



**Cell 1 Regional Coastal Monitoring Programme  
Analytical Report 1: 'Full Measures' Survey 2011**

**Hartlepool Borough Council  
Final Report**



**October 2012**

## Contents

Disclaimer .....	i
Abbreviations and Acronyms.....	ii
Water Levels Used in Interpretation of Changes .....	ii
Glossary of Terms.....	iii
Preamble .....	iv
1. Introduction .....	1
1.1 Study Area .....	1
1.2 Methodology.....	1
2. Analysis of Survey Data .....	6
2.1 North Sands .....	6
2.2 Middleton.....	8
2.3 Hartlepool Bay.....	9
3. Problems Encountered and Uncertainty in Analysis .....	11
4. Recommendations for 'Fine-tuning' the Monitoring Programme .....	11
5. Conclusions and Areas of Concern .....	11

## Appendices

Appendix A	Beach Profiles
Appendix B	Topographic Survey
Appendix C	Cliff Top Survey

## List of Figures

Figure 1	Sediment Cells in England and Wales
Figure 2	Survey Locations

## List of Tables

Table 1	Analytical, Update and Overview Reports Produced to Date
Table 2	Sub-division of the Cell 1 Coastline

Authors	
Lily Booth	Halcrow
Dr Paul Fish	Halcrow
Dr Andy Parsons	Halcrow

## **Disclaimer**

Halcrow Group Limited ('Halcrow') is a CH2M HILL company. Halcrow has prepared this report in accordance with the instructions of our client Scarborough Borough Council (SBC) for the client's sole and specific use. Any other persons who use any information contained herein do so at their own risk. This report is a review of coastal survey information made available by SBC. The objective of this report is to provide an assessment and review of the relevant background documentation and to analyse and interpret the coastal monitoring data. Halcrow has used reasonable skill, care and diligence in the interpretation of data provided to them and accepts no responsibility for the content, quality or accuracy of any Third party reports, monitoring data or further information provided either to them by SBC or, via SBC from a Third party source, for analysis under this term contract.

Raw data analysed in this report is available to download via the project's webpage: [www.northeastcoastalobservatory.org.uk](http://www.northeastcoastalobservatory.org.uk). The North East Coastal Observatory does not "license" the use of images or data or sign license agreements. The North East Coastal Observatory generally has no objection to the reproduction and use of these materials (aerial photography, wave data, beach surveys, bathymetric surveys), subject to the following conditions:

1. North East Coastal Observatory material may not be used to state or imply the endorsement by North East Coastal Observatory or by any North East Coastal Observatory employee of a commercial product, service, or activity, or used in any manner that might mislead.
2. North East Coastal Observatory should be acknowledged as the source of the material in any use of images and data accessed through this website, please state "Image/Data courtesy of North East Coastal Observatory". We recommend that the caption for any image and data published includes our website, so that others can locate or obtain copies when needed. We always appreciate notification of beneficial uses of images and data within your applications. This will help us continue to maintain these freely available services. Send e-mail to [Robin.Siddle@scarborough.gov.uk](mailto:Robin.Siddle@scarborough.gov.uk)
3. It is unlawful to falsely claim copyright or other rights in North East Coastal Observatory material.
4. North East Coastal Observatory shall in no way be liable for any costs, expenses, claims, or demands arising out of the use of North East Coastal Observatory material by a recipient or a recipient's distributees.
5. North East Coastal Observatory does not indemnify nor hold harmless users of North East Coastal Observatory material, nor release such users from copyright infringement, nor grant exclusive use rights with respect to North East Coastal Observatory material.
6. North East Coastal Observatory material is not protected by copyright unless noted (in associated metadata). If copyrighted, permission should be obtained from the copyright owner prior to use. If not copyrighted, North East Coastal Observatory material may be reproduced and distributed without further permission from North East Coastal Observatory.

## 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)			
	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 Parameter	Water Level (m AOD)			
	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

**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). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

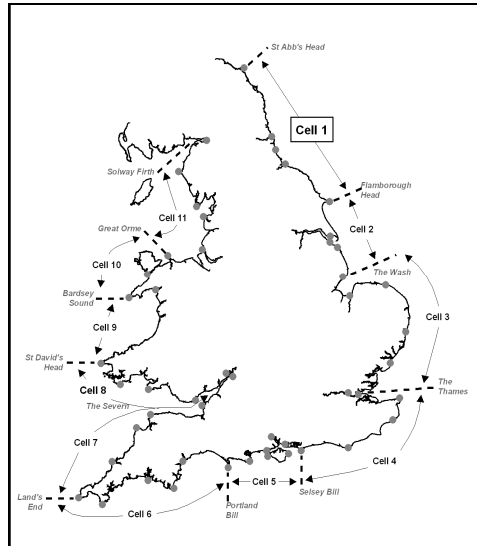


Figure 1 Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:



The original three year programme of work was undertaken as a partnership between Royal Haskoning, Halcrow and Academy Geomatics. For the current five year programme of work the data collection associated with beach profiles, topographic surveys and cliff top surveys is being undertaken by Academy Geomatics. The analysis and reporting for the programme is being undertaken by Halcrow.



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.

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys.

This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

Annually, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage.

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	Sep-Dec 08	May 09	Mar-May 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	Sept 11
4	2011/12	Oct 2011	Aug 12(*)			

(\*) The present report is **Analytical Report 4** and provides an analysis of the 2011 Full Measures survey for Hartlepool Borough Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections.

For purposes of analysis, the Cell 1 frontage has been split into the sub-sections listed in the Table 2.

**Table 2 Sub-divisions of the Cell 1 Coastline**

<b>Authority</b>	<b>Zone</b>
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
Blyth South Beach	
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Uppgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
Filey Bay	

## 1. Introduction

### 1.1 Study Area

Hartlepool Borough Council's frontage extends from Crimdon Beck in the north to the North Gare Breakwater in the south. For the purposes of this report, it has been sub-divided into four areas, namely:

- North Sands
- Hartlepool Headland
- Middleton
- Hartlepool Bay

### 1.2 Methodology

Along Hartlepool 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 part of North Sands (referred to as Hartlepool North or 'HN')
  - Topographic survey along Middleton (referred to as Hartlepool Central or 'HC')
  - Topographic survey along Hartlepool Bay (referred to as Hartlepool South or 'HS')
- Partial Measures survey annually each spring comprising:
  - Beach profile surveys along 9 no. transect lines
- Additionally, every five years (starting with 2008 as the baseline year), the Full Measures topographic survey at Hartlepool North is extended to fully cover the whole of North Sands and Hartlepool Headland with a topographic survey. This extends across the boundary of jurisdiction between Hartlepool Borough Council and County Durham Council.

The location of these surveys is shown in Figure 2. The 2011 Full Measures survey was undertaken along this frontage in October 2011 when the weather was fine and overcast and the sea state was moderate

All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

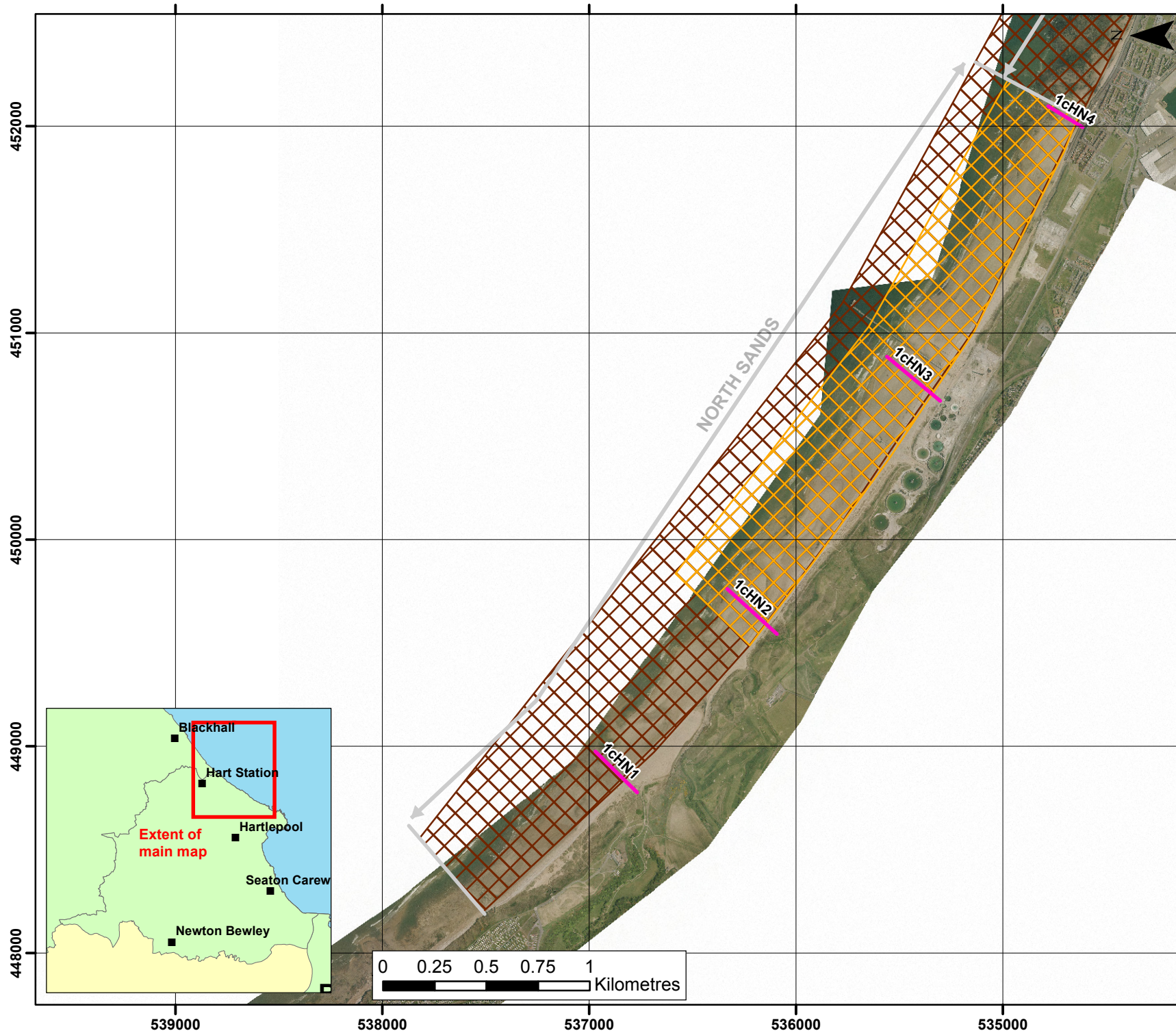
The Analytical Report is then produced following a standard structure for each authority. This involves:

- 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.





**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

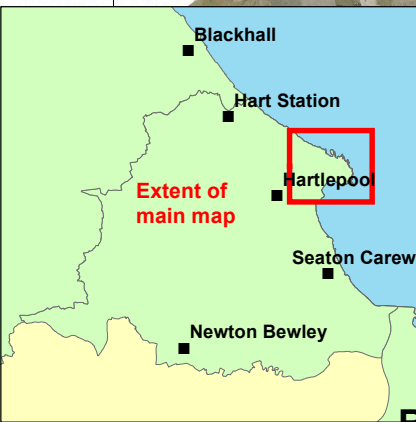
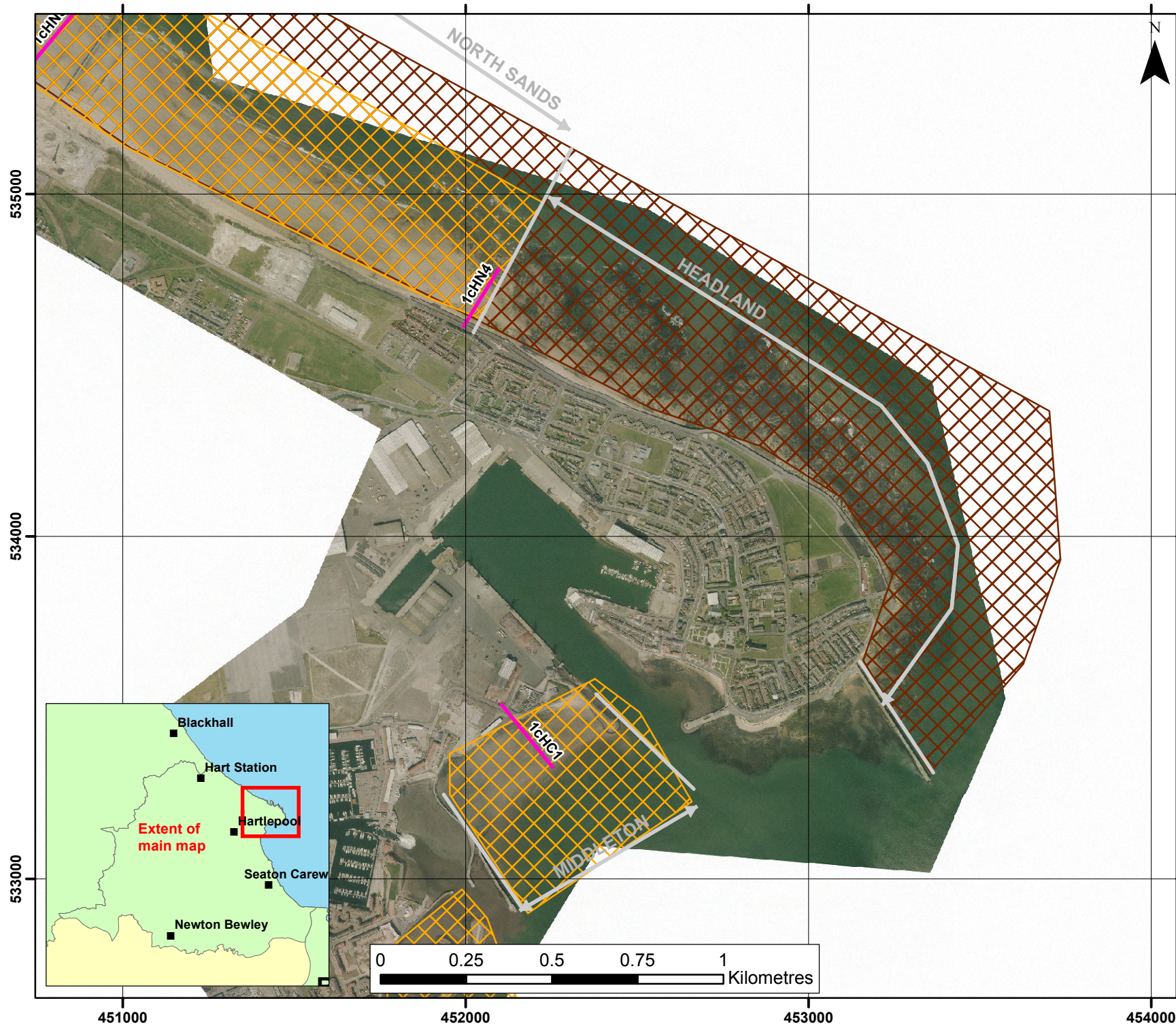
**Figure 2 - Map 1**  
**Survey Locations**  
**North Sands**  
**Hartlepool Borough**  
**Council**

Analytical Report 4  
 Full Measures Survey  
 Winter 2011

**Halcrow**  
 A CH2M HILL COMPANY  
 Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE  
 Tel: +44 (0)121 456 2345  
 Fax: +44(0)121 456 1569  
 www.halcrow.com

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





**KEY**

**Topographic Profiles**  
 — Annual (blue line)  
 — 6 monthly (pink line)

**Topographic Surveys**  
 ▨ 6 monthly (green hatching)  
 ▨ yearly (orange hatching)  
 ▨ 5 yearly (brown hatching)

**Cliff Top Monitoring Pegs**  
 ■ 50m centres (purple square)  
 ■ 100m centres (green square)  
 ■ 300m centres (red square)

*(Indicative Survey Extents shown)*

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

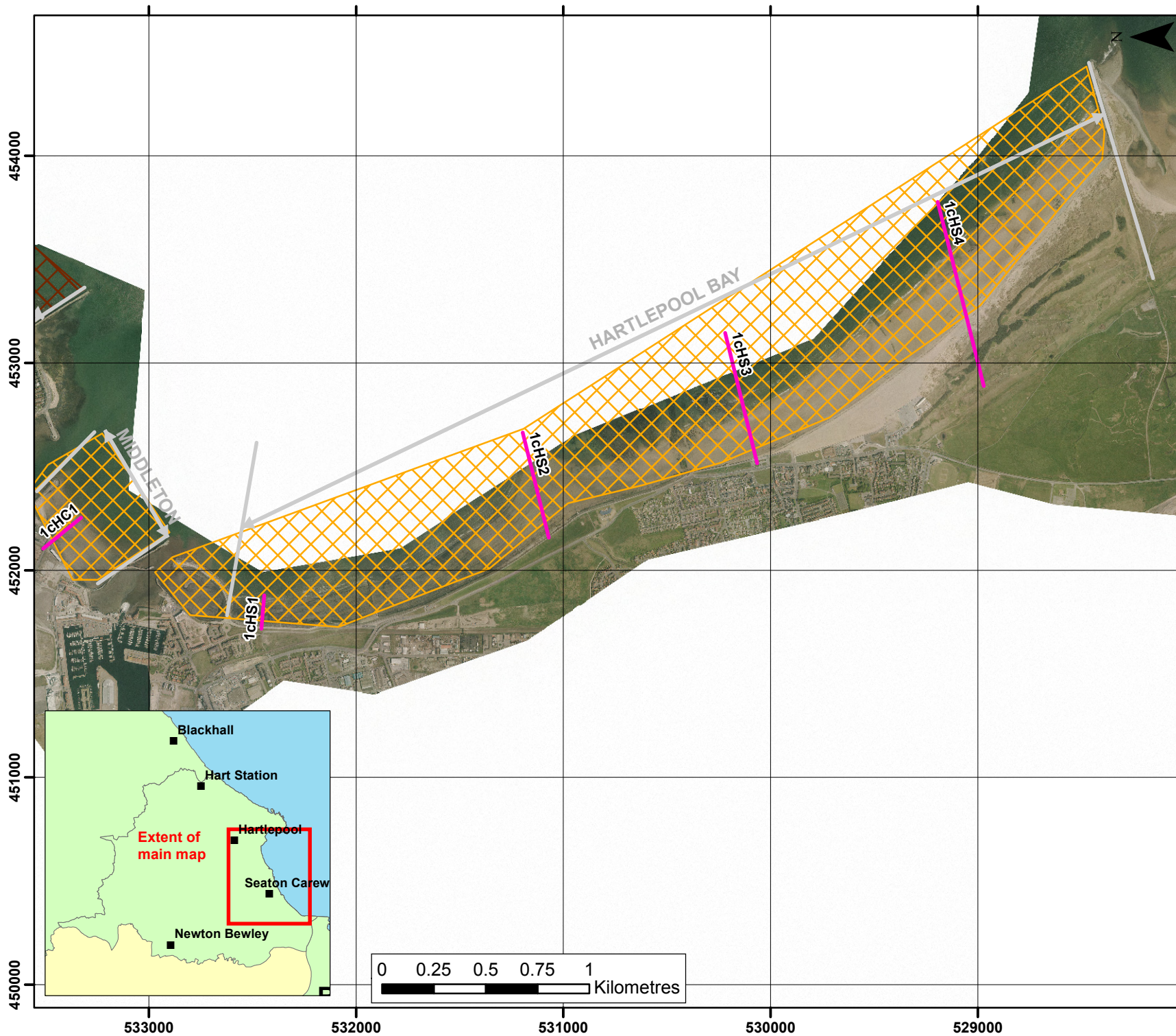
**Figure 2 - Map 2**  
**Survey Locations**  
**Headland and Middleton**  
**Hartlepool Borough**  
**Council**

Analytical Report 4  
 Full Measures Survey  
 Winter 2011

**Halcrow**  
 A CH2M HILL COMPANY  
 Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE  
 Tel: +44 (0)121 456 2345  
 Fax: +44(0)121 456 1569  
 www.halcrow.com

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





**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  
Hartlepool Bay  
Hartlepool Borough  
Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011



A CH2M HILL COMPANY

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

Tel: +44 (0)121 456 2345

Fax: +44(0)121 456 1569

www.halcrow.com

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

## 2. Analysis of Survey Data

### 2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
29 <sup>th</sup> Oct 2011	<p><b>Beach Profiles:</b></p> <p>North Sands is covered by four beach profile lines during the Full Measures survey (Appendix A).</p> <p>Profile <b>1cHN1</b> is located within Durham County Council's jurisdiction, about 400m north of the outfall of Crimdon Beck, but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands at HN2, HN3 and HN4. At <b>1cHN1</b> there is a large sand berm on the lower foreshore which is the most mobile feature on this section. The position of the berm has fluctuated since November 2008. The berm has moved seawards, since March 2011. The crest of the berm was at 180m chainage in March 2011 had moved 50m further down the foreshore October 2011. The crest of the berm is typically 0.3m above the surrounding beach level. The beach between the berm and MHWS has accreted.</p> <p>The lowering which previously occurred at the toe of the dunes along <b>1cHN2</b> during past surveys has been reversed in the October 2011 survey. The toe of the dunes has accreted by 1m since the erosion was at its worst on March 2010 and is comparable with the other post-summer surveys. The beach above MHWS has accreted by around 0.5m although there has been slight erosion (0.25m) below MHWS.</p> <p>Profile <b>1cHN3</b> has been stable above the level of HAT since 2008. Below HAT there is a 1.5m high lump in the profile. The lump is assumed to be the sand ridge at north end of beach, which was noted in the survey. It is unknown what process formed this accumulation of material. There appears to have been erosion of the foreshore beneath the berm (110m to 190m chainage) where the beach level has dropped by 0.5m over a width of 60m. It appears that the volume of the beach as a whole is similar between the Spring 2011 and Autumn 2011 surveys.</p> <p>At Profile <b>1cHN4</b> in the March 2011 survey there had been some erosion at the base of the defence, where the beach level has dropped by 0.3m. The trend foreshore lowering had reversed over the</p>	<p>The North Sands frontage has been characterised by seasonal changes again in 2011. The variability of beach berms and accretion at the toe of the dunes/defence in HN1, HN2 and HN4 is likely to be due to seasonal variations in forcing factors on this beach.</p> <p>Profile HN3 has been stable but it is difficult to interpret the mound on the foreshore, which could be man made.</p> <p>The topographic difference plot shows accretion overall, which agrees with the berms observed topographic survey. The differences in accretion and erosion recorded on the beach shows that the beach is steepening. This is very different from the behaviour observed in 2010 when there was notable lowering of the upper beach along its entire length, with the central section experiencing erosion across its whole inter-tidal zone.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>summer of 2011 and the toe of the defence has accreted in October 2011. However, below MHWS the March 2011 profile is 0.3m higher than the October profile, showing erosion of the mid-beach. From 95m chainage to MLWS the beach has accreted by up to 0.5m since March 2011.</p> <p><b>Topographic Survey:</b></p> <p>North Sands is covered by an annual topographic survey. Data from the 2011 Full Measures survey have been used to create a DGM (Appendix B – Map 1a) using a Geographic Information System (GIS) computer software package. The plot shows that a number of berms or banks have developed in the middle of the beach. The majority of the frontage is characterised by shore parallel topographic contours.</p> <p>The GIS has also been used to calculate the differences between the Winter 2010 and Winter 2011 topographic survey, as shown in Appendix B – Map 1b, to identify areas of erosion and accretion. During 2011 North Sands has accreted overall with the largest build-ups of sediment being 1m of accretion for extensive parts of the upper beach. There are also bands of erosion on the lower beach of varying severity. For example, in some areas 2m of material has been lost.</p>	

## 2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
27 <sup>th</sup> Sept 2011	<p><b>Beach Profiles:</b></p> <p>Middleton is covered by one beach profile line during the Full Measures survey (Appendix A).</p> <p>Profile <b>1cHC1</b> experienced significant lowering of around 1.5m at the toe of the vertical sea wall between September 2009 and March 2011. Over the subsequent summer months this scour at the base of the sea wall appears to have abated and the profile has accreted by around 0.4m at the toe of the sea wall since by September 2011. The foreshore has also accreted and is at a high level compared to the previous surveys.</p>	<p>The changes along most of the beach profile are within the bounds of previously recorded change. In the previous 2 surveys, the levels directly at the toe of the wall were particularly low, being 1.9m lower than those recorded in September 2009. In the September 2011 survey this has recovered significantly and the recorded beach level adjacent to the wall is about 0.5m higher although still 1.3m lower than in 2009.</p>
	<p><b>Topographic Survey:</b></p> <p>Middleton is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2011 Full Measures survey have been used to create a DGM (Appendix B – Map 2a) using a Geographic Information System (GIS) computer software package. The beach contours recorded in September 2011 show a difference in the steepness of the beach at each end of the frontage. The beach closest to the harbour breakwaters is steep with an almost concave pattern of contours. At the western part of the beach has a much shallower slope. There do not appear to be any berms on the beach. These observations are very similar to those reported in the 2010 Full Measures Report.</p> <p>The GIS has also been used to calculate the differences between the Winter 2010 and Winter 2011 topographic survey, as shown in Appendix B – Map 2b, to identify areas of erosion and accretion. Over 2011, on the eastern side, the beach has eroded by 1m close to the harbour breakwaters. On the western side and at the very top of the beach for the whole frontage there was accretion of around 0.5m over 2011. This means that the difference in beach slopes on each side of the Middleton Section has continued to develop since 2010.</p>	<p>The beach has an observed increase in steepness as you move east. This change was also apparent in the 2010 Full Measures plots. The prevailing processes in 2011 have acted to exacerbate the difference in beach levels with erosion on the steepest part close to the harbour wall. On the western side of the bay on the shallow slope accretion has occurred.</p> <p>It is likely that the eastern side of Middleton will come under greater pressure from coastal processes with more severe waves causing erosion. It will be interesting to see how this develops through the coming years.</p>

### 2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
29 <sup>th</sup> Oct 2011	<p><b>Beach Profiles:</b></p> <p>Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A).</p> <p>Profile <b>1cHS1</b> is located approximately 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends across the promenade, over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. It then gently slopes down to low water. The profile experienced lowering at the toe of the defence and throughout the rest of the beach of up to 0.4m.</p> <p>Profile <b>1cHS2</b> has been largely stable along its length since March 2011. Overall the beach level on this profile was high compared to the profiles carried out since March 2009.</p> <p>At profile <b>1cHS3</b> there were construction works being carried out on the seawall and the survey could not be carried out at this location.</p> <p>The profile <b>1cHS4</b> is located further south, around 1km north of the North Gare breakwater. It is in the area of undefended dunes at Seaton Sands. The profile covers approximately 350m of dunes before reaching the open coast. The Dune section looks reasonably stable. The beach beyond 325m chainage has accreted by 0.25m with modest erosion (a loss of around 0.1m) occurring since March 2011 from 375m chainage onwards. The level of this frontage is high compared to profiles carried out since March 2009.</p> <p><b>Topographic Survey:</b></p> <p>Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2009 Full Measures survey have been used to create a DGM (Appendix B – Map 3a) using a Geographic Information System (GIS) computer software package. The plot shows the two smaller bays within the log-form Hartlepool Bay. There is a slight headland or promontory in the shoreline plan form at Carr House Sands in the lee of Long Scar rocks between Hartlepool and Seaton Carew. For the rest of the bay the contours run shore parallel, meaning that there is a gently shelving</p>	<p>There has been some beach lowering at HS1, the erosion has been concentrated at the toe of the defence.</p> <p>Both HS2 and HS4 have shown relative stability, although both profiles are high compared to previous surveys. HS3 could not be fully surveyed.</p> <p>The topographic change plots show that during 2011 the north and south parts of the bay accreted overall with the dividing promontory showing erosion. The Seaton Carew frontage has been subject to more erosion than in the north, especially on the upper third of the beach. There has also been erosion on the lower part of the beach at Seaton Sands, close to the North Gare Breakwater. Erosion was recorded here during 2010 and it is possible the beach is getting steeper.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>slope.</p> <p>The GIS has also been used to calculate the differences between Winter 2010 and Winter 2011 topographic survey, as shown in Appendix B – Map 1b, to identify areas of erosion and accretion. Throughout 2011 the part of Hartlepool Bay, north of the Long Scar promontory has been accreting by around 0.25m with localised erosion at the very top of the beach.</p> <p>There has been significant erosion on the south side of Long Scar with a loss of around 1.5m in beach level. On the north side of Long Scar there was accretion in the region of 0.75m. During 2010 there had been a negative change in topography on the very tip of Long Scar, so the pattern of erosion is similar. There are also patches of erosion close to the rock outcrops between Long Scar and Little Scar, which were also present in 2010.</p> <p>In the southern half of Hartlepool Bay there has been accretion of up to 1m depth throughout the middle part of the beach. On the upper beach at Seaton Carew there has been moderate erosion with around 0.5m of beach lowering. There has also been erosion on the lower part of the beach in front of Seaton Sands which has been recoded as a loss of 1-2m of material.</p>	

### **3. Problems Encountered and Uncertainty in Analysis**

It should be noted that beach profile HN1 is located within Durham County Council's jurisdiction but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands, along HN2, HN3 and HN4. Construction works being carried out on the seawall at beach profile 1cHS3 meant the full survey could not be undertaken. The site will hopefully be accessible in future surveys.

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

No changes are needed at the present time.

### **5. Conclusions and Areas of Concern**

- The North Sands beach profiles show variability but accretion overall. This broadly agrees with the observed berms on the topographic plot and the accretion recorded in the difference plot. The differences in accretion and erosion recorded on the beach shows that the beach is steepening.
- At Middleton beach profiles show that there is large variability in the level of the beach on this frontage. In the previous survey, the levels directly at the toe of the wall are particularly low, being 1.9m lower than those recorded in September 2009. This has recovered and now the beach level adjacent to the wall is higher. The topographic change plots show that the beach has an observed increase in steepness as you move east. This change was also apparent in the 2010 Full Measures plots. The prevailing processes in 2011 have acted to exacerbate the difference in beach levels with erosion on the steepest part close to the harbour wall. On the western side of the bay on the shallow slope accretion has occurred.
- Hartlepool Bay has shown stability overall in the beach profiles. There has been some erosion recorded at the toe of the defences. The topographic change plots show that during 2011 the north and south parts of the bay accreted overall with the dividing promontory showing erosion. There has also been erosion on the lower part of the beach at Seaton Sands, close to the North Gare Breakwater. Erosion was recorded here during 2010 and it is possible the beach is getting steeper.

## **Appendices**

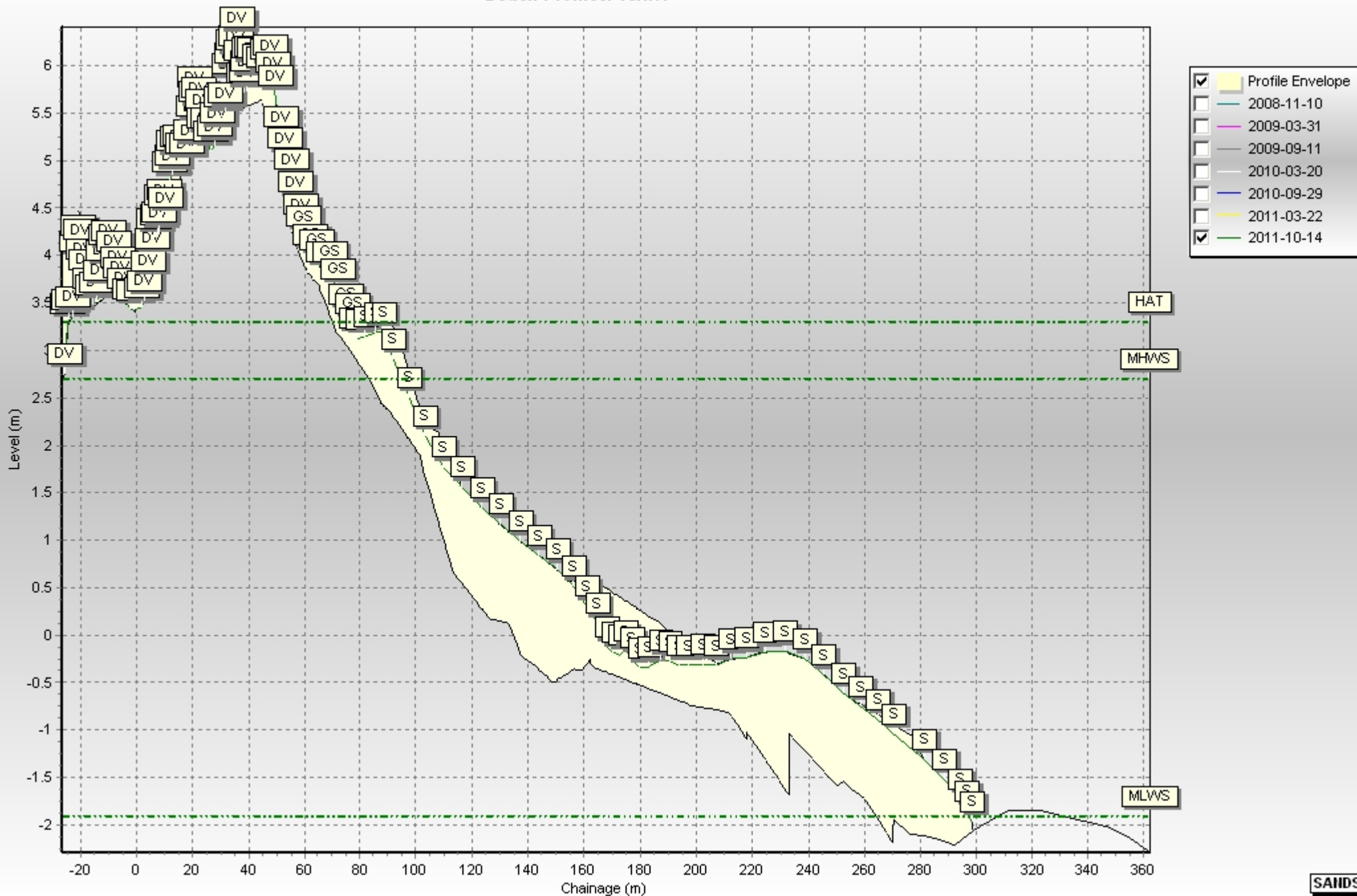


**Appendix A**  
**Beach Profiles**

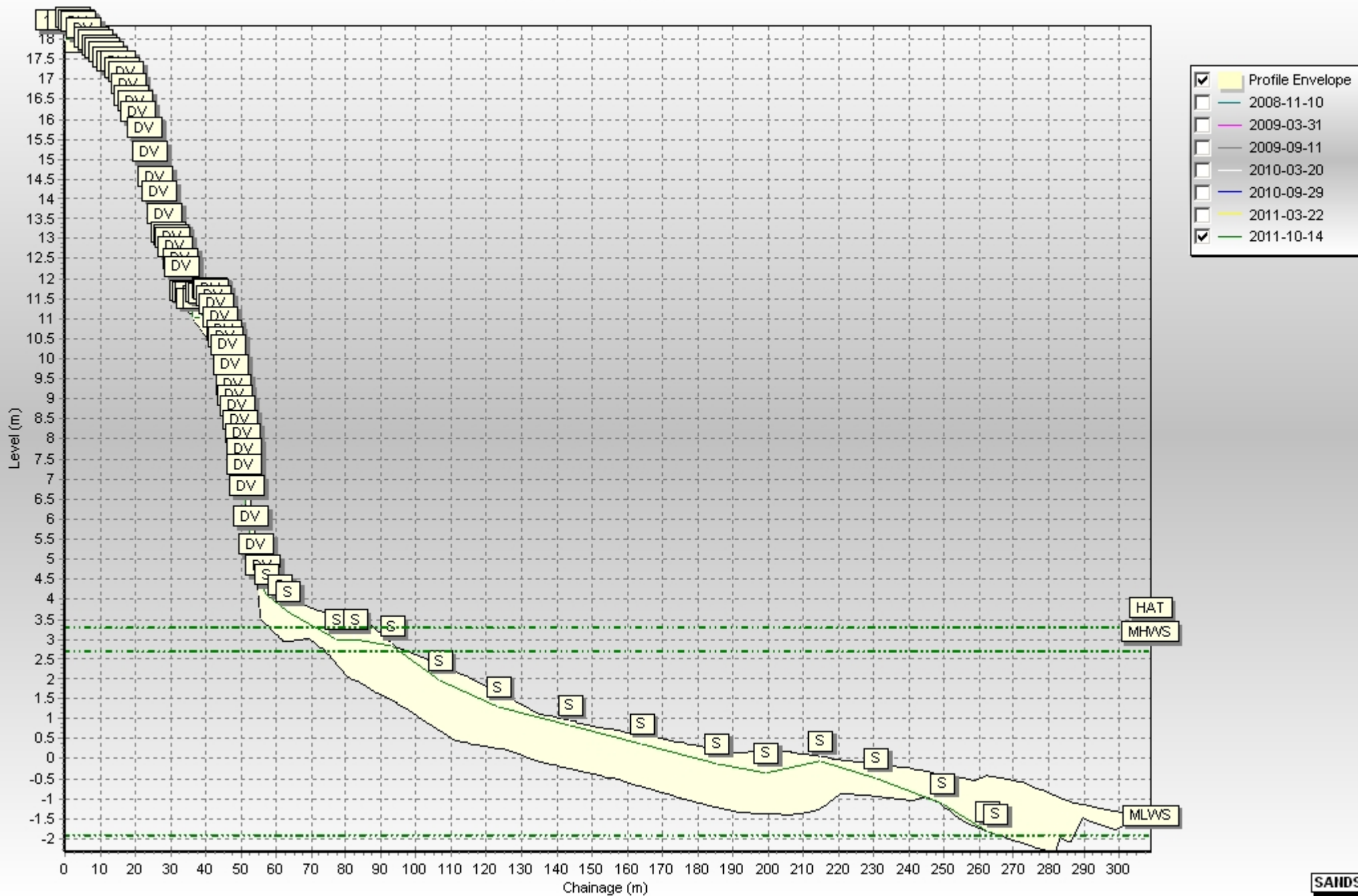
The following sediment feature codes are used on some profile plots:

<b>Code</b>	<b>Description</b>
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

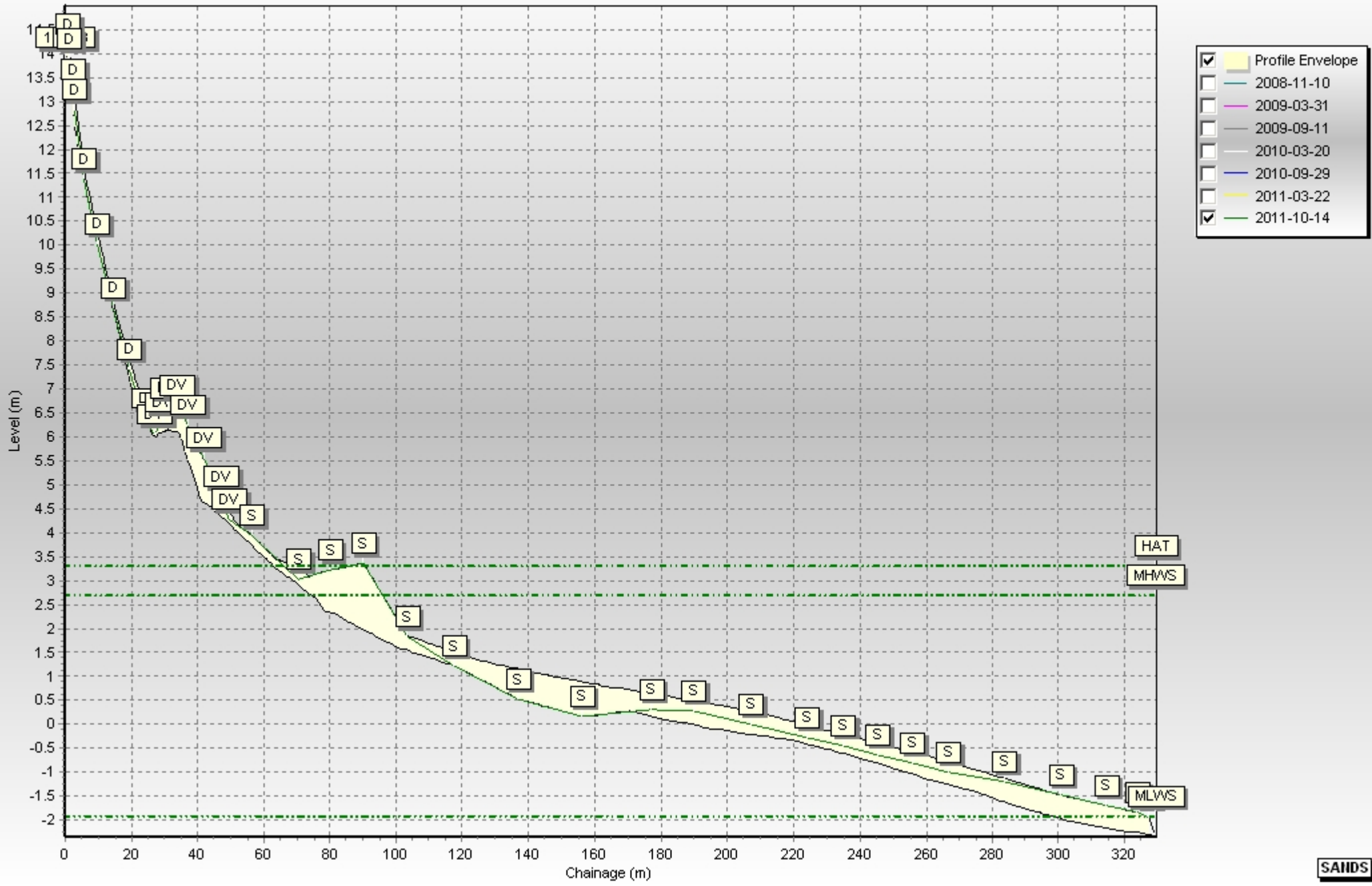
### Beach Profiles: 1cHN1



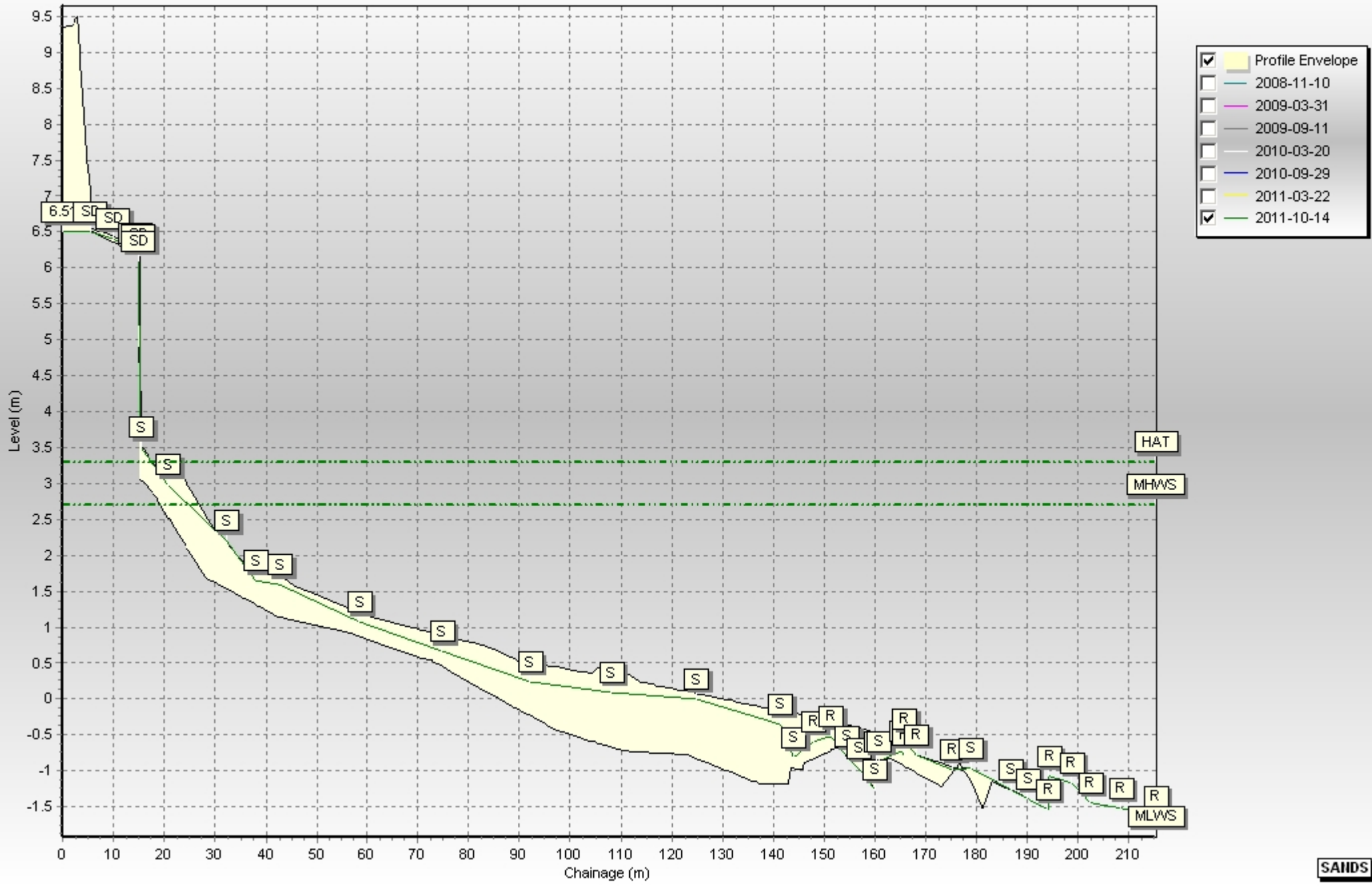
### Beach Profiles: 1cHN2



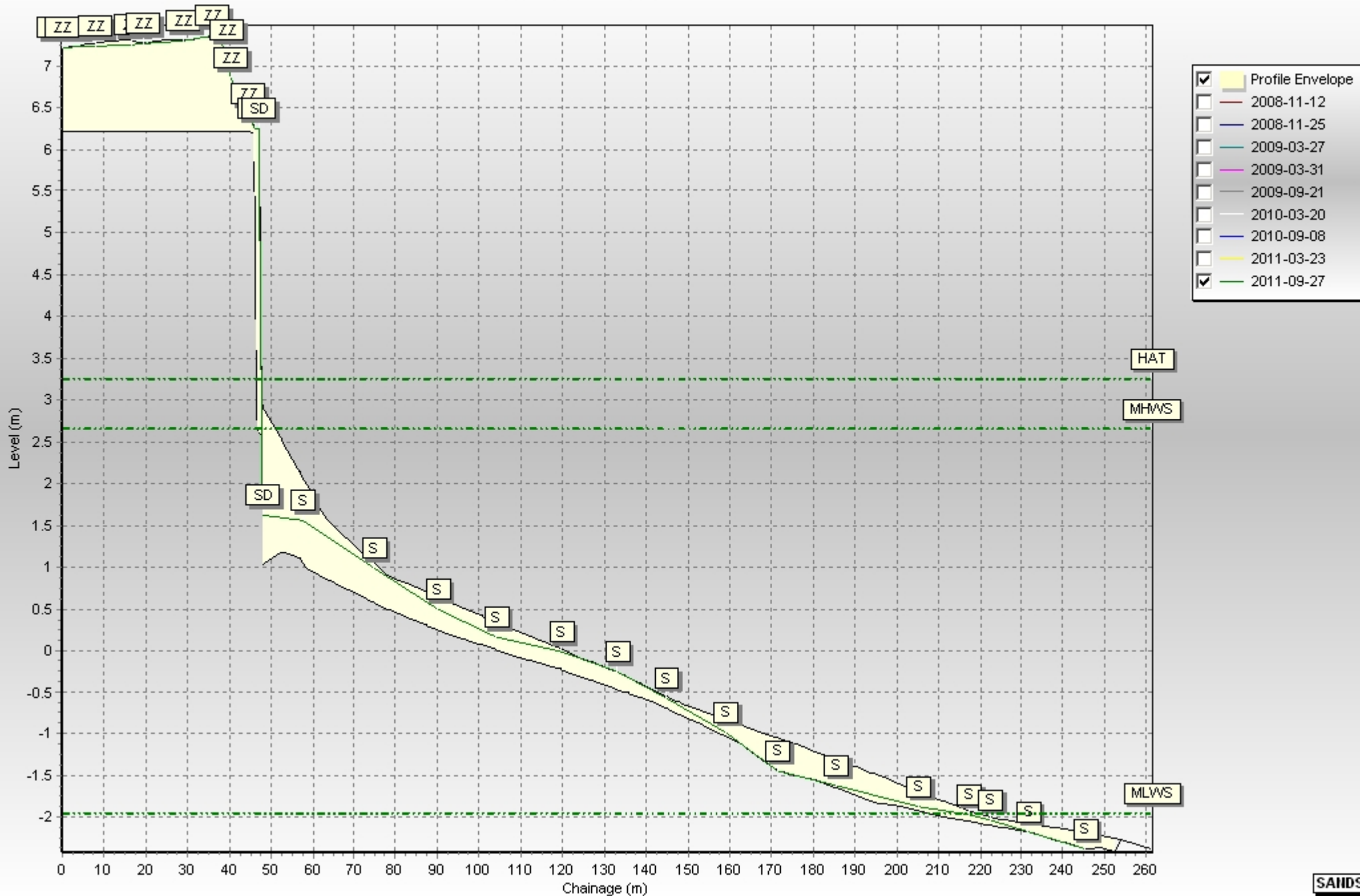
### Beach Profiles: 1cHN3



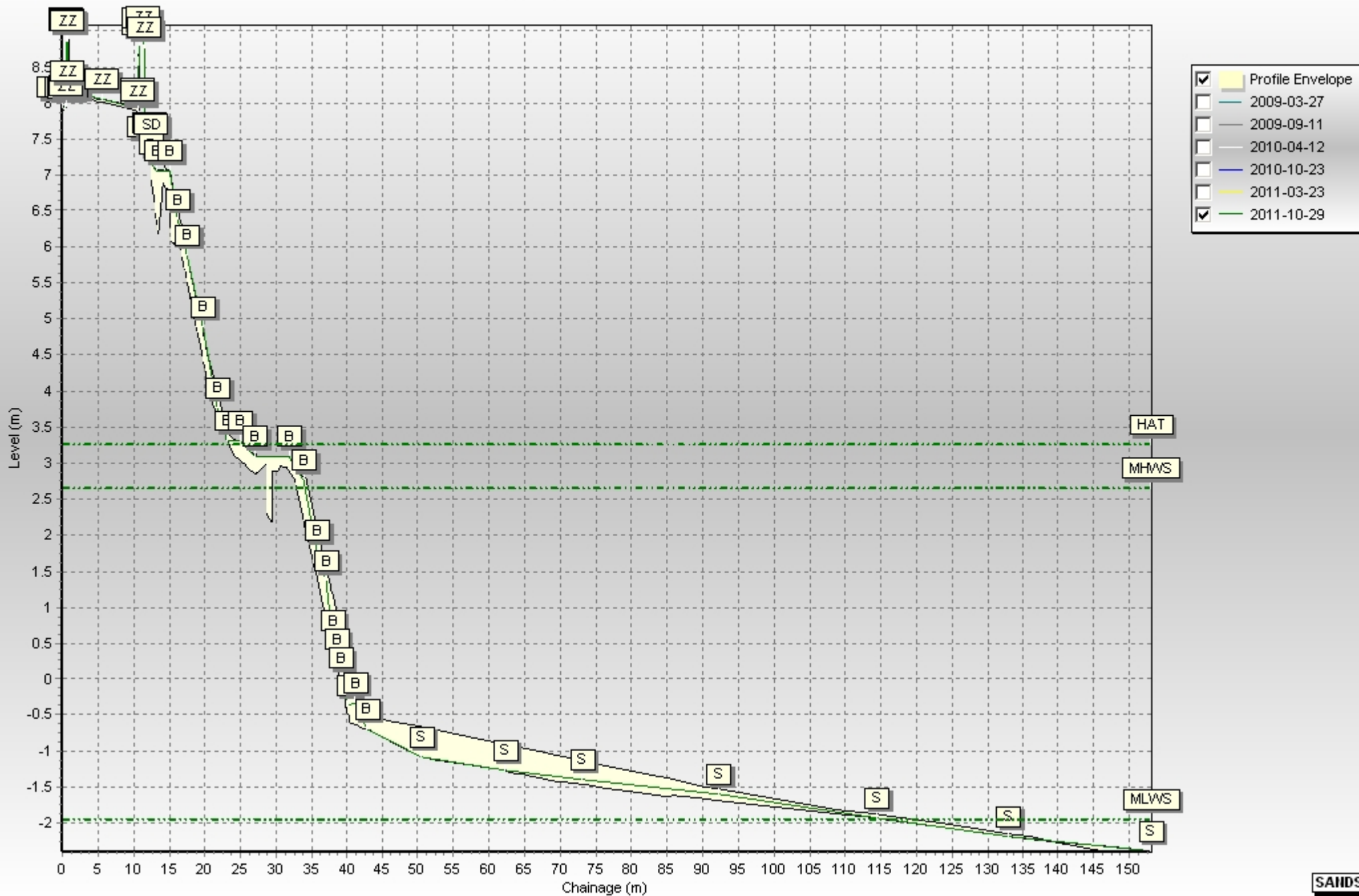
### Beach Profiles: 1cHN4



### Beach Profiles: 1cHC1

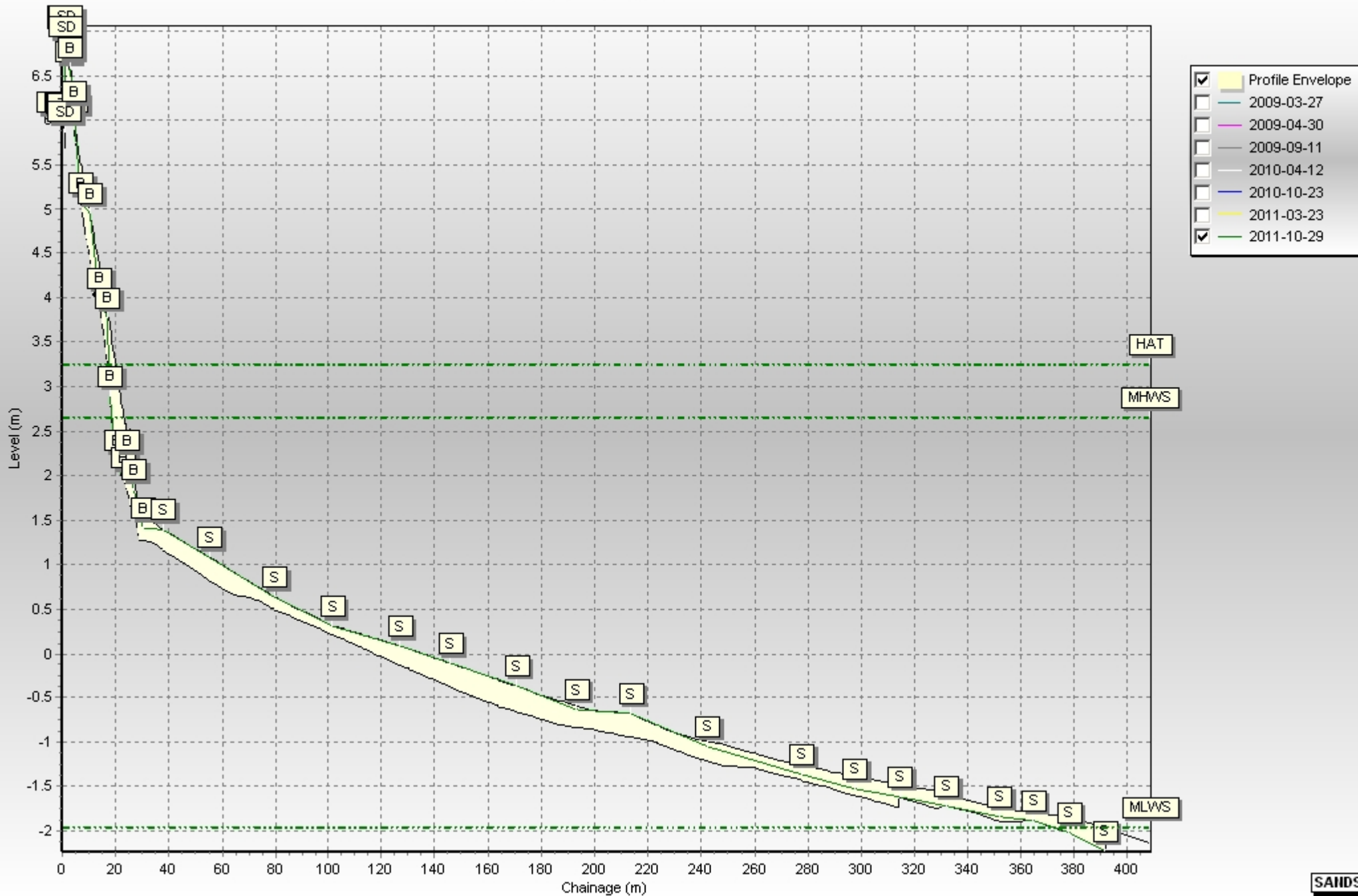


### Beach Profiles: 1cHS1

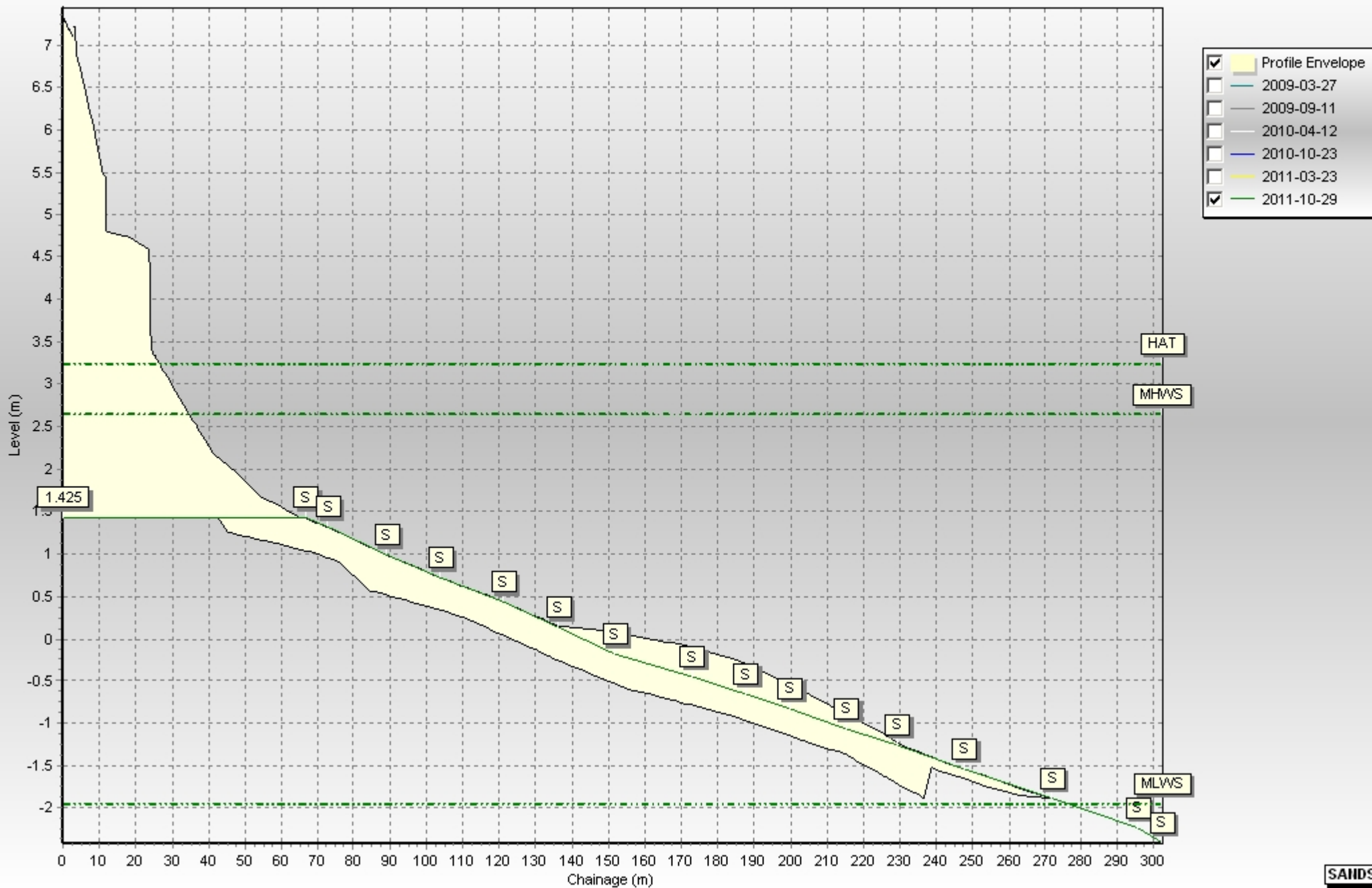




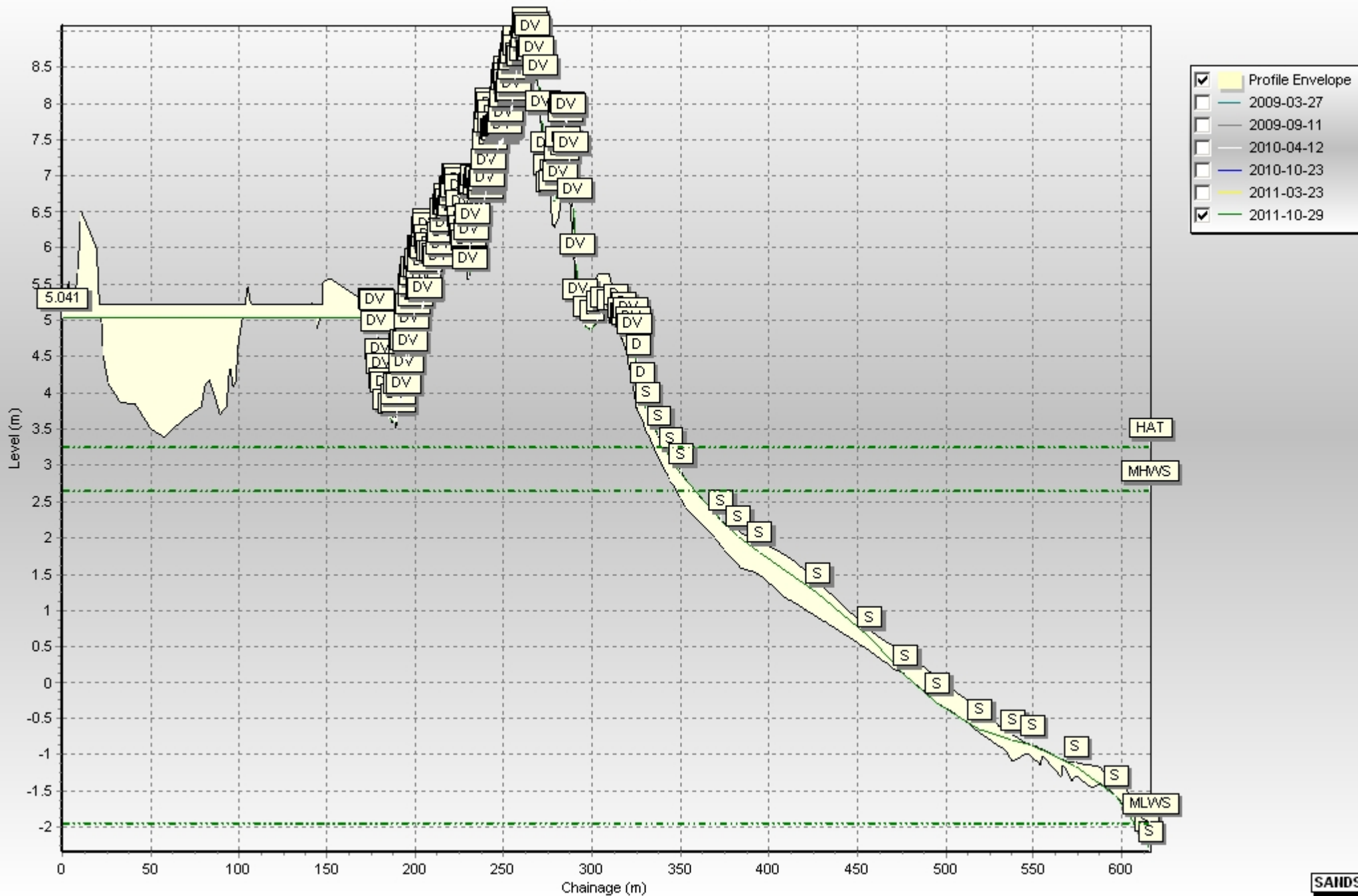
### Beach Profiles: 1cHS2



### Beach Profiles: 1cHS3

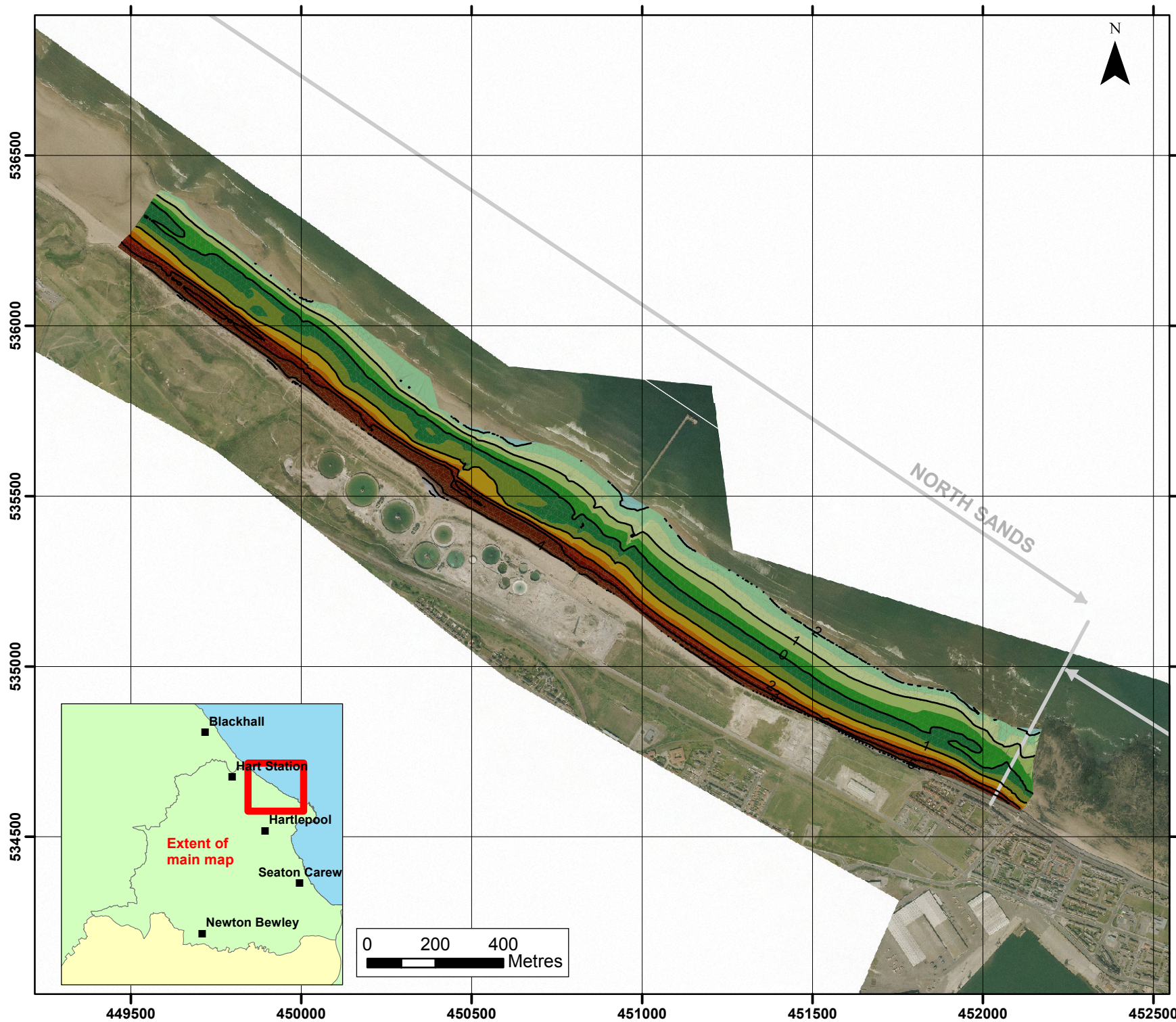


### Beach Profiles: 1cHS4



**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
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix B - Map 1a  
Topographic Survey  
North Sands  
Hartlepool Borough  
Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011



A CH2M HILL COMPANY

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

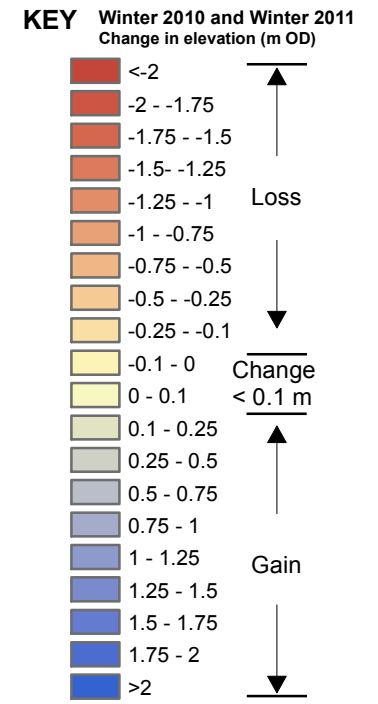
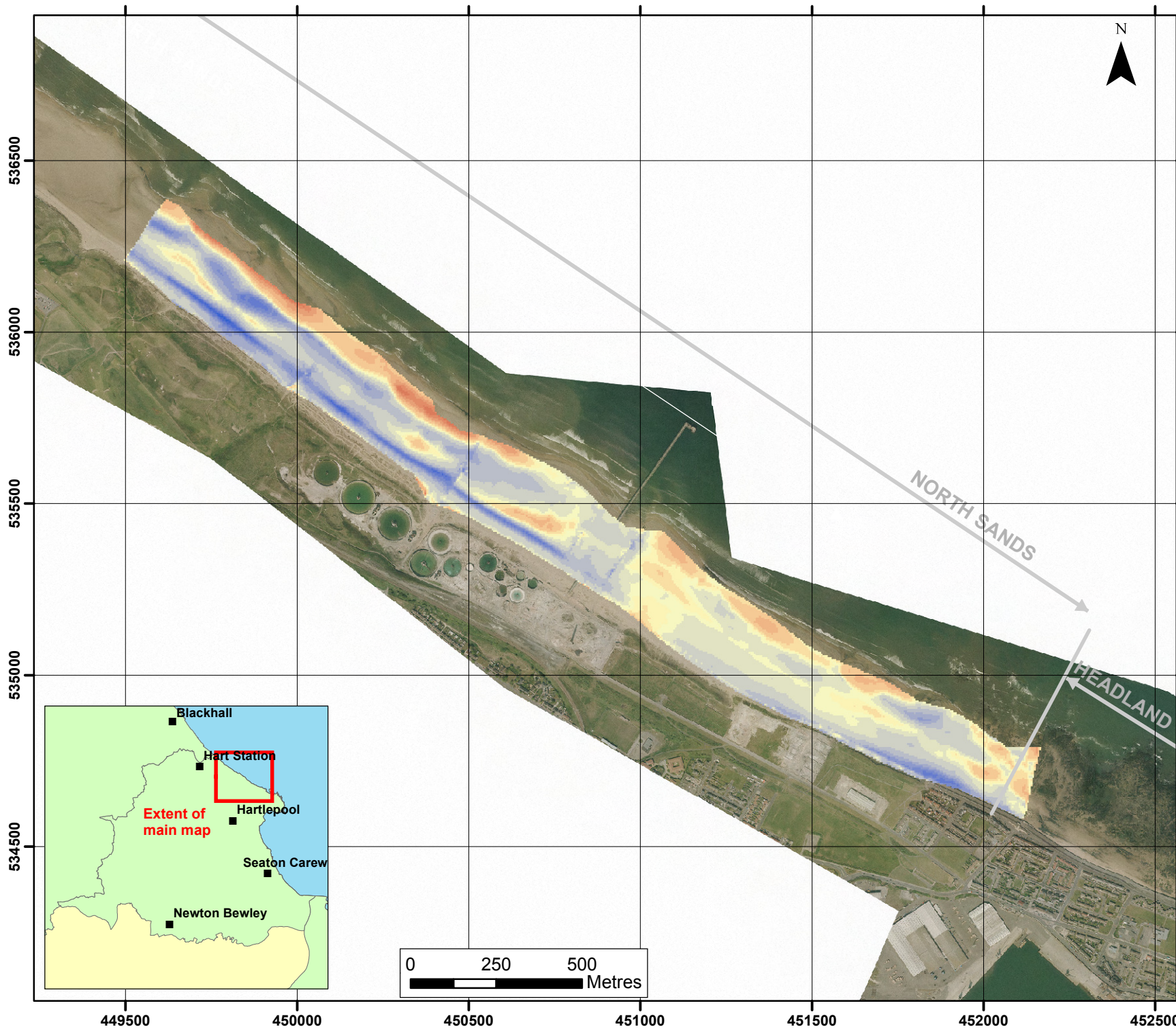
Tel: +44 (0)121 456 2345

Fax: +44(0)121 456 1569

www.halcrow.com

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





Client: North East Coastal Group

Project: Cell 1 Regional Coastal  
Monitoring Programme 2011 to 2016

**Appendix B - Map 1b**  
**Topographic Difference**  
**North Sands**  
**Hartlepool Borough**  
**Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011

**Halcrow**

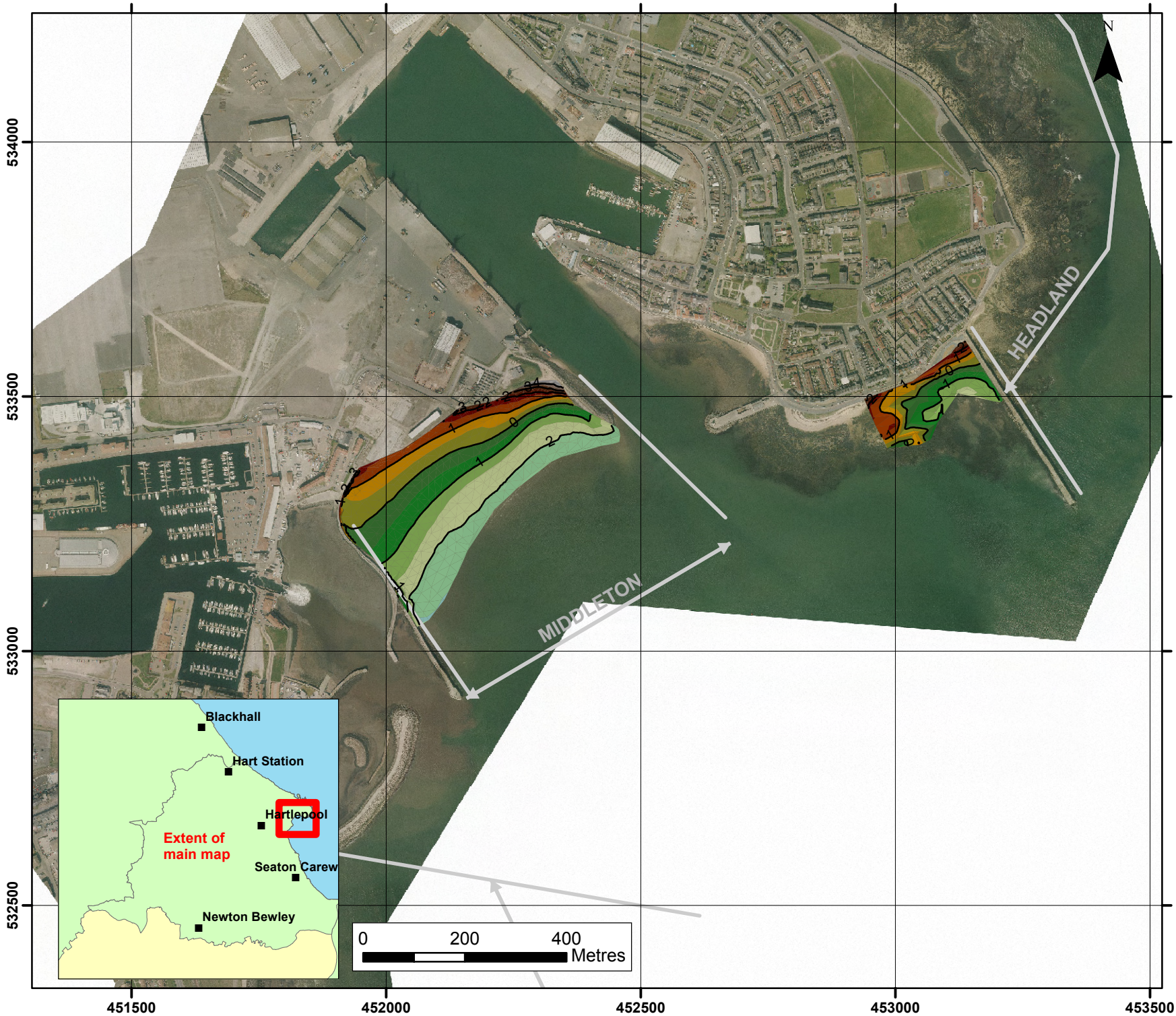
A CH2M HILL COMPANY

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

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

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





**KEY**

**Elevation**

- 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  
Headland and Middleton  
Hartlepool Borough  
Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011



A CH2M HILL COMPANY

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

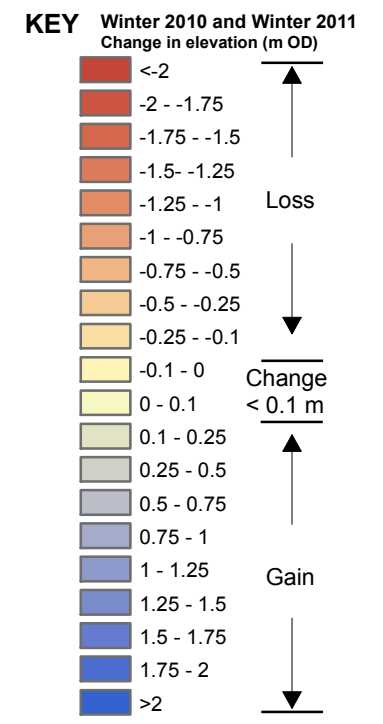
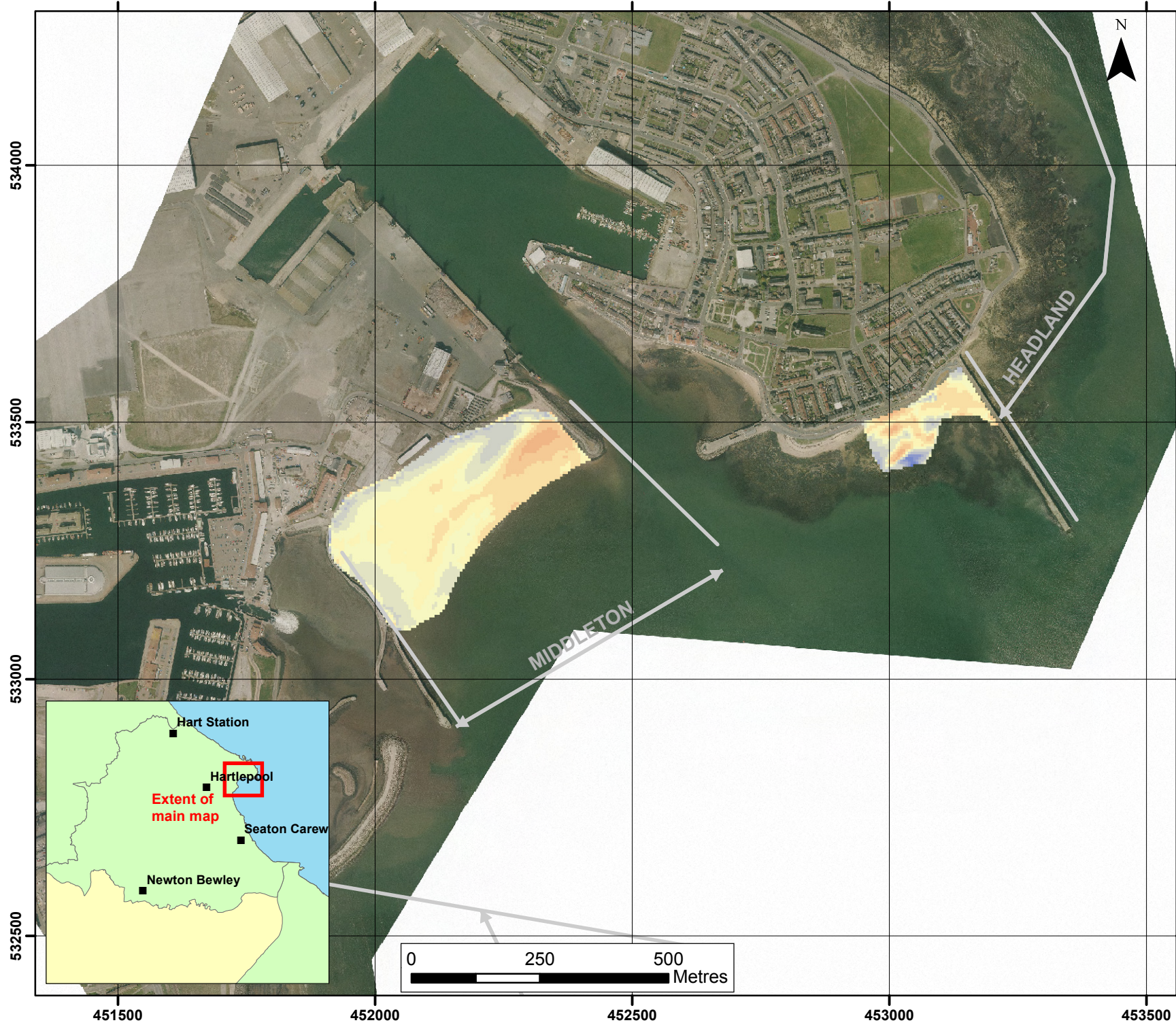
Tel: +44 (0)121 456 2345

Fax: +44(0)121 456 1569

www.halcrow.com

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





Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

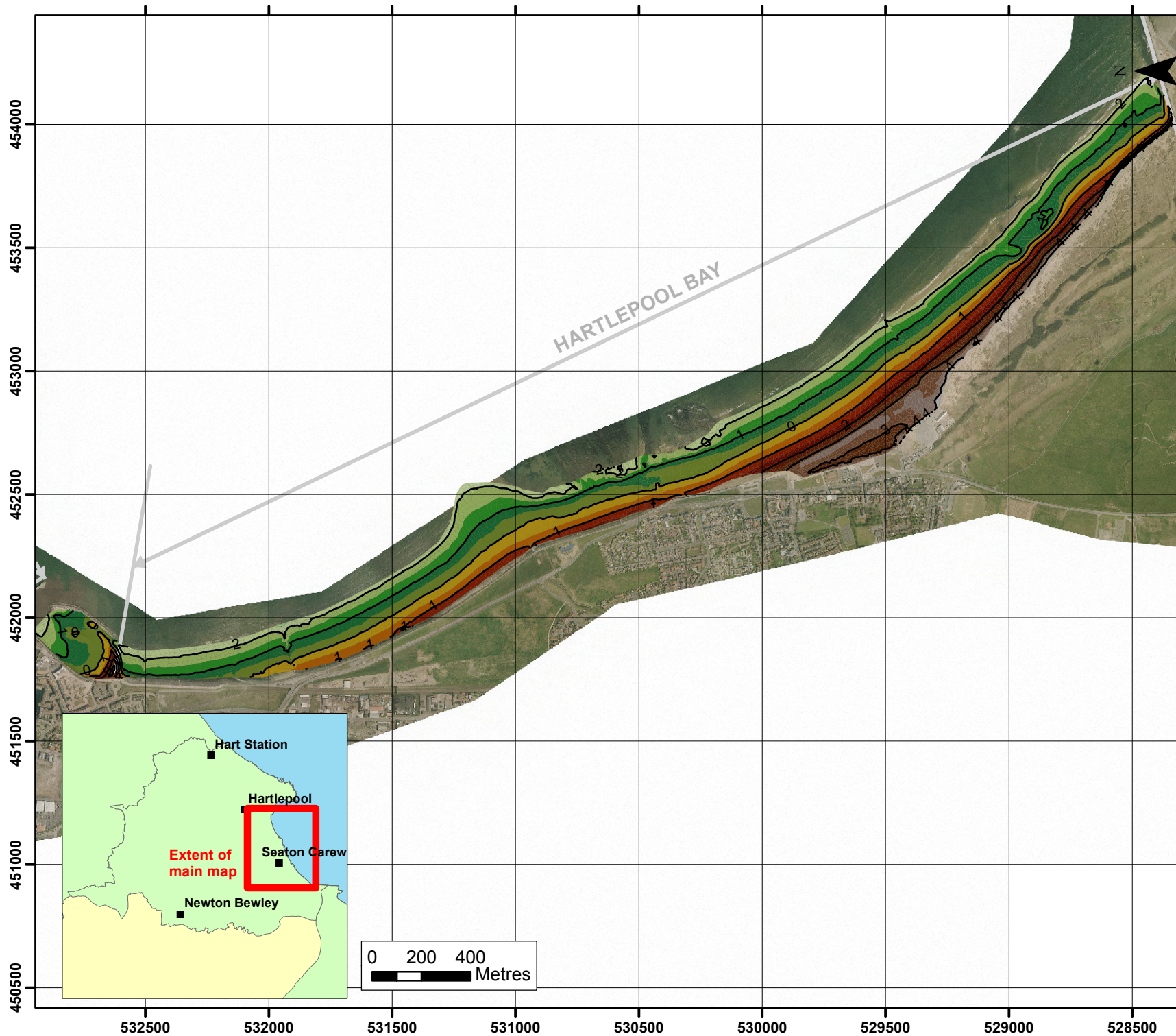
**Appendix B- Map 2b  
 Topographic Difference  
 Headland and Middleton  
 Hartlepool Borough  
 Council**

Analytical Report 4  
 Full Measures Survey  
 Winter 2011

**Halcrow**  
 A CH2M HILL COMPANY  
 Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE  
 Tel: +44 (0)121 456 2345  
 Fax: +44(0)121 456 1569  
 www.halcrow.com

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





**KEY**

**Elevation (m OD)**

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
-3.5 - -3
— Contour 1m

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

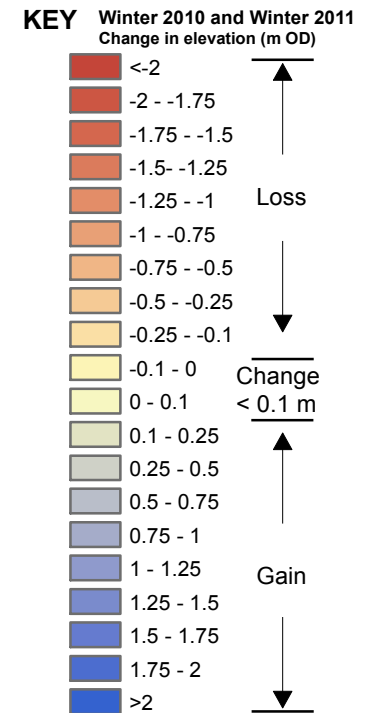
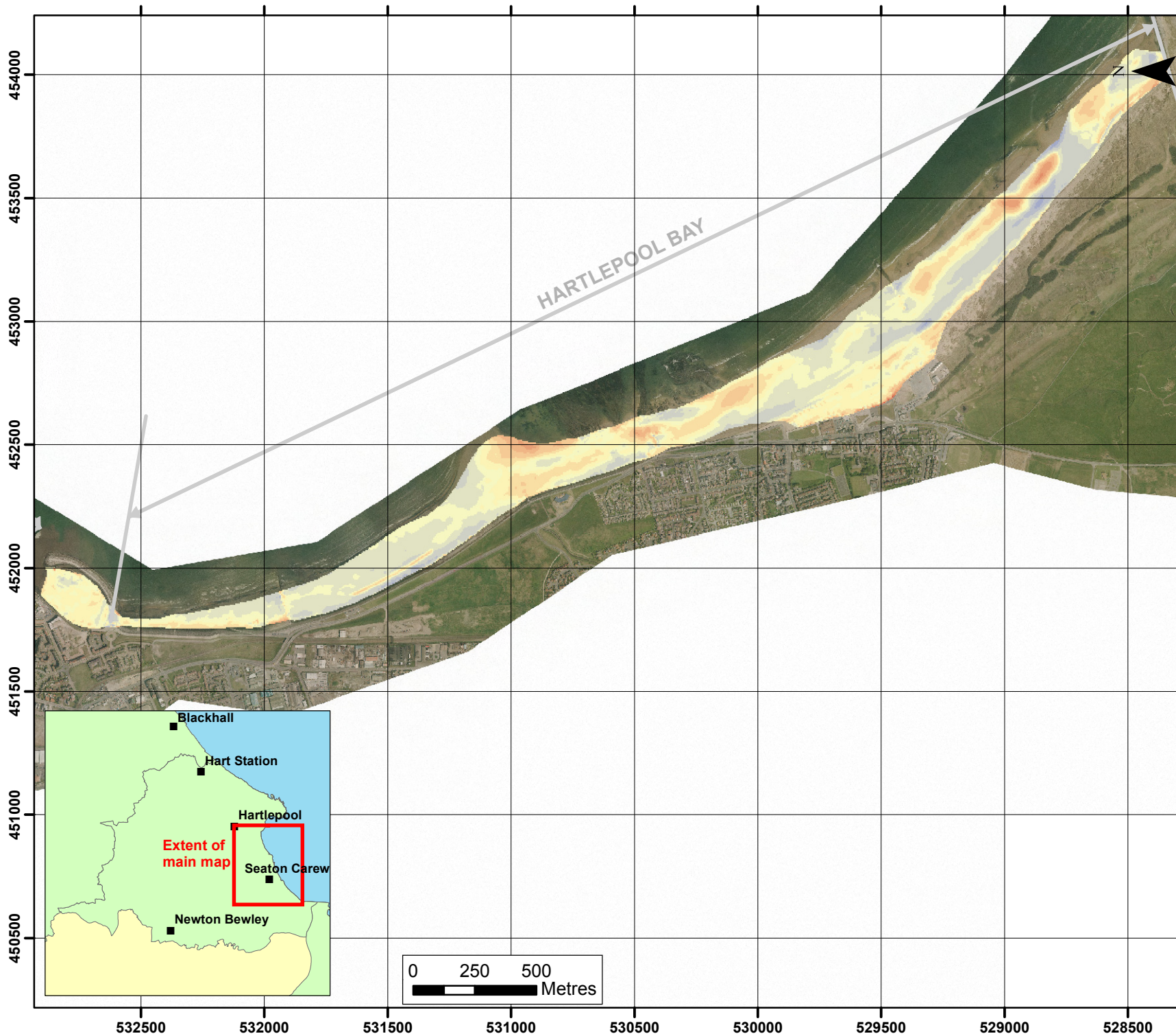
**Appendix B - Map 3a**  
**Topographic Survey**  
**Hartlepool Bay**  
**Hartlepool Borough**  
**Council**

Analytical Report 4  
 Full Measures Survey  
 Winter 2011

**Halcrow**  
 A CH2M HILL COMPANY  
 Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE  
 Tel: +44 (0)121 456 2345  
 Fax: +44(0)121 456 1569  
 www.halcrow.com

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





Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix B- Map 3b**  
**Topographic Difference**  
**Hartlepool Bay**  
**Hartlepool Borough**  
**Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011

**Halcrow**

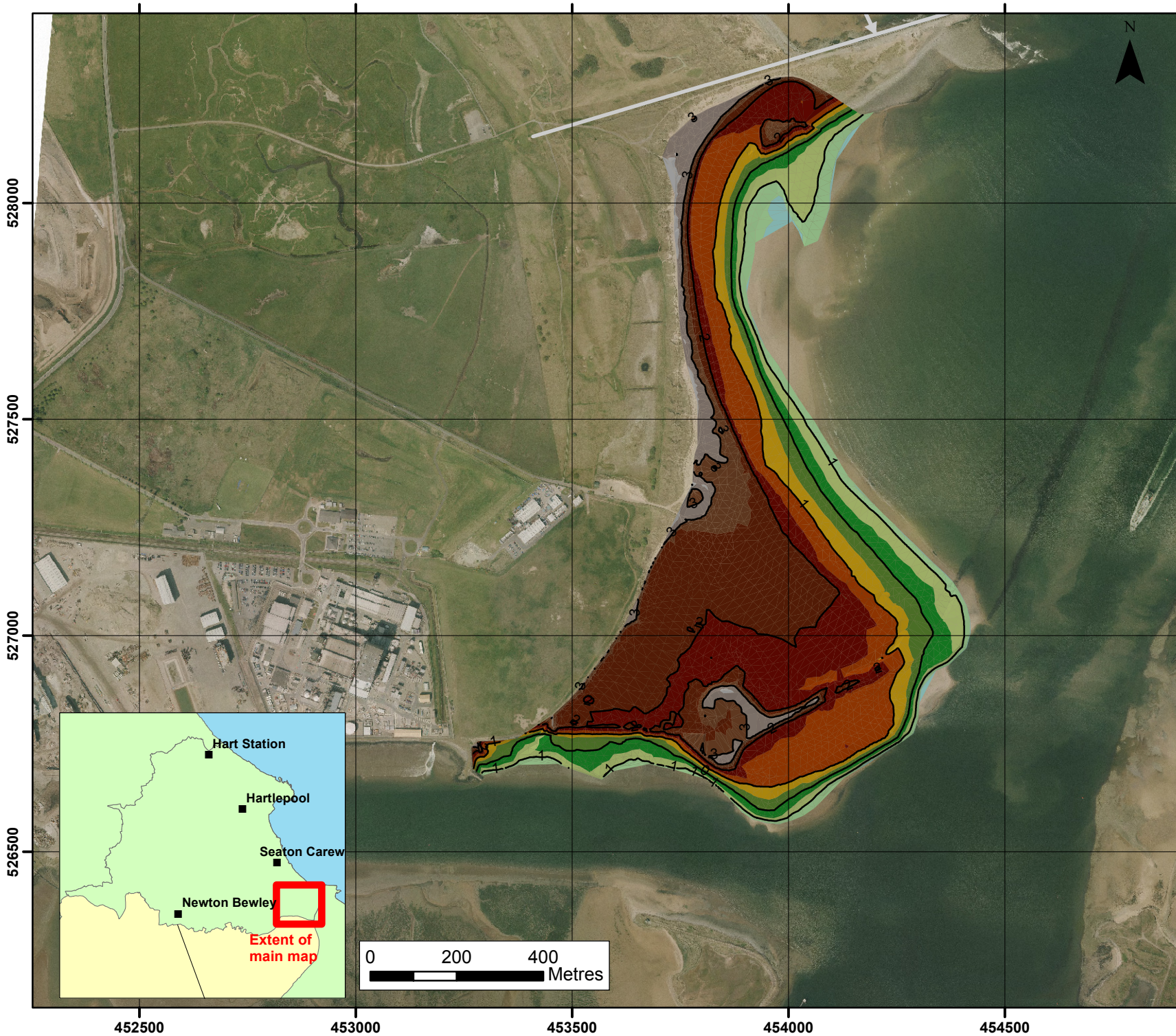
A CH2M HILL COMPANY

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

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

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





**KEY**

**Elevation (m OD)**

- 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
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Topographic Survey  
North Gare  
Hartlepool Borough  
Council**

Analytical Report 4  
Full Measures Survey  
Winter 2011



A CH2M HILL COMPANY

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

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

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