



**Cell 1 Regional Coastal Monitoring Programme
Analytical Report 1: 'Full Measures' Survey 2008**



**Redcar & Cleveland
Borough Council
Final Report**

May 2009

Contents

Abbreviations and Acronyms
Glossary of Terms

Preamble	i
1. Introduction.....	1
1.1 Study Area	1
1.2 Methodology.....	1
2. Analysis of Survey Data	8
2.1 Coatham Sands	8
2.2 Redcar Sands	9
2.3 Marske Sands	10
2.4 Saltburn Sands.....	11
2.5 Cattersty Sands.....	11
2.6 Staithes	12
3. Problems Encountered and Uncertainty in Analysis.....	13
4. Recommendations for 'Fine-tuning' the Monitoring Programme	13
5. Conclusions and Areas of Concern	13

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

Abbreviations and Acronyms

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

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 till to varying thicknesses, softer rock cliffs, and extensive landslide complexes.

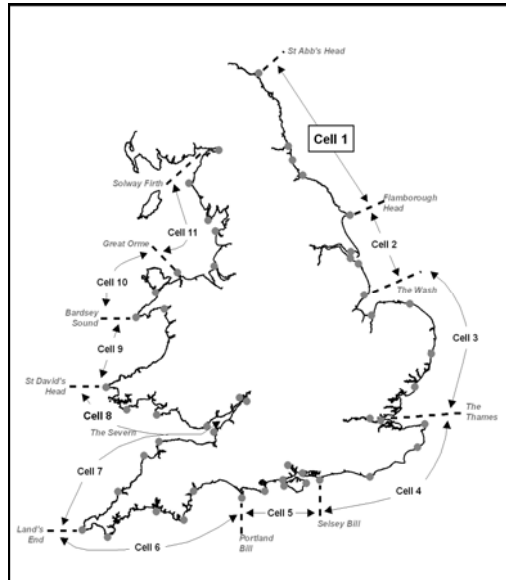


Figure 1 Sediment Cells in England and Wales

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:



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		-

^(*) The present report is **Analytical Report 1** and provides an analysis of the 2008 'baseline' 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 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
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

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 bi-annually at:
 - Staithes

The location of these surveys is shown in Figure 2. Also enclosed on the accompanying CD-rom is a file which can be opened in Google Earth showing the locations of the surveys.

The baseline Full Measures survey was undertaken along this frontage in November 2008. During the surveys at Coatham Sands, Redcar Sands, Marske Sands and Saltburn Sands the weather conditions were fair but wet, with a fairly rough sea state. During the Cattersty Sands survey the weather was fine, with a calm sea. Conditions were windy with rain and snow and a rough sea state during the Staithes survey.

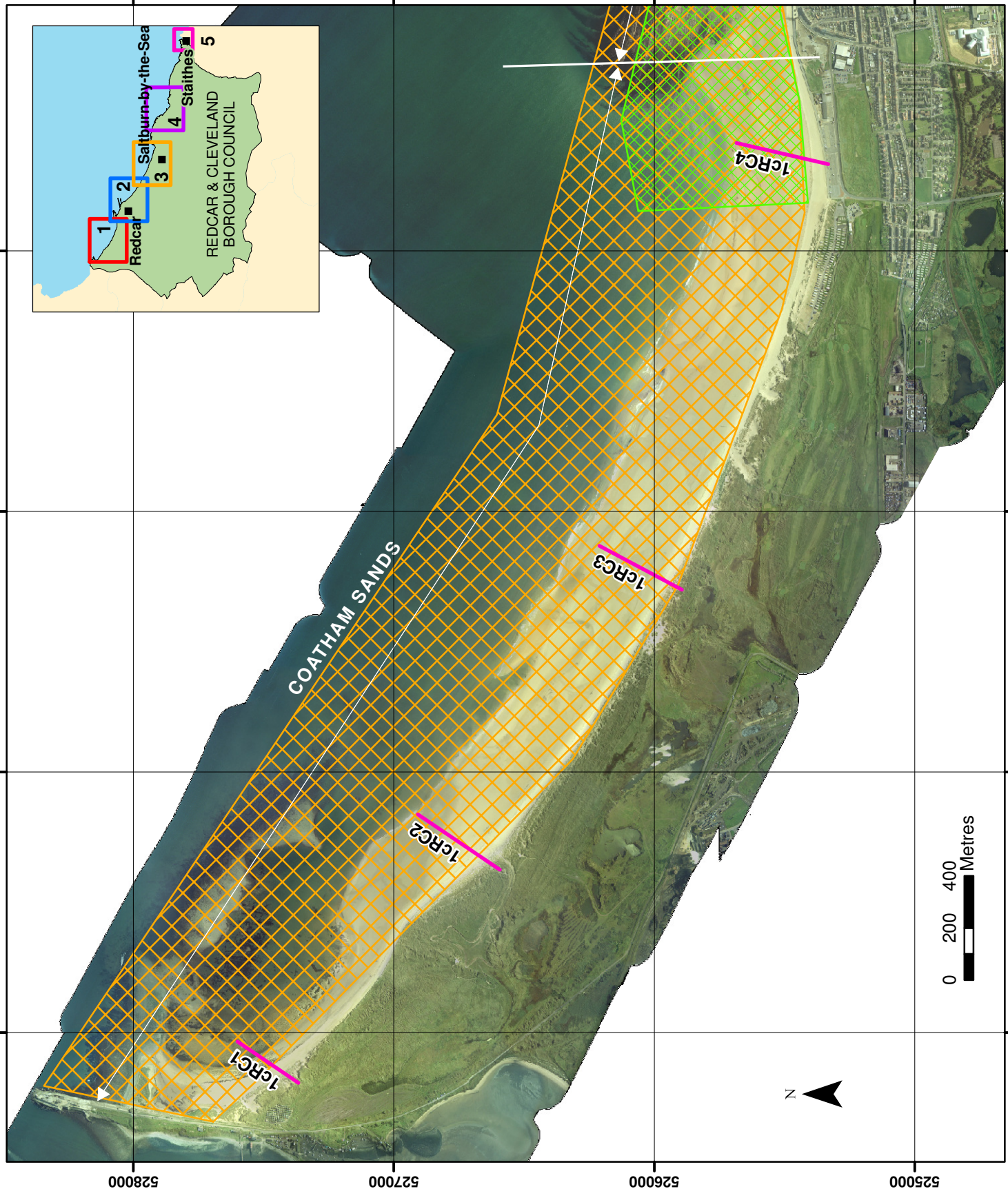
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and Arc-GIS. This 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.



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 1
 Redcar & Cleveland
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:20,000 at A4
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 Checked by: NC Date: 08/05/2009
 Approved by: NC Date: 08/05/2009

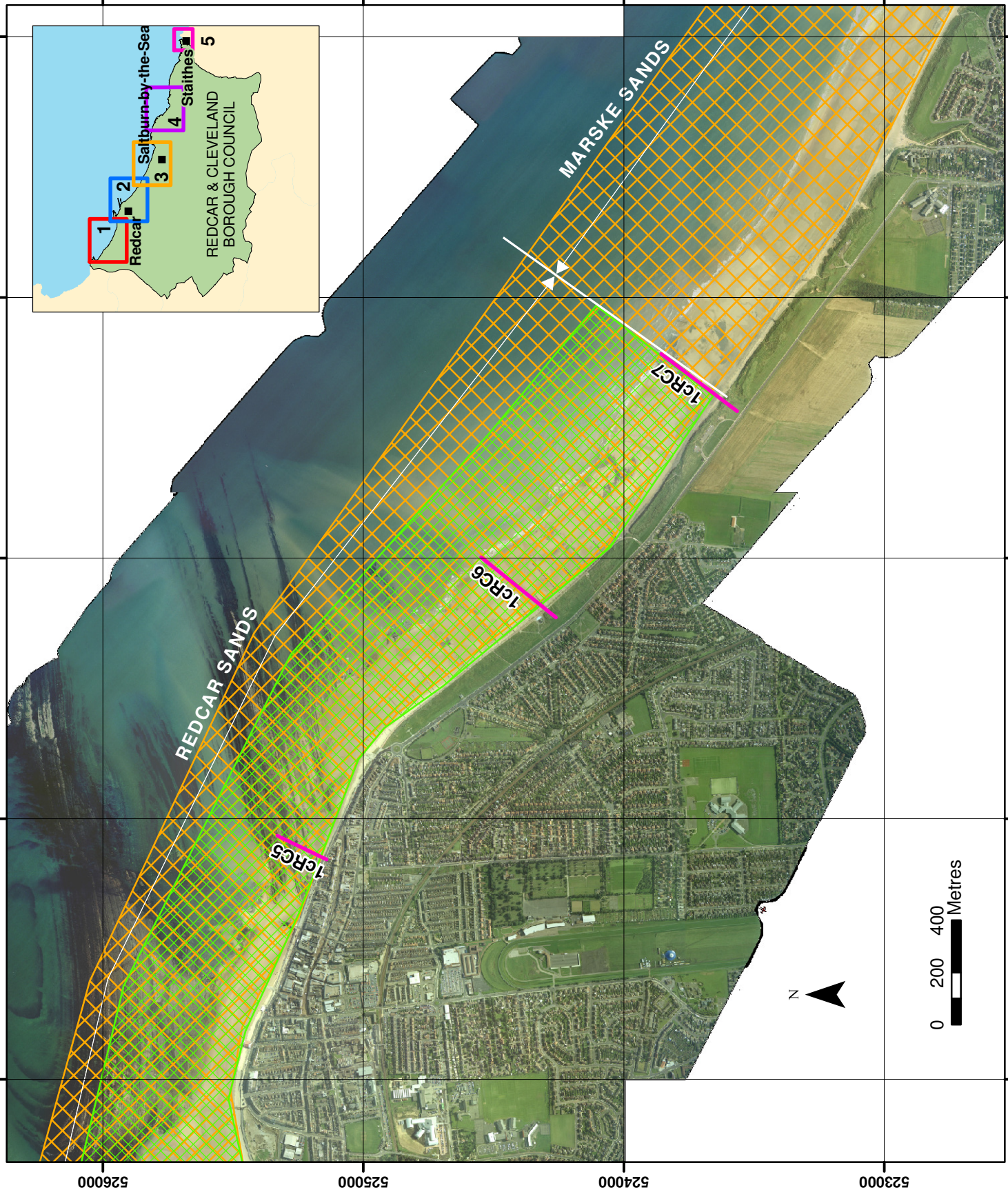
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SURVEY LOCATIONS

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 2
 Redcar & Cleveland
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

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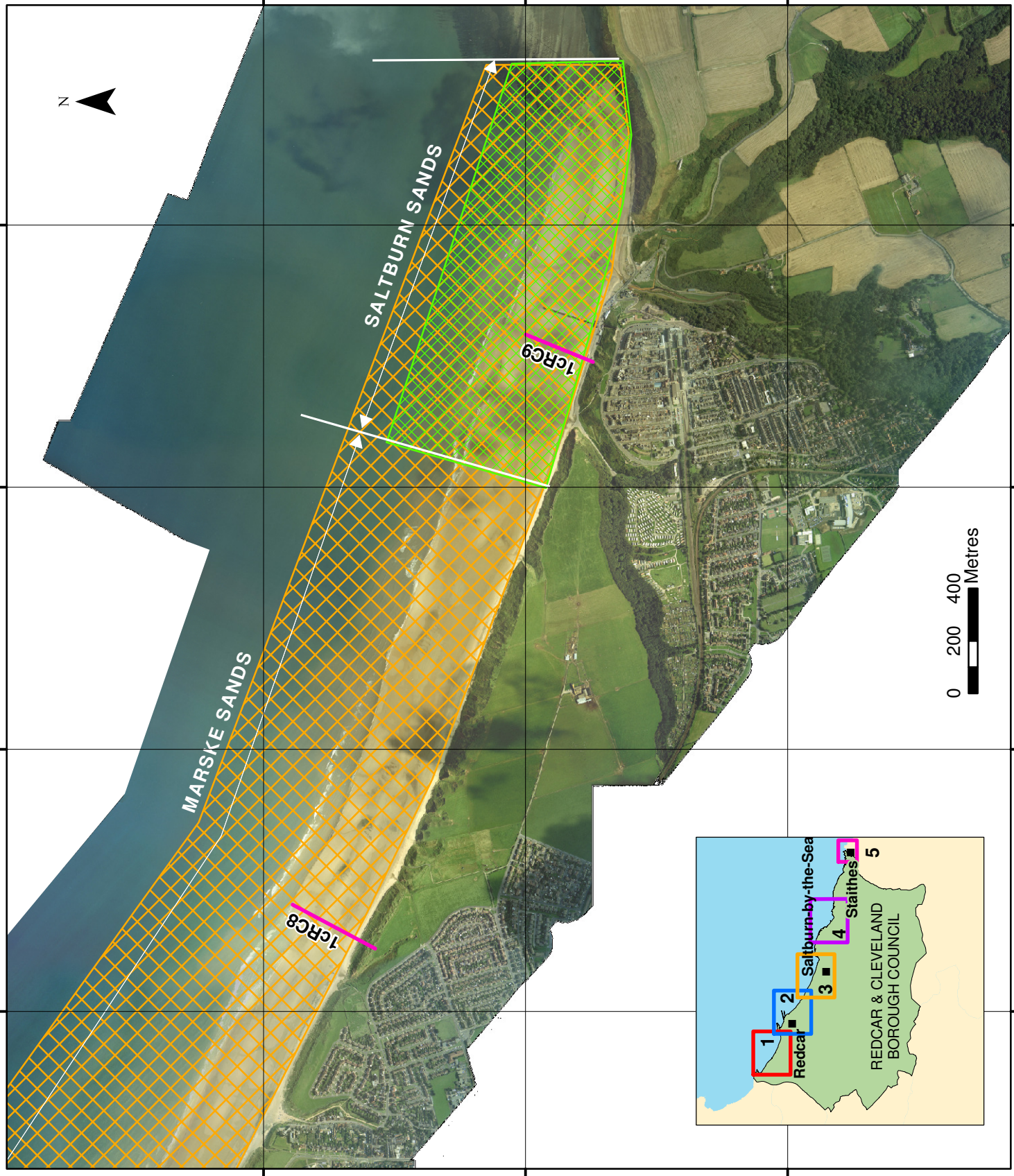


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SURVEY LOCATIONS

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 1
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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 4
Redcar & Cleveland
Borough Council Frontage

Analytical Report 1
 'Full Measures' Survey 2008

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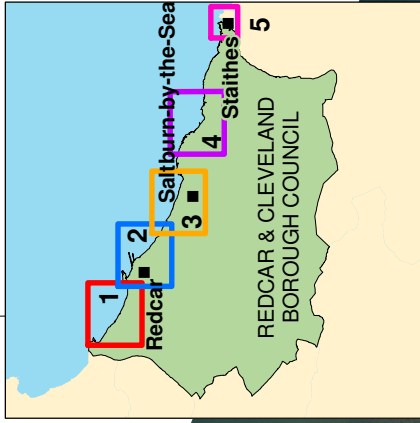
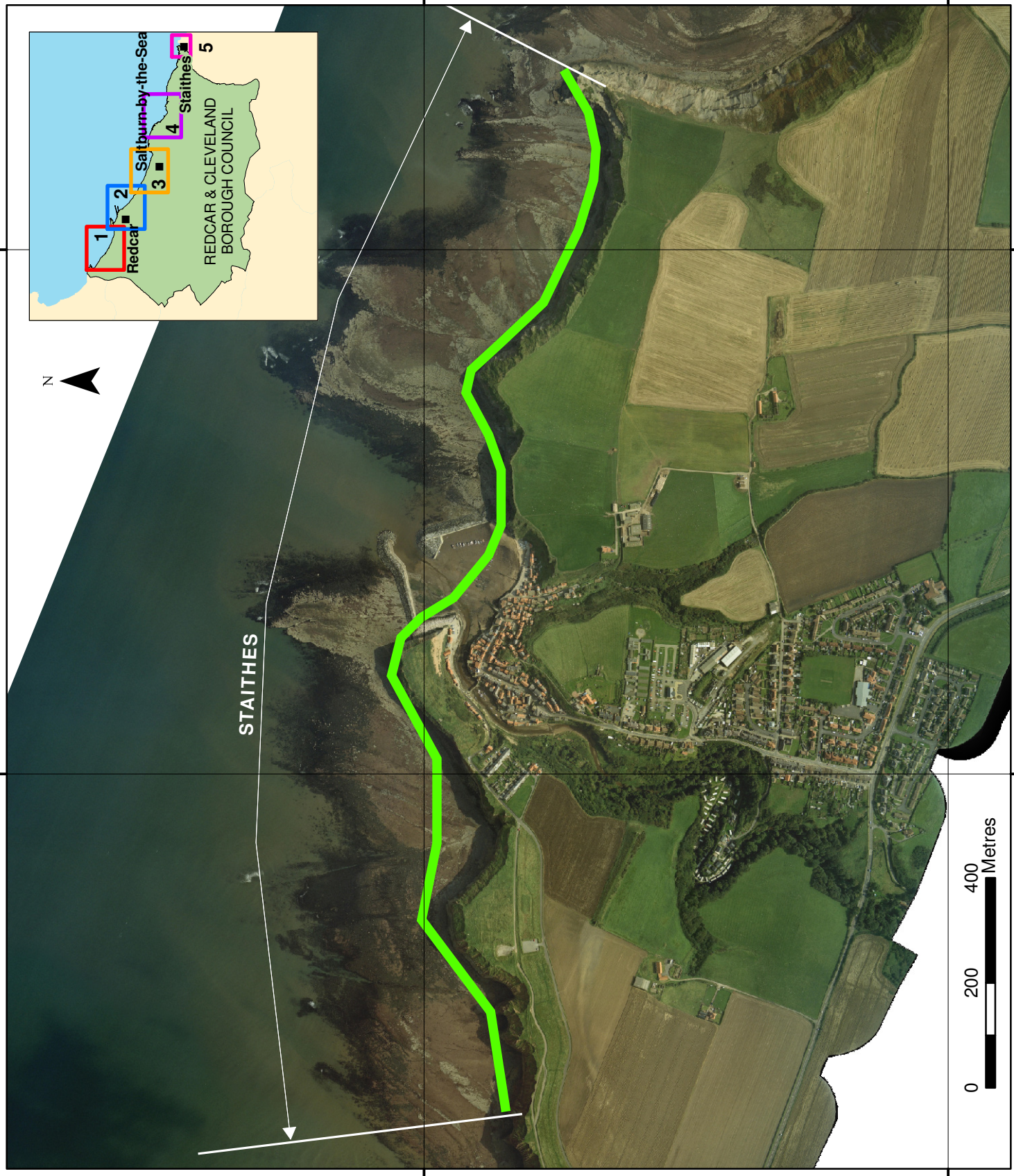
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SURVEY LOCATIONS

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 5
 Redcar & Cleveland
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

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2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>Coatham Sands is covered by four beach profiles (RC1 to RC4; Appendix A).</p> <p>RC1 is located approximately 300m south of the South Gare Breakwater, immediately in the lee of the German Charlies. Here the profile starts at the rear of the dunes and extends across them, reaching a peak height of 7.0mODN before dropping in level down to the low water mark at the time of the survey. There is a notable berm at a chainage of around 110m, which coincides approximately with HAT level.</p> <p>RC2 is just over 1km south of RC1. Here the profile starts landward of the narrow fronting dune crest, which peaks at an elevation of 6.1mODN. There is a reasonable beach level at the toe of the dunes and a relatively uniform gradient down the profile to low water.</p> <p>RC3 has two dune ridges, with the crest of the landward ridge at 9.1mODN and the crest of the fronting ridge at 7.8mODN. There is a reasonable beach level at the toe of the dunes and a wide but low berm formed between chainages of 125m and 230m.</p> <p>RC4 is at the southern end of Coatham Sands, close to Coatham Rocks. The profile line starts on the Coach and Car Park and extends across the seawall, which has a crest level of 6.2mODN. There is a near-vertical drop to beach level and then a relatively uniform gradient down to low water mark at the time of the survey.</p>	<p>The northern section of Coatham Sands, as represented by RC1, is sheltered against waves from all but north-easterly and easterly directions due to the presence of the South Gare Breakwater and German Charlies slag banks. Waves from the north-east and east would tend to push sediment towards more sheltered locations in the lee of these features where it probably would accumulate.</p> <p>The main frontage of Coatham Sands is developed between the controlling features of the German Charlies and the Coatham Rocks. The foreshore is relatively featureless and possesses a comparatively uniform cross-shore gradient along its length. It will be important to monitor here for signs of rolling-back of the beach and dune system due to sea level rise.</p> <p>The southern section of Coatham Sands, as represented by profile RC4, is sheltered against waves from east of north by Coatham Rocks.</p>
	<p>Topographic Survey:</p> <p>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 1).</p> <p>The DGM shows how the German Charlies slag banks draw the shoreline seaward and provide protection to the foreshore in their lee. In particular, accumulation is greatest in the pocket formed at the</p>	

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>junction of the South Gare Breakwater and the German Charlies and here vegetation has established.</p> <p>Between the eastern limit of the German Charlies slag banks and the rock outcrops of Coatham Rocks, a shallow dune-backed bay has developed. This has a relatively featureless foreshore and comparatively uniform cross-shore gradient along its length.</p>	

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>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.</p> <p>RC5 extends across the concrete crest wall fronting the Esplanade. This reaches a crest level of 7.1mODN. There is then a drop of some 5.5m to beach level, down the sloping face of the concrete revetment. The lower section of this revetment will be influenced by marine processes during most high tides due to these very low beach levels at its toe. The Redcar Rocks appear at the seaward end of the profile.</p> <p>RC6 is located along The Stray amenity land which separates the Coast Road from the sea. The profile starts across the dunes at the seaward side of the promenade before dropping initially quite steeply across the beach. The foreshore is relatively featureless.</p> <p>RC7 is also along The Stray, but here the dunes are higher, reaching around 10.3mODN before dropping quite steeply to beach level. The beach then drops gradually to low water level.</p> <p>Topographic Survey:</p> <p>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 2).</p>	<p>Redcar Sands is partially protected by the outcrops named Coatham Rocks and Redcar Rocks which both tend to locally retain sand in their lee. In between these outcrops, however, the shoreline is more exposed and beach levels are relatively low, resulting in direct tidal and wave loading on the seawall fronting the Esplanade. This area, together with adjacent frontages, is currently under investigation for capital coastal defence works.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>From this DGM the main aspect that immediately can be identified is how the beach levels drop dramatically in front of Redcar. This leads to the Esplanade sea wall intercepting high water. The shoreline is drawn seaward in the lee of rock outcrops before narrowing along The Stray.</p>	

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>Marske Sands is covered by two beach profiles (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area.</p> <p>RC7 is located along The Stray and has been discussed in Section 2.2.</p> <p>RC8 is located approximately 150m south of Church Howle and drops from the dune crest of 22mODN down to beach level over some 60m width. There is then a relatively uniform gradient down to low water.</p> <p>Topographic Survey:</p> <p>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 – Maps 2 and 3).</p> <p>Marske Sands has a relatively featureless foreshore and comparatively uniform cross-shore gradient along its length. Beach widths are narrower than along Coatham Sands, but wider than along Redcar Sands.</p>	<p>Marske Sands represents an unconstrained beach and dune system and is expected to show a degree of seasonal variability in beach form and, in the longer term, may exhibit signs of roll-back under rising sea levels.</p>

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
11-2008 (Baseline)	<p>Beach Profiles:</p> <p>Saltburn Sands is covered by one beach profile (RC9; Appendix A).</p> <p>RC9 is located approximately 150m north of Saltburn Pier. The profile line extends across the promenade to the seaward edge where it has a crest level of 5.2mODN. There is then a vertical drop of some 2.0m down the sea wall to beach level and a gradual drop in levels down to the low water mark at the time of the survey.</p>	Saltburn Sands represents a more constrained beach and dune system and is expected to show a degree of seasonal variability in beach form and potentially lowering at the toe of the defence.
	<p>Topographic Survey:</p> <p>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 3).</p> <p>Saltburn Sands represents a continuation of Marske Sands and exhibits similar characteristics, with relatively uniform cross-shore gradients.</p>	

2.5 Cattersty Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
11-2008 (Baseline)	<p>Topographic Survey:</p> <p>Cattersty Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 4).</p> <p>This DGM shows different beach morphologies either side of the Jetty. To the west of the Jetty Cattersty Sands is a uniform concave beach, with higher beach levels below Cattersty Cliff where dunes exist. The high point at the Jetty relates to this structure rather than the beach surface. To the east of the Jetty the beach topography is generally of lower gradient but more complex. Higher elevations near the river</p>	The beach sediment dynamics at Cattersty Sands are subject to multiple influences, which account for the spatially variable and complex patterns observed. Factors probably include: the shoreline Jetty which appears to regulate along shore sediment transfer, coastal rock armour defences, and the outflowing river. Variations in these factors will account for modification of the beach topography.

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>mouth are associated with rock armour defences. Also apparent are the incised channels of the river, and a scour pool immediately to the east of the Jetty.</p> <p>This DGM will be used as a baseline against which future topographic surveys will be compared on an annual basis to identify areas of accretion and erosion.</p>	

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Cliff Top Survey:</p> <p>Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is typically around 100m (although occasionally less). The cliff top surveys are to be undertaken bi-annually and will involve a distance offset measurement from the ground control point to the cliff edge along a fixed bearing.</p> <p>Appendix C provides results from 2008 (baseline) survey, and shows the position from the ground control point to the edge of the cliff top along the defined bearing (Appendix C - Map 1). Future reports will show results from subsequent surveys and provide a means of addressing erosion since the baseline survey.</p>	<p>No change can be currently reported. However, this area, particularly at Cowbar Lane, is prone to significant cliff recession. These measurements will help manage risks posed by cliff instability, and may in due course assist in the evaluation of climate change impacts.</p>

3. Problems Encountered and Uncertainty in Analysis

There were no major problems encountered during the surveys, although the topographic surveys along Coatham Sands, Redcar Sands, Marske Sands and Saltburn Sands covered extensive areas and therefore were time-consuming to conduct.

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

- Some cliffline recession hotspots at Staithes are not captured by ground point locations, e.g. between points 2 and 3. The distribution of survey locations, or the addition of extra survey locations should be considered.

5. Conclusions and Areas of Concern

- The northern section of Coatham Sands is sheltered against waves from all but north-easterly and easterly directions due to the presence of the South Gare Breakwater and German Charlies slag banks.
- The main frontage of Coatham Sands is relatively featureless and possesses a comparatively uniform cross-shore gradient along its length. It will be important to monitor here for signs of rolling-back of the beach and dune system due to sea level rise.
- Redcar Sands is partially protected by the outcrops named Coatham Rocks and Redcar Rocks which both tend to locally retain sand in their lee. In between these outcrops, however, the shoreline is more exposed and beach levels are relatively low, resulting in direct tidal and wave loading on the seawall fronting the Esplanade. Due to this, Redcar Sands is the area of principal concern along this frontage.
- Marske Sands represents an unconstrained beach and dune system and is expected to show a degree of seasonal variability in beach form and, in the longer term, may exhibit signs of roll-back under rising sea levels.
- Saltburn Sands represents a more constrained beach and dune system and is expected to show a degree of seasonal variability in beach form and potentially lowering at the toe of the defence.
- Cattersty Sands (Skinningrove) is a beach with different morphologies up and down drift of the Jetty. Controls on beach topography are multiple and complex. The beach to the east of the Jetty is more likely to show degradational change.
- The Staithes frontage is known to experience significant cliff instability, particularly to the west at Cowbar Lane. Continued monitoring is warranted, and could be improved with the addition of further ground control points along Cowbar Lane.

Appendices

Appendix A
Beach Profiles

Beach Profile

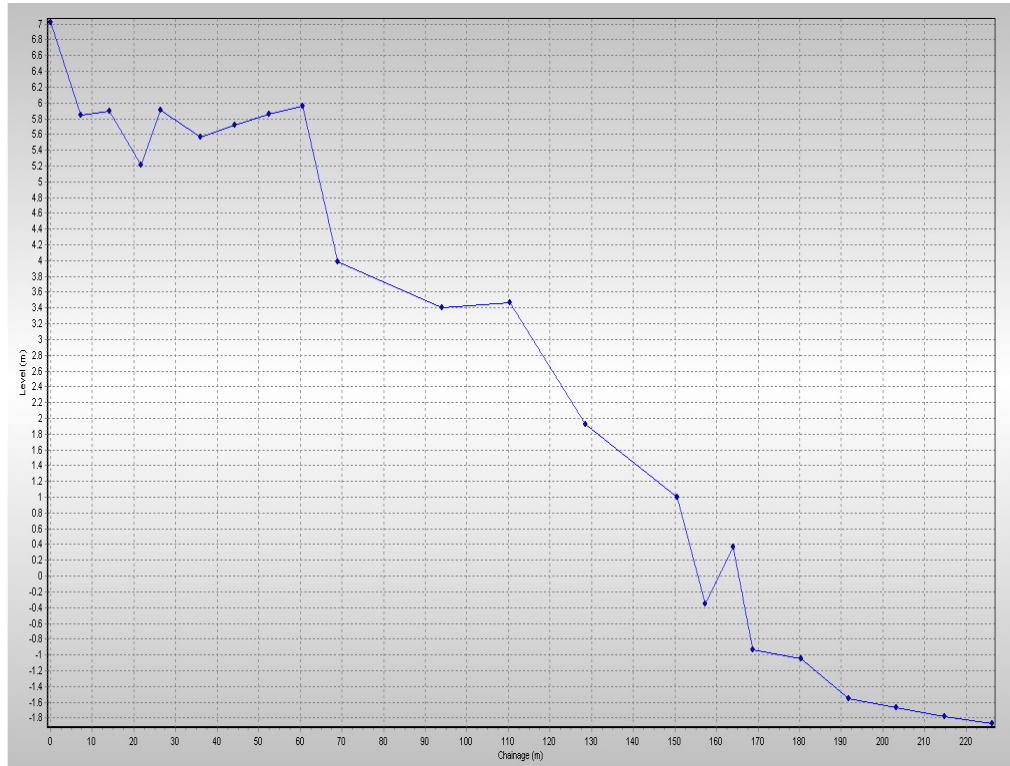
1cRC1

Date 17/11/2008 Inspector RH
Wind Light Sea State
Summary

Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 455811.440 Northing 527373.400 Bearing 34

Chainage	Level
0.000	7.021
7.154	5.842
14.179	5.892
21.666	5.212
26.363	5.914
35.943	5.562
44.288	5.718
52.565	5.857
60.538	5.960
69.024	3.988
94.066	3.400
110.360	3.469
128.470	1.923
150.550	1.002
157.274	-0.358
163.974	0.374
168.774	-0.934
180.274	-1.051
191.774	-1.550
203.274	-1.663
214.773	-1.784
226.273	-1.871



Beach Profile

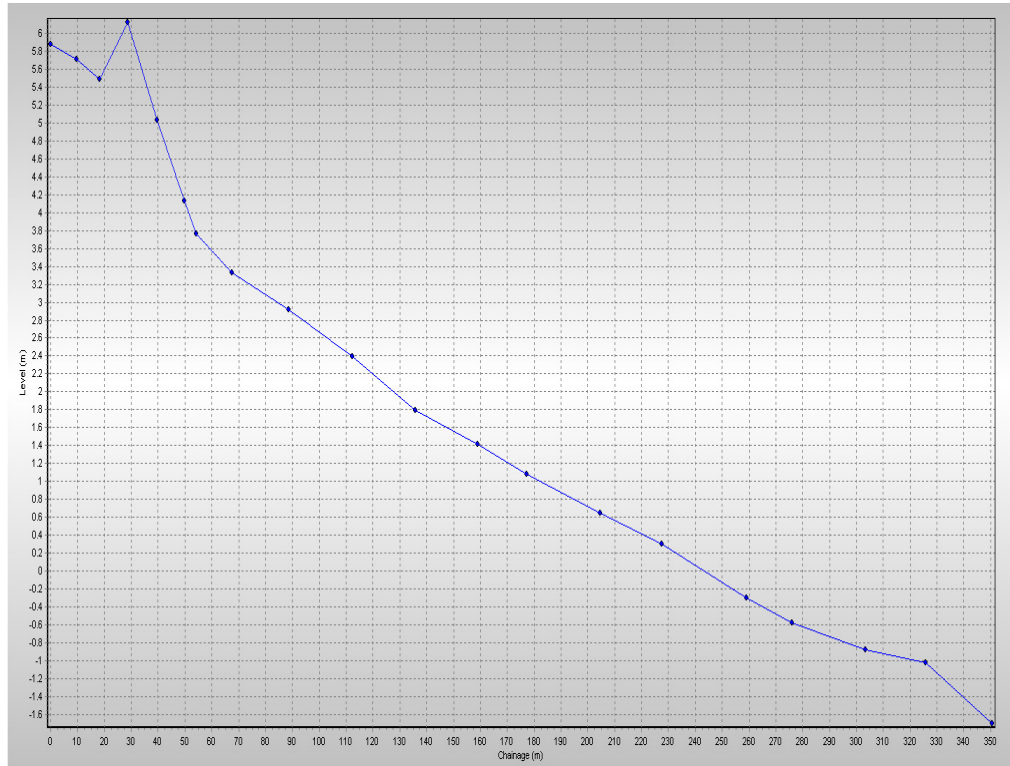
1cRC2

Date 17/11/2008 **Inspector** RH
Wind Light **Sea State**
Summary

Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 456633.250 **Northing** 526599.580 **Bearing** 34

Chainage	Level
0.000	5.873
9.706	5.705
18.259	5.483
28.594	6.122
39.591	5.030
49.740	4.128
54.195	3.758
67.612	3.334
88.615	2.920
112.217	2.392
135.796	1.796
159.068	1.419
177.320	1.080
204.589	0.649
227.546	0.301
259.188	-0.303
275.942	-0.577
303.252	-0.881
325.850	-1.019
350.557	-1.701



Beach Profile

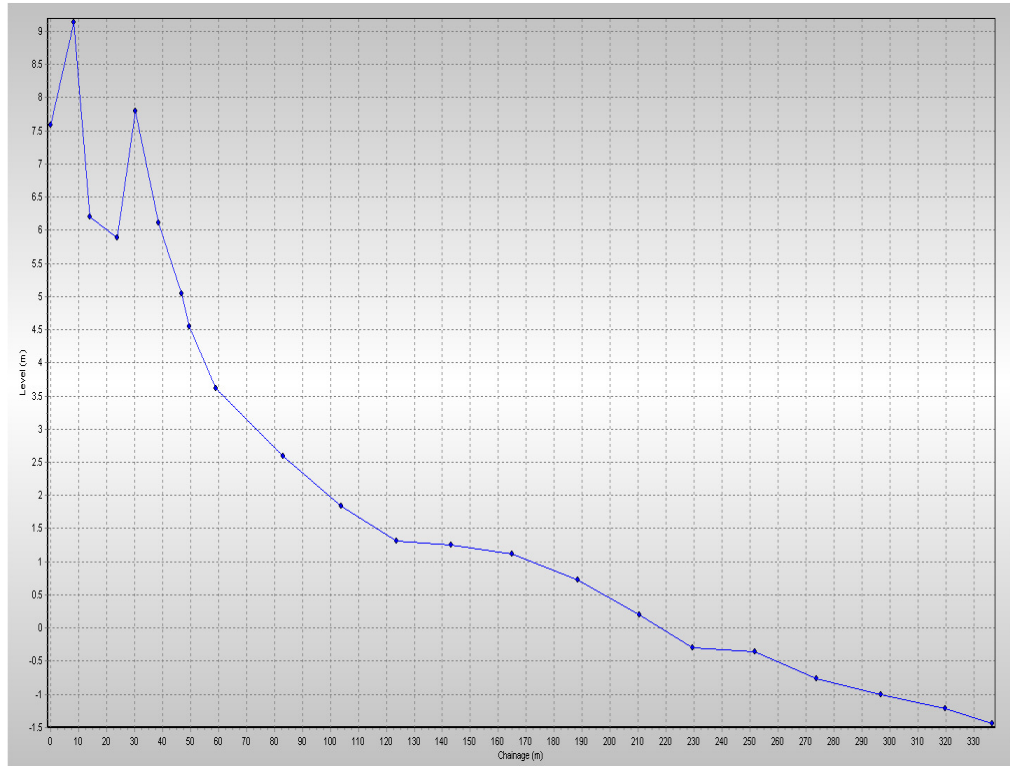
1cRC3

Date 17/11/2008 Inspector RH
Wind Light Sea State
Summary

Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 457706.360 Northing 525898.600 Bearing 28

Chainage	Level
0.000	7.579
8.237	9.136
13.992	6.205
23.756	5.887
30.364	7.792
38.419	6.117
46.880	5.037
49.423	4.541
59.147	3.618
83.102	2.597
103.903	1.835
123.677	1.310
143.214	1.254
164.922	1.117
188.367	0.720
210.496	0.190
229.534	-0.292
251.651	-0.363
273.869	-0.761
296.722	-1.002
319.745	-1.224
336.555	-1.443



Beach Profile

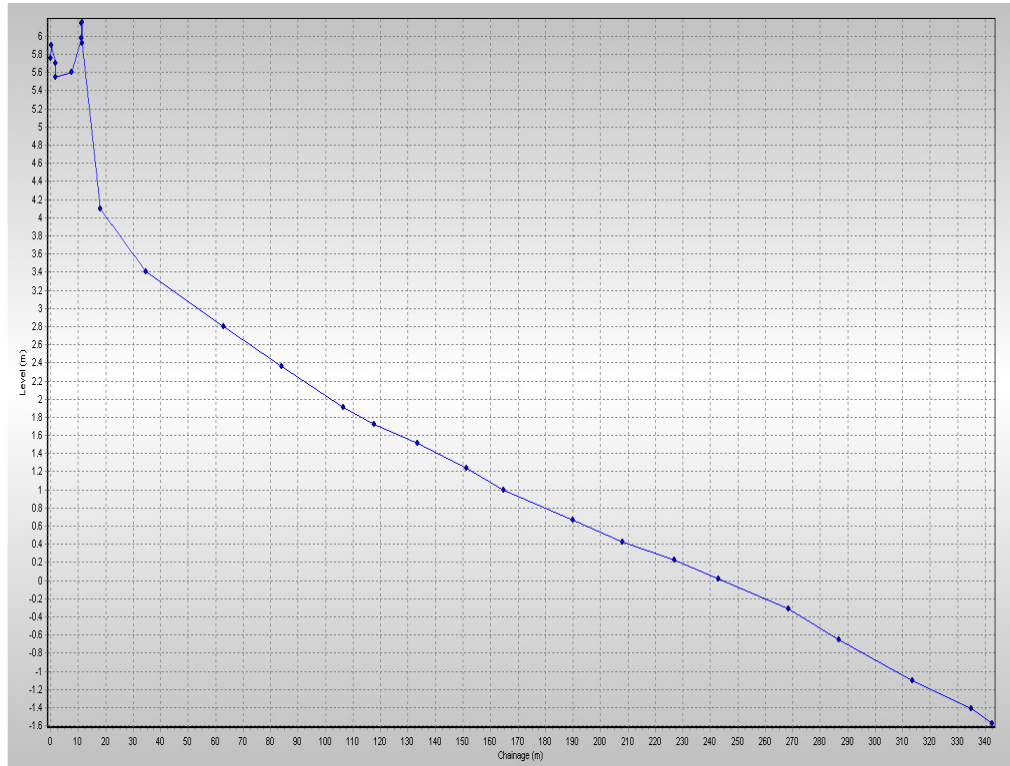
1cRC4

Date 17/11/2008 Inspector RH
Wind Light Sea State
Summary

Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 459337.600 Northing 525336.990 Bearing 13

Chainage	Level
0.000	5.751
0.161	5.904
1.676	5.696
1.884	5.547
7.687	5.600
11.094	5.980
11.152	6.146
11.516	6.152
11.553	5.925
18.139	4.091
34.519	3.399
62.939	2.794
84.137	2.354
106.362	1.913
117.582	1.718
133.447	1.516
151.397	1.242
164.864	0.996
189.975	0.670
208.083	0.425
227.046	0.225
243.011	0.020
268.317	-0.312
286.667	-0.648
313.550	-1.099
334.950	-1.411
342.544	-1.576



Beach Profile

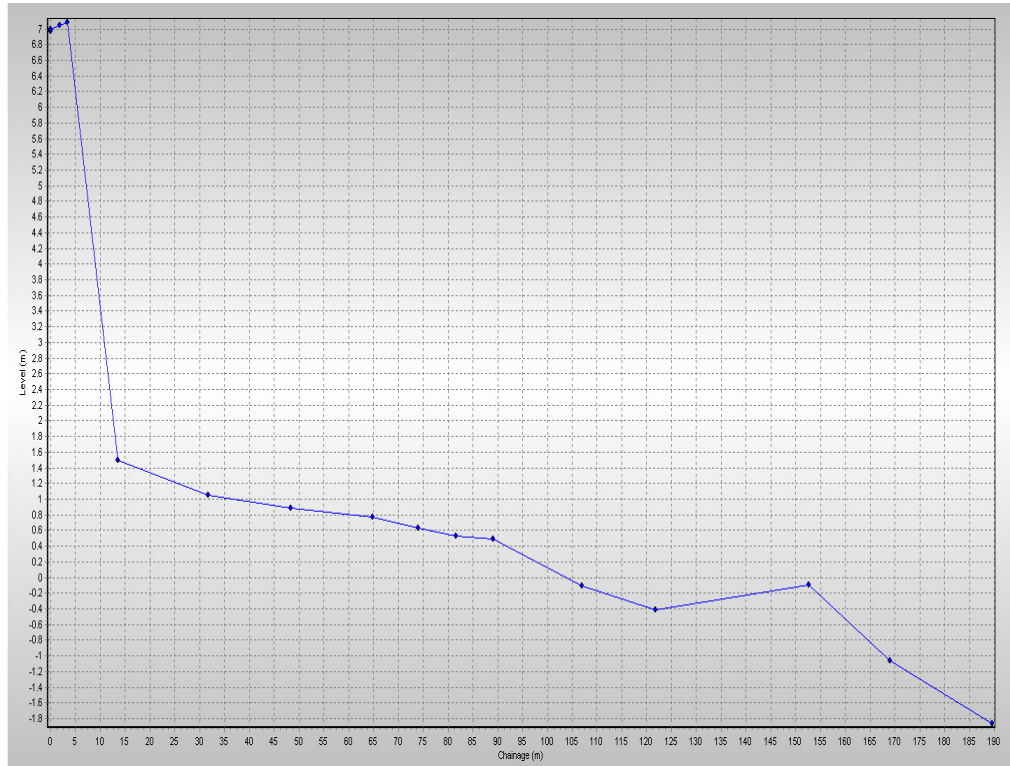
1cRC5

Date 17/11/2008 **Inspector** RH
Wind Light **Sea State**
Summary

Low Tide (m) **Low Tide Time**
Visibility Good **Rain** No

Easting 460845.210 **Northing** 525147.000 **Bearing** 26

Chainage	Level
0.000	6.964
0.054	6.999
1.792	7.043
3.430	7.084
13.593	1.494
31.684	1.057
48.353	0.883
64.898	0.773
73.947	0.635
81.633	0.533
89.013	0.491
107.043	-0.111
121.791	-0.410
152.623	-0.089
169.012	-1.066
189.570	-1.863



Beach Profile

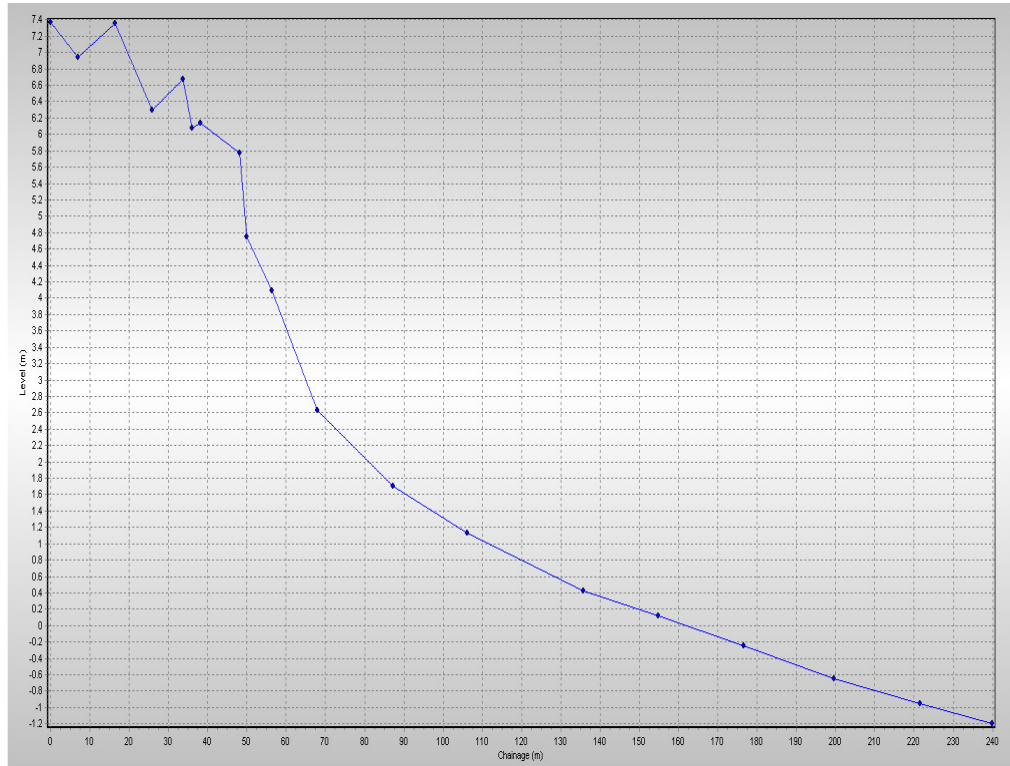
1cRC6

Date 17/11/2008 **Inspector** RH
Wind Light **Sea State**
Summary

Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 461776.840 **Northing** 524269.590 **Bearing** 39

Chainage	Level
0.000	7.368
6.980	6.942
16.461	7.357
25.904	6.299
33.677	6.678
35.951	6.076
38.169	6.136
48.206	5.770
49.994	4.743
56.320	4.088
67.885	2.630
87.208	1.709
106.057	1.126
135.648	0.421
154.823	0.122
176.567	-0.242
199.545	-0.650
221.521	-0.954
239.897	-1.196



Beach Profile

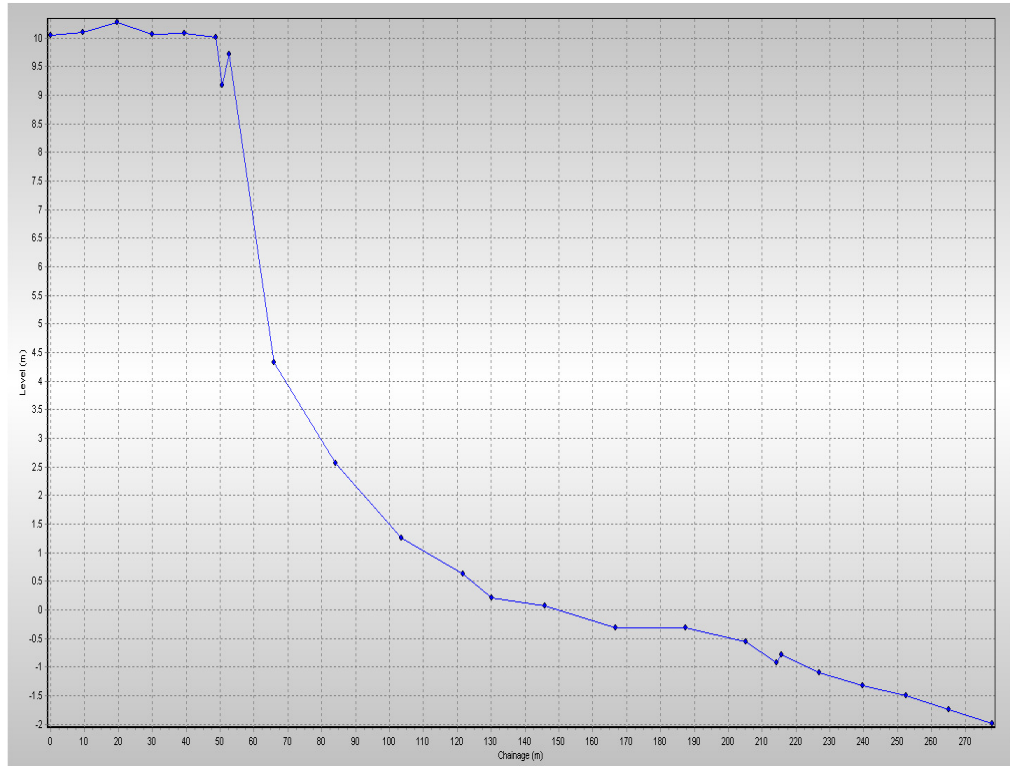
1cRC7

Date 17/11/2008 Inspector RH
Wind Light Sea State
Summary

Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 462568.450 Northing 523568.440 Bearing 37

Chainage	Level
0.000	10.040
9.416	10.104
19.556	10.272
29.996	10.057
39.558	10.075
48.685	10.018
50.716	9.177
52.697	9.713
65.996	4.321
84.103	2.560
103.486	1.259
121.695	0.628
130.196	0.201
145.826	0.077
166.829	-0.315
187.445	-0.317
205.213	-0.558
214.216	-0.925
215.808	-0.787
226.957	-1.094
239.697	-1.320
252.438	-1.504
265.179	-1.750
277.920	-1.988



Beach Profile

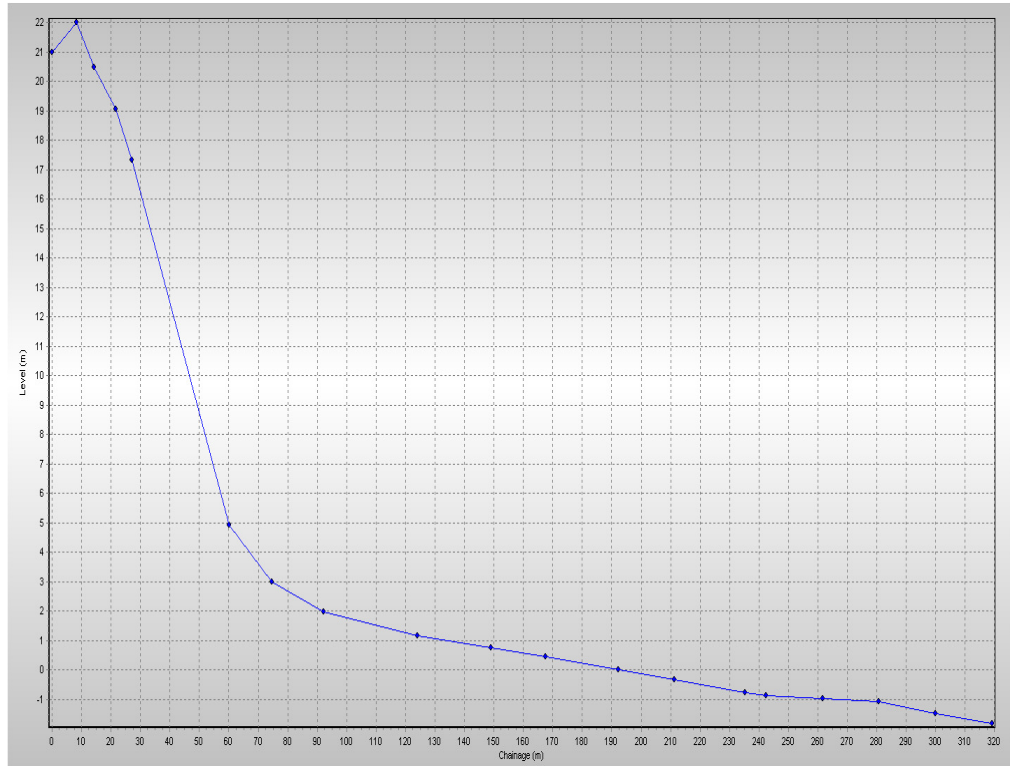
1cRC8

Date 17/11/2008 **Inspector** RH
Wind Light **Sea State**
Summary

Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 464245.580 **Northing** 522578.100 **Bearing** 28

Chainage	Level
0.000	20.984
8.219	22.005
14.204	20.471
21.741	19.072
27.044	17.336
60.139	4.937
74.714	2.976
92.145	1.988
124.170	1.150
148.986	0.761
167.510	0.434
192.209	0.001
211.288	-0.340
235.342	-0.780
242.389	-0.861
261.587	-0.980
280.784	-1.065
299.982	-1.495
319.179	-1.823



Beach Profile

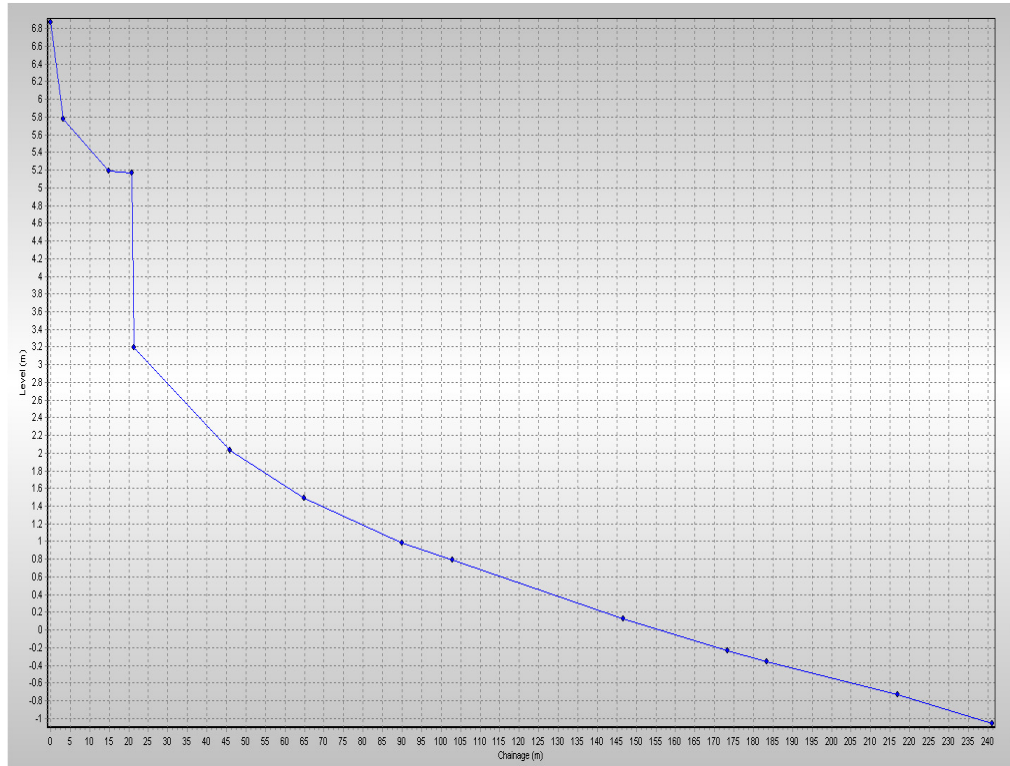
1cRC9

Date 17/11/2008 **Inspector** RH
Wind Light **Sea State**
Summary

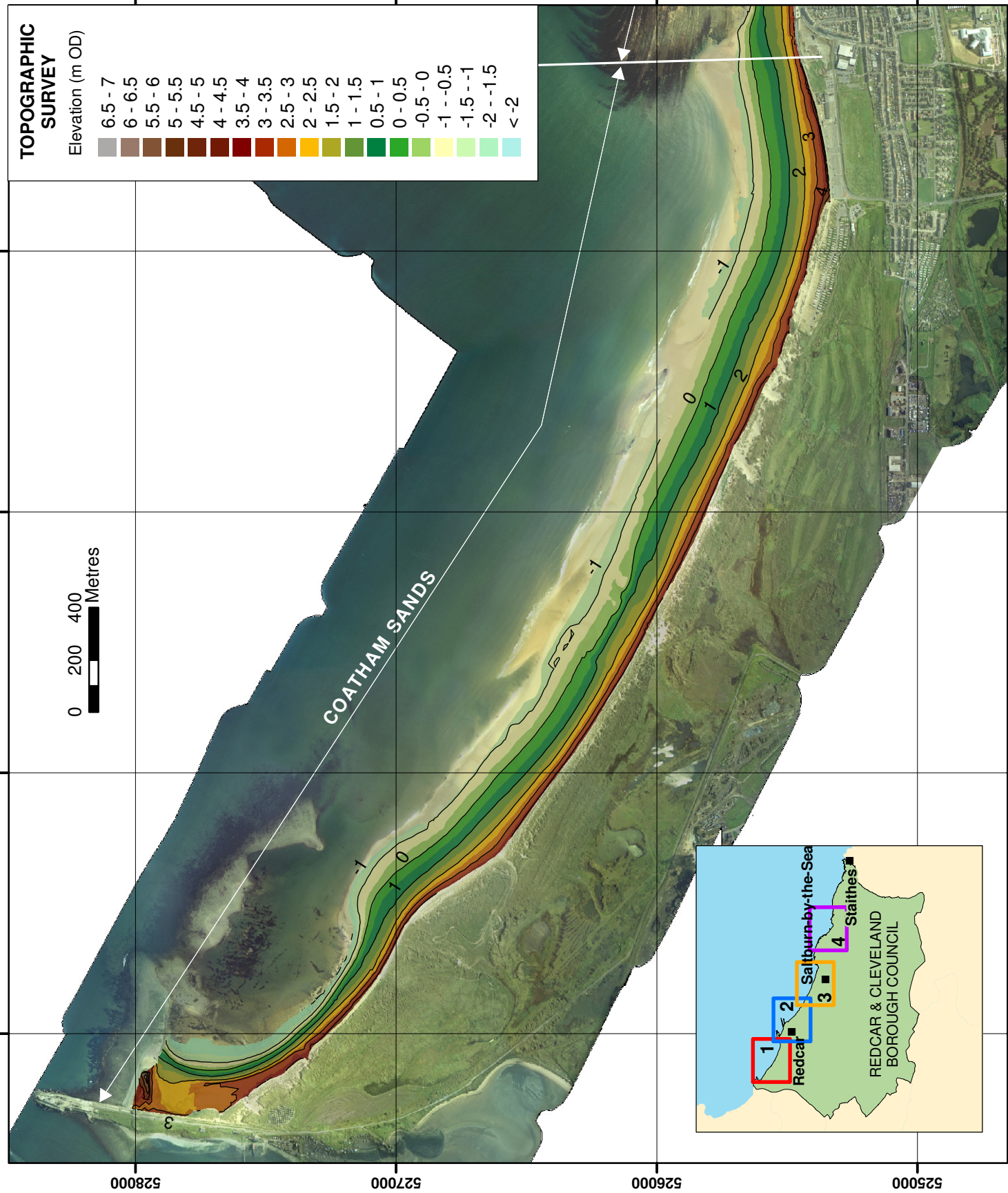
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 466477.530 **Northing** 521748.870 **Bearing** 22

Chainage	Level
0.000	6.871
3.145	5.782
14.908	5.189
20.744	5.171
21.294	3.193
45.855	2.037
64.840	1.493
90.085	0.986
102.979	0.791
146.690	0.124
173.416	-0.239
183.338	-0.358
216.946	-0.736
241.129	-1.059



Appendix B
Topographic Survey



— Topographic Contours
at 1 metre interval

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

Appendix B - Map 1 Redcar & Cleveland Borough Council Frontage

Analytical Report 1
'Full Measures' Survey 2008

Drawing Scale 1:20,000 at A4

Drawn by: TC Date: 08/05/2009
Checked by: NC Date: 08/05/2009
Approved by: NC Date: 08/05/2009



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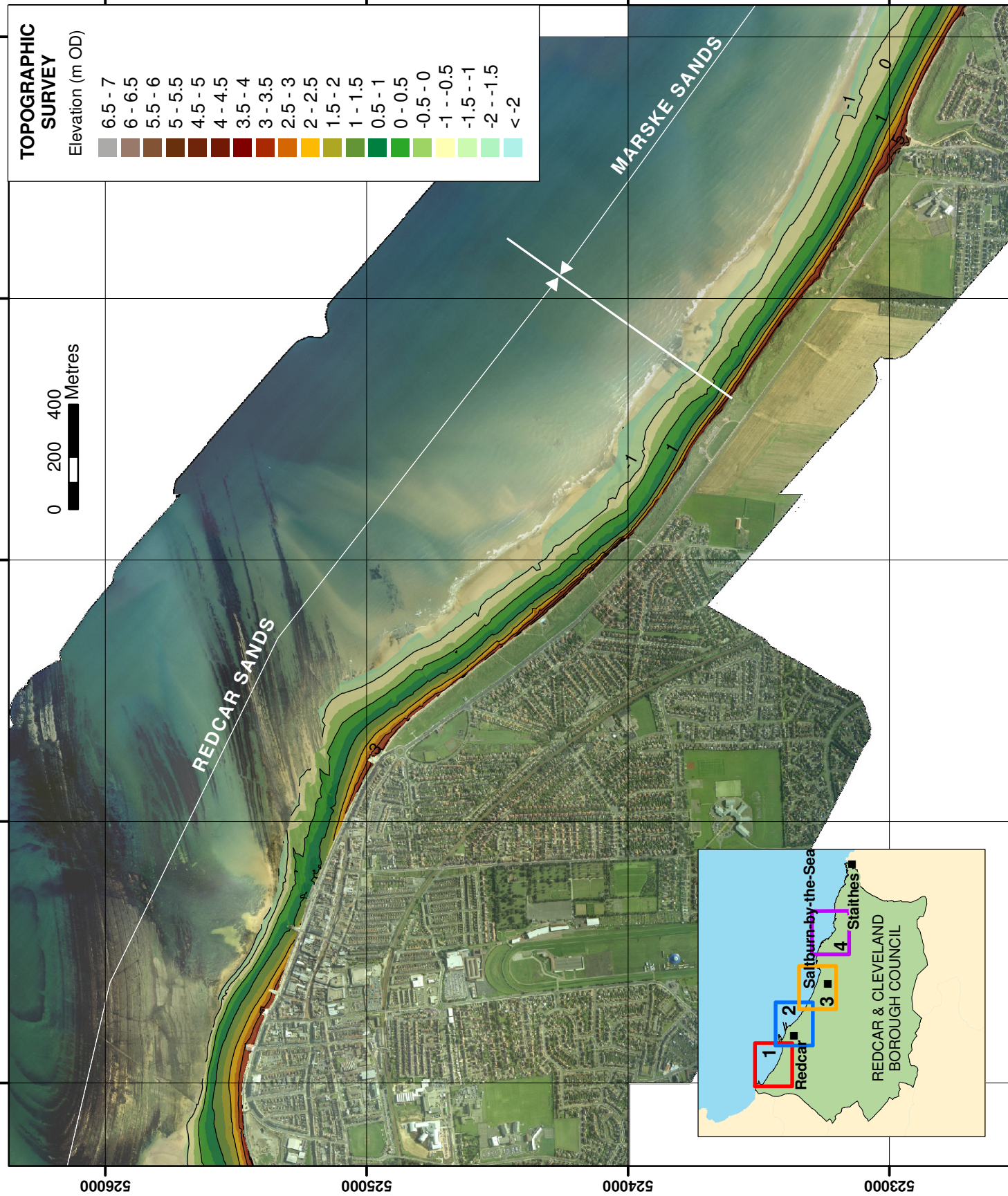
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Fax: +44 (0)191 211 1313
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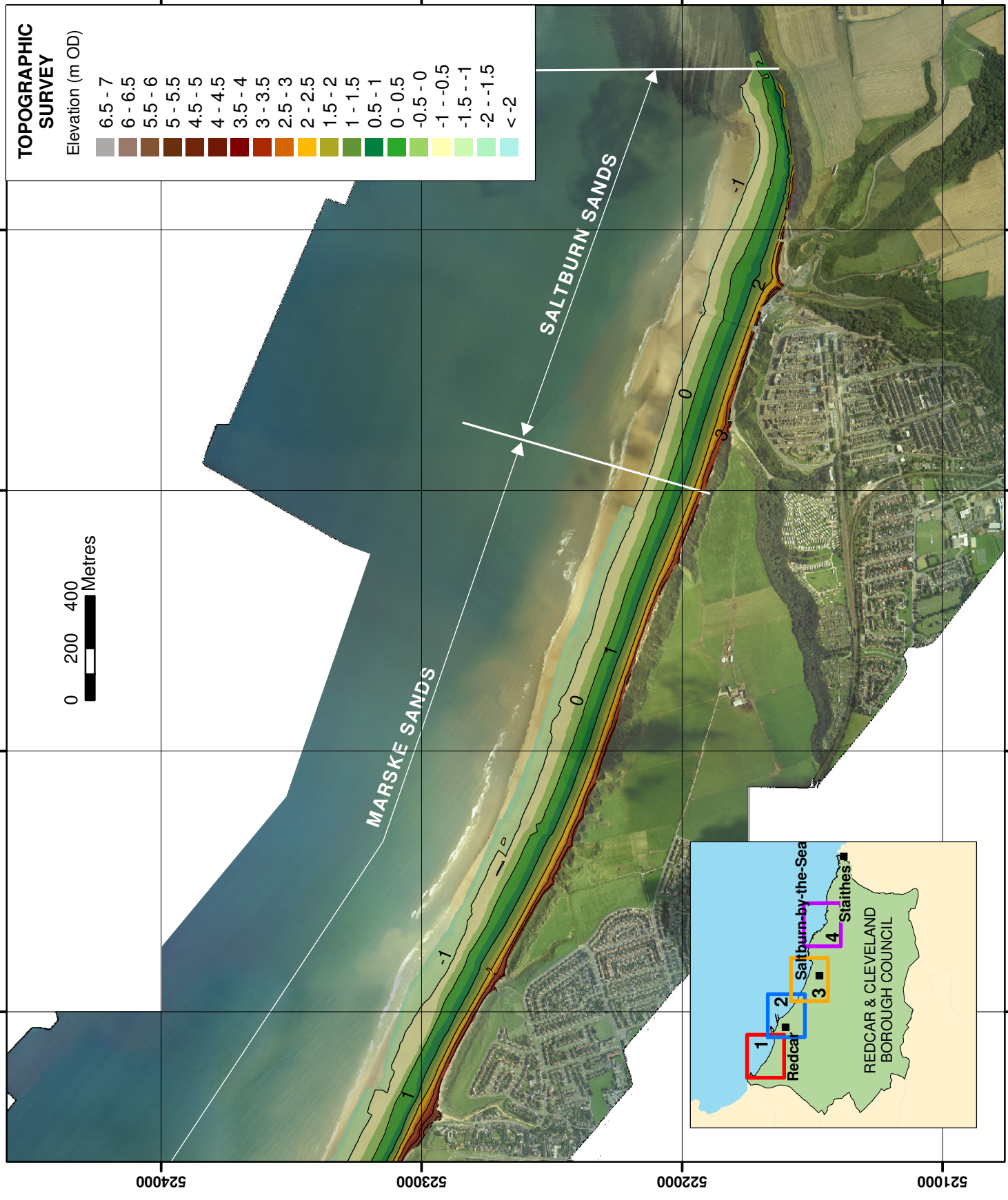
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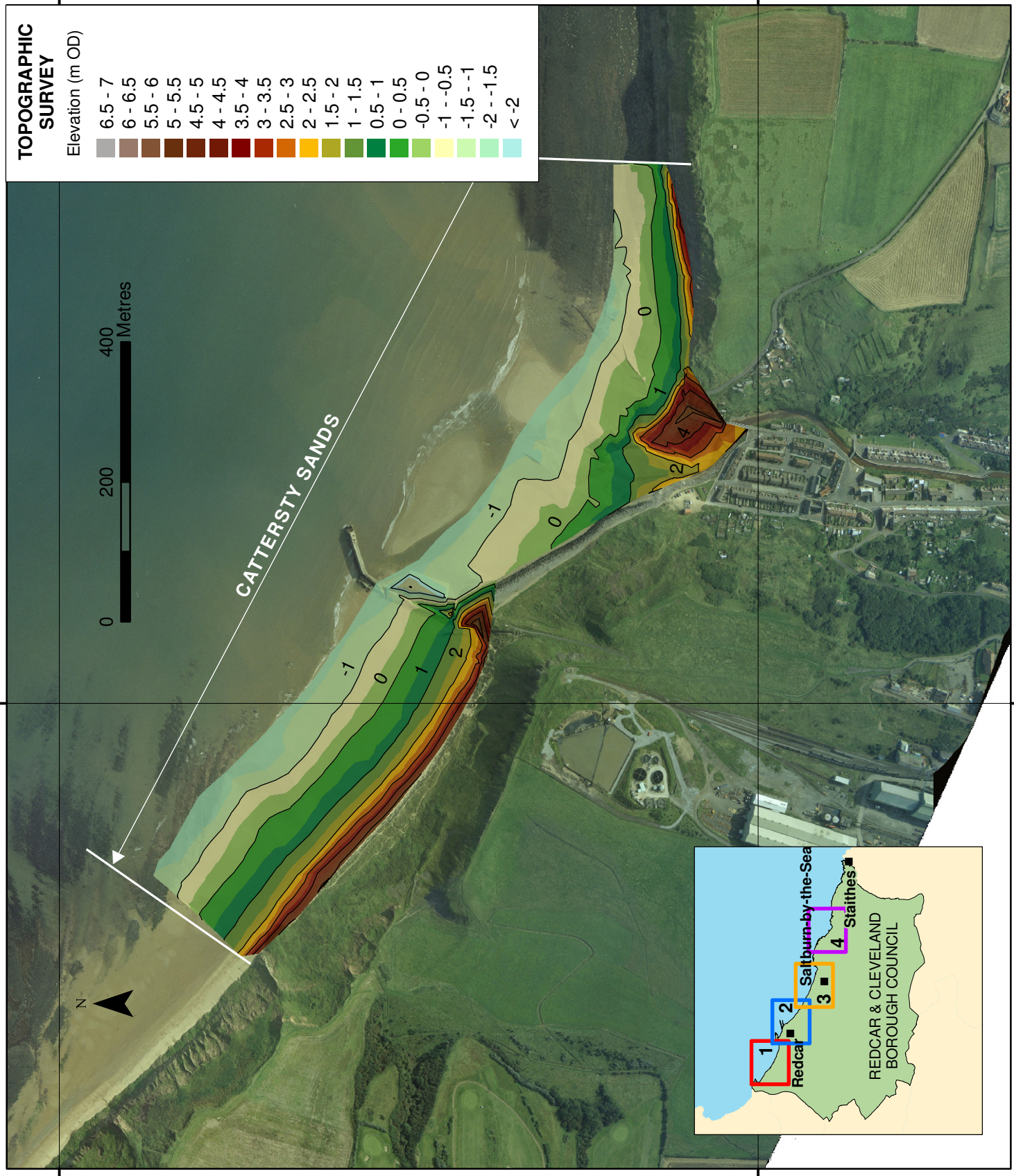
<p>— Topographic Contours at 1 metre interval</p>	<p>TOPOGRAPHIC SURVEY Elevation (m OD)</p> <table border="1"> <tr><td>6.5 - 7</td></tr> <tr><td>6 - 6.5</td></tr> <tr><td>5.5 - 6</td></tr> <tr><td>5 - 5.5</td></tr> <tr><td>4.5 - 5</td></tr> <tr><td>4 - 4.5</td></tr> <tr><td>3.5 - 4</td></tr> <tr><td>3 - 3.5</td></tr> <tr><td>2.5 - 3</td></tr> <tr><td>2 - 2.5</td></tr> <tr><td>1.5 - 2</td></tr> <tr><td>1 - 1.5</td></tr> <tr><td>0.5 - 1</td></tr> <tr><td>0 - 0.5</td></tr> <tr><td>-0.5 - 0</td></tr> <tr><td>-1 - -0.5</td></tr> <tr><td>-1.5 - -1</td></tr> <tr><td>-2 - -1.5</td></tr> <tr><td>< -2</td></tr> </table>	6.5 - 7	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
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-1.5 - -1																				
-2 - -1.5																				
< -2																				
<p>Client: North East Coastal Group</p> <p>Project: Cell 1 Regional Coastal Monitoring Programme</p>	<p>Appendix B - Map 2 Redcar & Cleveland Borough Council Frontage</p> <p>Analytical Report 1 'Full Measures' Survey 2008</p>																			
<p>Drawn by: TC Date: 08/05/2009</p> <p>Checked by: NC Date: 08/05/2009</p> <p>Approved by: NC Date: 08/05/2009</p>	<p>Drawing Scale 1:20,000 at A4</p>																			
<p>ROYAL HASKINING Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE</p>	<p>halcrow Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE</p>																			
<p>Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com</p>	<p>Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com</p>																			
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<p>— Topographic Contours at 1 metre interval</p>	<p>Client: North East Coastal Group</p> <p>Project: Cell 1 Regional Coastal Monitoring Programme</p>	<p>Appendix B - Map 3 Redcar & Cleveland Borough Council Frontage</p> <p>Analytical Report 1 'Full Measures' Survey 2008</p> <p>Drawing Scale 1:20,000 at A4</p> <p>Drawn by: TC Date: 08/05/2009 Checked by: NC Date: 08/05/2009 Approved by: NC Date: 08/05/2009</p>
 <p>ROYAL HASKINING Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE</p> <p>Halcrow Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE</p> <p>Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com</p> <p>Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com</p> <p>© Aerial Photography copyright Scarborough Borough Council</p>		



<p>— Topographic Contours at 1 metre interval</p>	<p>Client: North East Coastal Group</p> <p>Project: Cell 1 Regional Coastal Monitoring Programme</p>	<p>Appendix B - Map 4 Redcar & Cleveland Borough Council Frontage</p> <p>Analytical Report 1 'Full Measures' Survey 2008</p> <p>Drawing Scale 1:7,500 at A4</p> <p>Drawn by: TC Date: 08/05/2009 Checked by: NC Date: 08/05/2009 Approved by: NC Date: 08/05/2009</p>
		
<p>ROYAL HASKINGING</p> <p>Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE</p> <p>Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE</p> <p>Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com</p> <p>Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com</p> <p>© Aerial Photography copyright Scarborough Borough Council</p>		



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 100m.

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

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

Table C1 – Cliff Top Surveys at Staithes

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (2008)	Previous Survey (N/A)	Present Survey (N/A)	Baseline (2008) to Present (N/A)	Previous (N/A) to Present (N/A)	Baseline (2008) to Present (N/A)
1	477228	518769	60.6	320	1.9	-	-	-	-	-
2	477334	518798	57.5	0	10.9	-	-	-	-	-
3	477487	518789	54.9	350	7.1	-	-	-	-	-
4	477594	518801	53.6	340	5.9	-	-	-	-	-
5	477683	518911	48.4	350	8.4	-	-	-	-	-
6	477792	518867	47.4	30	8.6	-	-	-	-	-
7	477891	518828	44.6	60	7.7	-	-	-	-	-
8	477959	518873	40.0	350	8.7	-	-	-	-	-
9	478088	518950	37.3	350	7.6	-	-	-	-	-
10	478191	519023	42.7	340	8.4	-	-	-	-	-
11	478237	519007	40.0	60	6.9	-	-	-	-	-

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
12	478213	518988	37.2	150	6.1	-	-	-	-	-
13	478501	518809	50.3	15	11.4	-	-	-	-	-
14	478624	518807	55.3	20	7.5	-	-	-	-	-
15	478737	518858	56.0	60	6.1	-	-	-	-	-
16	478823	518757	50.2	60	8.0	-	-	-	-	-
17	478944	518671	46.8	30	9.3	-	-	-	-	-
18	479052	518630	47.0	20	9.2	-	-	-	-	-
19	479147	518610	47.1	0	14.2	-	-	-	-	-
20	479274	518618	44.2	20	11.4	-	-	-	-	-