



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



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Scarborough Borough Council Final Report

May 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
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
m	metres
ODN	Ordnance Datum Newlyn

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.

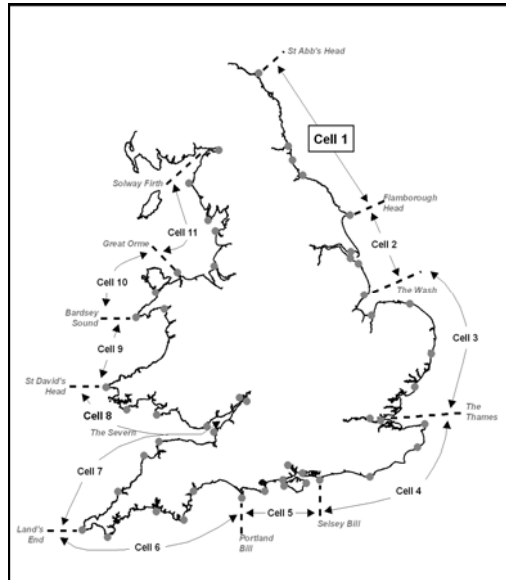


Figure 1 Sediment Cells in England and Wales

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 Scarborough 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, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
Filey Bay	

1. Introduction

1.1 Study Area

Scarborough Borough Council's frontage extends from Staithes Harbour to Speeton (Filey Bay). For the purposes of this report, it has been sub-divided into eight areas, namely:

- Staithes
- Runswick Bay
- Sandsend Beach, Uppang Beach and Whitby Sands
- Robin Hood's Bay
- Scarborough North Bay
- Scarborough South Bay
- Cayton Bay
- Filey Bay

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 Scarborough Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 20 no. transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey along the Sandsend to Whitby frontage
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Scarborough North Bay
 - Topographic survey at Scarborough South Bay
 - Topographic survey at Cayton Bay
 - Topographic survey at Filey Bay (Two surveys: Town and Bay coverage)
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 20 no. transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Filey Bay (Town coverage)
- Cliff top survey bi-annually at:
 - Staithes
 - Cayton Bay
 - Filey

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 Runswick Bay, Cayton Bay, and Filey Bay, the weather conditions were poor- including rain, strong wind, with a sea state ranging fairly choppy to rough. Conditions were windy with rain and snow and a rough sea state during the Staithes survey, whereas the surveys at Robin Hood's Bay, Scarborough North Bay, Scarborough South Bay enjoyed fine weather and calm sea conditions.

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

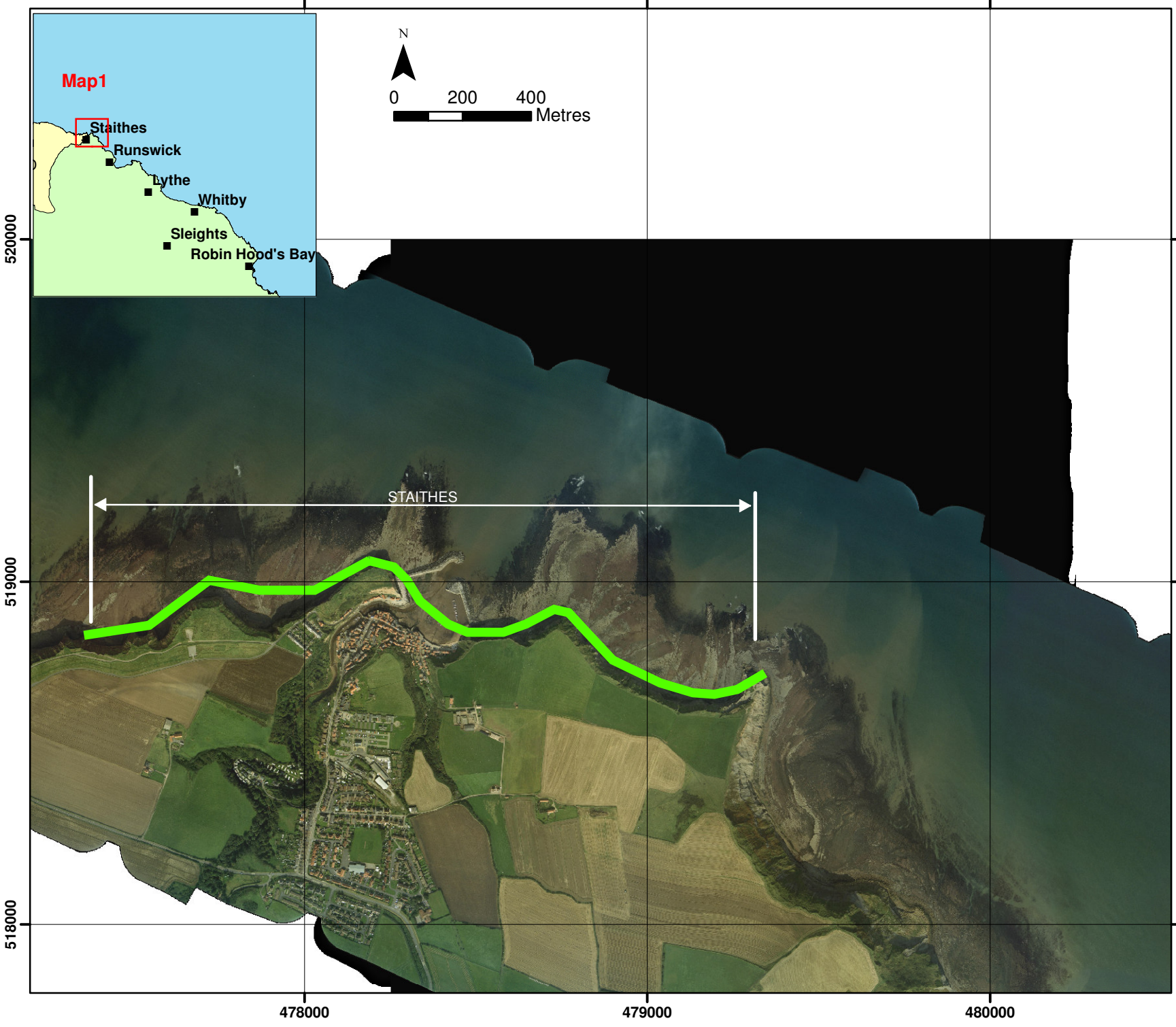
analysis, namely SANDS and Arc-GIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

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
 Scarborough
 Borough Council Frontage**

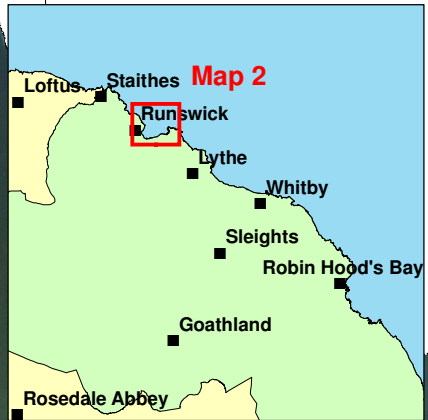
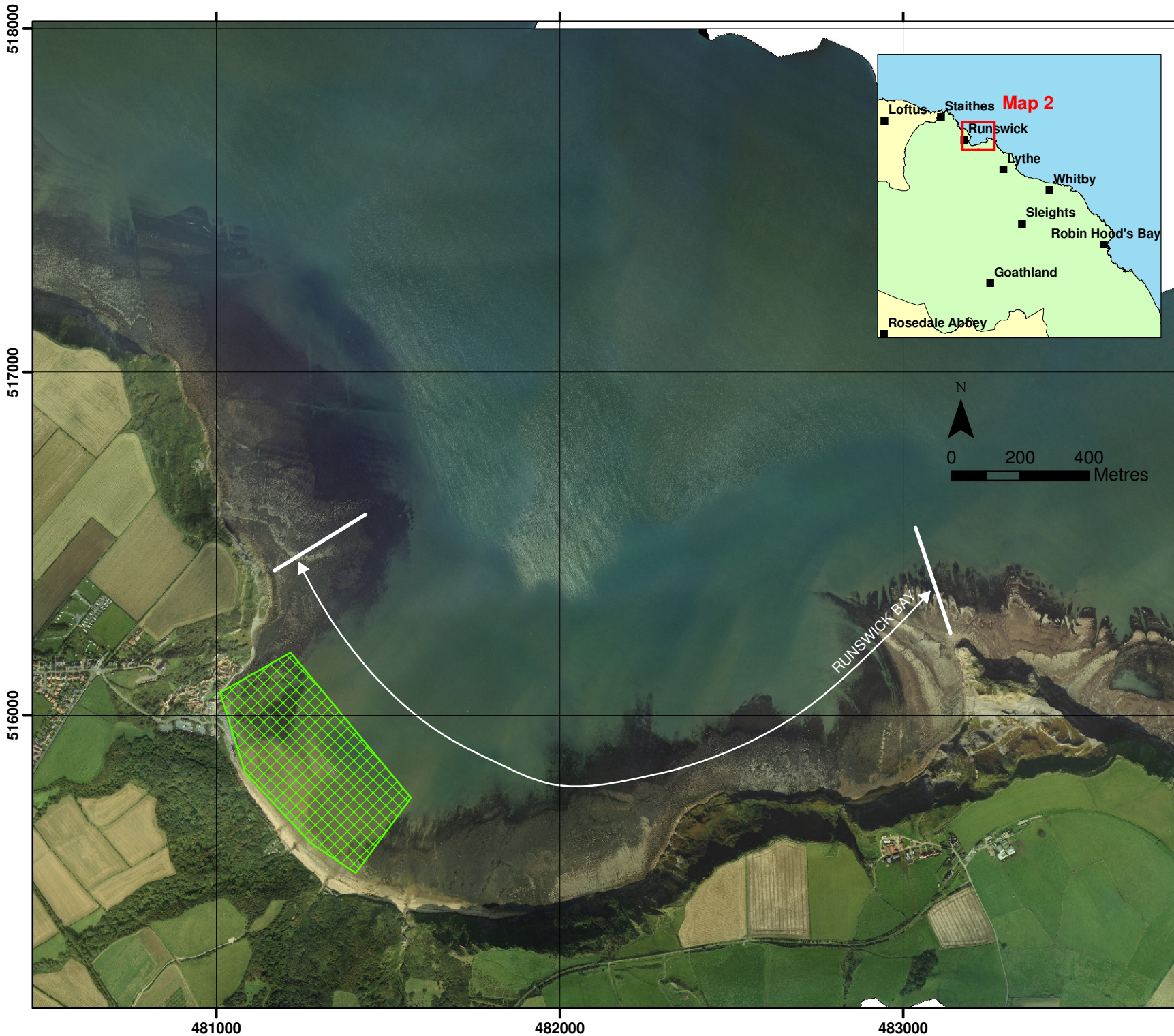
Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:15,000 at A4

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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
Scarborough
Borough Council Frontage**

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'Full Measures' Survey 2008

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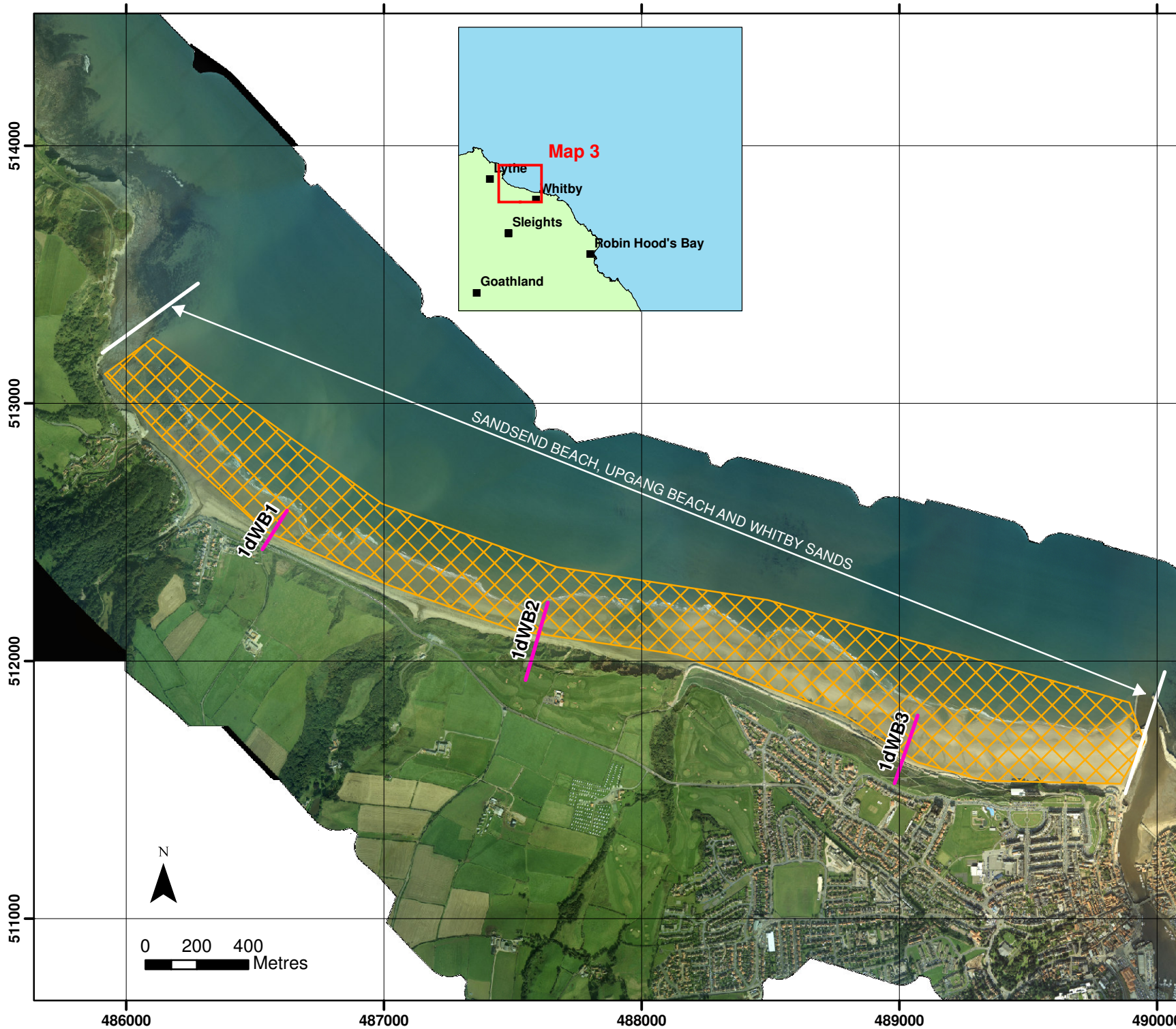


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SURVEY LOCATIONS

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 Scarborough Borough Council Frontage

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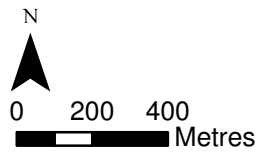
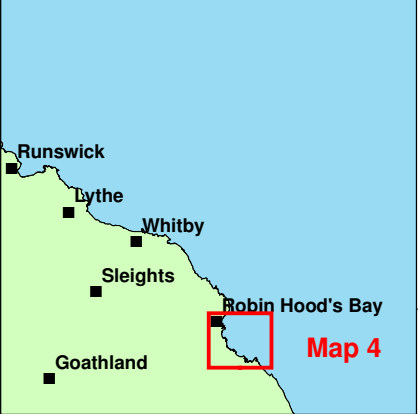
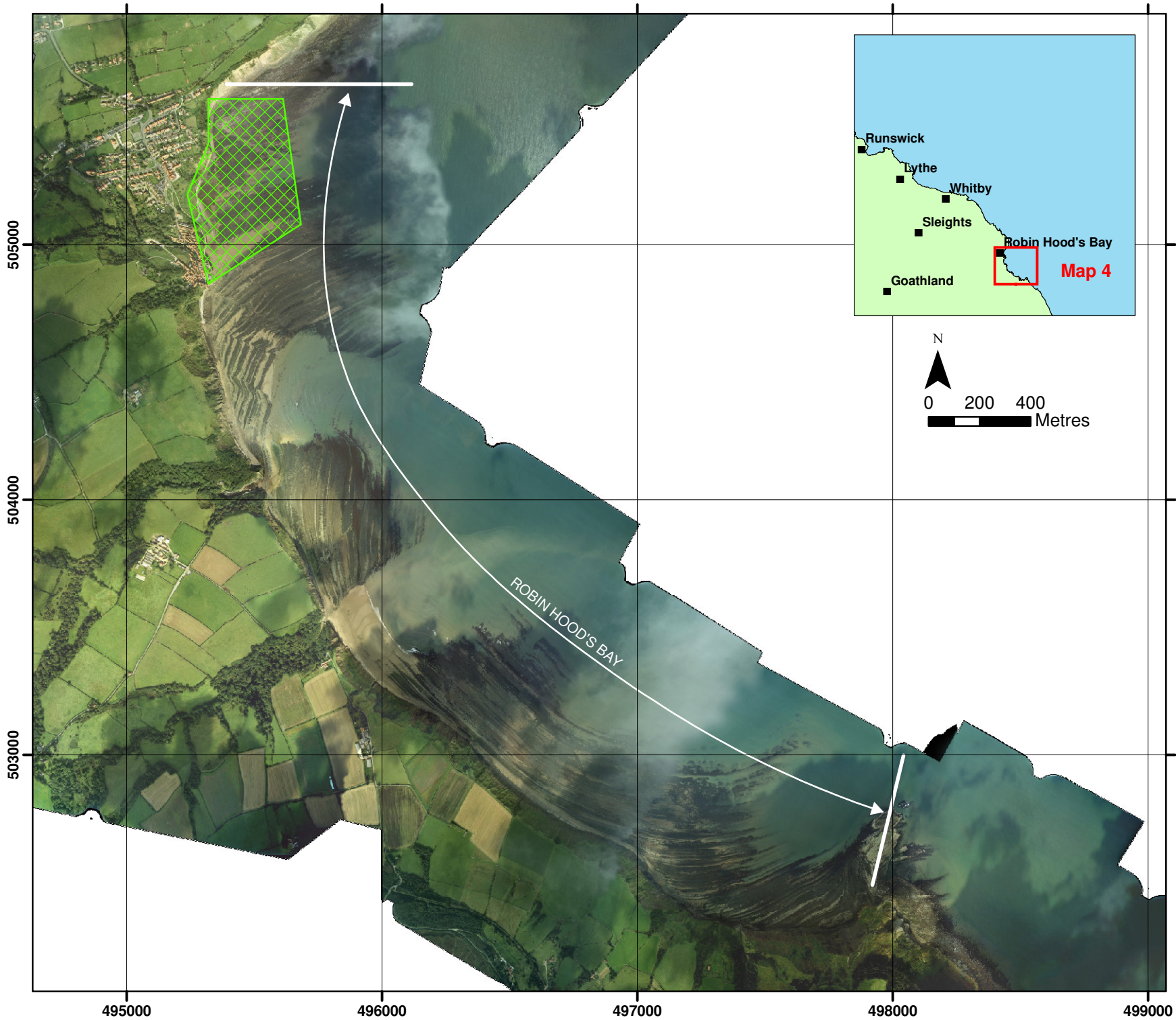


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SURVEY LOCATIONS

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 4
Scarborough
Borough Council Frontage**

Analytical Report 1
'Full Measures' Survey 2008

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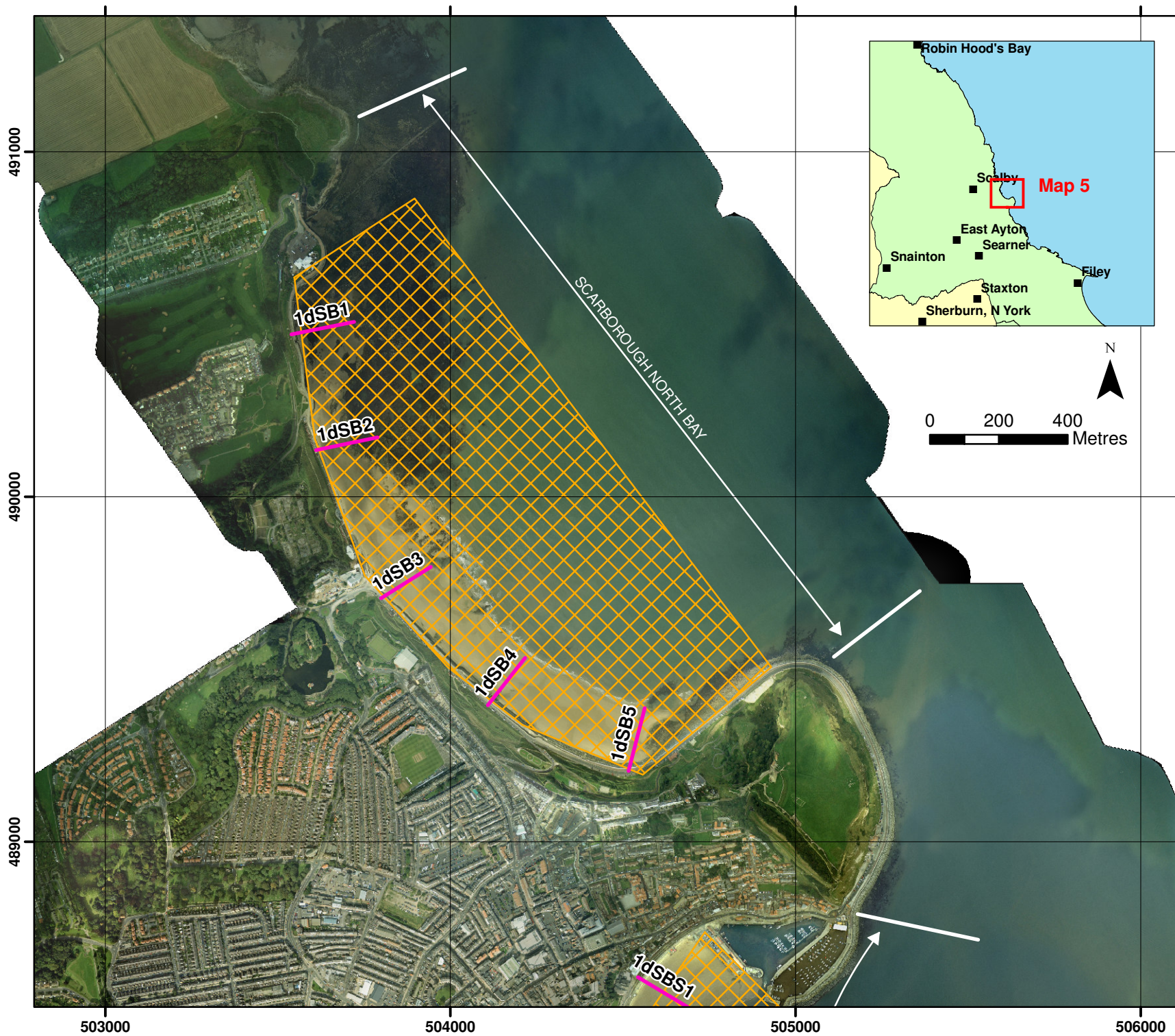
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SURVEY LOCATIONS

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
Scarborough
Borough Council Frontage**

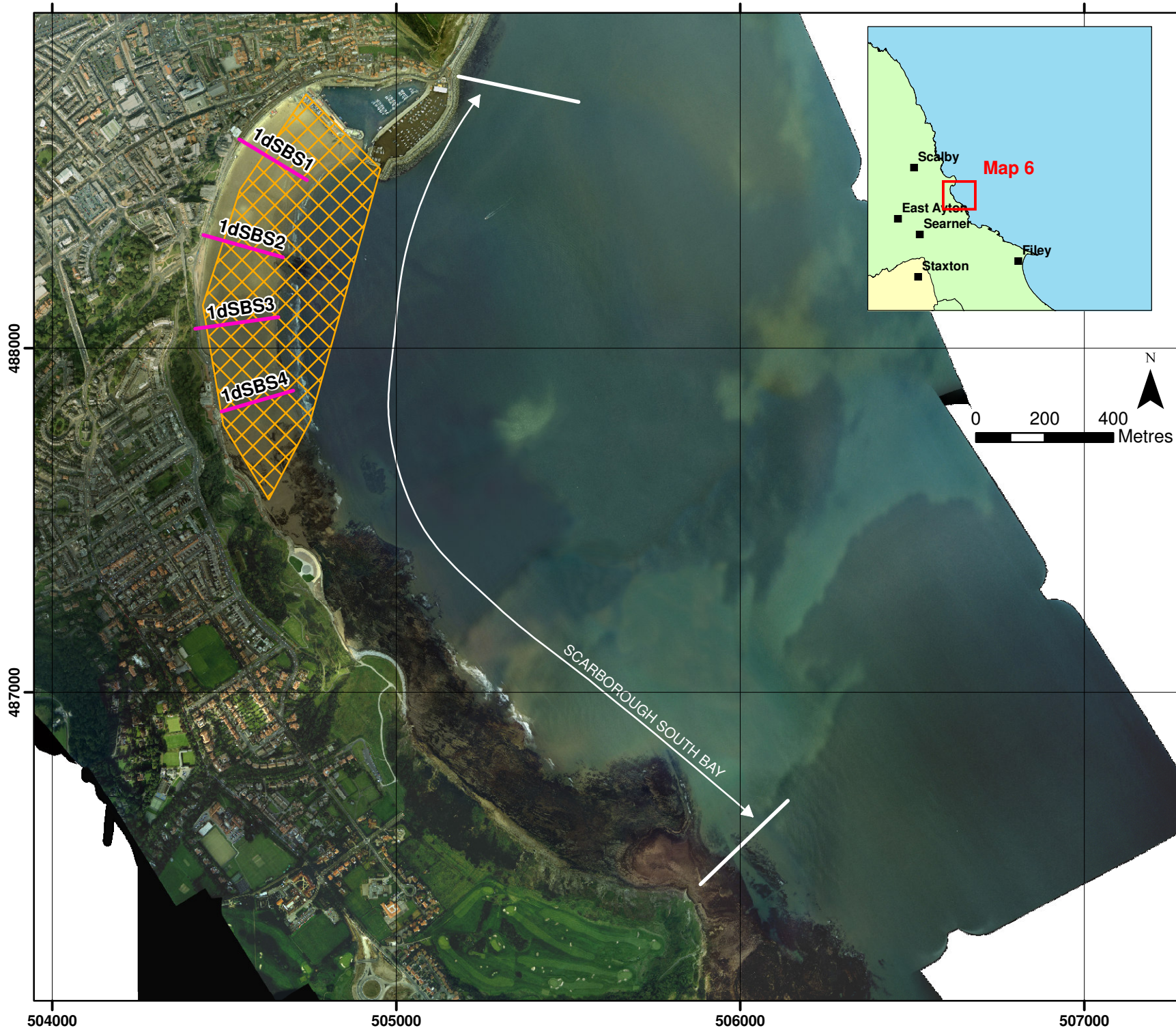
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SURVEY LOCATIONS

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 6
Scarborough
Borough Council Frontage**

Analytical Report 1
'Full Measures' Survey 2008

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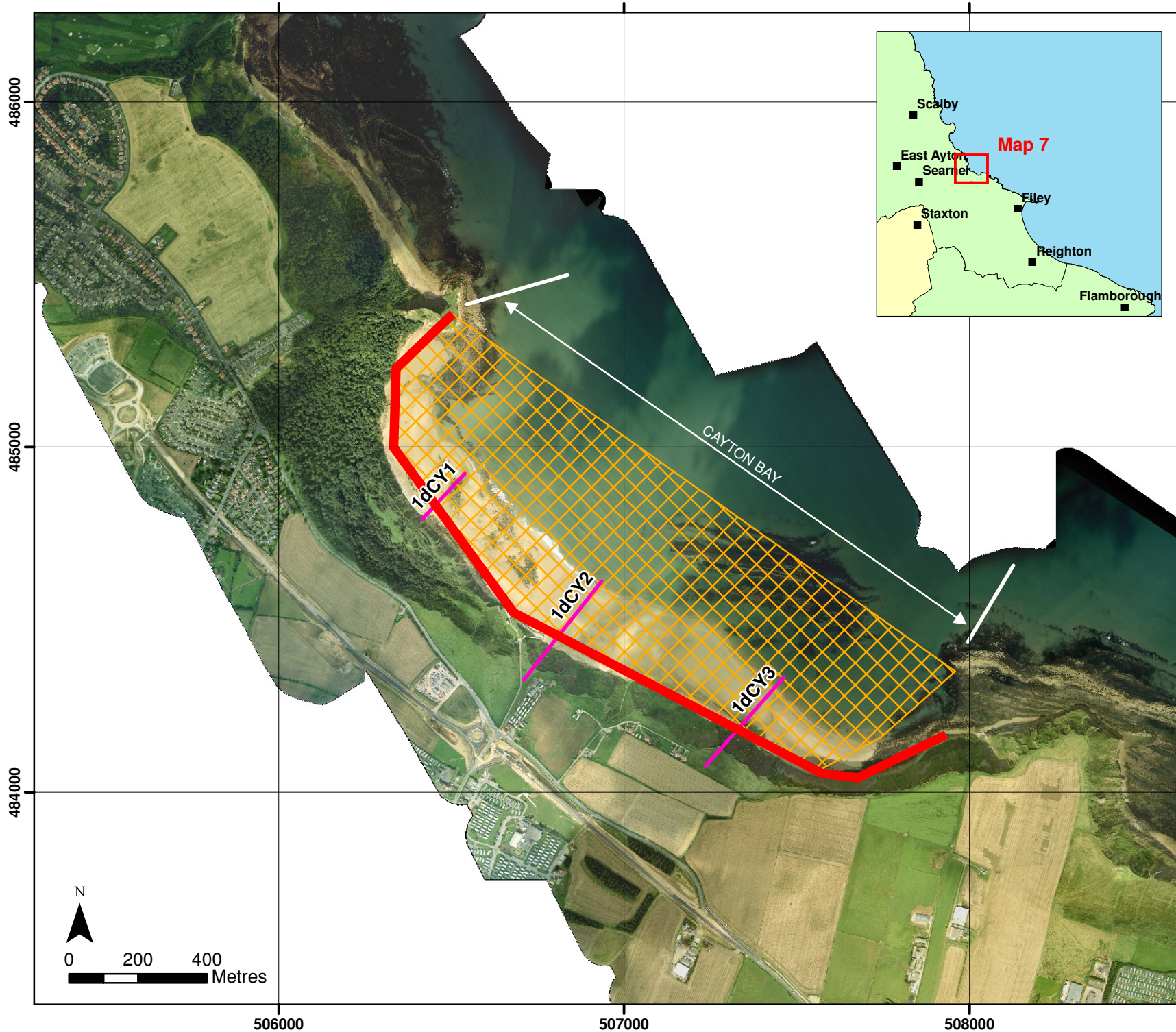
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SURVEY LOCATIONS

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 7 Scarborough Borough Council Frontage

Analytical Report 1
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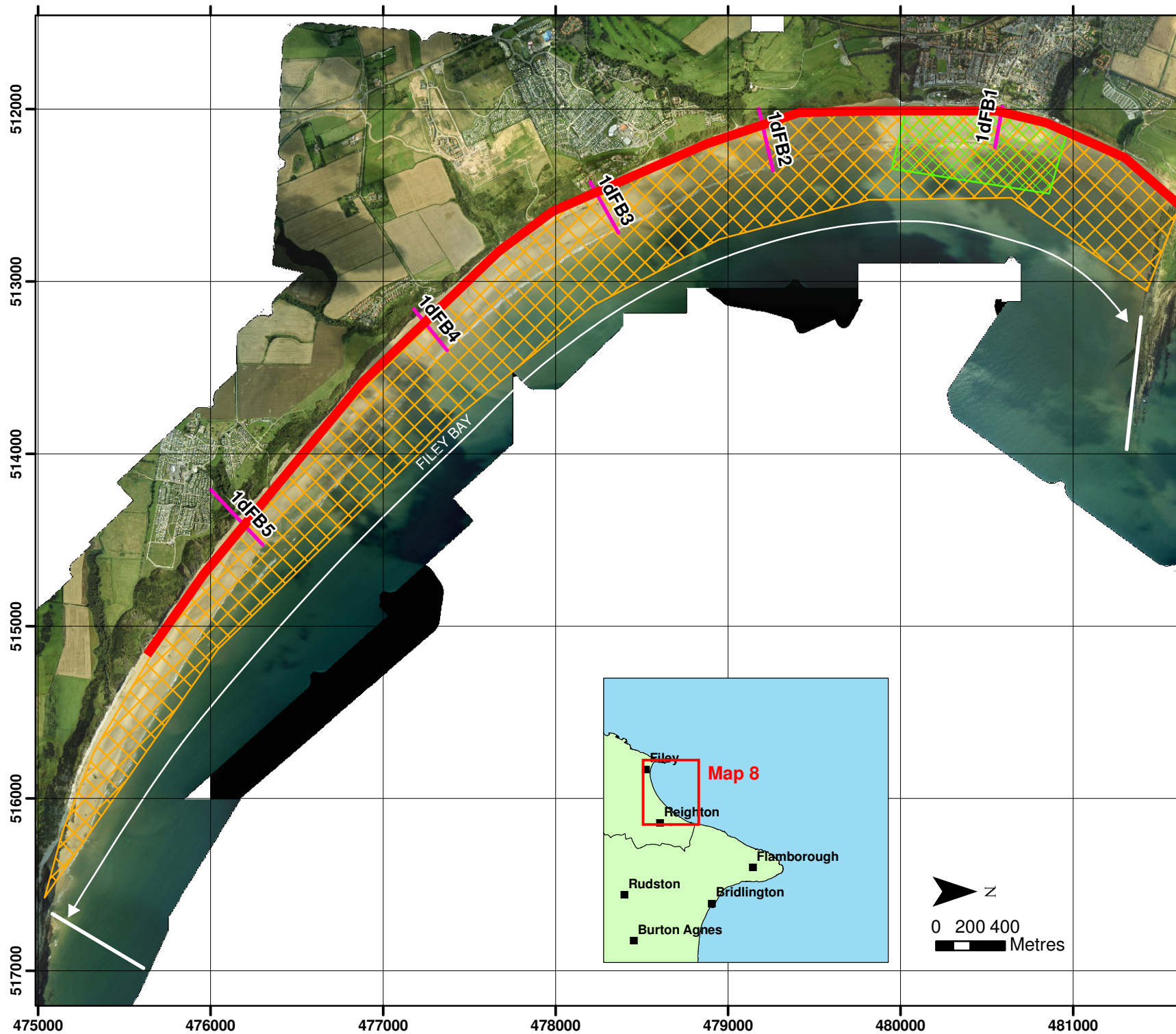


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SURVEY LOCATIONS

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 8
Scarborough
Borough Council Frontage**

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
11-2008 (Baseline)	<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 twice a year 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>

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Topographic Survey:</p> <p>Runswick Bay is covered by a 6-monthly topographic survey focussing on Runswick Sands, between the village of Runswick Bay and Hob Holes. Data have been used to create a DGM (Appendix B- Map 1).</p> <p>This DGM shows the higher beach levels in the south of the frontage. The steep beach face here is dissected by a stream, whose channel is apparent in the DGM. To the north, fronting Runswick Bay village the surveyed extent of foreshore is both broader and of lesser gradient.</p> <p>This DGM will be used as a baseline against which future topographic surveys will be compared on a biannual basis to identify areas of accretion and erosion.</p>	<p>The small beach at Runswick Bay is constrained between headlands, and shoreline platforms. Wave energy and fluvial erosion to the south, are expected to cause seasonal and episodic variations in the beach profile, respectively.</p>

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
11-2008 (Baseline)	<p>Beach Profiles:</p> <p>The frontage spanning Sandsend Beach, Upgang Beach, and Whitby Sands is covered by three beach profile lines, spaced between Sandsend and Whitby West Cliff (Appendix A).</p> <p>WB 1 is located on the south-east edge of Sandsend. It begins landward of the A174, and then descends a steeply sloping concrete covered/ partially vegetated seacliff, before descending along a gravel dominated beach surface (0.053 m m⁻¹, or 1:18.9).</p> <p>WB 2 is located 125m from the Whitby Golf Club-Club House, above Upgang Beach. It begins within the Golf course at the 4th hole, through a track cutting, and descends the partially vegetated, periodically active till cliffs (28.5 m elevation difference cliff toe to cliff base). It then crosses a sand/ gravel beach. (0.048 m m⁻¹)</p> <p>WB 3 is above Whitby Sands, at North Promenade. The profile descends the steep/ re-engineered/ vegetated seacliff. It then crosses the concrete sea-wall promenade at the cliff toe (top at 5.6 ODN), before descending along the gentle sloping sandy beach (0.036 m m⁻¹).</p>	<p>These joined beaches provide a moderately long expanse of sediment accumulation, which are backed up behind the West Pier at Whitby, significantly reducing alongshore sediment transfer and helping maintain the navigability of the River Esk. The cliffline at Whitby sands has been stabilized by engineering, however to the west at Upgang beach, cliff recession could eventually cause outflanking. At Sandsend Beach the foreshore is typically narrower and steeper (Appendix B- Map 2a). Degradation of coastal defences (<i>cf.</i> NECAG Coast Protection Assets and Coastal Slope Condition Analysis' report (Royal Haskoning & Halcrow, January 2009)) and instability of the cliffline pose a continuing risk to the A174 at Sandsend. Continued monitoring is therefore warranted, to assist in the development of coastal management options for this section of frontage.</p>
	<p>Topographic Survey:</p> <p>The Sandsend to Whitby frontage is covered by an annual topographic survey, providing continuous survey of Sandsend Beach, Upgang Beach, and Whitby Sands. Data have been used to create a DGM (Appendix B- Maps 2a & 2b).</p> <p>This DGM shows the higher levels along the rear of the beach, throughout most of the survey area (excepting the rock armour backed beach at Whitby Sands). Overall beach gradients are typically steeper at Sandsend Beach. The extent of foreshore visible on the aerial photograph is much broader than that represented by the DGM, demonstrating the highly variable nature of the beach here.</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>	

2.4 Robin Hood's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Topographic Survey:</p> <p>Robin Hood's Bay is covered by a 6-monthly topographic survey focussing on an area immediately fronting the village of Robin Hood's Bay (c. Dungeon Hole to East Scar). Data have been used to create a DGM (Appendix B- Map 3).</p> <p>This DGM generally shows a thin sediment accumulation over the foreshore with localised pocket beaches at Dungeon Hole, West Scar and Landing Scar. The aerial photograph shows the inter-tidal zone to be dominated by rocky scar outcrops, rather than by fine beach sediment accumulation.</p> <p>This DGM will be used as a baseline against which future topographic surveys will be compared on a biannual basis to identify areas of accretion and erosion.</p>	<p>The small beaches within Robin Hood's Bay are in between the more extensive shoreline platforms. Given the moderate exposure of this Bay, in an environment of apparently limited sediment supply to the north, the loss of beach sediments fronting the village remains possible. Continued evaluation of this asset is therefore warranted.</p>

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>Scarborough North Bay is covered by five beach profile lines, spaced between the Oceanarium at Scalby Mills to Clarence Gardens (Appendix A).</p> <p>SB 1 is located c. 175m from the Scarborough Sea-Life Centre. It begins on the North Bay promenade, and descends the seawall (top at 4.0 m ODN). This crosses a sandy beach, with underlying rock platforms.</p> <p>SB 2 is located c. 350 m north of the new 'Sands' development. As with SB1 it begins on the North Bay promenade and descends the seawall (top at 3.9 m ODN). After chainage 50.7m the sandy beach is of steepening gradient. A rock platform is evident further seaward and moderates wave energy, causing wave breaking at low tide.</p> <p>SB 3 is c. 80 m south-east of the 'Sands' development, on Royal Albert Drive. This begins alongside the road, crosses a seawall (elevated 1.3m above the road surface), and then descends a sandy beach (0.038 m m⁻¹)</p> <p>SB 4 is beneath Clarence Gardens. At the rear this is dominated by a high seawall (c. 7.3m elevation difference). The beach is dominated by gently sloping sands (0.008 m m⁻¹) and a local rock outcrop, although the latter is not readily apparent in the beach profile data.</p> <p>SB 5 is also beneath Clarence Gardens. This profile crosses the newer promenade and coastal defences associated with Royal Albert Drive/ Marine Drive. This comprises a seawall (1.0m above the road surface), and a sloping rock armour berm (top at 5.5 ODN, chainage 10.6- 32.4 m). This is fronted by a gently sloping sandy beach (0.014 m m⁻¹).</p>	<p>Scarborough North Bay has a heavily defended frontage, and the North Sands are contained between Scalby Ness and the Castle. Future sea-level rises would pose issues of coastal squeeze. Low beach levels north of the rock armour/ tetrapod defences may expose the defences to greater wave energies; monitoring here is necessary to determine if this is an ongoing concern. Continued monitoring will reveal long-term trends in the health of the beach, which acts both as a coastal defence, and tourist asset to Scarborough's economy.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Topographic Survey:</p> <p>Scarborough North Bay is covered by an annual topographic survey, providing continuous survey of North Sands. Data have been used to create a DGM (Appendix B- Map 4).</p> <p>This DGM shows lower beach levels towards the south of the survey area fronting the rock armour/ tetrapod defences near Clarence Gardens, with the lowest levels immediately north of the defence. There are higher levels to the centre and north of the survey area, in particular adjacent to the new Sands development.</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 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
11-2008 (Baseline)	<p>Beach Profiles:</p> <p>Scarborough South Bay is covered by four beach profile lines, spaced between South Sands adjacent to the Old Harbour to The Spa Complex (Appendix A).</p> <p>SBS 1 is located 200m north east of the Scarborough Grand Hotel. It starts on Foreshore Road, descends the stonework seawall (top at 3.9m ODN, 0.46m exposed elevation difference to the beach). It then descends a shallow gradient (0.030 m m⁻¹) sandy beach face.</p> <p>SBS 2 is located outside the Scarborough Grand Hotel. As with SBS 1, it starts on Foreshore Road. A stonework sea defence, with crest level of 4.9 m ODN, backs the beach, which currently sits 1.4m below the crest of the defence. The beach is again sandy, with a low gradient of (0.028 m m⁻¹).</p> <p>SBS 3 is located 155m north of the Spa complex. The profile begins on Foreshore Road, crossing a sloping stonework seawall (stands 0.9m above the road surface, with crest elevation of 7.61 m ODN, beach beginning at 1.98 m ODN). A sandy, low gradient (0.022 m m⁻¹) beach exists thereafter.</p> <p>SBS 4 is located immediately in front of the Suncourt at the Spa Complex. The profile crosses the sloping stonework seawall (stands 1 m above the road surface, with crest elevation of 7.55 m ODN, beach beginning at 0.77 m ODN). A sandy, low gradient (0.015 m m⁻¹) beach exists thereafter</p>	<p>Scarborough South Bay has a heavily defended frontage, and the South Sands are contained between the Old Harbour and Spa Complex. The beach appears healthier than that existing in North Bay. Continued monitoring will reveal long-term trends in the health of the beach, which acts both a coastal defence, and tourist asset to Scarborough's economy.</p>
	<p>Topographic Survey:</p> <p>Scarborough South Bay is covered by an annual topographic survey, providing continuous survey of South Sands. Data have been used to create a DGM (Appendix B- Map 5).</p> <p>This DGM shows an arcuate beach, with near-parallel topographic level contours rising towards the rear of the beach. The highest contours are between the Old Harbour and Scarborough Grand Hotel. Levels decline to the south around the Spa complex.</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>	

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>Cayton is covered by three beach profile lines, spaced between Tenants' Cliff and the south of Cayton Sands (Appendix A).</p> <p>CY 1 underlies the palaeo Tenant's Cliff landslide. The profile begins at the foot of the seacliff at 4 m ODN, crosses a boulder berm (probably derived from rockfall, chainage 0 to 14 m), and descends across a beach comprising a mosaic of sand and rock platforms.</p> <p>CY 2 is located 70 m south-east of the Cayton Bay Pumping Station. The profile begins to the rear of the undercliff (site of periodic landsliding). No survey of the undercliff is undertaken, it is instead represented as an interpolated profile between single cliff top and base points (cliff top 36 m ODN, beach beginning at 2.2 m ODN). The profile descends across a sandy beach, with occasional gravel exposures (0.022 m m^{-1}).</p> <p>CY 3 is located 70 m south-east of properties at Killerby Cliff, near WW2 cliff top military defence structures (pill boxes). Its general setting is similar to that of CY2, with an interpolated profile for the steep undercliff (cliff top 49m ODN, beach beginning at 4.4 m ODN), followed by a sandy beach (0.031 m m^{-1}).</p> <p>Topographic Survey:</p> <p>Cayton Bay is covered by an annual topographic survey, providing continuous survey of Cayton Sands. Data have been used to create a DGM (Appendix B- Map 6).</p> <p>This DGM shows a broad, moderately low gradient foreshore, with steeply shelving beach behind. The surveyed extent of foreshore is more comprehensive to the south of the Bay. The known beach uplift associated with the Cayton Cliff landslide toe uplift (1 April 2008) is not apparent in this DGM, potentially reflecting the original survey data or the processing to achieve this surface model.</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>	<p>Cayton Sands are contained between Osgodby Point and Yons Nab. Sediment supply from cliff erosion and landsliding periodically occurs. Concerns about inland recession along this frontage are currently focussed on ground movements at Cayton Cliff. Detailed and continued monitoring of this locality is required to best manage risks. Rising sea levels would likely to promote further inland recession of the cliffline.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Cliff Top Survey:</p> <p>Eight ground control points have been established at Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is typically around 300m. The cliff top surveys are to be undertaken twice a year 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 2). Future reports will show results from subsequent surveys and provide a means of addressing erosion since the baseline survey.</p>	

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>11-2008 (Baseline)</p>	<p>Beach Profiles:</p> <p>Filey Bay is covered by five beach profile lines, spaced between Filey Sands and Speeton Sands (Appendix A).</p> <p>FB 1 is located 30 m from the Beach Road/ Cargate Hill Junction at Filey. Beginning on the promenade the profile descends the seawall (crest level 6.3 m ODN, beach beginning at 1.5 m ODN), then across a broad sandy beach with occasional gravels (0.018 m m⁻¹).</p> <p>FB 2 is located at Filey Golf Club, on the 17th Hole, 200m north-west of the Primose Valley Holiday Village (at The Fold). The profile starts above the vegetated seacliff (crest level 25.8 m ODN, beach beginning at 2.3 m ODN), and only provides an interpolated measurement of the seacliff face. It then descends across a sand beach (0.018 m m⁻¹).</p> <p>FB 3 is located at Flat Cliffs, a site of known coastal slope instability. The profile starts on the 'Lower Flat Cliffs' road, and descends the toe of the undercliff (top at 10.6 m ODN, beach beginning at 2.5 m ODN). This then crosses a gravel berm charged with urban debris, followed by a sandy beach (0.019 m m⁻¹).</p> <p>FB 4 is located at Hunmanby Moor. The profile begins around 150 m from Gap Road, at the Seacliff top. The steep, partially vegetated cliff top is at 27.6 m OND, with the beach starting at 3.1 m ODN. The top of the beach is characterised by a gravel berm around the elevation of mean high water (chainage ~34 m), followed by a sandy beach (0.023 m m⁻¹).</p> <p>FB 5 is located at Reighton Sands Holiday Village. The profile begins above the seacliff, within the grounds of the holiday village, and cuts across a heavily vegetated tributary valley, accounting for the notable reduction in elevation at 176m chainage. Due to limited access the survey profile is coarse, based upon a limited number of points between chainage 63 and 220 m. The true seacliff aligned parallel to the shoreline begins at chainage 196m (23.6 m ODN) and has an active and poorly vegetated face. The fronting beach rises to roughly 4 m ODN; it comprises a small gravel berm, and a dominant expanse of low gradient sands (0.025 m m⁻¹)</p>	<p>This is a large and exposed frontage, with small areas of coastal defences (especially at Filey), and more extensive zones of coastal cliff instability and erosion. In many cases marine transgression should easily be accommodated owing to the rural setting and temporary nature of dwellings (e.g. holiday camps), although a number of areas may be subject to coastal squeeze, e.g. Filey and Flat Cliffs. Continued monitoring will inform the management of Filey Bay.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Topographic Survey:</p> <p>Filey Bay is covered by an annual topographic survey, providing continuous survey of Filey Sands, Muston Sands, Hunmanby Sands, Reighton Sands and Speeton Sands. Data have been used to create a DGM (Appendix B- Map 7a, 7b, & 7c). Note: the beach section fronting Filey town is surveyed bi-annually and will be reported on in update reports accompanying the partial measures survey.</p> <p>A 6-monthly topographic survey focusing on the beach fronting Filey (Figure 2-Map 8) is not reported here.</p> <p>This DGM shows a foreshore which is both broad and low gradient, backed by a small area of steeper beach, along the entire frontage, excepting Filey Sands. Beach levels are lowest fronting Filey.</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> <hr/> <p>Cliff Top Survey:</p> <p>Twenty-three ground control points have been established at Filey Bay for the purposes of cliff top monitoring. The separation between any two points is around 300m. The cliff top surveys are to be undertaken twice a year 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- Maps 3a & 3b). Future reports will show results from subsequent surveys and provide a means of addressing erosion since the baseline survey.</p>	

3. Problems Encountered and Uncertainty in Analysis

No major problems were reported during the surveys

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

Beach Profiles

- Beach profile surveys frequently begin above the cliff top, however they do not capture the undercliff/ seacliff profiles in any detail, but instead interpolate from a small number of survey points. Where judged safe to do so, cliff profile surveys should be of greater resolution, thereby providing improved understanding of slope morphology. Alternatively, where tree covers are sparse and absent, terrestrial laser scanning may be worthy of consideration ;
- An additional survey profile should be added in Cayton Bay. At this time none cover the recently re-activated Cayton Cliff landslide (Figure 2- Map 7), where changes in beach profiles since April 2008 have been known to be dramatic, associated with landslide toe uplift and subsequent marine erosion;
- Survey profile 1dFB5 (Figure 2- Map 8) needs to be relocated to a nearby location (perhaps southwards) of much improved access, focussing on shore parallel morphology alone.

Topographic Survey

- The time/ and date of surveys need to be optimised in respect of predicted tidal and weather conditions, to maximise the extent of foreshore survey. Some DGM survey areas are notably less extensive than existing on the aerial photography. Whilst this will always remain a challenge, the desire to maximise data coverage should be kept in mind.

Ground Control Points

- Some cliffline recessional 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 (Appendix C- Map 1);
- Ground control points exclude the Cayton Cliff seacliff (Appendix C- Map 2), this should be captured (see previous rationale);
- Ground control points could be extended to cover the southern flank of Filey Brigg, which is known to be undergoing rapid incision and erosion of the till cliffs (Appendix C- Map 3a). Furthermore, Flat Cliffs (a risk hotspot) have limited coverage (Appendix C- Map 3b)

Survey Recording

- Survey reports need to outline survey dates, and not just months of data capture. Similarly site photographs should be taken on the same day as field surveying, if this is not already the case;

Other

- There would be benefit in integrating this study data, with knowledge from more detailed investigations which have been conducted along the Scarborough Borough Council Frontage, e.g. Scalby Mills, Cayton Bay, and Flat Cliffs;
- Areas of known coastal slope instability not already subject to detailed monitoring may benefit from beach profiles, for example Cornelian Bay, where headscarp recession recently re-activated (October 2008) and poses risk to adjacent properties. If this principle were accepted, candidate sites would require further assessment, and could be informed by the 'NECAG Coast Protection Assets and Coastal Slope Condition Analysis' report (Royal Haskoning & Halcrow, January 2009), which is now a component of the Cell1 monitoring programme.

5. Conclusions and Areas of Concern

- 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.
- The small beach at Runswick Bay is constrained between headlands, and shoreline platforms. Wave energy and fluvial erosion to the south, are expected to cause seasonal and episodic variations in the beach profile, respectively.
- Whitby Sands appear to be moderately healthy, and backed by stabilised cliffs. Upgang Beach is backed by a receding cliffline largely owing to slope instability. Issues of coastal squeeze may be increasing at Sandsend, where future marine transgression, associated with ageing coastal defences could pose a hazard to assets (i.e. A174 road, buildings). Continued monitoring is therefore warranted.
- The small beaches within Robin Hood's Bay are in between the more extensive shoreline platforms. Given the moderate exposure of this Bay, in an environment of apparently limited sediment supply to the north, the loss of beach sediments fronting the village remains possible. Continued evaluation of this asset is therefore warranted.
- Scarborough North and South Bay's have heavily defended frontage, and are moderately constrained. Future sea-level rises would pose issues of coastal squeeze. Low beach levels north of the rock armour / tetrapod defences may expose the defences to greater wave energies; monitoring here is necessary to determine if this is an ongoing concern. Continued monitoring will reveal long-term trends in the health of the beach, which acts both as a coastal defence and tourist asset to Scarborough's economy.
- Cayton Bay is known to experience cliff erosion and periodic landsliding. Recent attention is focussed on Cayton Cliff to the north, where continued ground movement continues to pose a risk to adjacent assets (Knipe Point residential complex, A165). Detailed and continued monitoring of this locality is required to best manage risks, across the range of site stakeholders. Rising sea levels would likely promote further inland recession of the cliffline. The monitoring programme should be improved with the addition of a beach profile and ground control points at Cayton Cliff.
- Filey Bay has a large and exposed frontage, with small areas of coastal defences (especially at Filey), and more extensive zones of coastal cliff instability and erosion. In many cases marine transgression should easily be accommodated owing to the rural setting and temporary nature of dwellings (e.g. holiday camps), although there are a number of areas which may be subject to coastal squeeze, e.g. Filey and Flat Cliffs. Continued monitoring will inform the management of Filey Bay. The monitoring programme should be improved with the addition of ground control points at Filey Brigg, and a greater number at Flat Cliffs.

Appendices

Appendix A

Beach Profiles

Beach Profile

1dWB1

Date 26/11/2008
Wind
Summary

Inspector
Sea State Rough

Low Tide (m)
Visibility Good

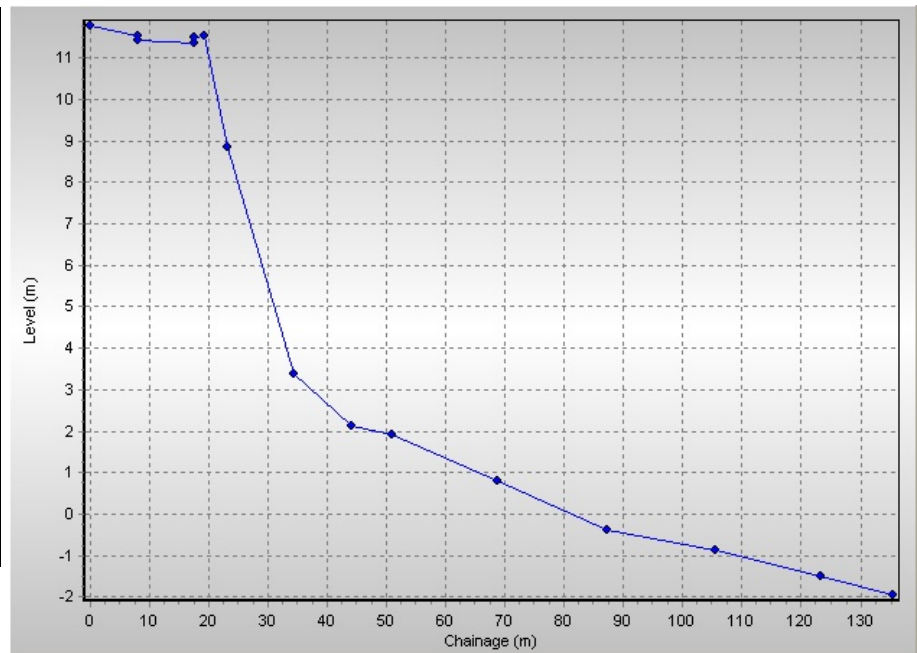
LowTideTime 0841
Rain Yes

Easting 486535.075

Northing 512437.797

Bearing 32

Chainage	Level
0	11.772
7.965	11.545
8.144	11.421
17.493	11.364
17.593	11.479
19.285	11.536
23.123	8.863
34.336	3.397
44.209	2.136
50.824	1.912
68.663	0.801
87.303	-0.372
105.426	-0.878
123.274	-1.511
135.481	-1.948



Beach Profile

1dWB2

Date 26/11/2008
Wind
Summary

Inspector
Sea State Rough

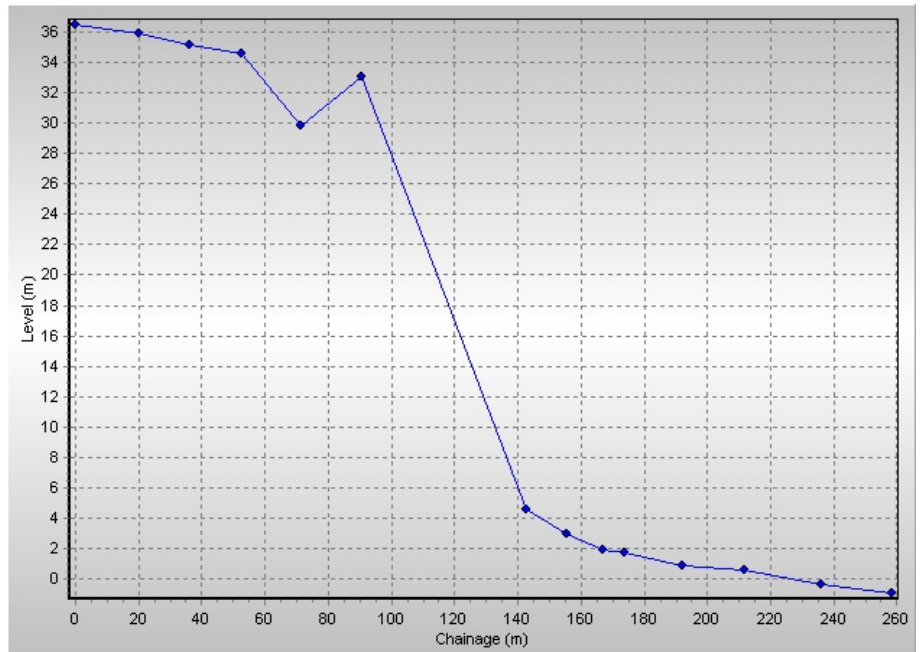
Low Tide (m)
Visibility Good

LowTideTime 0841
Rain Yes

Easting 487550.221

Northing 511927.902 Bearing 16

Chainage	Level
0	36.522
20.257	35.967
36.31	35.162
52.398	34.661
71.499	29.87
90.599	33.078
142.914	4.5
155.675	2.901
167.053	1.85
173.948	1.632
191.948	0.82
211.838	0.567
236.239	-0.389
258.428	-0.998



Beach Profile

1dWB3

Date 26/11/2008
 Wind
 Summary

Inspector
 Sea State Rough

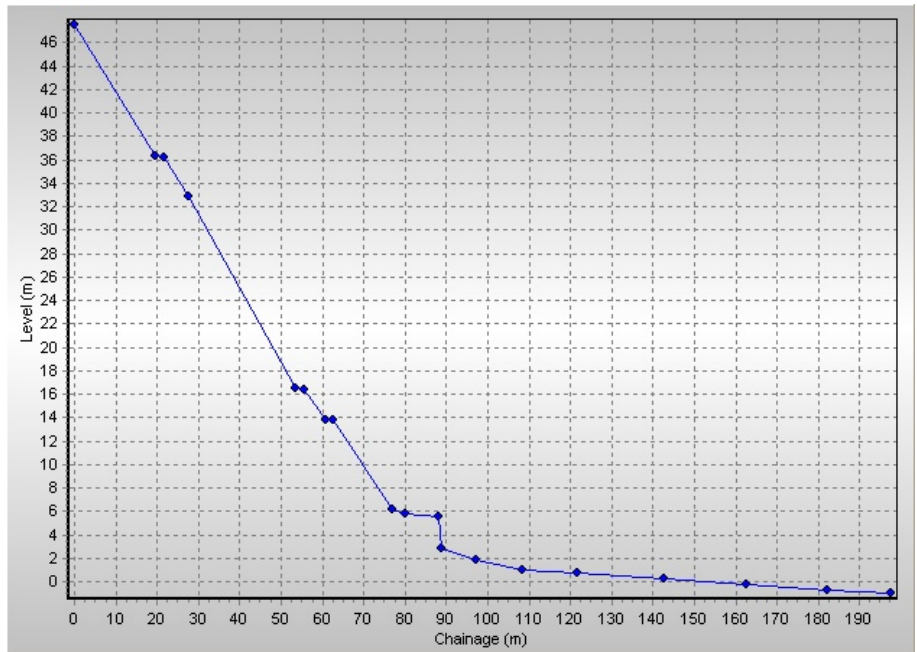
Low Tide (m)
 Visibility Good

LowTideTime 0841
 Rain Yes

Easting 488983.57

Northing 511527.047 Bearing 19

Chainage	Level
0	47.507
19.476	36.338
21.847	36.136
27.483	32.847
53.642	16.542
55.755	16.386
60.857	13.83
62.667	13.813
76.915	6.202
80.159	5.762
88.294	5.557
88.799	2.912
97.12	1.842
108.506	1.07
121.863	0.728
142.661	0.316
162.463	-0.189
182.363	-0.662
197.587	-0.954



Beach Profile

1dSB1

Date 15/11/2008
 Wind
 Summary

Inspector
 Sea State Calm

Low Tide (m)
 Visibility Good

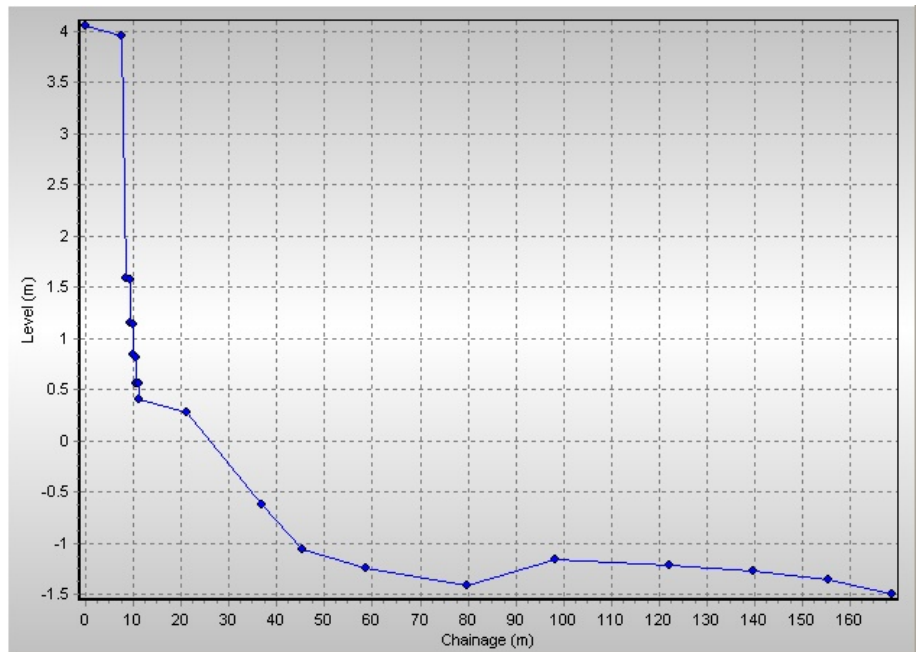
LowTideTime 1052
 Rain No

Easting 503543.363

Northing 490470.74

Bearing 79

Chainage	Level
0	4.051
7.701	3.951
8.611	1.586
9.331	1.57
9.411	1.156
10.004	1.138
10.021	0.847
10.578	0.817
10.608	0.56
11.151	0.555
11.258	0.398
21.17	0.279
36.74	-0.626
45.348	-1.063
58.522	-1.241
79.663	-1.41
98.14	-1.156
122.068	-1.209
139.647	-1.267
155.458	-1.355
168.669	-1.496



Beach Profile

1dSB2

Date 15/11/2008
Wind
Summary

Inspector
Sea State Calm

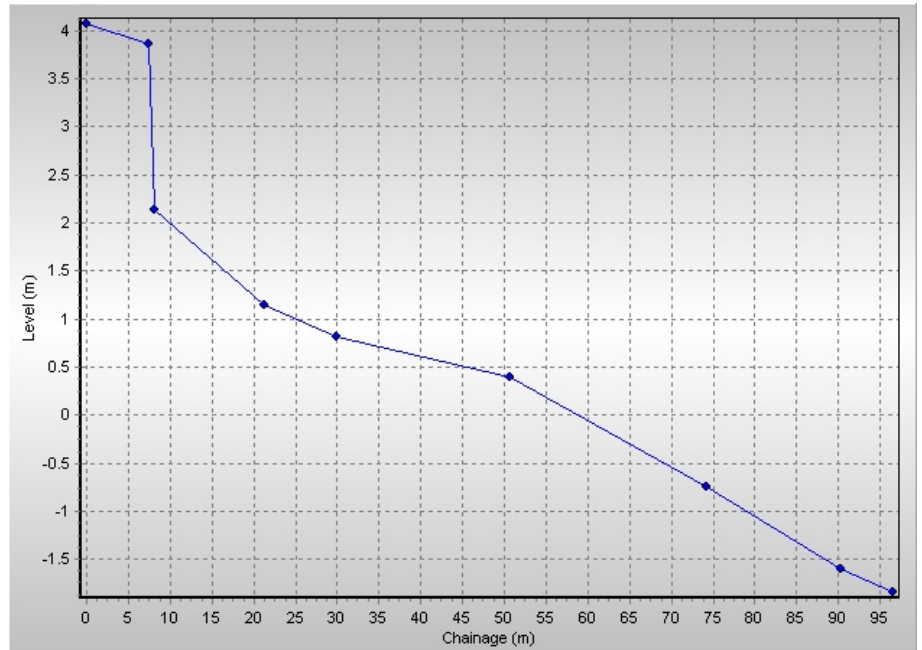
Low Tide (m)
Visibility Good

LowTideTime 1052
Rain No

Easting 503616.346

Northing 490135.674 Bearing 78

Chainage	Level
0	4.071
7.373	3.865
8.083	2.137
21.289	1.141
29.997	0.808
50.752	0.387
74.246	-0.743
90.337	-1.603
96.534	-1.842



Beach Profile

1dSB3

Date 15/11/2008
Wind
Summary

Inspector
Sea State Calm

Low Tide (m)
Visibility Good

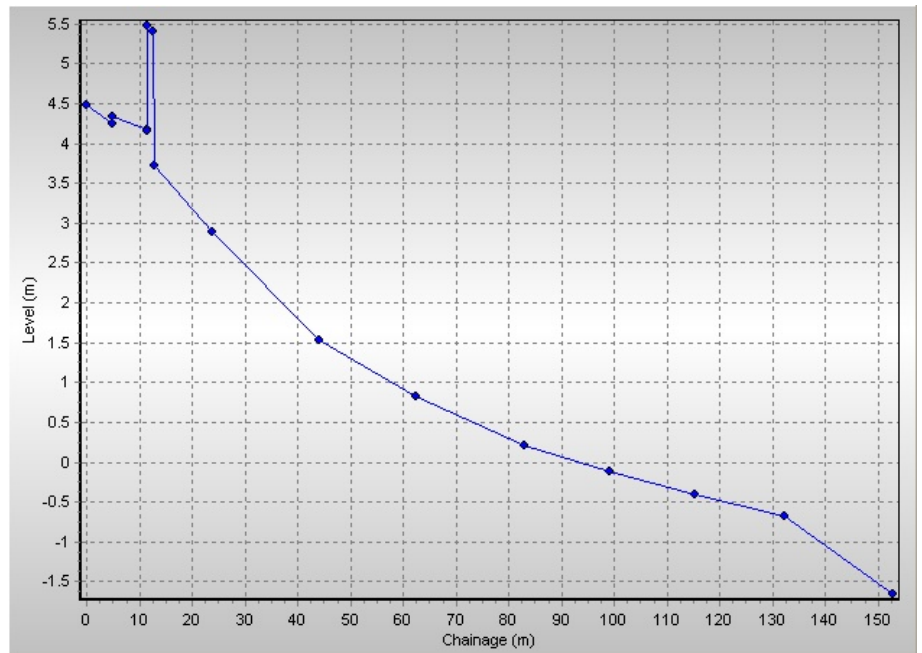
LowTideTime 1052
Rain No

Easting 503803.958

Northing 489708.316

Bearing 58

Chainage	Level
0	4.49
4.911	4.251
4.983	4.34
11.47	4.168
11.543	4.156
11.544	5.477
12.484	5.406
12.783	3.721
23.802	2.895
44.092	1.538
62.49	0.818
82.891	0.211
99.232	-0.116
115.416	-0.397
132.261	-0.684
152.861	-1.655



Beach Profile

1dSB4

Date 15/11/2008
 Wind
 Summary

Inspector
 Sea State Calm

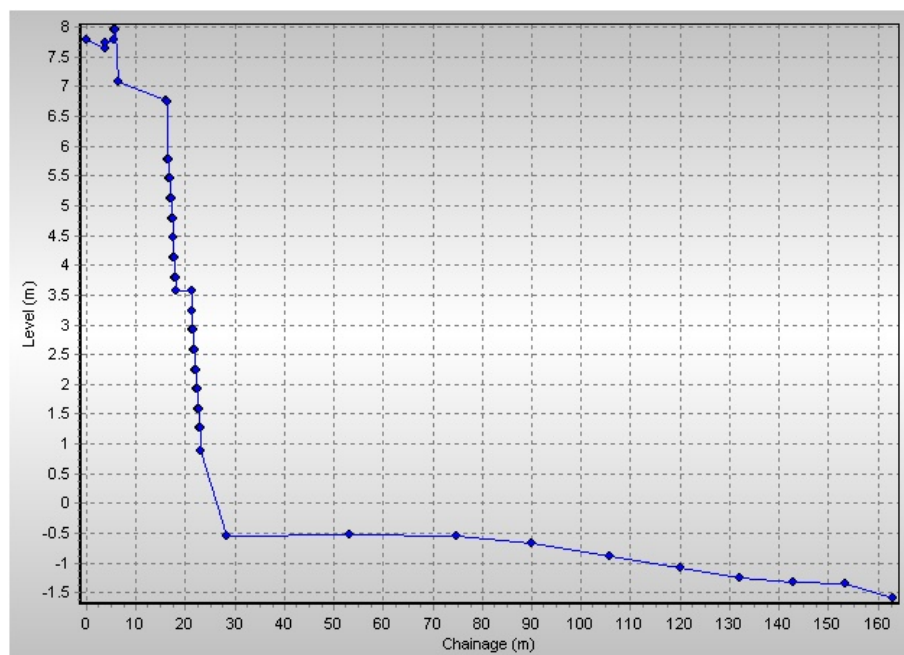
Low Tide (m)
 Visibility Good

LowTideTime 1052
 Rain No

Easting 504111.79

Northing 489397.699 Bearing 38

Chainage	Level
0	7.785
3.758	7.65
3.79	7.729
5.624	7.798
5.66	7.957
5.965	7.953
6.287	7.093
16.155	6.776
16.474	6.757
16.479	5.781
16.678	5.45
16.678	5.78
16.927	5.45
16.928	5.12
17.178	4.79
17.178	5.12
17.427	4.79
17.428	4.46
17.678	4.46
17.679	4.13
17.927	4.13
17.928	3.8
18.177	3.8
18.178	3.57
21.228	3.24
21.228	3.57
21.476	3.24
21.478	2.91
21.727	2.91
21.729	2.58
21.977	2.58
21.979	2.25
22.227	2.25
22.229	1.92
22.476	1.92
22.478	1.59
22.725	1.59
22.728	1.26
23.005	1.26
23.006	0.873
28.35	-0.536
53.208	-0.533
74.874	-0.537
90.027	-0.669
105.842	-0.896
120.05	-1.082
131.937	-1.26
142.979	-1.315
153.314	-1.355
163.058	-1.59



Beach Profile

1dSB5

Date 15/11/2008
Wind
Summary

Inspector
Sea State Calm

Low Tide (m)
Visibility Good

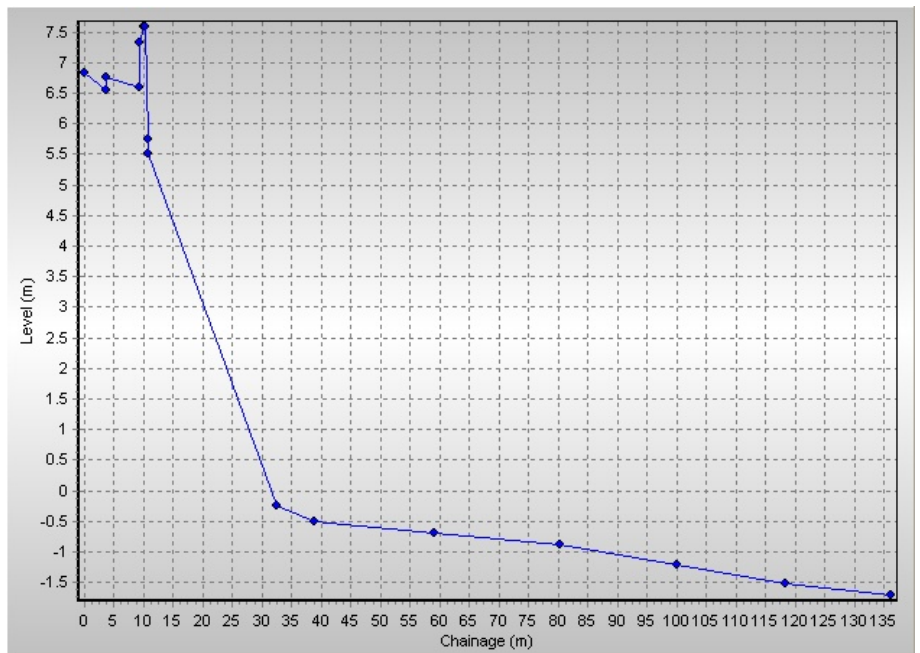
LowTideTime 1052
Rain No

Easting 504515.599

Northing 489205.723

Bearing 14

Chainage	Level
0	6.836
3.594	6.541
3.634	6.767
9.299	6.587
9.338	7.318
10.04	7.575
10.238	7.575
10.281	7.586
10.612	5.518
10.612	5.742
32.374	-0.243
38.766	-0.494
59.003	-0.694
80.184	-0.89
100.103	-1.215
118.239	-1.52
136.102	-1.708



Beach Profile

1dSBS1

Date 14/11/2008
Wind
Summary

Inspector
Sea State Calm

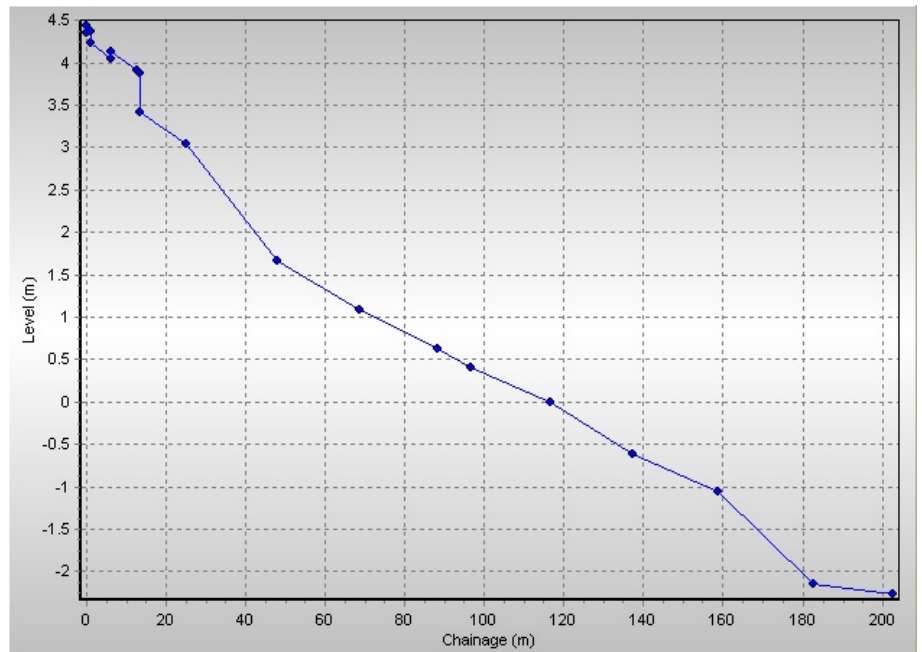
Low Tide (m)
Visibility Good

LowTideTime 0958
Rain No

Easting 504544.727

Northing 488604.814 Bearing 120

Chainage	Level
0	4.351
0.038	4.435
1.185	4.359
1.252	4.228
6.272	4.047
6.303	4.129
12.781	3.903
13.334	3.873
13.351	3.414
24.89	3.045
47.818	1.669
68.533	1.089
88.344	0.629
96.764	0.408
116.584	0.001
137.12	-0.609
158.855	-1.051
182.657	-2.152
202.681	-2.267



Beach Profile

1dSBS2

Date 14/11/2008
Wind
Summary

Inspector
Sea State Calm

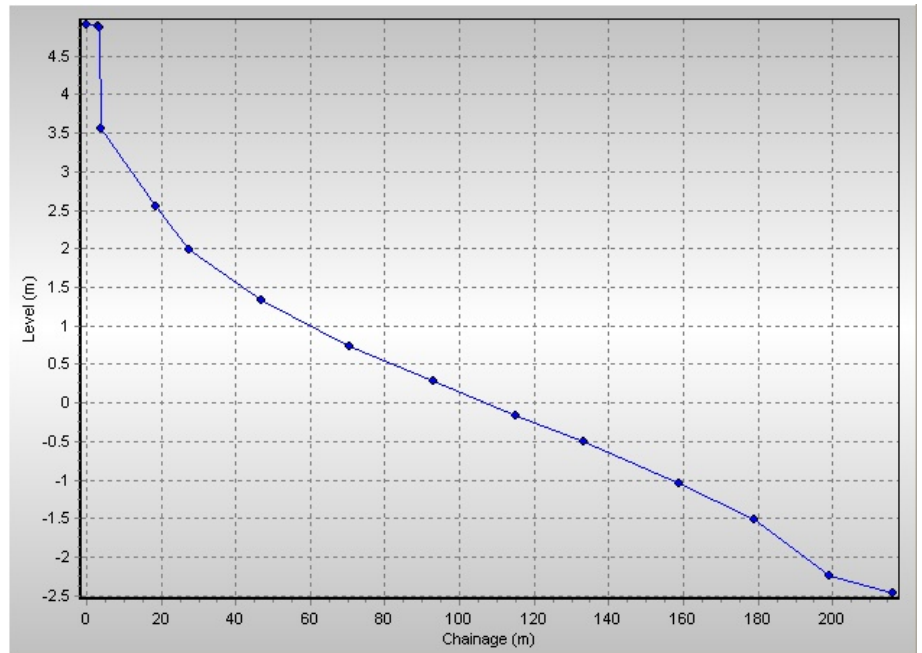
Low Tide (m)
Visibility Good

LowTideTime 0958
Rain No

Easting 504443.218

Northing 488326.371 Bearing 105

Chainage	Level
0	4.905
3.164	4.879
3.493	4.868
3.689	3.549
18.474	2.551
27.476	1.993
46.891	1.332
70.361	0.731
92.793	0.283
115.209	-0.161
133.308	-0.504
158.93	-1.045
178.923	-1.508
198.997	-2.239
216.182	-2.465



Beach Profile

1dSBS3

Date 14/11/2008
Wind
Summary

Inspector
Sea State Calm

Low Tide (m)
Visibility Good

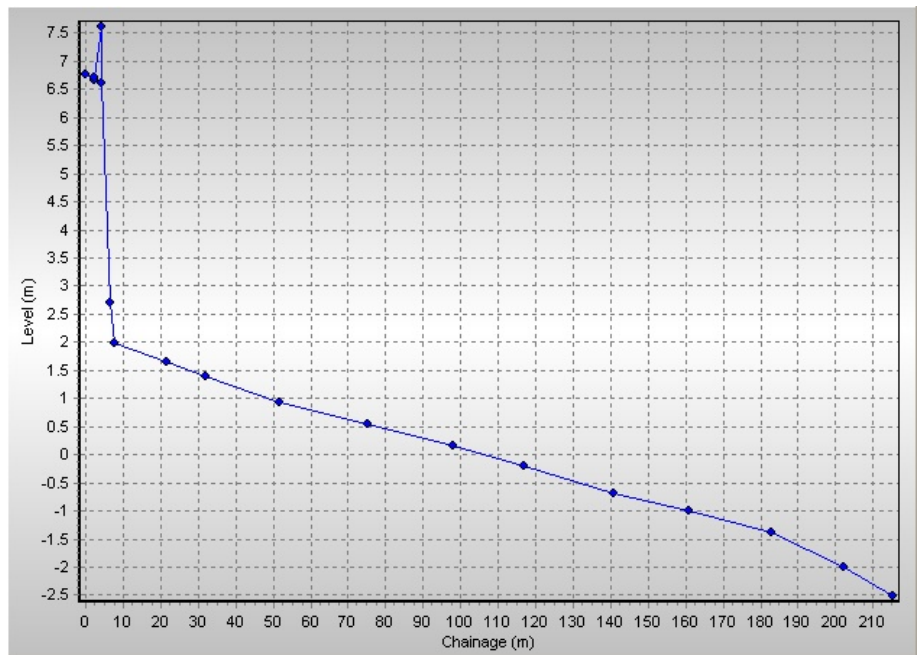
LowTideTime 0958
Rain No

Easting 504423.086

Northing 488057.66

Bearing 83

Chainage	Level
0	6.759
2.459	6.672
2.502	6.7
4.297	7.611
4.313	6.621
6.417	2.69
7.806	1.976
21.668	1.647
31.912	1.396
51.602	0.926
75.411	0.541
98.162	0.158
117.087	-0.192
140.768	-0.693
160.742	-0.988
183.036	-1.375
202.186	-1.999
215.299	-2.515



Beach Profile

1dSBS4

Date 14/11/2008
 Wind
 Summary

Inspector
 Sea State Calm

Low Tide (m)
 Visibility Good

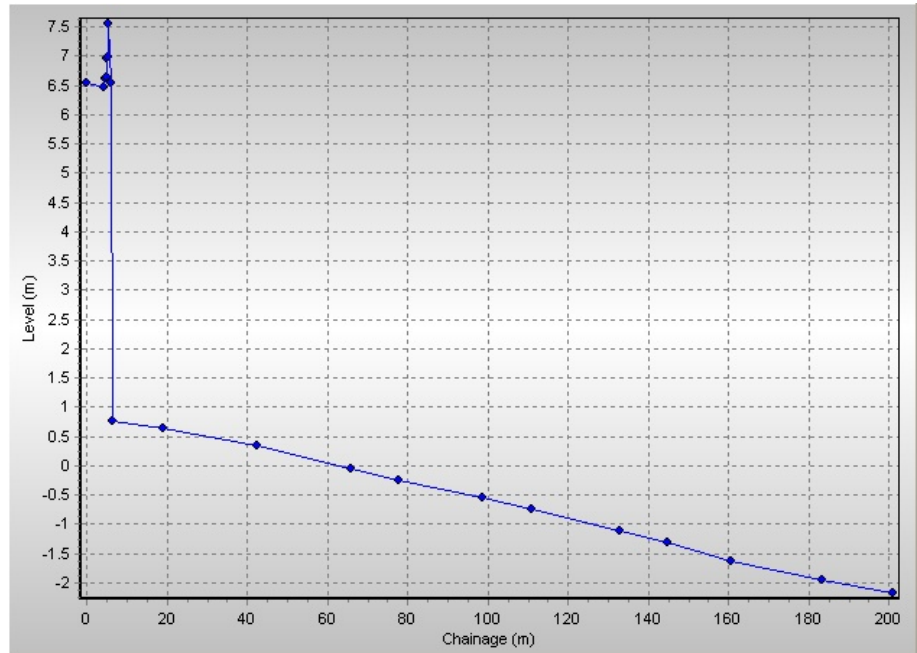
LowTideTime 0958
 Rain No

Easting 504494.785

Northing 487816.983

Bearing 74

Chainage	Level
0	6.53
4.443	6.472
4.513	6.605
4.986	6.633
5.07	6.969
5.519	6.972
5.544	7.55
5.982	6.537
6.575	0.77
18.994	0.645
42.443	0.343
65.959	-0.061
77.874	-0.241
98.688	-0.55
110.729	-0.732
133.031	-1.103
144.778	-1.299
160.638	-1.643
183.334	-1.957
200.911	-2.175



Beach Profile

1dCY1

Date 17/11/2008
Wind
Summary

Inspector
Sea State Rough

Low Tide (m)
Visibility Good

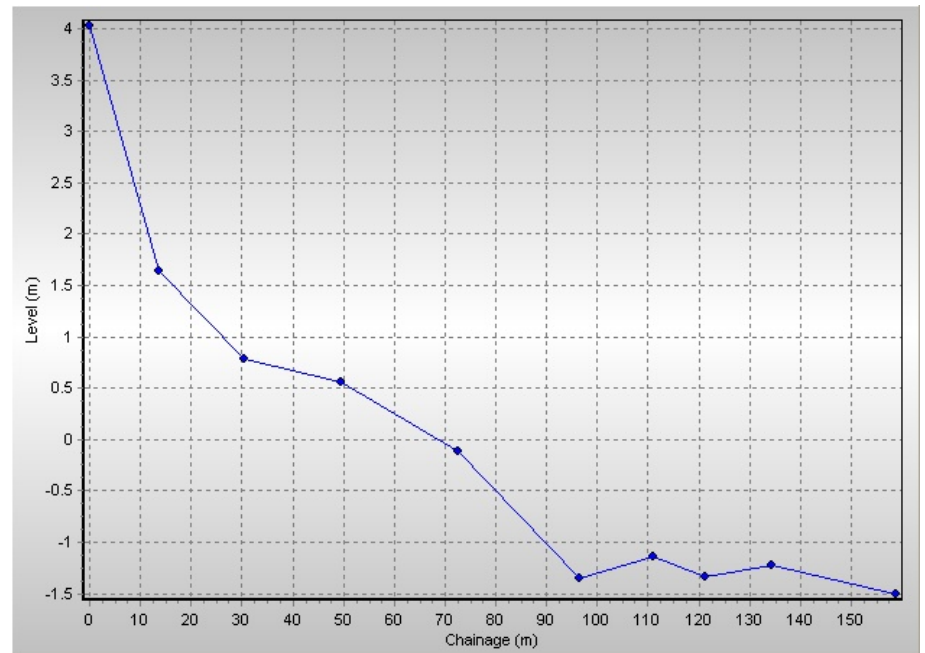
LowTideTime 1216
Rain Yes

Easting 506420.411

Northing 484793.941

Bearing 43

Chainage	Level
0	4.027
13.66	1.645
30.336	0.782
49.532	0.566
72.62	-0.116
96.447	-1.353
111.068	-1.132
121.279	-1.334
134.251	-1.219
158.843	-1.504



Beach Profile

1dCY2

Date 17/11/2008
Wind
Summary

Inspector
Sea State Rough

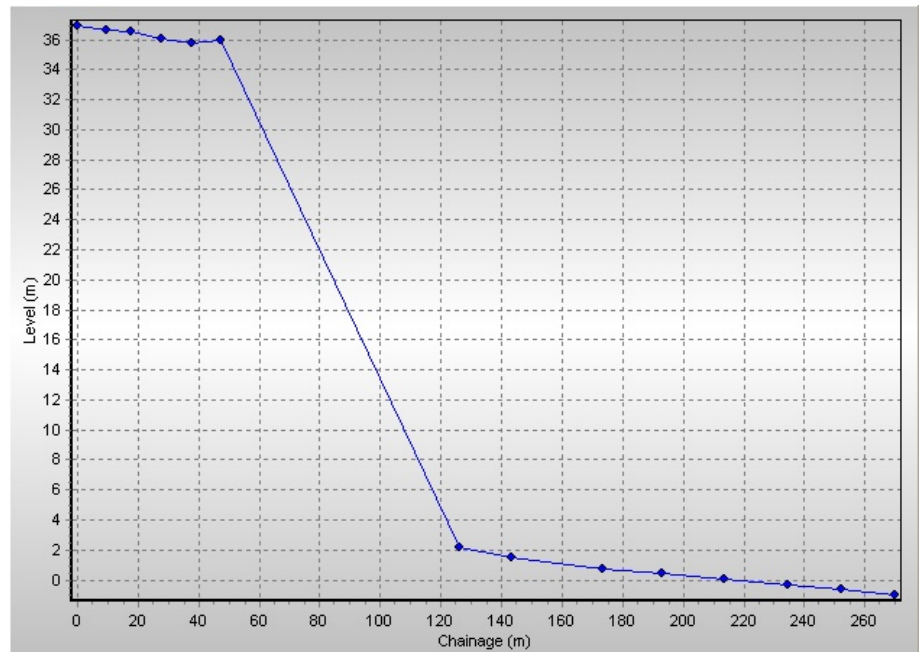
Low Tide (m)
Visibility Good

LowTideTime 1216
Rain Yes

Easting 506712.583

Northing 484325.966 Bearing 38

Chainage	Level
0	36.926
9.51	36.67
17.903	36.539
27.571	36.024
37.544	35.809
47.231	36.002
125.946	2.201
143.336	1.509
173.266	0.757
193.113	0.409
213.476	0.073
234.359	-0.303
252.244	-0.665
269.86	-1.009



Beach Profile

1dCY3

Date 17/11/2008
 Wind
 Summary

Inspector
 Sea State Rough

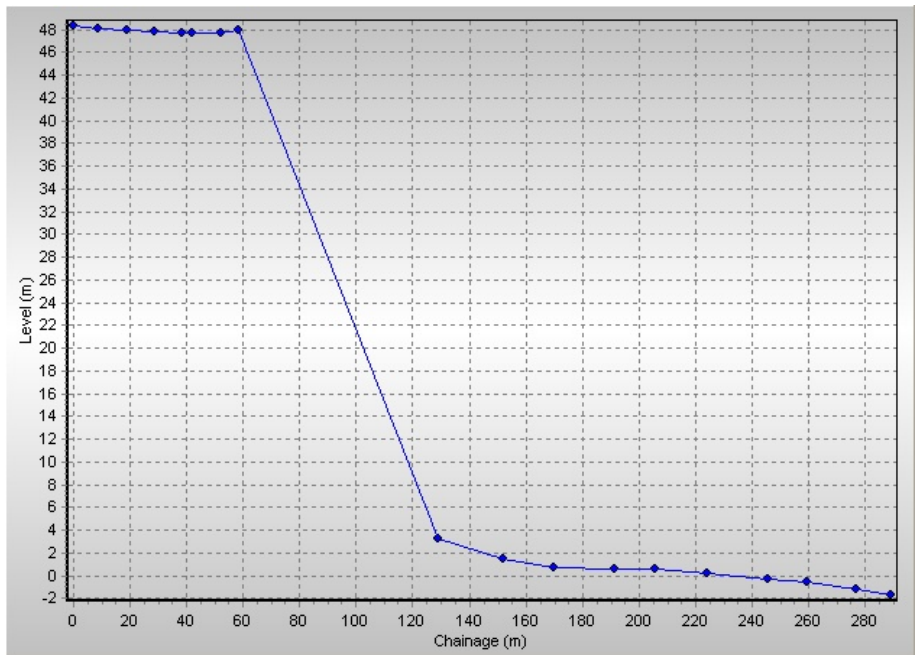
Low Tide (m)
 Visibility Good

LowTideTime 1216
 Rain Yes

Easting 507242.203

Northing 484080.896 Bearing 42

Chainage	Level
0	48.326
8.728	48.091
18.834	47.989
28.67	47.872
38.507	47.709
41.756	47.656
52.385	47.695
58.465	47.896
129.075	3.293
152.174	1.441
170.033	0.722
191.386	0.619
205.617	0.524
224.321	0.148
245.605	-0.294
259.227	-0.573
276.972	-1.154
289.145	-1.701



Beach Profile

1dFB1

Date 26/11/2008
 Wind
 Summary

Inspector
 Sea State Rough

Low Tide (m)
 Visibility Good

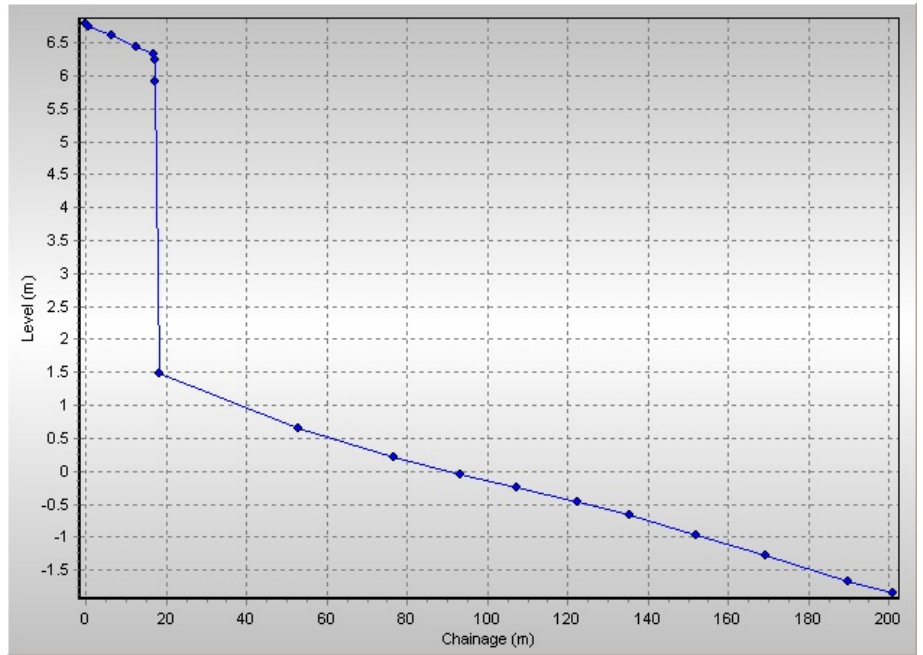
LowTideTime 0841
 Rain Yes

Easting 511989.528

Northing 480590.964

Bearing 100

Chainage	Level
0	6.788
0.726	6.742
6.502	6.609
12.639	6.434
17.053	6.318
17.125	6.233
17.161	5.912
18.368	1.489
52.884	0.659
76.646	0.223
93.235	-0.043
107.451	-0.246
122.362	-0.462
135.455	-0.665
152.11	-0.969
169.324	-1.284
189.706	-1.665
201.028	-1.846



Beach Profile

1dFB2

Date 26/11/2008
Wind
Summary

Inspector
Sea State Rough

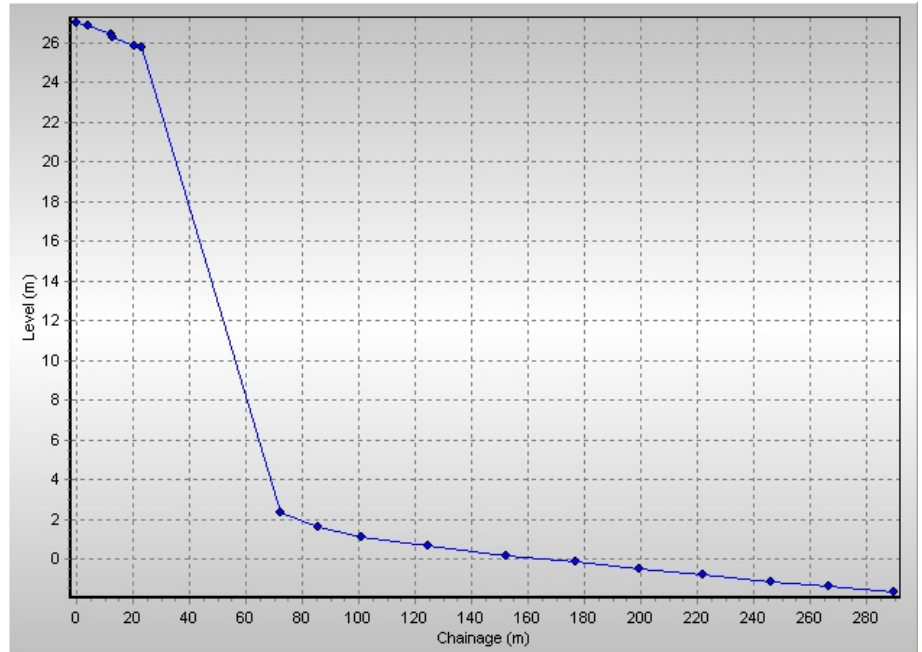
Low Tide (m)
Visibility Good

LowTideTime 0841
Rain Yes

Easting 512005.564

Northing 479181.575 Bearing 77

Chainage	Level
0	26.992
3.914	26.866
12.066	26.439
12.857	26.296
20.351	25.825
23.062	25.754
72.271	2.341
85.481	1.617
101.063	1.136
124.853	0.645
152.416	0.175
176.709	-0.128
199.636	-0.483
222.313	-0.764
246.01	-1.137
266.876	-1.36
289.798	-1.657



Beach Profile

1dFB3

Date 26/11/2008
 Wind
 Summary

Inspector
 Sea State Rough

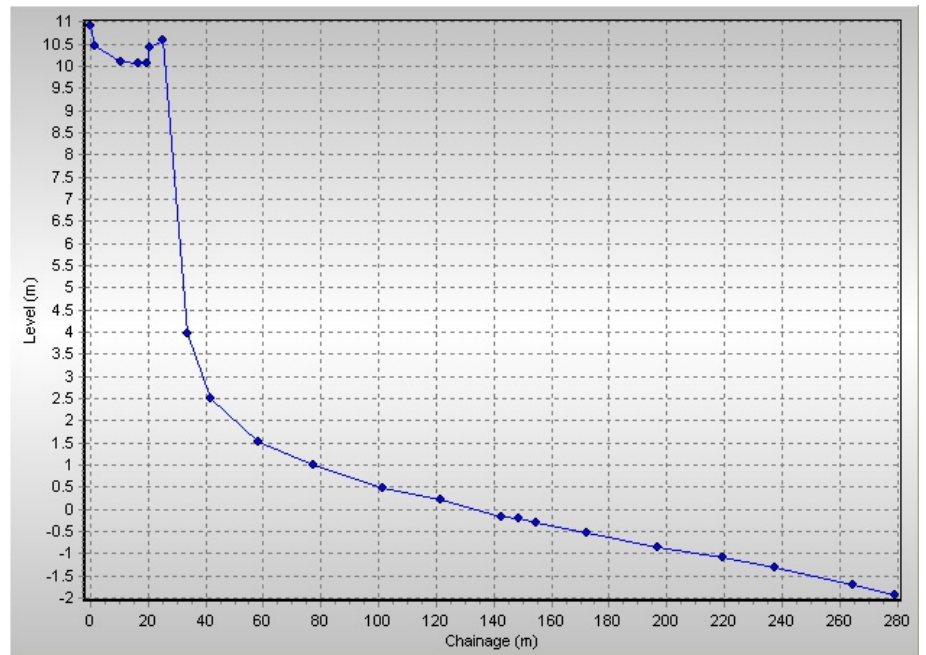
Low Tide (m)
 Visibility Good

LowTideTime 0841
 Rain Yes

Easting 512429.303

Northing 478202.148 Bearing 61

Chainage	Level
0	10.916
1.524	10.473
10.568	10.114
16.405	10.071
19.748	10.083
20.47	10.421
25.086	10.597
33.828	3.969
41.563	2.504
58.167	1.532
77.156	1.002
101.323	0.477
121.609	0.207
142.391	-0.159
148.526	-0.212
154.454	-0.3
172.346	-0.545
196.992	-0.86
219.266	-1.1
237.497	-1.309
264.474	-1.697
279.168	-1.932



Beach Profile

1dFB4

Date 26/11/2008
Wind
Summary

Inspector
Sea State Rough

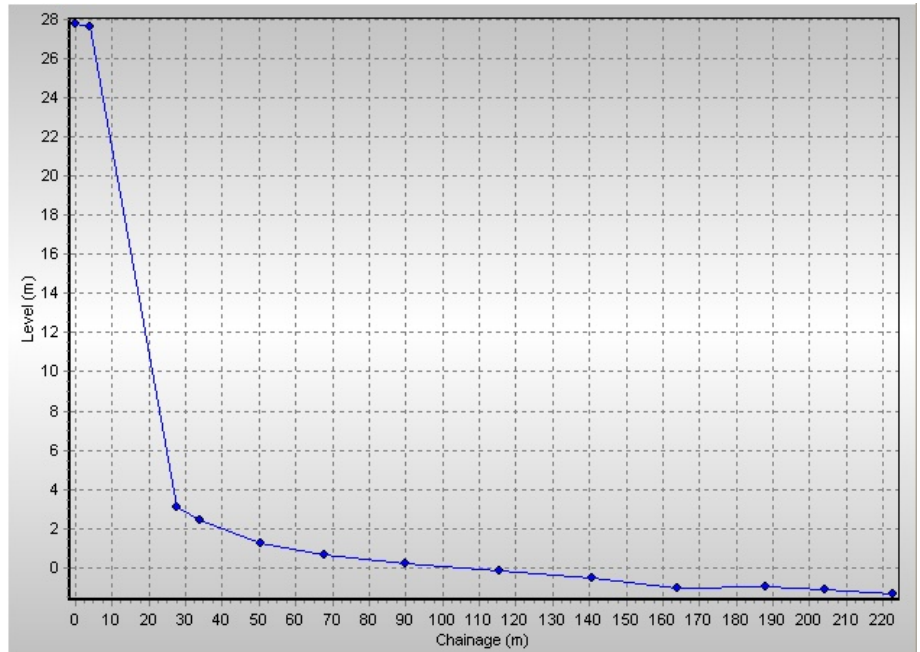
Low Tide (m)
Visibility Good

LowTideTime 0841
Rain Yes

Easting 513165.53

Northing 477182.418 Bearing 51

Chainage	Level
0	27.754
4.013	27.638
27.563	3.061
34.045	2.404
50.399	1.276
67.917	0.682
89.917	0.221
115.63	-0.147
140.542	-0.555
163.906	-1.063
188.224	-0.954
204.265	-1.099
222.72	-1.333



Beach Profile

1dFB5

Date 26/11/2008
 Wind
 Summary

Inspector
 Sea State Rough

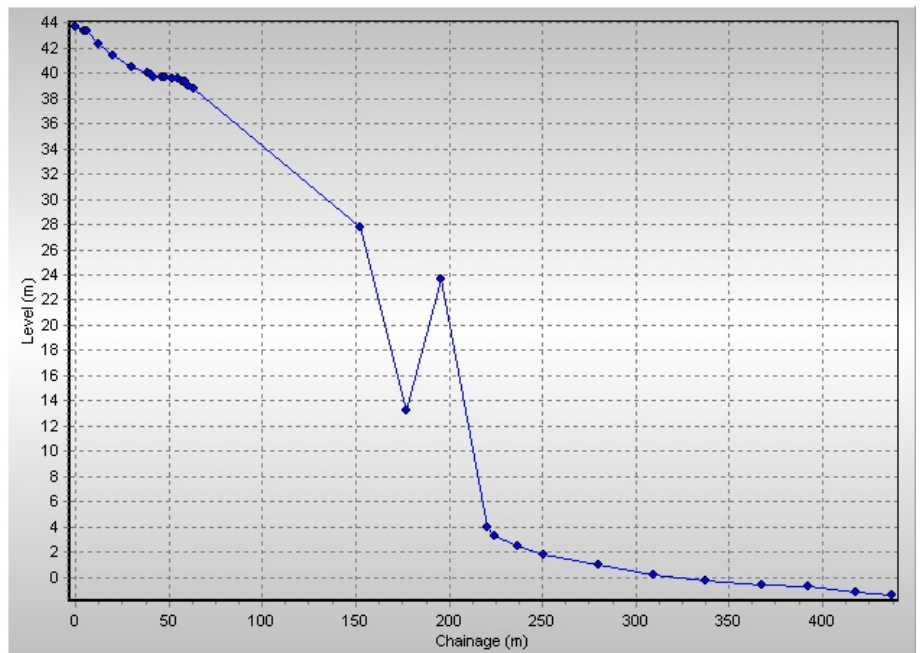
Low Tide (m)
 Visibility Good

LowTideTime 0841
 Rain Yes

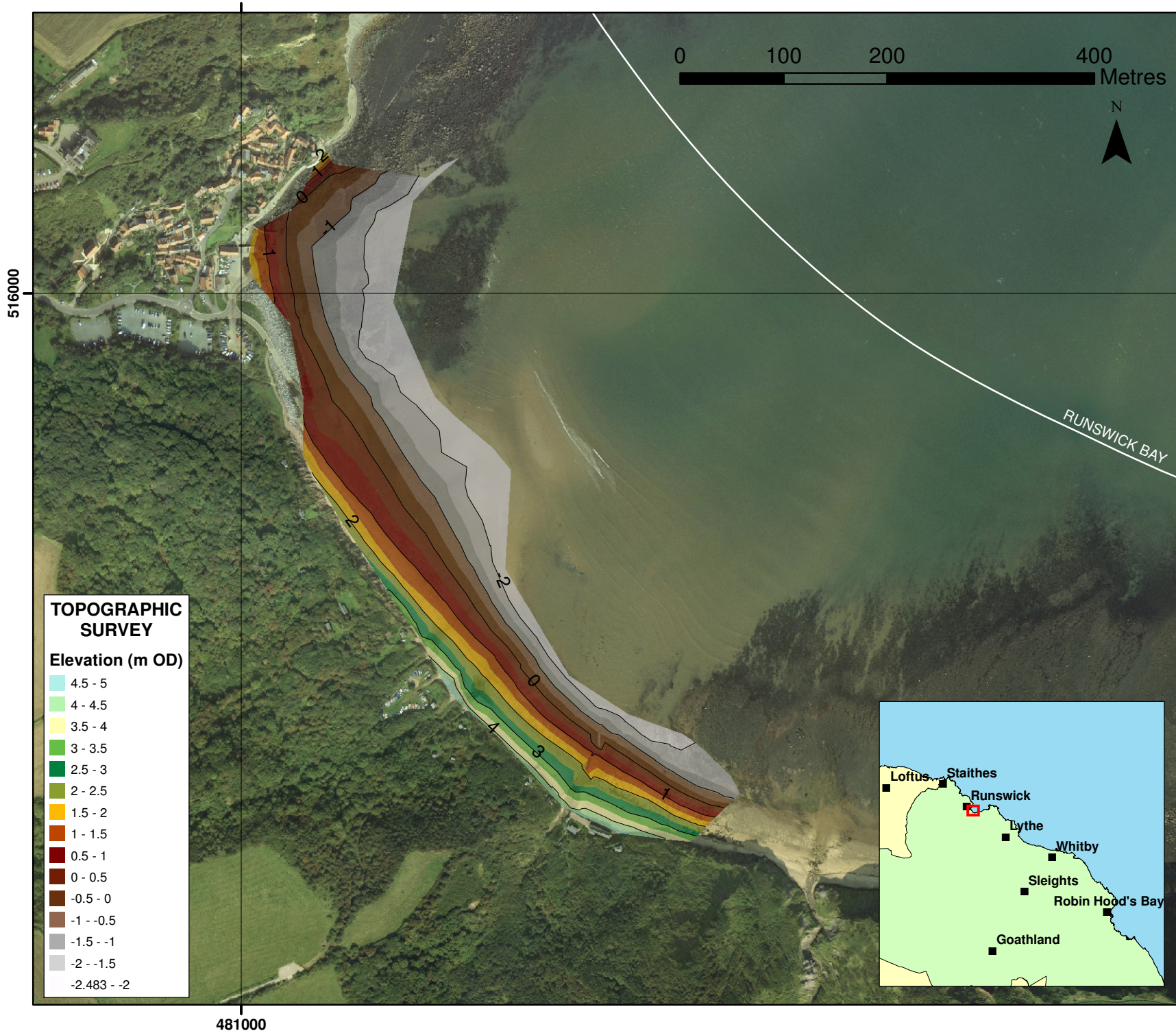
Easting 514207.792

Northing 476001.334 Bearing 47

Chainage	Level
0	43.696
4.962	43.369
6.193	43.312
12.637	42.279
19.754	41.375
30.006	40.438
38.333	39.98
40.524	39.942
42.118	39.74
46.209	39.718
48.091	39.735
51.983	39.619
54.863	39.519
57.601	39.4
58.595	39.361
60.707	39.001
63.209	38.753
152.118	27.776
176.751	13.255
196.02	23.606
220.82	3.939
224.103	3.282
236.33	2.481
250.515	1.772
279.904	0.939
309.358	0.225
337.298	-0.319
367.275	-0.6
391.93	-0.779
417.616	-1.144
437.018	-1.423



Appendix B
Topographic Survey



TOPOGRAPHIC SURVEY

Elevation (m OD)

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
-2.483 - -2

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 1
 Scarborough
 Borough Council Frontage**

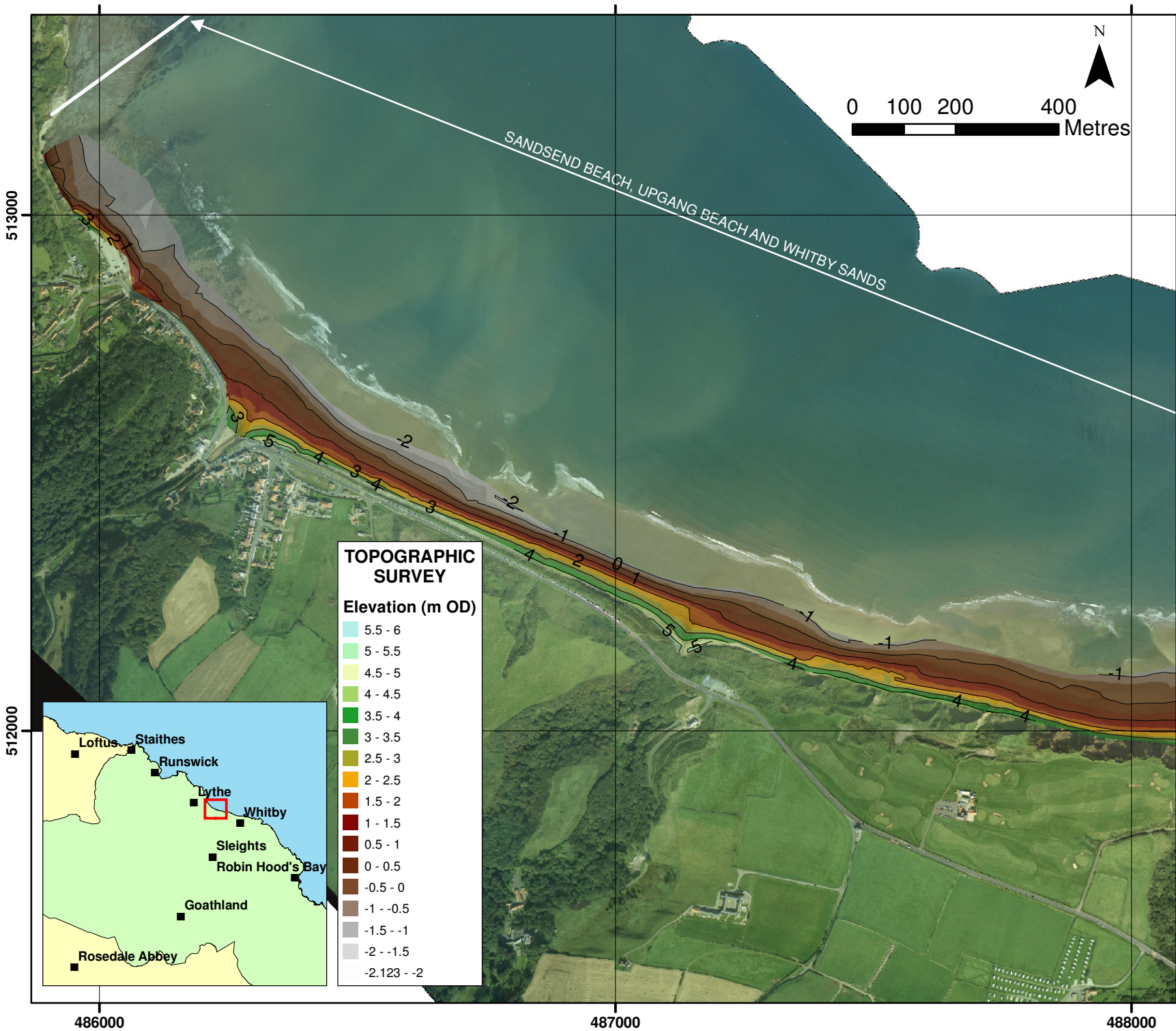
Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:5,000 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009

 ROYAL HASKONING	 Halcrow
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— Topographic Contours at 1 metre interval

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

Appendix B - Map 2a
Scarborough
Borough Council Frontage

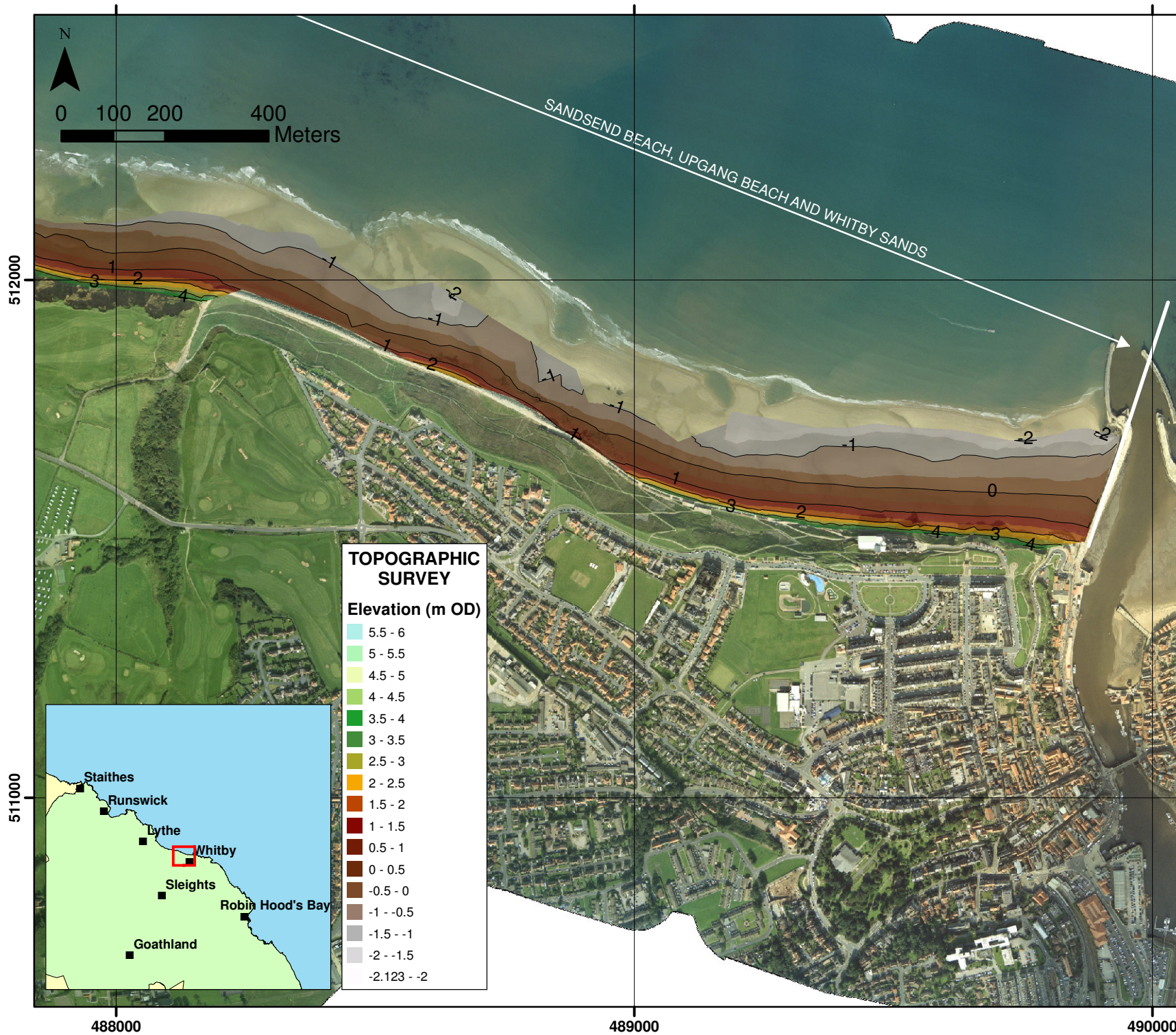
Analytical Report 1
'Full Measures' Survey 2008

Drawing Scale 1:10,000 at A4

Drawn by: ES Date: 18/05/2009
Checked by: RJ Date: 18/05/2009
Approved by: RJ Date: 18/05/2009

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— Topographic Contours at 1 metre interval

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

**Appendix B - Map 2b
Scarborough
Borough Council Frontage**

Analytical Report 1
'Full Measures' Survey 2008

Drawing Scale 1:10,000 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009



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

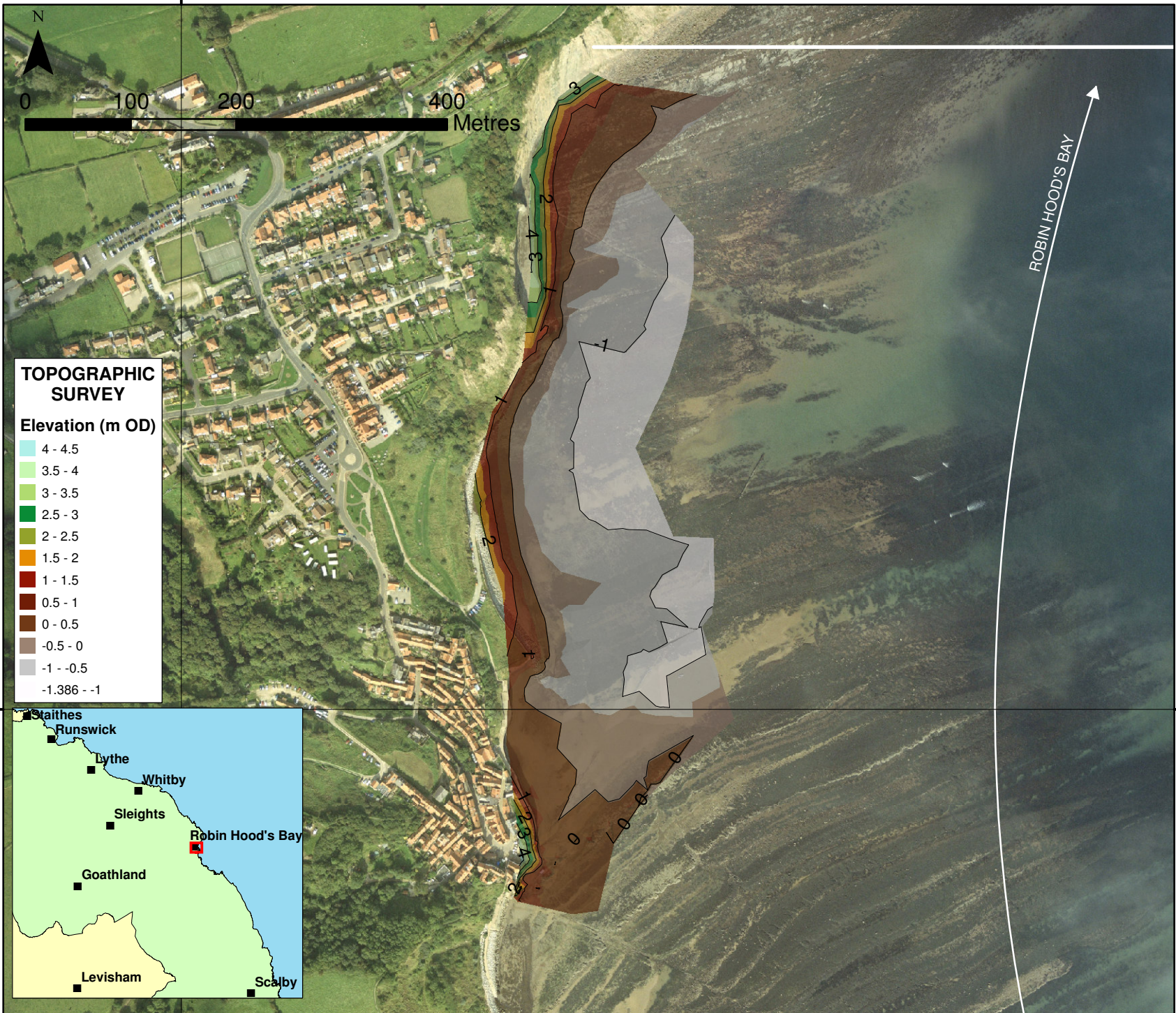


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TOPOGRAPHIC SURVEY

Elevation (m OD)

4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0.5 - 1
0 - 0.5
-0.5 - 0
-1 - -0.5
-1.386 - -1

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 3
 Scarborough
 Borough Council Frontage**

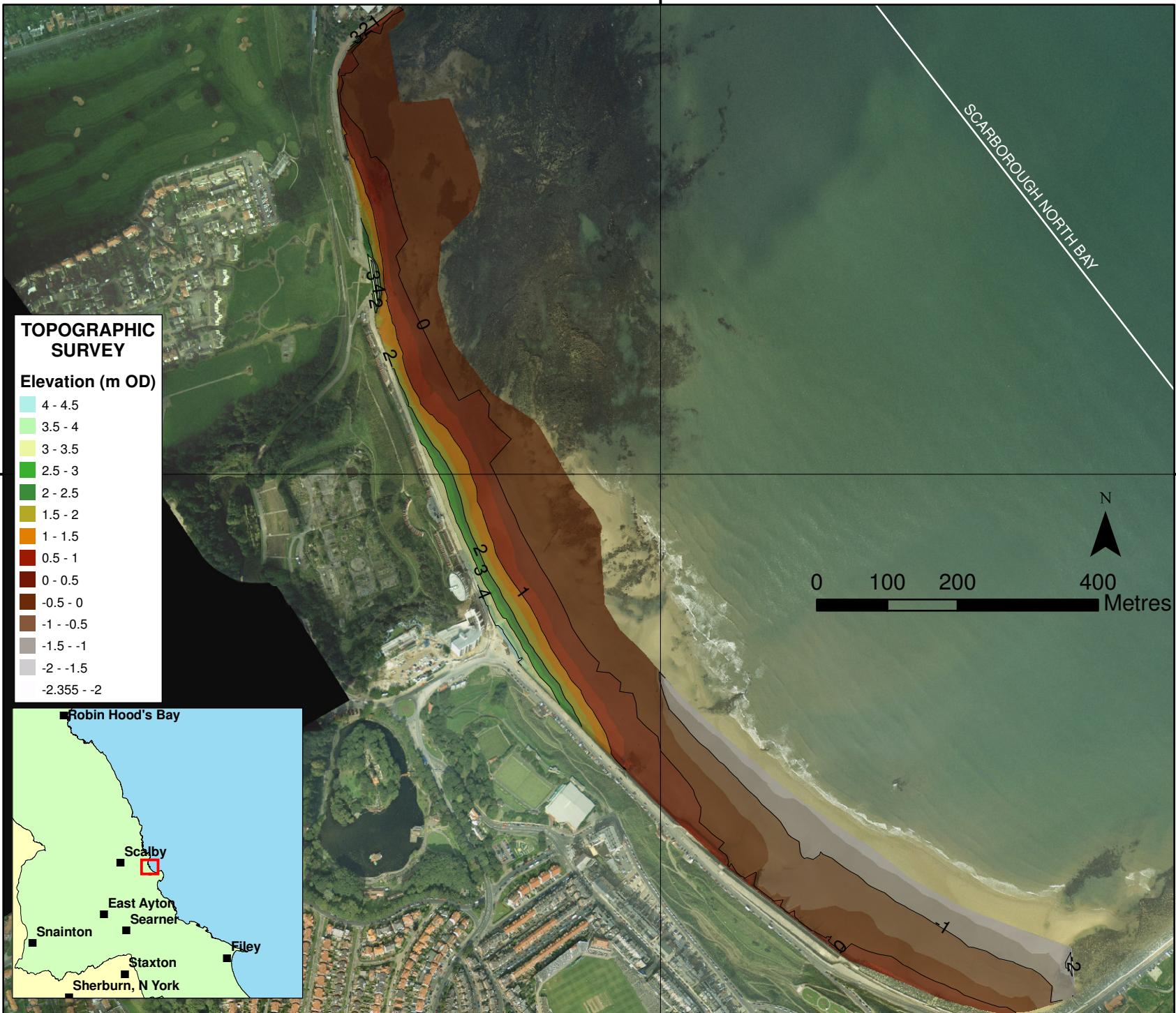
Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:5,000 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009

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TOPOGRAPHIC SURVEY

Elevation (m OD)

- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- 0.5 - 0
- 1 - -0.5
- 1.5 - -1
- 2 - -1.5
- 2.355 - -2

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 4
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:7,500 at A4

Drawn by: ES Date: 18/05/2009
 Checked by: RJ Date: 18/05/2009
 Approved by: RJ Date: 18/05/2009

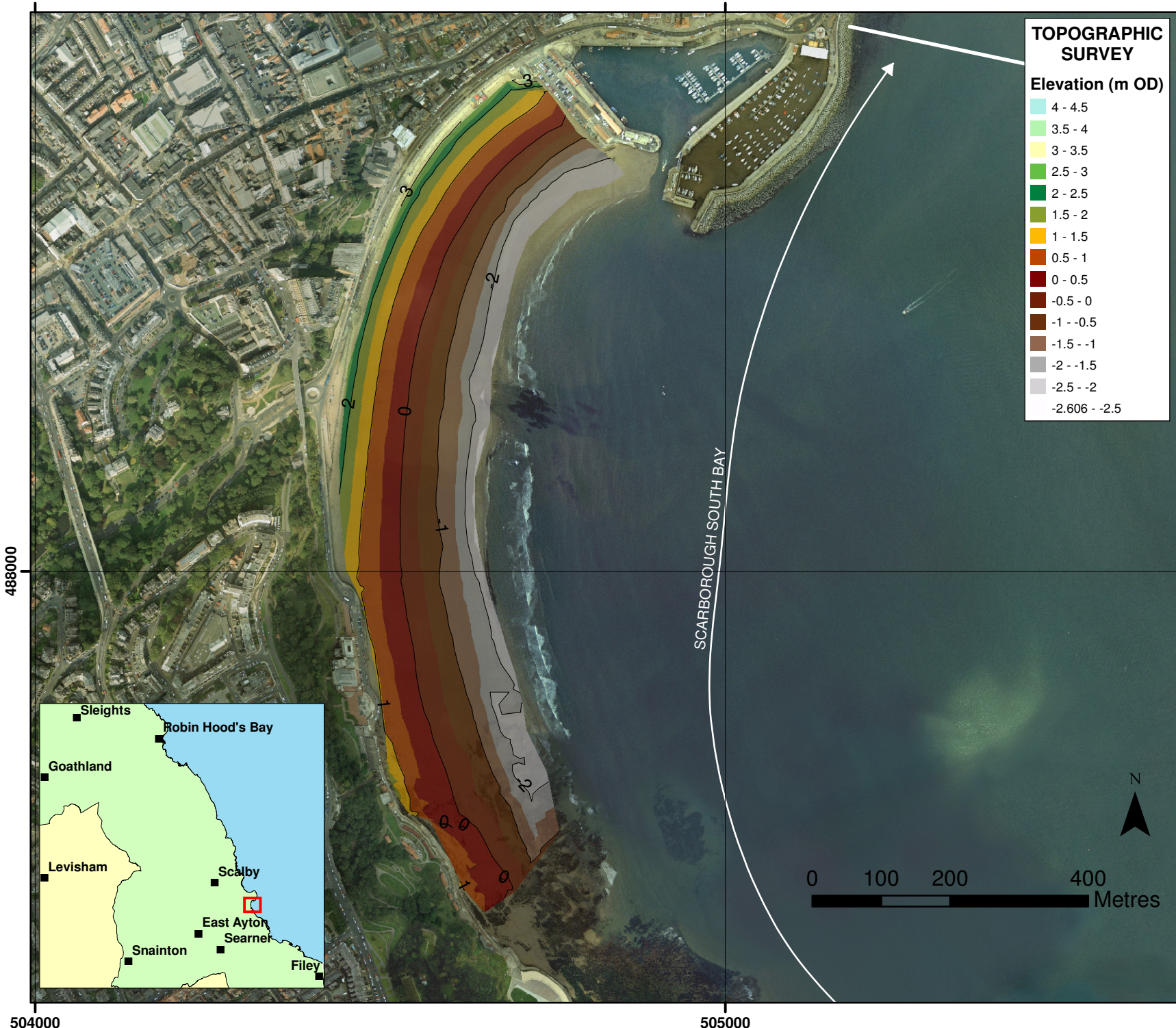
 ROYAL HASKONING	 Halcrow
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490000

504000





TOPOGRAPHIC SURVEY

Elevation (m OD)

- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- 0.5 - 0
- 1 - -0.5
- 1.5 - -1
- 2 - -1.5
- 2.5 - -2
- 2.606 - -2.5

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 5
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:7,500 at A4

Drawn by: ES Date: 18/05/2009
 Checked by: RJ Date: 18/05/2009
 Approved by: RJ Date: 18/05/2009

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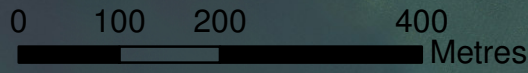
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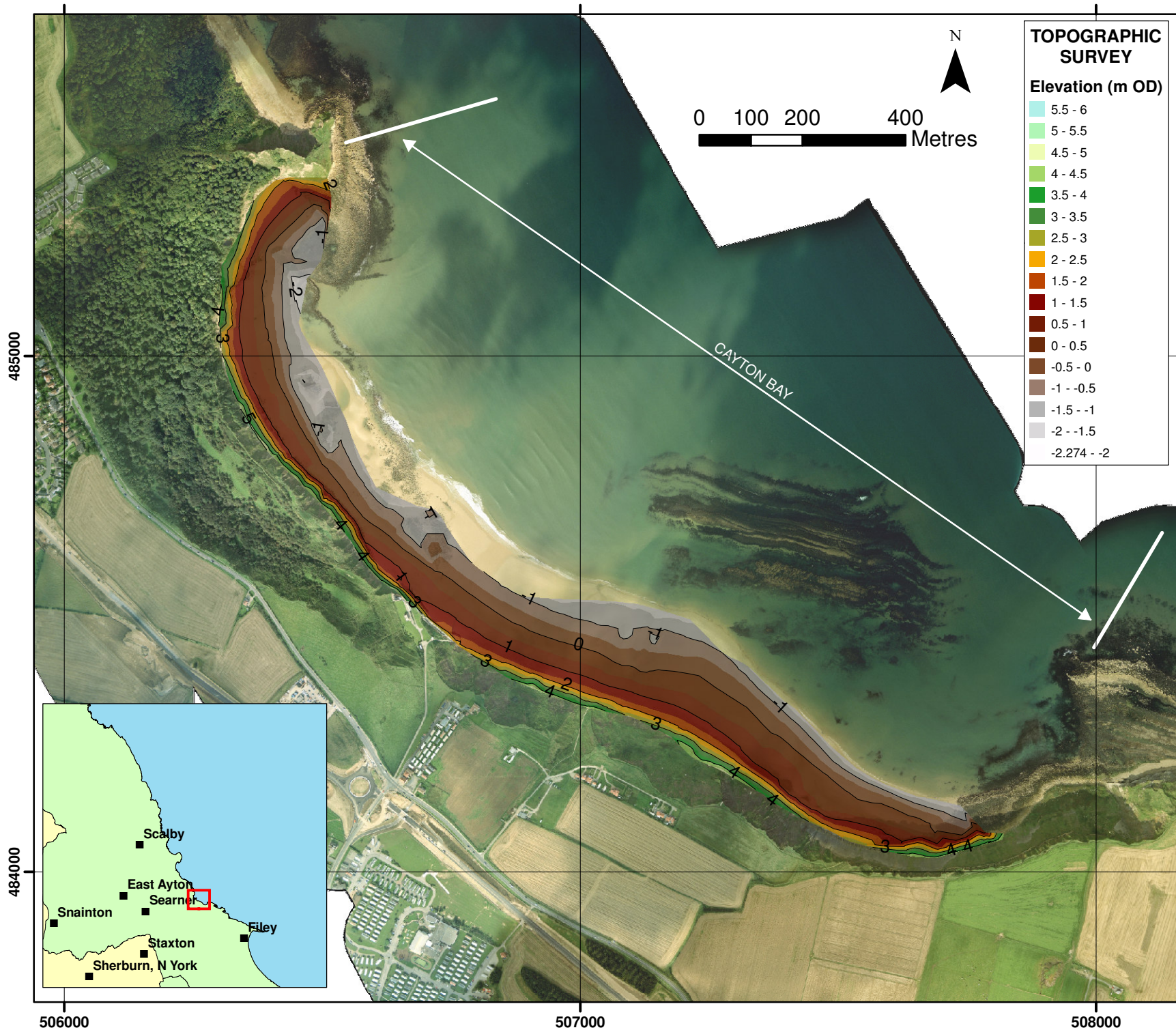
488000

504000

SCARBOROUGH SOUTH BAY

505000





TOPOGRAPHIC SURVEY

Elevation (m OD)

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
-2.274 - -2

— Topographic Contours at 1 metre interval

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

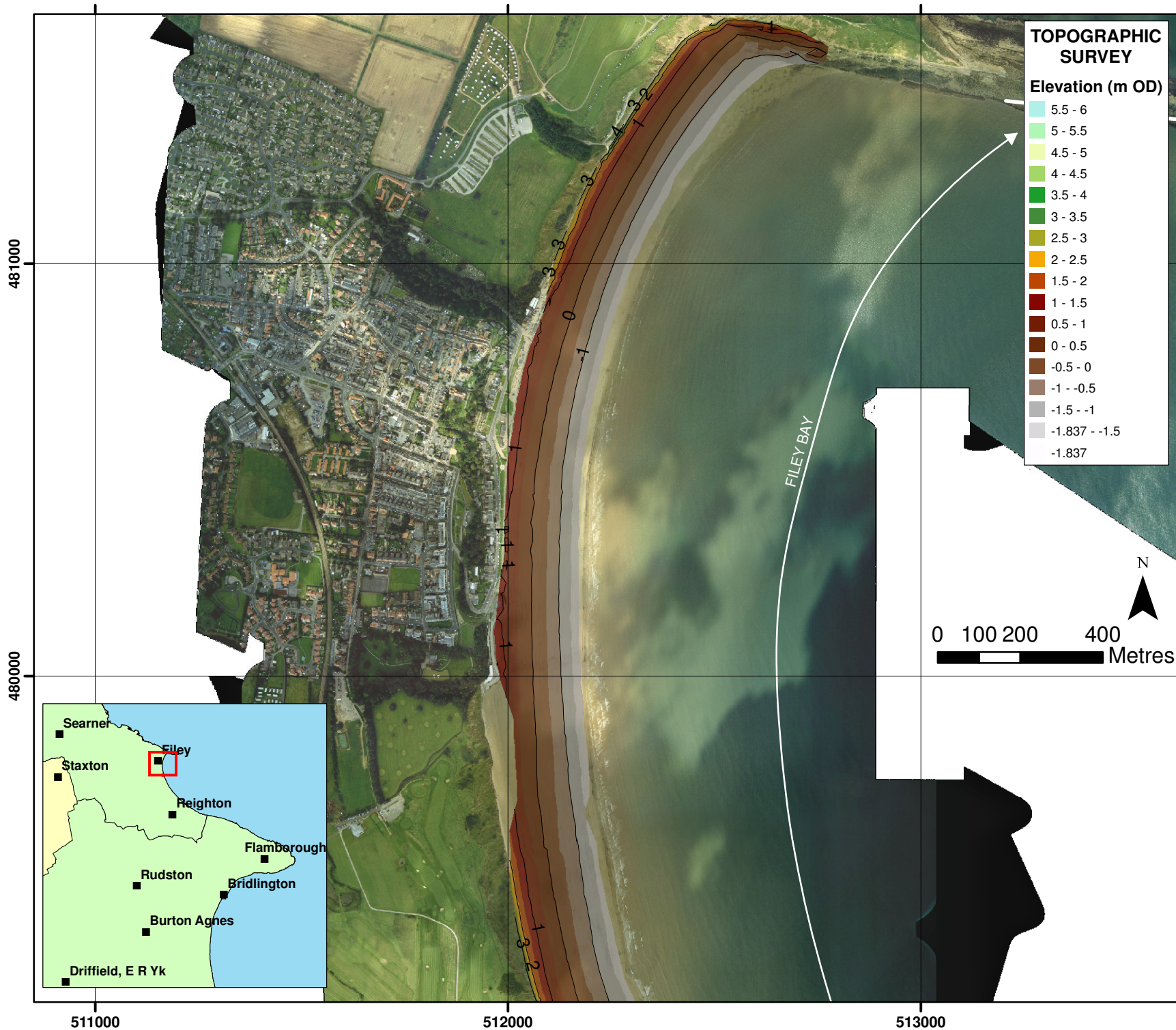
**Appendix B - Map 6
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008
 Drawing Scale 1:10,000 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009

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— Topographic Contours at 1 metre interval

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

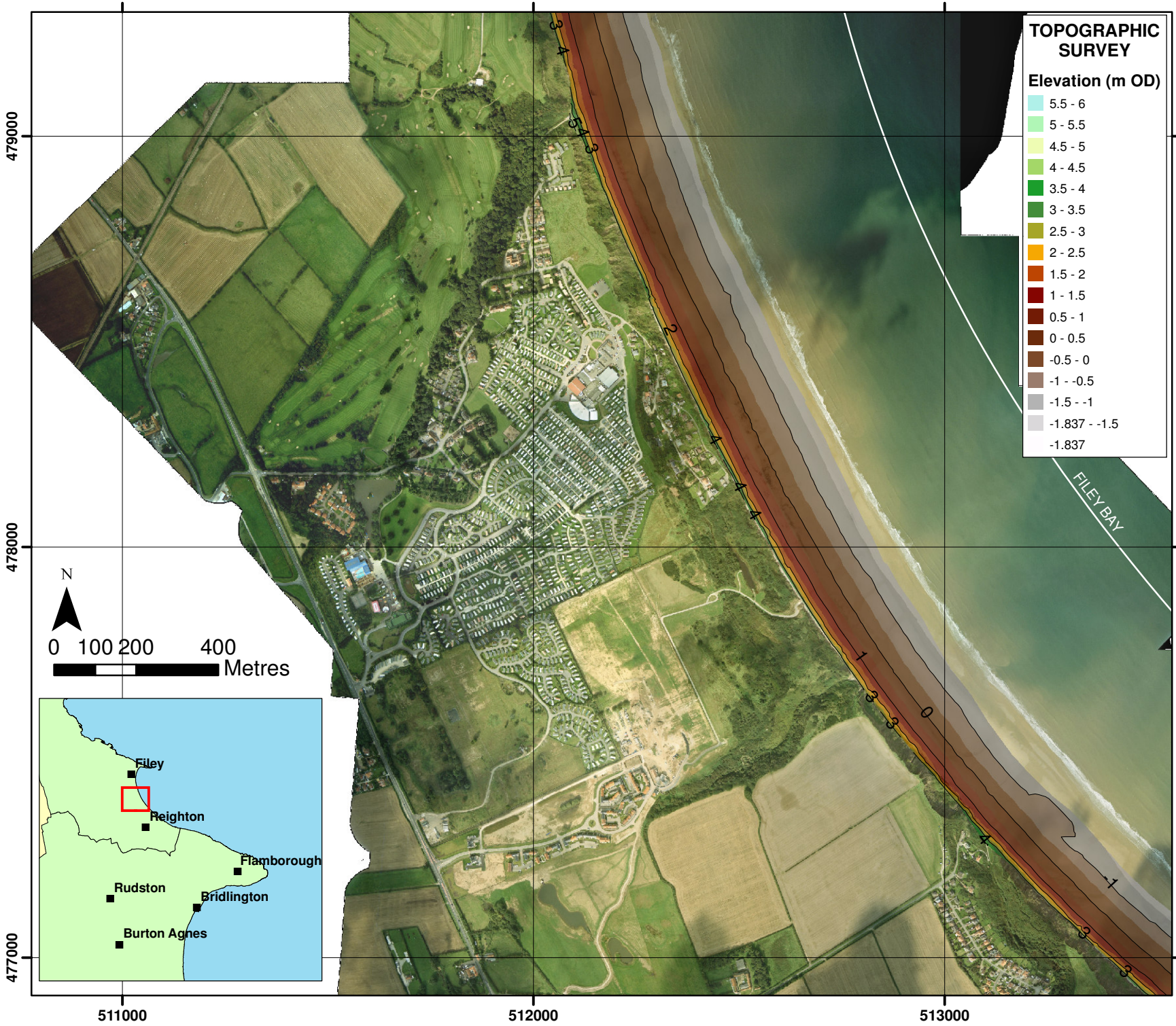
**Appendix B - Map 7a
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008
 Drawing Scale 1:12,500 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009

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TOPOGRAPHIC SURVEY

Elevation (m OD)

- 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
- 1.837 - -1.5
- 1.837

— Topographic Contours at 1 metre interval

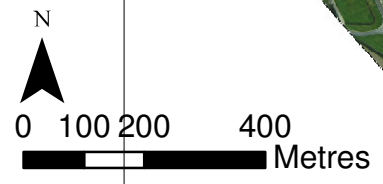
Client: North East Coastal Group
 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix B - Map 7b
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

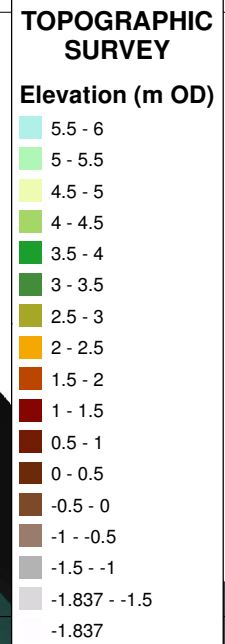
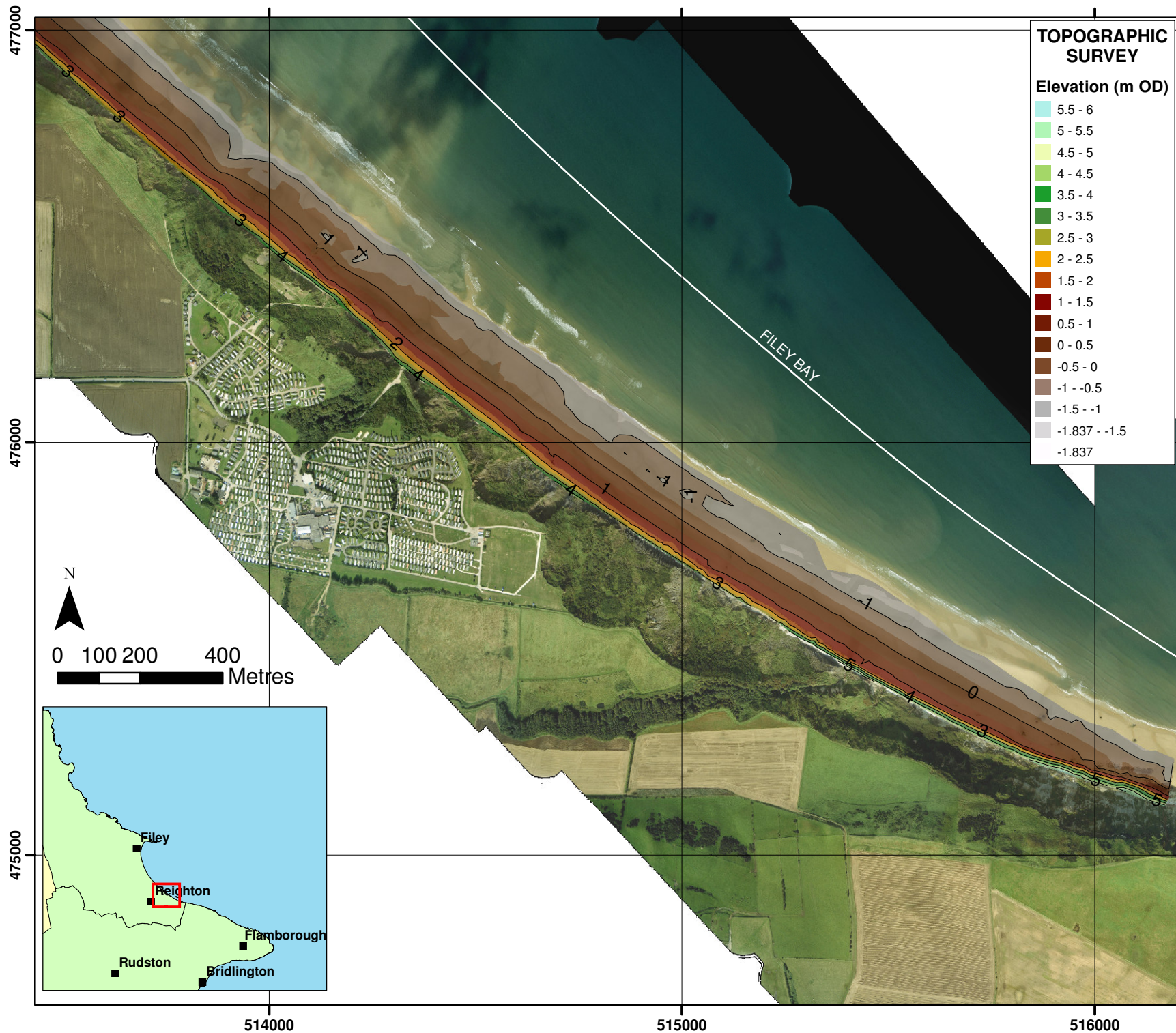
Drawing Scale 1:12,500 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009



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— Topographic Contours at 1 metre interval

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

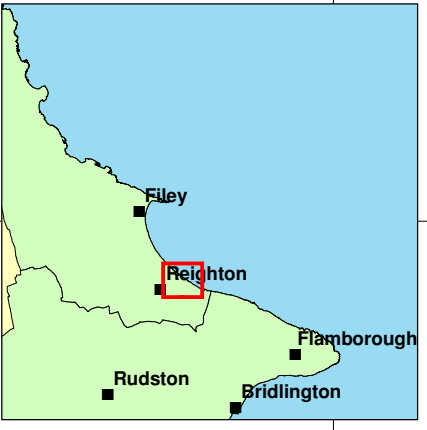
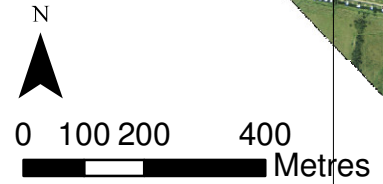
**Appendix B - Map 7c
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008
 Drawing Scale 1:12,500 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009

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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 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	-	-	-	-	-
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	-	-	-	-	-

Cliff Top Survey

Cayton Bay

Eight ground control points have been established within Cayton Bay (Appendix C- Map 2). The maximum separation between any two points is nominally 300m.

The cliff top surveys at Cayton Bay 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 C2 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 C2 – Cliff Top Surveys at Cayton Bay

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	506325	484850	32.1	50	4.0	-	-	-	-	-
2	506459	484716	28.2	65	5.0	-	-	-	-	-
3	506597	484539	28.2	65	5.0	-	-	-	-	-
4	506778	484345	38.9	21	9.0	-	-	-	-	-
5	507019	484222	38.8	342	7.7	-	-	-	-	-
6	507242	484122	46.5	2	7.4	-	-	-	-	-
7	507518	484008	69.5	25	7.5	-	-	-	-	-
8	507819	484006	80.1	1	5.5	-	-	-	-	-

Cliff Top Survey

Filey Bay

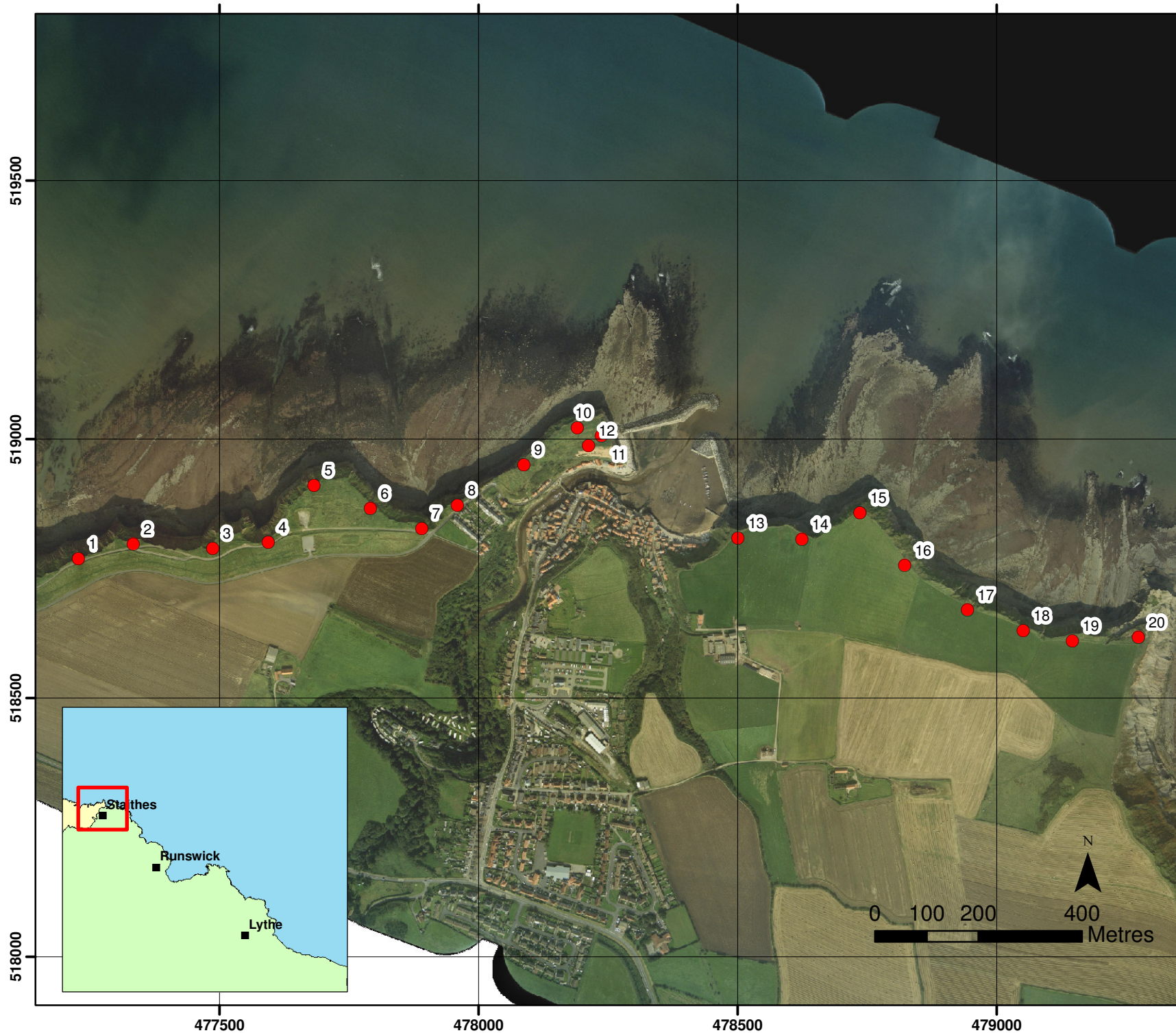
Twenty-three ground control points have been established within Filey Bay (Appendix C- Map 3a & 3b). The maximum separation between any two points is nominally 300 m.

The cliff top surveys at Filey Bay 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 C3 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 C3 – Cliff Top Surveys at Filey Bay

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	512445	481631	42.5	130	8.7	-	-	-	-	-
2	512307	481490	37.5	144	7.6	-	-	-	-	-
3	512154	481235	34.6	122	8.3	-	-	-	-	-
4	512029	480960	33.0	112	7.4	-	-	-	-	-
5	511895	479888	28.8	89	7.1	-	-	-	-	-
6	511908	479597	31.8	48	6.7	-	-	-	-	-
7	511991	479310	29.2	69	6.7	-	-	-	-	-
8	512083	478981	27.2	66	10.2	-	-	-	-	-
9	512121	478786	30.9	76	8.3	-	-	-	-	-
10	512226	478548	33.0	74	7.5	-	-	-	-	-
11	512471	478153	11.3	53	6.6	-	-	-	-	-
12	512559	477902	20.3	66	7.7	-	-	-	-	-
13	512698	477719	20.2	34	4.2	-	-	-	-	-
14	512939	477401	31.7	66	8.0	-	-	-	-	-
15	513157	477193	27.6	51	5.2	-	-	-	-	-
16	513299	477025	28.0	30	7.7	-	-	-	-	-
17	513508	476821	36.8	34	10.7	-	-	-	-	-
18	513721	476602	39.7	31	7.2	-	-	-	-	-
19	513917	476354	48.9	51	6.6	-	-	-	-	-
20	514175	476179	41.8	32	7.0	-	-	-	-	-
21	514472	475966	43.2	66	7.6	-	-	-	-	-
22	514656	475729	56.6	101	8.1	-	-	-	-	-
23	514889	475538	68.5	60	9.1	-	-	-	-	-



● Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix C - Map 1
Scarborough
Borough Council Frontage**

Analytical Report 1
'Full Measures' Survey 2008

Drawing Scale 1:10,000 at A4

Drawn by: ES Date: 18/05/2009

Checked by: RJ Date: 18/05/2009

Approved by: RJ Date: 18/05/2009



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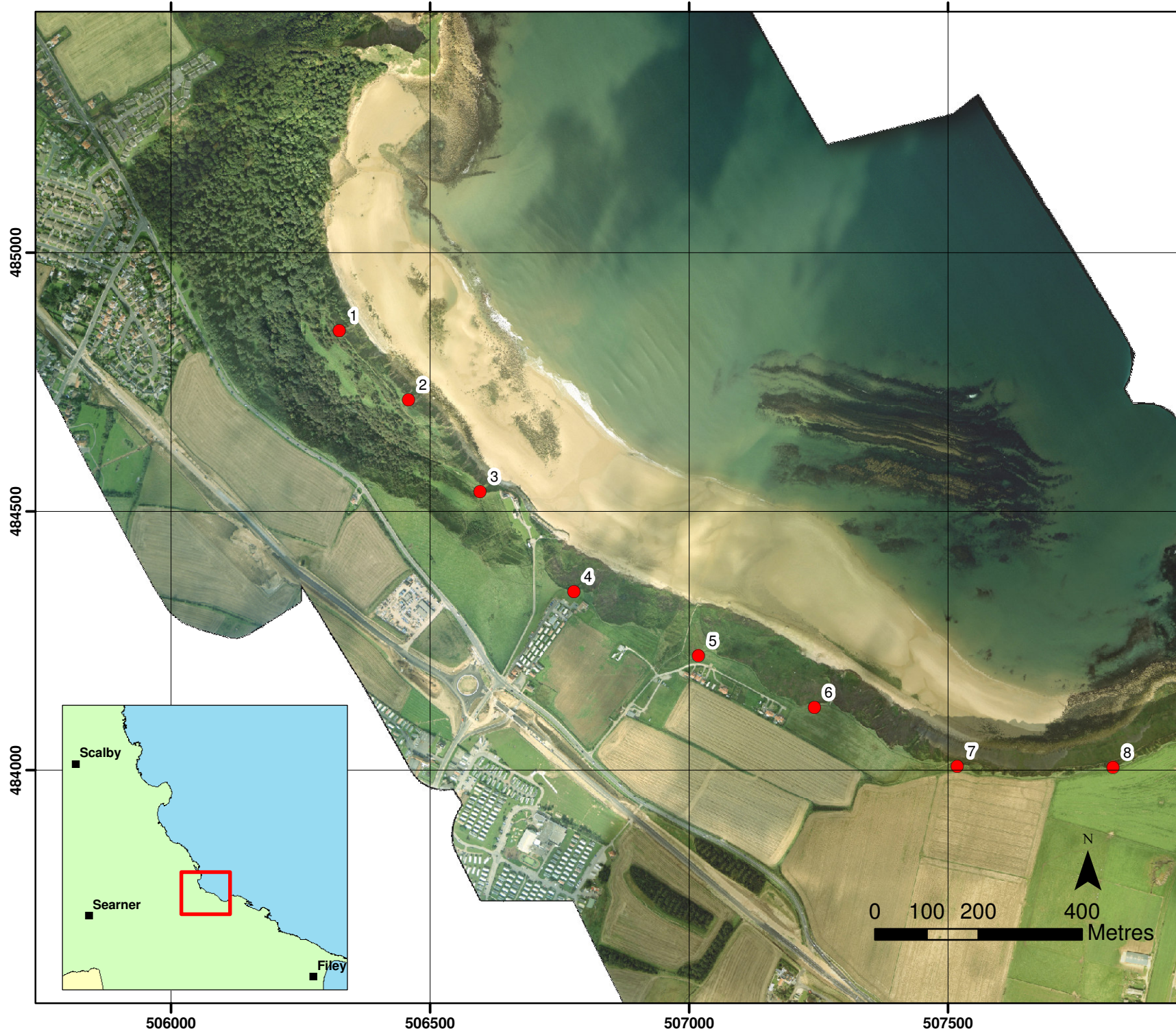


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● Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix C - Map 2
Scarborough
Borough Council Frontage**

Analytical Report 1
'Full Measures' Survey 2008

Drawing Scale 1:10,000 at A4

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Checked by: RJ Date: 18/05/2009

Approved by: RJ Date: 18/05/2009



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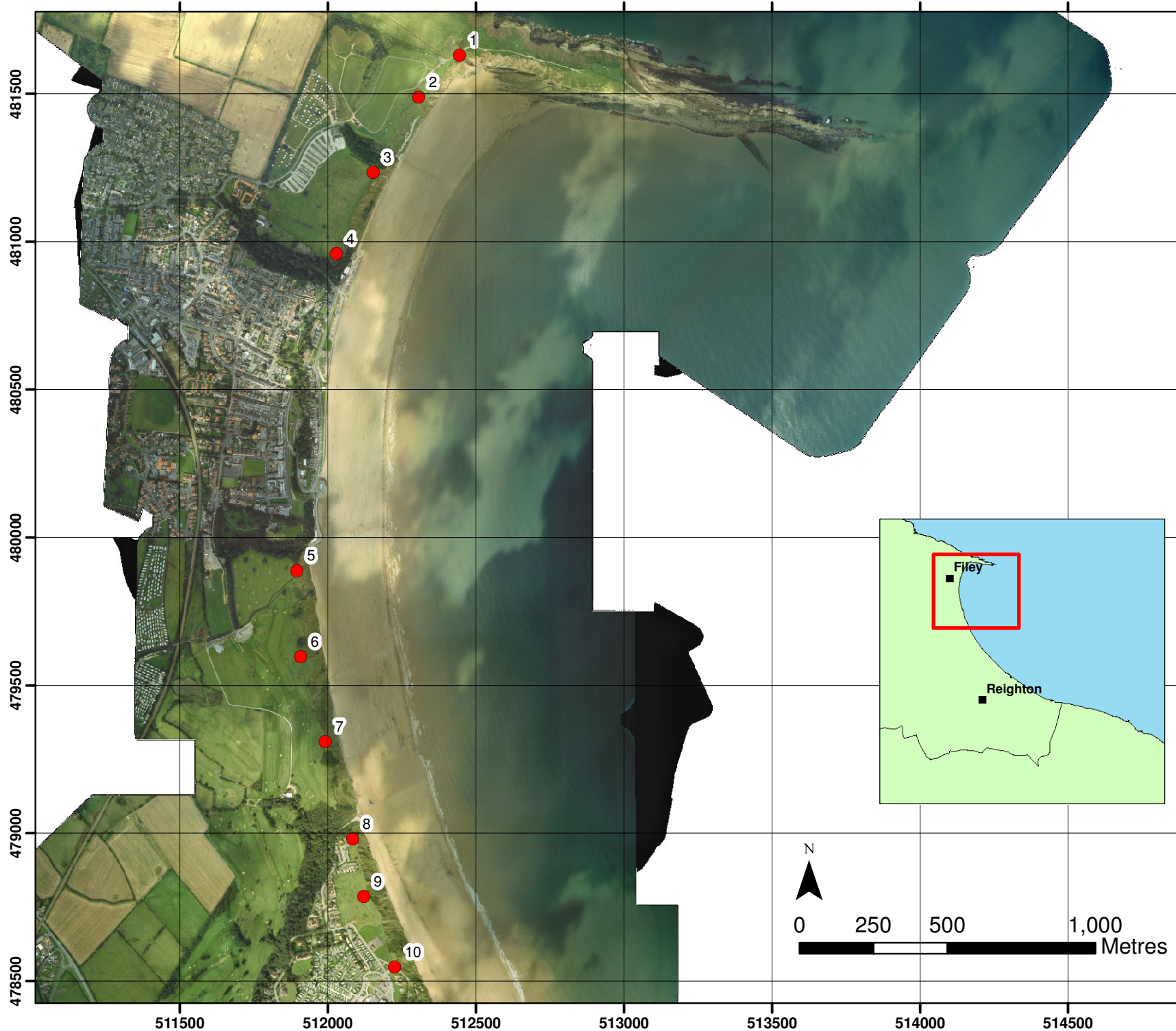


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● Ground Control Points

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 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix C - Map 3a
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:17,500 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009



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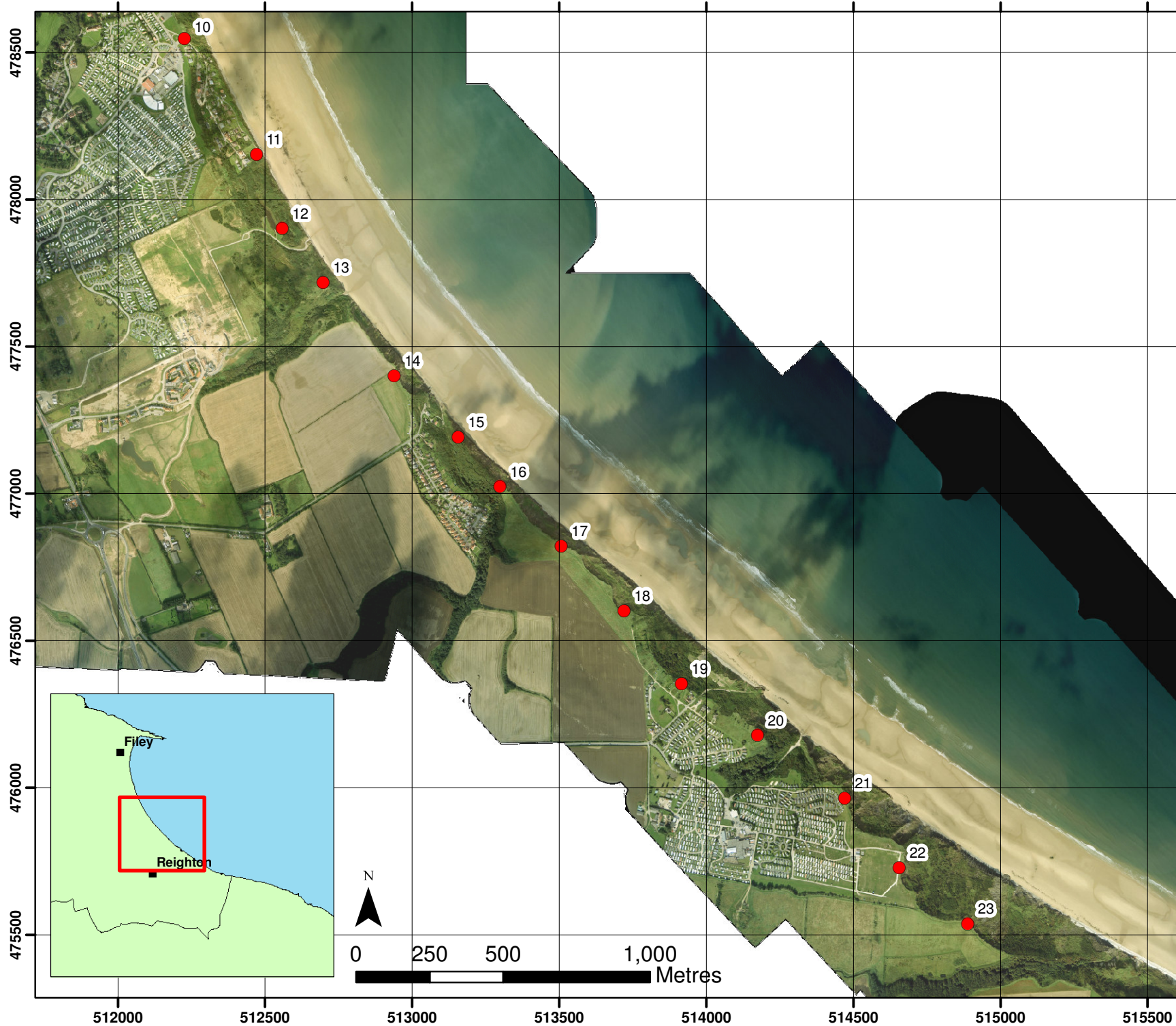


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● Ground Control Points

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 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix C - Map 3b
 Scarborough
 Borough Council Frontage**

Analytical Report 1
 'Full Measures' Survey 2008

Drawing Scale 1:17,500 at A4

Drawn by: ES	Date: 18/05/2009
Checked by: RJ	Date: 18/05/2009
Approved by: RJ	Date: 18/05/2009



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