



**Cell 1 Regional Coastal Monitoring Programme
Update Report 1: 'Partial Measures' Survey 2009**



**Redcar & Cleveland
Borough Council
Final Report**

June 2009

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (mODN)			
	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 (mODN)			
	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20
Water Level Parameter	Water Level (mODN)			
	Saltwick Nab to Hundale Point	Hundale Point to White Nab	White Nab to Filey Brigg	Filey Brigg to Flamborough Head
1 in 200 year	3.88	3.93	3.93	4.04
HAT	3.10	3.05	3.05	3.10
MHWS	2.60	2.45	2.45	2.50
MLWS	-2.20	-2.35	-2.35	-2.30

Source: *River Tyne to Flamborough Head Shoreline Management Plan 2*.
Royal Haskoning, February 2007.

Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the 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.

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

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

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

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09	June 09 ^(*)	-

^(*) The present report is **Update Report 1** and provides an analysis of the 2009 Partial Measures survey for Redcar & Cleveland Borough Council's frontage. It is intended as a brief update of the key findings from this survey to maintain an understanding of ongoing changes.

1. Introduction

1.1 Study Area

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

Note: The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland Council and Scarborough Borough Council.

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

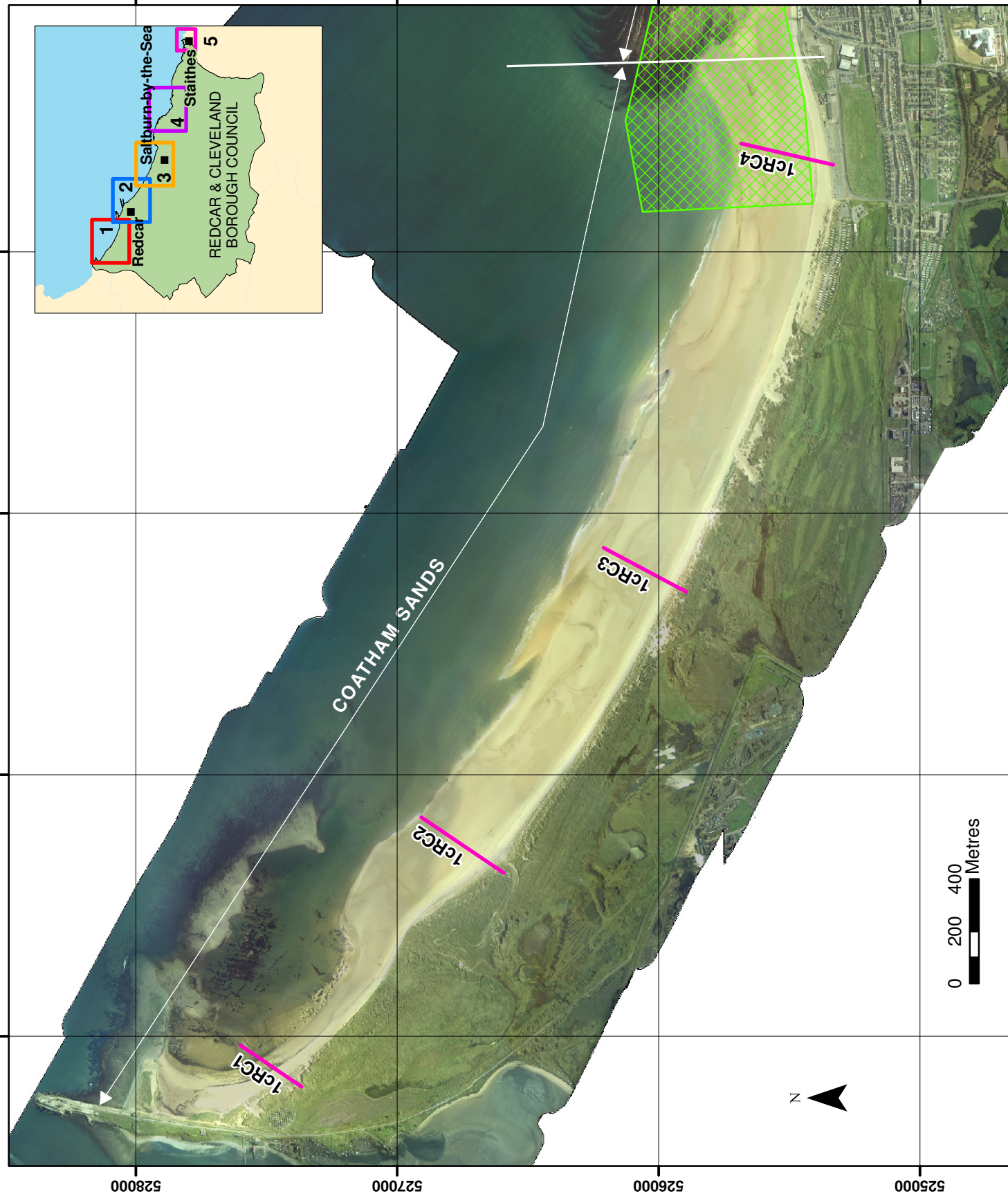
The location of these surveys is shown in Figure 1. Also enclosed on the accompanying CD-ROM is a file which can be opened in Google Earth showing the locations of the surveys.

The Partial Measures survey was undertaken along this frontage in March 2009, when weather conditions were fine with showers and the sea state was mild.

The Update Report presents the following:

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

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



SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 1 - Map 1
Redcar & Cleveland
Borough Council Frontage**

Update Report 1
'Partial Measures' Survey 2009

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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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

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

(Indicative Survey Extents shown)

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

Figure 1 - Map 2 Redcar & Cleveland Borough Council Frontage

Update Report 1
 'Partial Measures' Survey 2009

Drawing Scale 1:20,000 at A4
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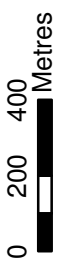
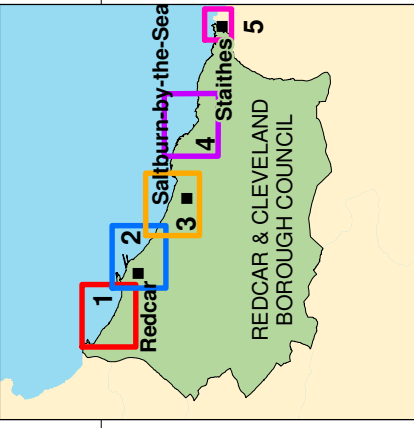


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- SURVEY LOCATIONS**
- Topographic Profiles**
- Annual
 - Bi-Annual
- Topographic Surveys**
- 6 monthly
 - yearly
 - 5 yearly
- Cliff Top Monitoring Pegs**
- @ 50 centres
 - @ 100 centres
 - @ 300 centres
- (Indicative Survey Extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 3 Redcar & Cleveland Borough Council Frontage

Update Report 1
'Partial Measures' Survey 2009

Drawing Scale 1:20,000 at A4

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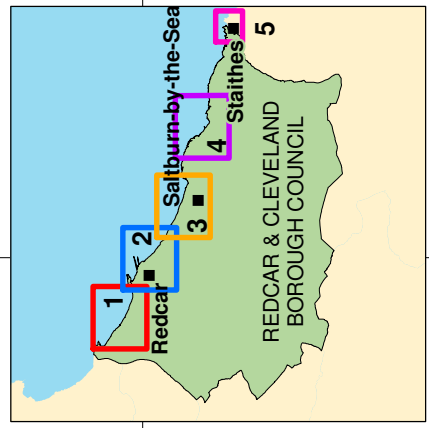
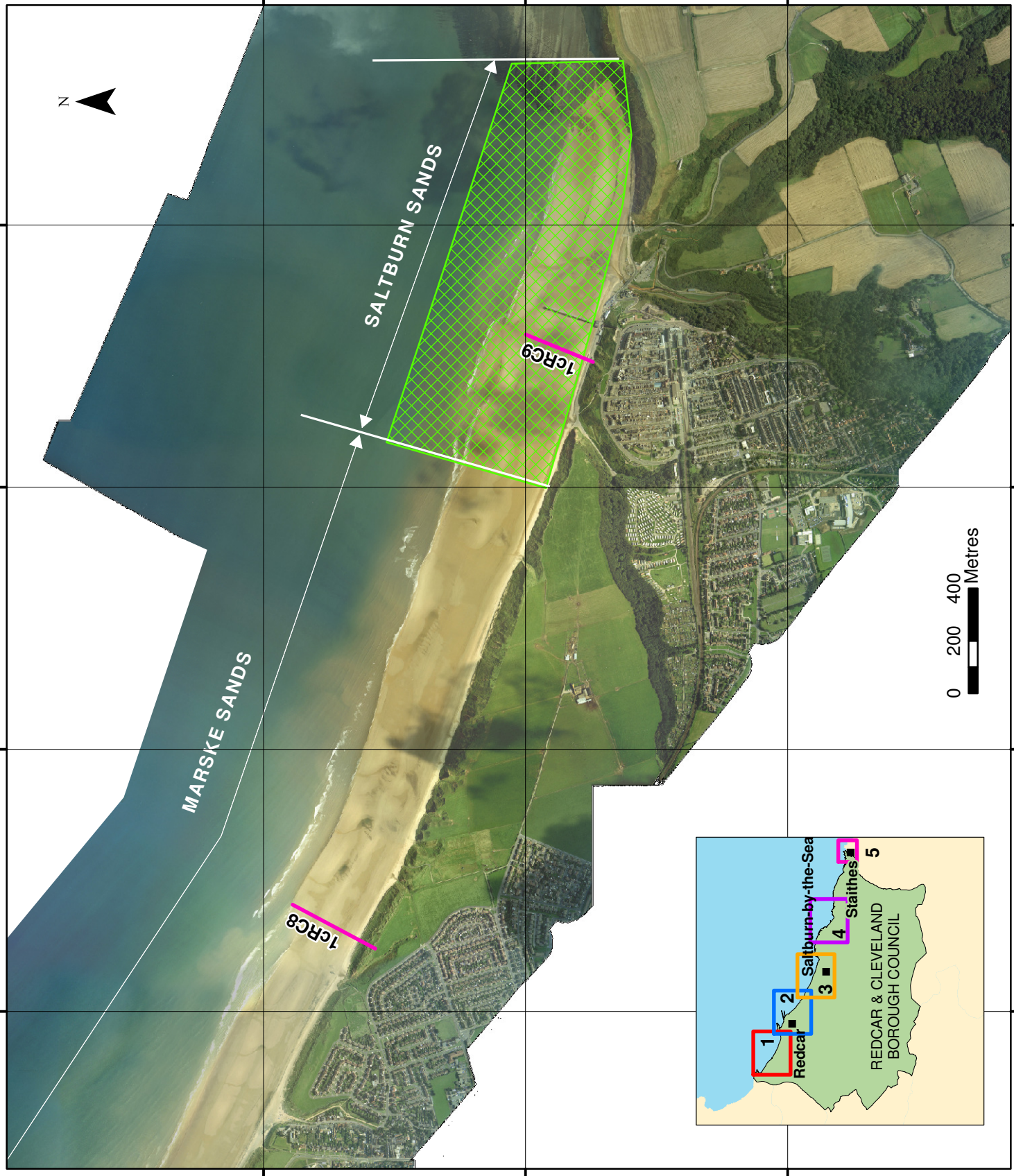
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523000 522000 521000

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

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

(Indicative Survey Extents shown)

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

Figure 1 - Map 4 Redcar & Cleveland Borough Council Frontage

Update Report 1
 'Partial Measures' Survey 2009

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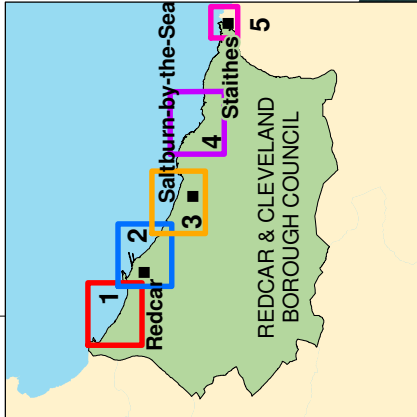
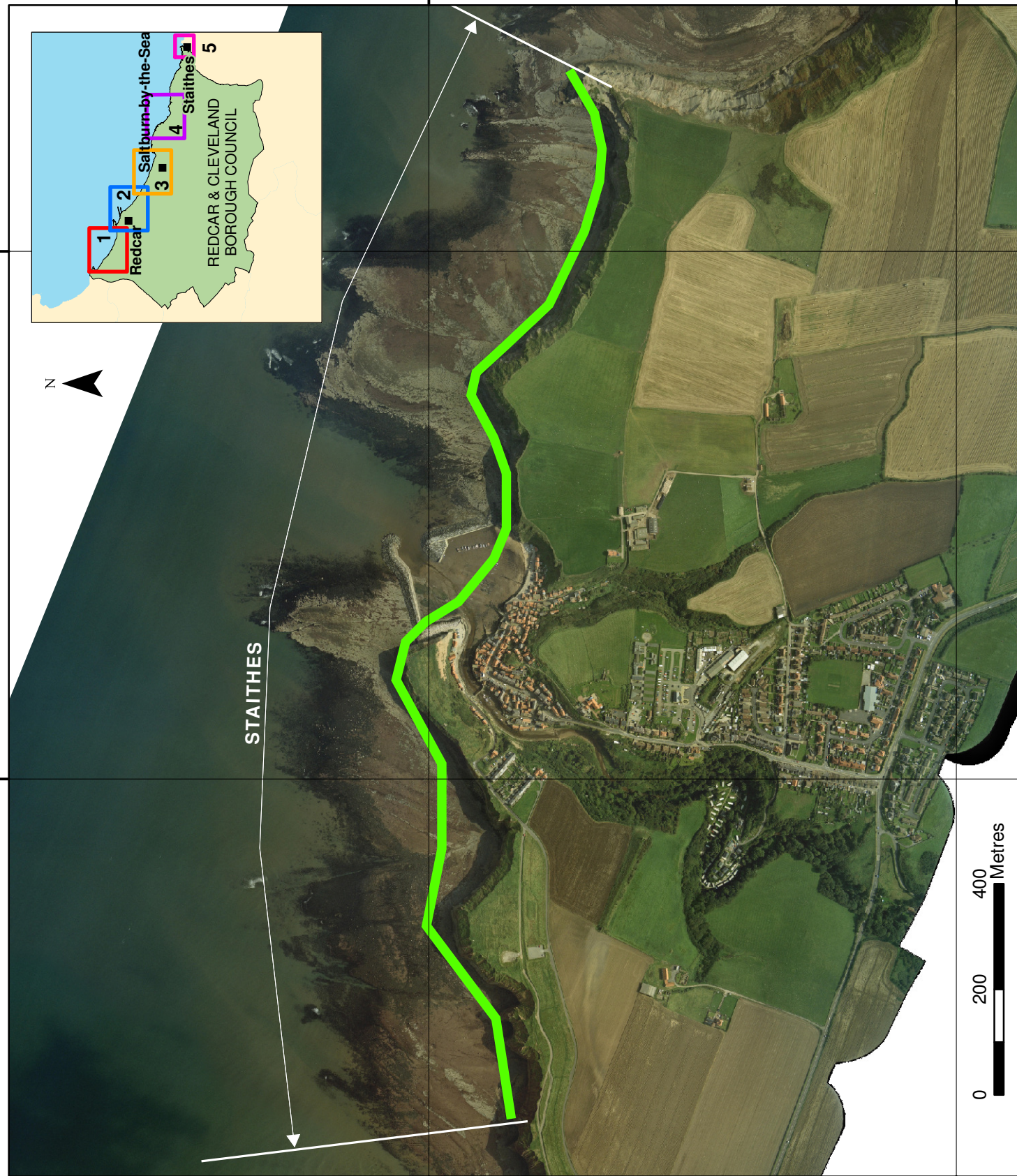
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SURVEY LOCATIONS

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 1 - Map 5
Redcar & Cleveland
Borough Council Frontage**

Update Report 1
'Partial Measures' Survey 2009

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Approved by:	NC	Date:	08/05/2009



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2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2009	<p>Beach Profiles:</p> <p>Coatham Sands is covered by four beach profiles (RC1 to RC4; Appendix A).</p> <p>The March 2009 survey along RC1 picks out good definition of the dune crest, with a number of ridges clearly noted. The seaward face and toe of the dunes experienced a small amount of lowering and the berm previously identified at a chainage of around 110m was slightly flattened, but lower down the beach profile sediment accumulation occurred. This typically resulted in increased beach levels by around 0.5, but at a chainage of 170m, the beach levels were some 1.35m higher.</p> <p>The main change along RC2 occurred seaward of a chainage of 220m, where beach lowering occurred. This started with quite modest differences, but increased to a difference of the order of 0.7m at a chainage of 290m. Lowering also occurred along the upper beach, between about MHWN and HAT, although the magnitude of this was much less, being of the order of 0.1m at most.</p> <p>Along RC3 the wide berm identified on the previous survey had become flattened, resulting in a lowering of levels around the former crest of the berm, but a general increase in levels, by around 0.3m, along the rest of the profile (both to landward and to seaward). A slight berm formed around MHWS on the upper section of beach. There was also some slight accretion at the toe and face of the seaward dune ridge.</p> <p>Very little change occurred along RC4 although between chainages of 105 and 250m on the mid beach some modest accretion occurred. Typically this was of the order of 0.1m, but locally increased to 0.2m.</p>	<p>At the northern end of Coatham Sands, the accretion experienced along profile RC1 is typical of the accretion expected at this location, which is sheltered to an extent by the presence of the German Charlies slag banks.</p> <p>Further south the frontage is outwith the zone of protection of these features and there appears to have been some loss from RC2 and gain along RC3, perhaps indicating a longshore redistribution of sediment.</p> <p>At the southern end of Coatham Sands, the profile was relatively stable, indicating the sheltering effect provided against waves from some sectors by Coatham Rocks.</p>

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2009	<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>Beach levels at the toe of the concrete wall and revetment along RC5 recovered over a width of some 25m from the wall, with levels directly at the toe improving by 0.2m. This is likely to be due to redistribution of material from lower down the profile, around 40m to 80m chainage, to both the upper profile and the lower profile where levels also increased.</p> <p>Only very modest changes were recorded along RC6 and RC7, with some local redistribution of sediment across each profile resulting in areas of slight accretion and a smaller zone of slight lowering on each.</p>	<p>RC5 was previously identified as an area of concern due to low beach levels at the toe of the concrete crest wall fronting The Esplanade. Here, levels directly at the toe were improved slightly, but not significantly, due to redistribution of sediment from lower down the profile.</p> <p>Whilst the profiles showed only relatively modest change, more substantial changes occurred along beach sections in between the profiles. Some of the upper beach lowering along parts of The Esplanade and parts of The Stray is of particular concern.</p> <p>Overall, it appears that beach morphology along Redcar Sands is highly variable, with a combination of cross-shore and longshore redistributions occurring. It is envisaged that future surveys will show continued variability, but a longer term series of surveys should reveal any trends of erosion or accretion underlying the seasonal variability.</p>
	<p>Topographic Survey:</p> <p>Redcar Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 1a). This DGM has been compared against the previous (November 2008) survey in Appendix B – Map 1b.</p> <p>This DGM shows that considerable redistribution of sediment occurred across Redcar Sands. In particular, there were three main zones of beach lowering: (i) along approximately a 1km zone from Coatham Rocks up to the second shore-perpendicular access ramp/slipway along The Esplanade; (ii) from Redcar Rocks to the start of The Stray; (iii) at the south-eastern end of the survey. In the first zone, there appeared to be some drawdown of material from the upper beach with it becoming deposited on the lower beach along the north-western part of this zone, but further to the south-east lowering occurred over most of the cross-shore length. At the start of The Stray, lowering occurred along the whole cross-shore section of beach, but further south-east along The Stray there seemed to be redistribution from the lower beach to the upper. In the third zone, material was similarly moved from the lower to upper beach.</p>	

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2009	<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 experienced some minor redistribution of sediment from the toe of the dunes to form a slight berm at around MHWS level. Lower down the profile, minor lowering occurred. This was of modest values, but reached a maximum difference of around 0.3m locally.</p>	<p>Marske Sands represents a continuation of Redcar Sands and seemed to be experiencing similar redistribution of sediment, although the changes recorded along profile RC8 are within the anticipated bounds of natural variability and do not present a concern.</p>

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2009	<p>Beach Profiles:</p> <p>Saltburn Sands is covered by one beach profile (RC9; Appendix A).</p> <p>Upper beach levels dropped in front of the sea wall, with a reduction of some 0.35m observed at the toe of the defence. Seaward of a chainage of 70m, however, the profile accreted down to low water level, with maximum difference between levels being around 0.2m.</p>	<p>Beach changes suggest a degree of flattening, with material eroded from the very upper beach and redistributed across the lower sections, particularly to the west of Skelton Beck. East of the beck, accretion occurred over the mid and lower profile, with less upper beach lowering. This is perhaps a consequence of the presence of Saltburn Scar, which traps some of the beach sediment moving along the coast.</p>
	<p>Topographic Survey:</p> <p>Saltburn Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2a). This DGM has been compared against the previous (November 2008) survey in Appendix B – Map 2b.</p> <p>This DGM shows lowering along a narrow section of upper beach along much of the length between Hazel Grove Foot and Skelton Beck. This is particularly severe along a 100m stretch immediately east of Saltburn Pier. However, the lower beach has accreted over this length. East of Skelton Beck the upper beach erosion is less noticeable and the accretion has occurred over the mid and lower beach.</p>	

2.5 Cattersty Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2009	<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 3a). This DGM has been compared against the previous (November 2008) survey in Appendix B – Map 3b.</p> <p>This difference model plot highlights areas of accretion (gain) and erosion (loss), in 0.1 m elevation bands. Survey error is anticipated to be c. \pm 0.1m, so indicated changes of this magnitude may not be real but instead a product of survey error. The plot reveals different behaviours either side of the Jetty. Cattersty Sands to the west show a sequence of shore-parallel change and net stasis. At the head of the beach erosion occurs, followed c.100m seaward from the dune field by small discontinuous berm building. This is in turn followed by an erosional trough. Collectively this represents a net seaward transfer of beach materials over the winter period. To the east of the Jetty, a similar sequence is evident below Hummersea Cliff, with the most intense erosion adjacent to rock armour defences. The river outflowing onto the beach is probably responsible for the depositional zone moving through the central area. To the north-west an area of erosion has developed, and immediately adjacent to the Jetty is an area of accretion.</p>	<p>This frontage shows beach change influenced by both marine and fluvial processes. The shore-parallel troughs and berms are indicative of the transition from a swell (summer) to storm (winter) dominated beach profile. In contrast, fluvial impacts are orthogonal to the coastline, resulting in different patterns of beach/river mouth change.</p>

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2009	<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 100 m (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.</p> <p>Appendix C provides results from the April 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.</p>	<p>When survey accuracy is taken into consideration, six of the twenty points have shown no change since the November 2008 survey, indicating local stability of the cliff face. Eight locations (points 1, 2, 4, 5, 9, 13, 14, 20) have shown cliff line recession ranging 0.2 - 0.6 m (± 0.1m due to survey accuracy). The specific processes responsible for this would need to be determined by field inspection. Six locations (points 3, 10, 12, 15, 17, 19) have shown an increase in distance to the cliff edge (0.2 - 0.7m). Whilst possibly representing a toppling failure, the more likely scenario is different interpretation of the cliff edge between successive surveys. Future surveys will reveal longer-term trends in the dynamics of this cliff line.</p>

3. Problems Encountered and Uncertainty in Analysis

The topographic survey along Redcar Sands revealed that quite notable changes, including zones of erosion at the toe of existing defences, occurred in between the surveyed profile lines. This suggests that interpretation based on profile lines alone, where changes were generally quite modest, would not necessarily have been representative of trends across the whole foreshore and this further supports the benefits of 6-monthly surveys along Redcar Sands.

The cliff top surveys at Staithes are assumed to have a limit of accuracy of $\pm 0.1\text{m}$ due to the techniques used. At a number of locations apparent cliff advance is 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 is marked at Staithes, which may reflect a particular site condition, which requires further investigation.

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

Further to the recommendations outlined by the Analytical Report 1 (May 2009), the following is suggested:

- Consider and implement measures to improve the accuracy of cliff top survey data capture. Photography at the time of each survey (alike beach profiles) and a site visit by a geomorphologist would increase understanding and value of these data at all sites.

5. Conclusions and Areas of Concern

- The German Charlies slag banks are providing a degree of shelter to the northern section of Coatham Sands, where foreshore accretion is occurring. Beyond the limit of protection of these features, longshore redistribution of sediment appears to have occurred towards the south-east. At the southern end of Coatham Sands, there is relatively stability in the beach form.
- Along Redcar Sands the beach morphology is highly variable, with a combination of cross-shore and longshore redistributions occurring dependent upon the governing tidal and wave conditions. It is envisaged that future surveys will show continued variability, but a longer term series of surveys should reveal any trends of erosion or accretion underlying the seasonal variability.
- Marske Sands also experienced a redistribution of sediment, although the changes recorded are within the anticipated bounds of natural variability and do not present a concern.
- Saltburn Sands showed a degree of flattening, with material eroded from the very upper beach and redistributed across the lower sections, particularly to the west of Skelton Beck. East of the beck, accretion occurred over the mid and lower profile, with less upper beach lowering. This is perhaps a consequence of the presence of Saltburn Scar, which traps some of the beach sediment moving along the coast.
- Cattersty Sands (Skinningrove) shows beach change typical of seasonal marine processes, and also depicts the influence of the outflowing river. 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, apparent advance (due to limits of survey accuracy), and recession. Hotspots for cliff top retreat at this time are to the west adjacent to Cowbar Lane, the cliff backing Penny Steel, and also at Old Nab.

Appendices

Appendix A
Beach Profiles

Beach Profile

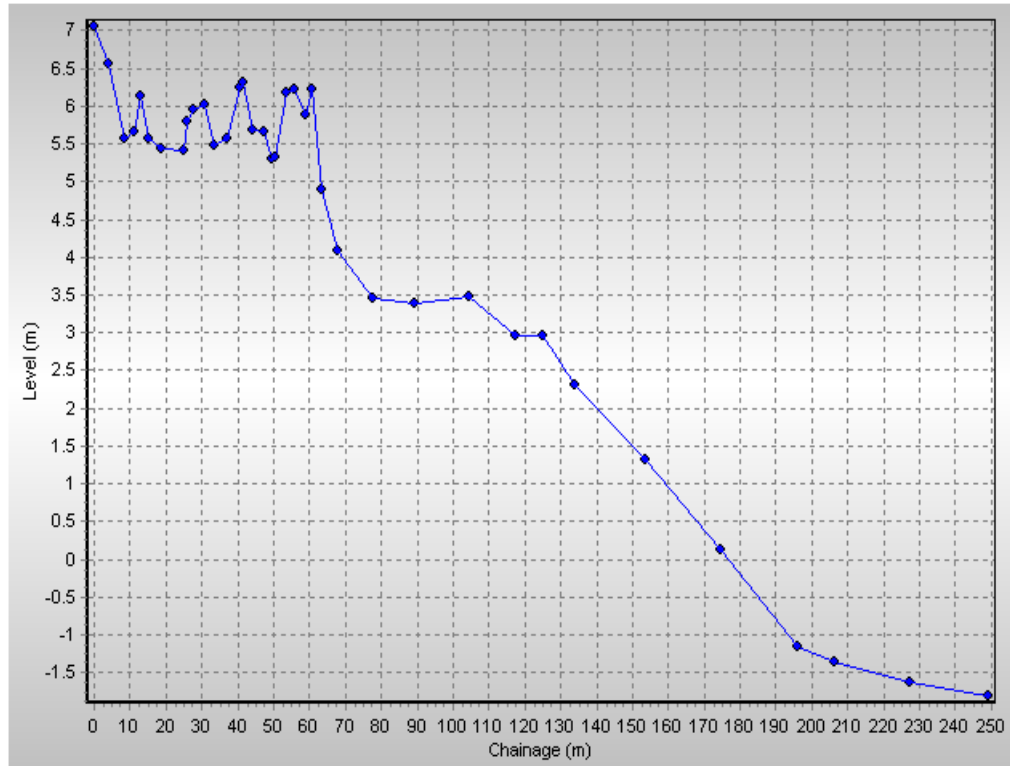
1cRC1

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

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

Easting 455811.440 **Northing** 527373.400 **Bearing** 34

Chainage	Level
0.000	7.056
0.020	7.056
4.080	6.555
8.580	5.570
11.280	5.653
12.850	6.140
15.160	5.566
18.820	5.432
24.850	5.409
25.800	5.802
27.820	5.956
30.980	6.020
33.690	5.475
36.850	5.565
40.510	6.240
41.630	6.305
44.230	5.685
47.500	5.654
49.370	5.303
50.370	5.328
53.760	6.182
55.780	6.218
58.730	5.885
60.550	6.217
63.230	4.901
68.060	4.089
77.750	3.464
89.360	3.392
104.460	3.473
117.330	2.967
125.150	2.960
133.860	2.301
153.460	1.311
174.760	0.130
196.120	-1.164
206.100	-1.365
227.460	-1.626
249.170	-1.810



Beach Profiles: 1cRC1



17/11/2008
30/04/2009

Beach Profile

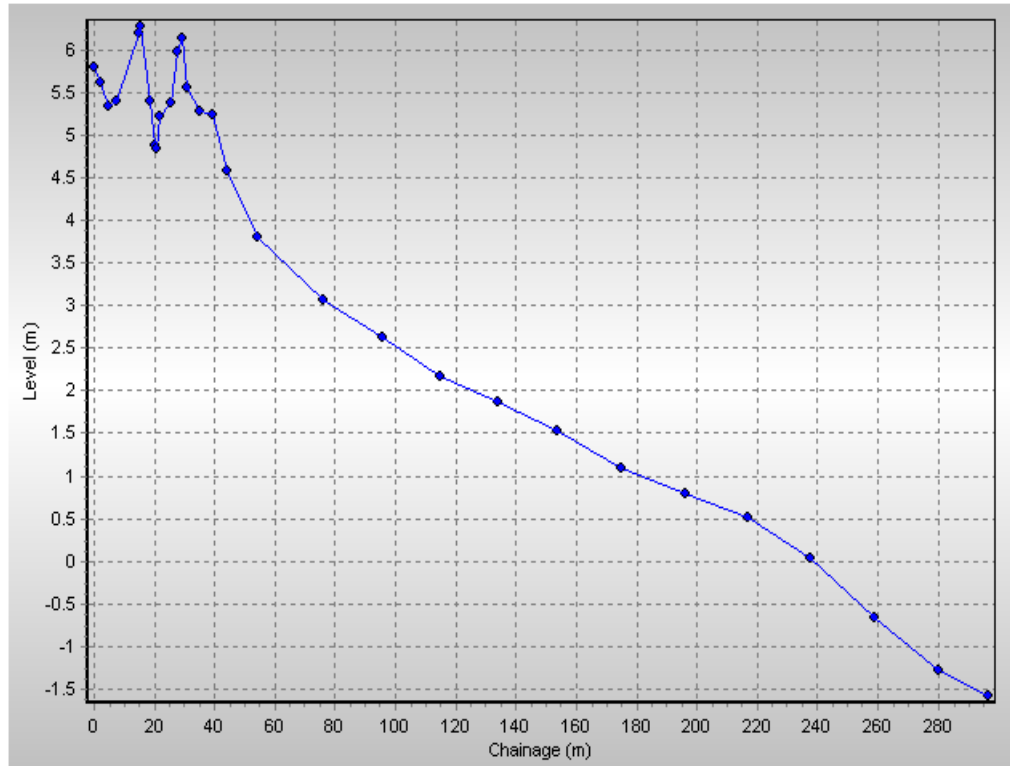
1cRC2

Date 30/04/2009 Inspector RH
Wind Light Sea State
Summary

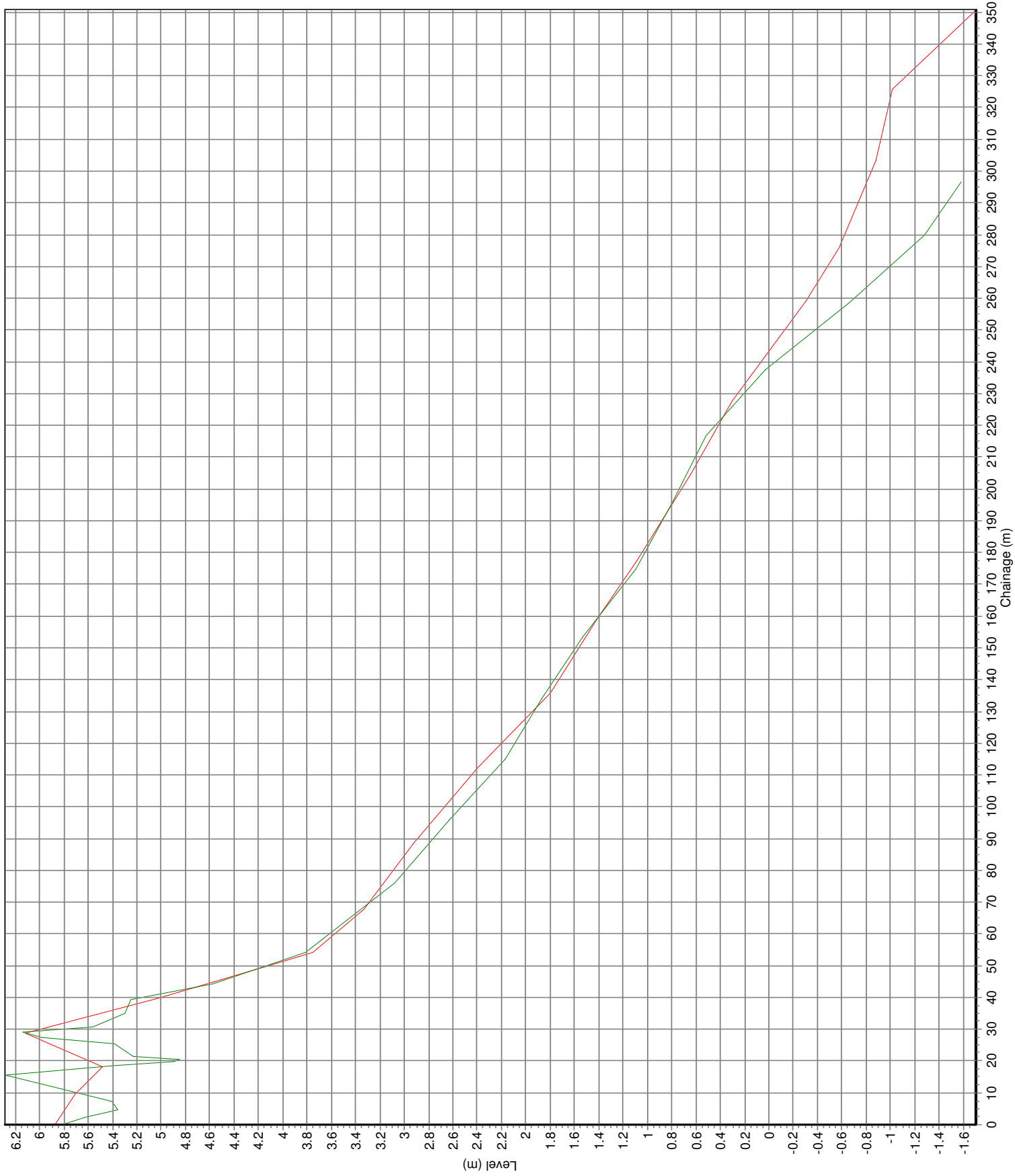
Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 456633.250 Northing 526599.580 Bearing 34

Chainage	Level
0.000	5.815
0.030	5.815
2.170	5.616
4.560	5.353
7.340	5.404
14.870	6.205
15.510	6.285
18.590	5.398
19.940	4.895
20.470	4.850
21.600	5.234
25.380	5.387
27.400	5.980
29.030	6.138
30.820	5.560
35.090	5.294
39.480	5.253
44.240	4.577
54.210	3.816
76.070	3.076
95.820	2.634
114.870	2.173
134.030	1.870
153.440	1.534
174.720	1.099
195.910	0.787
216.880	0.520
237.470	0.029
258.820	-0.668
279.990	-1.285
296.630	-1.587



Beach Profiles: 1cRC2



17/11/2008
30/04/2009

Beach Profile

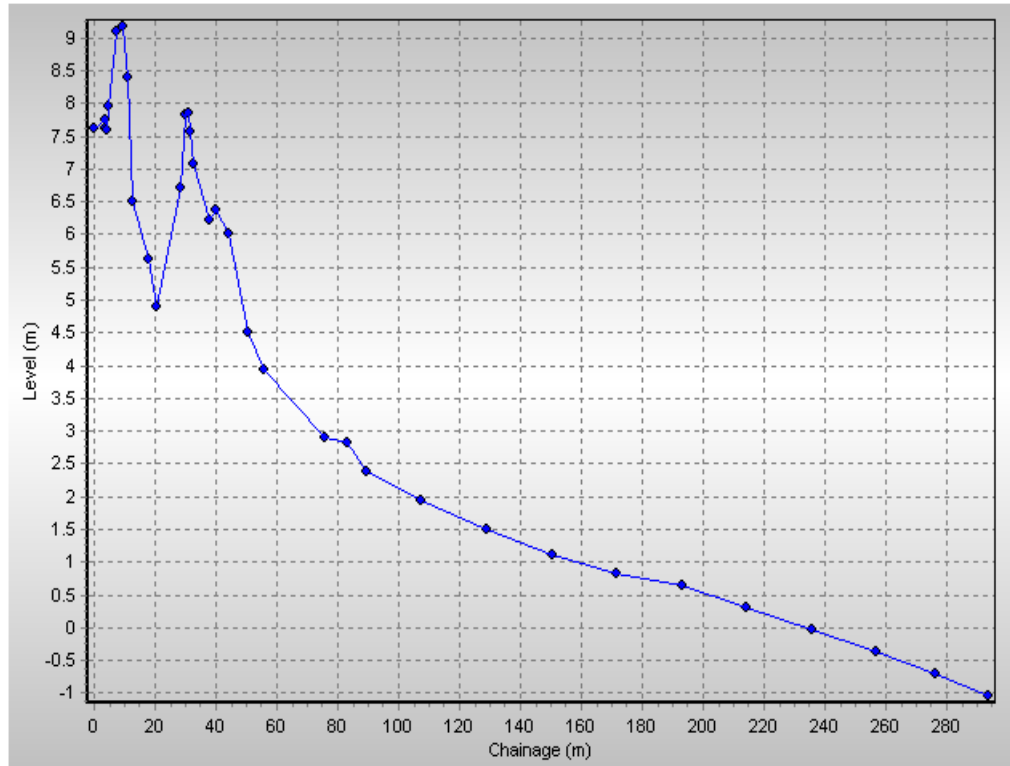
1cRC3

Date 30/04/2009 Inspector RH
Wind Light Sea State
Summary

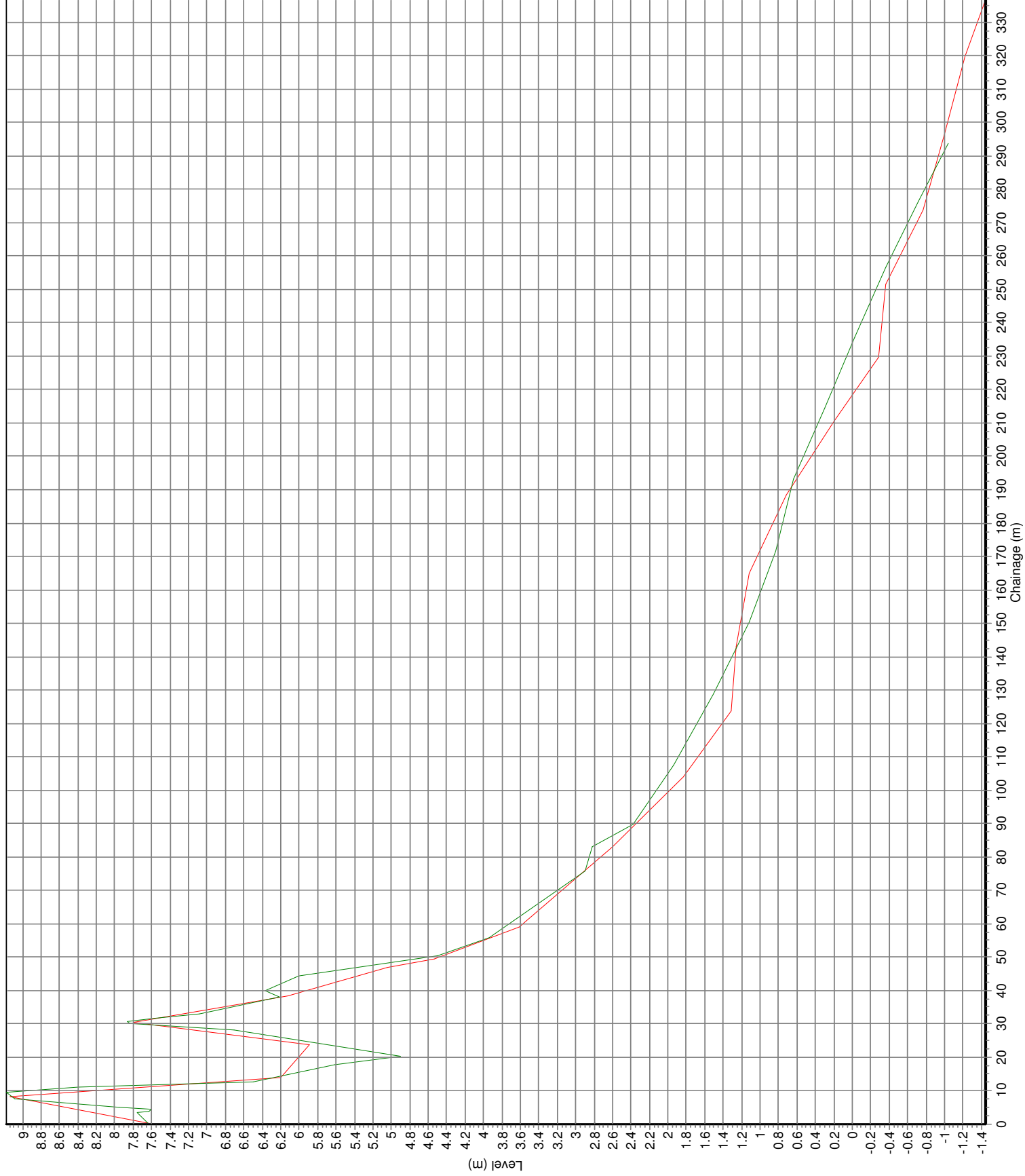
Low Tide (m) Low Tide Time
Visibility Good Rain No

Easting 457706.360 Northing 525898.600 Bearing 28

Chainage	Level
0.000	7.627
0.060	7.627
3.480	7.760
3.720	7.626
4.330	7.603
4.950	7.952
7.530	9.087
9.380	9.176
10.980	8.395
12.700	6.495
17.920	5.617
20.400	4.902
28.210	6.705
30.100	7.835
30.850	7.859
31.760	7.560
32.850	7.085
37.930	6.210
40.070	6.368
44.410	6.011
50.460	4.501
55.750	3.942
75.680	2.902
83.150	2.816
89.660	2.378
107.390	1.935
128.880	1.507
150.510	1.112
171.760	0.832
193.070	0.640
214.390	0.305
235.710	-0.020
256.720	-0.358
276.240	-0.711
293.650	-1.043



Beach Profiles: 1cRC3



17/1/2008
30/04/2009

Beach Profile

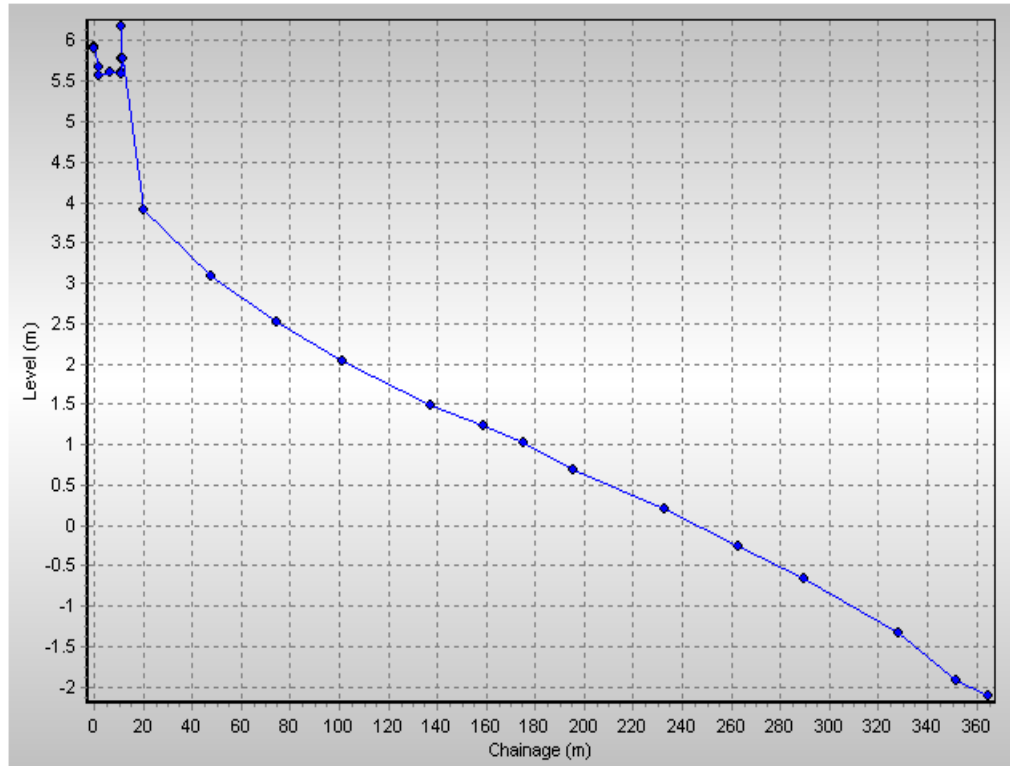
1cRC4

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

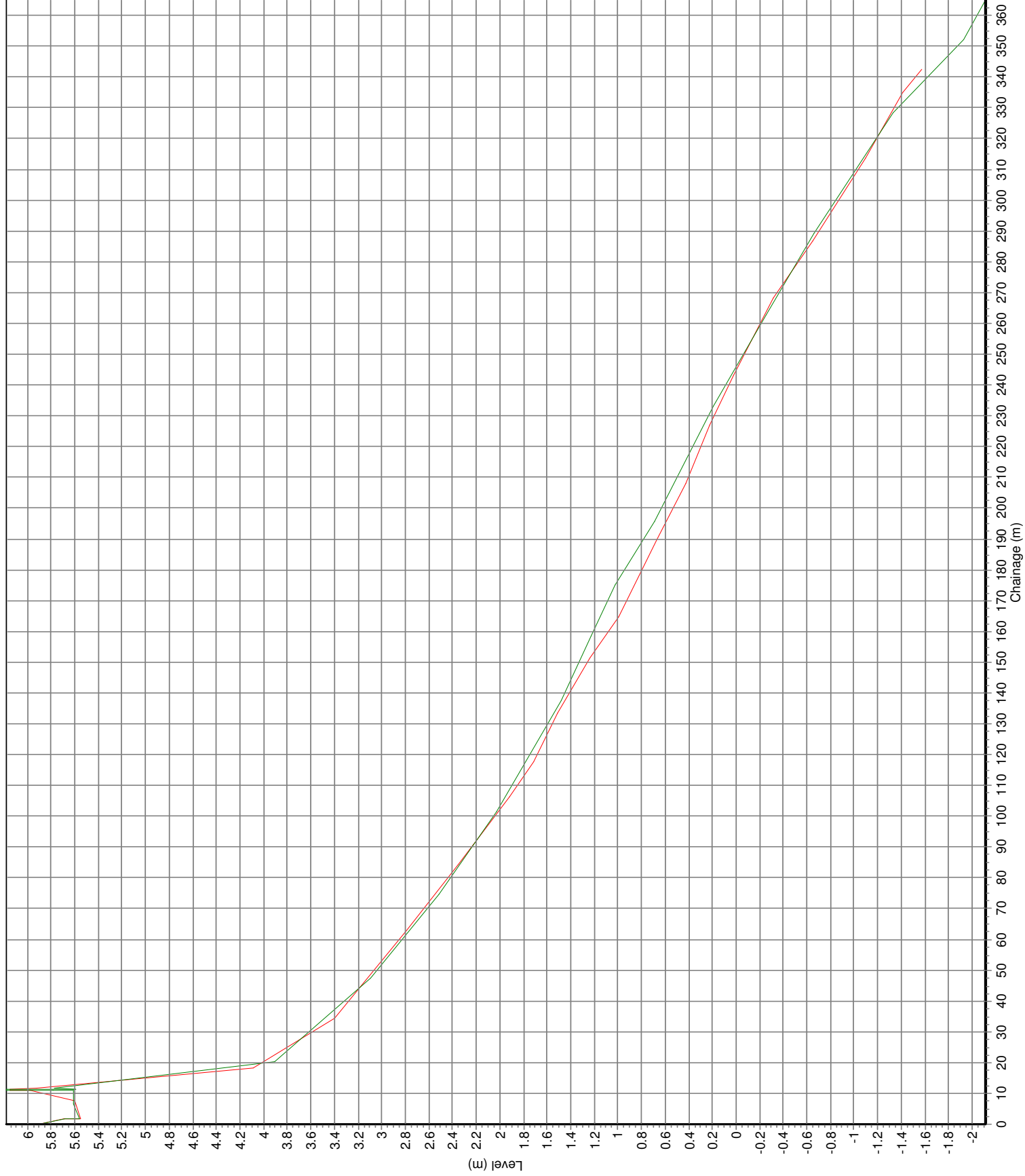
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 459337.600 **Northing** 525336.990 **Bearing** 13

Chainage	Level
0.000	5.935
0.000	5.935
0.110	5.909
1.640	5.679
1.670	5.560
6.430	5.613
10.850	5.609
10.950	5.779
11.030	6.178
11.350	6.174
11.390	5.590
11.590	5.768
20.220	3.908
47.490	3.092
74.520	2.518
101.460	2.032
137.620	1.485
158.610	1.228
175.130	1.023
195.580	0.689
233.000	0.197
262.830	-0.255
289.380	-0.662
328.450	-1.329
352.060	-1.925
364.870	-2.111



Beach Profiles: 1cRC4



Legend for Beach Profiles: 1cRC4

- 17/1/2008 (Red line)
- 30/04/2009 (Green line)

Beach Profile

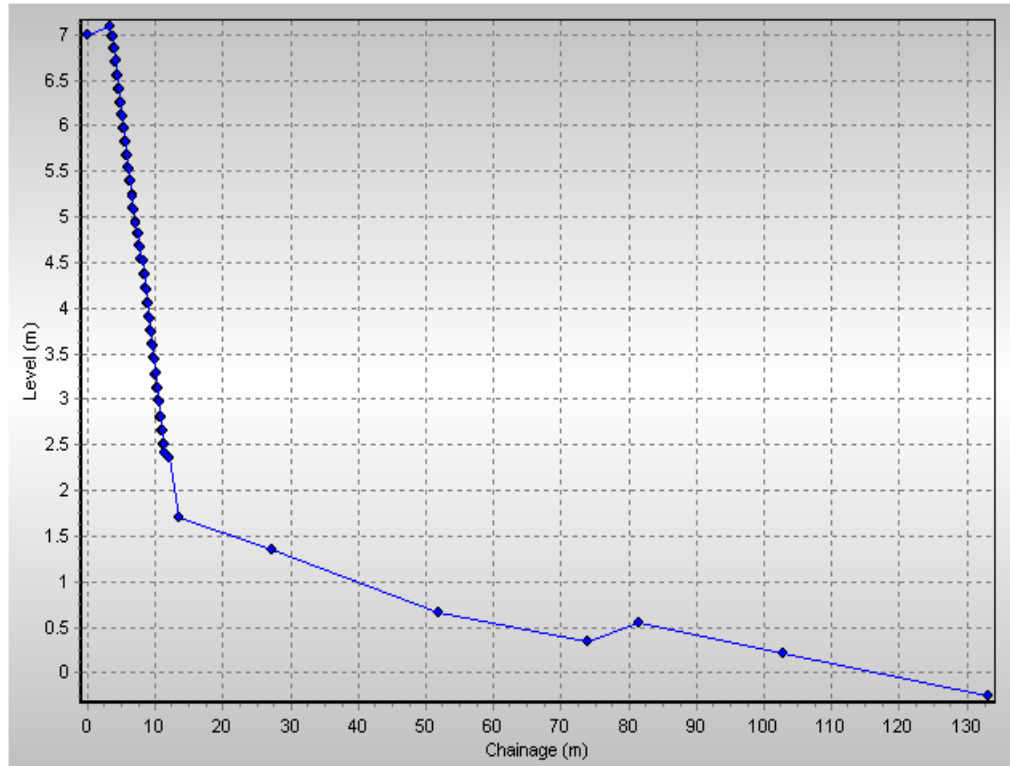
1cRC5

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

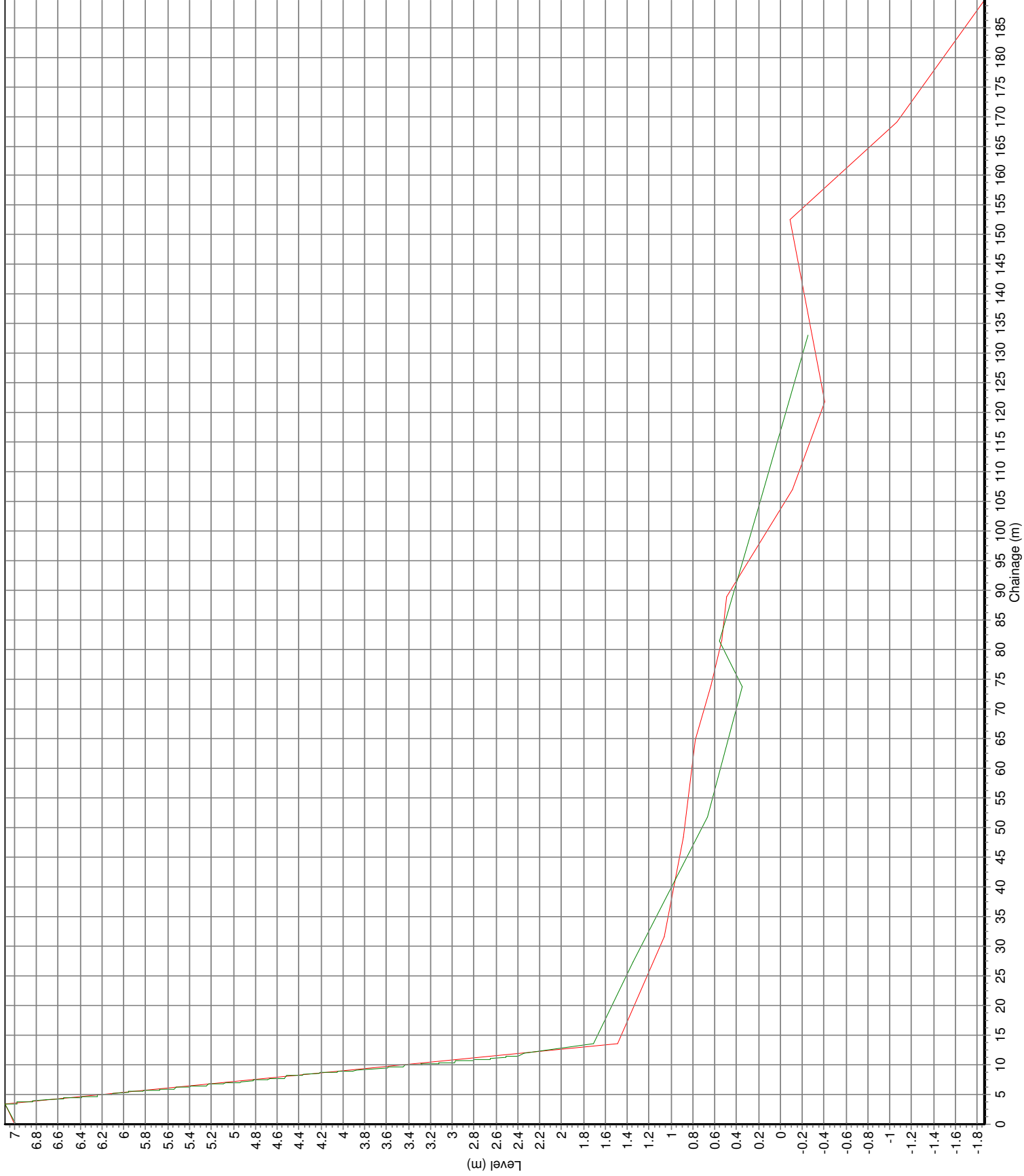
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

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

Chainage	Level
0.000	6.988
0.000	6.988
3.420	7.087
3.440	6.978
3.720	6.973
3.730	6.840
3.940	6.840
4.070	6.699
4.190	6.710
4.240	6.549
4.460	6.549
4.480	6.390
4.710	6.398
4.720	6.245
4.970	6.242
4.990	6.111
5.220	6.105
5.300	5.962
5.460	5.961
5.500	5.828
5.700	5.819
5.770	5.675
5.960	5.670
5.980	5.537
6.220	5.523
6.230	5.398
6.440	5.388
6.520	5.245
6.720	5.230
6.750	5.088
6.980	5.072
7.020	4.944
7.210	4.927
7.240	4.819
7.470	4.816
7.510	4.687
7.720	4.666
7.760	4.535
8.230	4.516
8.260	4.365
8.470	4.364
8.510	4.215
8.710	4.207
8.720	4.053
8.940	4.043
8.960	3.905
9.170	3.875
9.210	3.747
9.360	3.733
9.480	3.595



Beach Profiles: 1cRC5



17/1/2008
30/04/2009

Beach Profile

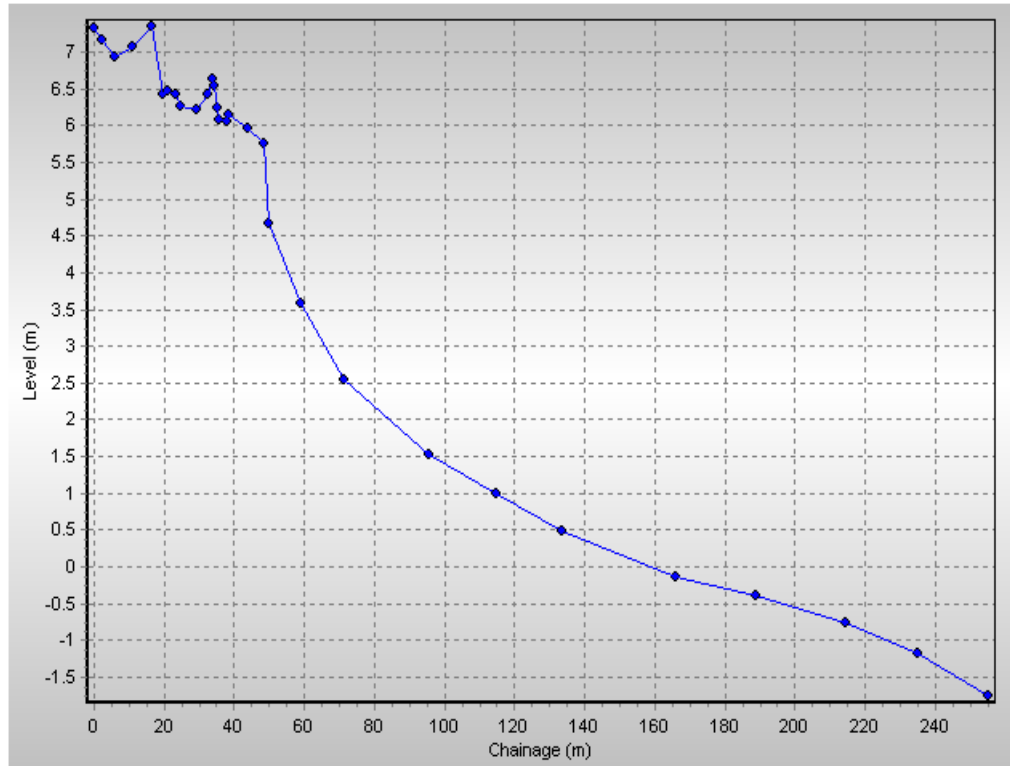
1cRC6

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

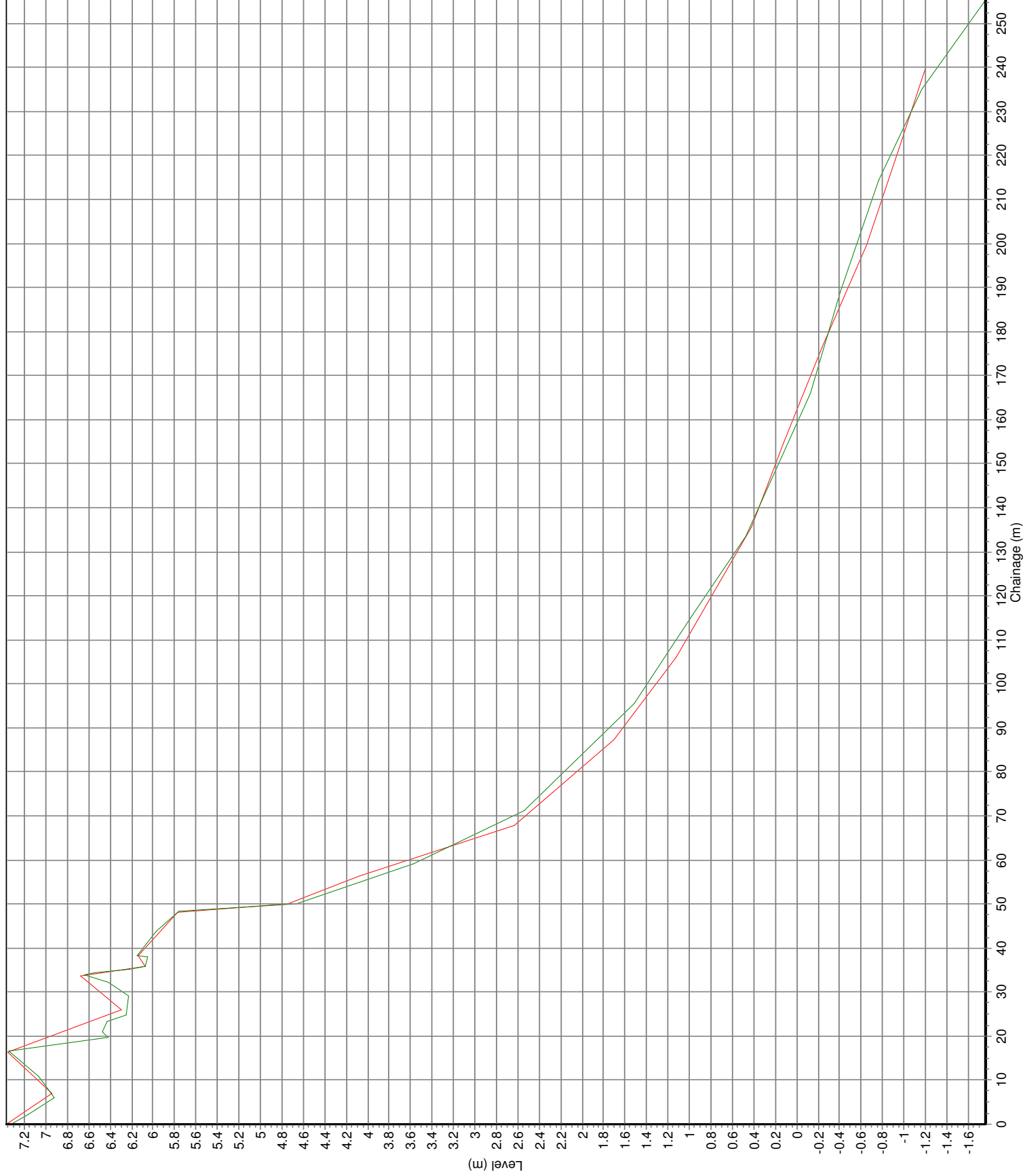
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

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

Chainage	Level
0.000	7.319
0.010	7.319
2.240	7.166
5.970	6.926
10.900	7.061
16.680	7.349
19.810	6.422
20.830	6.470
23.310	6.427
24.710	6.252
29.120	6.226
32.320	6.413
34.020	6.637
34.450	6.536
35.110	6.234
35.860	6.072
38.040	6.050
38.280	6.150
43.740	5.971
48.290	5.765
50.080	4.661
59.180	3.575
71.270	2.543
95.590	1.517
114.970	0.986
133.450	0.481
166.000	-0.129
189.000	-0.401
214.450	-0.763
235.000	-1.171
255.230	-1.758



Beach Profiles: 1cRC6



17/1/2008
30/04/2009

Beach Profile

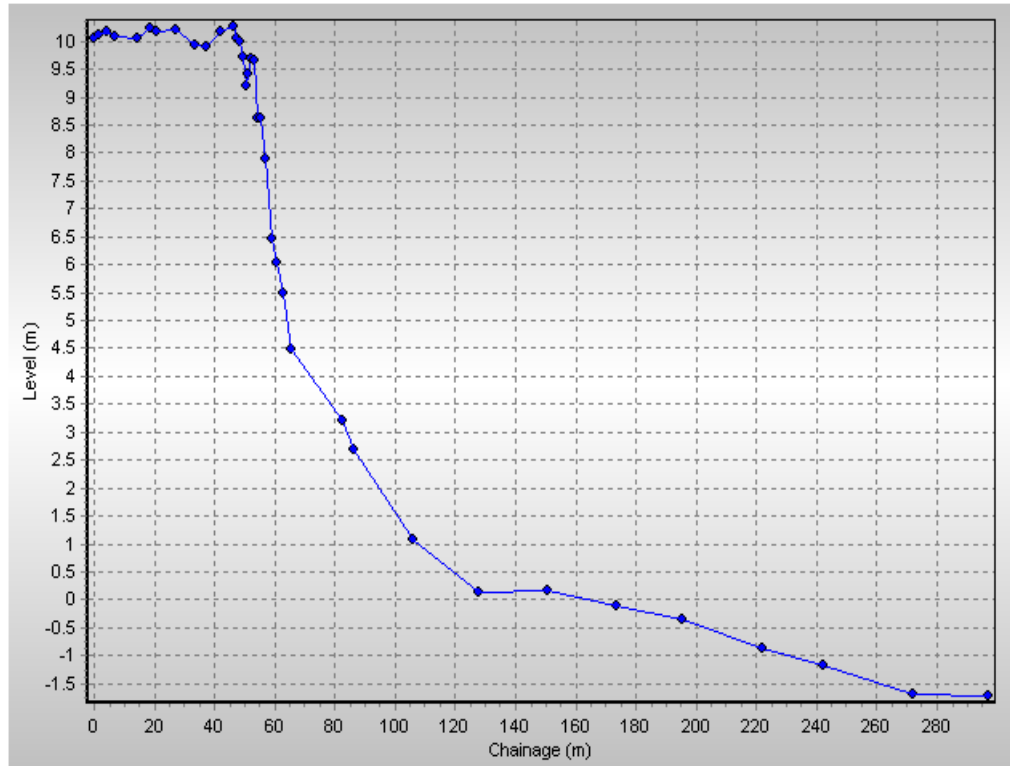
1cRC7

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

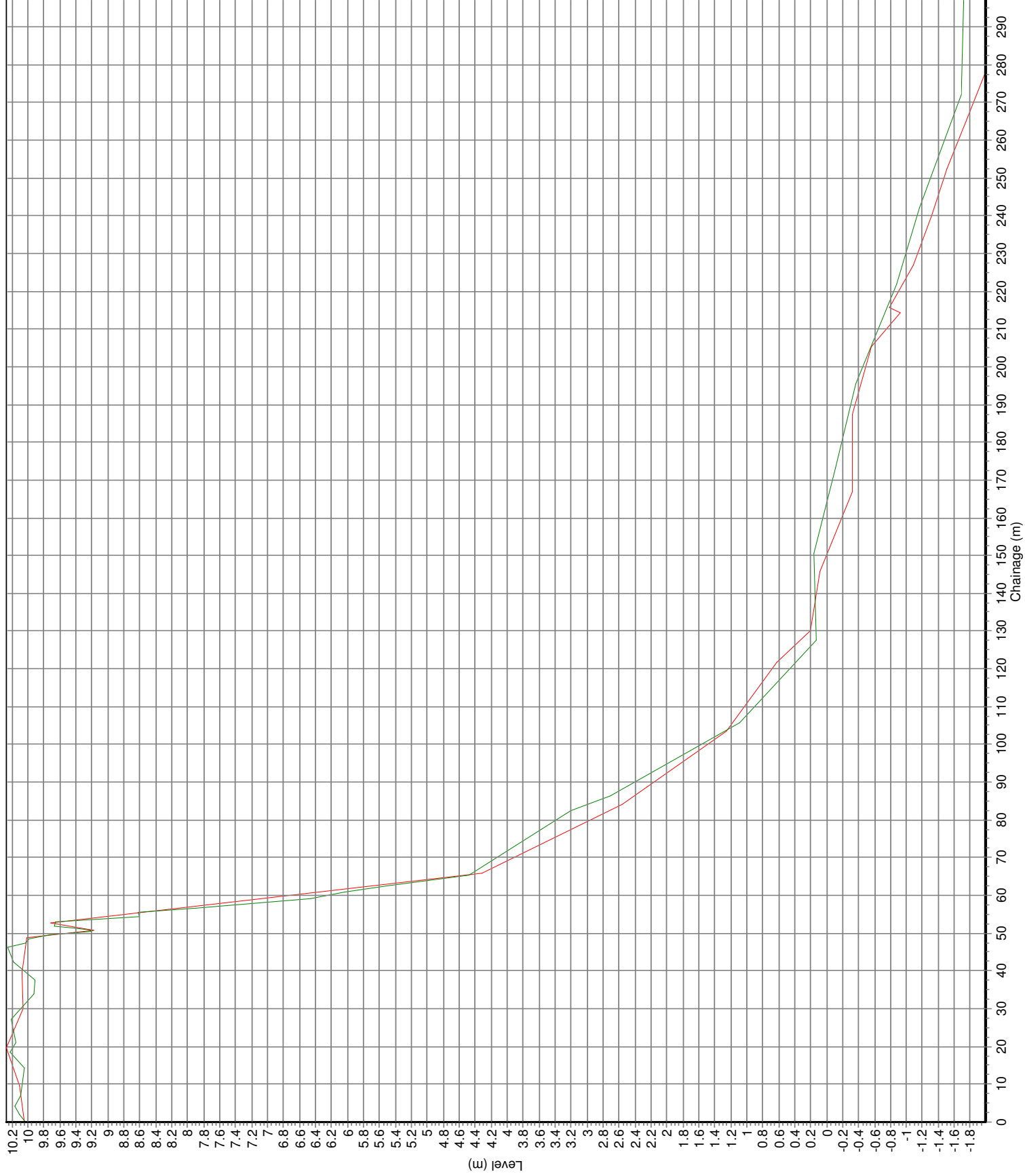
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

Easting 462568.450 **Northing** 523568.440 **Bearing** 37

Chainage	Level
0.000	10.036
0.080	10.036
1.860	10.113
4.210	10.169
7.130	10.095
14.210	10.044
18.540	10.231
20.930	10.157
27.170	10.211
33.800	9.930
37.450	9.913
42.240	10.181
46.300	10.263
47.530	10.036
48.660	9.989
49.550	9.719
50.510	9.209
50.810	9.190
51.260	9.421
51.970	9.678
52.990	9.656
54.520	8.610
55.610	8.625
56.760	7.894
59.100	6.454
60.740	6.036
62.650	5.493
65.430	4.477
82.380	3.201
86.270	2.703
105.770	1.081
127.710	0.134
150.490	0.164
173.350	-0.111
195.610	-0.364
221.830	-0.881
242.130	-1.166
271.940	-1.685
297.020	-1.722



Beach Profiles: 1cRC7



17/1/2008
30/04/2009

Beach Profile

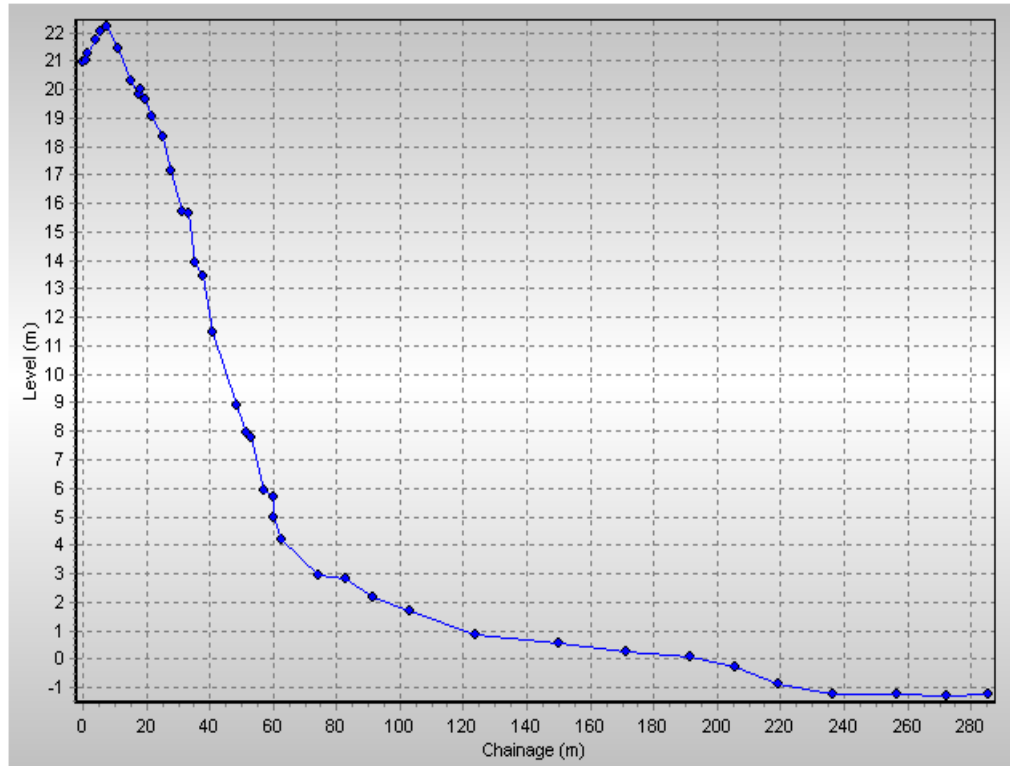
1cRC8

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

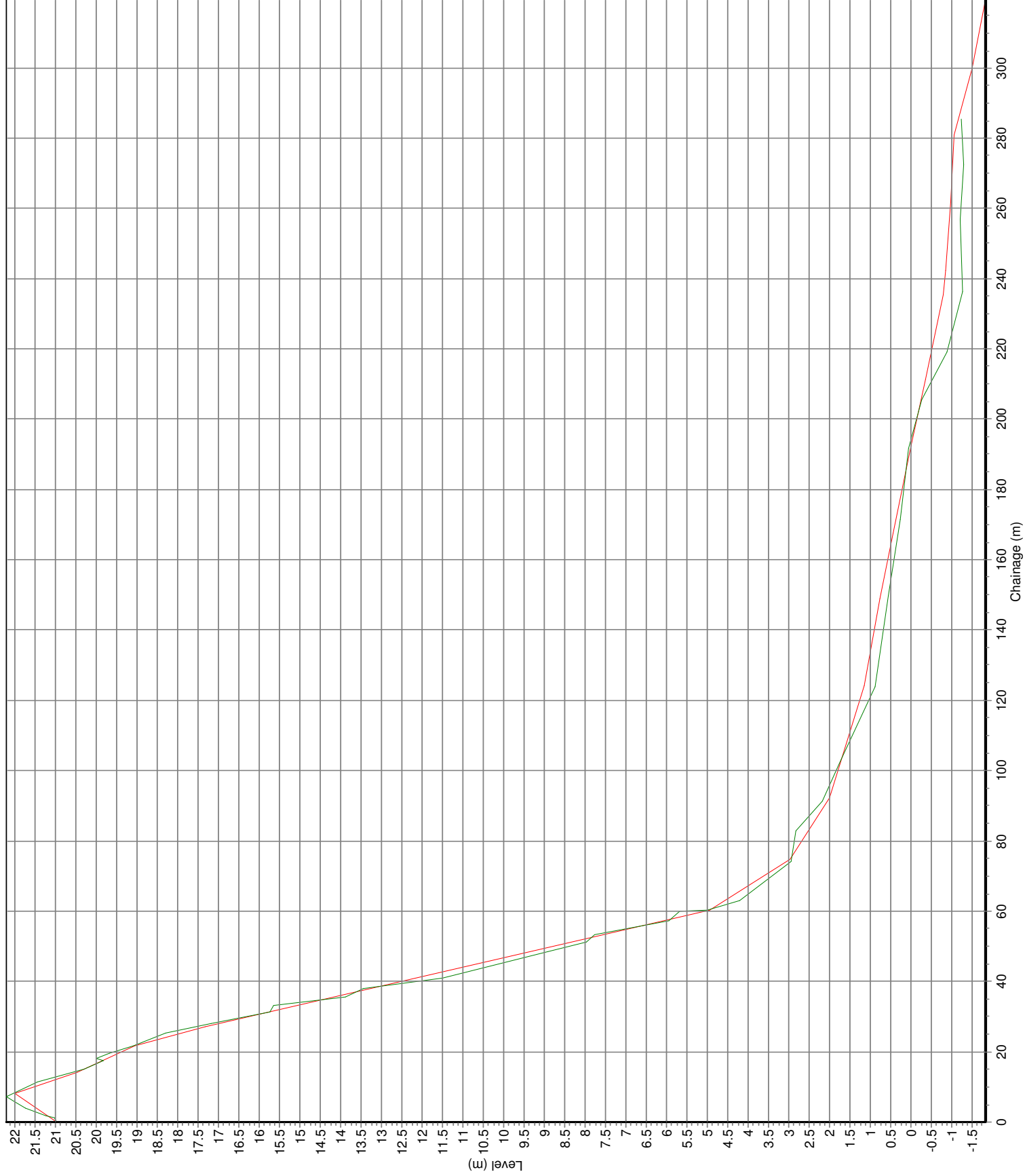
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

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

Chainage	Level
0.000	20.968
0.030	20.968
1.070	21.050
1.700	21.250
3.800	21.750
5.770	22.015
7.370	22.214
11.320	21.453
15.050	20.308
17.480	19.817
18.220	19.999
19.730	19.671
21.640	19.081
25.170	18.311
27.900	17.170
31.330	15.731
33.200	15.649
35.470	13.900
38.060	13.444
40.910	11.504
48.570	8.903
51.290	7.968
53.250	7.763
57.290	5.948
59.900	5.672
60.130	4.995
62.870	4.210
74.140	2.937
82.870	2.816
91.420	2.173
103.320	1.700
123.810	0.883
149.830	0.570
171.360	0.275
191.710	0.064
205.490	-0.257
219.070	-0.885
236.420	-1.256
256.820	-1.213
272.410	-1.293
285.490	-1.231



Beach Profiles: 1cRC8



17/1/2008
30/04/2009

Beach Profile

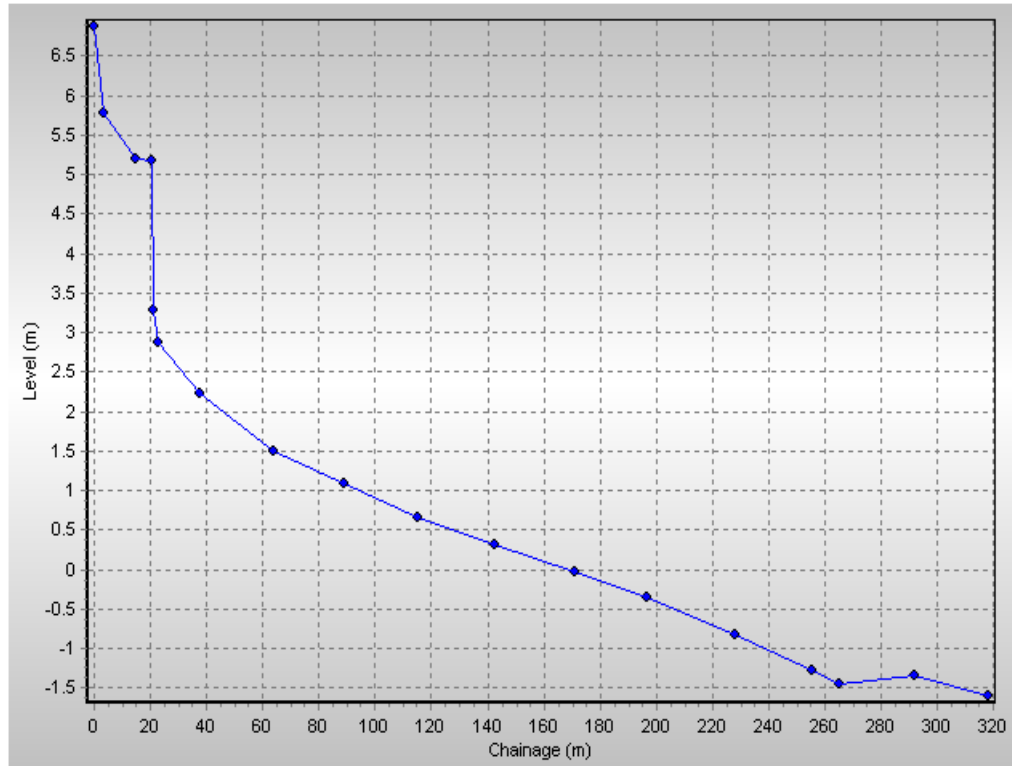
1cRC9

Date 30/04/2009 **Inspector** RH
Wind Light **Sea State**
Summary

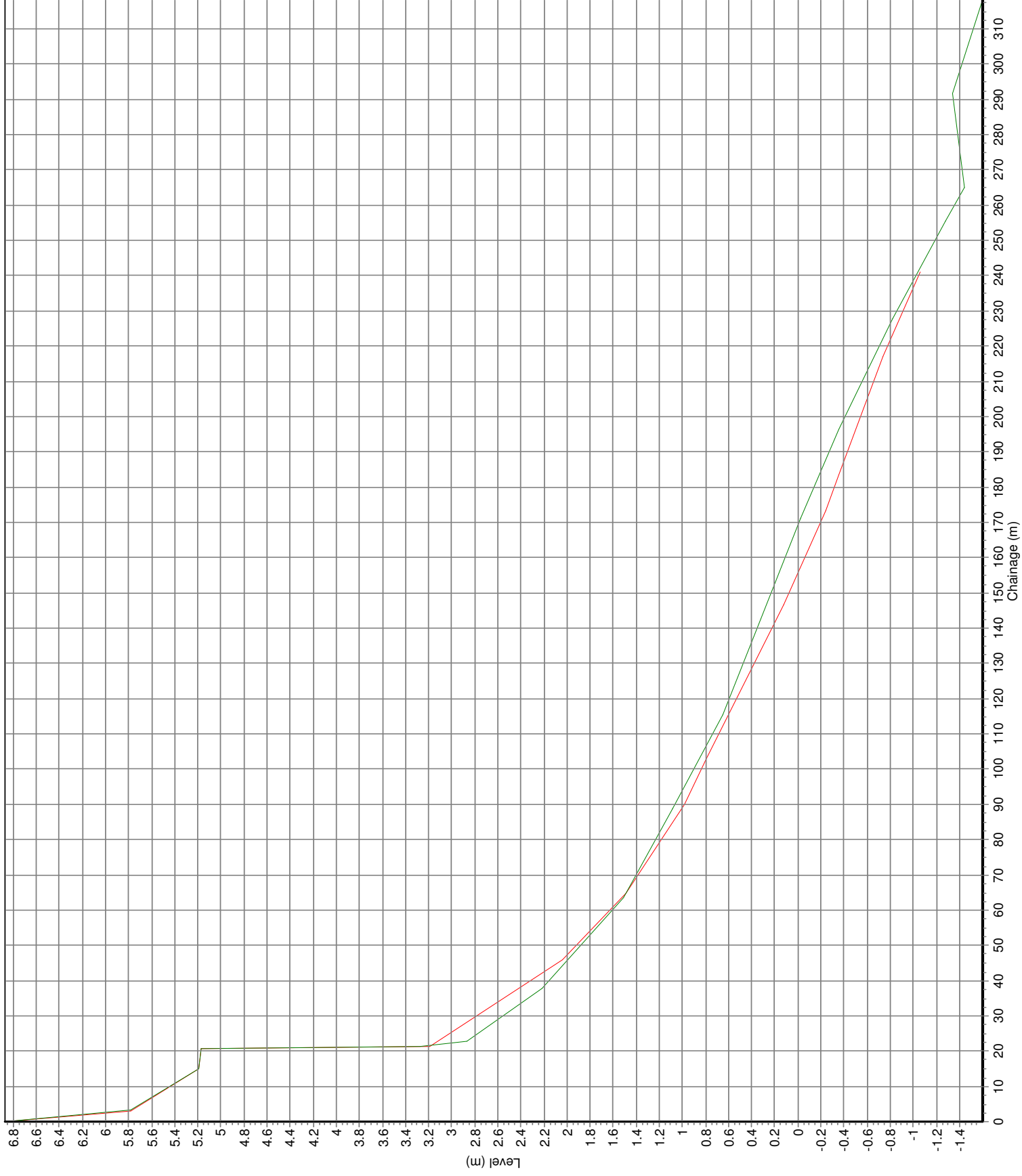
Low Tide (m)
Visibility Good **Low Tide Time**
Rain No

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

Chainage	Level
0.000	6.871
0.040	6.871
3.190	5.782
14.930	5.189
20.740	5.171
21.190	3.274
22.770	2.868
37.800	2.218
63.640	1.506
88.660	1.083
115.340	0.651
142.790	0.315
171.230	-0.021
196.490	-0.358
227.850	-0.825
255.560	-1.282
265.010	-1.448
291.620	-1.345
318.100	-1.599



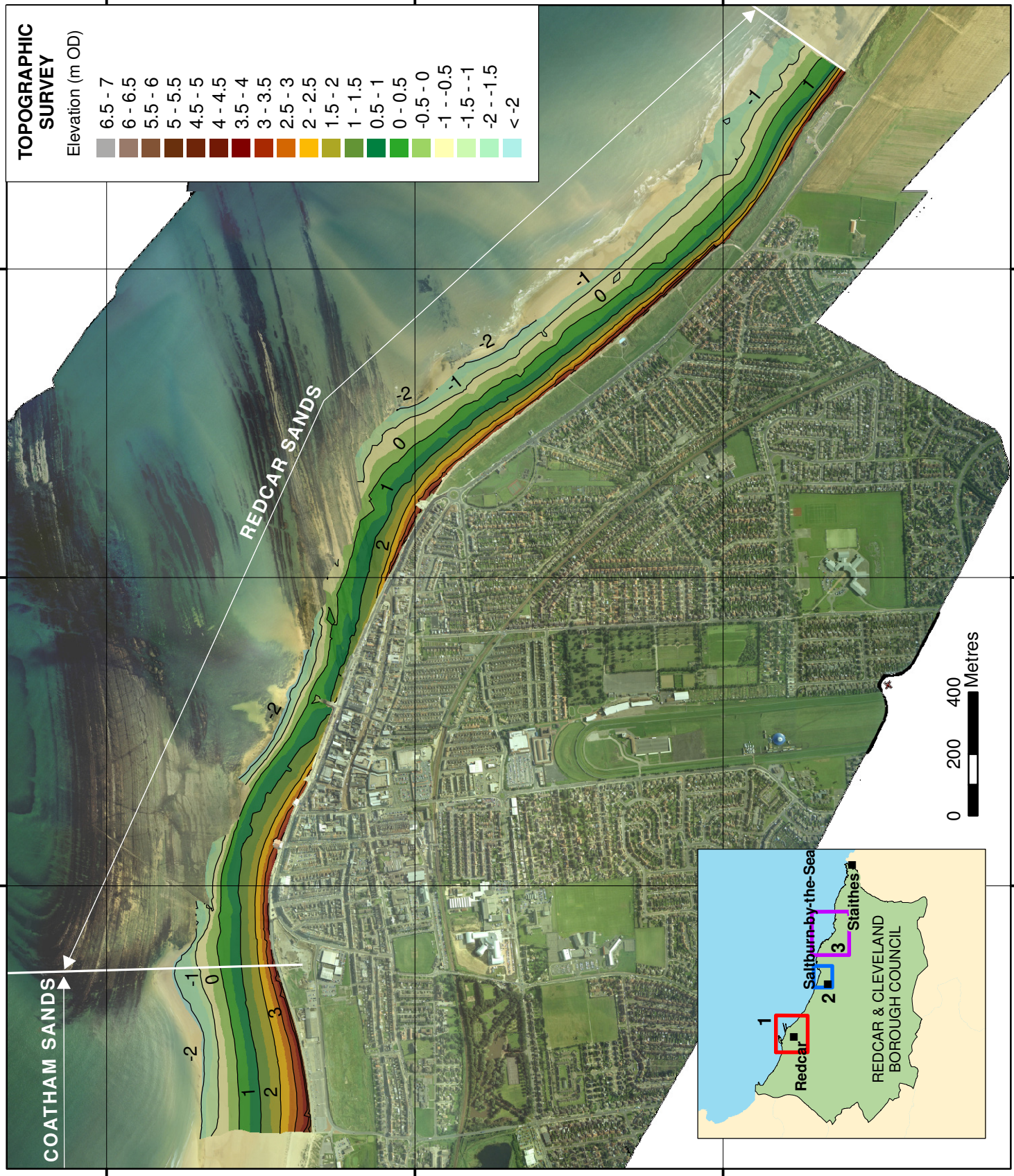
Beach Profiles: 1cRC9



17/1/2008
30/04/2009

Appendix B
Topographic Survey

<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 1a Redcar & Cleveland Borough Council Frontage</p> <p>Update Report 1 'Partial Measures' Survey 2009</p> <p>Drawing Scale 1:17,000 at A4</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>Tel: +44 (0)191 211 1300 Tel: +44 (0)121 456 2345</p> <p>Fax: +44 (0)191 211 1313 Fax: +44(0)121 456 1569</p> <p>www.royalhaskoning.com www.halcrow.com</p> <p>© Aerial Photography copyright Scarborough Borough Council</p>		



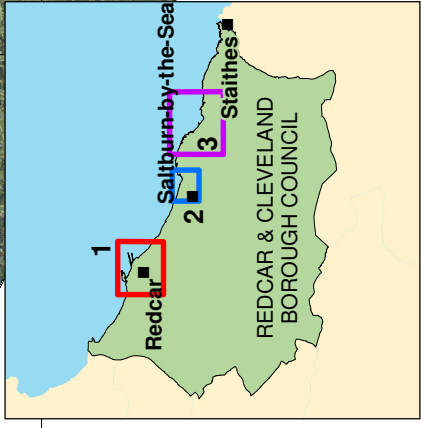
TOPOGRAPHIC SURVEY
Elevation (m OD)

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

COATHAM SANDS

REDCAR SANDS

0 200 400 Metres



526000

525000

524000

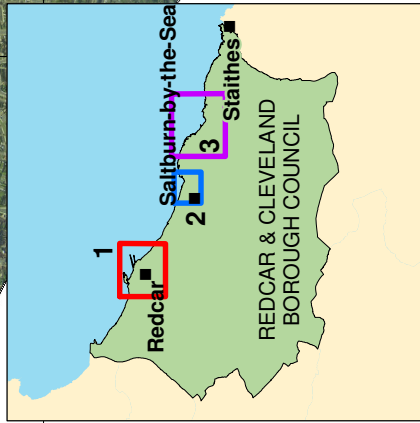
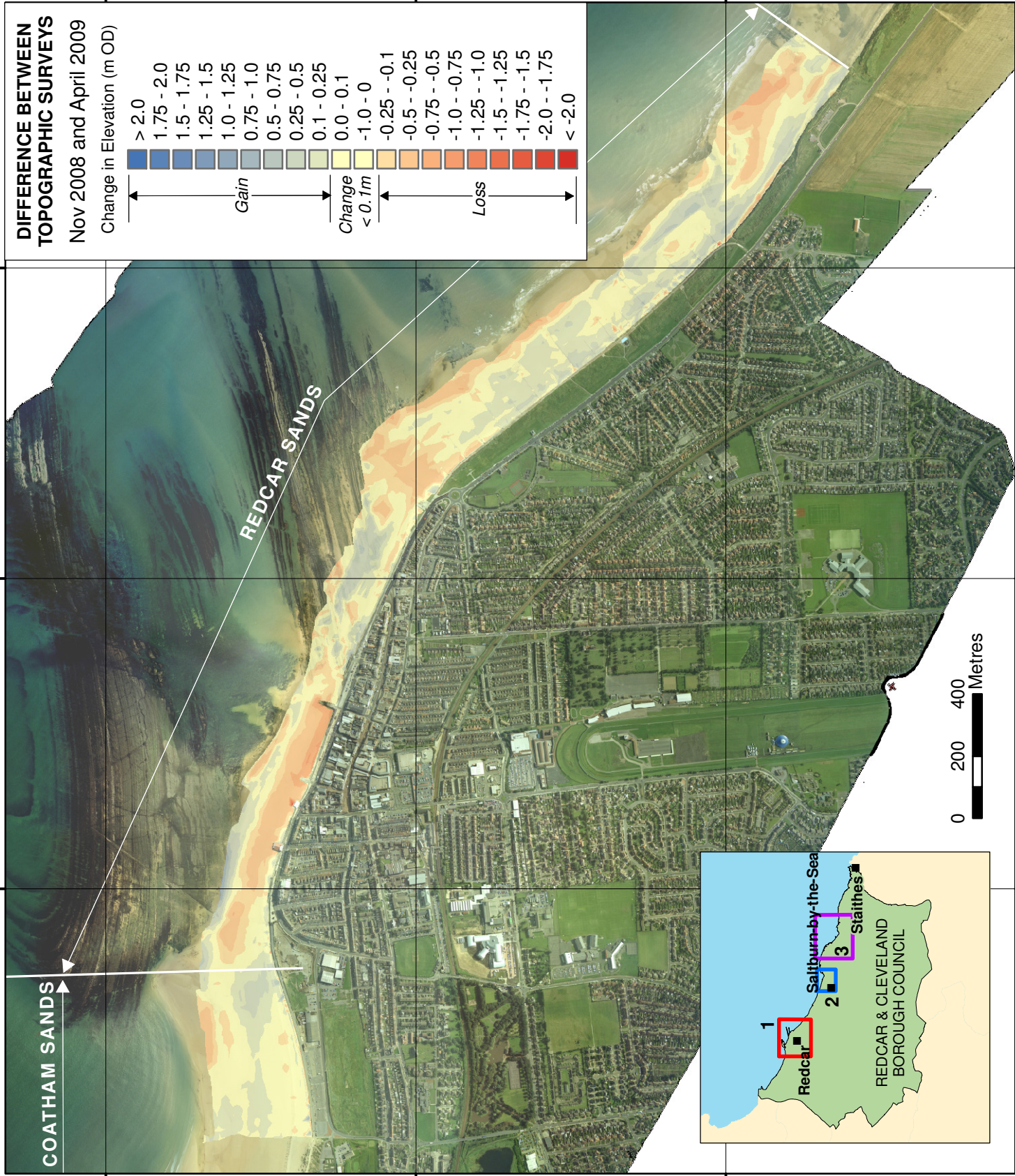
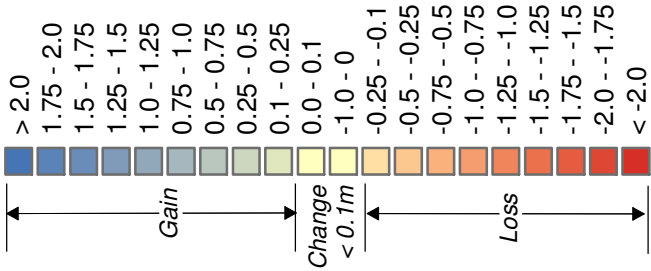
460000

461000

462000

DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Nov 2008 and April 2009

Change in Elevation (m OD)



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

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

Update Report 1
 'Partial Measures' Survey 2009

Drawing Scale 1:17,000 at A4
Drawn by: TC Date: 08/05/2009
Checked by: NC Date: 08/05/2009
Approved by: NC Date: 08/05/2009



ROYAL HASKINING
 Royal Haskoning
 Marlborough House
 Marlborough Crescent
 Newcastle upon Tyne
 NE1 4EE

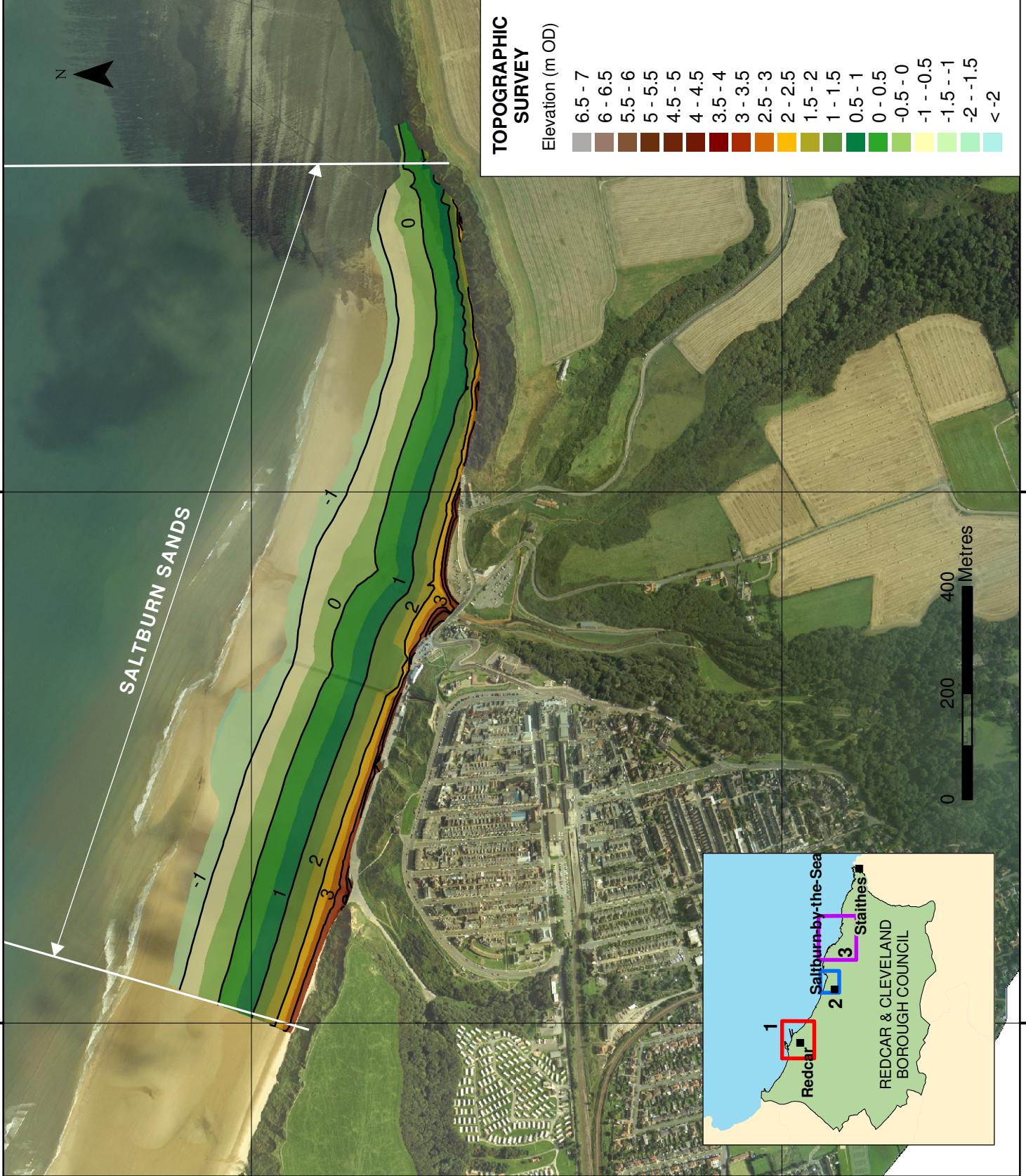
halcrow
 Halcrow Group Ltd
 Lyndon House
 62 Hagley Road
 Edgbaston
 Birmingham
 B16 8PE

Tel: +44 (0)191 211 1300
 Fax: +44 (0)191 211 1313
 www.royalhaskoning.com

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

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<p>— Topographic Contours at 1 metre interval</p>	<p>Client: North East Coastal Group Project: Cell 1 Regional Coastal Monitoring Programme</p>	<p>Appendix B - Map 2a Redcar & Cleveland Borough Council Frontage</p> <p>Update Report 1 'Partial Measures' Survey 2009</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 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 www.halcrow.com</p> <p>© Aerial Photography copyright Scarborough Borough Council</p>

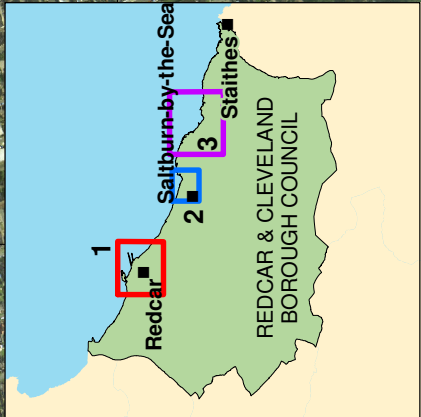


TOPOGRAPHIC SURVEY

Elevation (m OD)

- 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

SALTBURN SANDS





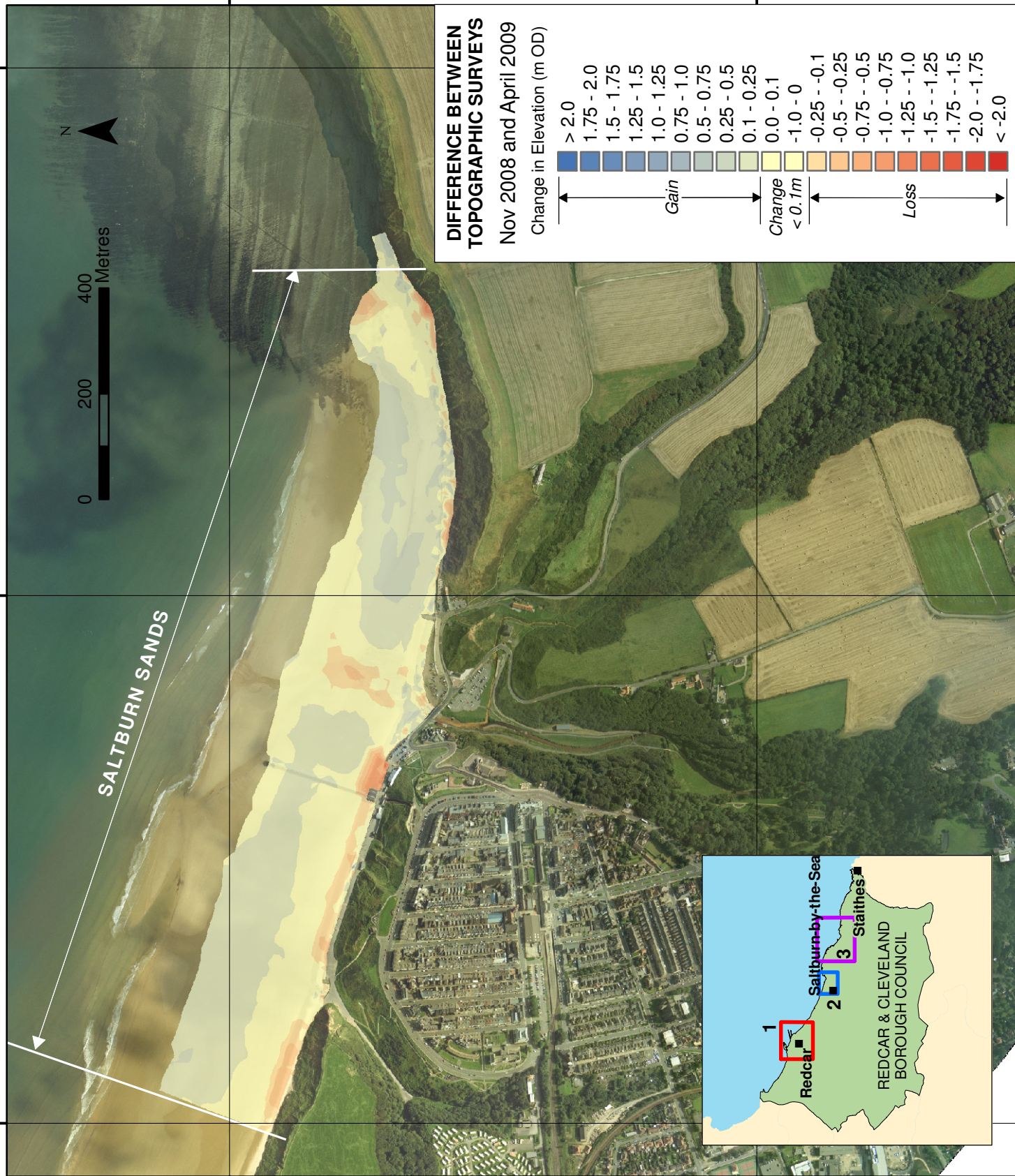
522000

521000

466000

467000

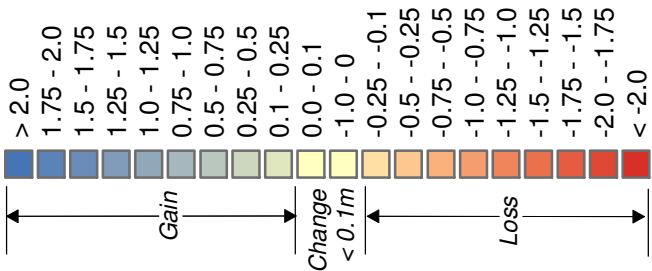
Client: North East Coastal Group	 Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE Tel: +44 (0)121 211 1300 Fax: +44 (0)121 456 2345 www.halcrow.com
Project: Cell 1 Regional Coastal Monitoring Programme	
Appendix B - Map 2b Redcar & Cleveland Borough Council Frontage	
Update Report 1 'Partial Measures' Survey 2009	
Drawing Scale 1:10,000 at A4	
Drawn by: TC	Date: 08/05/2009
Checked by: NC	Date: 08/05/2009
Approved by: NC	Date: 08/05/2009
 Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com	
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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Nov 2008 and April 2009

Change in Elevation (m OD)



SALTBURN SANDS

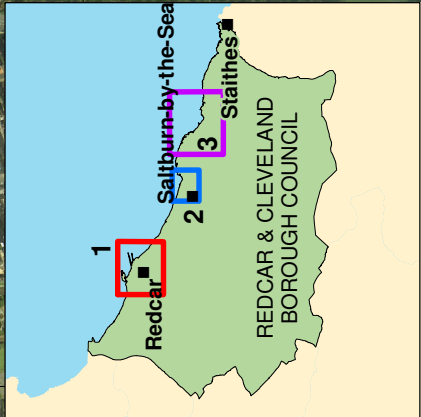
468000

467000

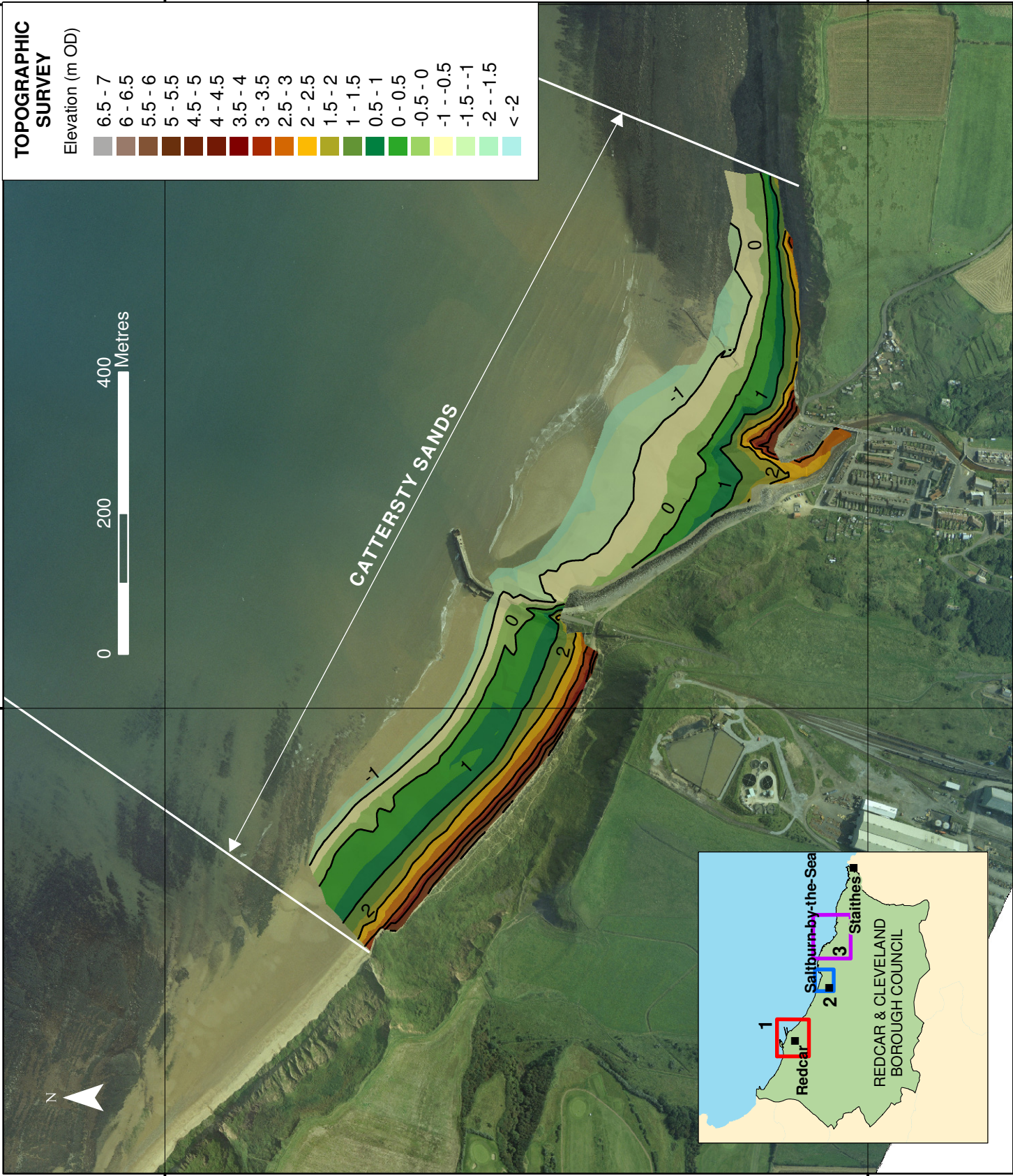
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522000

521000



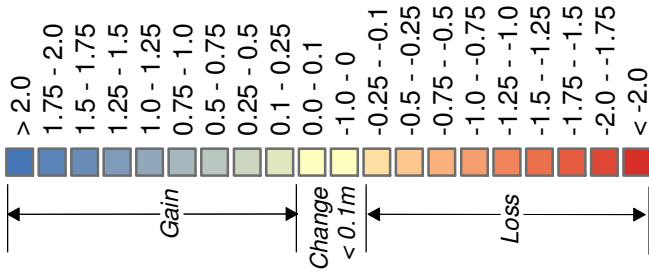
<p>— Topographic Contours at 1 metre interval</p>	<p>Client: North East Coastal Group</p> <p>Project: Cell 1 Regional Coastal Monitoring Programme</p>	<p>Appendix B - Map 3a Redcar & Cleveland Borough Council Frontage</p> <p>Update Report 1 'Partial Measures' Survey 2009</p> <p>Drawing Scale 1:7,500 at A4</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>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	<p>ROYAL HASKINING</p> <p>Royal Haskoning Marlborough House Newcastle upon Tyne NE1 4EE</p> <p>Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com</p> <p>halcrow</p> <p>Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE</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>
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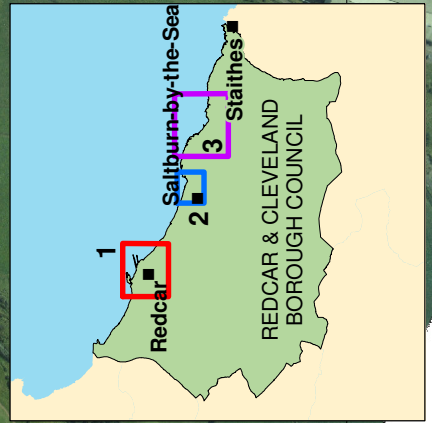
DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Dec 2008 and April 2009

Change in Elevation (m OD)



CATTERSTY SANDS



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

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

Update Report 1
 'Partial Measures' Survey 2009

Drawing Scale 1:7,500 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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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 April 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.

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 (Nov 2008)	Previous Survey (Nov 2008)	Present Survey (April 2009)	Baseline (Nov 2008) to Present (April 2009)	Previous (Nov 2008) to Present (April 2009)	Baseline (Nov 2008) to Present (April 2009)
1	477228	518769	60.587	320	1.9	1.9	1.7	-0.2	-0.2	-0.5
2	477334	518798	57.543	0	10.9	10.9	10.6	-0.3	-0.3	-0.7
3	477487	518789	54.861	350	7.1	7.1	7.8	+0.7	+0.7	0.0
4	477594	518801	53.636	340	5.9	5.9	5.6	-0.3	-0.3	-0.7
5	477683	518911	48.371	350	8.4	8.4	7.8	-0.6	-0.6	-1.4
6	477792	518867	47.422	30	8.6	8.6	8.5	-0.1	-0.1	-0.2
7	477891	518828	44.602	60	7.7	7.7	7.6	-0.1	-0.1	-0.2
8	477959	518873	39.974	350	8.7	8.7	8.7	0.0	0.0	0.0
9	478088	518950	37.281	350	7.6	7.6	7.3	-0.3	-0.3	-0.7
10	478191	519023	42.655	340	8.4	8.4	8.6	+0.2	+0.2	0.0
11	478237	519007	39.990	60	6.9	6.9	6.8	-0.1	-0.1	-0.2
12	478213	518988	37.169	150	6.1	6.1	6.7	+0.6	+0.6	0.0

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (Nov 2008)	Present Survey (April 2009)	Baseline (Nov 2008) to Present (April 2009)	Previous (Nov 2008) to Present (April 2009)	Baseline (Nov 2008) to Present (April 2009)
13	478501	518809	50.260	15	11.4	11.4	10.9	-0.5	-0.5	-1.2
14	478624	518807	55.345	20	7.5	7.5	7.0	-0.5	-0.5	-1.2
15	478737	518858	56.017	60	6.1	6.1	6.8	+0.7	+0.7	0.0
16	478823	518757	50.237	60	8.0	8.0	8.1	+0.1	+0.1	0.0
17	478944	518671	46.764	30	9.3	9.3	9.5	+0.2	+0.2	0.0
18	479052	518630	47.026	20	9.2	9.2	9.1	-0.1	-0.1	-0.2
19	479147	518610	47.108	0	14.2	14.2	14.4	+0.2	+0.2	0.0
20	479274	518618	44.243	20	11.4	11.4	11.2	-0.2	-0.2	-0.5

Note: It is assumed that the accuracy of cliff top monitoring using this technique is $\pm 0.1\text{m}$. 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.

● Cliff Top Monitoring Points

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

Appendix C - Map 1 Redcar & Cleveland Borough Council Frontage

Update Report 1
'Partial Measures' Survey 2009

Drawing Scale 1:10,000 at A4

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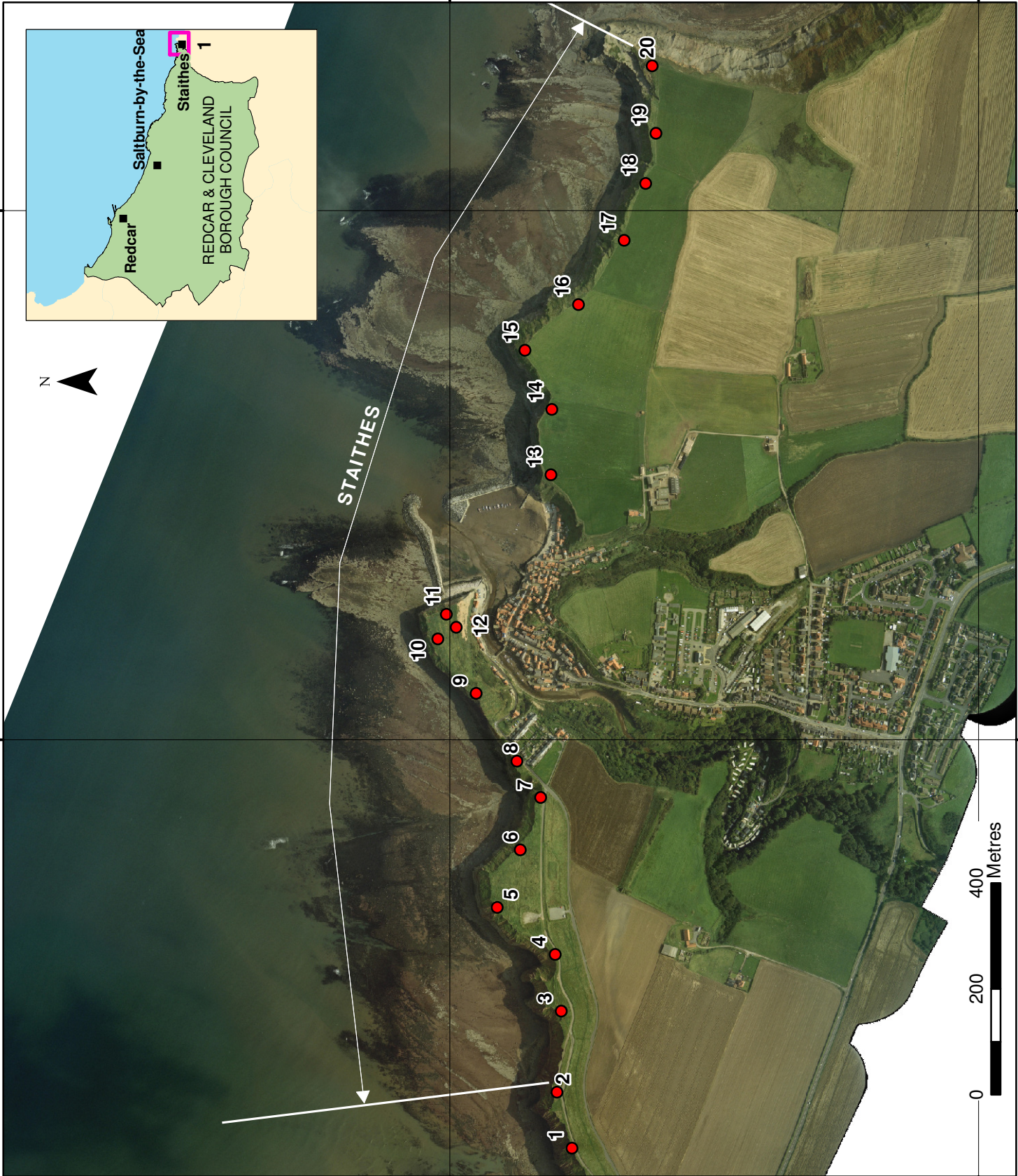


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