Additional Note

HASKONING UK LTD.
COASTAL & RIVERS

To	:	Stewart Rowe
From	:	Nick Cooper
Date	:	29 March 2011
Copy	:	Paul Knight, Emma Hick
Our reference	:	9T6403 – Additional Note

Subject : Additional Beach Topographic Surveys

Background

On 22nd February 2011, Scarborough Borough Council observed notable lowering of beach levels at the toe of the revetment protecting the A174 road at Sandsend Beach. Due to this, Royal Haskoning was asked to facilitate a topographic survey of the beach between Sandsend and Whitby, and also along beaches at Scarborough North Bay and Scarborough South Bay, with an accompanying brief analysis and interpretation of the changes.

The topographic surveys were undertaken by Academy Geomatics on the following dates:

- Scarborough South Bay – 24th February 2011
- Scarborough North Bay – 25th February 2011
- Sandsend to Whitby – 4th March 2011

This report provides a summary of findings from these surveys.

Scarborough South Bay

Scarborough South Bay has been surveyed annually as a beach 'topographic survey' each autumn since 2008 as part of the Cell 1 Regional Coastal Monitoring Programme. Four beach profiles, named SBS1-SBS4, have also been surveyed twice a year since autumn 2008.

Previous *Analytical Reports* have identified that between November 2008 and October 2009 there was some accretion along the lower foreshore in the north of the Bay and lowering across the upper beach in this zone. In the centre of the Bay there was lowering of the mid beach levels, but stability at the seaward and landward limits, with lowering of lower beach levels through the south of the Bay. Much of the upper beach remained unchanged in level in the central and southern sections.

In January 2010 a one-off additional survey was undertaken to help determine the impact of sand mining from South Bay. This was undertaken for purposes of supplementing highways department salt supplies during the sustained severe winter weather. Between October 2009 and January 2010 there was notable reduction in beach levels through much of the Bay, especially between St. Nicholas Cliff and South Cliff, in front of the Spa. In all, some 34,000m^3 of sand was lost (or removed) from the Bay, although some of the artificially removed sand was later replaced to the beach after the snow and ice thawed.

The subsequent September 2010 survey and the difference between the January 2010 and September 2010 surveys are shown in **Appendix A**. There was a general tendency for modest accretion throughout much of the Bay, showing no long-lasting detrimental effects of the sand mining (and subsequent substantial replacement) with a zone of erosion of the lower foreshore just south of the harbour, and another zone of erosion of the lower foreshore south of the Spa.

In the vicinity of profile line SBS1, the upper foreshore accretion was of the order of 0.35m at the toe of the sea wall, peaking at 0.6m at a chainage of around 18m from the wall. Accretion occurred along the profile across a width of upper beach of about 50m in total. A berm was then formed around mid beach level before the lower foreshore started to reduce in level compared to the previous survey, by up to 0.8m in places. This suggests that material was removed from the lower profile and driven up the beach, forming a berm around mid beach level. A similar trend was observed along profile line SBS2, but the upper beach accretion was less. Along profile line SBS3 no lowering was recorded, and accretion of up to 0.35m occurred along the width of the foreshore. Immediately offshore of the Spa, profile line SBS4 experienced accretion over much of its length (across a beach width of around 100m), with slight lowering at the very seaward end of the transect.

The February 2011 survey is also shown in **Appendix A**, together with a figure showing difference between the September 2010 and February 2011 surveys. In contrast to the preceding analysis, South Bay generally experienced a loss of material between these dates, with the upper beach levels notably reduced through much of the Bay and mid beach levels also reduced from north of the Spa northwards to the harbour. Some accretion occurred on the lower foreshore in the north of the Bay.

These changes were most marked at profile lines SBS2 and SBS3, where the drop in level of the upper beach was of the order of 0.6m. At the Spa, the drop in levels at the toe of the sea wall was less, being of the order of 0.35m.

Scarborough South Bay does tend to exhibit drawdown of material during stormy periods and subsequent build up of beach levels during calmer wave conditions, with greatest change in levels appearing to occur between from just north of the Spa to St. Nicholas Cliff.

Scarborough North Bay

Scarborough North Bay has been surveyed annually each autumn since 2008 as part of the Cell 1 Regional Coastal Monitoring Programme. Five beach profiles, named SB1-SB5, have also been surveyed twice a year since autumn 2008.

Previous *Analytical Reports* have identified that between November 2008 and October 2009 there was very notable lowering of the lower foreshore in the northern half of the Bay, but deposition of sand across upper foreshore throughout the Bay.

Between October 2009 and September 2010 there was generally lowering of upper beach levels throughout much of the Bay and accretion along the mid and lower beach in the northern half of the Bay, almost reversing the previously observed trend.

The February 2011 survey is shown in **Appendix B**, together with a figure showing difference between the September 2010 and February 2011 surveys. Between these dates changes were generally accretion in the north of the Bay, erosion in the centre and general stability with some modest areas of accretion along the upper beach in the south of the Bay. In the vicinity of profile line SB1, accretion of up to 0.8m was observed at the toe of the sea wall, but in contrast at profile lines SB2 and SB3 levels at the toe of the wall were around 0.3 – 0.4m lower than the previous survey. The worst affected area appeared to be just north of profile SB3, where beach levels within a width of around 10m from the toe of the wall were some 0.8m lower.

Scarborough North Bay exhibits a relatively complex behaviour along its length, with no uniform patterns or trends. Typically, many beaches will fairly widely experience lower foreshore lowering and upper foreshore accretion (or *vice versa*) due to prevailing wave conditions, or general loss of material from one end of a frontage and re-distribution along to another, but North Bay showed almost distinctly different zones of behaviour across its length. This may be attributable to the more complex wave patterns which operate in this Bay, caused by reflection off the sea walls and refraction across the bathymetry of the sea bed.

Sandsend to Whitby

The beach between Sandsend and Whitby comprises Sandsend Beach, Upgang Beach and Whitby Sands and has been surveyed annually as a beach 'topographic survey' each autumn since 2008 as part of the Cell 1 Regional Coastal Monitoring Programme. Three beach profiles, named WB1-WB3, have also been surveyed twice a year since autumn 2008.

In the short time over which beach surveys have been undertaken, there does seem to be notable variability in beach form and level, as reported in previous *Analytical Reports*.

Between November 2008 and October 2009 there was notable lowering of the lower foreshore seaward of East Row Beck, but accretion of the upper foreshore at this location. Along Upgang Beach there was a mixed response, with areas of both lowering and deposition, whilst along Whitley Sands there was a predominant trend of across, notwithstanding some local lowering at the very top of the foreshore.

Between October 2009 and November 2010 there was predominantly accretion along Sandsend Beach, lowering along the upper foreshore and deposition along the lower foreshore along Upgang Beach, and predominantly lowering across Whitley Sands.

The March 2011 survey is shown in **Appendix C**, together with a figure showing difference between the November 2010 and March 2011 surveys. Between these dates there was a section of frontage along Sandsend Beach, extending eastwards of East Row Beck for a distance of approximately 625m where the road runs close to the coastline, where beach lowering occurred. Along Upgang Beach, deposition occurred across the mid and upper profile, with lowering of the lower foreshore. This trend was also noticed at Whitby Sands, although the magnitude of the changes was less than at Upgang Beach. It is envisaged that the upper foreshore lowering at the toe of the cliffs along Sandsend Road is within the natural bounds of behaviour and will recover due to natural variations in level over forthcoming months.

Considering the beach profile transects surveyed since November 2008 at location WB1, in front of the A174 road, **Appendix D** shows that recorded beach level variations at the toe of the revetment have been in excess of 1m. The most recent survey of March 2011 recorded the lowest levels to date at the toe, but further down the profile the beach levels were quite high, suggesting a drawdown of material from the upper beach to mid and lower sections. Such low beach levels at the toe were previously approached in October 2009, but during that particular survey the whole inter-tidal profile transect suffered lowering, suggesting that material was stripped off the beach to the nearshore zone whereupon some of it may have been transported eastwards by stronger tidal currents. However, by the time of the subsequent survey in March 2010, the low levels were restored and the beach was again relatively healthy, indicating the variable nature of the foreshore levels at this section of the frontage.

Along profile WB2, extending from the undefended cliffs at Upgang, beach levels are also quite volatile, with changes of the order of 1m not uncommon between successive surveys along certain lengths of the profile. During the March 2011 survey, levels were relatively high on the upper beach, but dropped notably at the seaward end of the section.

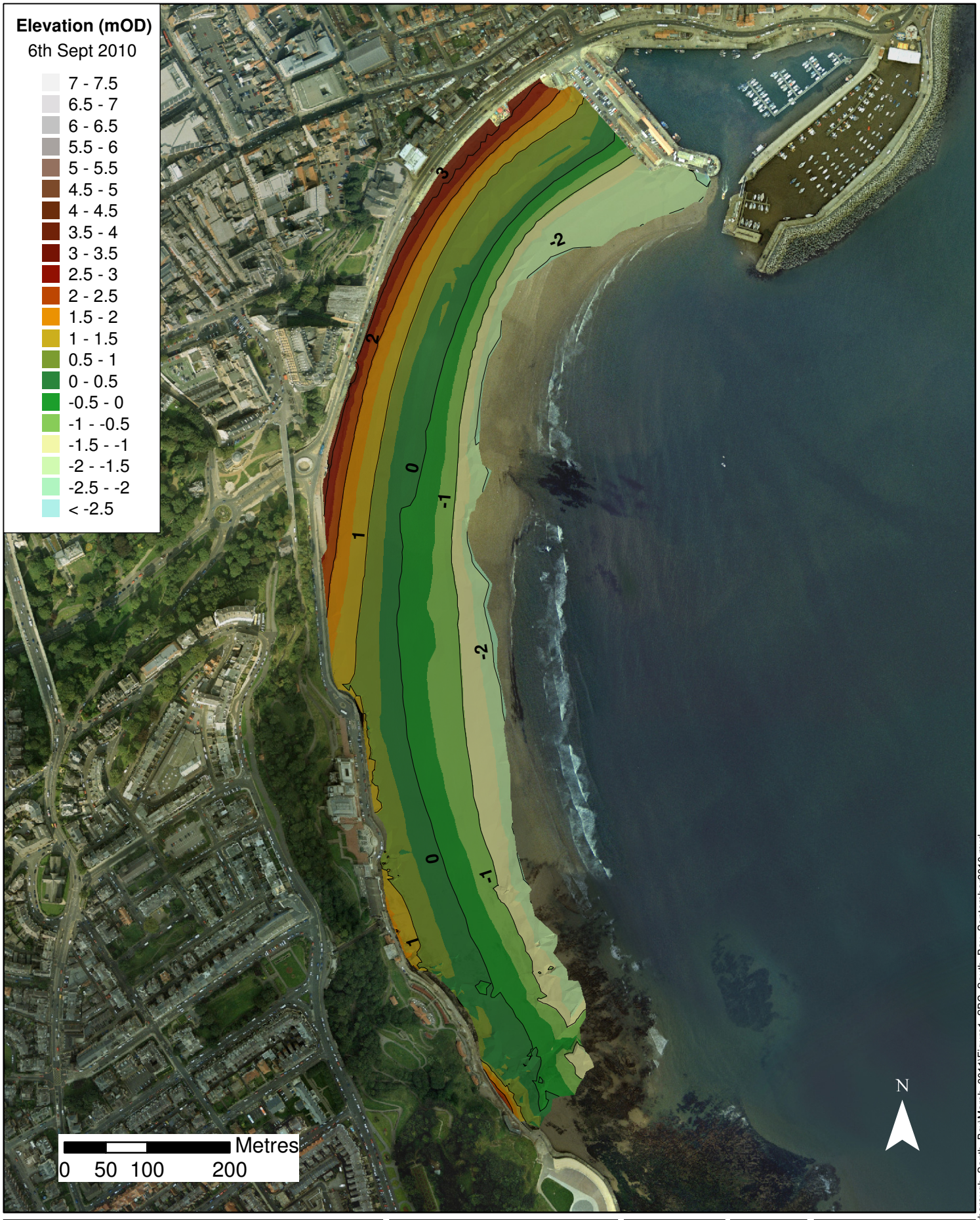
WB3, which extends from the defended Whitby West Cliff, is generally more stable in beach levels, although the last survey showed a significant drop in level a short distance from the seawall.

Sandsend Beach, Upgang Beach and Whitby Sands are all relatively active beaches, dominated by prevailing wave conditions, especially when they approach the shore from due north, drawing material down the profile, with subsequent recovery during calmer wave conditions.

Appendix A

Scarborough South Bay

Topographic Surveys



Key:

Title:
Topographic Survey (Sep 2010)

Project:
Scarborough South Bay

Client:
Scarborough Borough Council

Date:
March 2011

Scale on A4:
1:6,000

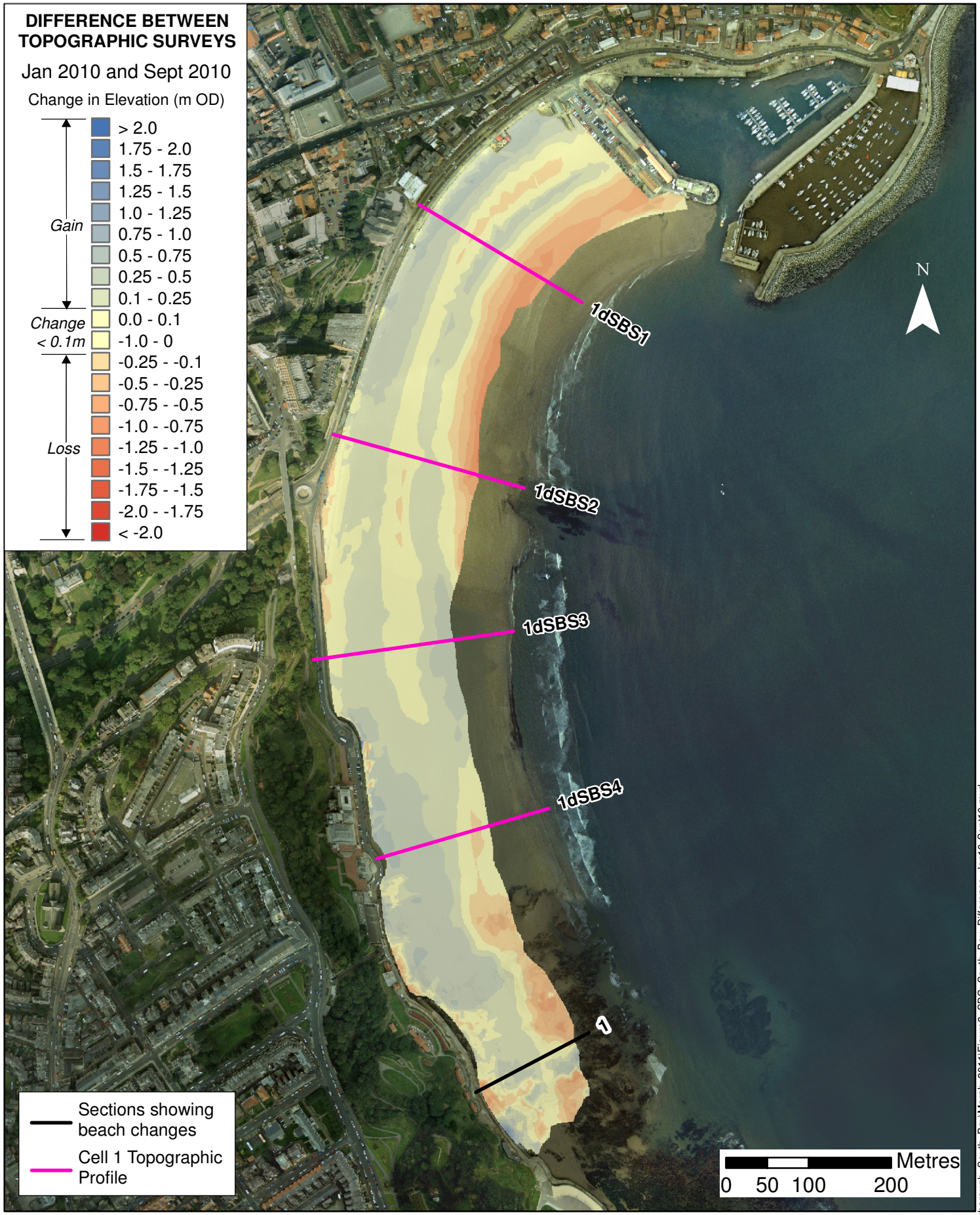
Figure:
1

Drawn:
TC

Checked:
NC

ROYAL HASKONING

I:\9T6403\Technical_Data\gis\figure\Scarborough_South_Bay\March_2011\Figure1_SBC_South_Bay_September2010.mxd



Key:

Title:
Changes between Jan 2010 and Sept 2010 Topographic Surveys

Project:
Scarborough South Bay

Client:
Scarborough Borough Council

Date:
March 2011

Scale on A4:
1:6,000

Figure:
3

Drawn:
TC

Checked:
NC

ROYAL HASKONING

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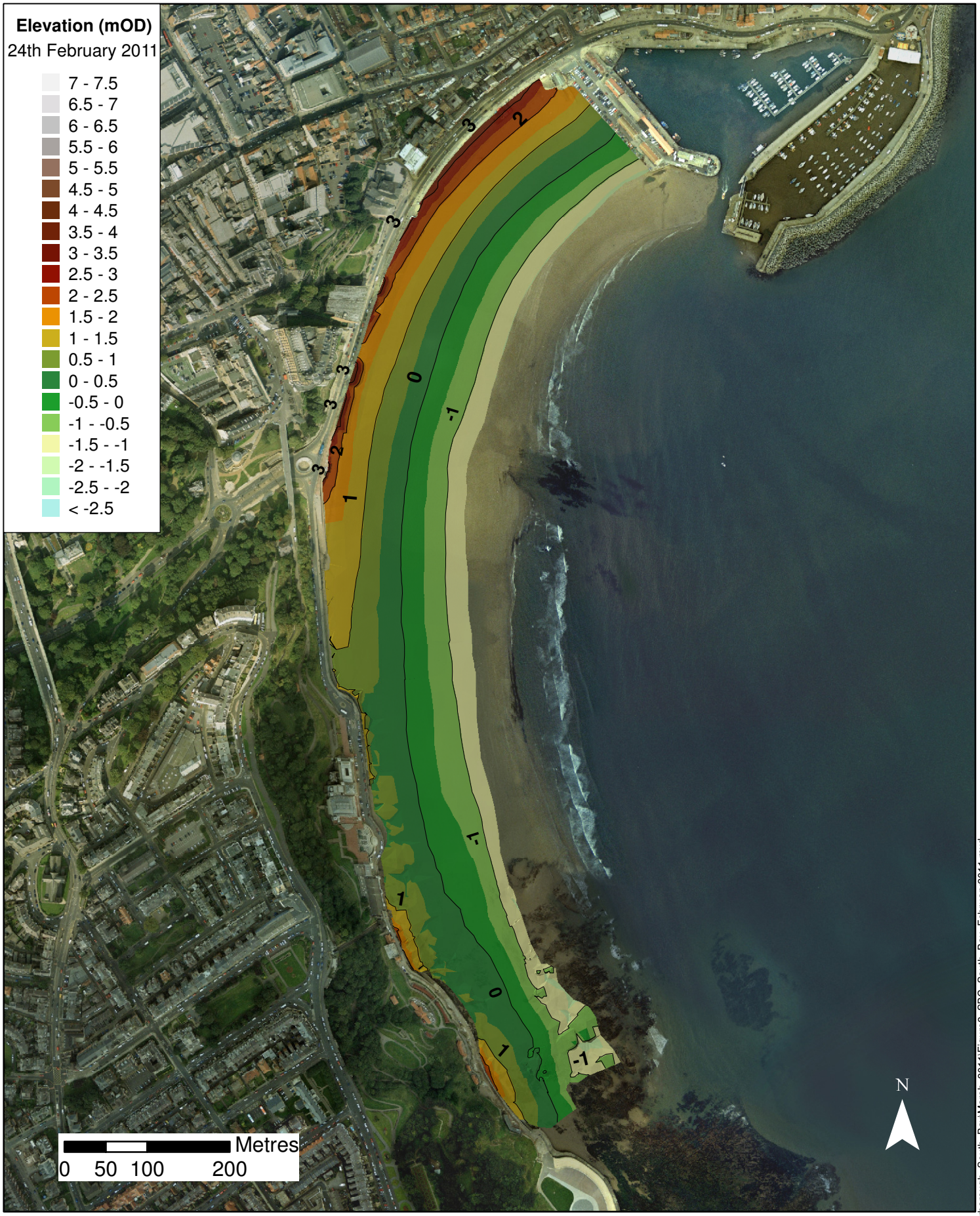

Key:

Title:
Topographic Survey (Feb 2011)

Project:
Scarborough South Bay

Client:
Scarborough Borough Council

Date:
March 2011

Scale on A4:
1:6,000

Figure:
2

Drawn:
TC

Checked:
NC

ROYAL HASKONING

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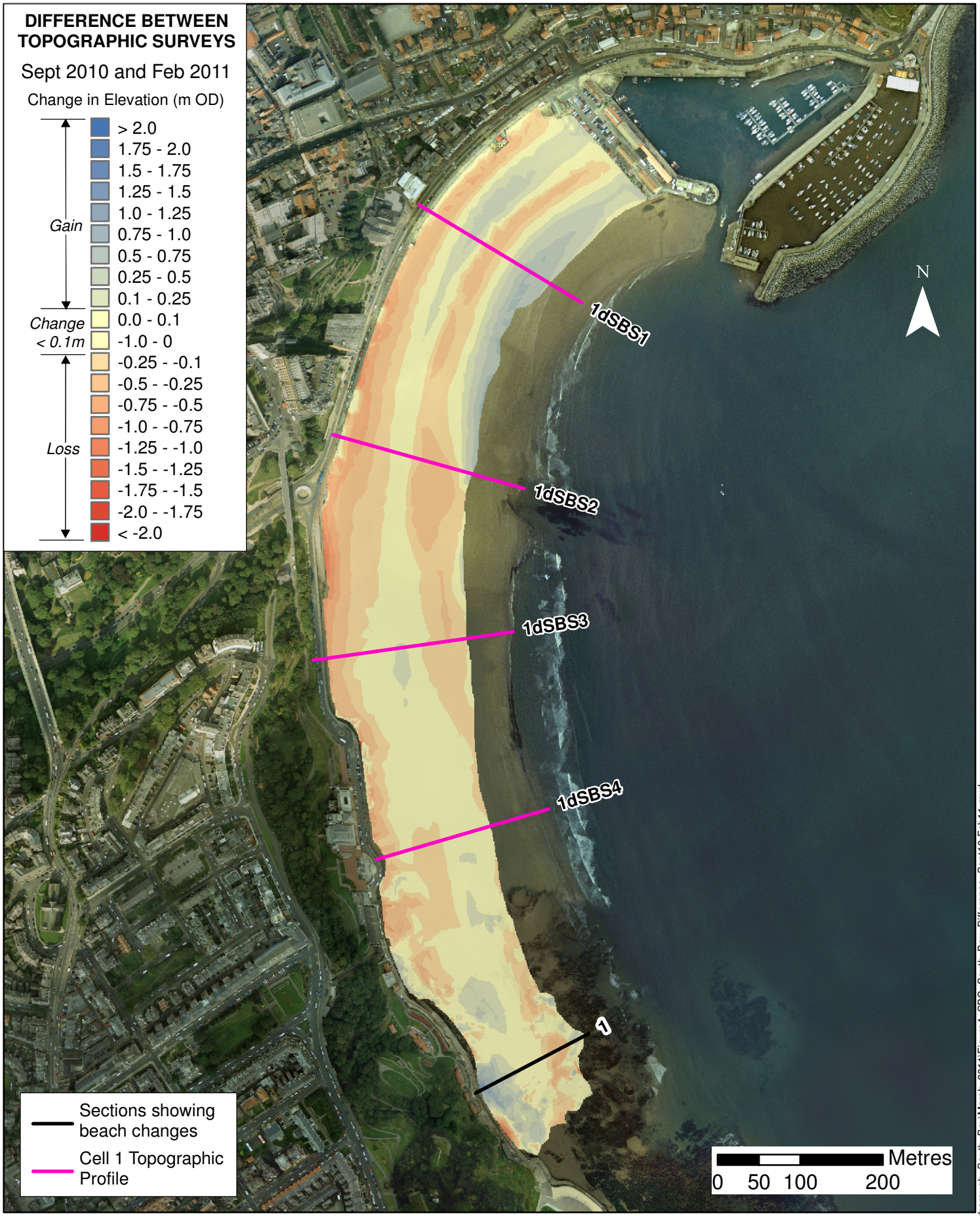

Key:

Title:
Changes between Sept 2010 and Feb 2011 Topographic Surveys

Project:
Scarborough South Bay

Client:
Scarborough Borough Council

Date: March 2011

Scale on A4: 1:6,000

Figure: 4

Drawn: TC

Checked: NC

ROYAL HASKONING

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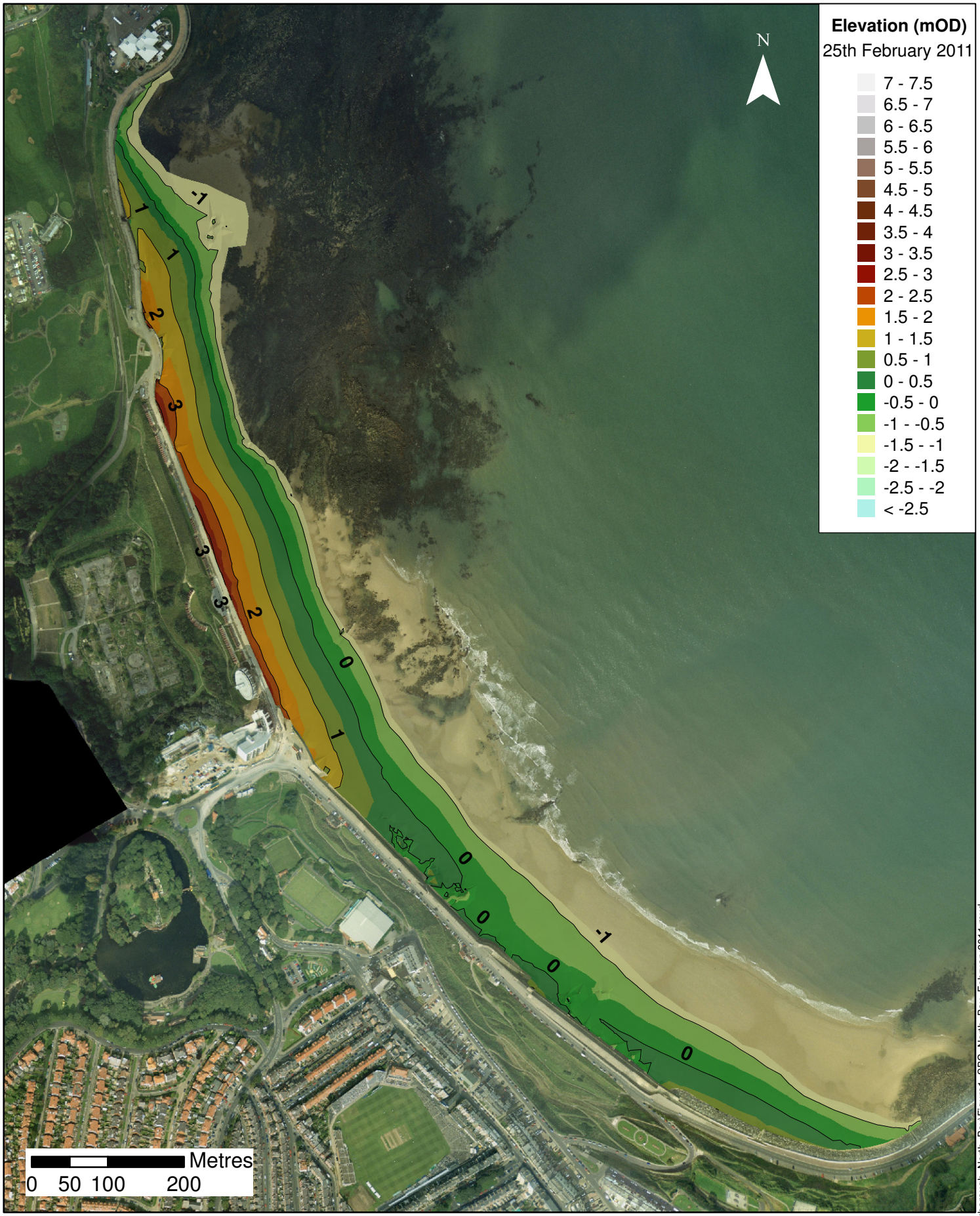
Appendix B

Scarborough North Bay

Topographic Surveys



Key:

Title:
Topographic Survey (Feb 2011)

Project:
Scarborough North Bay

Client:
Scarborough Borough Council

Date:
March 2011

Scale on A4:
1:6,500

Figure:
1

Drawn:
TC

Checked:
NC

ROYAL HASKONING

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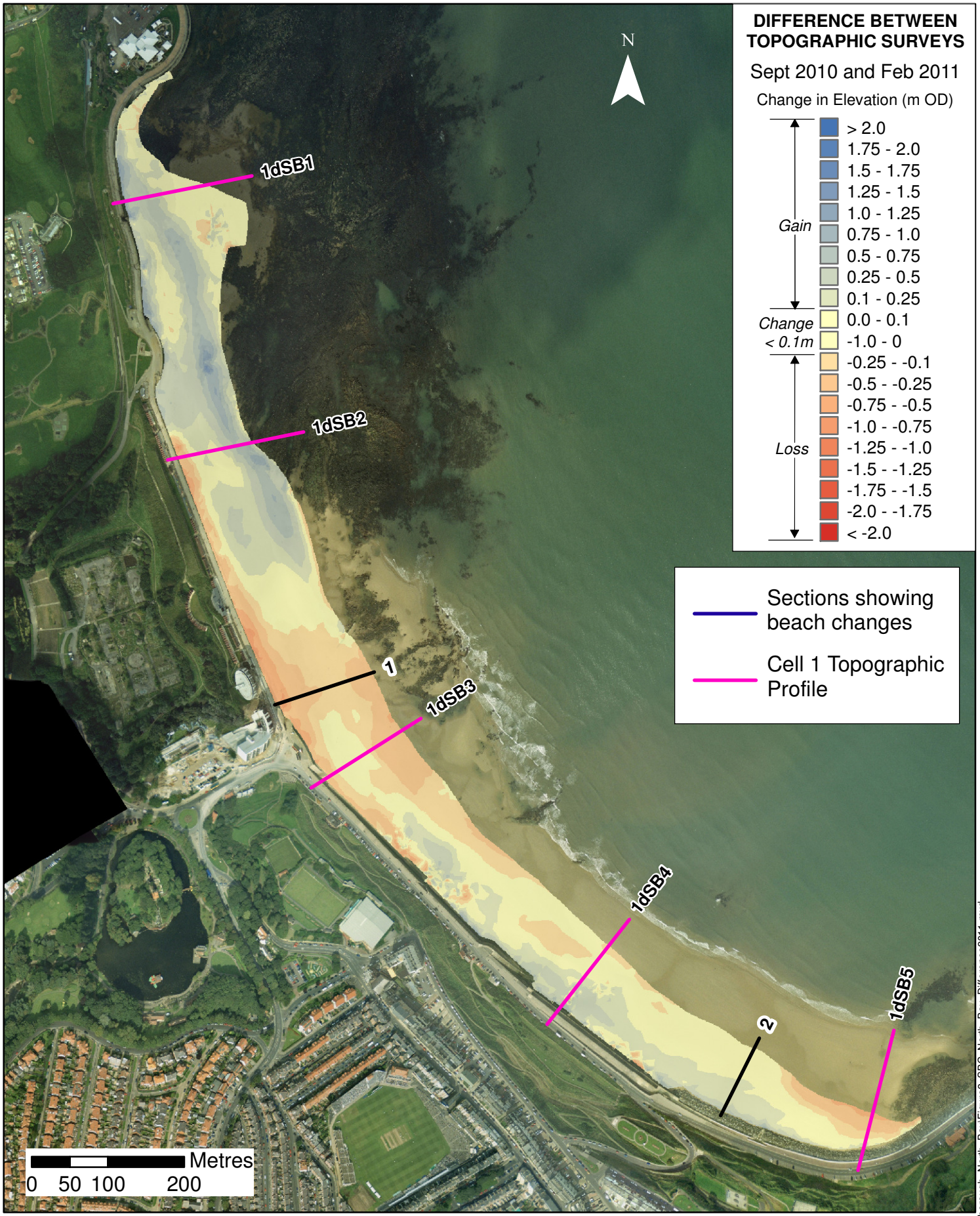

Key:	Title: Changes between Sept 2010 and Feb 2011 Topographic Surveys Project: Scarborough North Bay Client: Scarborough Borough Council	Date: March 2011	Scale on A4: 1:6,500	ROYAL HASKONING
		Figure: 2	Drawn: TC	Checked: NC

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Appendix C

Sandsend to Whitby

Topographic Surveys

N

Elevation (mOD)

4th March 2011

- 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
- -2.081 - -2

Metres

0 250 500 1,000

Title:
Topographic Survey
(March 2011)

Project:
Whitby

Client:
Scarborough Borough Council

Date:	Scale on A3:
March 2011	1:12,500

Figure:	Drawn:	Checked:
1	TC	NC

ROYAL HASKONING

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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Nov 2010 and Mar 2011

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Title:
Changes between Nov 2010 and Mar 2011 Topographic Surveys

Project:
Whitby

Client:
Scarborough Borough Council

Date:	Scale on A3:
March 2011	1:12,500

Figure:	Drawn:	Checked:
1	TC	NC

ROYAL HASKONING

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Appendix D

Sandsend to Whitby

Beach Profiles

Beach Profiles: 1dWB1

Beach Profiles: 1dWB2

Beach Profiles: 1dWB3