Cell 1 Regional Coastal Monitoring Programme
Analytical Report 3: ‘Full Measures’ Survey 2010

Redcar & Cleveland
Borough Council
Final Report

February 2011
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Authors

<table>
<thead>
<tr>
<th>Authors</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nick Cooper</td>
<td>Royal Haskoning</td>
</tr>
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<td>Nick Pettitt</td>
<td>Halcrow</td>
</tr>
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<td>Royal Haskoning</td>
</tr>
<tr>
<td>Richard Johnson</td>
<td>Halcrow</td>
</tr>
</tbody>
</table>
### Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Acronym / Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AONB</td>
<td>Area of Outstanding Natural Beauty</td>
</tr>
<tr>
<td>DGM</td>
<td>Digital Ground Model</td>
</tr>
<tr>
<td>HAT</td>
<td>Highest Astronomical Tide</td>
</tr>
<tr>
<td>LAT</td>
<td>Lowest Astronomical Tide</td>
</tr>
<tr>
<td>m</td>
<td>metres</td>
</tr>
<tr>
<td>MHWN</td>
<td>Mean High Water Neap</td>
</tr>
<tr>
<td>MHWS</td>
<td>Mean High Water Spring</td>
</tr>
<tr>
<td>MLWN</td>
<td>Mean Low Water Neap</td>
</tr>
<tr>
<td>MLWS</td>
<td>Mean Low Water Spring</td>
</tr>
<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
</tr>
<tr>
<td>ODN</td>
<td>Ordnance Datum Newlyn</td>
</tr>
</tbody>
</table>

### Water Levels Used in Interpretation of Changes

<table>
<thead>
<tr>
<th>Water Level Parameter</th>
<th>Water Level (mODN)</th>
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<tbody>
<tr>
<td></td>
<td>River Tyne to Frenchman’s Bay</td>
</tr>
<tr>
<td>1 in 200 year</td>
<td>3.41</td>
</tr>
<tr>
<td>HAT</td>
<td>2.85</td>
</tr>
<tr>
<td>MHWS</td>
<td>2.15</td>
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<tr>
<td>MLWS</td>
<td>-2.15</td>
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<table>
<thead>
<tr>
<th>Water Level Parameter</th>
<th>Water Level (mODN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hartlepool Headland to Saltburn Scar</td>
</tr>
<tr>
<td>1 in 200 year</td>
<td>3.87</td>
</tr>
<tr>
<td>HAT</td>
<td>3.25</td>
</tr>
<tr>
<td>MHWS</td>
<td>2.65</td>
</tr>
<tr>
<td>MLWS</td>
<td>-1.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Level Parameter</th>
<th>Water Level (mODN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saltwick Nab to Hundale Point</td>
</tr>
<tr>
<td>1 in 200 year</td>
<td>3.88</td>
</tr>
<tr>
<td>HAT</td>
<td>3.10</td>
</tr>
<tr>
<td>MHWS</td>
<td>2.60</td>
</tr>
<tr>
<td>MLWS</td>
<td>-2.20</td>
</tr>
</tbody>
</table>

# Glossary of Terms

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

![Figure 1 Sediment Cells in England and Wales](image)

The programme commenced in its present guise in September 2008 and is managed by Scarborough Borough Council on behalf of the North East Coastal Group. It is funded by the Environment Agency, working in partnership with the following organisations.
The data collection, analysis and reporting is being undertaken as a partnership between the following organisations:

![Logos of the organisations involved]

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.

A Cell 1 Overview Report will also be produced periodically. This will provide a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage within distinct time phases of the programme, defined by specific funding allocations. The first such report is expected to be produced in spring 2011 (covering 2008 – 2011) when the initial three year funding allocation comes towards an end.

To date the following reports have been produced:

**Table 1** Analytical, Update and Overview Reports Produced to Date

<table>
<thead>
<tr>
<th>Year</th>
<th>Full Measures Survey</th>
<th>Analytical Report</th>
<th>Partial Measures Survey</th>
<th>Update Report</th>
<th>Cell 1 Overview Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2008/09</td>
<td>Sep-Dec 08</td>
<td>May 09</td>
<td>Mar-May 09</td>
<td>June 09</td>
<td>-</td>
</tr>
<tr>
<td>2 2009/10</td>
<td>Sep-Dec 09</td>
<td>Mar 10</td>
<td>Mar-May 10</td>
<td>July 10</td>
<td>-</td>
</tr>
<tr>
<td>3 2010/11</td>
<td>Sep-Dec 10</td>
<td>Feb 11(*)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) The present report is **Analytical Report 3** and provides an analysis of the 2010 full measures survey for Redcar & Cleveland 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>
<thead>
<tr>
<th>Authority</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Northumberland County Council</strong></td>
<td>Spittal A</td>
</tr>
<tr>
<td></td>
<td>Spittal B</td>
</tr>
<tr>
<td></td>
<td>Goswick Sands</td>
</tr>
<tr>
<td></td>
<td>Holy Island</td>
</tr>
<tr>
<td></td>
<td>Bamburgh</td>
</tr>
<tr>
<td></td>
<td>Beadnell Village</td>
</tr>
<tr>
<td></td>
<td>Beadnell Bay</td>
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<tr>
<td></td>
<td>Embelton Bay</td>
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<tr>
<td></td>
<td>Boulmer</td>
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<td></td>
<td>Alnmouth Bay</td>
</tr>
<tr>
<td></td>
<td>High Hauxley and Druridge Bay</td>
</tr>
<tr>
<td></td>
<td>Lynemouth Bay</td>
</tr>
<tr>
<td></td>
<td>Newbiggin Bay</td>
</tr>
<tr>
<td></td>
<td>Cambois Bay</td>
</tr>
<tr>
<td></td>
<td>Blyth South Beach</td>
</tr>
<tr>
<td><strong>North Tyneside Council</strong></td>
<td>Whitley Sands</td>
</tr>
<tr>
<td></td>
<td>Cullercoats Bay</td>
</tr>
<tr>
<td></td>
<td>Tynemouth Long Sands</td>
</tr>
<tr>
<td></td>
<td>King Edward’s Bay</td>
</tr>
<tr>
<td><strong>South Tyneside Council</strong></td>
<td>Littehaven Beach</td>
</tr>
<tr>
<td></td>
<td>Herd Sands</td>
</tr>
<tr>
<td></td>
<td>Trow Quarry (incl. Frenchman’s Bay)</td>
</tr>
<tr>
<td></td>
<td>Marsden Bay</td>
</tr>
<tr>
<td><strong>Sunderland Council</strong></td>
<td>Whitburn Bay</td>
</tr>
<tr>
<td></td>
<td>Harbour and Docks</td>
</tr>
<tr>
<td></td>
<td>Hendon to Ryhope (incl. Halliwell Banks)</td>
</tr>
<tr>
<td><strong>Durham County Council</strong></td>
<td>Featherbed Rocks</td>
</tr>
<tr>
<td></td>
<td>Seaham</td>
</tr>
<tr>
<td></td>
<td>Blast Beach</td>
</tr>
<tr>
<td></td>
<td>Hawthorn Hive</td>
</tr>
<tr>
<td></td>
<td>Blackhall Colliery</td>
</tr>
<tr>
<td><strong>Hartlepool Borough Council</strong></td>
<td>North Sands</td>
</tr>
<tr>
<td></td>
<td>Headland</td>
</tr>
<tr>
<td></td>
<td>Middleton</td>
</tr>
<tr>
<td></td>
<td>Hartlepool Bay</td>
</tr>
<tr>
<td><strong>Redcar &amp; Cleveland Borough Council</strong></td>
<td>Cattersty Sands (Skinningrove)</td>
</tr>
<tr>
<td></td>
<td>Coatham Sands</td>
</tr>
<tr>
<td></td>
<td>Redcar Sands</td>
</tr>
<tr>
<td></td>
<td>Marske Sands</td>
</tr>
<tr>
<td></td>
<td>Saltburn Sands</td>
</tr>
<tr>
<td><strong>Scarborough Borough Council</strong></td>
<td>Staithes</td>
</tr>
<tr>
<td></td>
<td>Runswick Bay</td>
</tr>
<tr>
<td></td>
<td>Sandsend Beach, Upgang Beach and Whitby Sands</td>
</tr>
<tr>
<td></td>
<td>Robin Hood’s Bay</td>
</tr>
<tr>
<td></td>
<td>Scarborough North Bay</td>
</tr>
<tr>
<td></td>
<td>Scarborough South Bay</td>
</tr>
<tr>
<td></td>
<td>Cayton Bay</td>
</tr>
<tr>
<td></td>
<td>Filey Bay</td>
</tr>
</tbody>
</table>
1. **Introduction**

1.1 **Study Area**

Redcar & Cleveland Borough Council’s frontage extends from the 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 six areas, namely:

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes

The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland Council and Scarborough Borough Council and therefore reporting has been duplicated in both reports.

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 9 no. transect lines
  - Topographic survey along Coatham Sands
  - Topographic survey along Redcar Sands
  - Topographic survey along Marske Sands
  - Topographic survey along Saltburn Sands
  - Topographic survey along Cattersty Sands

- **Partial Measures survey annually each spring comprising:**
  - Beach profile surveys along 9 no. transect lines
  - Topographic survey along Redcar Sands
  - Topographic survey along Saltburn Sands
  - Topographic survey along Cattersty Sands

- **Cliff top survey annually at:**
  - Staithes

The location of these surveys is shown in Figure 2. They have also previously been provided on a digital file which can be opened in Google Earth showing the locations of the surveys.

The Full Measures survey was undertaken along this frontage between September and November 2010. During the Coatham, Redcar, Marske and Saltburn surveys (November 2010) weather conditions were wet and breezy and the sea state was moderate but with a long swell. During the Skinningrove survey (November 2010) weather conditions were wet and windy and the sea state was rough with a light swell. During the Staithes survey (September 2010) weather conditions were breezy and wet 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 Arc-GIS. 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.
Figure 2 - Map 1
Redcar & Cleveland Borough Council Frontage

Analytical Report 3
‘Full Measures’ Survey 2010

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

Drawing Scale 1:20,000 at A4

Drawn by: TC
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www.northeastcoastalobservatory.org.uk
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

Analytical Report 3
‘Full Measures’ Survey 2010

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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 2 - Map 3
Redcar & Cleveland Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:20,000 at A4

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Checked by: NC  Date: 29/11/2010
Approved by: NC  Date: 06/12/2010

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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

Redcar & Cleveland Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by: TC Date: 29/11/2010
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Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk
Figure 2 - Map 5
Redcar & Cleveland
Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

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)
2. Analysis of Survey Data

2.1 Coatham Sands

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-2010</td>
<td><strong>Beach Profiles:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coatham Sands is covered by four beach profile lines during the Full Measures survey (RC1 to RC4; Appendix A).</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>RC1</strong> is located approximately 300m south of the South Gare breakwater, immediately in the lee of the German Charlies. The profile shows some minor accretion to upper foreshore levels, above MHWS, and also to the face and crest of the seaward dune ridge. The berm previously recorded around MHWN in April 2010 had been flattened by the November 2010 survey, but the lower foreshore received some of this sediment and increased in level by up to around 0.5m.</td>
<td>Whilst the dunes and beach along RC1 are relatively well protected by the German Charlies slag banks offshore, the profile has experienced some variations over time, particularly in relation to the presence (November 2008, April 2009, September 2009) or absence (April 2010, November 2010) of a berm at around the level of HAT. The most recent survey shows relatively healthy conditions in terms of lower foreshore levels, with an absence of a berm around HAT.</td>
</tr>
<tr>
<td></td>
<td><strong>RC2</strong> showed clear growth on the seaward face of the fronting dune ridge and accretion by up to 0.15m on the upper beach profile, down to a chainage of around 175m. Seaward of this point, the lower foreshore lowered by around 0.15m.</td>
<td>Changes along RC2 indicate presently healthy upper beach and dune levels, and whilst the lower foreshore experienced some lowering it remains at a healthy level compared to some earlier surveys.</td>
</tr>
<tr>
<td></td>
<td><strong>Along RC3</strong> upper beach levels remained similar to those recorded in April 2010, despite some dune accretion on the seaward face. Modest lowering of &lt;0.1m occurred along the profile seaward of around MHWN, increasing to a peak of around 0.2m towards the seaward end of the transect.</td>
<td>Although beach levels remained low along RC3, the profile form was characteristic of the previous survey records along this transect and do not present a significant net change from the previous surveys.</td>
</tr>
<tr>
<td></td>
<td><strong>Considerable accretion was recorded along RC4 between September 2009 and April 2010, but this trend was reversed to November 2010 with material eroded from the mid and lower profile to record new low levels, but for the first time since surveys began in November 2008 two berms were formed on the upper beach, one around MHWS and one just above HAT.</strong></td>
<td>A new behaviour was observed along RC4, with berm formation on the upper beach from sediment eroded from the mid and lower profiles.</td>
</tr>
</tbody>
</table>
## Survey Date

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
</table>
| 11-2010     | **Topographic Survey:**

Coatham Sands is covered by an annual topographic survey extending from the South Gare Breakwater, although the survey is contiguous with the Redcar Sands topographic survey (which is surveyed 6-monthly). Data have been used to create a DGM (Appendix B – Map 1a) using a Geographic Information System (GIS) computer software package. This shows that the beach contours recorded in November 2010 were relatively consistent across the frontage, with a slight accumulation of material directly in the lee of the German Charlies slag banks, and that the foreshore was relatively featureless across its inter-tidal width.

The GIS has also been used to calculate the differences between the current topographic survey and the earlier (September 2009) topographic survey, as shown in Appendix B – Map 1b, to identify areas of erosion and accretion. Since the previous topographic survey in September 2009 the changes along Coatham Sands can be characterised along two distinct sections. In the north of the frontage, there has been a notable redistribution of sediment, with lowering (generally) along the upper beach and accretion (generally) along the lower beach, representing a flatter profile gradient overall. In the centre and south of the frontage, the net change since September 2009 has been one of foreshore lowering across the entire width of the inter-tidal zone.

Whilst the 6-monthly beach profile transects are designed show typical seasonal behaviour of Coatham Sands, the annual topographic survey is intended to identify longer terms trends of net erosion or accretion. At present the surveys are too short to determine any significant longer term trends, but the changes between September 2009 and November 2010 are characteristic of redistribution of sediment in the northern part of Coatham Sands, but in the southern section there may have been a net loss of sediment from the frontage, rather than purely redistribution, but future datasets will aid in this understanding.
## 2.2 Redcar Sands

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-2010</td>
<td>Beach Profiles:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Redcar Sands is covered by three beach profile lines during the Full Measures survey (RC5 to RC7; Appendix A), with RC7 being approximately on the boundary with the Marske Sands area.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Along RC5 there was a lowering of beach levels within a zone of about 10m wide at the toe of the sea defences, but alternate accretion then lowering then accretion further down the profile, with the rock outcrops identified in the April 2010 survey now being covered with a veneer of sand.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between September 2009 and April 2010 a section of profile RC6 became ‘scalloped’ with liberated material being deposited at the toe of the dunes to form a new foredune. To November 2010 this foreshore remained, but had been eroded landward slightly, with material released partly infilling the scalloped trough in the beach. Further seaward of these changes there was very modest accretion of sand on the mid and lower foreshore.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Profile RC7 generally experienced lowering along its entire length following the accretion that previously occurred between September 2009 and April 2010.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Topographic Survey:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Redcar Sands is covered by a 6-monthly topographic survey, although the survey is contiguous with the Coatham Sands and Marske Sands topographic surveys (which are surveyed annually). Data have been used to create a DGM (Appendix B – Map 2a) using a Geographic Information System (GIS) computer software package. This shows that the general beach contours move inland, and in particular the higher beach contours become intercepted by the sea wall, in the vicinity of the main section of Redcar town. This is the area where a major capital coastal defence scheme is due to commence imminently. Beyond this 600m length, the contours are relatively consistent across the frontage and exhibit a relatively featureless beach form.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The GIS has also been used to calculate the differences between the current topographic survey and the earlier Full Measures (September 2009) topographic survey, as shown in Appendix B – Map 2b, to identify areas of erosion and accretion. Between the previous Full Measures topographic survey in Where 6-monthly survey data is available, it has shown that whilst there appears to be a notable difference between the September 2009 and November 2010 surveys, the processes of most upper beach drawdown occurred between September 2009 and April 2010 (a characteristic winter profile response to the increased wave climate) with subsequent redistribution of material from the lower profile to the upper between April 2010 and November 2010 (a classic summer profile response to the more ‘constructive’ wave action leading to upper beach build up).</td>
<td></td>
</tr>
</tbody>
</table>
September 2009 and the current November 2010 survey, there has been a general lowering of upper foreshore levels along the main town frontage, with some of the liberated sediment being deposited on the lower foreshore to present a flatter overall gradient. Along The Stray the changes were more modest but also generally involved redistribution from upper to lower foreshore areas.

The GIS has also been used to calculate the differences between the current topographic survey and the most recent (April 2009) topographic survey, as shown in Appendix B – Map 2c, to identify areas of erosion and accretion. Between the last survey in April 2010 and the current November 2010 survey the pattern of change along the main town frontage was one of erosion of the lower foreshore and accretion along parts of the upper foreshore. Changes along The Stray were relatively modest, although increased towards the southern end at its boundary with Marske Sands (discussed in Section 2.3).
### Marske Sands

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11-2010</strong></td>
<td><strong>Beach Profiles:</strong> Marske Sands is covered by two beach profile lines during the Full Measures survey (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area. RC7 is located along The Stray and has been discussed in Section 2.2. RC8 showed modest redistribution of sediment along the foreshore and general stability in the high backing dunes.</td>
<td>Marske Sands represents a continuation of Redcar Sands and appears to be relatively stable, with changes confined to minor redistribution of sediments across and along the foreshore, rather than any significant net trends of erosion or accretion.</td>
</tr>
<tr>
<td><strong>Topographic Survey:</strong> Marske Sands is covered by an annual topographic survey, although the survey is contiguous with the Redcar Sands and Saltburn Sands topographic surveys (both of which are surveyed 6-monthly). Data have been used to create a DGM (Appendix B – Map 3a) using a Geographic Information System (GIS) computer software package. This shows that the beach contours are relatively consistent across the frontage and exhibit a relatively featureless beach form. The GIS has also been used to calculate the differences between the current topographic survey and the earlier (September 2009) topographic survey, as shown in Appendix B – Map 3b, to identify areas of erosion and accretion. Since the previous topographic survey in September 2009, there has been a general redistribution of sediment from the upper foreshore to the lower, although the process is not as continuous as may be expected. Towards the southern end, at the junction with Saltburn Sands, the lowering becomes greater in magnitude and width across the foreshore, with few areas of corresponding accretion.</td>
<td>There may be a slight tendency for net loss of material towards the southern end of Marske Sands, but in general the frontage shows a redistribution of sediment depending on the prevailing wave and tidal conditions.</td>
<td></td>
</tr>
</tbody>
</table>
## 2.4 Saltburn Sands

<table>
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<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-2010</td>
<td><strong>Beach Profiles:</strong>&lt;br&gt;Saltburn Sands is covered by one beach profile lines during the Full Measures survey (RC9; Appendix A).&lt;br&gt;The survey reveals no significant change since the April 2010 survey and therefore foreshore levels remain relatively low. There was no further lowering at the toe of the sea defence.</td>
<td>The profile along Saltburn Sands shows that beach levels remain at relatively low levels, but generally the variations between maximum and minimum levels along this transect are relatively modest at around only 0.2 – 0.3m.</td>
</tr>
<tr>
<td></td>
<td><strong>Topographic Survey:</strong>&lt;br&gt;Saltburn Sands is covered by a 6-monthly topographic survey, although the survey is contiguous with the Marske Sands topographic survey which is surveyed annually. Data have been used to create a DGM (Appendix B – Map 4a) using a Geographic Information System (GIS) computer software package. This shows that the beach contours are relatively consistent across the frontage, although the highest beach contours do taper out towards the southern end, and that the foreshore exhibits a relatively featureless form. The GIS has also been used to calculate the differences between the current topographic survey and the earlier Full Measures (September 2009) topographic survey, as shown in Appendix B – Map 4b, to identify areas of erosion and accretion. Over this time, foreshore lowering has occurred along almost the entire foreshore (length and width) west of Skelton Beck. However, comparison with the most recent Partial Measures survey in April 2010 (see Update Report (May 2010) Appendix B – Maps 2b and 2c) shows that most of this change occurred over the winter of 2009/10 and since April 2010 the foreshore has exhibited little net change.</td>
<td>West of Skelton Beck the foreshore exhibited lowering over the winter of 2009/10 but relatively stability since then to November 2010.</td>
</tr>
</tbody>
</table>
## 2.5 Cattersty Sands

<table>
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<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-2010</td>
<td>Topographic Survey:</td>
<td>The difference model shows this to be a dynamic area, influenced by both marine and fluvial processes; there is a marked difference in beach levels and beach behaviour on either side of the Jetty. The difference in behaviour may be partly attributed to the presence of the river to the east of the Jetty. To the west subtle seasonal shore parallel variability is identifiable. In contrast, in the east, fluvial impacts do not run parallel to the shoreline, resulting in different patterns of beach/river mouth change.</td>
</tr>
<tr>
<td></td>
<td>Cattersty Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 5a) 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 (November 2010) and the earlier (February 2010) topographic survey DGM, with better than 5 m raster grids (as shown in Appendix B – Map 5b), to identify areas of erosion and accretion. This figure reveals different patterns of beach change either side of the Jetty. Cattersty Sands to the west generally shows a sequence of shore-parallel change. At the head of the beach a narrow band of accretion dominates, as is typical of summer behaviour at this location. However, seawards there are marked bands of erosion and less extensive accretion, perhaps indicating the onset of beach drawdown typical of the winter season. To the east of the Jetty the upper beach has generally trended towards sediment loss over the period of comparison, whilst the inter-tidal zone has experienced accretion. As the river flows across the beach it produces a complex signal of change, with a trend towards erosion.</td>
<td></td>
</tr>
</tbody>
</table>
## Staithes

<table>
<thead>
<tr>
<th>Survey Date</th>
<th>Description of Changes Since Last Survey</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>09-2010</td>
<td>Cliff Top Survey: Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring (Appendix C – Map 1). 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 September 2009 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.</td>
<td>When survey accuracy is taken into consideration, ten of the twenty points have shown no change since the November 2008 survey, indicating local stability of the cliff face. Three locations (points 1, 4, 13) have shown cliff line recession ranging 0.2- 2.1 m (±0.1 m due to survey accuracy). Points 4 and 13 have consistently registered cliff erosion in each full and partial measures report to date. Less consistent, but repeated, recession measurements are also determined for points 1, 2, &amp; 5. These survey locations are principally located in the west adjacent to Cow Bar Lane. The specific processes responsible for this recessional change would need to be determined by a dedicated field inspection. Seven locations (points 3, 9, 10, 12, 16, 17, 19) have shown an increase in distance to the cliff edge (0.2- 1.5 m). It is noted that points 3, 10, 12 (all in the west) have consistently registered an advancing cliff line. Less consistent, but repeated, cliff advance measurements are also determined for points 9, 16, 17, &amp; 19. Whilst possibly representing a toppling failure the far more likely scenario is different interpretation of the cliff edge between comparative surveys.</td>
</tr>
</tbody>
</table>
3. **Problems Encountered and Uncertainty in Analysis**

There were no major problems encountered during the surveys.

The cliff top surveys at Staithes are assumed to have a limit of accuracy of ± 0.1m due to the techniques used. At a number of locations apparent cliff advance has been calculated, which is highly unlikely, excepting a toppling mechanism of failure. It is more likely that this is due to a different point being identified as the edge of the cliff, especially with different seasonal vegetation covers. This problem remains marked at Staithes, which may reflect a particular site condition, which requires further investigation (ideally by a cliff geomorphologist).

4. **Recommendations for ‘Fine-tuning’ the Monitoring Programme**

Specifically at Cowbar Lane, Redcar & Cleveland Borough Council is hoping to obtain Environment Agency funding to enable more detailed and more precise laser scanning of the cliffs at this location. This information would provide a more robust assessment of change in the cliff top position and behaviour of the cliff face.

5. **Conclusions and Areas of Concern**

- The northern section of Coatham Sands remains well sheltered against waves by the South Gare Breakwater and to a lesser extent German Charlie’s slag banks. In the southern section of Coatham Sands there may have been a net loss of sediment from the frontage, rather than purely redistribution, but future datasets will aid in this understanding.

- There appears to have been a classic summer profile response to the more ‘constructive’ wave action operating since the previous survey in April 2010 along Redcar Sands. This has led to upper beach build up along some parts of the frontage.

- There may have been a slight tendency for net loss of material towards the southern end of Marske Sands, but in general the frontage shows a redistribution of sediment depending on the prevailing wave and tidal conditions.

- West of Skelton Beck, the Saltburn Sands foreshore exhibited lowering over the winter of 2009/10 but relatively stability since then to November 2010.

- Cattersty Sands (Skinningrove) shows beach change typical of seasonal (summer and winter) marine processes to the west of the Jetty, and also depicts the influence of the outflowing river in the east. The patterns of beach change are therefore more complicated than would be anticipated by coastal processes alone.

- The Staithes frontage has shown areas of localised cliff top stasis, advance (either toppling failure or erroneous survey), and recession. Hotspots for cliff top retreat at this time are principally to the west adjacent to Cowbar Lane, and more locally the cliff west of Penny Steel.
Appendix A

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Mud</td>
</tr>
<tr>
<td>S</td>
<td>Sand</td>
</tr>
<tr>
<td>G</td>
<td>Gravel</td>
</tr>
<tr>
<td>GS</td>
<td>Gravel &amp; Sand</td>
</tr>
<tr>
<td>GM</td>
<td>Gravel &amp; Mud</td>
</tr>
<tr>
<td>MS</td>
<td>Mud &amp; Sand</td>
</tr>
<tr>
<td>B</td>
<td>Boulders</td>
</tr>
<tr>
<td>R</td>
<td>Rock</td>
</tr>
<tr>
<td>SD</td>
<td>Sea Defence</td>
</tr>
<tr>
<td>SM</td>
<td>Salt Marsh</td>
</tr>
<tr>
<td>GR</td>
<td>Grass</td>
</tr>
<tr>
<td>D</td>
<td>Dune (non-vegetated)</td>
</tr>
<tr>
<td>DV</td>
<td>Dune (vegetated)</td>
</tr>
<tr>
<td>F</td>
<td>Forested</td>
</tr>
<tr>
<td>X</td>
<td>Mixture</td>
</tr>
<tr>
<td>FB</td>
<td>Obstruction</td>
</tr>
<tr>
<td>CT</td>
<td>Cliff Top</td>
</tr>
<tr>
<td>CE</td>
<td>Cliff Edge</td>
</tr>
<tr>
<td>CF</td>
<td>Cliff Face</td>
</tr>
<tr>
<td>SH</td>
<td>Shell</td>
</tr>
<tr>
<td>W</td>
<td>Water Body</td>
</tr>
<tr>
<td>ZZ</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Appendix B

Topographic Survey
DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Sept 2009 and Nov 2010
Change in Elevation (m OD)

Gain

Change < 0.1m

Loss

> 2.0
1.75 - 2.0
1.5 - 1.75
1.25 - 1.5
1.0 - 1.25
0.75 - 1.0
0.5 - 0.75
0.25 - 0.5
0.1 - 0.25
0.0 - 0.1
-0.1 - 0.0
-0.25 - -0.1
-0.5 - -0.25
-0.75 - -0.5
-1.0 - -0.75
-1.25 - -1.0
-1.5 - -1.25
-1.75 - -1.5
-2.0 - -1.75
< -2.0

< 0.1 - 0.0

> 2.0
1.75 - 2.0
1.5 - 1.75
1.25 - 1.5
1.0 - 1.25
0.75 - 1.0
0.5 - 0.75
0.25 - 0.5
0.1 - 0.25
0.0 - 0.1
-0.25 - -0.1
-0.5 - -0.25
-0.75 - -0.5
-1.0 - -0.75
-1.25 - -1.0
-1.5 - -1.25
-1.75 - -1.5
-2.0 - -1.75
< -2.0

Analytical Report 3
‘Full Measures’ Survey 2010

Appendix B - Map 1b
Redcar & Cleveland Borough Council Frontage

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

Drawing Scale 1:20,000 at A4

Drawn by: TC
Checked by: NC
Approved by: NC

Date: 29/11/2010

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Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk
DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Sept 2009 and Nov 2010

Change in Elevation (m OD)

Gain

> 2.0
1.75 - 2.0
1.5 - 1.75
1.25 - 1.5
1.0 - 1.25
0.75 - 1.0
0.5 - 0.75
0.25 - 0.5
0.1 - 0.25
0.0 - 0.1
-0.1 - 0.0
-0.25 - -0.1
-0.5 - -0.25
-0.75 - -0.5
-1.0 - -0.75
-1.25 - -1.0
-1.5 - -1.25
-1.75 - -1.5
-2.0 - -1.75
< -2.0

Loss

Redcar & Cleveland Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:17,000 at A4

Drawn by: TC     Date: 29/11/2010
Checked by: NC     Date: 29/11/2010
Approved by: NC     Date: 06/12/2010

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

Appendix B - Map 2b
Redcar & Cleveland Borough Council Frontage
DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Sept 2009 and Nov 2010

Change in Elevation (m OD)

Gain

Loss

< 0.1m

> 2.0

1.75 - 2.0

1.5 - 1.75

1.25 - 1.5

1.0 - 1.25

0.75 - 1.0

0.5 - 0.75

0.25 - 0.5

0.1 - 0.25

0.0 - 0.1

-0.1 - 0.0

-0.25 - -0.1

-0.5 - -0.25

-0.75 - -0.5

-1.0 - -0.75

-1.25 - -1.0

-1.5 - -1.25

-1.75 - -1.5

-2.0 - -1.75

< -2.0

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

Appendix B - Map 3b
Redcar & Cleveland Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:18,000 at A4

Drawn by: TC Date: 29/11/2010
Checked by: NC Date: 29/11/2010
Approved by: NC Date: 06/12/2010

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Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk
Appendix C
Cliff Top Survey
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 100 m.

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 September 2010 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

<table>
<thead>
<tr>
<th>Ground Control Point Details</th>
<th>Distance to Cliff Top (m)</th>
<th>Total Erosion (m)</th>
<th>Erosion Rate (m/year)</th>
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</thead>
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<td>Northing</td>
<td>Level (mODN)</td>
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<td>-----</td>
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</tr>
<tr>
<td>1</td>
<td>477228</td>
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<td>60.587</td>
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<td>2</td>
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<td>518798</td>
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<td>47.108</td>
</tr>
<tr>
<td>20</td>
<td>479274</td>
<td>518618</td>
<td>44.243</td>
</tr>
</tbody>
</table>

**Note:** It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.
Appendix C - Map 1
Redcar & Cleveland Borough Council Frontage
Analytical Report 3 'Full Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawing by: AW
Checked by: RJ
Approved by: RJ

Date: 01/12/2010

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

Ground Control Points

Scale: 1:10,000

519000
518500
518000
517500
517000
516500
516000
515500
515000
514500
514000
513500
513000
512500
512000
511500
511000
510500
510000
509500

0 125 250 500 Metres

477500 478000 478500 479000
479500 480000 480500 481000

Runswick
Staithes
Whitby
Lythe