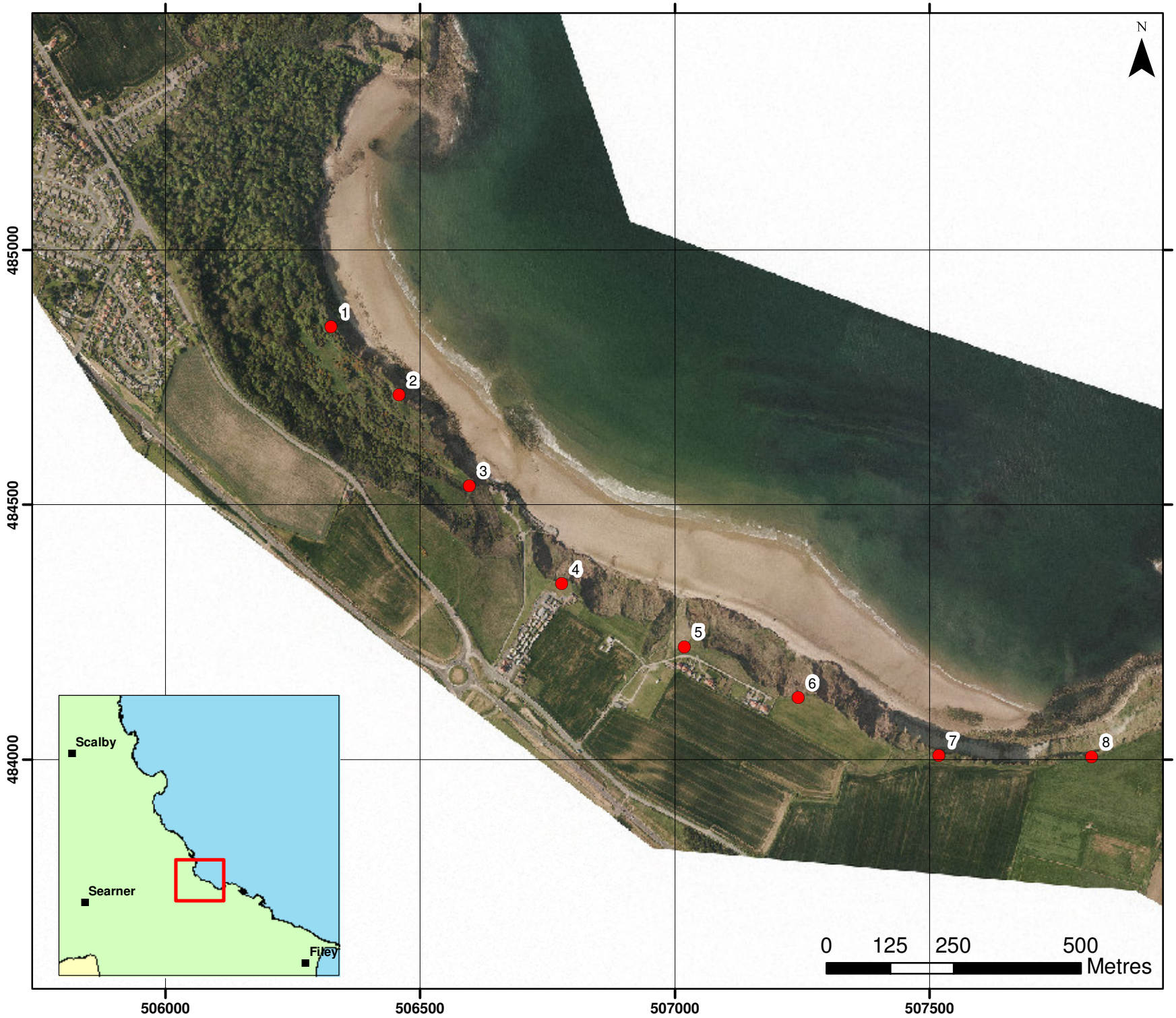

Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 4 Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4

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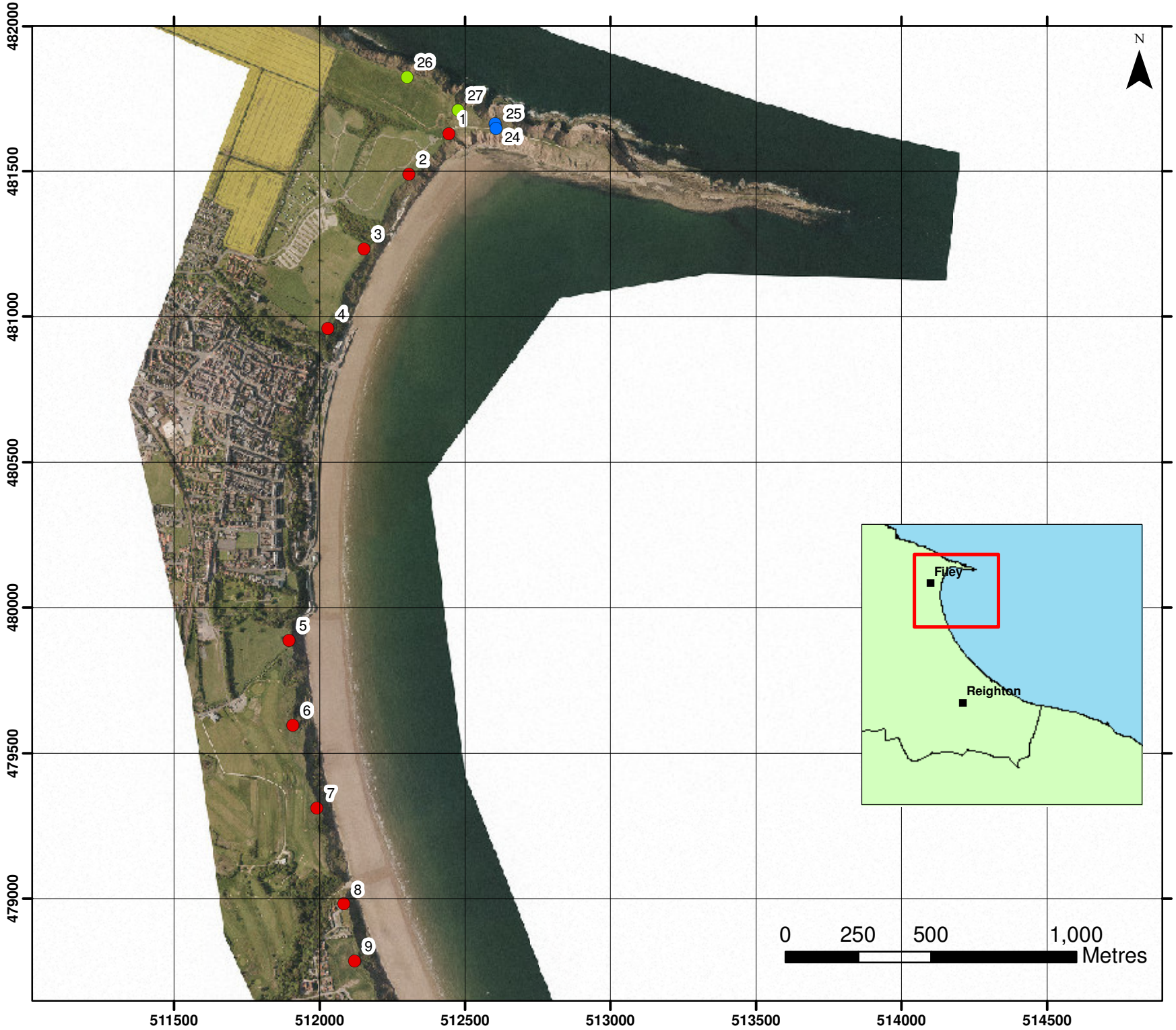

Ground Control Points

- Established March 2011
- Established Sept 2010
- Established Nov 2008

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 5a Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:17,500 at A4

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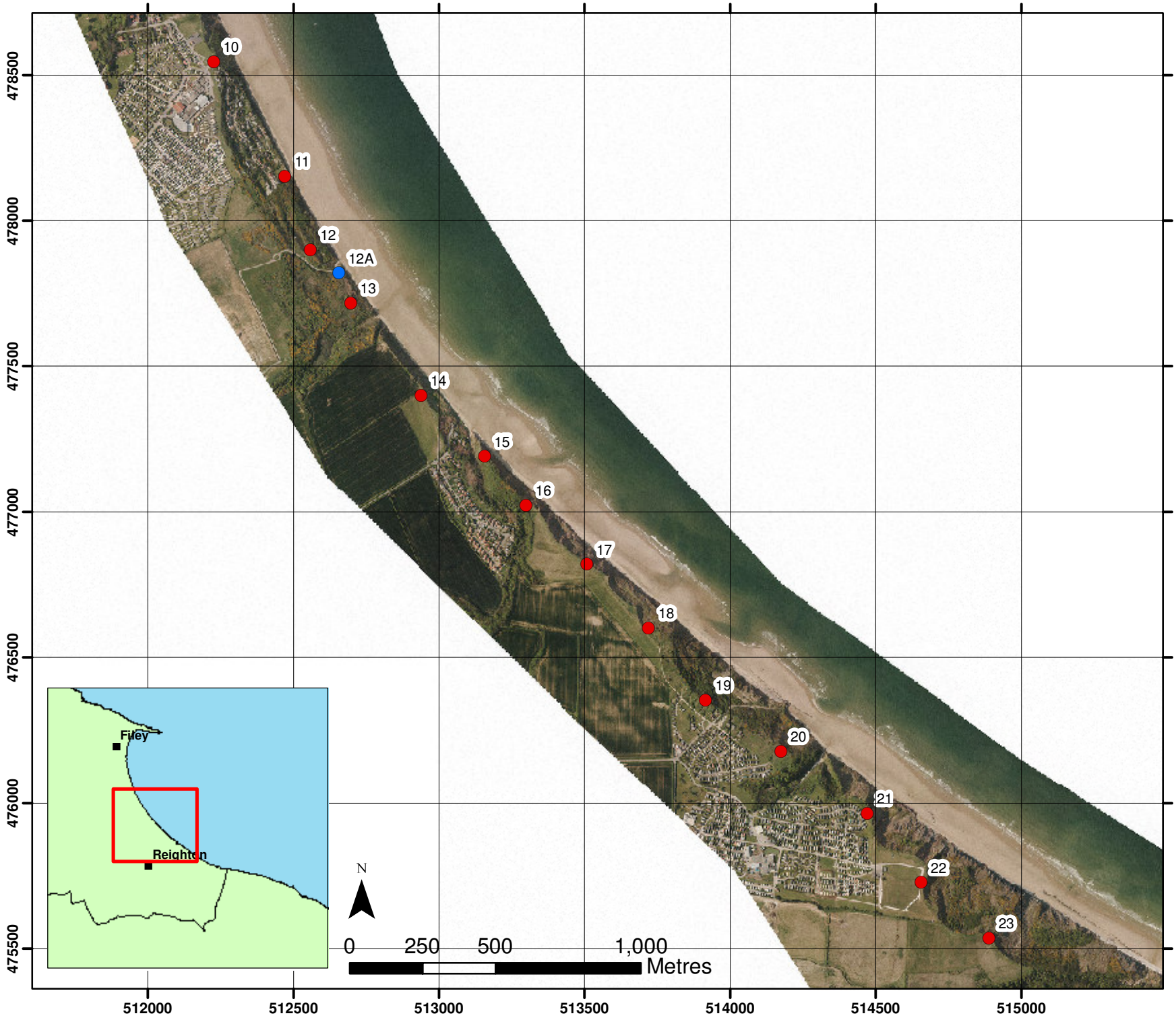

Ground Control Points

- Established Sept 2010
- Established Nov 2008

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix C - Map 5b
Scarborough Borough Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:17,500 at A4

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