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

Redcar and Cleveland Council Final Report

February 2013

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD) Berwick upon Tweed	Holy Island	North Sunderland
1 in 200 year	3.4	3.4	3.5
HAT	2.8	2.8	2.8
MHWS	2.2	2.4	2.4
MLWS	-1.9	-1.8	-1.7
Water Level Parameter	**Water Level (m AOD) Amble**	**Blyth**	**River Tyne**
1 in 200 year	3.5	3.6	3.7
HAT	3.1	3.1	3.1
MHWS	2.4	2.4	2.4
MLWS	-1.9	-1.8	-1.9

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 intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

Preamble

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

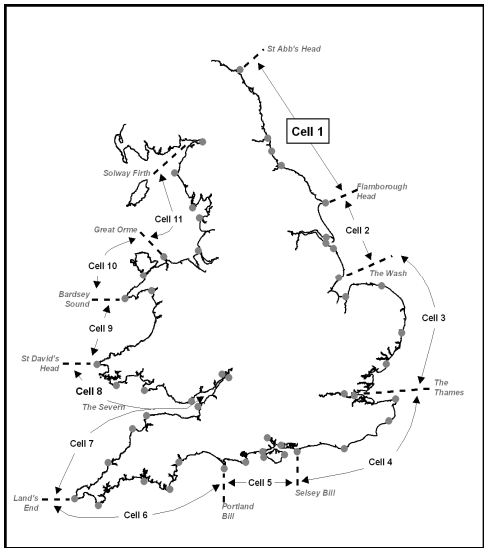


Figure 1 Sediment Cells in England and Wales

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

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

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

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

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

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

1. Introduction

1.1 Study Area

South Gare Breakwater at the mouth of the River Tees estuary to Cowbar Nab at Staithes. For the purposes of this report, it has been sub-divided into four areas, namely:

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes [1]

1.2 Methodology

Along Redcar & Cleveland Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along nine transect lines
    - Topographic survey along Coatham Sands
    - Topographic survey along Redcar Sands
    - Topographic survey along Marske Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey at Skinningrove along Cattersty Sands

- Partial Measures survey annually each spring comprising:
    - o Beach profile surveys along nine transect lines
    - o Topographic survey along Redcar Sands
    - o Topographic survey along Saltburn Sands
    - o Topographic survey at Skinningrove along Cattersty Sands

- Cliff top survey (biannually) at:
    - Staithes

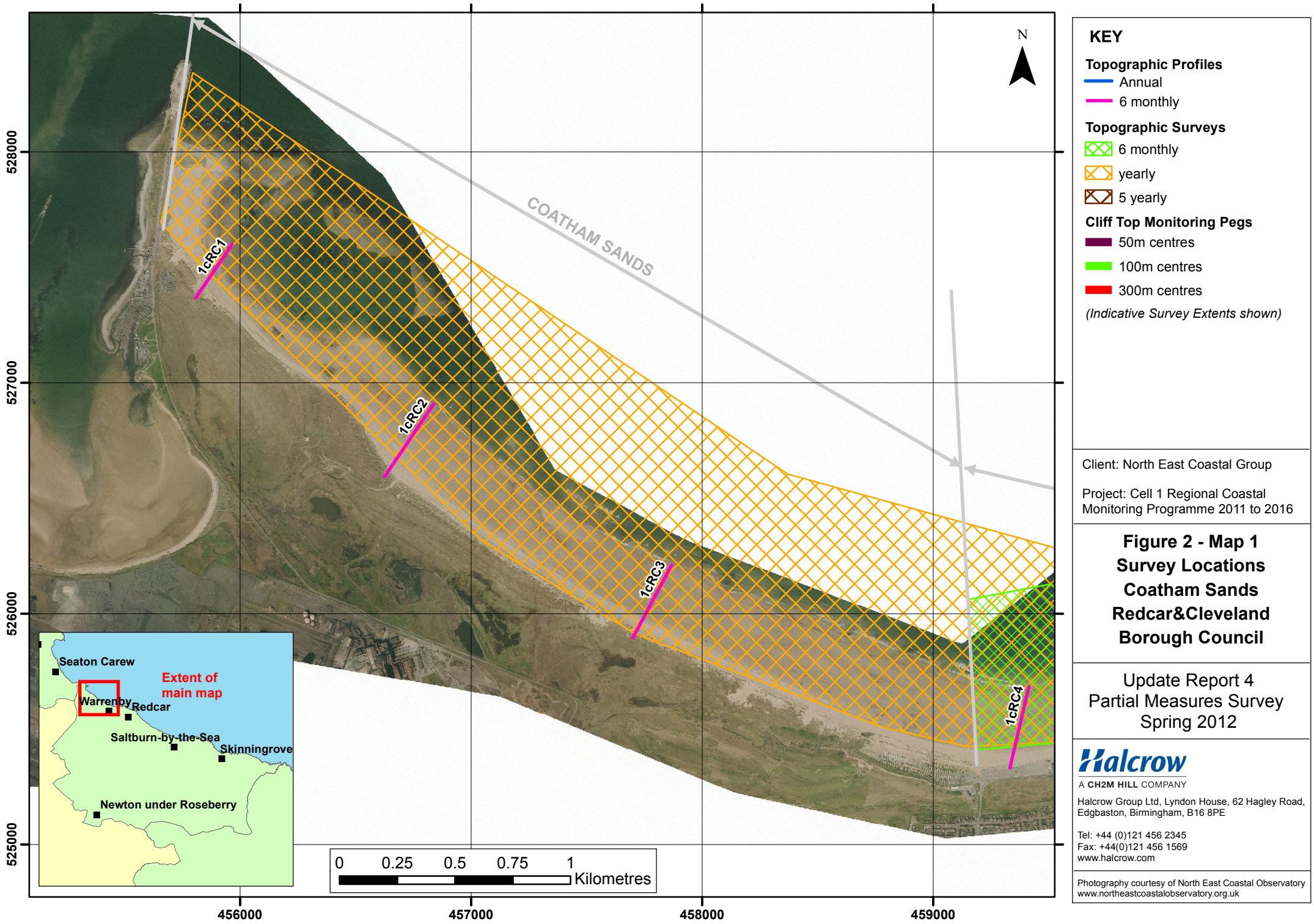
The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 12th and 24th March 2012. During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

The Update Report presents the following:

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

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

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



KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 1
Survey Locations
Coatham Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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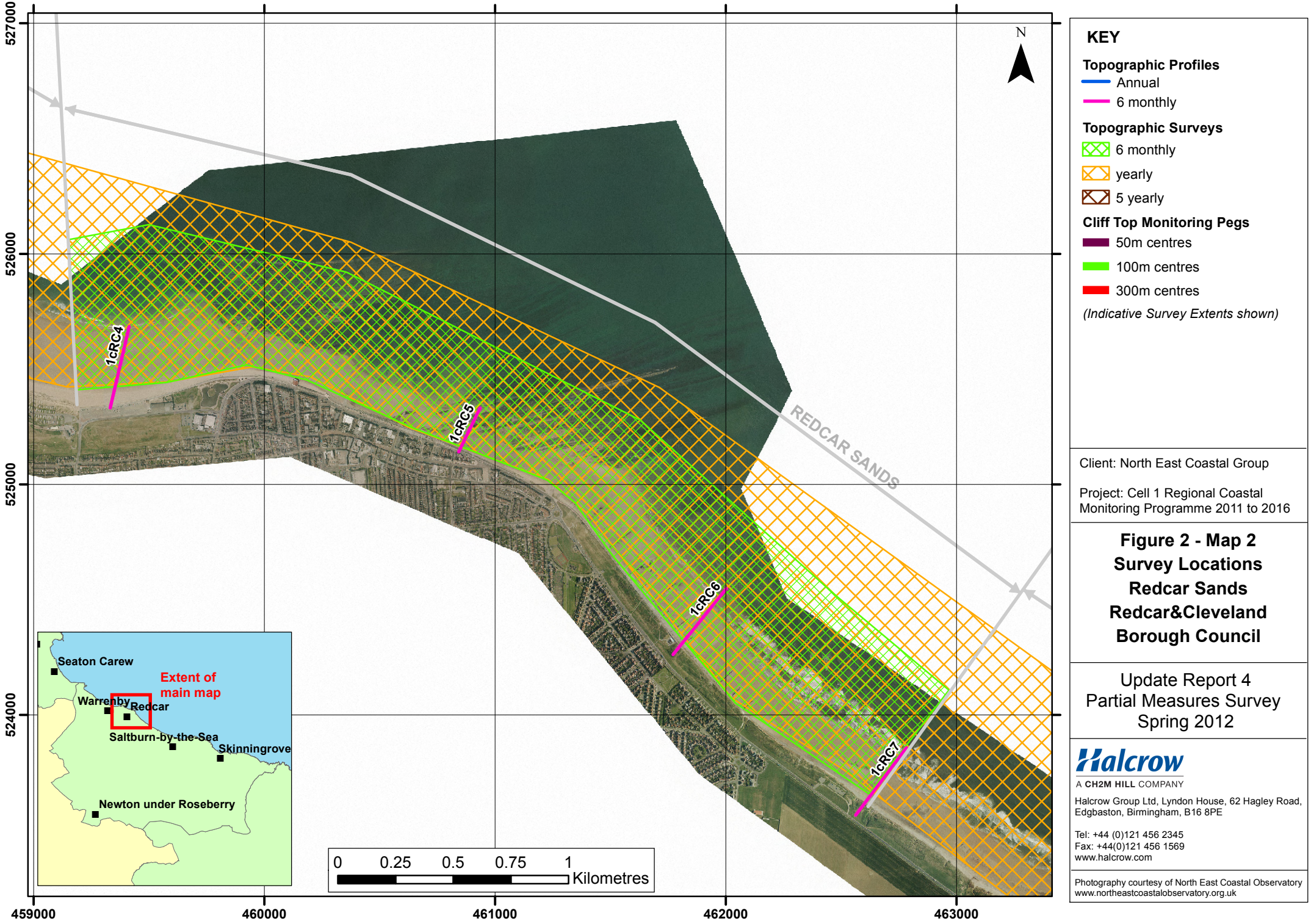

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 2
Survey Locations
Redcar Sands
Redcar&Cleveland Borough Council

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Partial Measures Survey
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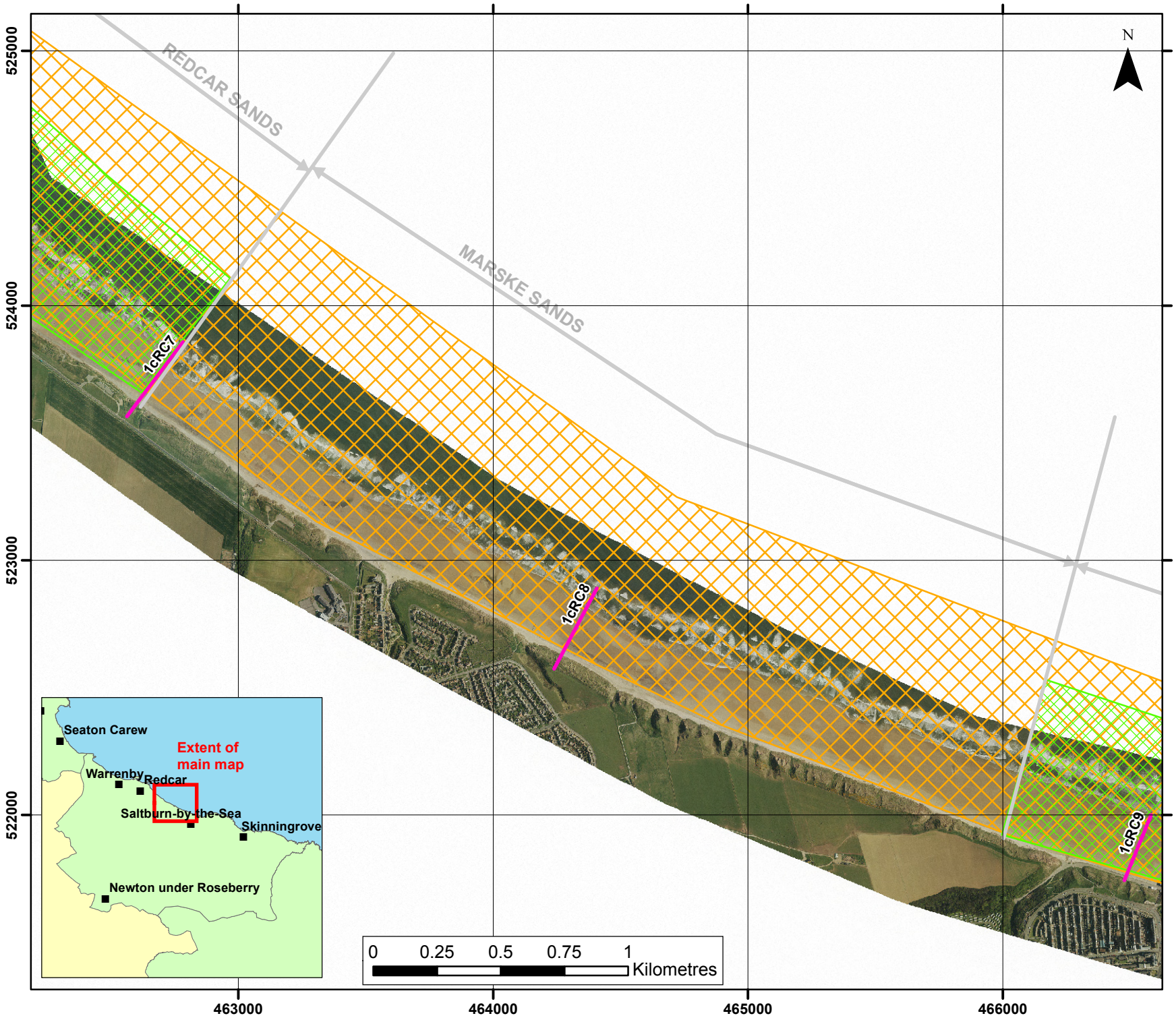

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 3 Survey Locations Marske Sands Redcar&Cleveland Borough Council

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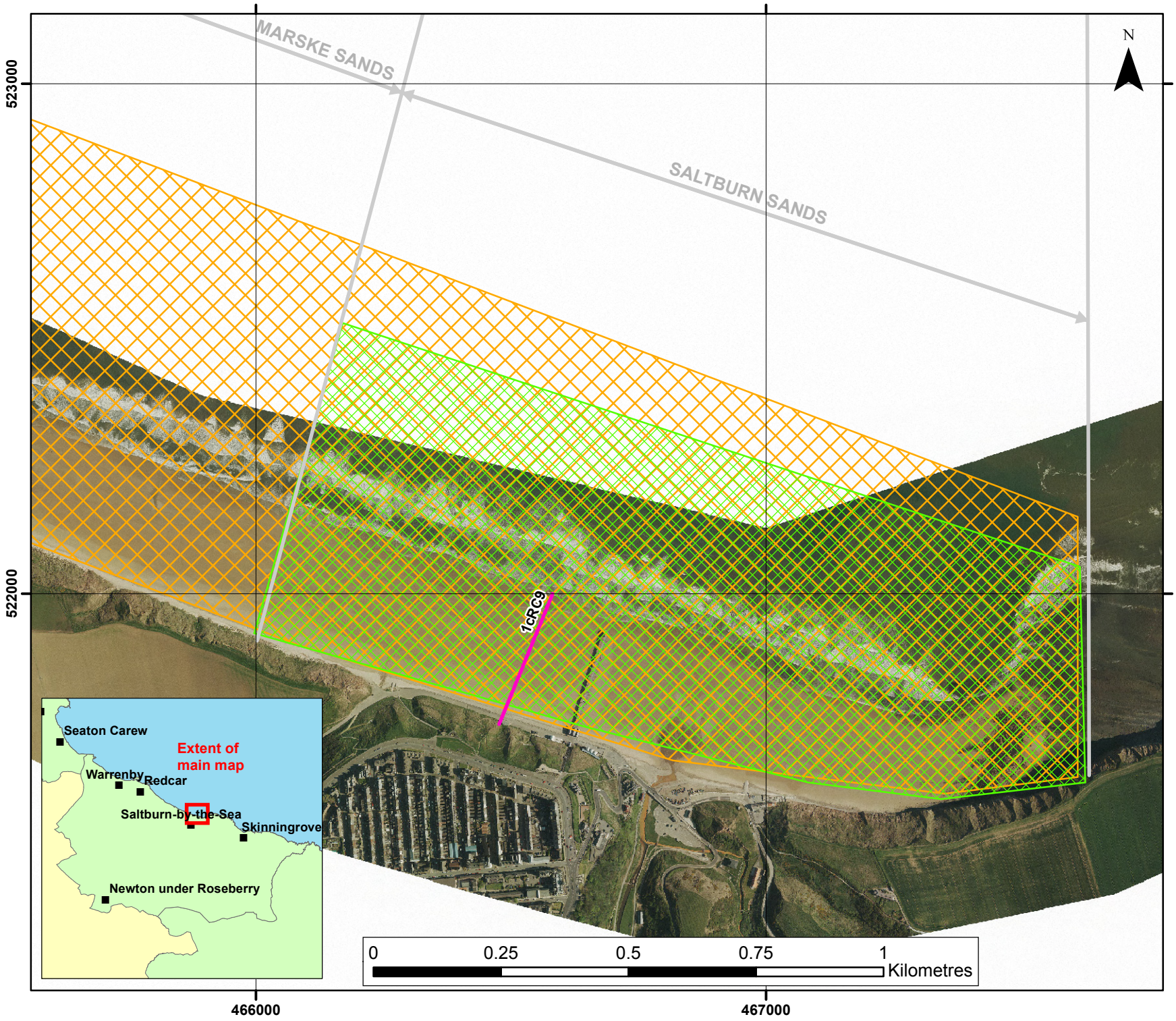

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2- Map 4 Survey Locations Saltburn Sands Redcar&Cleveland Borough Council

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Partial Measures Survey
Spring 2012

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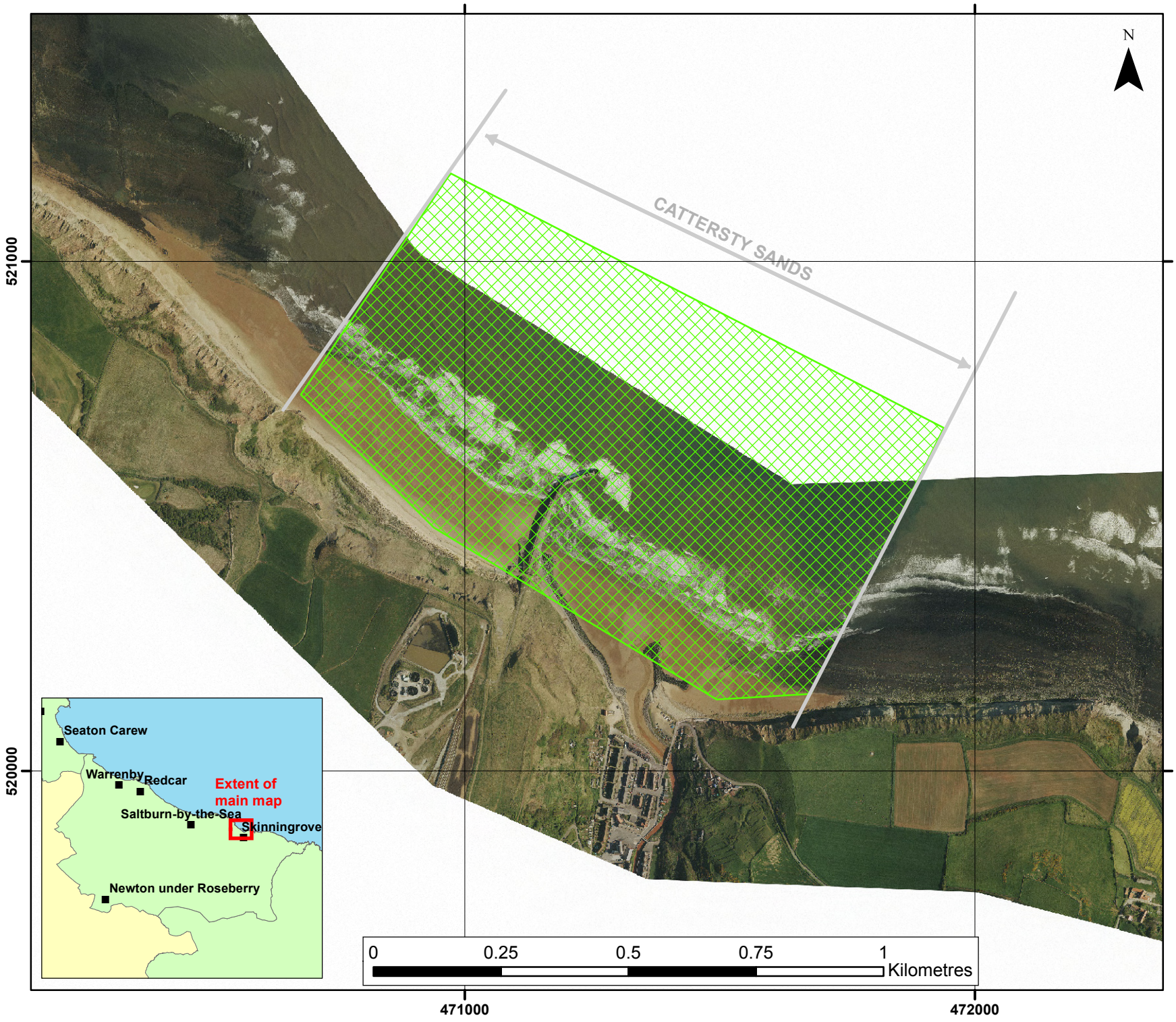

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 5
Survey Locations
Cattersty Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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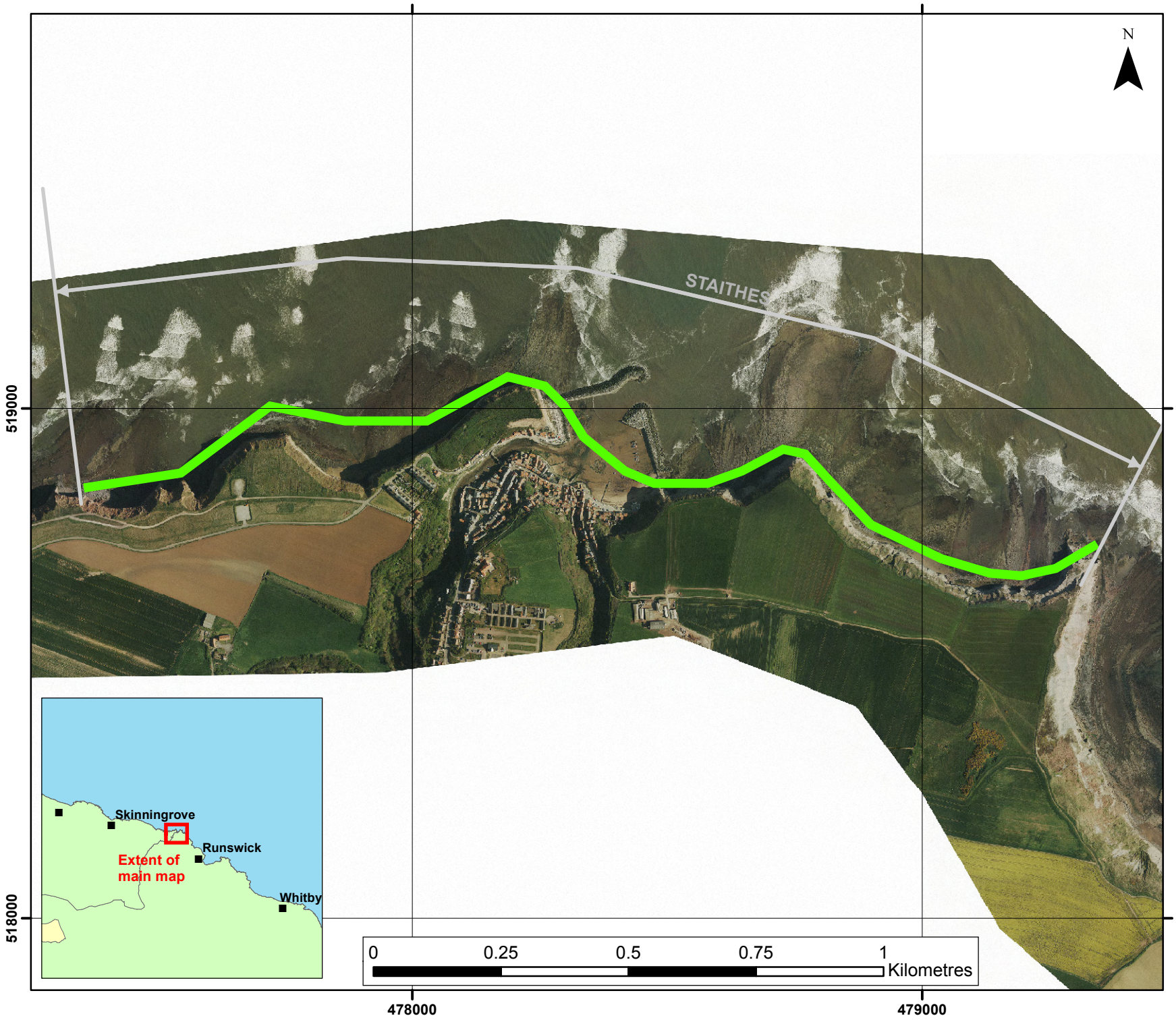

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 6
Survey Locations
Staithes
Redcar&Cleveland Borough Council

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2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
14/03/12	**Beach Profiles:** Coatham Sands is covered by four beach profiles during the Partial Measures survey (RC1 to RC4; Appendix A) that were last surveyed in October 2011. **Profile RC1** is located approximately 300m south east of the South Gare Breakwater, immediately in the lee of the German Charlies. The profile showed some continued minor accretion at the seaward face of the dunes and stability to landward within the main body of dunes. Between HAT and MHWS a large upper beach berm had reformed between since the last survey and this part of the beach has accreted by up to 0.5m. Along the foreshore, the berm visible in the previous survey has flattened between MHWS and MLWS. This part of the beach had eroded by 0.4m over the winter months. Along **profile RC2** dune levels remained healthy, with no change seen in the profile above HAT. Close to the HAT level there is a pocket of isolated erosion (a loss of about 0.1m since October 2011). The rest of the beach shows accretion of 0.2m between October 2011 and March 2012. **Profile RC3** showed no change on the dune section. There was an isolated section of erosion of less than 0.1m at the toe of the dunes. Between MHWS and the end of the survey there was 0.1m of accretion reported through much of the survey. Along **profile RC4** there is very little change above HAT. Between HAT and MHWS the berm that was seen in the last survey has been eroded by around 0.2m and a similar amount of erosion was seen in the seaward half of the profile.	Profile RC1 showed the formation of a berm between HAT and MHWS while lower down the beach, the berm had been flattened over the winter. RC2 and 3 show no significant change above the HAT level and accretion on the beach below HAT. There is no obvious erosion on either of these two profiles so it is difficult to delineate where the sediment has come from. RC 4 has eroded since October 2011 although the amount of erosion observed is limited and not a cause for concern. **Longer term trends:** The high water berm at RC1 had reformed over the winter of 2010/11. The berm between HAT and MHWS is a common feature on this part of the beach, being observed in all of the surveys since 2008 with the exception of April 2010, October 2010 and October 2011. Through much of profiles RC2 and RC3 the beach level is the highest it has been since November 2008. The level of the beach at Profile RC4 in March 2012 was well within the envelope of other vales, the profile appeared to be steeper than previous surveys.

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
14/03/12	**Beach Profiles:** Redcar Sands is covered by three beach profiles (RC5 to RC7; Appendix A), with RC7 being approximately on the boundary with the Marske Sands area. They were last surveyed in October 2011. At **profile RC5** the construction of a new sea defence continued, as a result the profiles have changed above HAT. Between 20 and 75m the beach has eroded by 0.3m. There are parts of the profile between 40 and 70m chainage which look uneven and it is unclear whether this is due to the nearby engineering works or the underlying rock platform being exposed. Between 90 and 115m chainage a berm visible in the last survey had been eroded. Beyond 115m chainage the profile has not changed between October 2011 and March 2012 because the rocks are exposed in both surveys. Along **profile RC6** levels were almost identical to those recorded the last survey along the dunes, upper beach and lower beach, but increased by around 0.1m along the mid beach. At **profile RC7** the data collected in October 2011 was corrupt and consequently the last survey was March 2011. When that survey is compared to the current profile they can be seen to be very similar above HAT. Between 75 (the HAT level) and 90m chainage there was erosion of the beach by around 0.2m. Between 90 and 180m chainage the beach has flattened since March 2011. From 180m to 270m chainage the beach has accreted by up to 0.5m. Below 270m chainage there was very little change from March 2011 to March 2012.	A new defence has been built at RC5 so the beach is likely to have been altered during the construction process. Future profile analysis should be cautions about interpretation of the 2011 and 2012 data and establish a new baseline following the completion of the works on construction of the defences. Both profiles RC9 and RC 7 show relative stability, with few changes in gradient or beach level. **Longer term trends:** With the exception of an accumulation of sand at the base of the seawall, the beach at RC5 was lowest beach level recorded. This is in contrast to RC6 and RC7, where the March 2012 profiles are among the highs recorded for the foreshore.
14/03/12	**Topographic Survey:** Redcar Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 1a). The DGM shows that the bathymetry in front of the two headlands at each end of the bay the underwater slope is reasonably shallow. In the centre of the bay the bathymetry gets deeper quicker. The DGMs show that most changes along Redcar Sands between Winter 2011 and Spring 2012 are in front of the town (where profile RC5 is located). There were minimal changes further south-east along The Stray (where profiles RC6 and RC7 are located). The beach in front of the town experienced erosion overall, although the distribution of changes in topography is patchy with accretion and erosion	There is no recognisable pattern to the areas of accretion and erosion observed from Winter 2011 to Spring 2012. The patchy distribution of the changes to topography points to the redistribution of sediment within the bay. Some of the changes may relate to the ongoing construction works on the seawall. **Longer term trends:** There is no clear long term trend to the behaviour of Redcar Sands. The recent construction of an improved sea defence at this

Survey Date	Description of Changes Since Last Survey	Interpretation
	occurring across the bay as sand bars and berms migrate over the beach. The majority of Redcar Sands appears to have eroded by 0.1m over the winter with a maximum recorded erosion of 1.5m. Areas of accretion were scattered about with the most noteworthy being on each of the headlands and within the bay in front of the town. At these areas of accretion around 1m of accretion was observed, with a maximum of 1.5m.	location will have had an effect on the natural processes within the bay.

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
14/03/12	**Beach Profiles:** Marske Sands is covered by two beach profiles during the Partial Measures survey (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area. The area was last surveyed in October 2011. **Profile RC7** is located along The Stray and has been discussed in Section 2.2. **Profile RC8** experienced little change since the last survey, but a small accumulation of sediment has formed at the seaward end of the profile.	Both RC7 and RC8 have remained stable since the last survey. **Longer term trends:** Over the longer term the beach tends to be stable with the lower beach being most prone to fluctuations in level.

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
14/03/12	**Beach Profiles:** Saltburn Sands is covered by one beach profile (RC9; Appendix A). Overall **Profile RC 9** appears to be stable with little change since October 2011. Beach levels at the toe of the sea wall and along the upper beach reduced by around 0.1m over the winter of 2011/12, with an increase of 0.2m along the mid-section of the beach.	Both RC 8 and 9 show stability between October 2011 and March 2012. **Longer term trends:** The general trend at this location is stability, with the majority of the fluctuations observed at the bottom of the beach.
14/03/12	**Topographic Survey:** Saltburn Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2a) the beach topography consists of shore parallel contours. This DGM has been compared against the previous (November 2010) survey in Appendix B – Map 2b. The DGMs show that since November 2011 the beach has been relatively stable, with isolated patches of small-scale accretion and erosion. The majority of the changes in beach topography are within a margin of ±0.25. The largest changes were observed on the upper beach, where a band of 0.75m of erosion runs parallel to the shore. Accretion of around 0.75m was observed at the mouth of the beck, probably relating to infilling of a scour channel that was present on the previous survey.	The beach has been stable overall with little change over the winter. **Longer term trends:** The erosion and accretion observed where much less severe than in the previous year. The accretion is usually centred on the mouth of the stream, as was observed in the most recent data.

2.5 Cattersty Sands

14/03/12	**Topographic Survey:** Cattersty Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2a). This DGM has been compared against the previous (November 2010) survey in Appendix B – Map 2b. The DGMs show that over the winter there was a mixed pattern of accretion and erosion across the bay. On the northern side of the jetty/breakwater there was accretion on the landward part of the beach, with 1m of accretion noted. South of the jetty there is a much more mixed pattern with ±0.75m of accretion or erosion across the southern part of the bay.	The spatially variable pattern of accretion and erosion suggests no net change in sediment volume. **Longer term trends:** The pattern of distribution of areas of erosion and accretion were similar over the winter of 2010 suggesting the resulting beach morphology is persistent. The accretion on the upper beach north of the jetty continued. While south of the jetty the erosion of the lower beach continued.

2.6 Staithes

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

3. Problems Encountered and Uncertainty in Analysis

Topographic Survey

At Redcar the Sea defence construction works continue around the area of Redcar town and works continue in the area of the groynes.

Profile RC5 now has new sea wall defence, which has resulted in the change to the profile. Offshore, foundations for a wind farm are currently being installed.

Cliff Top Surveys

The cliff top surveys at Staithes are assumed to have a limit of accuracy of ± 0.1 m due to the methodology. At many locations cliff advance is shown, which suggests error in the data or method of survey.

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

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

It is understood that Redcar & Cleveland Borough Council is undertaking terrestrial laser scan surveys of cliff faces and cliff tops at Cowbar Nab. The increased accuracy and resolution of data from laser scanning would enable a very detailed appreciation of changing conditions, and thereby further inform management planning.

5. Conclusions and Areas of Concern

- At Coatham Sands, the recorded profiles present no causes for concern.
- At Redcar Sands, the beach profiles had reduced in height over the winter of 2001 but this was matched by accretion elsewhere and there we no causes for concern raised by the topographic survey. The construction works are coming to an end so the beach should begin to behave more naturally.
- At Marske Sands, the recorded profiles show stability overall and thus present no cause for concern.
- At Saltburn Sands, the recorded profiles and topographic survey present no causes for concern.
- At Cattersty Sands, the results of the topographic survey present no causes for concern.
- At Staithes, the records of cliff erosion show stability, although there is concern over the reliability of these data. There is always the potential for the cliff to erode and create a hazard for those above or below the cliff so vigilance is encouraged.

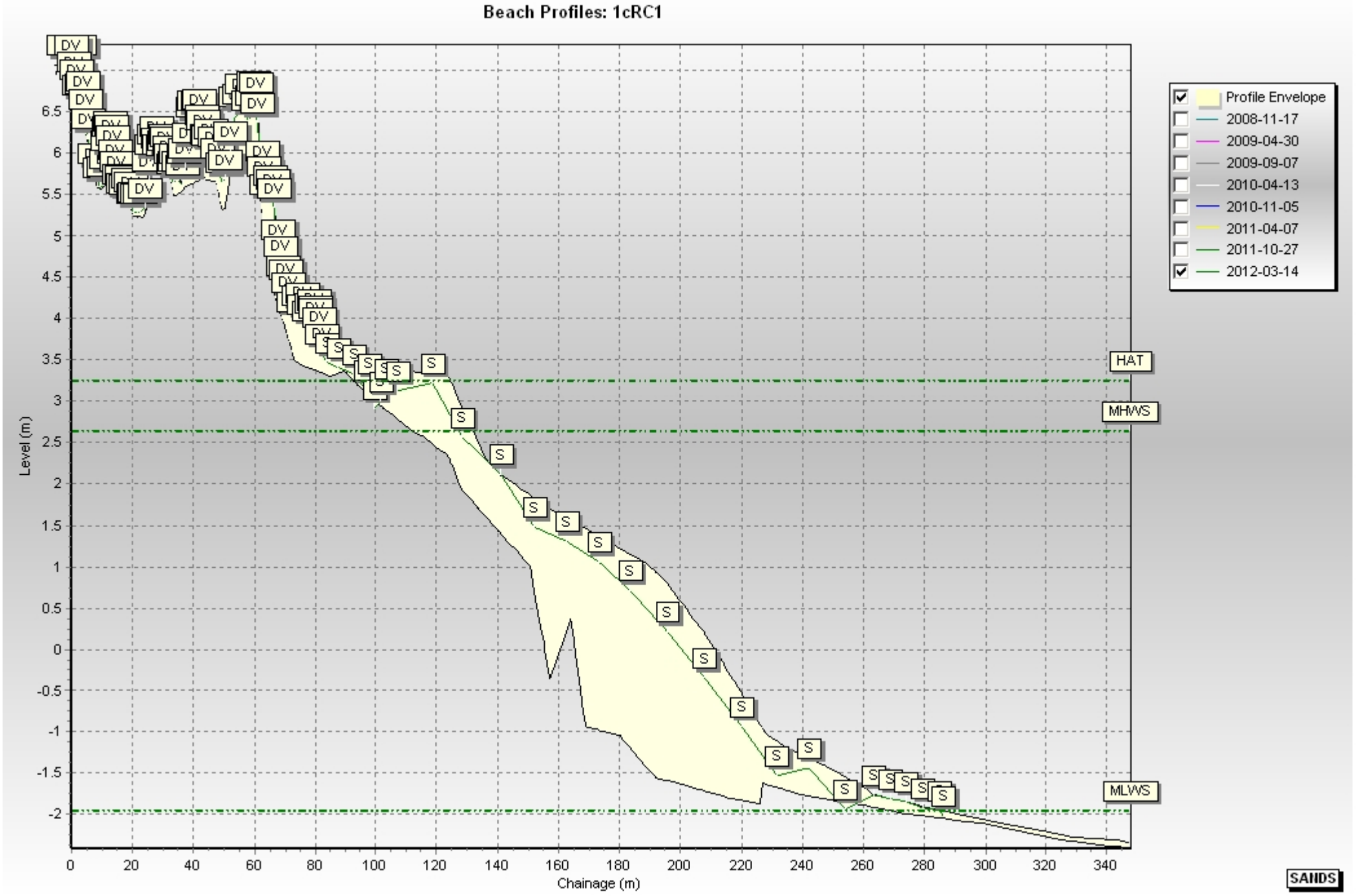
Appendices

Appendix A

Beach Profiles

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

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown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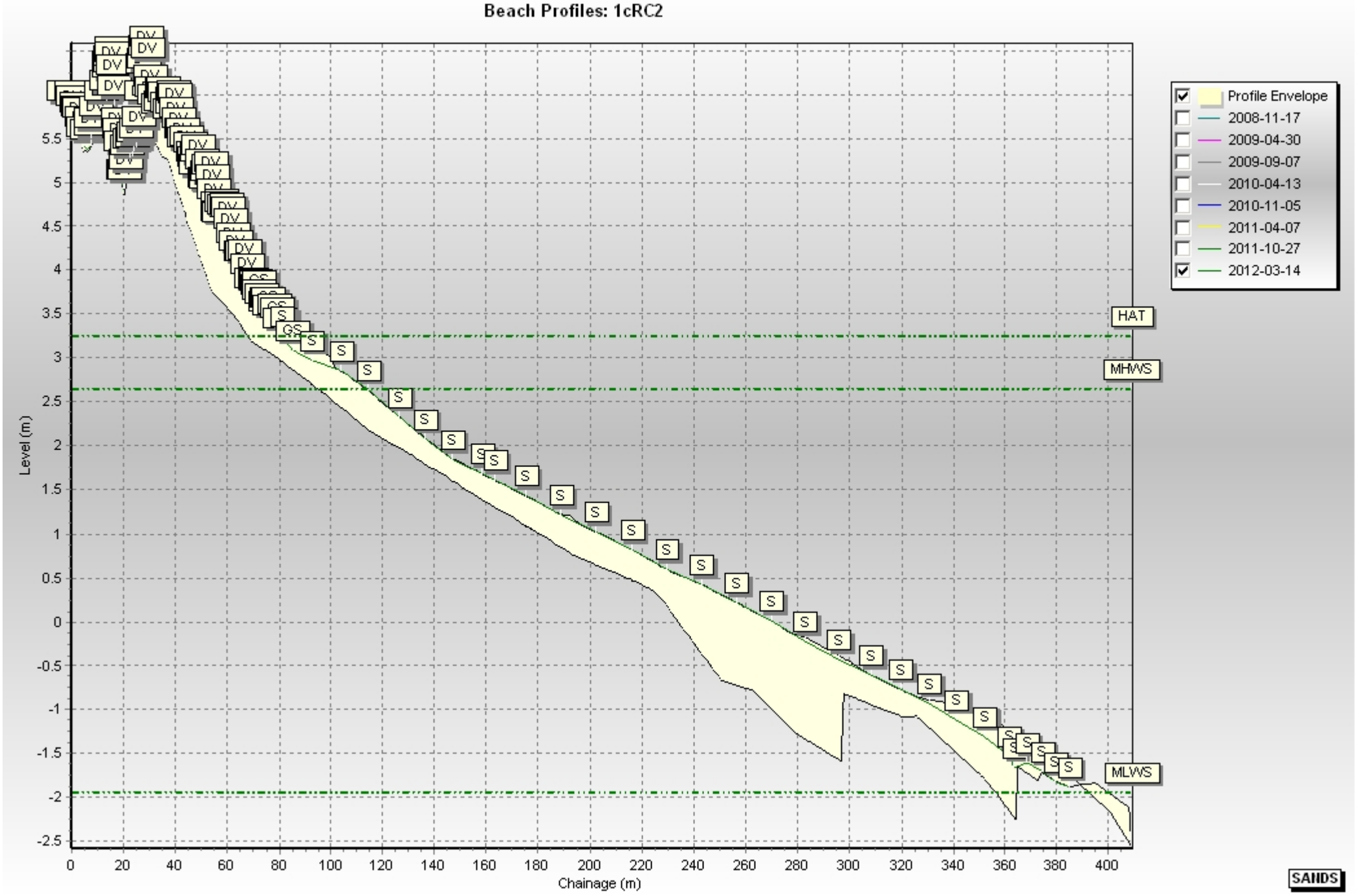
2010-04-13
2010-11-05
2011-04-07
2011-10-27
2012-03-14
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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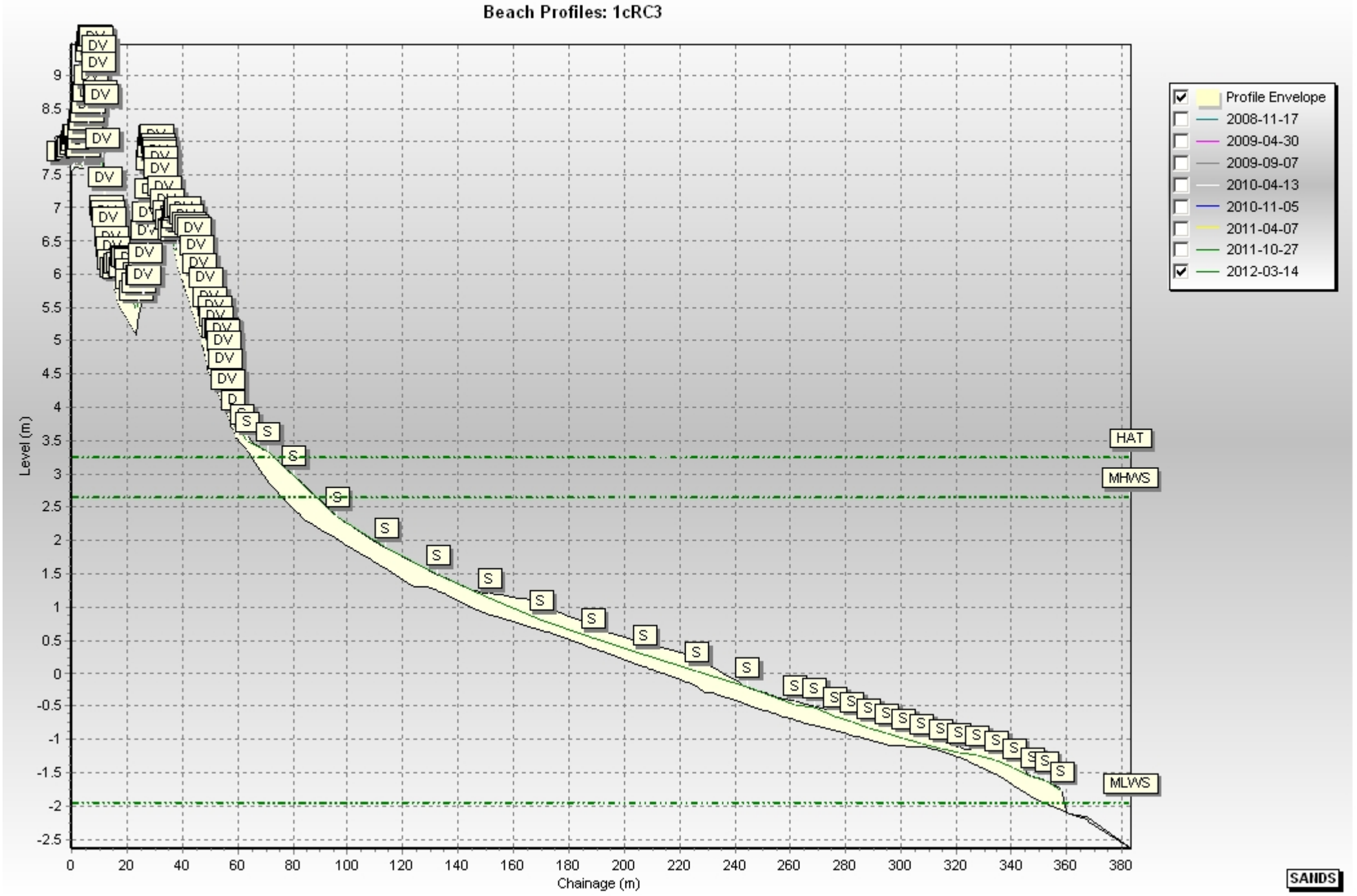
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2011-10-27
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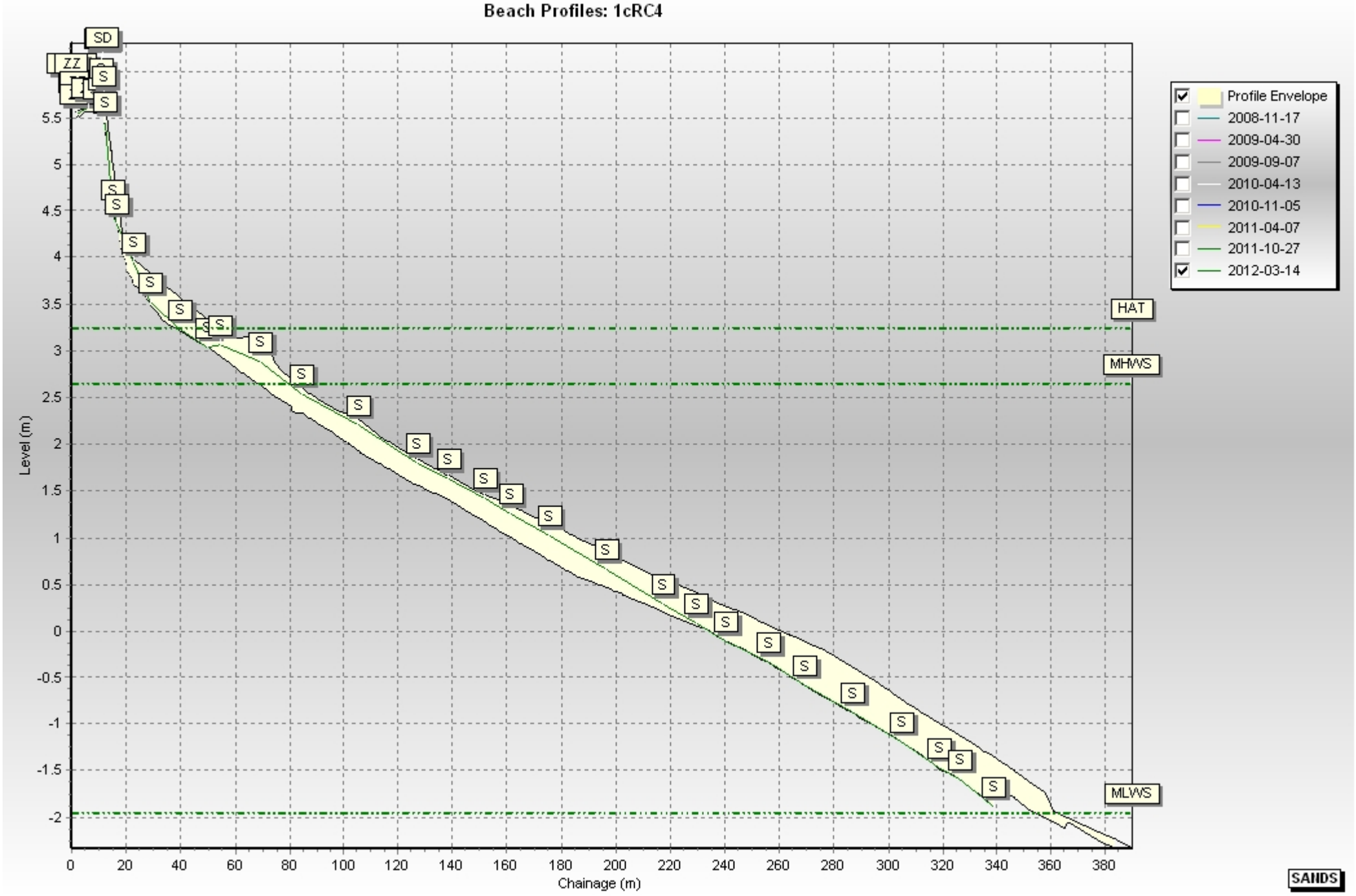
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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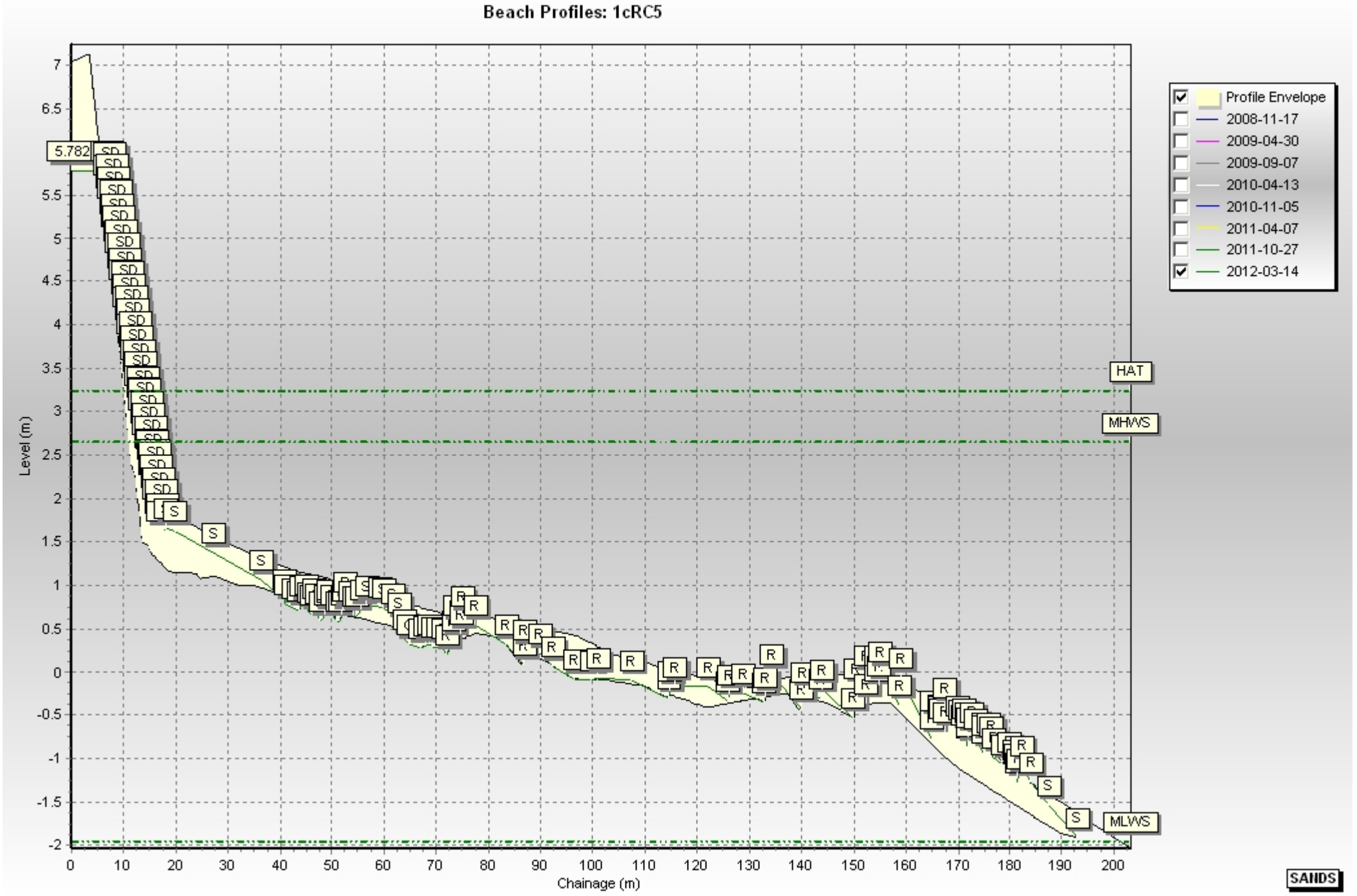
2011-10-27
2012-03-14
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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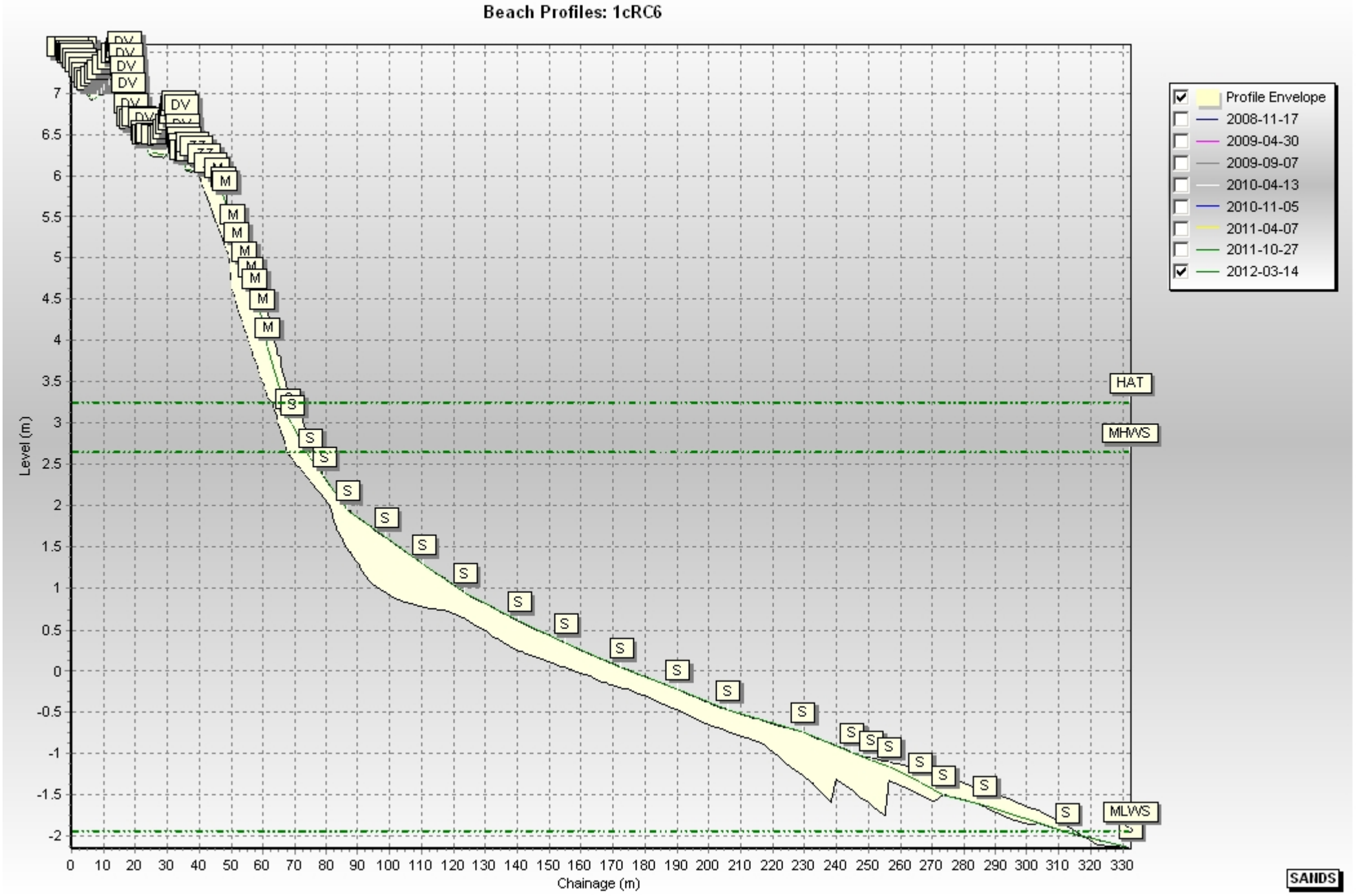
2011-10-27
2012-03-14
5.782
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2010-04-13
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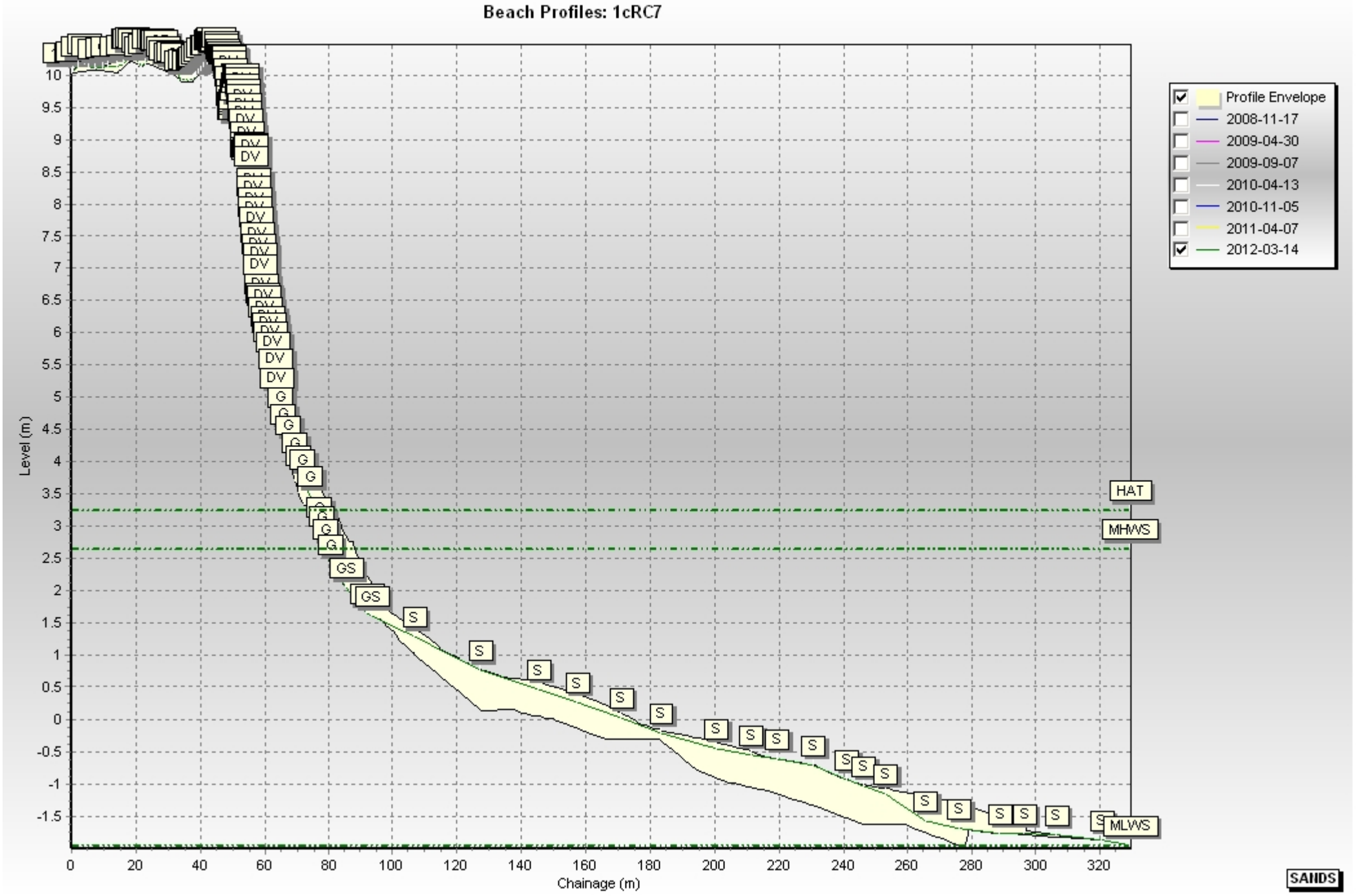
2011-10-27
2012-03-14
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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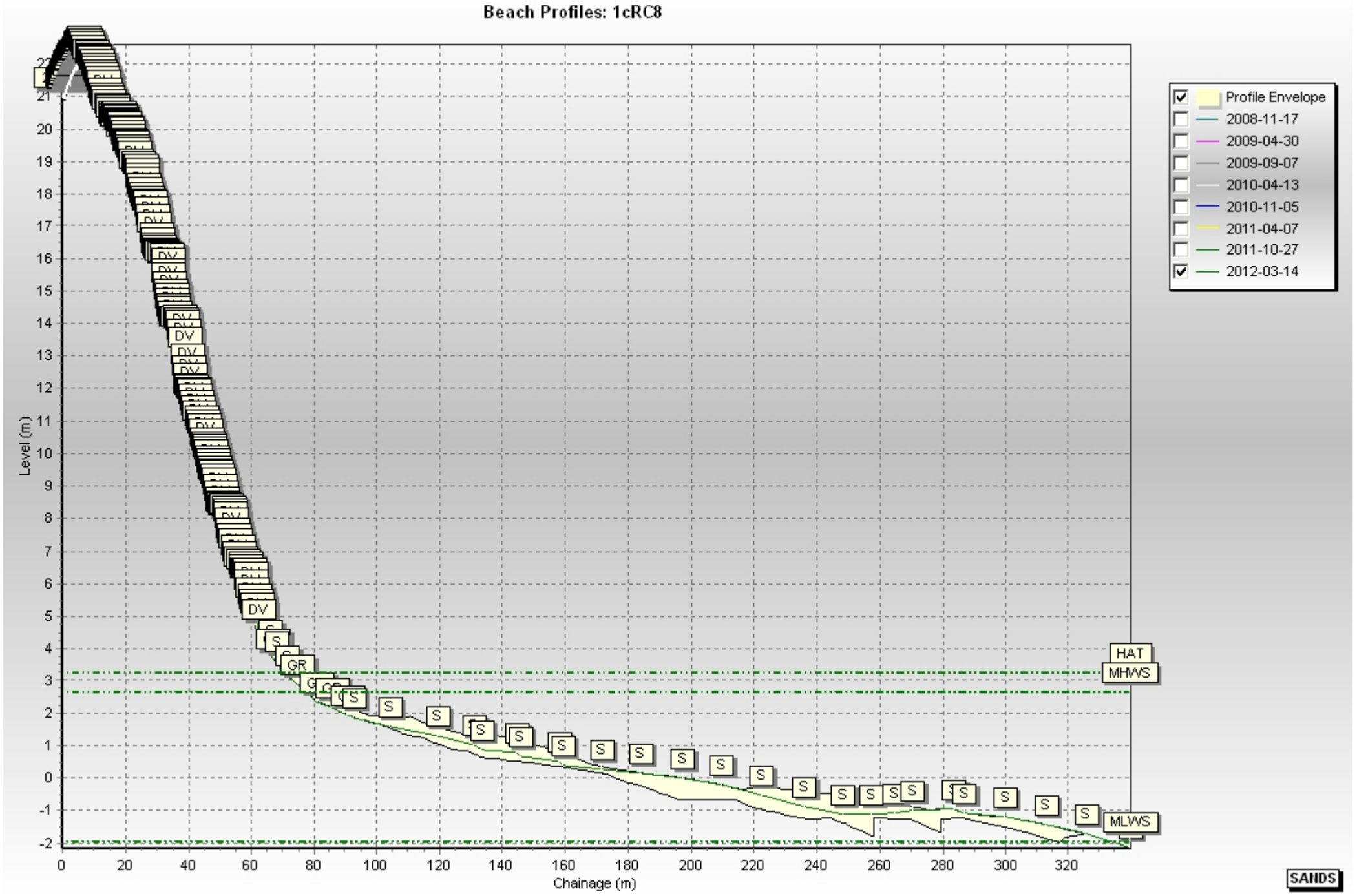
2009-09-07
2010-04-13
2010-11-05
2011-04-07
2012-03-14
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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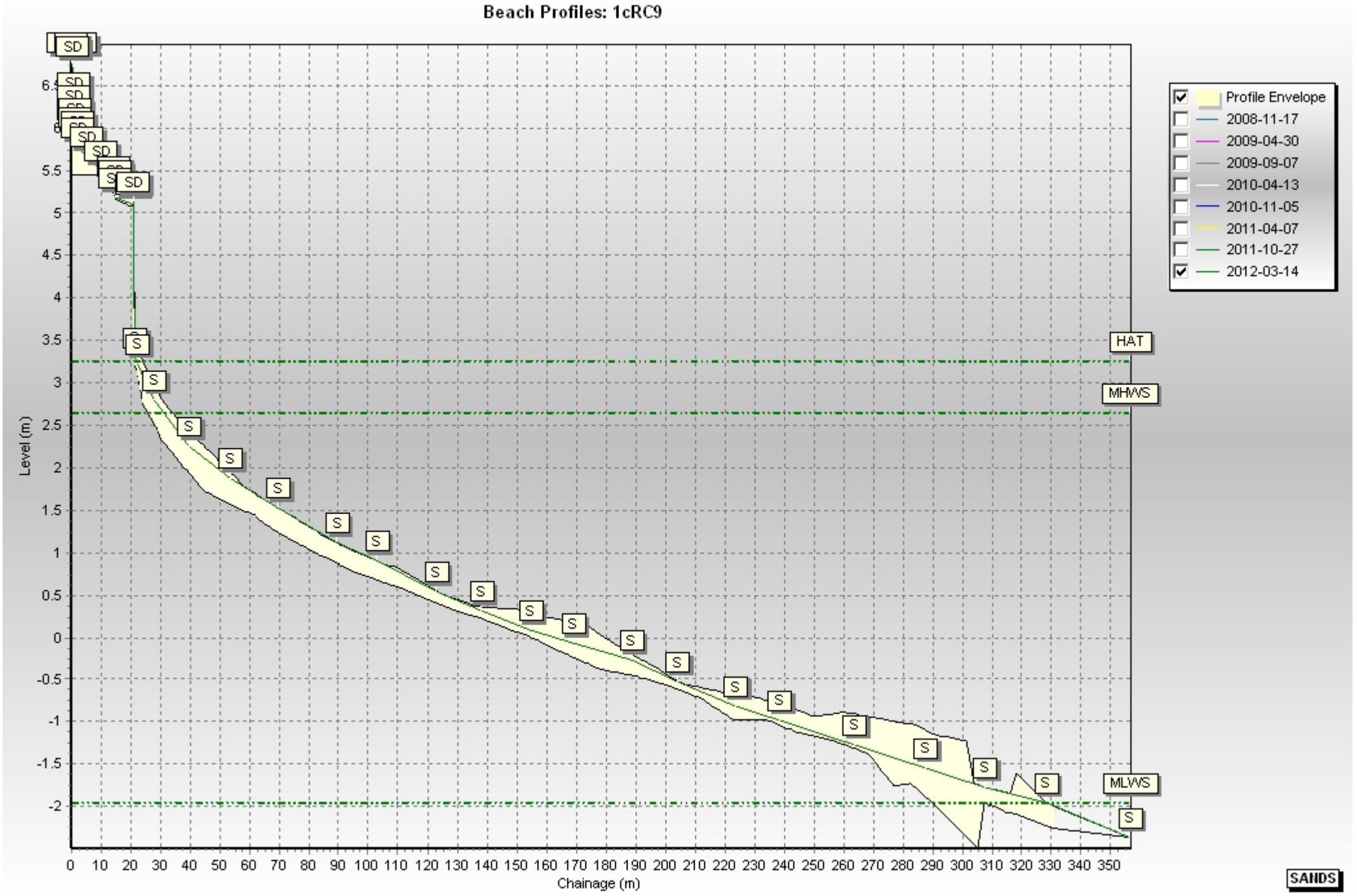
2011-10-27
2012-03-14
Level (m)
Chainage (m)
HAT
MHWS
MLWS
SANDS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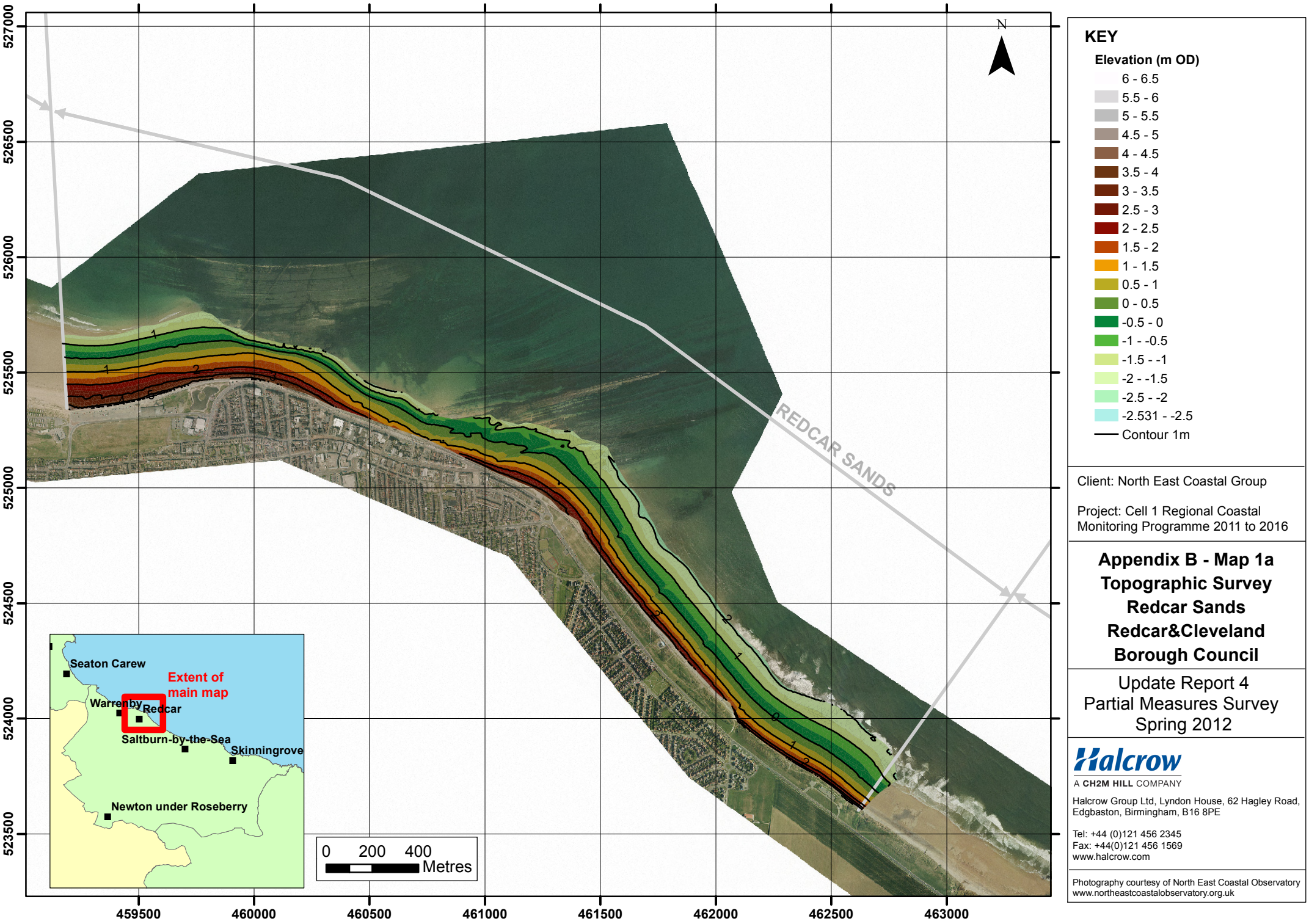
2009-09-07
2010-04-13
2010-11-05
2011-04-07
2011-10-27
2012-03-14
HAT
MHWS
MLWS
SD
S
Level (m)
Chainage (m)
SANDS

Appendix B

Topographic Survey



KEY

Elevation (m OD)

- 6 - 6.5
- 5.5 - 6
- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1 - -0.5
- -1.5 - -1
- -2 - -1.5
- -2.5 - -2
- -2.531 - -2.5
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1a
Topographic Survey
Redcar Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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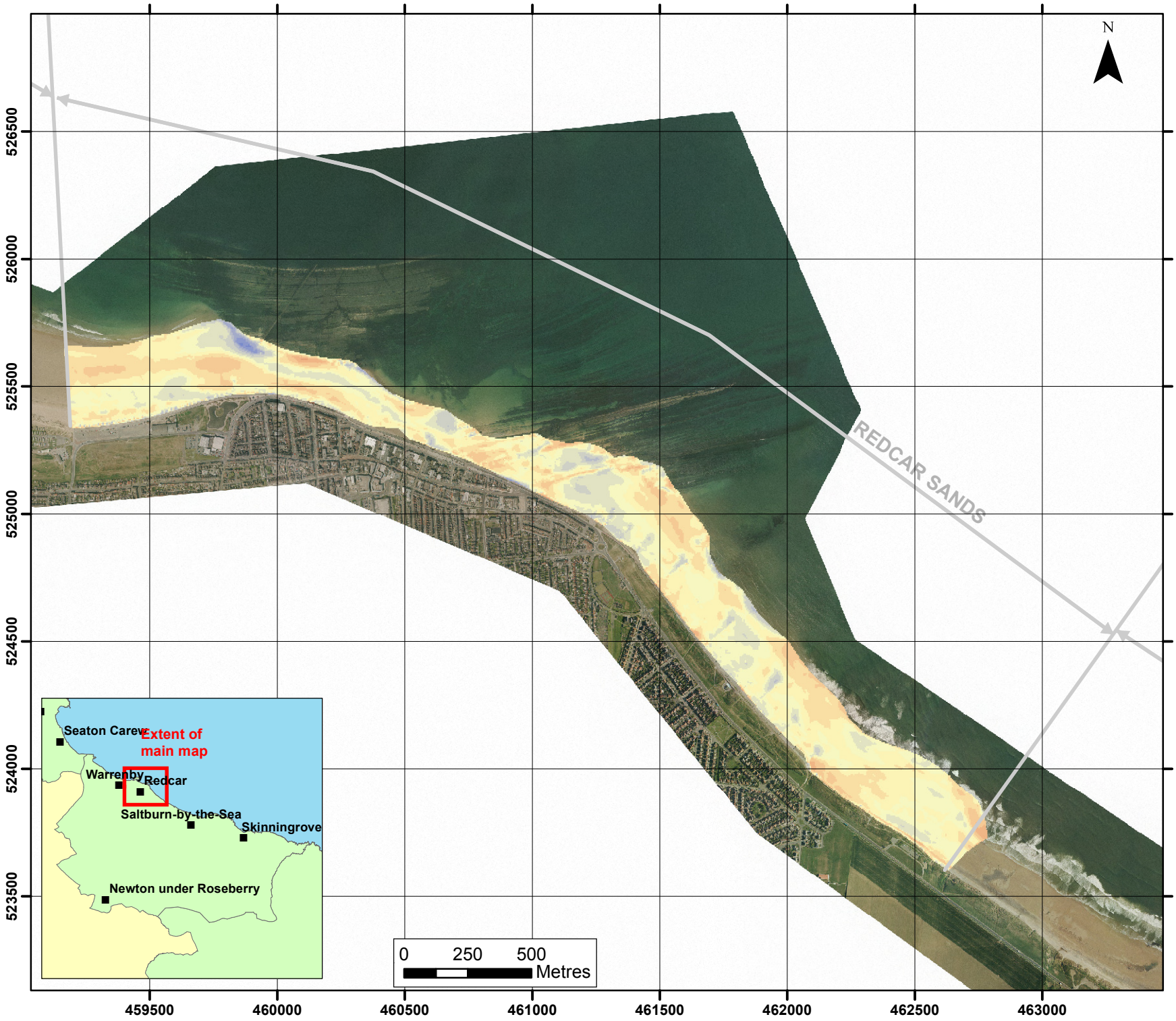

KEY Winter 2011 to Spring 2012
Change in elevation (m OD)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 1b
Topographic Difference
Redcar Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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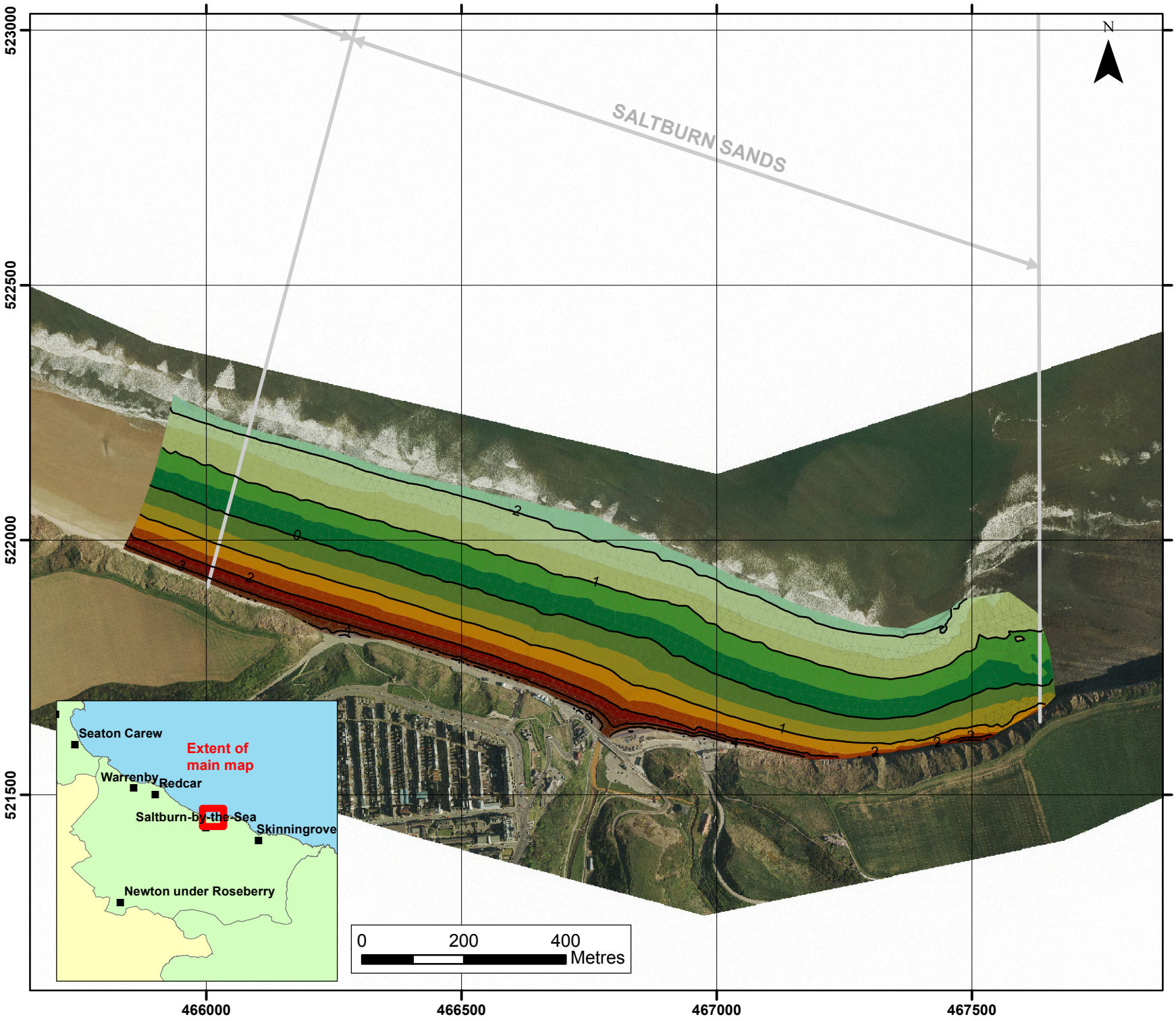

KEY

Elevation (m OD)

- 6 - 6.5
- 5.5 - 6
- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1 - -0.5
- -1.5 - -1
- -2 - -1.5
- -2.5 - -2
- -3 - -2.5
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2a
Topographic Survey
Saltburn Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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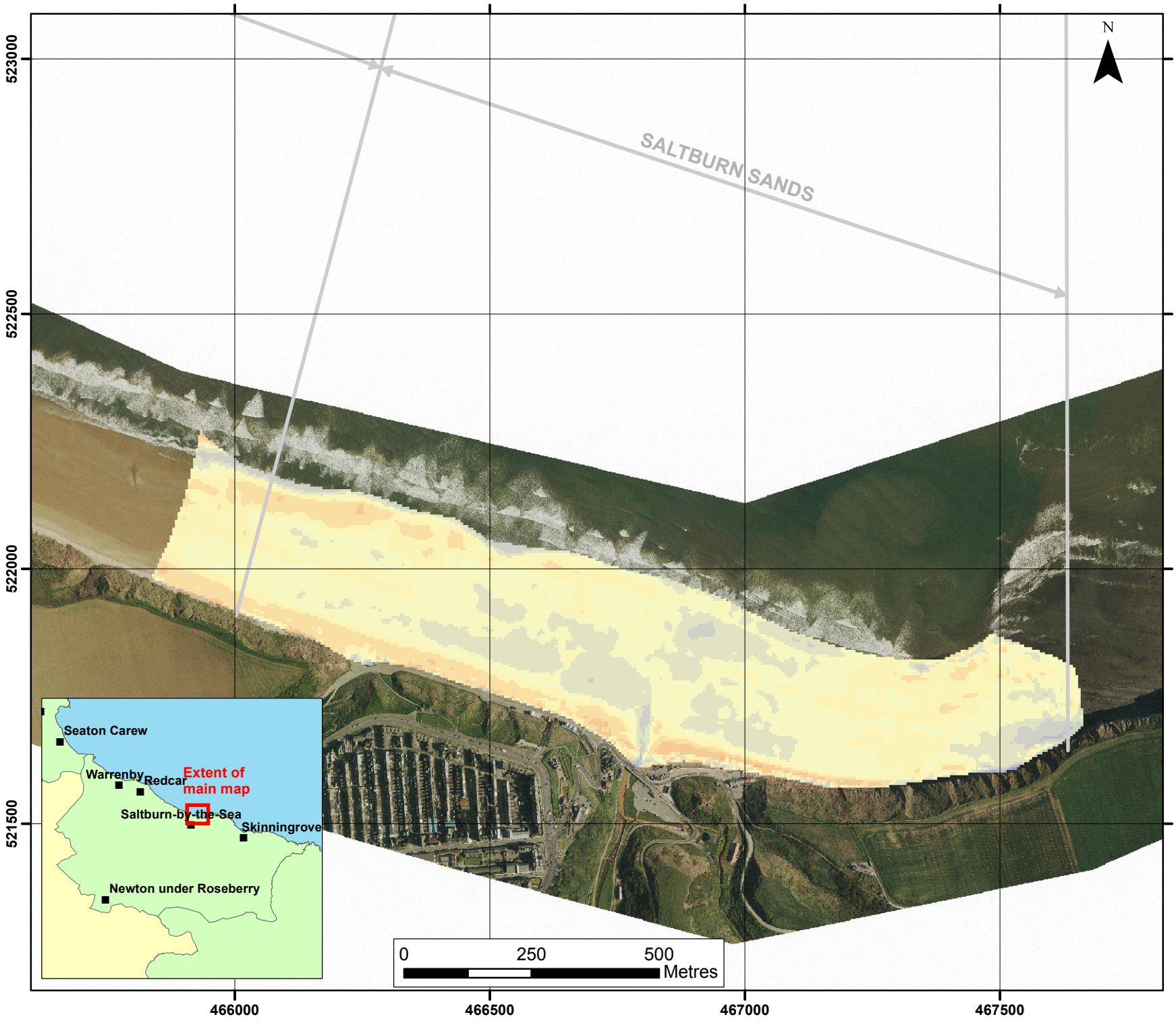

KEY Winter 2011 to Spring 2012
Change in elevation (m OD)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2b
Topographic Difference
Saltburn Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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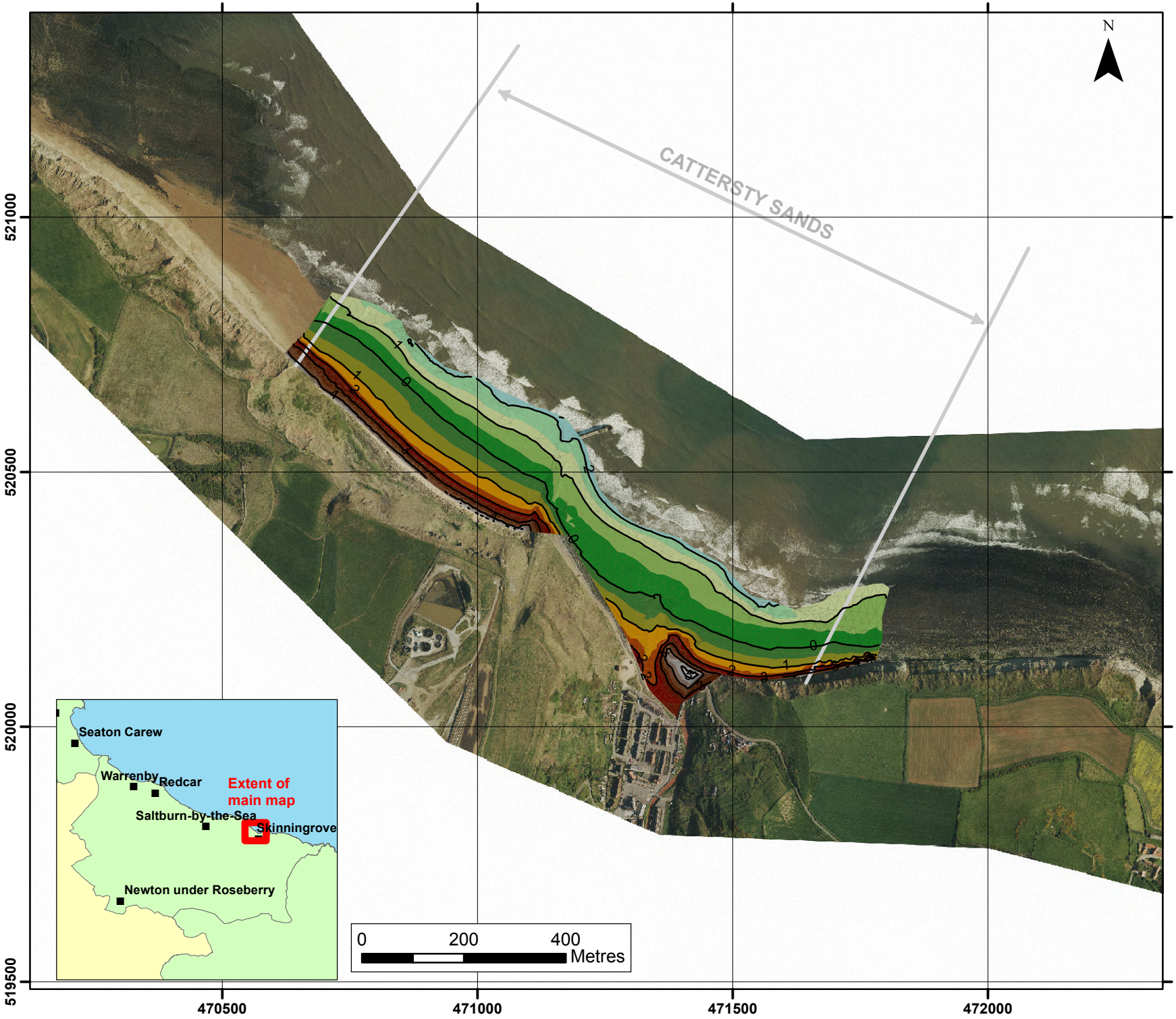

KEY

Elevation (mOD)

- 5.5 - 6
- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1 - -0.5
- -1.5 - -1
- -2 - -1.5
- -2.5 - -2
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 3a Topographic Survey Cattersty Sands Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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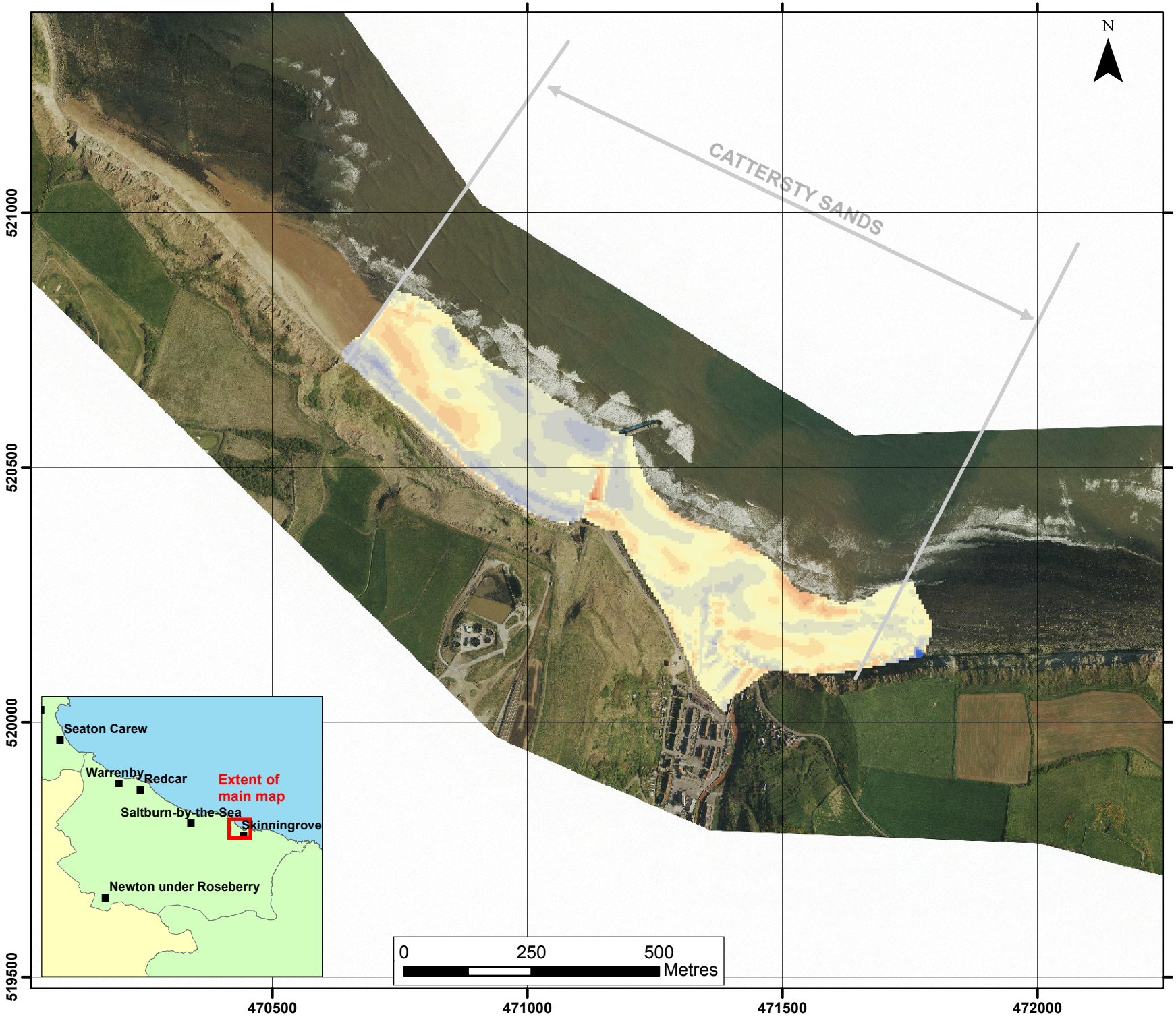

KEY Winter 2011 to Spring 2012
Change in elevation (m OD)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 3b
Topographic Difference
Cattersty Sands
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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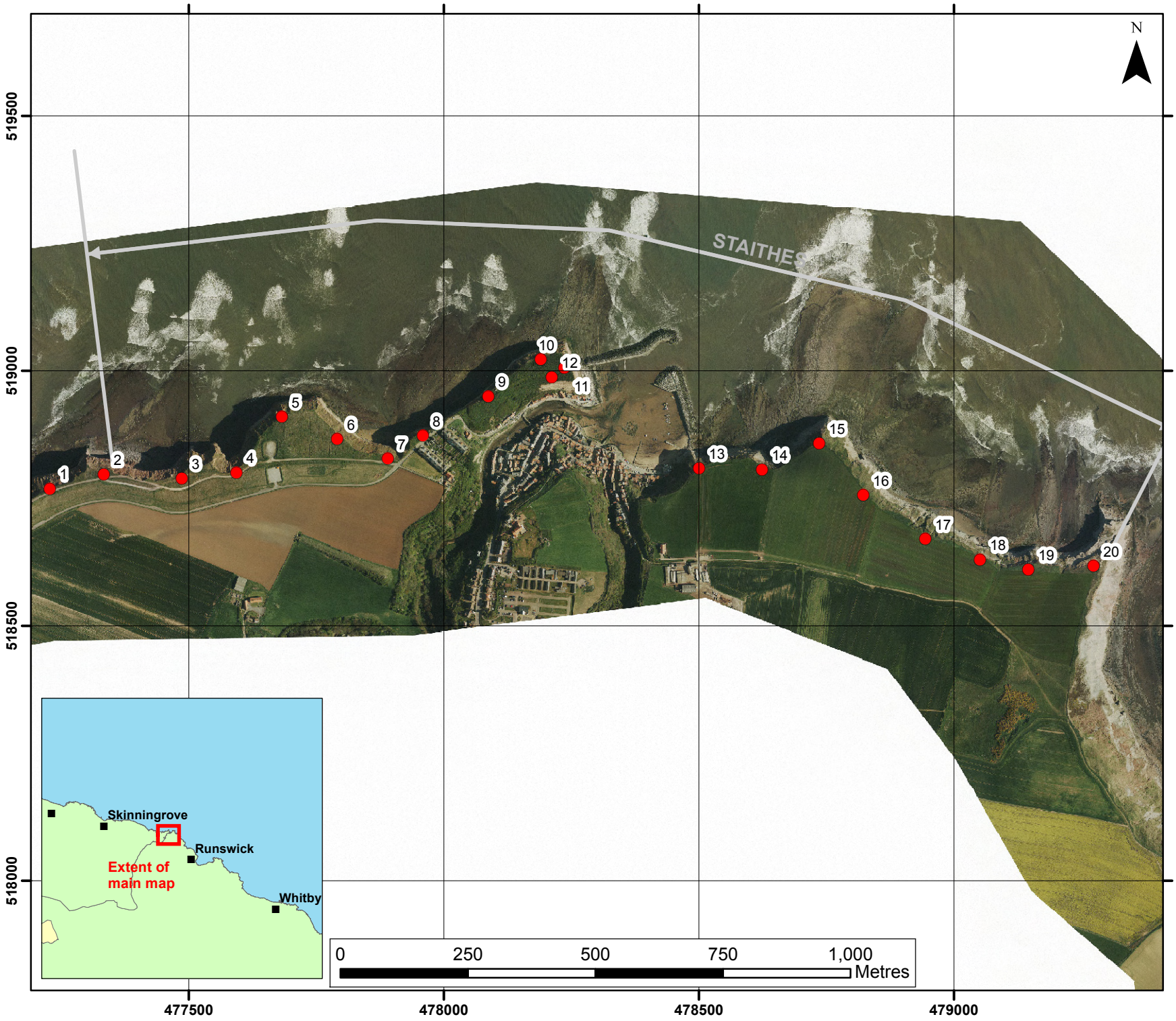
Appendix C

Cliff Top Survey



KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 1
Ground Control Points
Staithes
Redcar&Cleveland Borough Council

Update Report 4
Partial Measures Survey
Spring 2012

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Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Figure C1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

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

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