Cell 1 Regional Coastal Monitoring Programme
Analytical Report 10 Full Measures Survey 2017

Scarborough Council
February 2018

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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

Water Levels Used in Interpretation of Changes

	Water Level (m AOD)			
Water Level Parameter	**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 (m AOD) 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 northeast England 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 sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

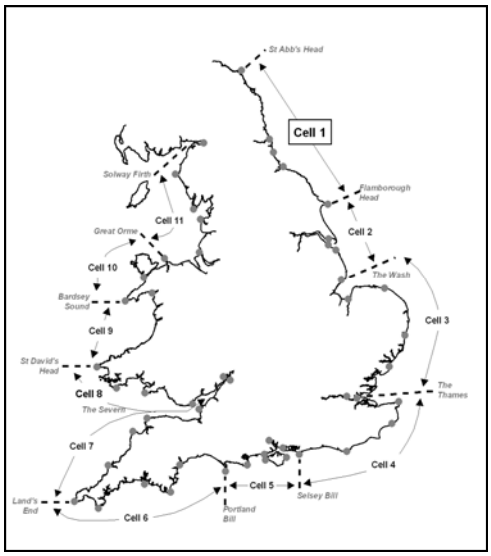


Figure 1 Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:

Northumberland County Council
North Tyneside Council
South Tyneside Council
Northumberland Coast AONB
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
Whitby Scarborough Filey Borough of Scarborough
A great place to live, work & play
East Riding of Yorkshire Council
Environment Agency
Natural England
The National Trust

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

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

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

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the Full Measures surveys. This is followed by a brief Update Report for each individual authority, providing ongoing findings from the Partial Measures surveys. A Cell 1 Overview Report is also produced regularly to provide 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		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Sep 11	Aug 12	Mar-May 12	Feb 13	
5	2012/13	Sep 12	Mar 13	Apr-May 13	May 13	
6	2013/14	Sep 13	Feb 14	Mar-Apr 14	Jul 14	
7	2014/15	Sep 14	Feb 15	Mar 15	Jul 15	
8	2015/16	Sep 15	Feb 16	Mar – Apr 16	Jul 16	Jun 16
9	2016/17	Sep–Nov16	Feb 17	Feb-Apr 17	Jul 17	
10	2017/18	Sep-Oct 17	Jan 17 (*)			

(*) The present report is **Analytical Report 10** and provides an analysis of the autumn/winter 2016 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 Table 2. Areas covered in the current report are highlighted

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, in Filey Bay. For the purposes of this report, the Scarborough frontage has been sub-divided into eight areas, namely:

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

1.2 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 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

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 20 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
    - Robin Hood's Bay (added Spring 2010)
    - Scarborough South Bay (added Spring 2010)
    - Cayton Bay
    - Filey

The location of these surveys is shown in Figure 2. Full Measures surveys were undertaken along this frontage between 4th September 2017 and 11th October 2017. The weather and sea state varied greatly in that time, for details of the survey conditions refer to the Academy Geomatics survey reports for each location.

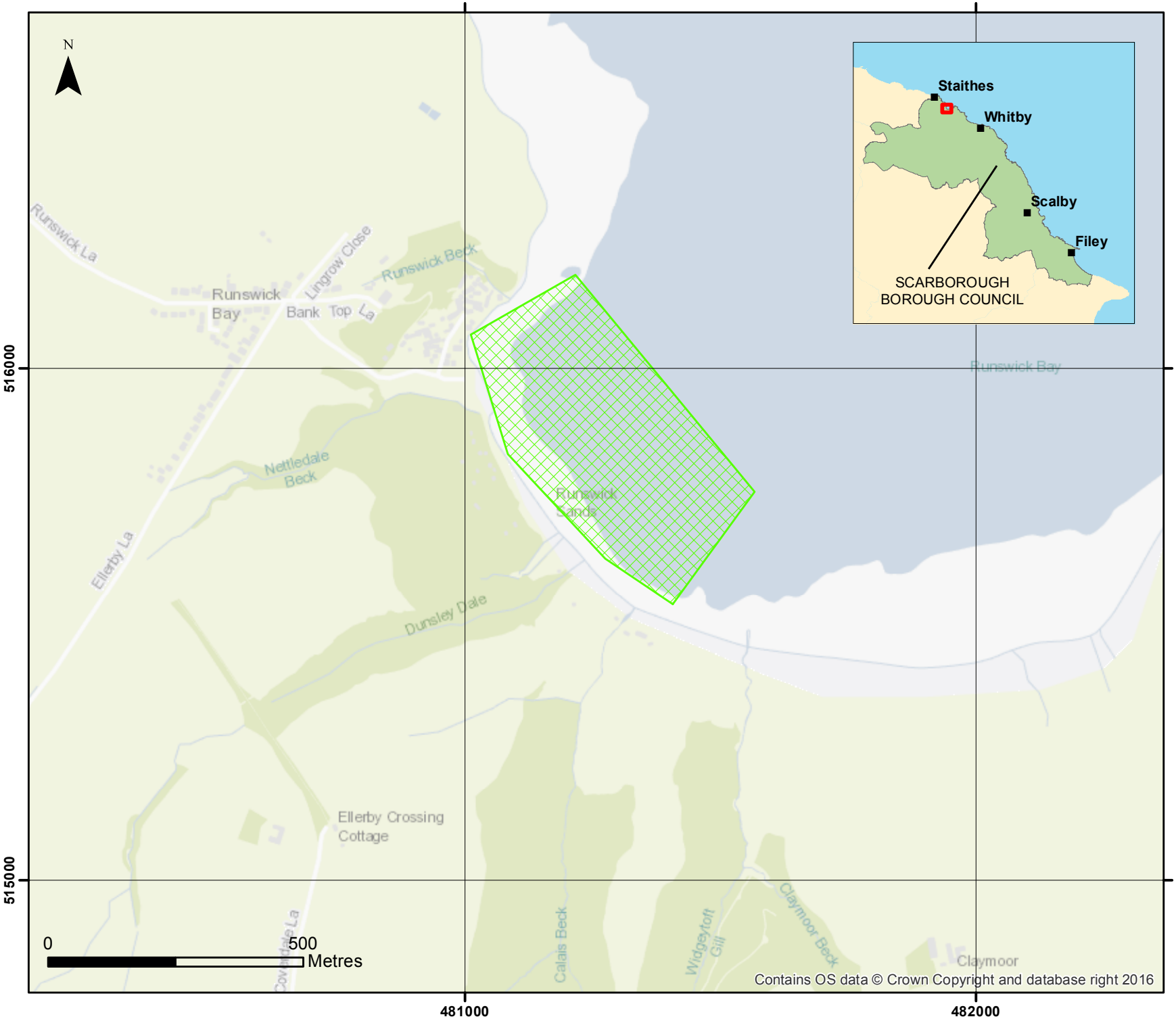
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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



Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(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
Topo Surveys

Drawing Scale at A4 1:10,000

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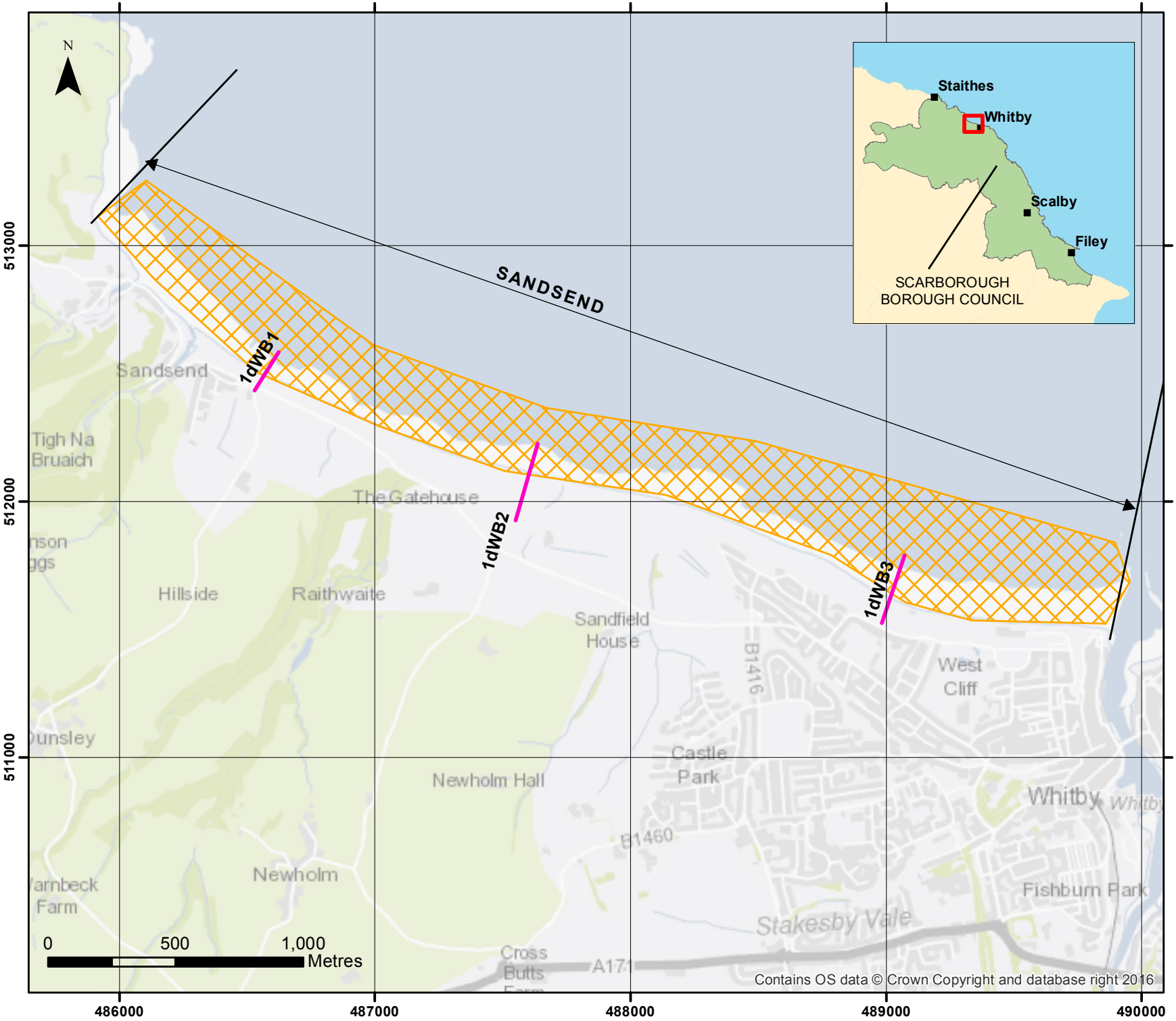

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 2

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:20,000

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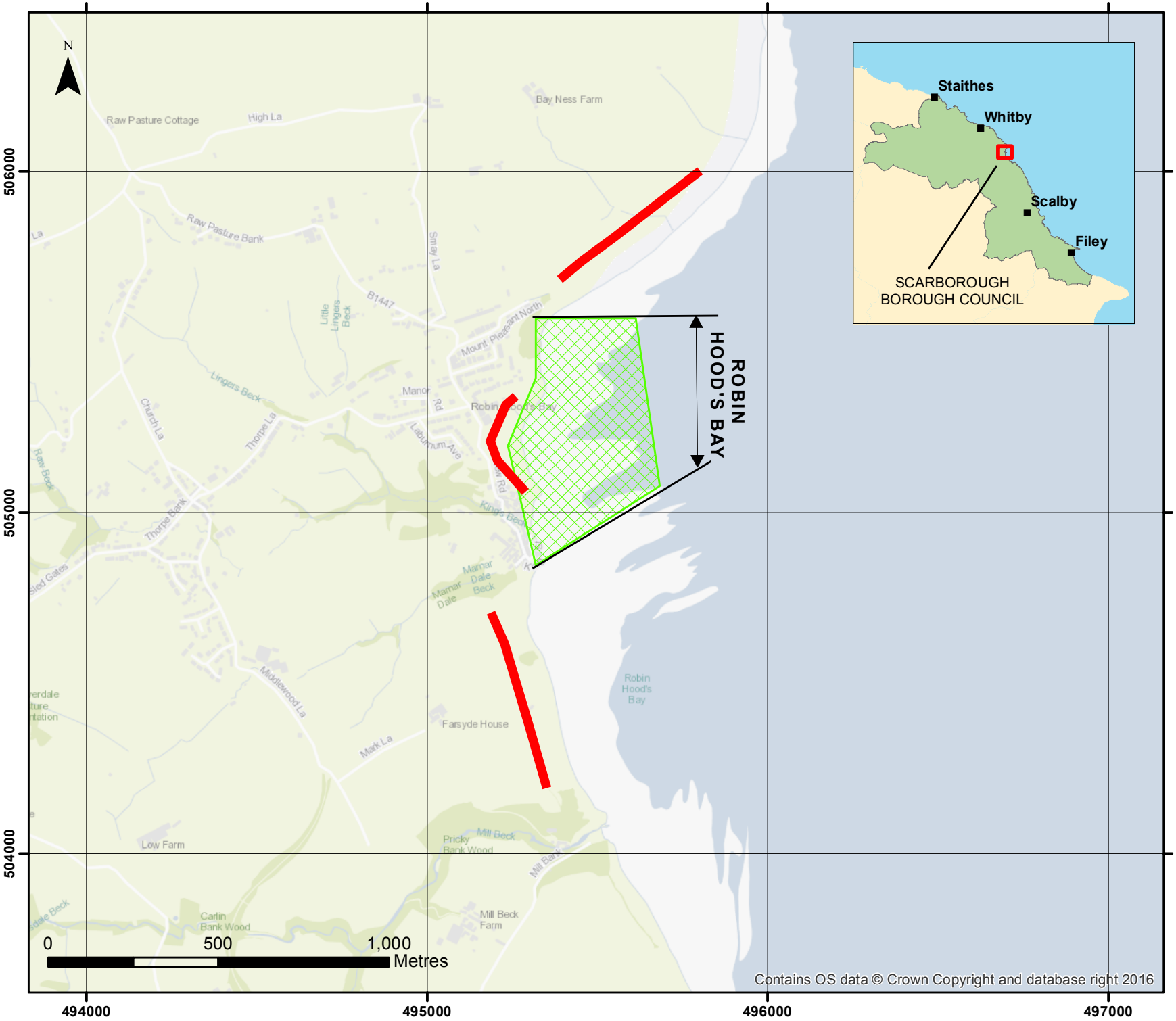

Key

SURVEY LOCATIONS

Topographic Profiles

Annual

Bi-Annual

Topographic Surveys

6 monthly

yearly

Cliff Top Monitoring Pegs

@ 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

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

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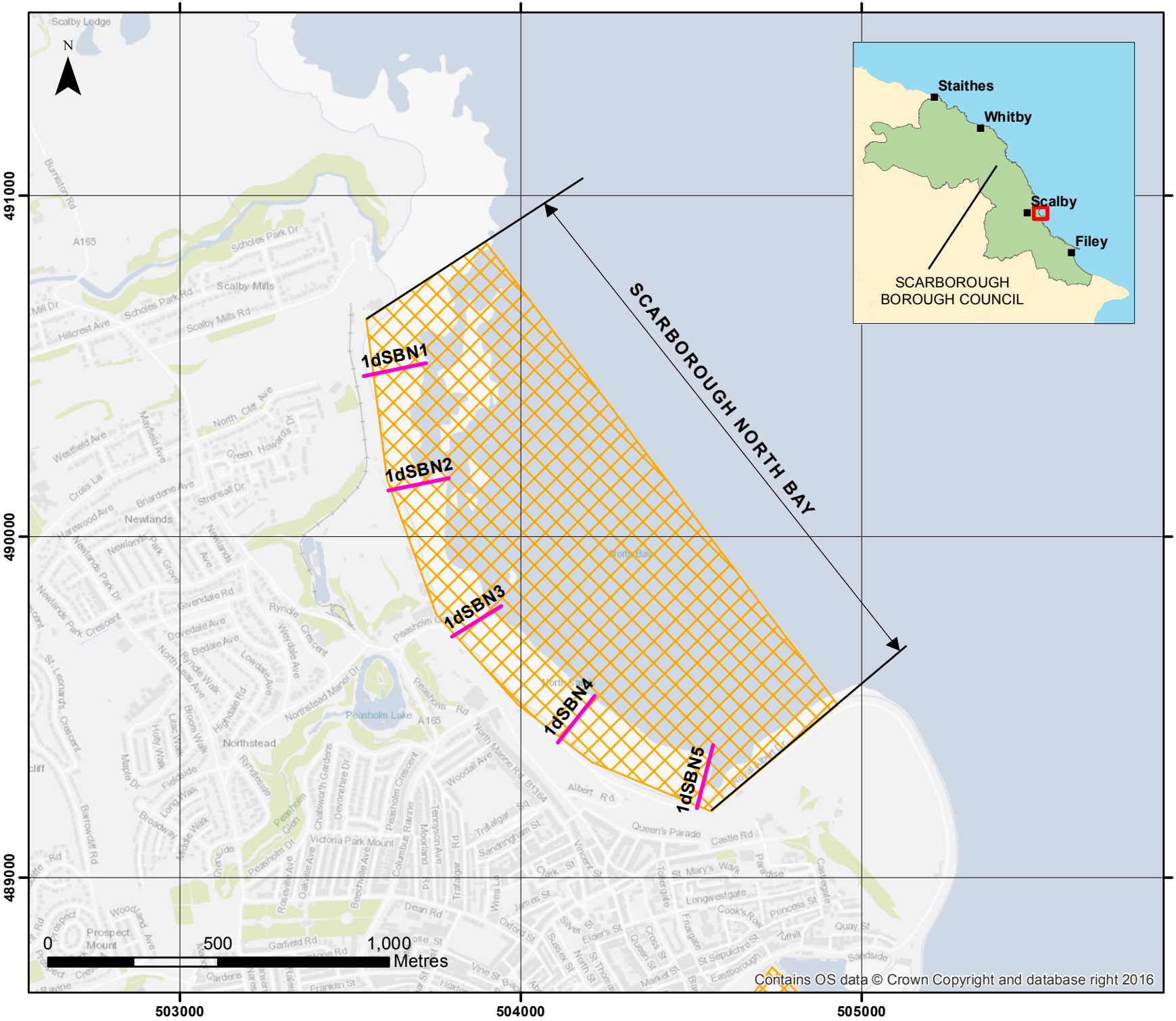

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(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
Topo Surveys

Drawing Scale at A4 1:15,000

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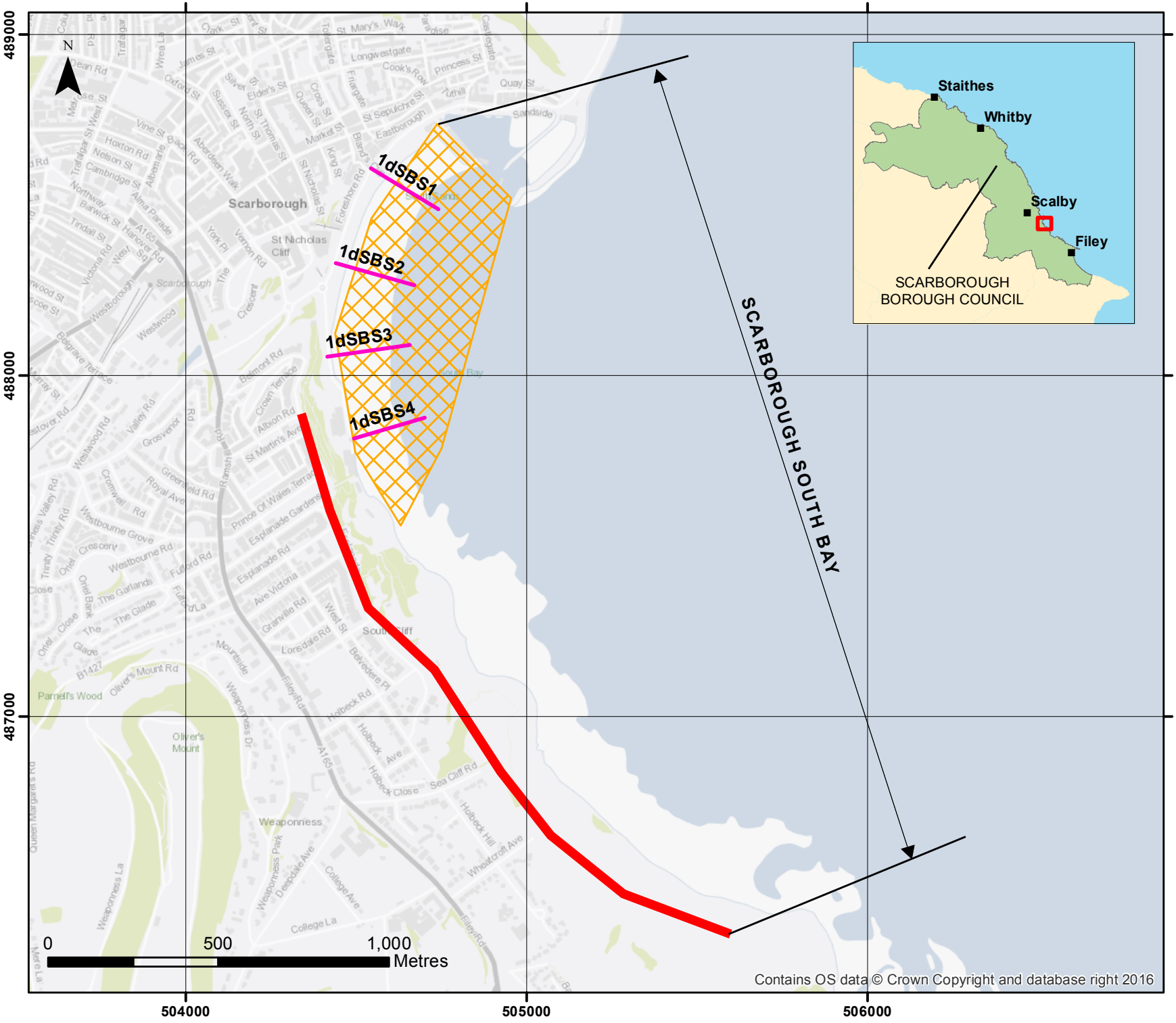

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 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

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

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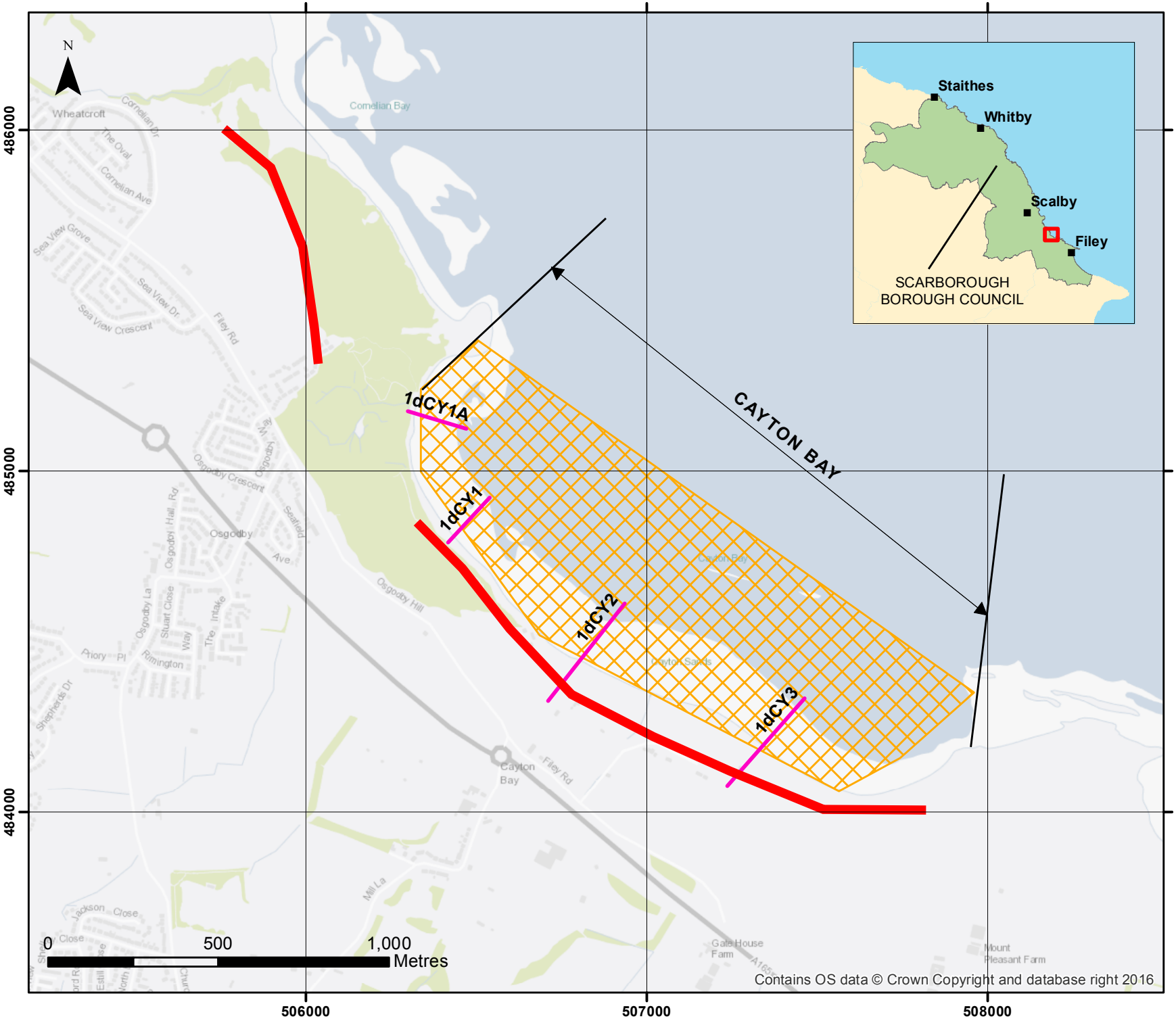

Key

SURVEY LOCATIONS

Cliff Top Monitoring Pegs

@ 300 centres

Topographic Profiles

Annual

Bi-Annual

Topographic Surveys

6 monthly

yearly

(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
Topo Surveys

Drawing Scale at A4 1:15,000

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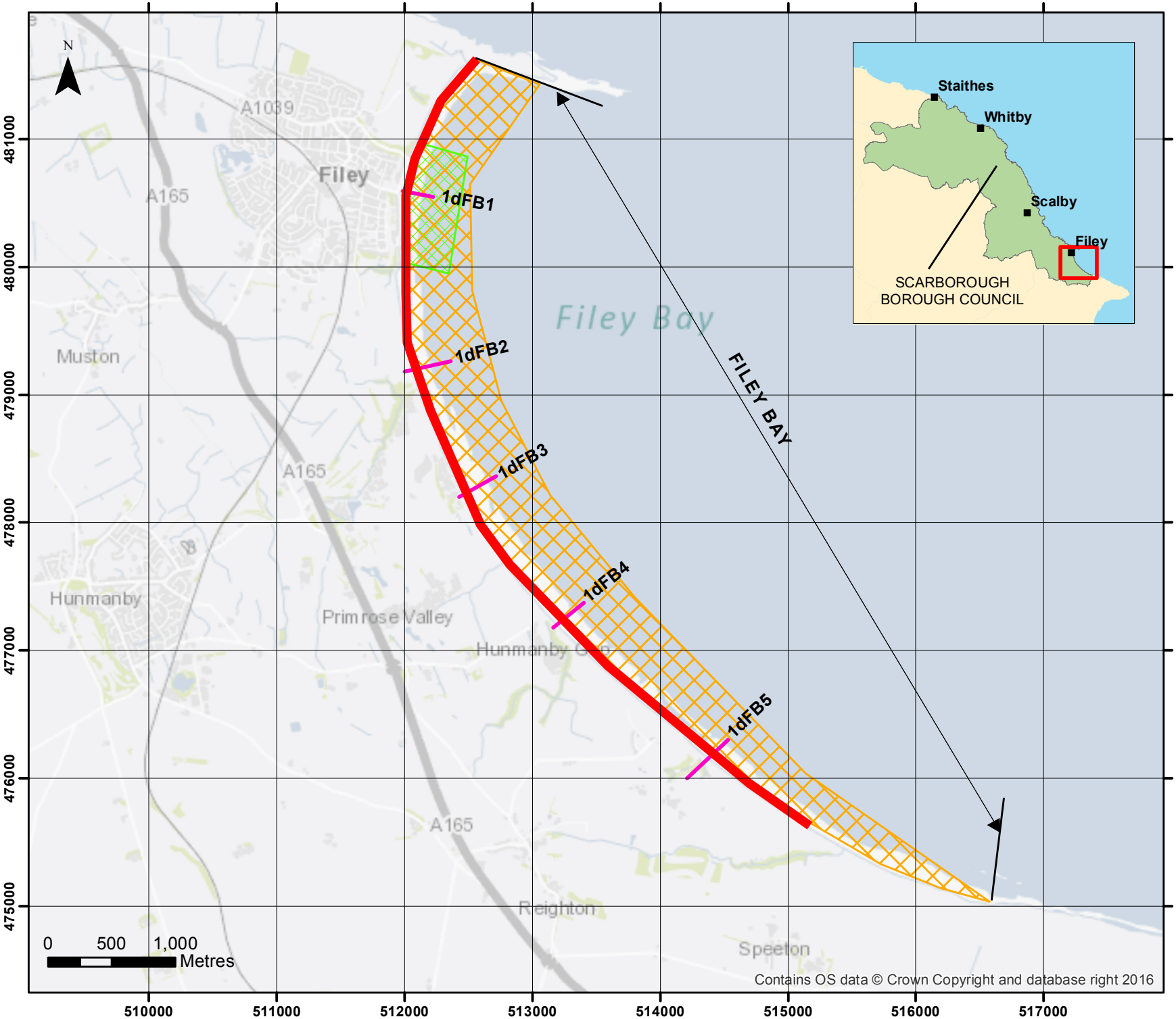

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 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
Topo Surveys

Drawing Scale at A4 1:40,000

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
4th September 2017	**Cliff-top Survey:** Twenty ground control points have been established at Cowbar and Staithes for biannual cliff top monitoring. Locations 12 to 20 are in the Scarborough Borough Council area. The separation between any two points is around 100 m. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Between March 2017 and September 2017 14 of the 20 posts showed change within a range of ±0.1m, which is not considered significant given the error of the technique. Only posts 3 and 18 showed erosion with 0.35m and 0.11m cliff recession recorded respectively. Calculation of longer-term erosion rates based on the recorded change between 2008 and 2017 indicates that 13 posts on the frontage recorded a change rate within a range of ±0.1m/yr, which is considered to be within the error of the measurement. Posts 1, 4, and 13 (near the eastern breakwater) shows consistent erosion through the surveys at 0.3m/yr. Posts 9 to 12 were inaccessible due to a landslip on the headland; the area was fenced off by the National Trust. Appendix C provides results from the September 2017 survey, showing the distance 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.	Two stations showed erosion of between 0.1 and 0.3m over the summer of 2017. A further four stations continued to be inaccessible due to a landslip on the headland. **Longer term trends**: Table C1 shows that survey location 13 has shown the greatest total erosion with a loss of 2.4m (±0.3m) between the November 2008 baseline and September 2017, resulting in a long-term average recession rate of 0.3m/yr. This area is above the eastern breakwater and is known to have experienced rock falls previously.

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
8th September 2017	**Topographic Survey:** Runswick Bay is covered by a 6-monthly topographic survey. A consistently applied GIS processing routine has been used to create a digital ground model (DGM) (Appendix B - Map 1) and to calculate the differences between the current topographic survey (Autumn 2017) and the previous survey (Spring 2017) to highlight areas and amounts of erosion and deposition. In all cases, a 5m resolution raster grid has been used to identify areas of erosion and accretion. (Appendix B – Map 8). Appendix B - Map 1 shows shore parallel bands of change on the beach at Runswick Bay. There has been evry little change at the very top of the beach. Accretion dominates in the upper- middle beach, whilst erosion is more prominent in the lower beach. In the north west of the bay, directly in front of the village, there has been very little change in beach levels (some minor accretion). The magnitude of change is up to ±1.5m, and the magnitude of change increases from north to south.	Between February and September 2017 Runswick Bay showed a mixed pattern of erosion and accretion in two shore parallel bands. This indicates movement of material from the bottom of the beach to the middle/upper beach. **Longer term trends**: The changes in the bay have been no more than ±1.5m. The data collected since 2008 indicate a general pattern of winter drawdown and spring recovery with no net change. The longer-term pattern of erosion in front of the village has paused since 2015.

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
21st & 22nd September 2017	**Beach Profiles:** 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). The beach level immediately in front of the new defences at Profile **1dWB1** (located around 400m south of Sandsend Village) has remained similar to that recorded in the previous survey (March 2017). However, between chainage 42m and 60m there has been a small drop in beach levels of up to 0.4m. Between chainage 60m and 125m the middle beach has increased by up to 1.0m, making it the highest recorded beach level from chainage 80m to 105m. The lower beach between chainage 125m and 180m has dropped by up to 0.6m, with the toe of the beach seawards of 180m showing accretion of up to 0.2m. Overall the beach is at a medium-high level compared with the range recorded in previous surveys. At **1dWB2** (located in centre of Upgang Beach) the profile to 140m chainage has not changed significantly. There has been accretion of up to 0.8m at the toe of the cliff (chainage 145m to 170m). Between 170m and 235m there has been erosion of up to 1.0m, and seawards of 235m there has been significant accretion of up to 1.0m flattening the lower beach profile, and making it the highest recorded beach level from chainage 290m. Overall the beach is medium-low in the upper and middle beach compared with the range recorded in previous surveys, but it is the highest on record for the lower beach. At profile **1dWB3** fronting the stabilised face of Whitby West Cliff, no change has occurred as far as 90m chainage. At the bottom of the seawall between 90m and 115m chainage, there has been up to 1.0m of accretion since March 2017. From chainage 115m seawards there has been very little change, ±0.2m, though predominantly accretion. Overall the beach is at a medium level compared to the range recorded from previous surveys.	The September 2017profiles tended to be near the mid-point of the range recorded by previous surveys, with accretion being the predominant process. The topographic difference plots show a complex spatial pattern. There are roughly equal areas of erosion and accretion, however the depth of erosion appears to be of a higher magnitude. There is however a clear area of accretion against the toe of the new defence at Sandsend. The cliffs of Upgang Beach in the central part of the study area are undefended and erosion provides an important source of material to the beach. It is likely that sediment released by erosion over the winter months is subsequently redistributed across the beach as migrating sand bars. **Longer term trends**: the beach profiles show seasonal variation but no linear trend of accretion or erosion. The annual topographic difference plots show similar patterns of accretion and erosion in the all surveys although the magnitude of change is modest.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Topographic Survey: The Sandsend to Whitby frontage is covered by an annual topographic survey, providing continuous data for Sandsend Beach, Upgang Beach, and Whitby Sands. Data have been used to create a DGM (Appendix B – Maps 2) using GIS. The GIS has also been used to calculate the differences between the current topographic survey DGM (Autumn 2016) and the earlier topographic survey DGM (Autumn 2016), with 5m resolution raster grids (as shown in Appendix B – Maps 9), to identify areas of erosion and accretion. Appendix B – Maps 9 show a varied picture of erosion and accretion. There are alternating bands of erosion and accretion in front of the car park at the northern end of the frontage. In front of the village of Sandsend there has been accretion across the full width of the beach. In front of the new defences there has generally been accretion at the toe of the defence, with either little change or erosion across the middle and lower beach. In front of the undefended cliffs the pattern is more perpendicular to shore with erosion dominating to the west and accretion to the east. Whitby Sands show a patchy distribution of both erosion and accretion with the magnitude of change generally decreasing towards the east, with very little change adjacent to the pier.	

2.4 Robin Hood's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
11th October 2017	**Topographic Survey:** Robin Hood's Bay is covered by a six-monthly topographic survey. Data have been used to create a DGM (Appendix B - Map 3) using GIS. The GIS has also been used to calculate the differences between the current topographic survey DGM (Autumn 2017) and the earlier topographic survey DGM (Spring 2017), with 5m resolution raster grids (as shown in Appendix B – Map 10), to identify areas of erosion and accretion. Appendix B - Map 10 shows a very patchy distribution of areas of accretion and erosion over the summer of 2017. The majority of the bay has seen little change (±0.25m) associated with the rocky outcrops which run perpendicular to the shore. Most of the erosion patches are located at the northern end of the bay, particularly at the toe of the cliff. The largest area of accretion is in the centre of the bay at the toe of the slipway. Overall, erosion is slightly more dominant and is up to 1.5m in the northern part of the bay.	The topographic change plot shows that there has been very little change across the frontage over the summer of 2017. Cliff top monitoring shows little or no erosion since April 2017. **Longer term trends:** The limited change recorded in Robin Hoods Bay is due to the resistant rock platforms and thin, patchy cover of sand.
	Cliff-top Survey: Thirteen ground control points have been established at Robin Hood's Bay since March 2010 to monitor cliff recession. The separation between any two points is around 200m. Table C2 shows that only one location showed erosion between April and October 2017, with marker 11 retreating by more than 0.2m. However, inspection of the survey photos indicates this could be due to difficulty locating the cliff edge precisely as the break in slope is covered by vegetation. Using data recorded between March 2010 and October 2017, calculated erosion rates show little change in all markers except Marker 1 which shows recession of 0.6m/yr. However, this marker has showed very little change since March 2012.	

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
19th September 2017	**Beach Profiles:** Scarborough North Bay is covered by five beach profile lines, distributed between the Sealife Centre at Scalby Mills and Clarence Gardens (Appendix A). The September 2017 survey shows that Profile **1dSBN1** remains stable at the defended, upper part of the profile. From 10m to 30m chainage, minor accretion of 0.2m of material has occurred since March 2017. Between 30m to 75m chainage there has been a small loss of material, up to 0.2m. From 75m to 150m chainage the beach level has increased slightly by up to 0.2m compared to the March 2017 profile. The September 2017 profile is relatively high compared to the range recorded from previous surveys, with chainage 105m to 140m showing highest recorded levels. At **1dSBN2** the beach is characterised by a shifting berm in the profile, which can form on the upper or lower beach. In September 2017 the beach level at the toe of the seawall had increased by 0.6m. The profile shows accretion in the upper beach to chainage 65m of up to 0.8m, with the berm crest moving up the beach to chainage 35m. From chainage 65m to 115m there has been erosion of up to 0.6m, exposing the rocks at the bottom of the beach earlier at chainage 100m. The September 2017 profile is medium to high compared to the range recorded from previous surveys, except at the bottom of the beach where the rocks are exposed where the profile is relatively low. The September 2017 survey shows that the beach at profile **1dSBN3** has experienced up to 0.5m accretion at the base of the seawall at 15m chainage since March 2017. The accretion continues to chainage 90m, seawards of here there has been erosion of up to 0.3m. The effect has been to steepen the gradient of the beach. The September 2017 profile is relatively medium-high compared to the range recorded from previous surveys There has been some accumulation of sand over the rocks at the base of the seawall in the profile at **1dSBN4** with the rocks remaining exposed between chainage 35m and 60m. Between chainage 60m and 110m there has been accretion of up to 0.7m, which then decreases in depth to around 0.2m seawards of 110. The September 2017 profile is relatively high compared to the range recorded by previous surveys, with the highest recorded levels at the toe of the seawall.	The beach profiles in September 2017 all show that beach building processes have generally dominated over the summer months. All the profiles are dominated by accretion and are relatively high compared to the range of previously recorded surveys. Profiles 1dSBN2 and 1dSBN3 vary slightly with erosion on the lower beach. **Longer term trends:** The observed trends in the topographic plots and beach profiles point to overall stability with seasonal fluctuations.

Survey Date	Description of Changes Since Last Survey	Interpretation
	On profile **1dSBN5** there has been erosion of 0.4m at the toe of the defences between the March 2017 and September 2017 surveys. Between chainage 35m and 95m there has been accretion of 0.4m forming an upper beach berm. There has been negligible change between chainage 95m and 115m. Seawards of chainage 115m there has been further accretion of up to 0.4m, pushing the toe of the beach seawards. The September 2017 survey is low at the toe of the defence but medium-high compared to the recorded range along most of its length.	
	Topographic Survey: Scarborough North Bay is covered by an annual topographic survey, which was carried out in September 2017. Data have been used to create a DGM (Appendix B - Map 4 and 16) with GIS for both surveys. The GIS has also been used to calculate the differences between the Full Measures topographic survey DGM (Autumn 2017) and the earlier topographic survey DGM (Autumn 2016), with 5m resolution raster grids (as shown in Appendix B – Map 11 and 17), to identify areas of erosion and accretion. Appendix B - Map 11 (October 2016 to September 2017) shows that there has been roughly shore parallel bands of erosion and accretion. There is a general pattern of accretion in the middle beach with some erosion on the upper beach, and generally little change or erosion on the lower beach.	

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
18th September 2017	**Beach Profiles:** Scarborough South Bay is monitored by four beach profiles, between the harbour in the north and the Spa Complex in the south (Appendix A). The comparisons of short-term change are between March and September 2017. Sediment recycling took place in November 2017 after the Full Measures survey had been carried out in September 2017 to address an accumulation of sediment at the north end of the bay and very low beach levels in front of Scarborough Spa. An additional post-sand movement survey was carried out on 20th November 2017 to record the immediate changes. At profile **1dSBS1** there has been limited change since March 2017. The upper beach shows accretion of up to 0.4m from the seawall to chainage 80m. Seawards of chainage 80m there has been negligible change of less than ±0.1m of change. The September 2017 profile is relatively high compared to the range recorded by previous surveys. The post-sand movement survey shows the removal of 0.5m of sand from the toe of the seawall. The rest of the profile has changed very little, ±0.1m, since the September 2017 survey. The profile remains at a medium-high level compared to the range recorded from previous surveys. The beach at profile at **1dSBS2** has remained stable with changes limited to ±0.2m. The upper beach between the seawall and chainage 130m shows accretion with slight erosion between chainage 130m and 190m. The September 2017 profile is at a medium-high level compared to the range previously recorded for the lower beach. The post-sand movement survey shows the removal of 0.2m of sand at the toe of the seawall, with very little change, ±0.1m, over the rest of the profile since the September 2017 survey. The profile remains at a medium-high level compared to the range recorded from previous surveys. At profile **1dSBS3** there has been accretion of up to 0.3m across the whole profile, with an upper beach berm forming at chainage 40m. Overall the September 2017 profile is at a medium-high level compared to the range recorded by previous surveys. The post-sand movement survey shows the placement of 0.7m of sand at the toe of the seawall, with very little change, ±0.1m, over the rest of the profile since the September 2017 survey. The profile remains at a medium-high level compared to the range	The level of the beach in the profiles is high-medium compared to the range recorded in previous years. All the profiles show accretion. The short-term change plot also shows variable erosion and accretion, matching the profiles. The accumulations in the mid-beach at the northern end is likely to be due to the action of constructive waves through the summer. The cliff top change markers have indicated negligible change at most locations markers, with, 0.1m loss recorded at one location. The November post-sand movement survey is consistent with the removal of sand from the northern end of the bay, and placement in the central portion of the bay (Spa approach road). **Longer term trends**: The beach is regularly re-profiled with sediment moved from near the harbour to the frontage of The Spa, but sediment naturally moves northwards towards the harbour. Table C3 shows that since March 2010 most of the cliff erosion profiles have shown negligible recession. Profiles 11 and 12 show erosion of 0.5 and 0.4 m/year respectively. These points are at the rear of a mudslide system which experiences periodic

Survey Date	Description of Changes Since Last Survey	Interpretation
	recorded from previous surveys. Profile **1dSBS4** shows accretion at the base of the seawall of up to 0.7m covering the rock outcrop. The accretion continues to chainage 105m, though more typically around 0.3m depth. From chainage 105m to 140m there has been negligible erosion of less than 0.1m. The toe of the beach seawards of chainage 140m shows minor accretion of up to 0.2m.The September 2017 profile is relatively high compared to the range recorded by previous surveys, particularly at the toe of the seawall and at the toe of the beach which both showthe highest recorded levels. The post-sand movement survey shows the loss of 0.2m at the toe of the seawall, which suggests the sand placement did not reach as far as this profile. The rest of the profile shows with very little change, ±0.1m, over the rest of the profile since the September 2017 survey. The profile remains at a high level compared to the range recorded from previous surveys.	reactivation or head scarp collapse, however there has been little movement in the last two years.
	Topographic Survey: Scarborough South Bay is covered by an annual topographic survey. Data have been used to create a DGM (Appendix B - Map 5) using GIS. The GIS has also been used to calculate the differences between the current topographic survey DGM (Autumn 2017) and the earlier topographic survey DGM (Autumn 2016), with 5m resolution raster grids (as shown in Appendix B – Map 12), to identify areas of erosion and accretion. Appendix B - Map 12 shows that the upper beach in the northern half of the bay has generally seen little change with some erosion immediately adjacent to the seawall in places. The mid to lower beach shows accretion, with some erosion at the toe of the beach immediately adjacent to West Pier. The southern half of the bay shows greater areas of change, with the upper beach having patchy areas of both erosion and accretion. The middle beach generally shows accretion with the lower beach being dominated by erosion. The magnitude of change cross the whole survey area is low, generally being less than 0.5m. Appendix B – Map 17 shows the difference between the September 2017 Full Measures survey and the November 2017 post-sand movement survey. The map shows the removal of sand at the toe of the seawall from West Pier to halfway round the Foreshore. There is a corresponding area of accretion at the toe of the seawall from halfway round the Foreshore to the Spa building, except for the curved	

Survey Date	Description of Changes Since Last Survey	Interpretation
	bandstand wall which shows small amount of erosion at the toe. Most of the rest of the beach shows very little change, with a few patches of erosion in the mid and lower beach. The southern end of the survey area shows patchy erosion and accretion across the whole beach.	
	Cliff-top Survey: Thirteen ground control points have been established at Scarborough South Bay, extending from South Bay to Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is around 300 m. The cliff top surveys at Scarborough South Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Between March and September 2017 only one of the thirteen locations showed change of more than ±0.1m, this was point 9 in Cornelian Bay The recession rates calculated for the period from March 2010 to September 2017 give a picture of the change over the longer term. Eleven of the markers have a recession rate of less than 0.1m/yr. Markers 11 and 12 are the only markers showing a higher rate of 0.5m/yr and 0.4m/yr respectively. Appendix C provides results from the September 2017 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the March 2010 baseline survey. Short-term and long-term average recession rates are also provided.	

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
20th September 2017	**Beach Profiles:** Cayton Bay is covered by three beach profile lines, distributed between Tenants' Cliff and the south of Cayton Sands (Appendix A). The cliff face at profile **1dCY1** (Tenant's Cliff) is vegetated and was difficult for the surveyors to access resulting in poor data in the top of the profile. In the rest of the profile, there was little change as far as 25m chainage between March and September 2017 with the rock exposed. From 25m to 70m chainage the beach level has increased by up to 0.6m. Between 70m and 120m chainage there has been erosion of up to 0.4m; this has exposed an extra 10m of the rock outcrops. From 120m to the end of the survey at 170m the rocky exposure has remained stable. Overall the September 2017 profile is at a relatively medium level compared to the range recorded in previous surveys. Profile **1dCY2** (close to former pumping station) has remained stable over the cliff up to chainage 120m. There has been accretion of up to 0.3m along the profile from the cliff to chainage 280m. The lower beach from chainage 280m seawards has eroded slightly by less than 0.2m. The September 2017 profile is at a medium-high level compared to the range recorded in the previous surveys, particularly in the mid beach between chainage 225m and 260m where it is the highest recorded . There has been little change across the cliff section of profile **1dCY3** (600m southeast of the pumping station). Accretion of up to 0.6m of sand at the toe of the cliff has covered the previously exposed rocks. There has been minor erosion of 0.2m between chainage 150m and 170m. Seaward of chainage 170m there has been accretion of 0.3m. Overall the September 2017 profile is at a medium level compared to the range recorded from previous surveys, with the toe of the beach between chainage 255m and 285m being the highest on record.	The beach profiles have been stable overall with accretion dominating in all the profiles. The plot of difference between Autumn 2016 to Autumn 2017 surveys shows variability in the erosion and accretion in the bay with little consistent pattern. The cliff top survey data shows no significant recession has occurred at any of the marker points during the summer of 2017. **Longer term trends:** The pattern of migrating sand bars has remained consistent since 2010 indicating seasonal variation in beach level with no net change.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Topographic Survey: Cayton Bay is covered by an annual topographic survey. Data have been used to create a DGM (Appendix B - Map 6) using GIS. The GIS has also been used to calculate the differences between the current topographic survey DGM (Autumn 2017) and the earlier topographic survey DGM (Autumn 2016), with 5m raster grids (as shown in Appendix B – Map 13), to identify areas of erosion and accretion. Appendix B - Map 13 shows that the observed changes are very patchy. During 2017 the northern part of the bay shows thin band of erosion int eh upper beach, with accretion in the mid beach and erosion in the lower beach. The central part of the bay is dominated by erosion across the profile. The southern part of the shows weakly shore parallel alternating bands, with accretion in the upper and lower beach, with erosion in the mid beach. The distribution is patchy however so the patterns of change vary across the beach.	
	Cliff-top Survey: Eight ground control points have been established within Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is typically around 200 m. The cliff top surveys at Cayton Bay are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. The results of the cliff top survey are shown in Table C4. Between March and September 2017 none of the eight profiles showed any discernible change, all were within the ±0.1m accuracy of the survey. Long-term erosion rates calculated using data collected since November 2008 show change either within the margin of error or advance, indicating survey difficulties, at most points. Markers 2, 4 and 6 show erosion rates of 0.6m/yr, 0.3m/yr and 0.1m/yr respectively. Appendix C provides results from the September 2017 survey showing the distance 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.	

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
5th – 7th September 2017	**Beach Profiles:** Filey Bay is covered by five beach profiles between Filey Sands and Speeton Sands (Appendix A). At profile **1dFB1** fronting Filey seawall, the upper beach has accreted by 0.6m at the toe of the seawall (chainage 20m to 50m). From chainage 50m there has been very little change of less than ±0.1m. The profile is at a high-medium level compared to the range recorded from previous surveys, with chainage 120m to 160m being the highest recorded. The changes observed at profile **1dFB2** (located to the north of Primrose Valley Holiday Village) since February 2017 are very small. There has been accretion of up to 0.2m across the whole beach, except right at the toe of the beach which shows 0.2m of erosion. The profile is the highest recorded at a high level compared to the range recorded from previous surveys, with chainage 210m to 270m being the highest recorded. At profile **1dFB3**, near Flat Cliffs, there has been the creation of a series of berms at chainages 80m, 200m, and to a lesser extent 290m. The upper beach berm is due to the accretion of up to 1.0m, with the mid-beach berm due to accretion of 0.3m. Chainage 290m shows a very slight berm starting to form on the lower beach. Between chainages 120m and 180m there has been erosion of up to 0.4m forming a depression between the two berms. The September 2017 profile is at a high level compared to the range recorded from previous surveys, with the berm between chainage 80m to 120m being the highest recorded. Profile **1dFB4** at Hunmanby Gap, has accreted over most of the profile, with erosion of 0.2m recorded at the toe of beach seawards of chainage 225m. The accretion varies significantly from less than 0.2m to 0.9m, with the formation of two berms; one at the toe of the cliff (chainage 30m to 70m) and another in the mid-beach (chainage 110m to 160m). The September 2017 profile is at a high level compared to the range recorded from previous surveys, with the berm between chainage 120m to 170m being the highest recorded.	The beach profiles are dominated by accretion, with some erosion on the lower beach at profiles 1dFB2, and 1dFB4. The beach levels are generally high-medium compared with the range recorded from the previous surveys. The topographic change map shows Filey Bay has shore parallel bands of accretion and erosion in the associated with migrating berms and very little change in the north. The cliff top survey data provided in Table C5 shows erosion at several monitoring points. The largest change was at markers 7, 12A, and 23 where 0.1m to 0.4m was lost over the summer of 2016. **Longer term trends**: Past trends dominated by migrating sand bars continue to the present day.

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1dFB5** (located close to Reighton Gap) the change in the cliff profile between chainage 60m and 200m is due to the difficulties the surveyors had in accessing the profile due to vegetation growth. There has been accretion across the majority of the profile, with the formation of berms at chainage 250m and 320m through the accretion of up to 0.8m. Overall the September 2017 profile is at a medium-high level compared to the range recorded from previous surveys, with the berm between chainage 240m to 250m being the highest recorded.	
	Topographic Survey (Filey Bay): Filey Bay is covered by an annual topographic survey. In addition to the annual survey of Filey Bay, a smaller area fronting Filey Town is re-surveyed every six months to document seasonal patterns. Data have been used to create a DGM (Appendix B – Map 7) using GIS. The GIS has also been used to calculate the differences between the current topographic survey DGM (Autumn 2017) and the earlier topographic survey DGM (Autumn 2016), with 5m resolution raster grids (as shown in Appendix B – Map 15) to identify areas of erosion and accretion. Appendix B - Map 15 shows that there are shore parallel alternating bands of accretion and erosion around the bay. The majority of the northern part of the bay from Filey Brigg to Primrose Valley shows very little change in beach levels. There are some shore parallel patches of erosion on the upper and lower beach in front of Filey Town. The southern section of the bay from Primrose Valley shows greater magnitude of change with shore parallel bands of erosion and accretion. The general pattern is for a very narrow band of accretion at the toe of the cliffs with further accretion bands in the mid beach and at the toe of the beach. Bands of erosion tend to occur on the upper beach and mid-lower beach. Overall there are roughly equal areas of accretion and erosion, and the area of greatest change is between Hunmanby Gap and Reighton Gap.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Cliff-top Survey: Twenty-eight ground control points have been established within Filey Bay for the purposes of cliff top monitoring. This includes the installation of three additional locations in September 2010: points 12A (as a replacement for point 13 which can no longer be accessed due to vegetation growth), 24 & 25 (to the north of Filey Bay at Filey Brigg). A further replacement for monitoring point 13, 13A, has been added in 2014. The maximum separation between any two points is nominally 300 m. The cliff top surveys at Filey Bay are undertaken every six months. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Between March and September 2017 24 of the ground control points showed no discernible change (within the ±0.1m accuracy of the survey). Three of the remaining points, markers 7, 12A, and 23, had shown apparent recession of 0.1m, 0.4m, and 0.4m respectively. Both markers 12A and 23 show significant movement for the second year running, despite no significant movement in the previous years recorded. Long term rates of change show only seven markers have erosion with rates between 0.1m/yr and 0.7m/yr. The largest erosion rate recorded is at control point 5, to the south of the Filey Town defences. Appendix C provides results from the September 2017 survey showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the baseline survey.	

3. Problems Encountered and Uncertainty in Analysis

Survey accuracy of beach/ cliff profiles
The aim of cliff monitoring data is to gain a reliable record of the frequency and magnitude of cliff top failures. Data are collected every six months, but previous surveys have had a low accuracy, meaning that survey error is typically greater than any measured short-term change. It is possible that a more reliable pattern of change will be determined over the longer term. However, in the short term, more reliable assessments of cliff recession can be derived from analysis of time-series remote sensing data. Under this programme a high-quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in 2012/13 and 2015. These data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report. More accurate estimates of long term cliff top change would be possible by comparing results from the current programme to historical aerial photography over the last 50 years.

At Staithes the surveyors noted that VMP's 9 to 12 were still inaccessible due to a landslip on the headland; the area has been cordoned off by the National Trust.

At Whitby the lifeguard station was being removed at the time of the survey.

At Robin Hoods Bay the surveyors noted there was continuous rock and gravel falls along the cliffs, and that VMP5 was located on a pile of deposited garden waste

At Scalby in Scarborough North Bay the cliff edge was very overgrown resulting in areas that were unable to be surveyed.

At Cayton Bay the surveyors could not measure the top of profile 1dCY1 due to dense vegetation. The middle of profiles 1dCY2 and 1dCY3 could not be measured due to the ground make-up, soft mud flows, unstable grass, and at 1dCY3 landslips. The cliff in profile 1dCY3 was measured to the cliff edge and as close to the cliff face at the bottom as possible.

At Filey the surveyor was unable to measure the start of profile 2 due to vegetation, the middle of profile 5 was not measured from chainage 61m to approximately 198m, due to undergrowth and bushes. VMP12 and 13 were inaccessible due to heavy vegetation.

Cliff top erosion errors & data capture techniques
The cliff top surveys are in general assumed to have a limit of accuracy of ± 0.1m due to the techniques used and problems have been experienced in precisely locating the cliff edge, due to vegetation growth and the convex profile. Most profiles have now been monitored for six years, and a more reliable picture of change is now emerging that indicates very low rates of erosion, with only occasional and localised examples of erosion exceeding 0.5m/yr.

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

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

The following points have been observed:

- The measurements of the Cowbar and Staithes cliff top show erosion of between 0.1 and 0.3m over the summer of 2017 at two stations. A further four stations continued to be inaccessible due to a landslip on the headland.
- Runswick Bay shows shore parallel changes, with erosion on the lower beach and accretion in the upper-middle beach.
- At Sandsend Beach, Upgang Beach and Whitby Sands accretion has been the dominant process over the summer of 2017 with beach levels at a medium level relative to the range recorded from previous surveys.

- At Robin Hoods Bay the beach and cliff have remained stable with very little change over the summer of 2017. No discernible change has been registered by the cliff top markers and only one cliff recession marker shows substantial change in the long-term record, and the majority of this change occurred in 2011.
- For Scarborough North Bay the September 2017 survey shows the beach remained stable with beach building processes dominating over summer resulting in relatively high beach levels.
- At Scarborough South Bay all the beach profiles show accretion over the summer of 2017 and are medium-high compared to the previous profiles. The November post-sand movement survey is consistent with the removal of sand from the northern end of the bay, and placement in the central portion of the bay (Spa approach road).
- The Cayton Bay beach profiles show stability overall with evidence of the formation of beach berms. The pattern of migrating sand bars has remained consistent since 2010 indicating seasonal variation in beach level with no net change. The cliff monitoring showed a no significant recession at any of the marker points (>0.1m).
- The profiles at Filey Bay show stability overall. The profiles have all seen accretion, with some erosion at the toe of the beach. The profiles are among the highest recorded for these locations. The topographic difference plot shows very little change in the north but shore parallel bands of accretion and erosion in the south associated with migrating berms. There has been significant recession recorded at various points through the centre and south of the bay of between 0.1m and 0.4m (markers 7, 12A, and 23). Marker 5 to the south of Filey Town remains the location with the highest erosion rate of 0.7m/yr despite showing no signs of recession over the summer of 2017.

Appendices

Appendix A

Beach Profiles

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

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown

Beach Profile

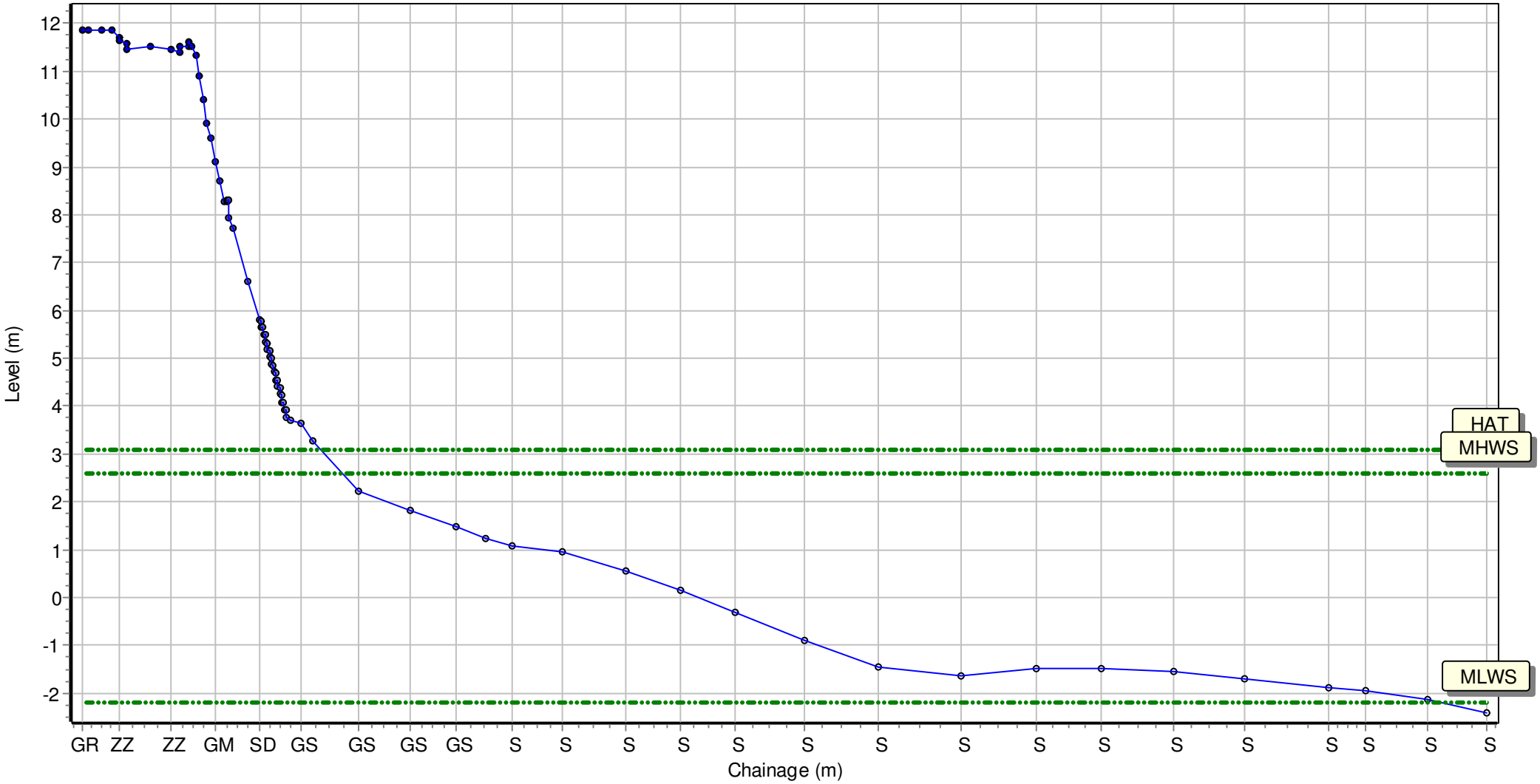
Location: **1dWB1**

Date: 22/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 486535.075 **Northing:** 512437.797 **Profile Bearing:** 32 ° from North



Beach Profile

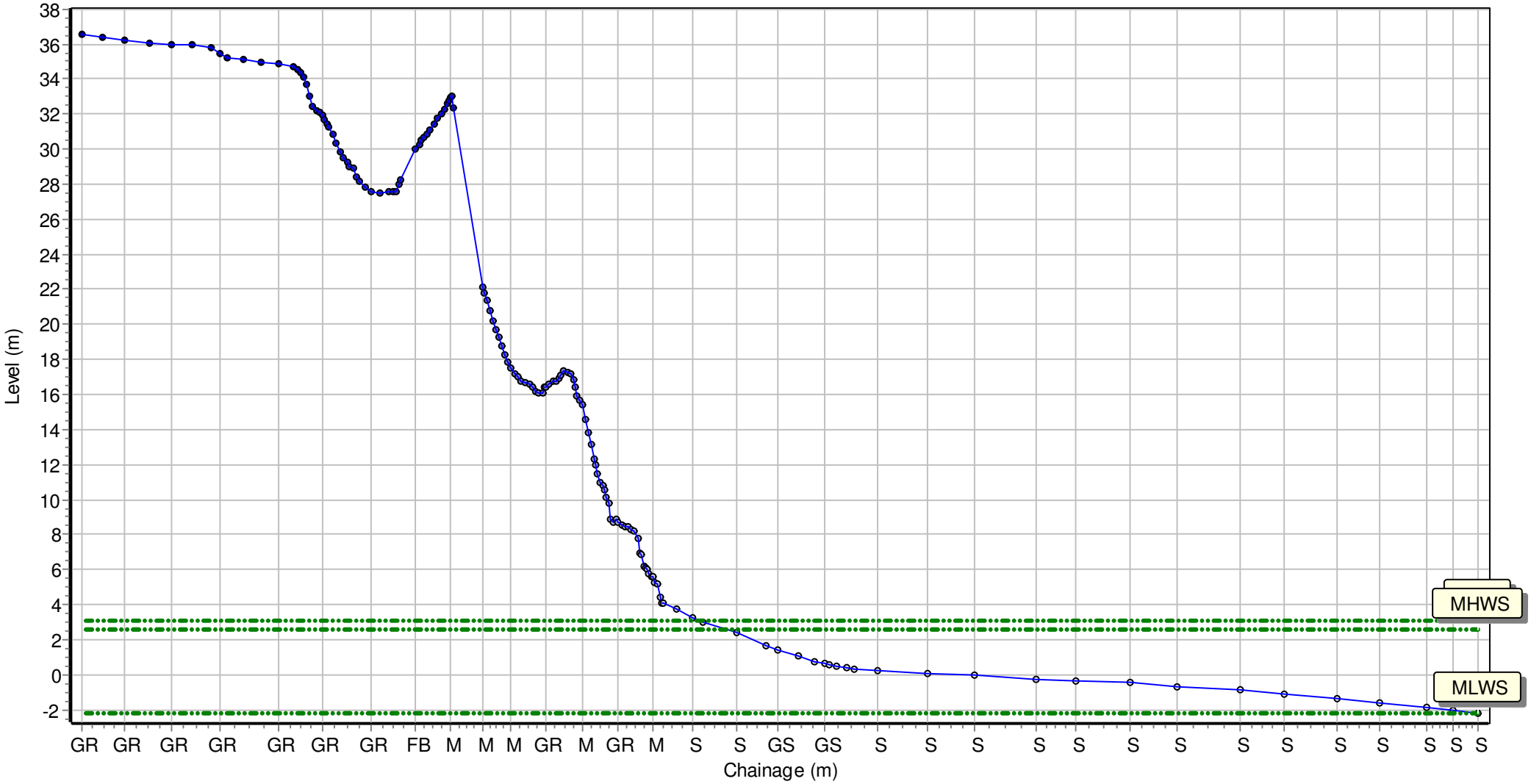
Location: **1dWB2**

Date: 22/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 487550.221 **Northing:** 511927.902 **Profile Bearing:** 16 ° from North



Beach Profile

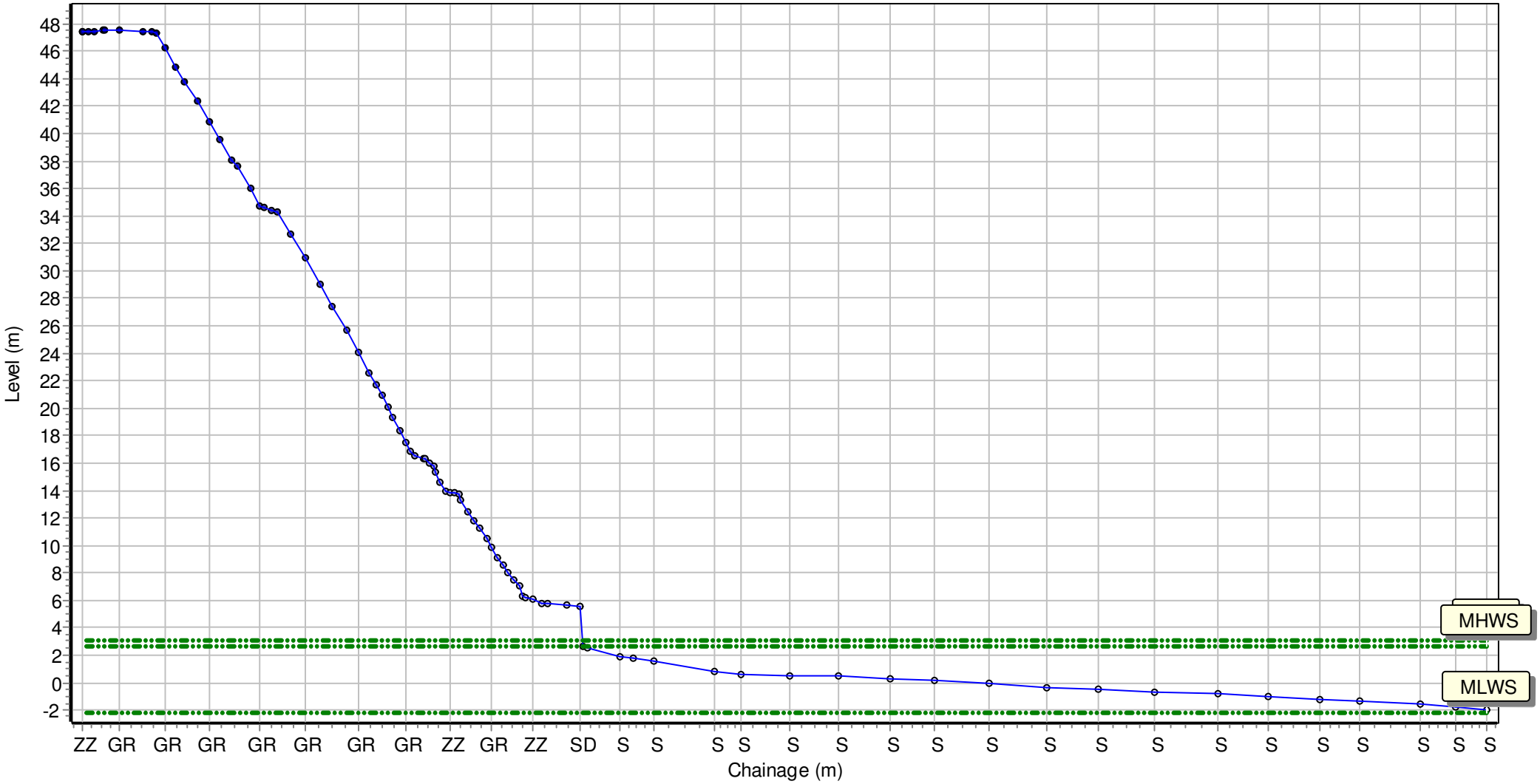
Location: **1dWB3**

Date: 22/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 488983.57 **Northing:** 511527.047 **Profile Bearing:** 19 ° from North



Beach Profile

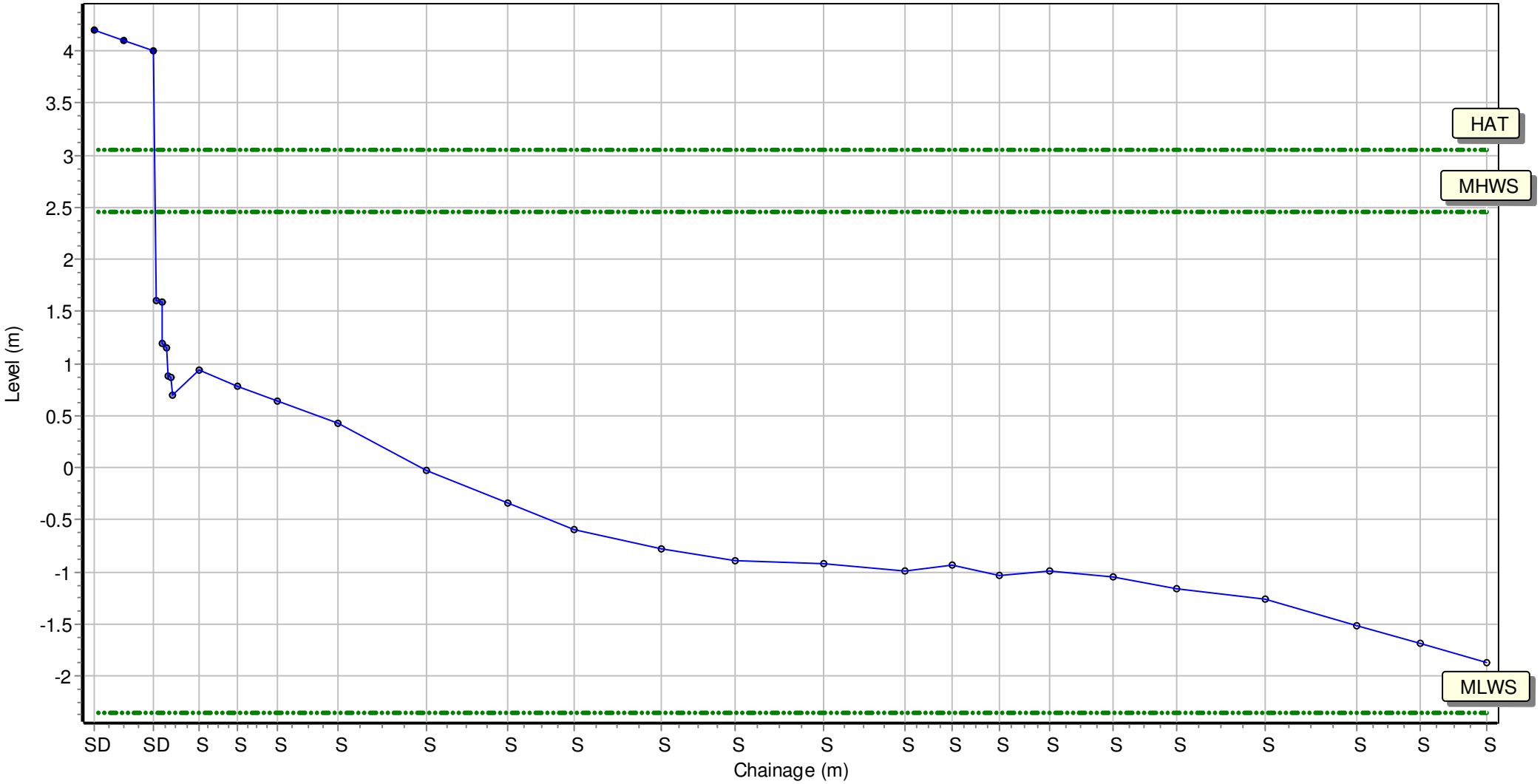
Location: **1dSBN1**

Date: 19/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 503543.363 **Northing:** 490470.74 **Profile Bearing:** 79 ° from North



Beach Profile

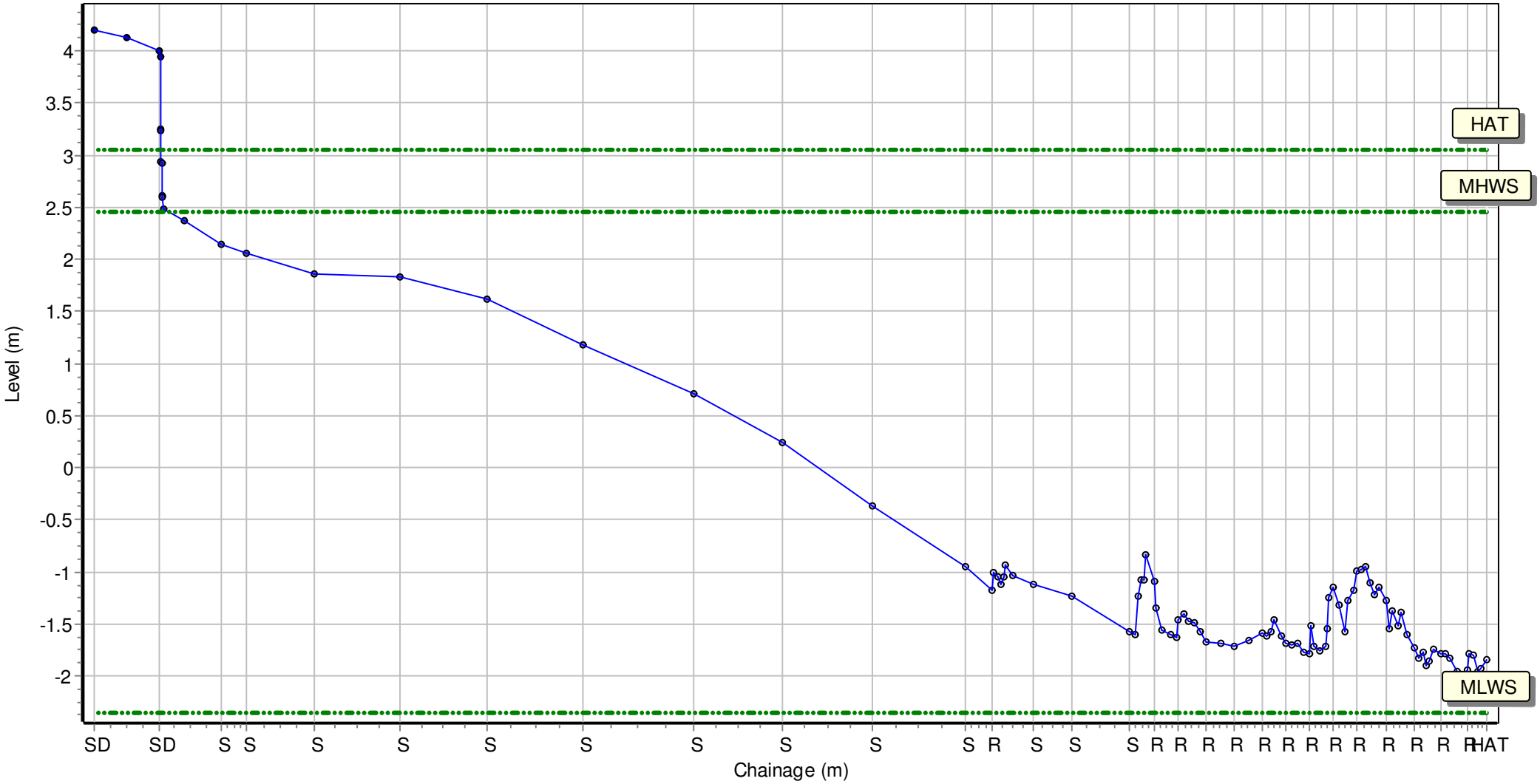
Location: **1dSBN2**

Date: 19/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 503616.346 **Northing:** 490135.674 **Profile Bearing:** 78 ° from North



Beach Profile

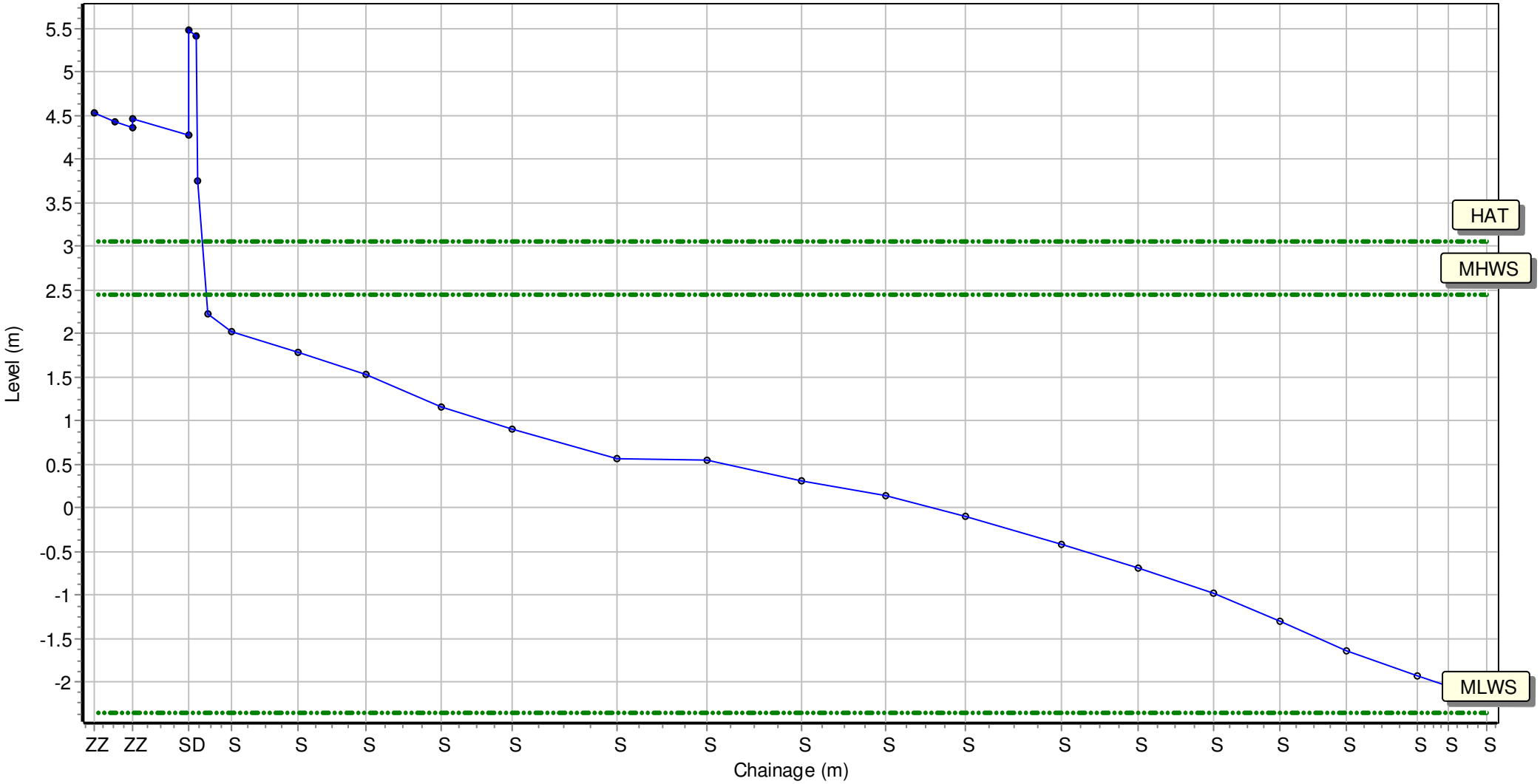
Location: **1dSBN3**

Date: 19/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 503803.958 **Northing:** 489708.315 **Profile Bearing:** 58 ° from North



Beach Profile

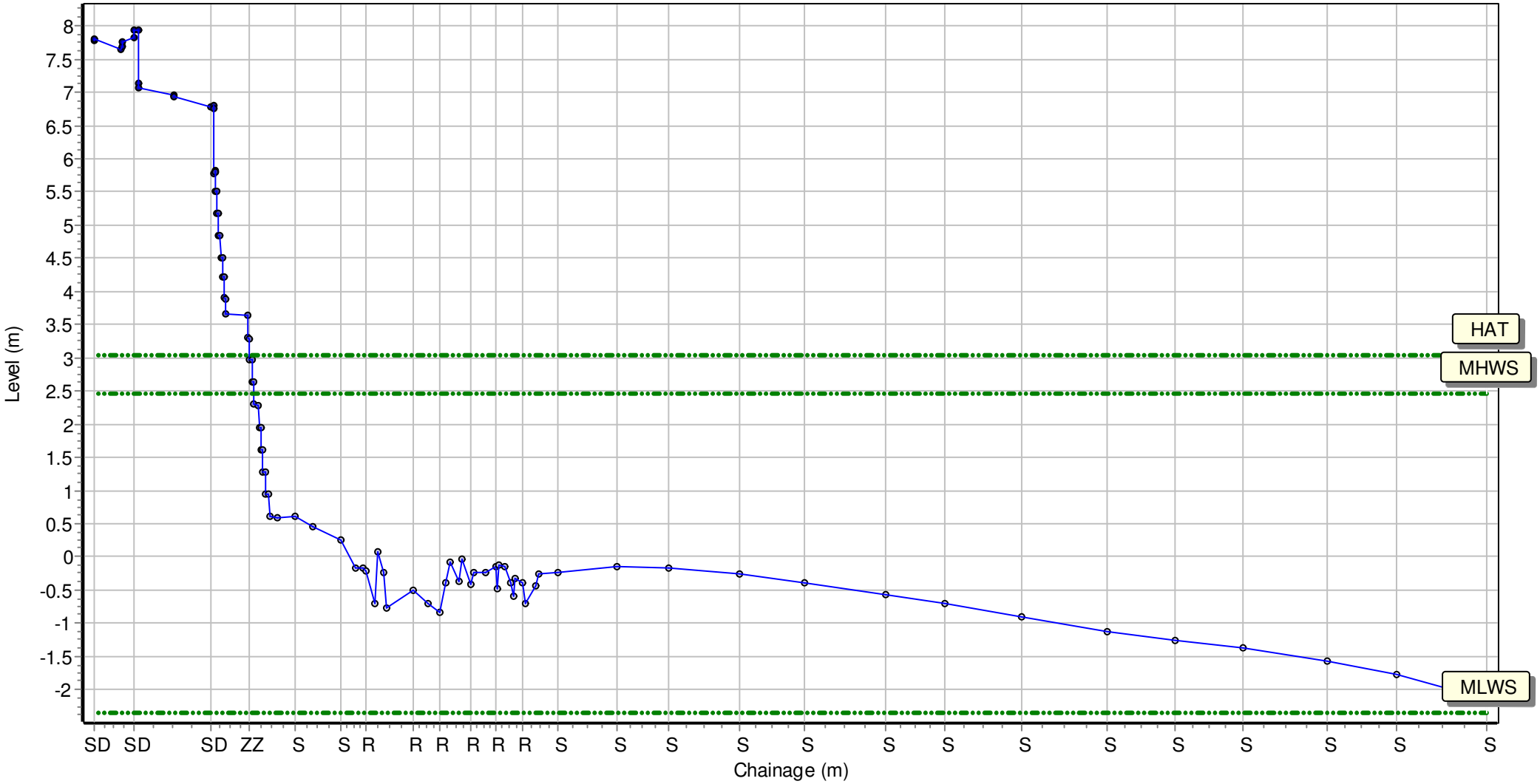
Location: **1dSBN4**

Date: 19/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504111.79 **Northing:** 489397.699 **Profile Bearing:** 38 ° from North



Beach Profile

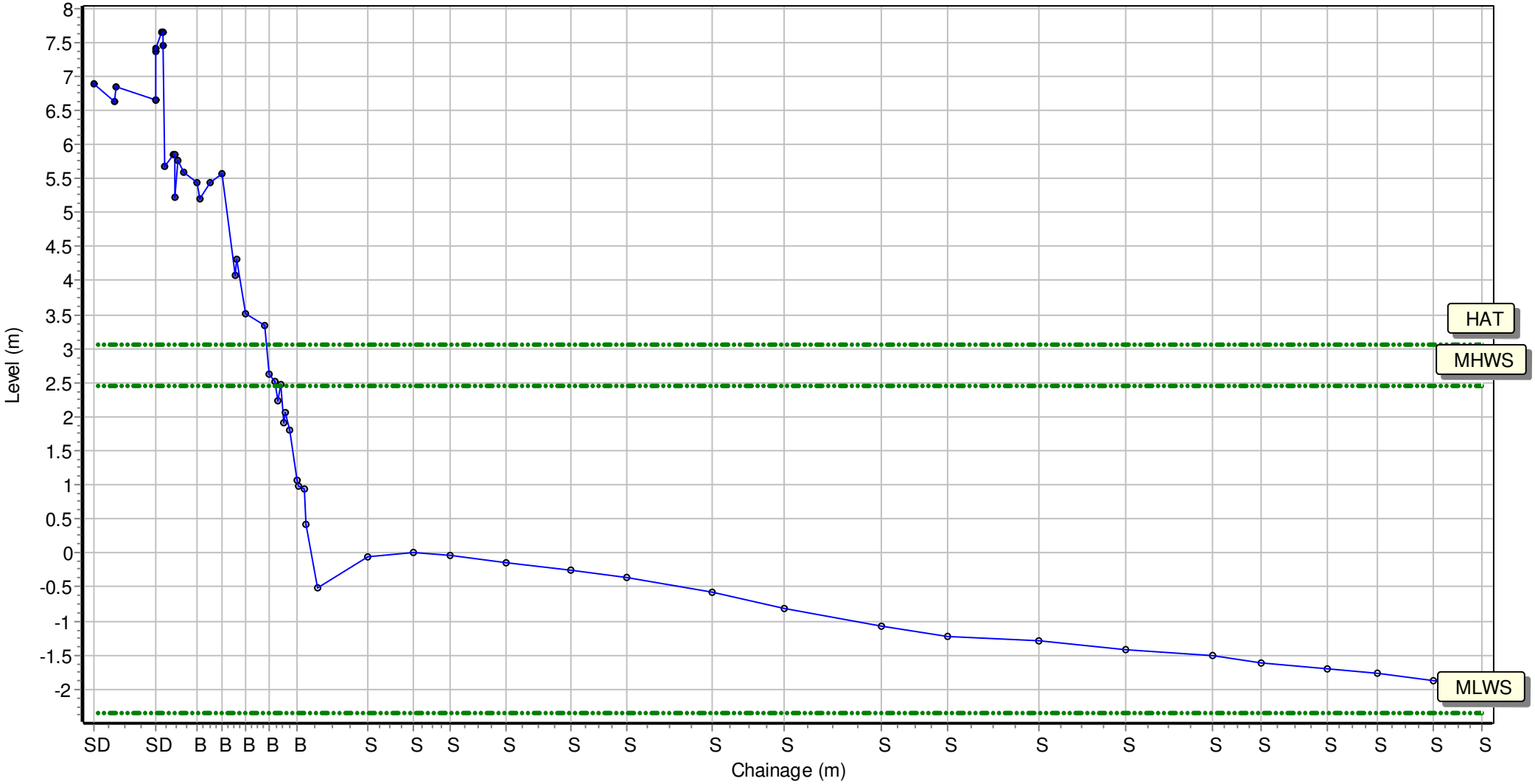
Location: **1dSBN5**

Date: 19/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504515.599 **Northing:** 489205.724 **Profile Bearing:** 14 ° from North



Beach Profile

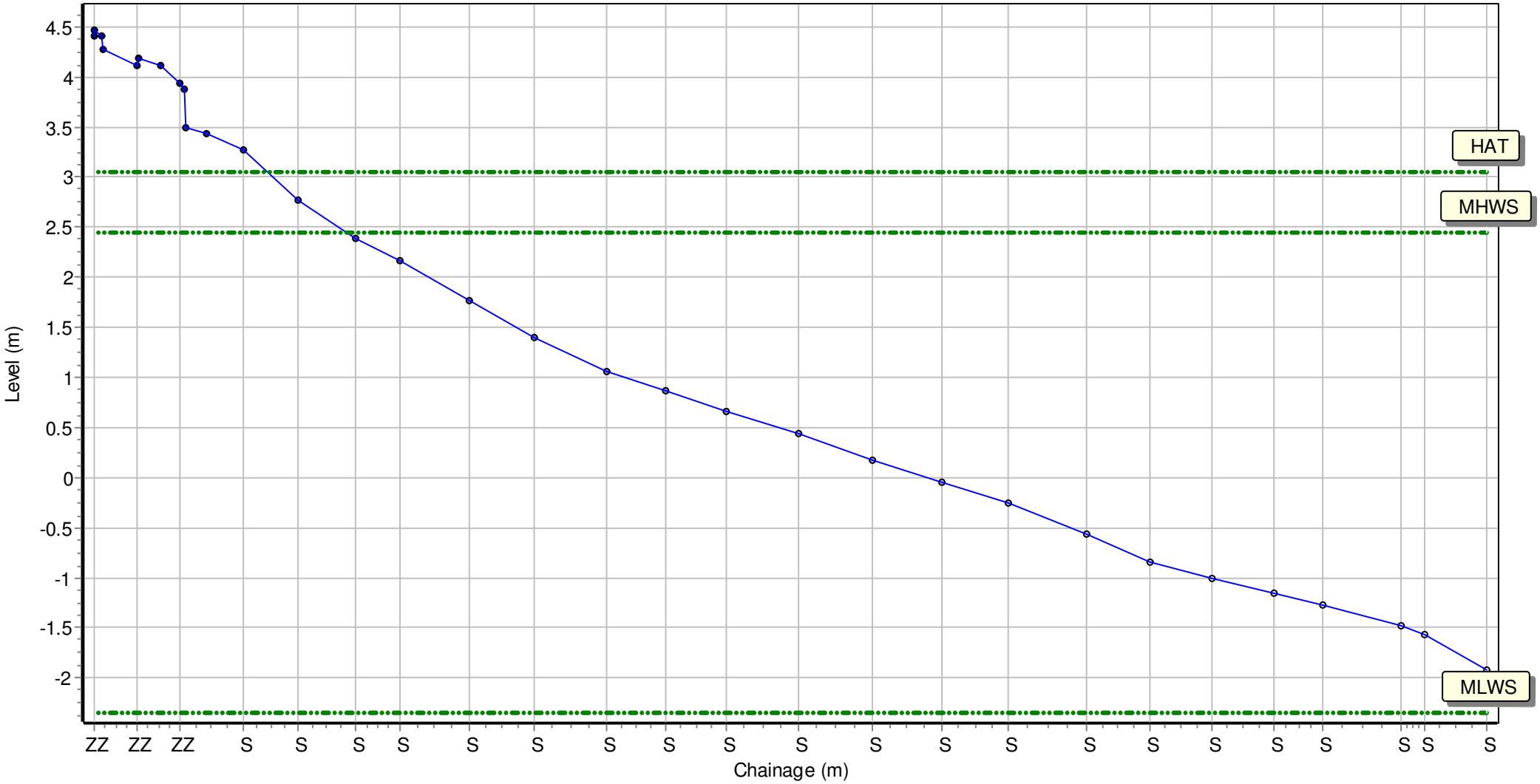
Location: **1dSBS1**

Date: 18/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504544.727 **Northing:** 488604.814 **Profile Bearing:** 120 ° from North



Beach Profile

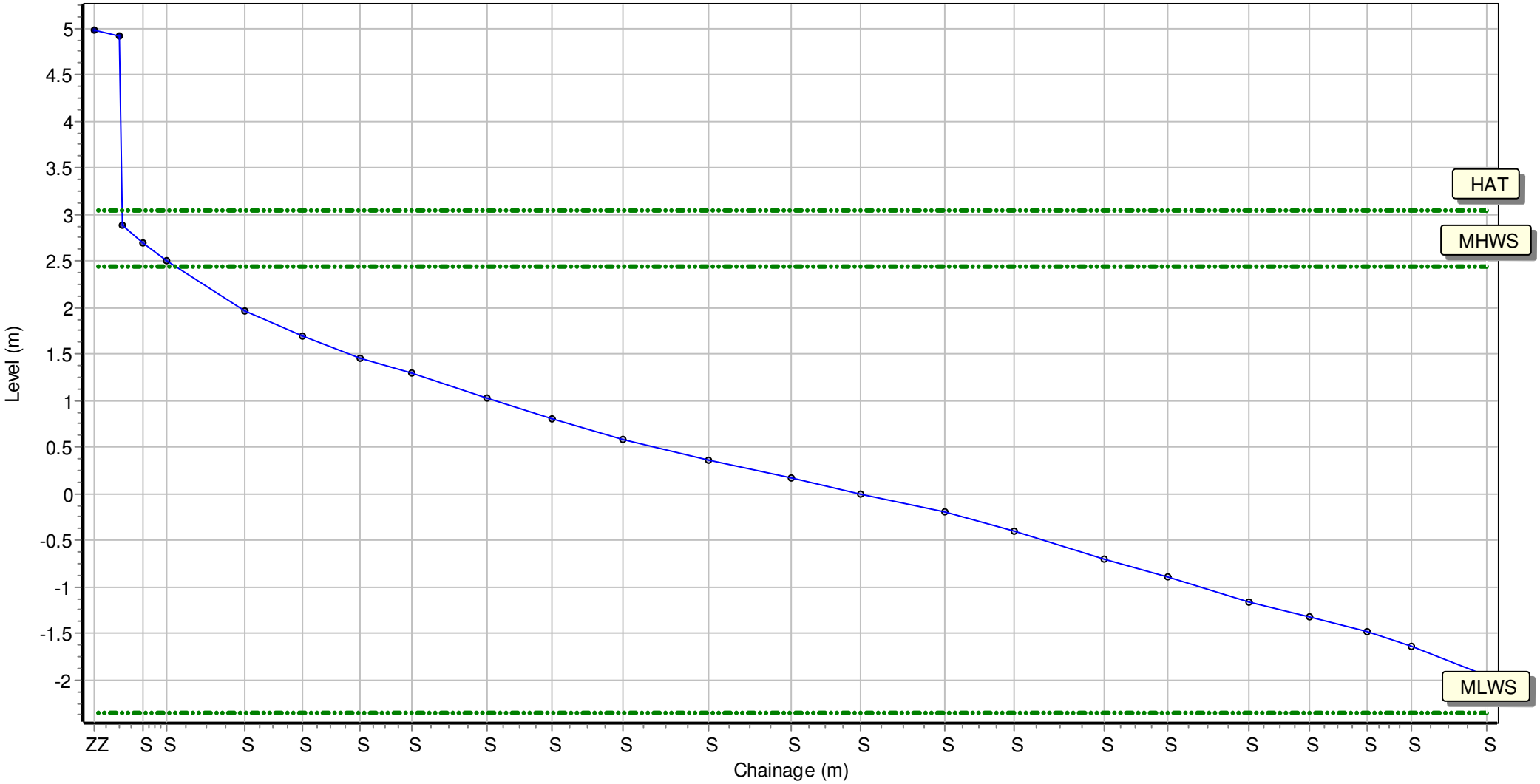
Location: **1dSBS2**

Date: 18/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504443.218 **Northing:** 488326.371 **Profile Bearing:** 105 ° from North



Beach Profile

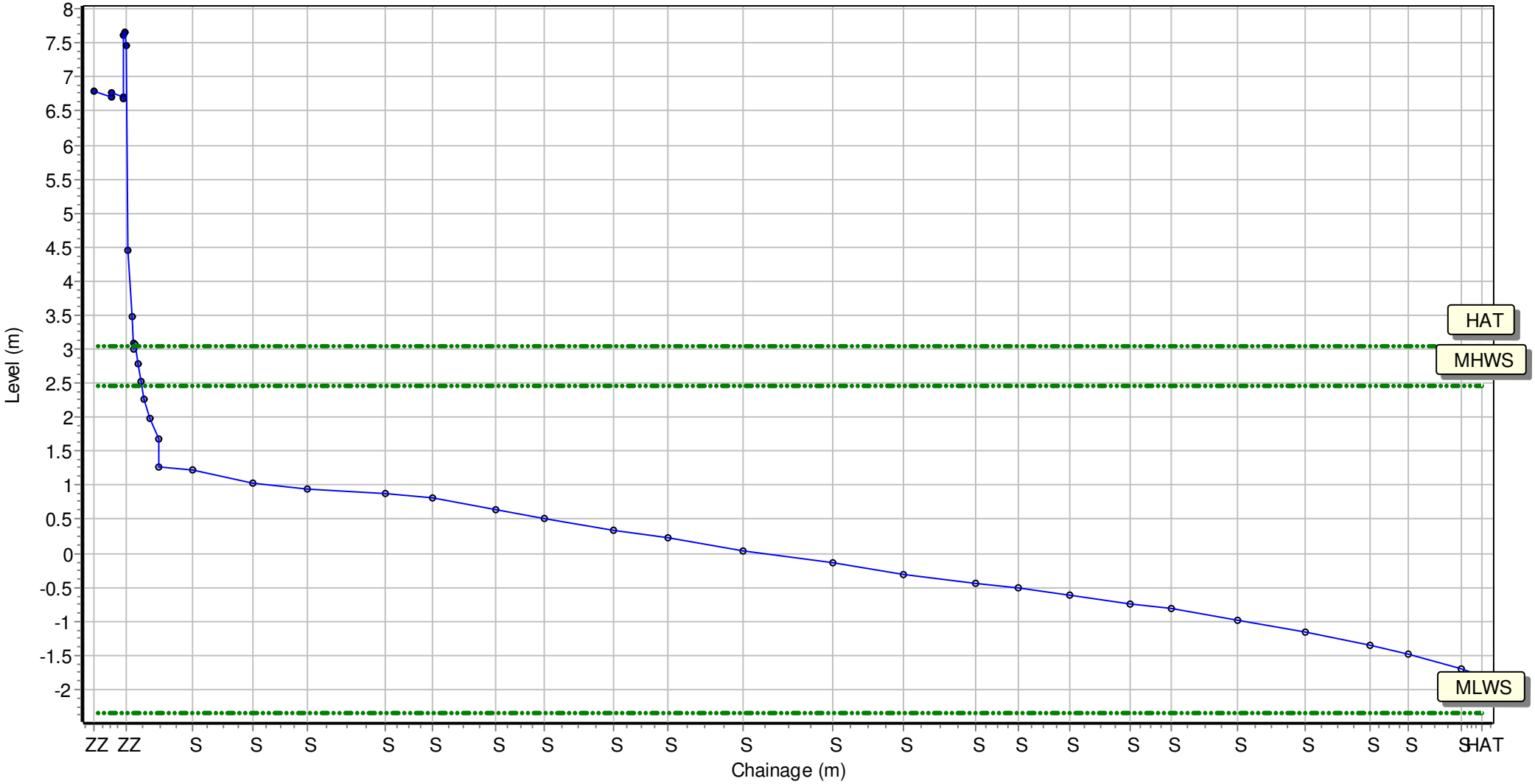
Location: **1dSBS3**

Date: 18/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504423.086 **Northing:** 488057.66 **Profile Bearing:** 83 ° from North



Beach Profile

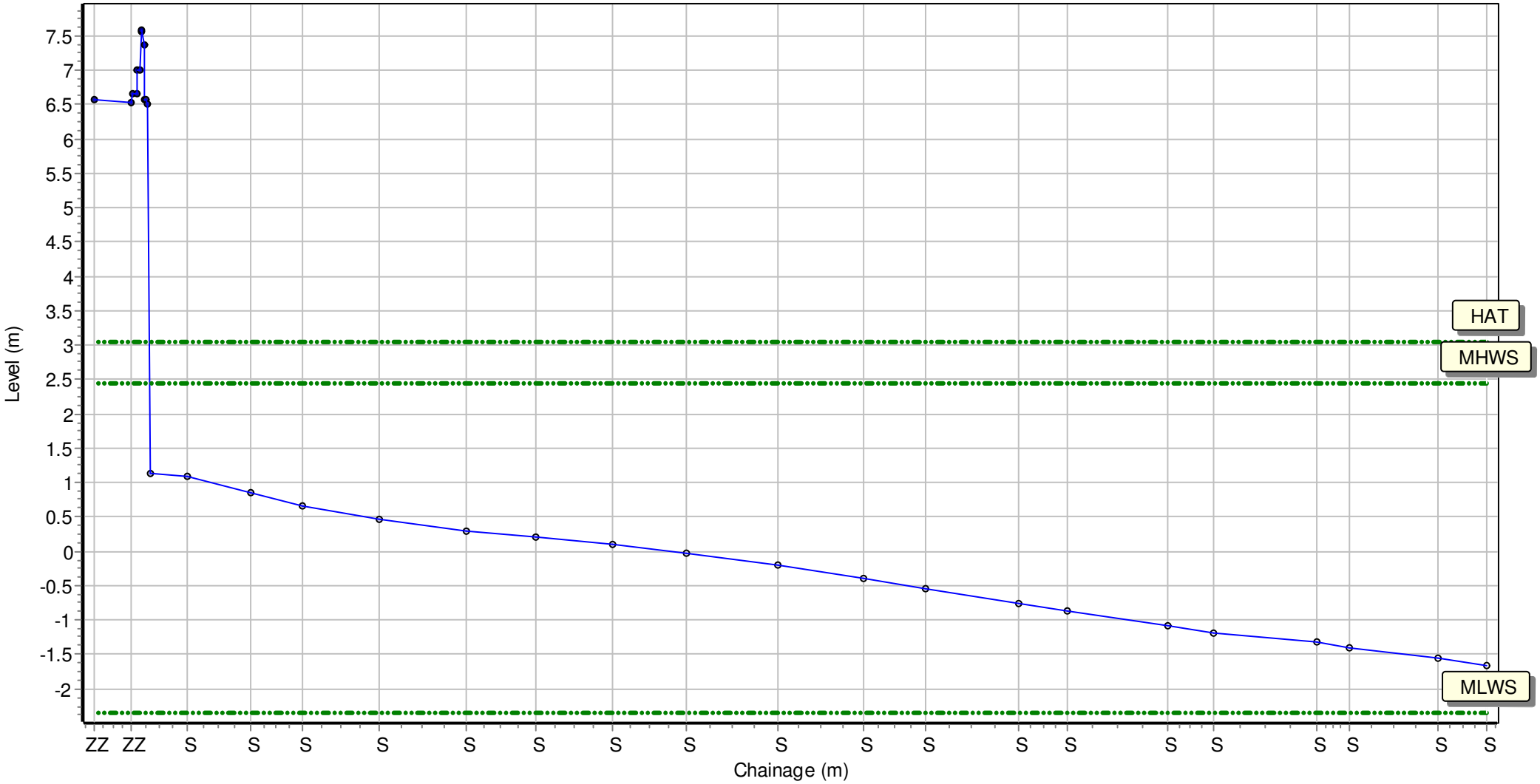
Location: **1dSBS4**

Date: 18/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 504494.785 **Northing:** 487816.983 **Profile Bearing:** 74 ° from North



Beach Profile

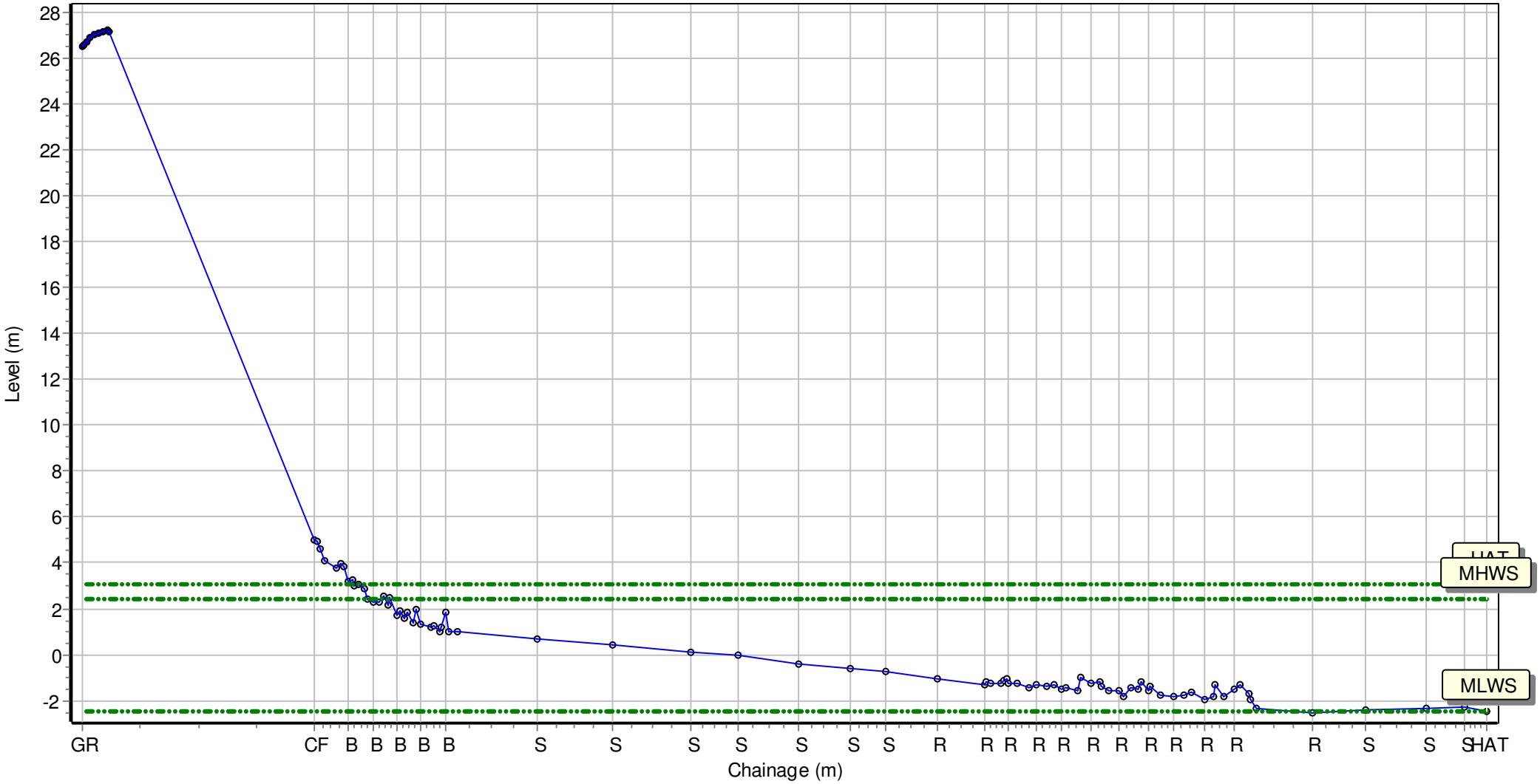
Location: **1dCY1**

Date: 20/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 506420.411 **Northing:** 484793.941 **Profile Bearing:** 43 ° from North



Beach Profile

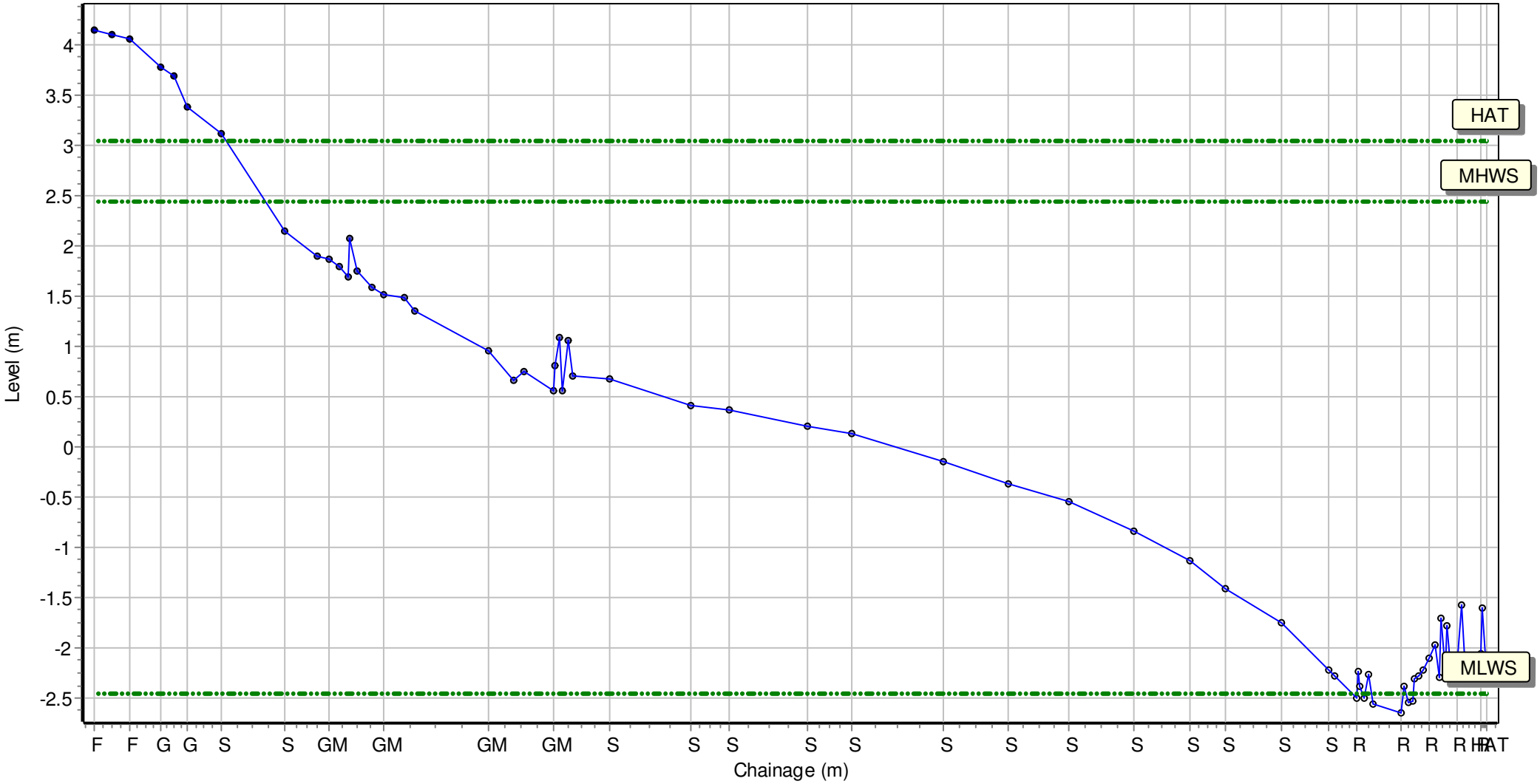
Location: **1dCY1A**

Date: 20/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 506298.519 **Northing:** 485175.932 **Profile Bearing:** 107 ° from North



Beach Profile

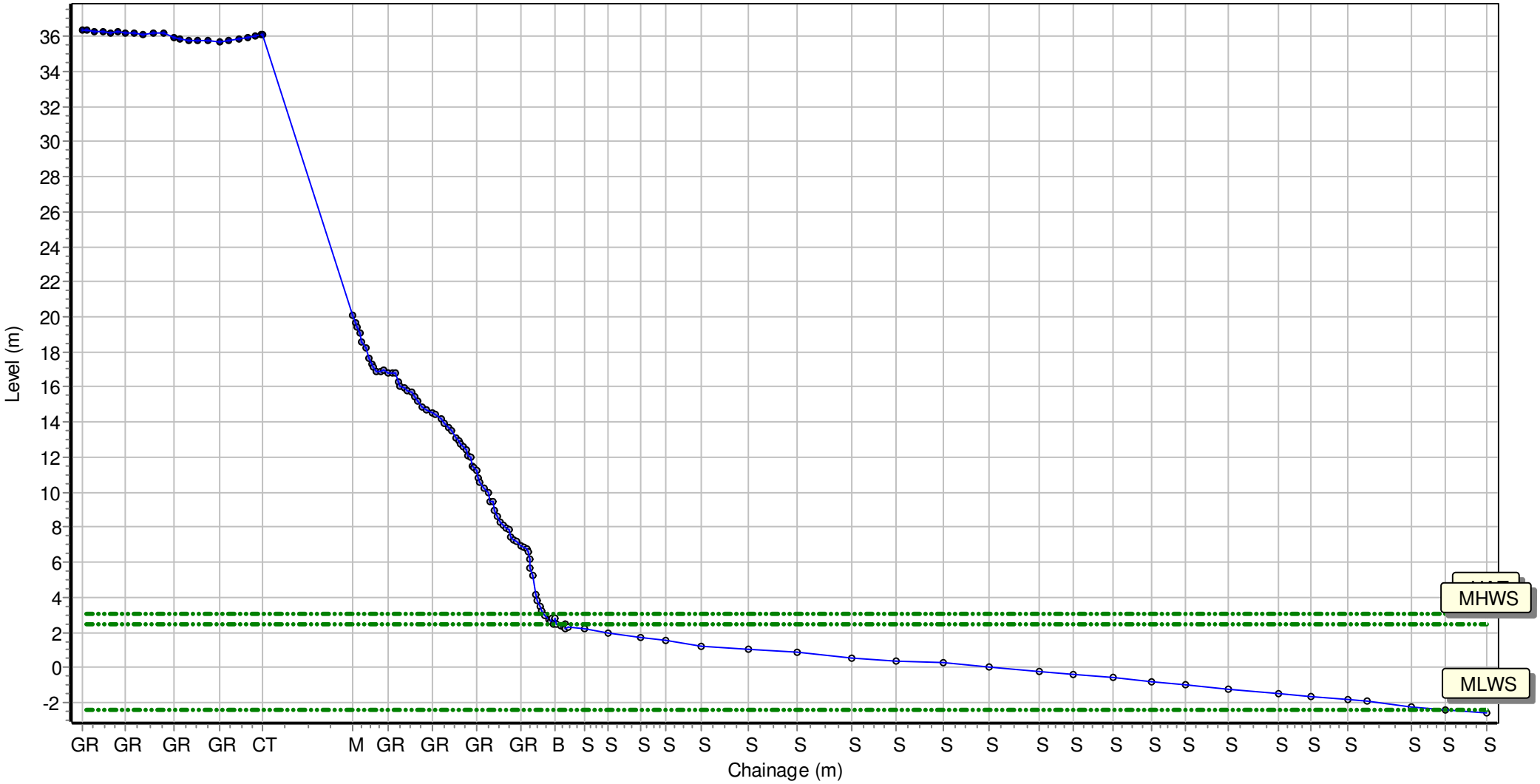
Location: **1dCY2**

Date: 20/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 506712.583 **Northing:** 484325.966 **Profile Bearing:** 38 ° from North



Beach Profile

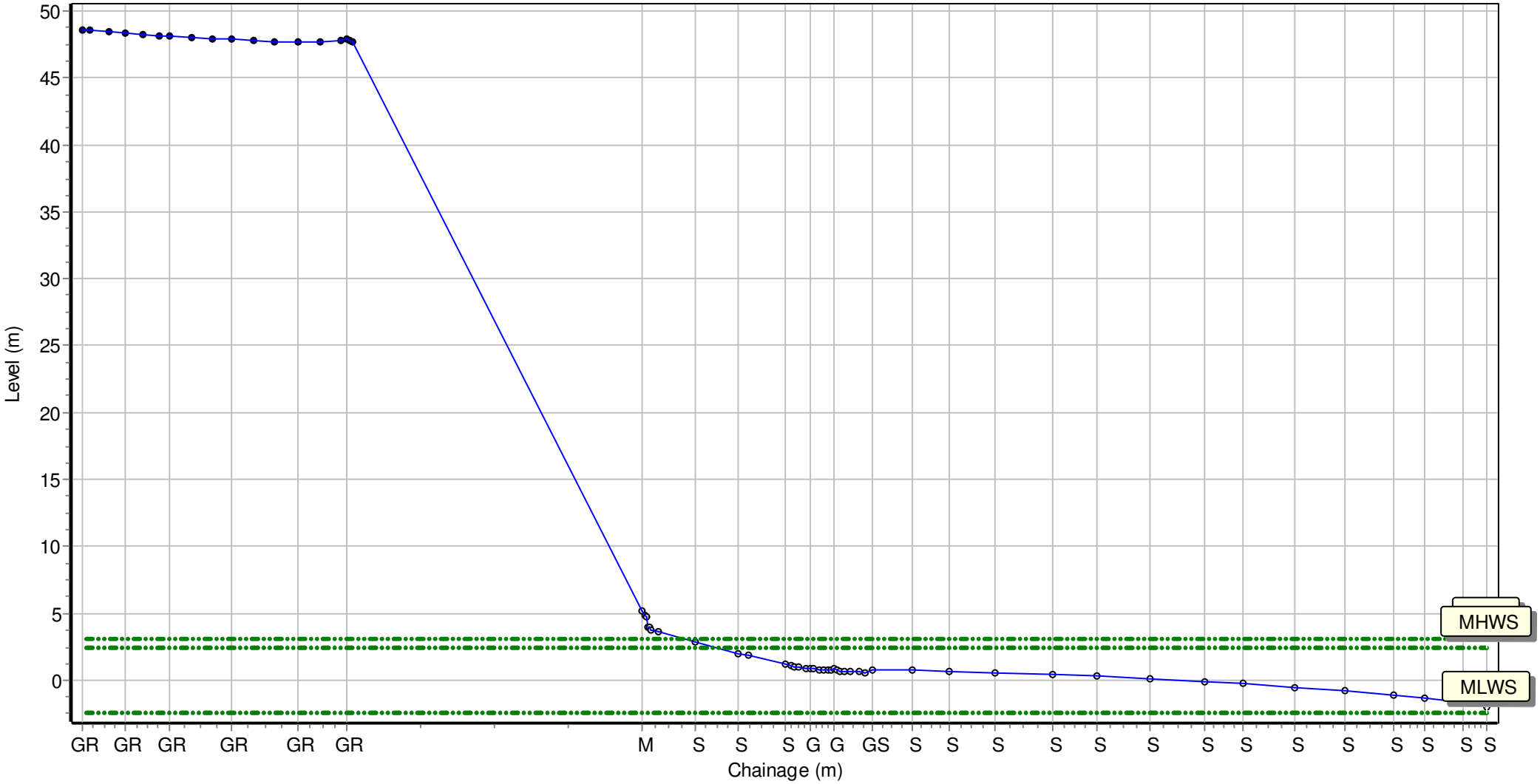
Location: **1dCY3**

Date: 20/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 507242.203 **Northing:** 484080.896 **Profile Bearing:** 42 ° from North



Beach Profile

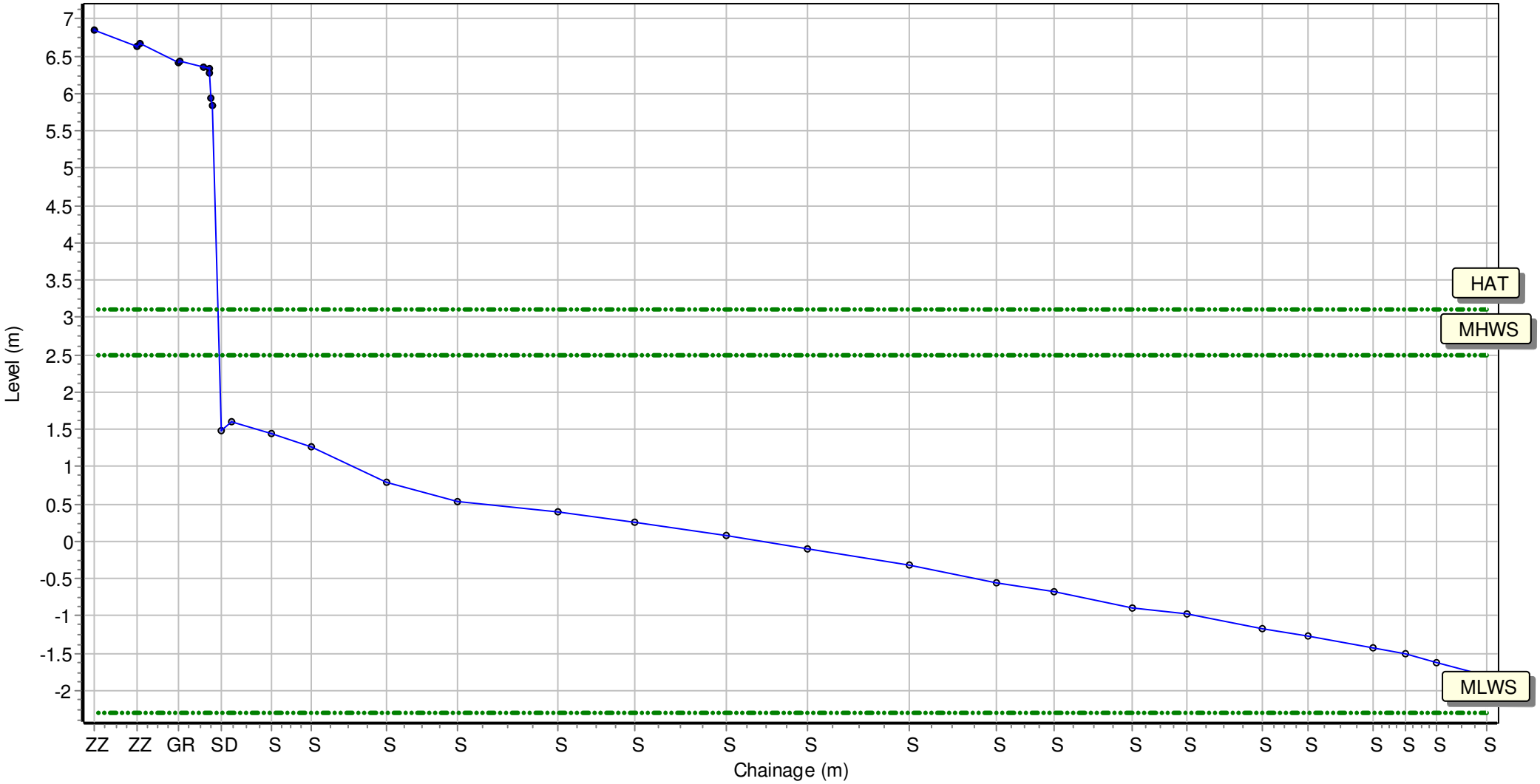
Location: **1dFB1**

Date: 07/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 511989.528 **Northing:** 480590.964 **Profile Bearing:** 100 ° from North



Beach Profile

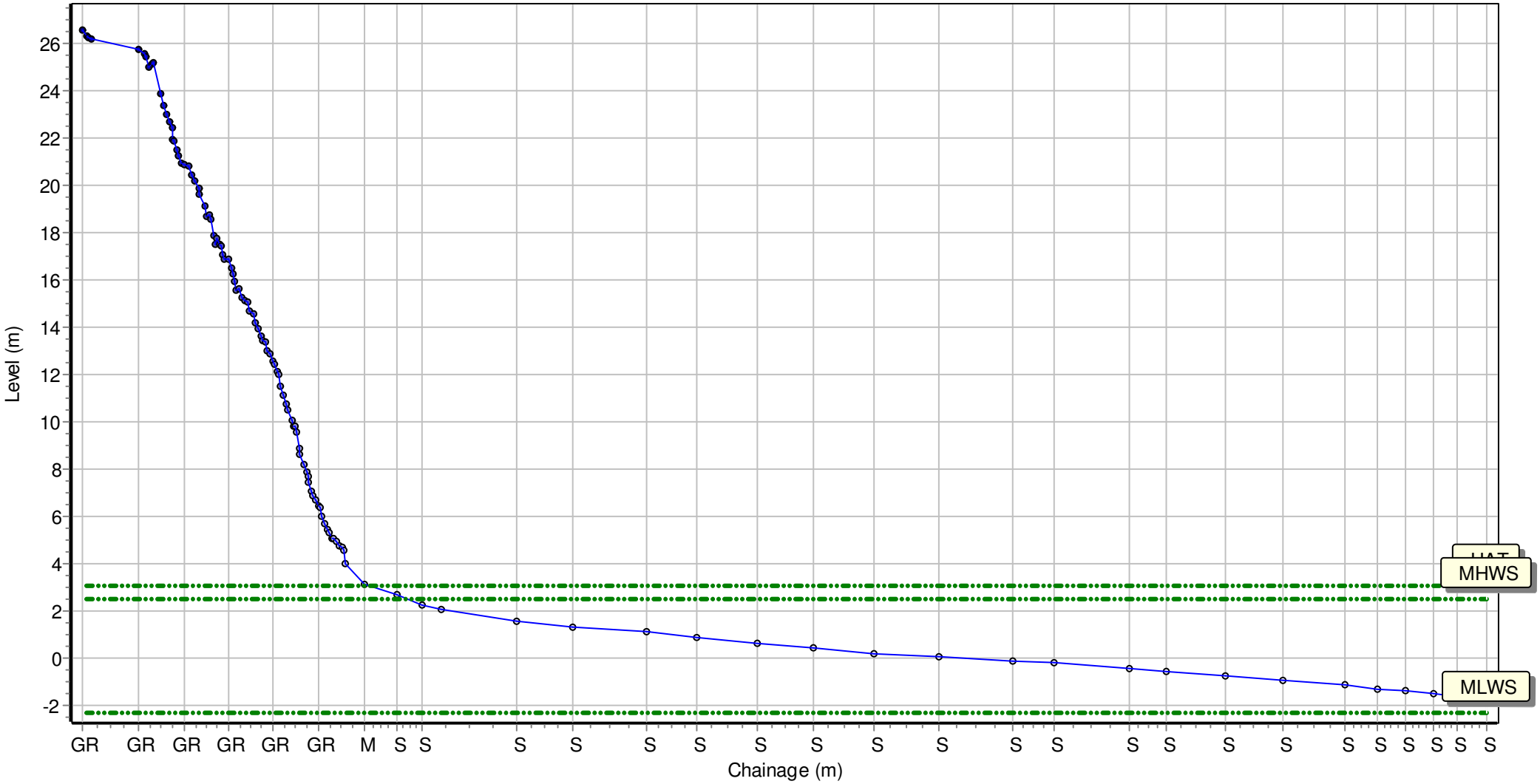
Location: **1dFB2**

Date: 07/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 512005.564 **Northing:** 479181.575 **Profile Bearing:** 77 ° from North



Beach Profile

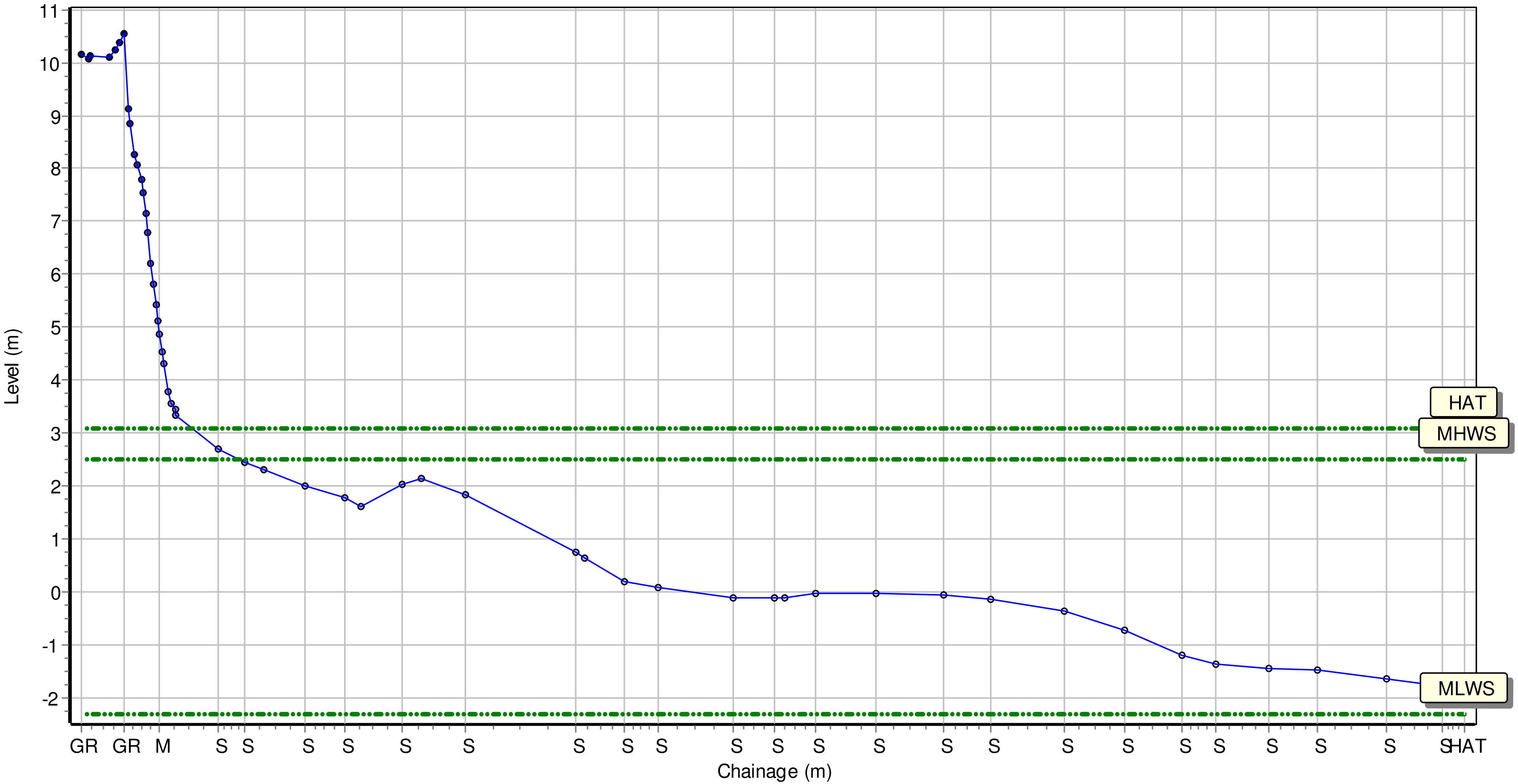
Location: 1dFB3

Date: 07/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 512429.303 **Northing:** 478202.148 **Profile Bearing:** 61 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

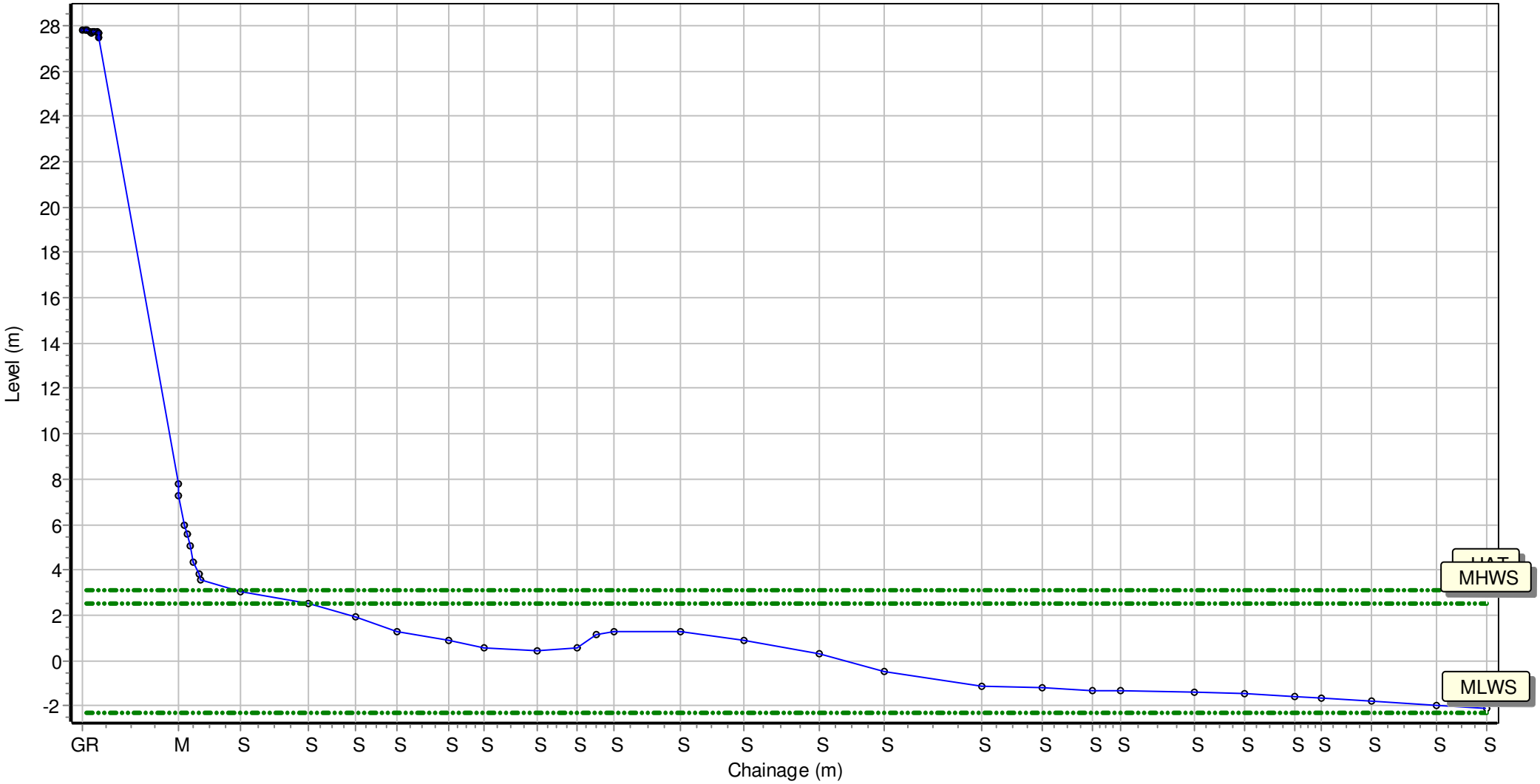
Location: **1dFB4**

Date: 07/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 513165.53 **Northing:** 477182.418 **Profile Bearing:** 51 ° from North



Beach Profile

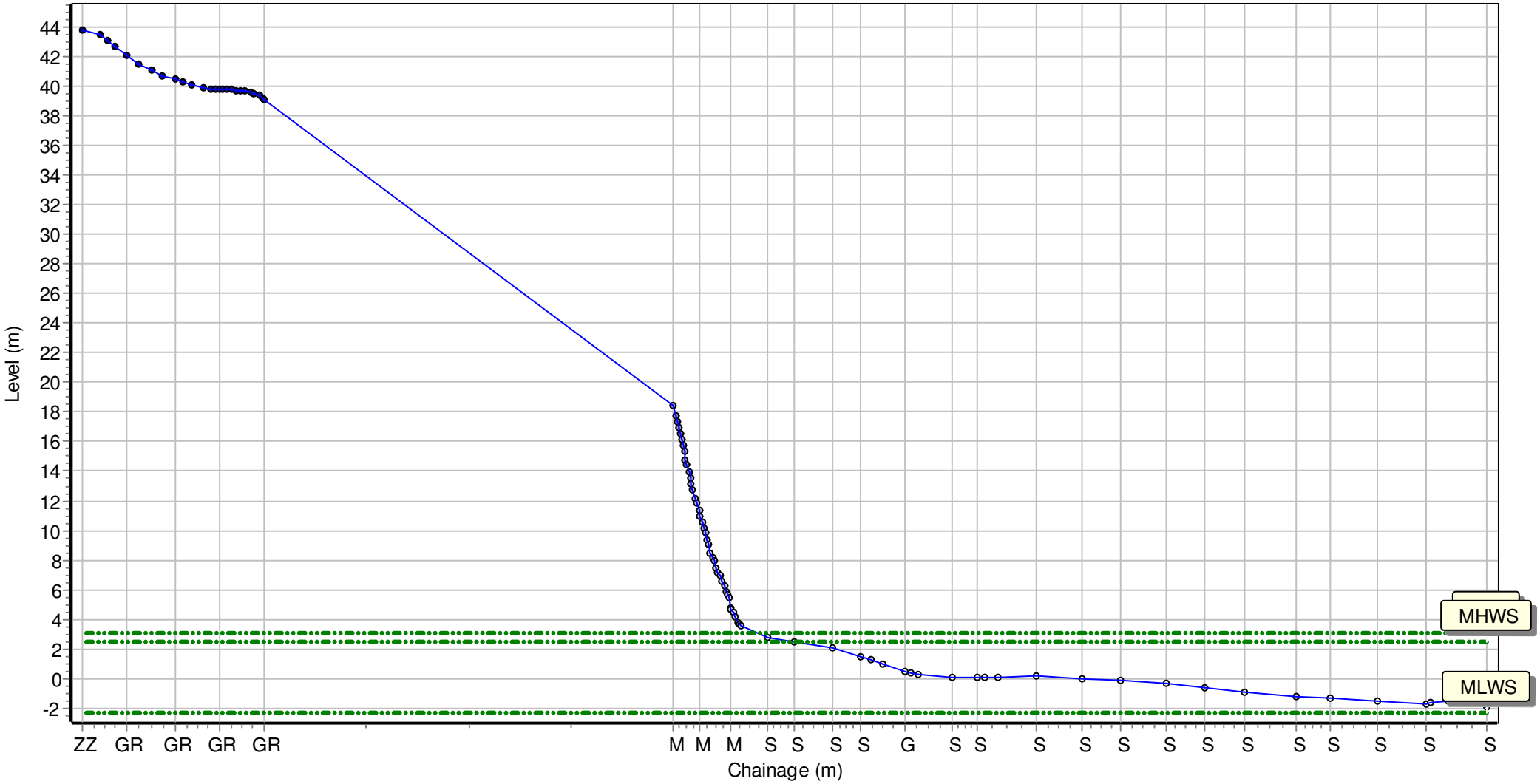
Location: **1dFB5**

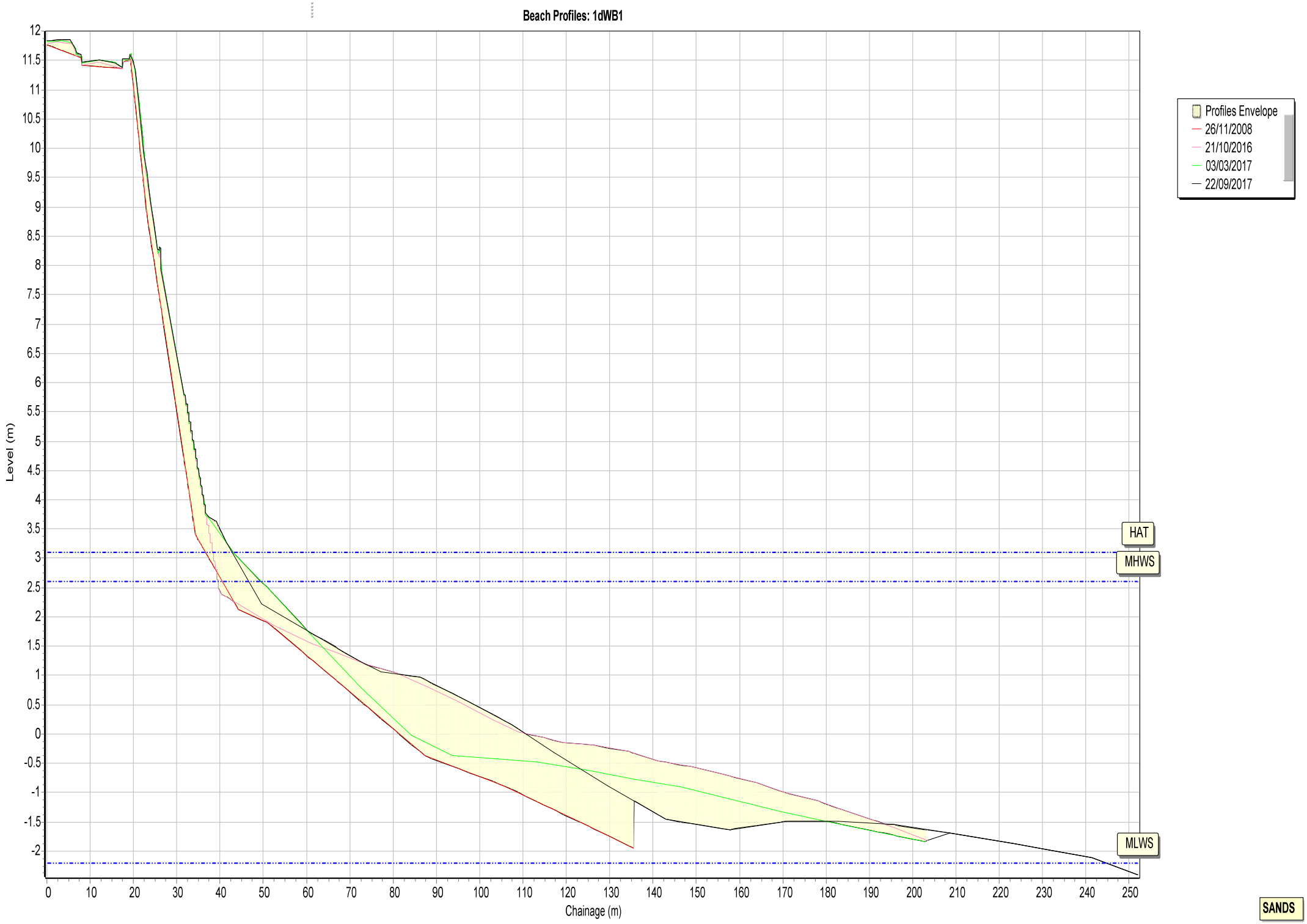
Date: 07/09/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2017 Full Measures Topo Survey

Easting: 514207.792 **Northing:** 476001.334 **Profile Bearing:** 47 ° from North




Beach Profiles: 1dWB1
Profiles Envelope
26/11/2008
21/10/2016
03/03/2017
22/09/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
12
11.5
11
10.5
10
9.5
9
8.5
8
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6.5
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4.5
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2.5
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1.5
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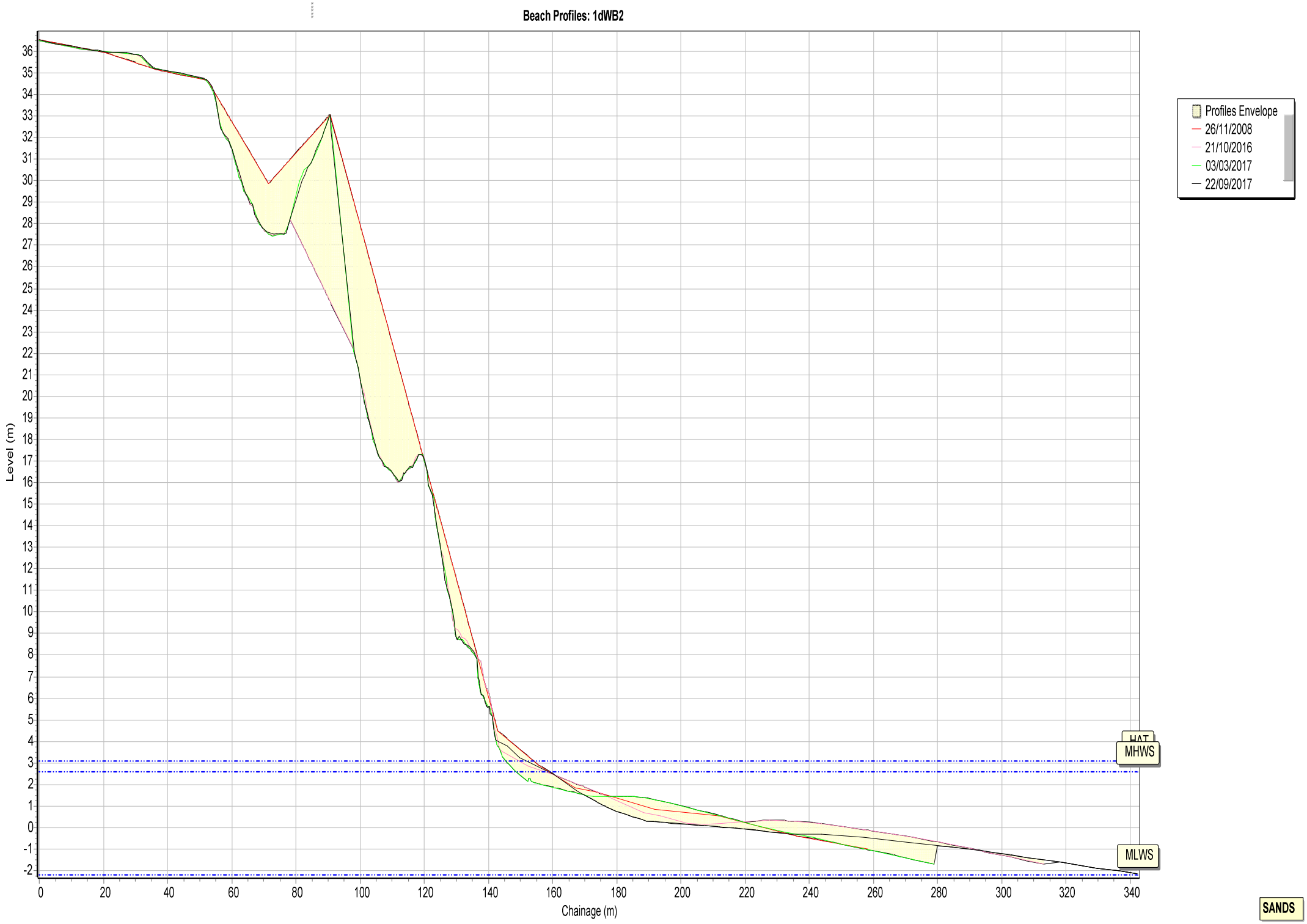
Beach Profiles: 1dWB2
Profiles Envelope
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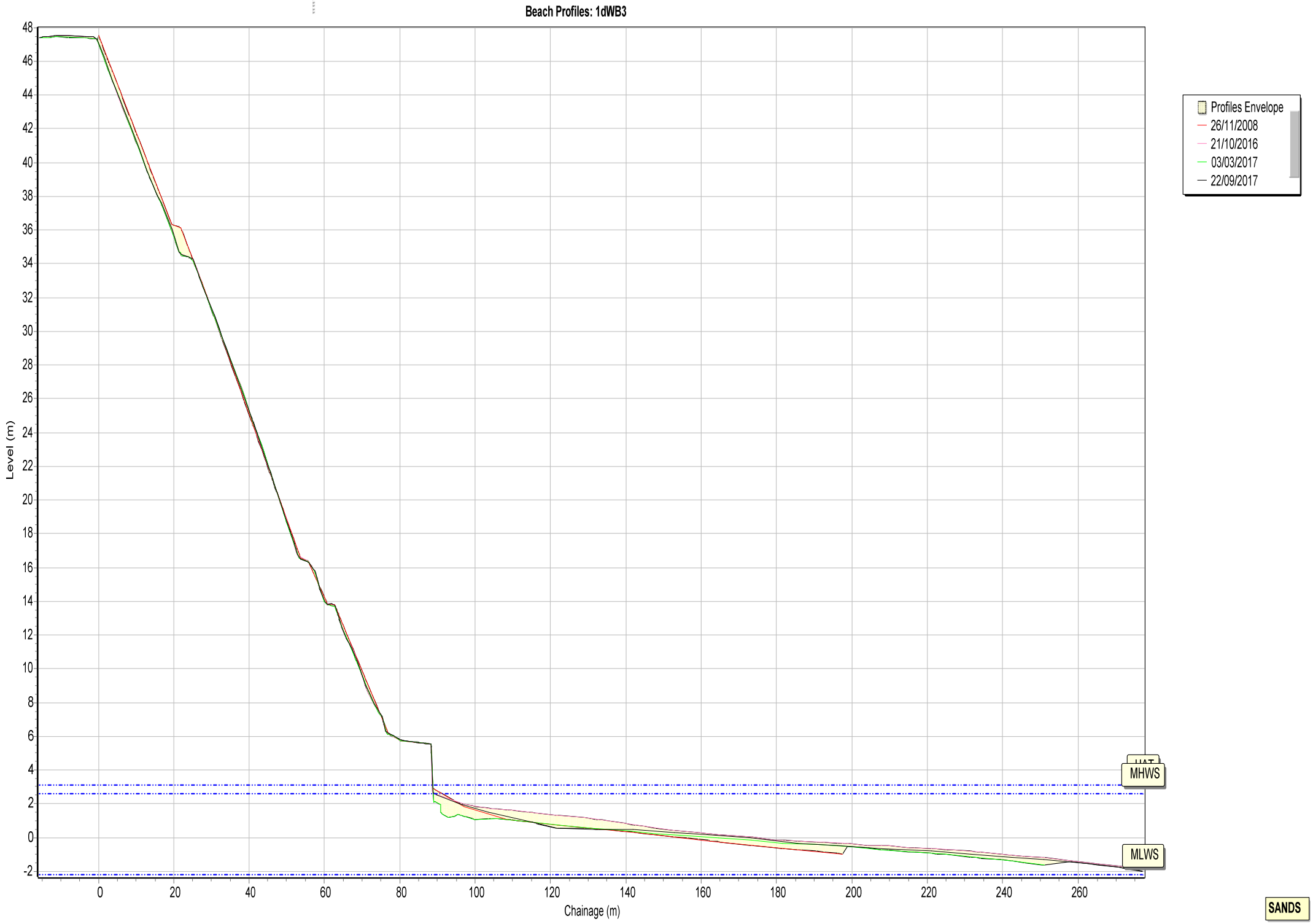
21/10/2016
03/03/2017
22/09/2017
Level (m)
Chainage (m)
MHWS
MLWS
SANDS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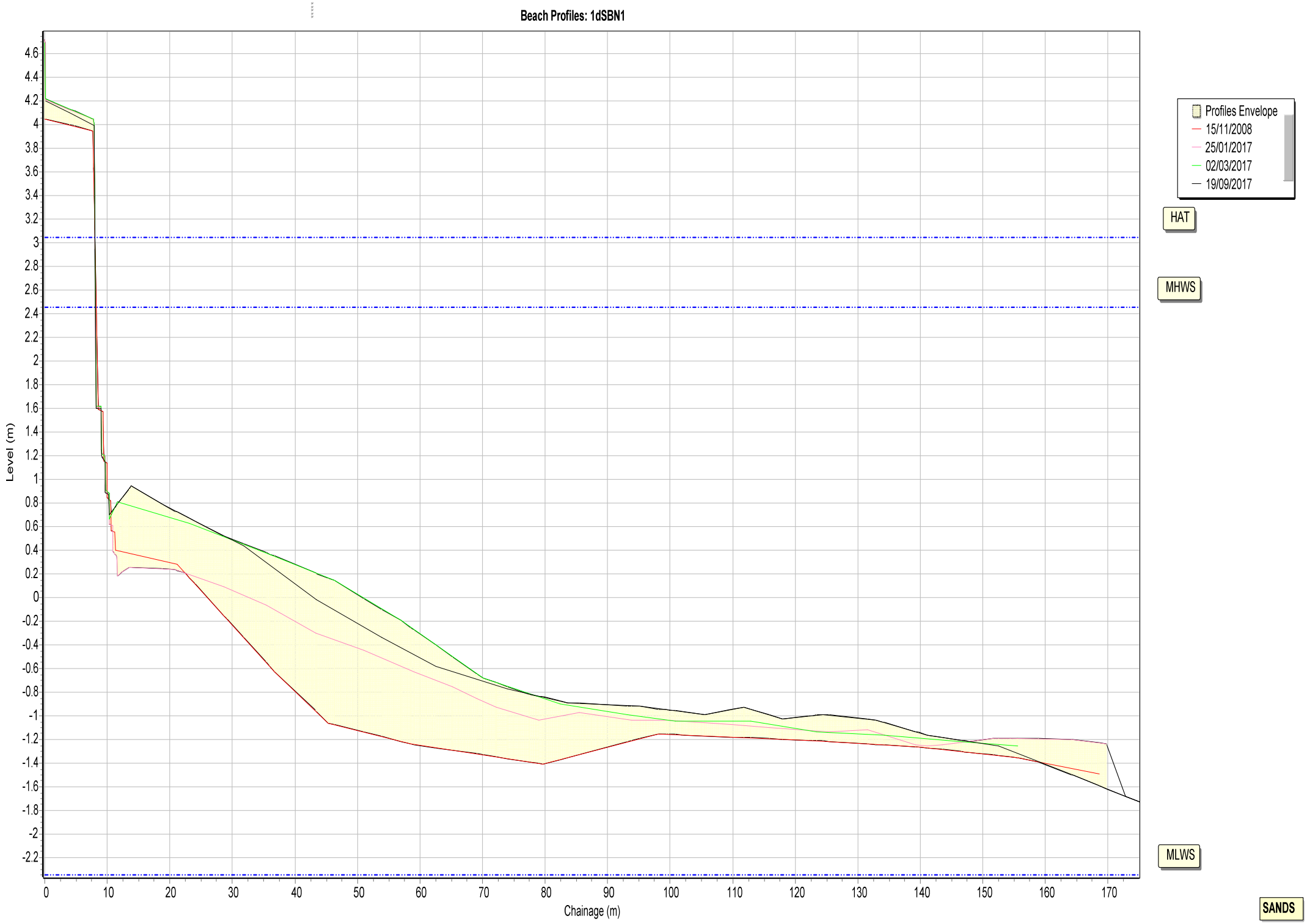
21/10/2016
03/03/2017
22/09/2017
Level (m)
Chainage (m)
MHWS
MLWS
SANDS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Profiles Envelope
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25/01/2017
02/03/2017
19/09/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
4.6
4.4
4.2
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3.8
3.6
3.4
3.2
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2.8
2.6
2.4
2.2
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1.6
1.4
1.2
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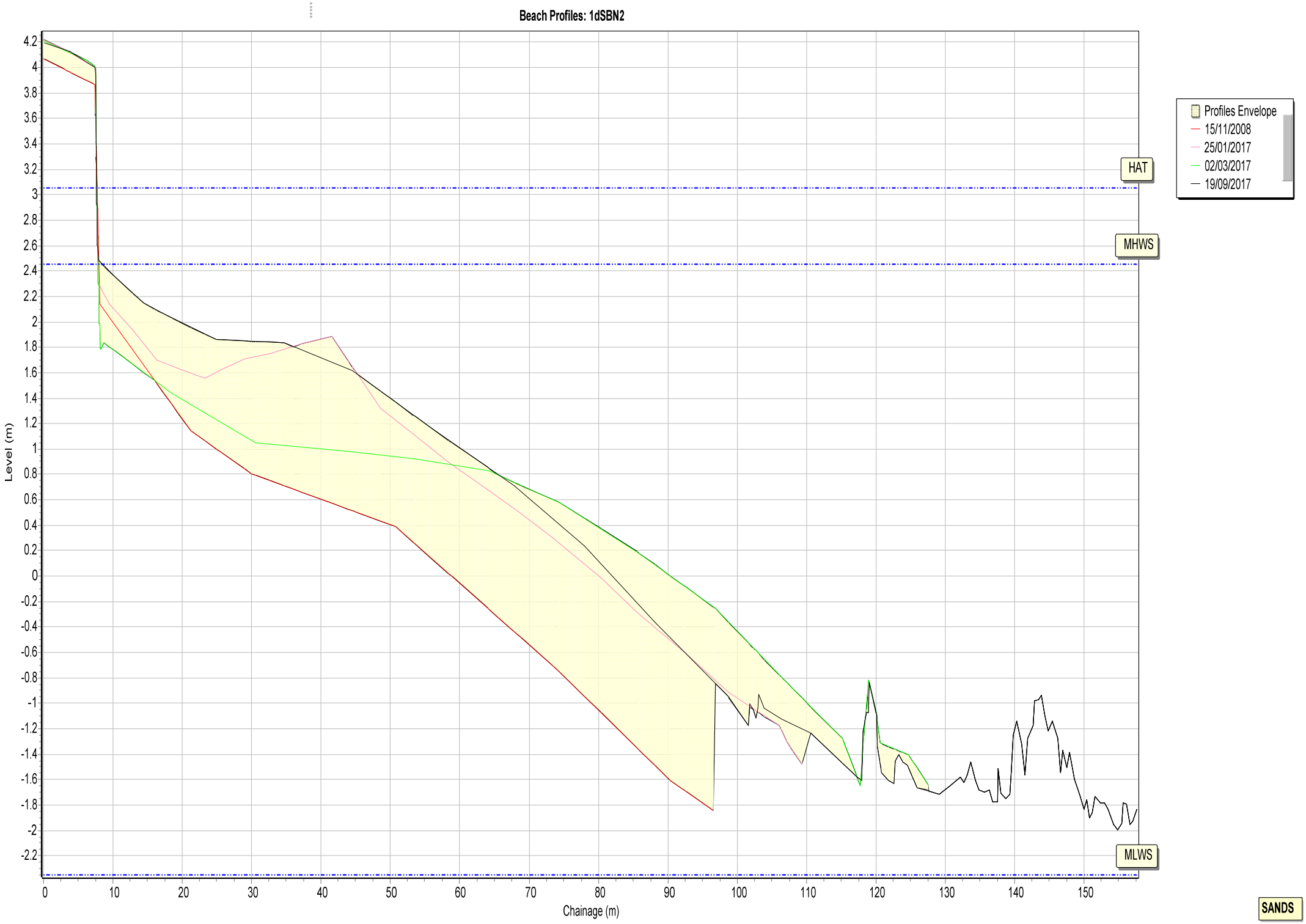
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Profiles Envelope
15/11/2008
25/01/2017
02/03/2017
19/09/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
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1.6
1.4
1.2
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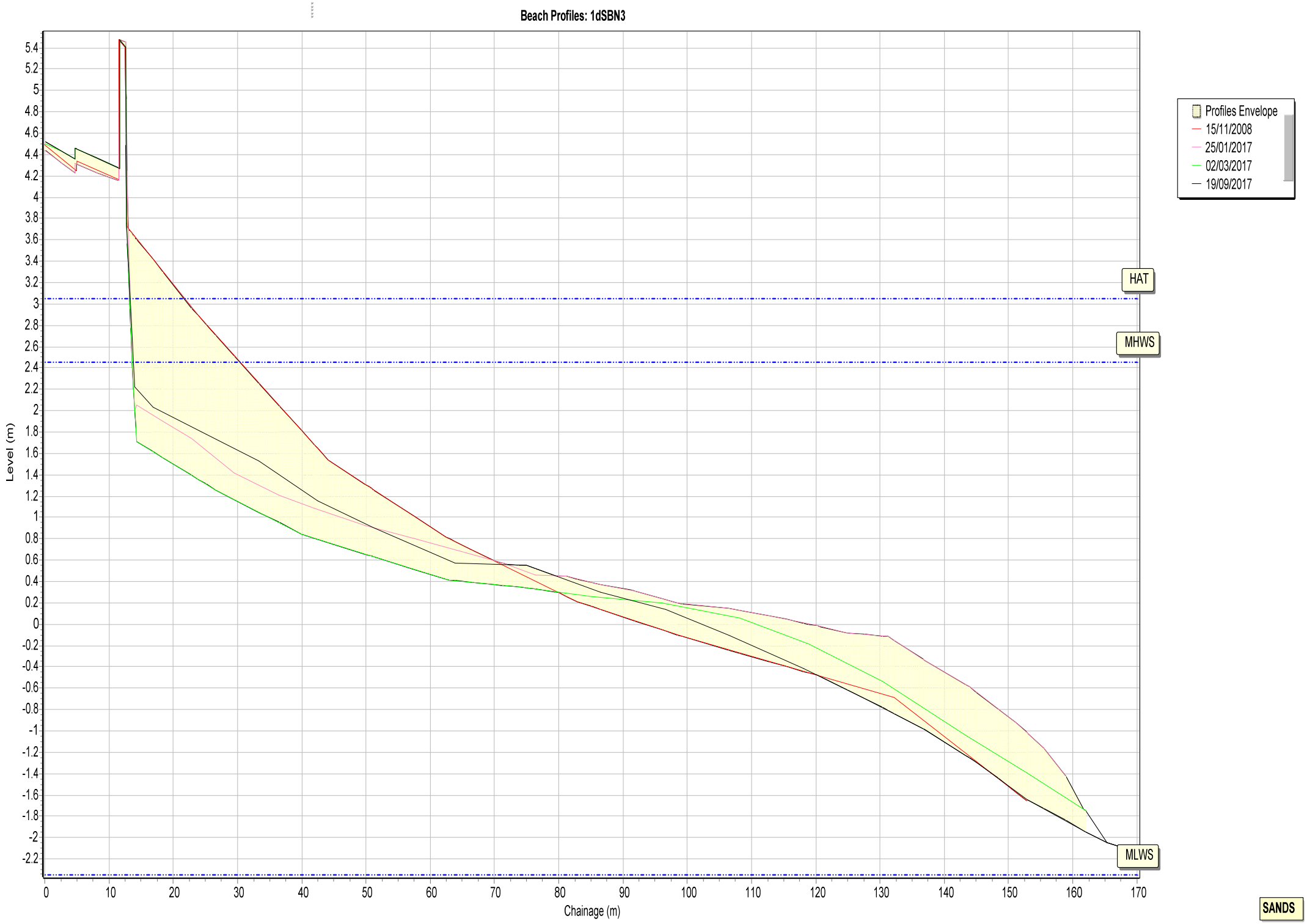
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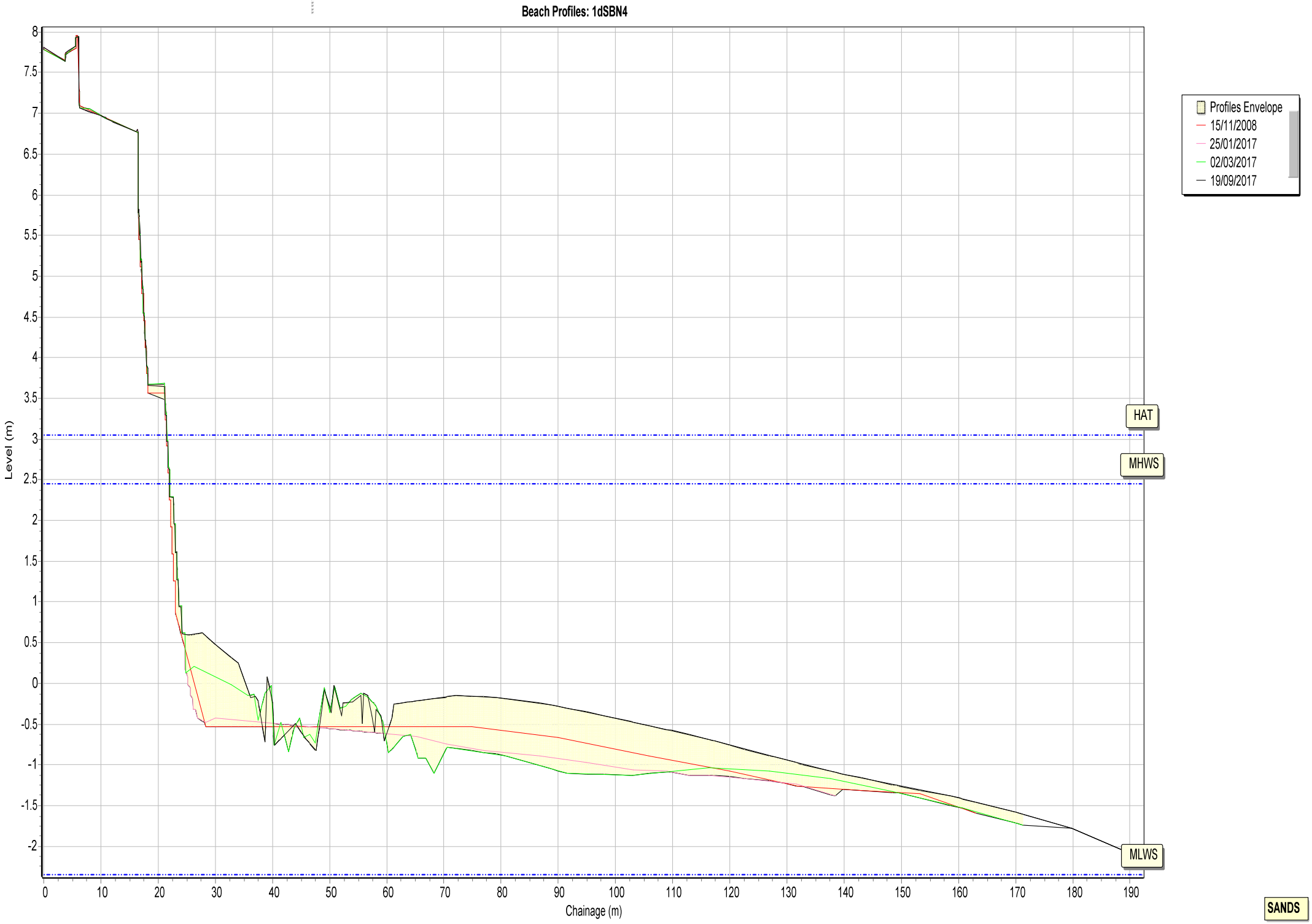
Profiles Envelope
15/11/2008
25/01/2017
02/03/2017
19/09/2017
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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Profiles Envelope
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25/01/2017
02/03/2017
19/09/2017
HAT
MHWS
MLWS
Level (m)
Chainage (m)
8
7.5
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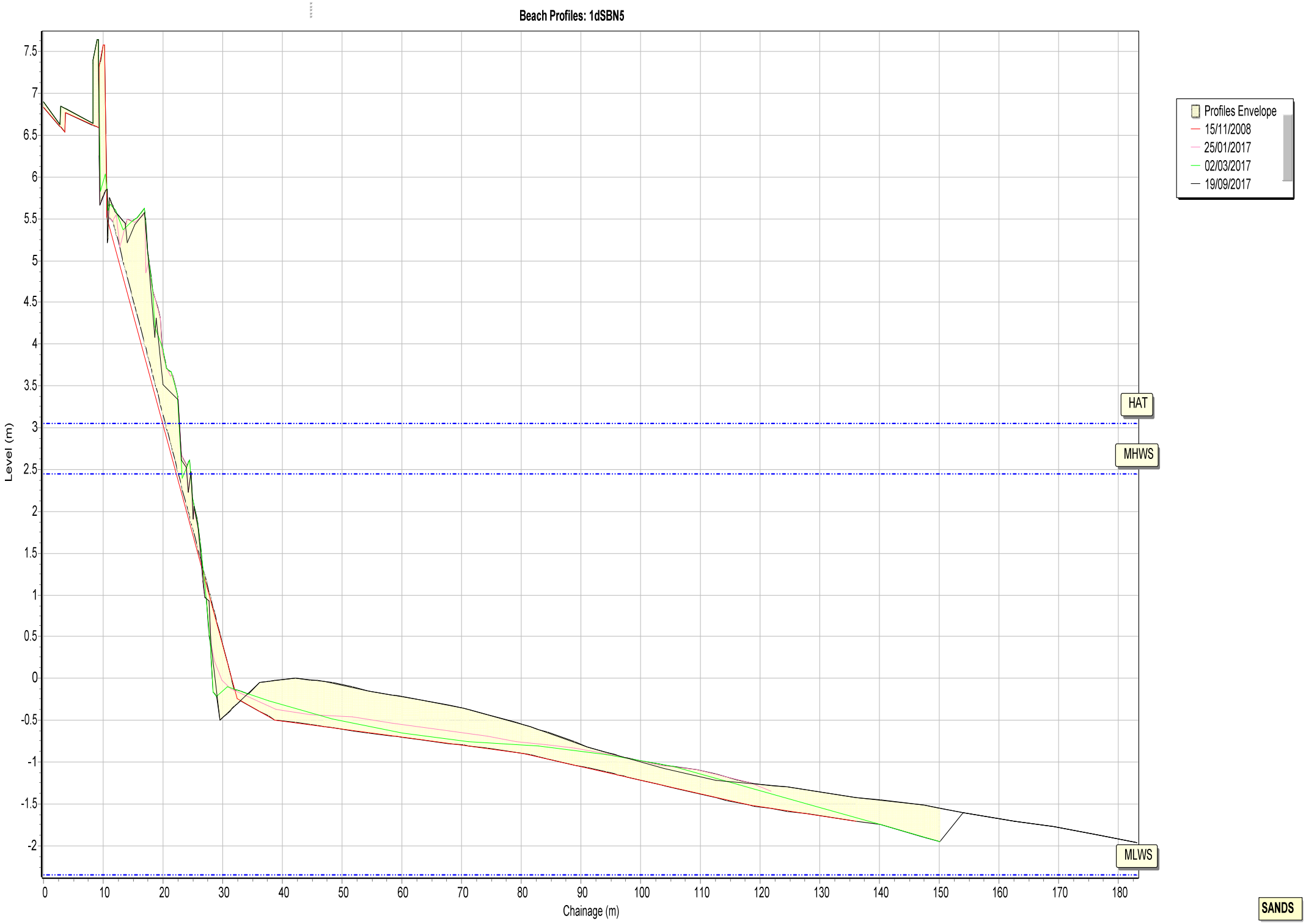
SANDS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02/03/2017
19/09/2017
HAT
MHWS
MLWS
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Chainage (m)
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7
6.5
6
5.5
5
4.5
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3
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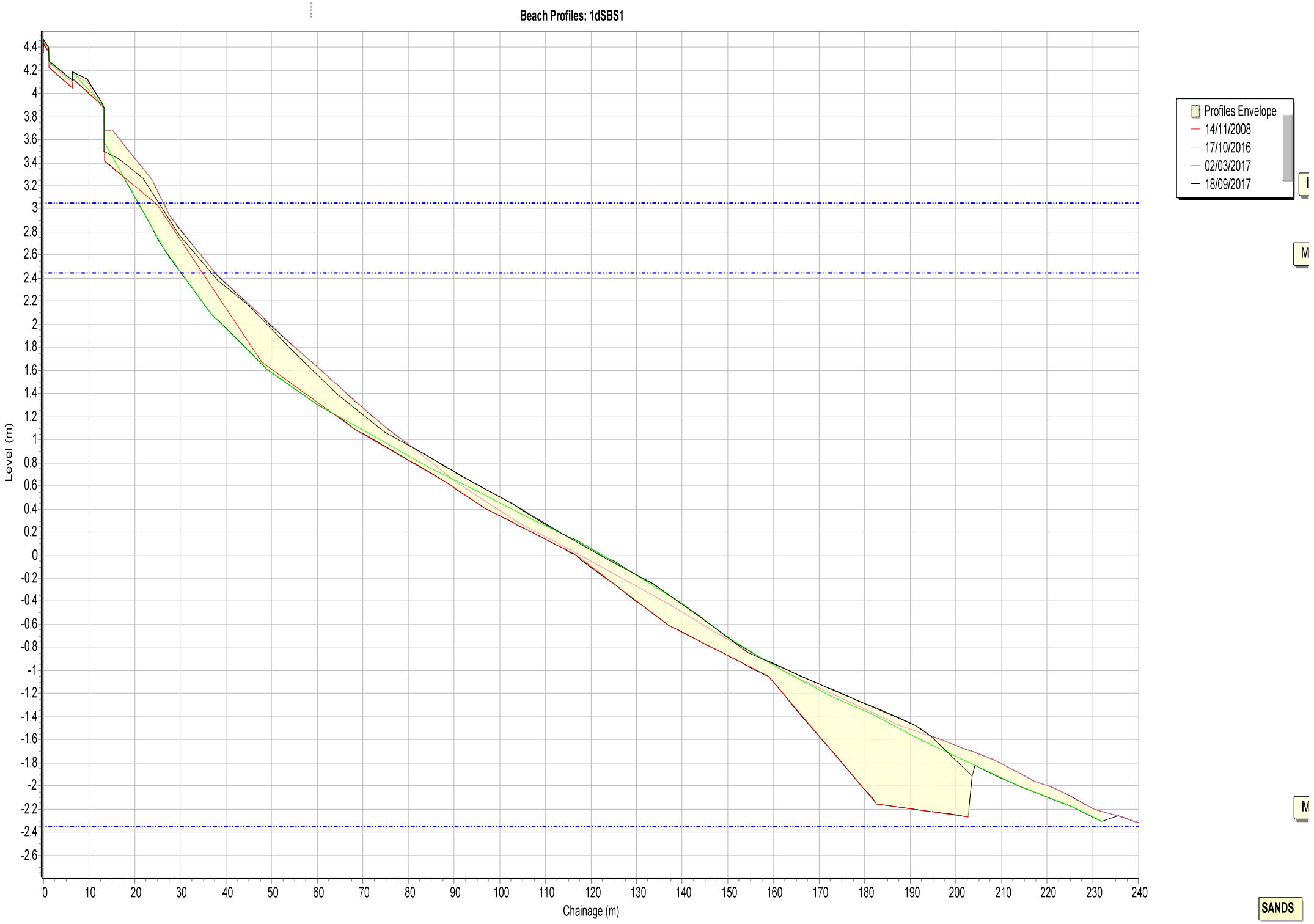
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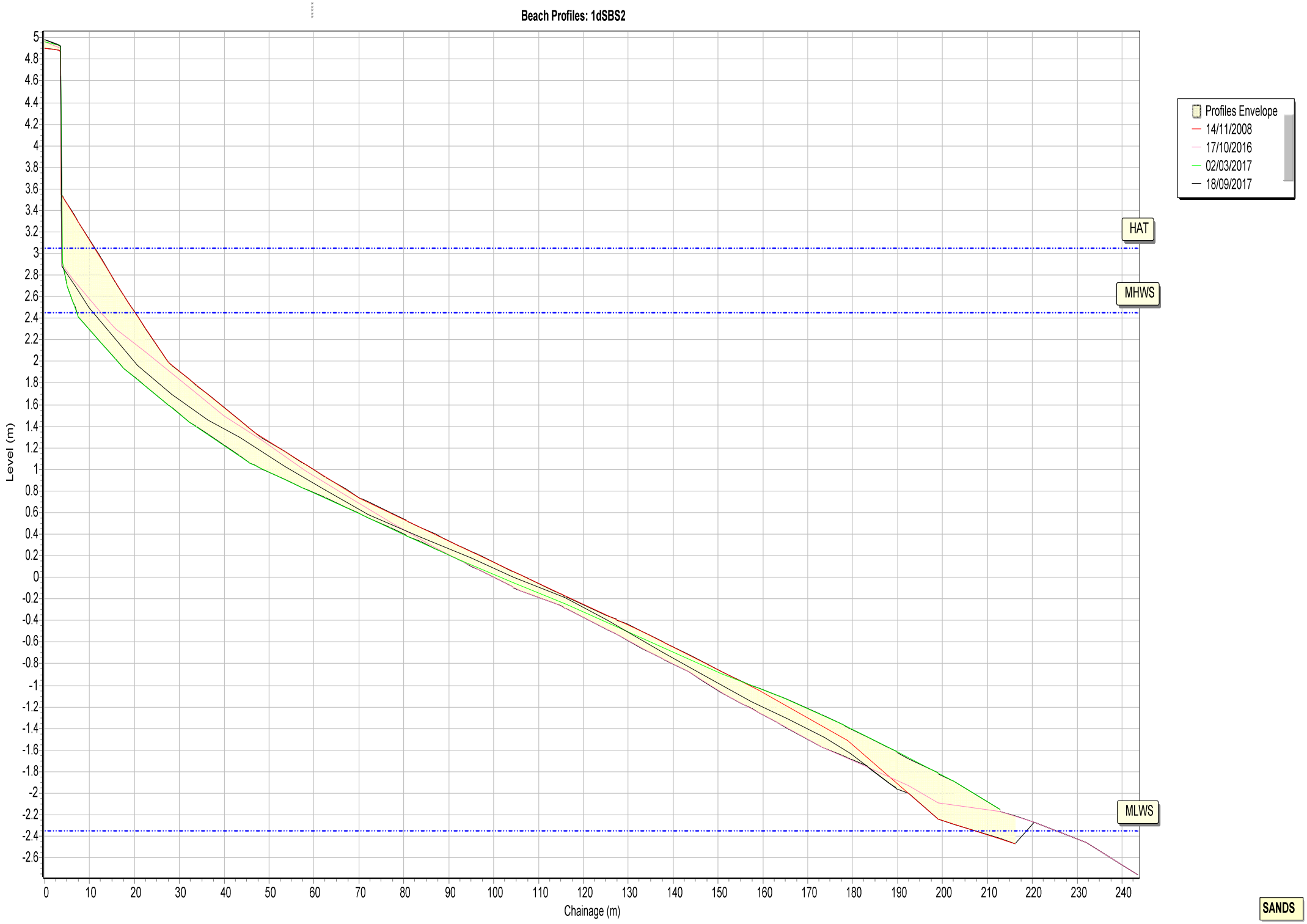
17/10/2016
02/03/2017
18/09/2017
Level (m)
Chainage (m)
SANDS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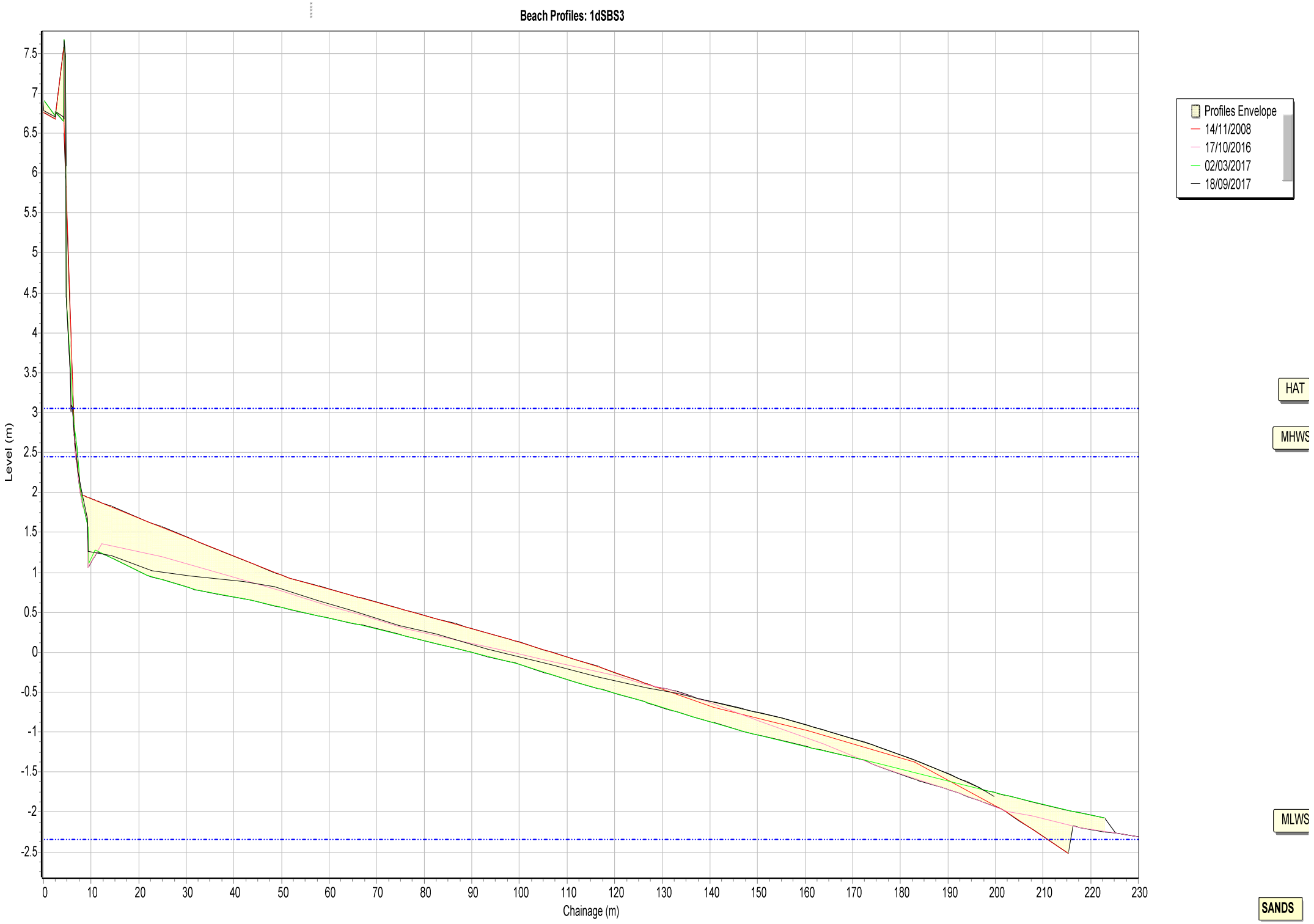
14/11/2008
17/10/2016
02/03/2017
18/09/2017
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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02/03/2017
18/09/2017
HAT
MHWS
MLWS
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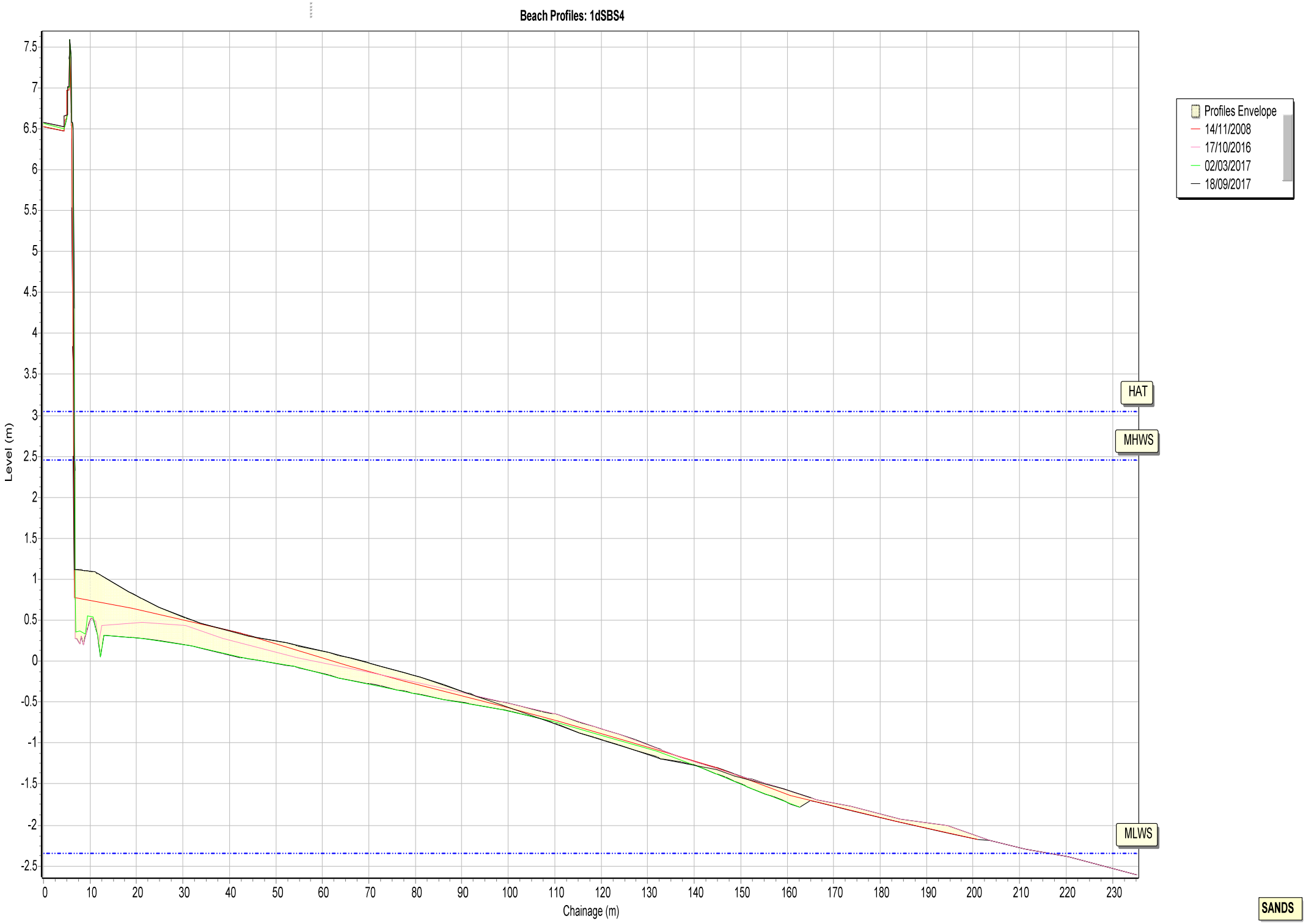
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Profiles Envelope
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17/10/2016
02/03/2017
18/09/2017
HAT
MHWS
MLWS
Level (m)
Chainage (m)
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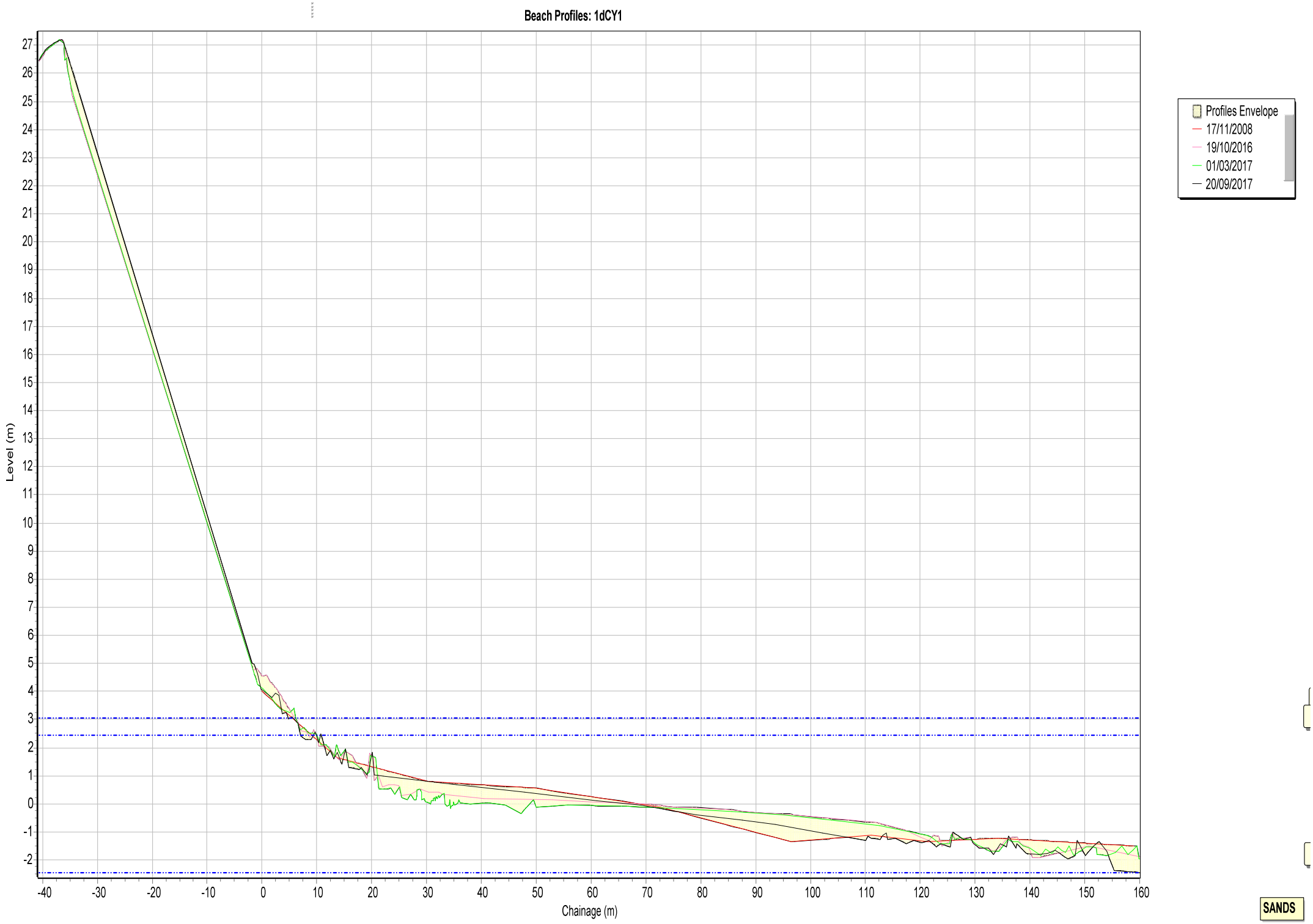
SANDS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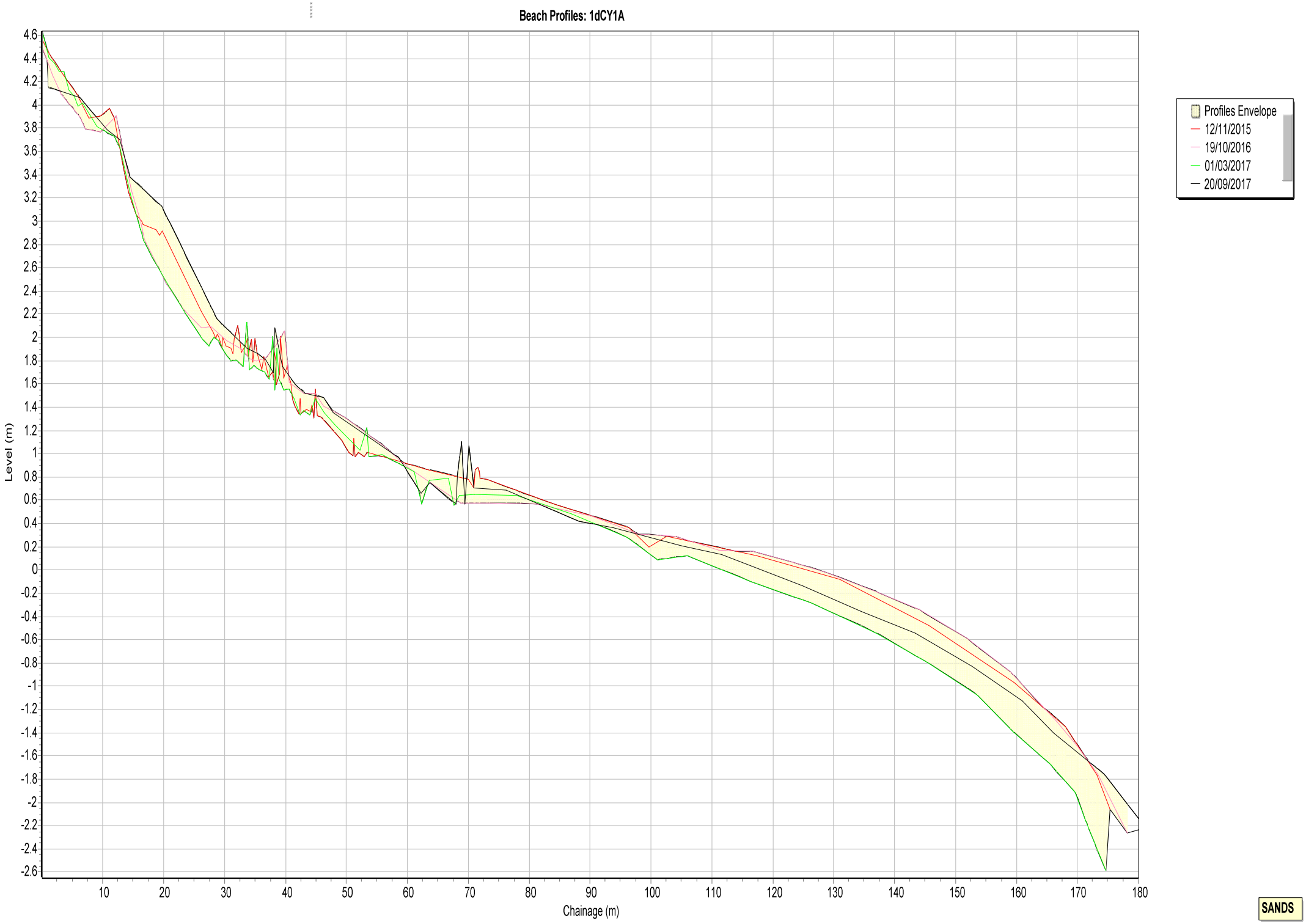
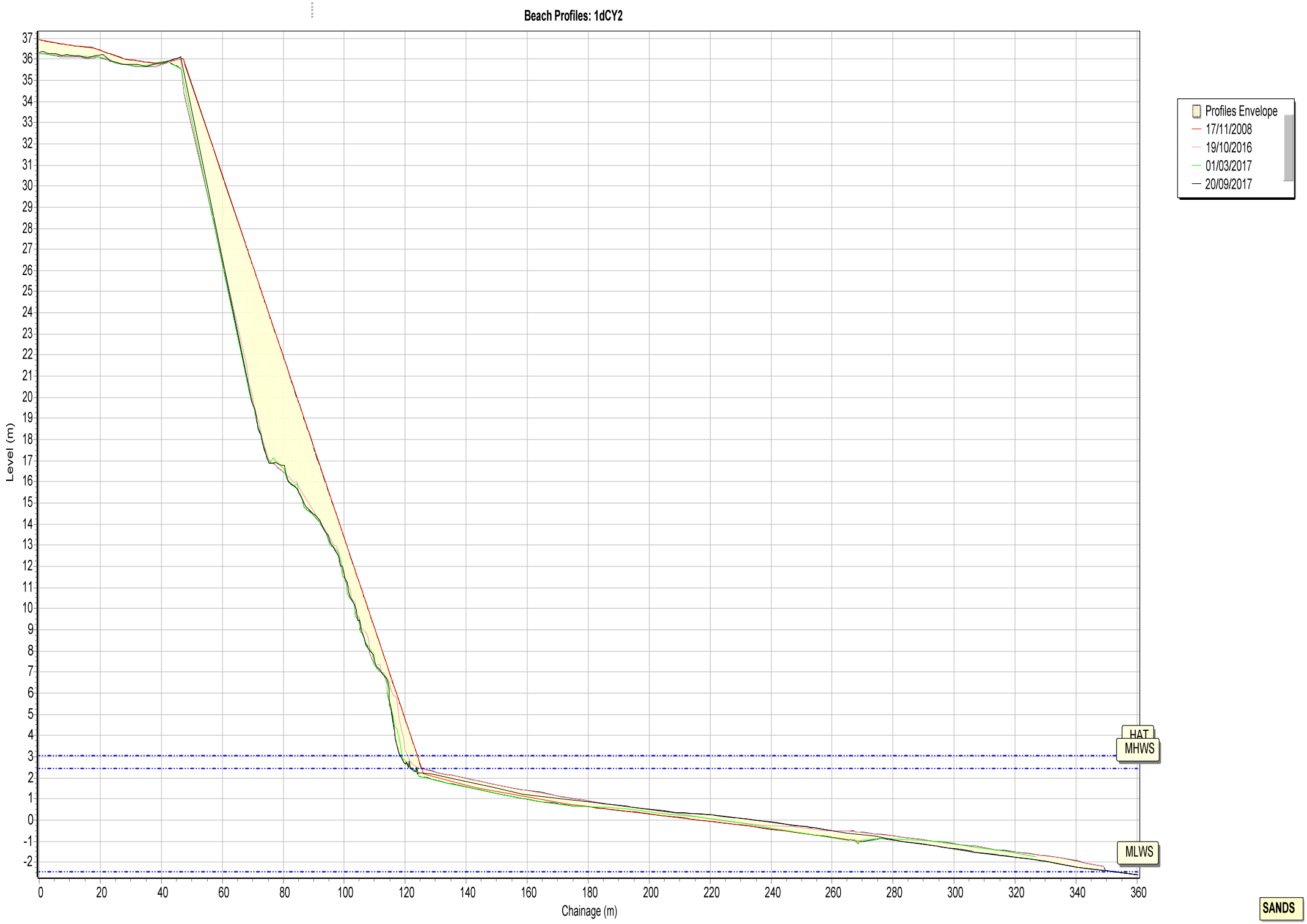
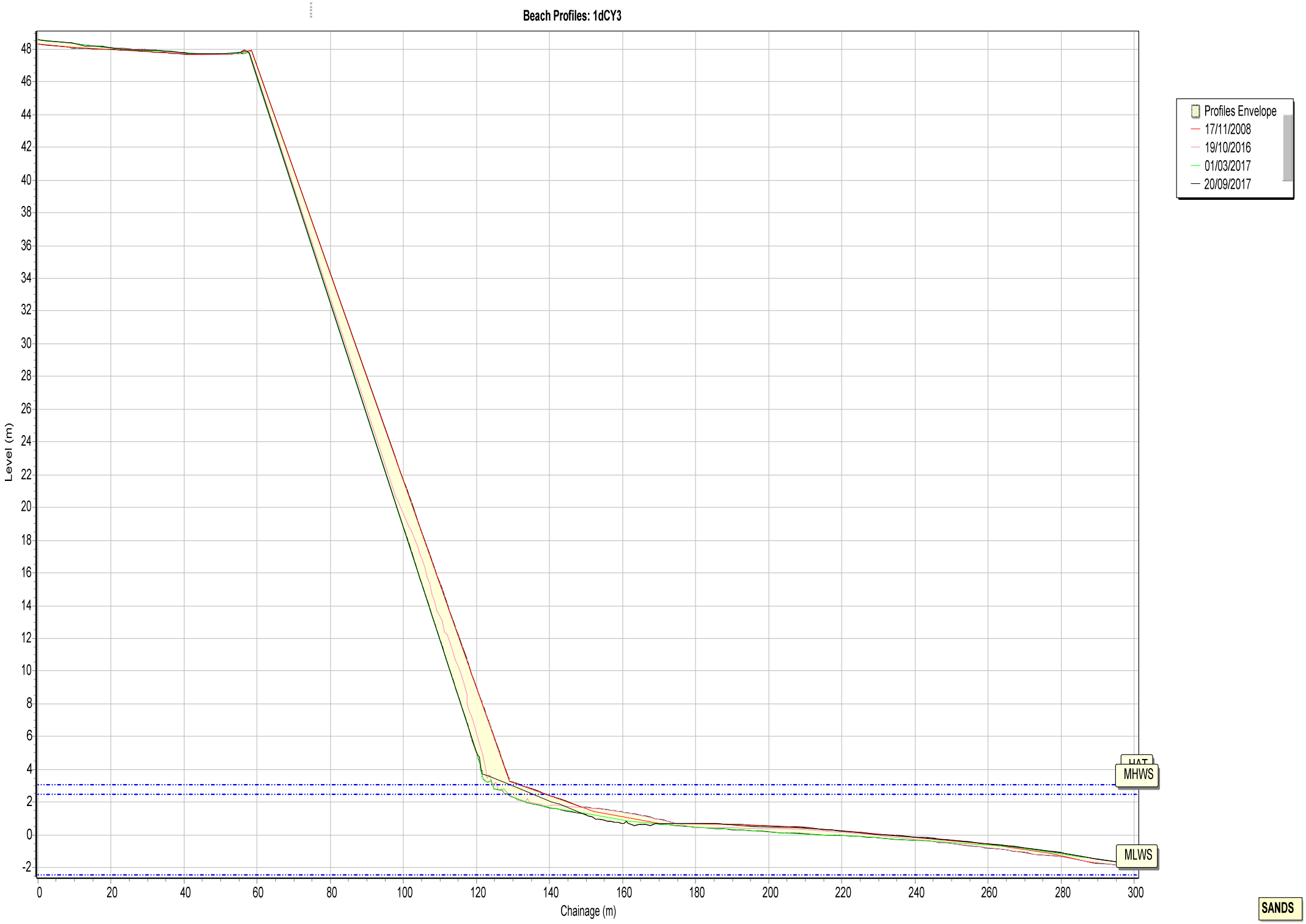
Profiles Envelope
17/11/2008
19/10/2016
01/03/2017
20/09/2017
Level (m)
Chainage (m)
SANDS


Beach Profiles: 1dCY1A
Profiles Envelope
12/11/2015
19/10/2016
01/03/2017
20/09/2017
Level (m)
Chainage (m)
SANDS


Beach Profiles: 1dCY2
Profiles Envelope
17/11/2008
19/10/2016
01/03/2017
20/09/2017
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS


Beach Profiles: 1dCY3
Profiles Envelope
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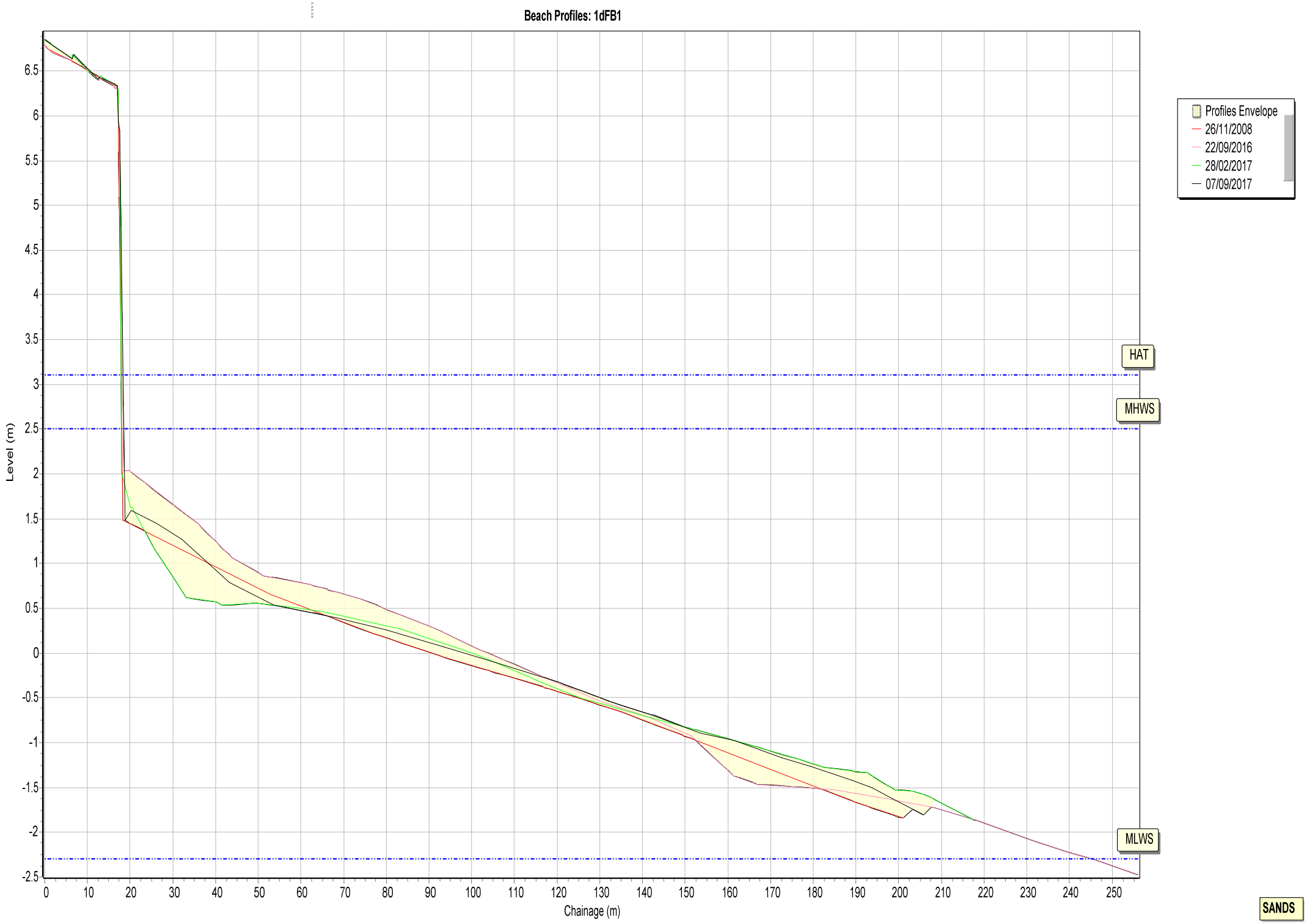
19/10/2016
01/03/2017
20/09/2017
Level (m)
Chainage (m)
MHWS
MLWS
SANDS


Beach Profiles: 1dFB1
Profiles Envelope
26/11/2008
22/09/2016
28/02/2017
07/09/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
6.5
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5.5
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2
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-1
-1.5
-2
-2.5
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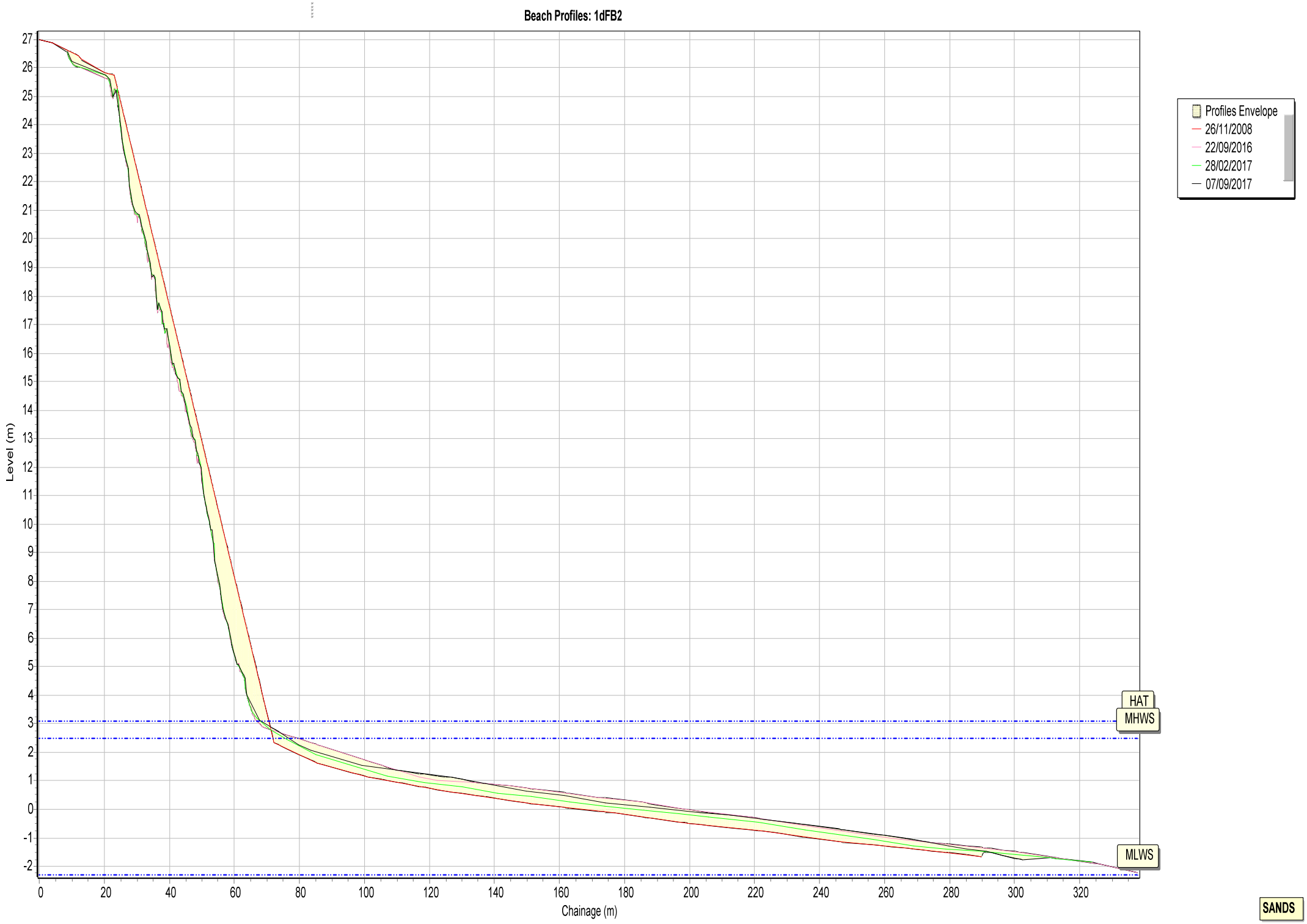
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HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
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-2
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300
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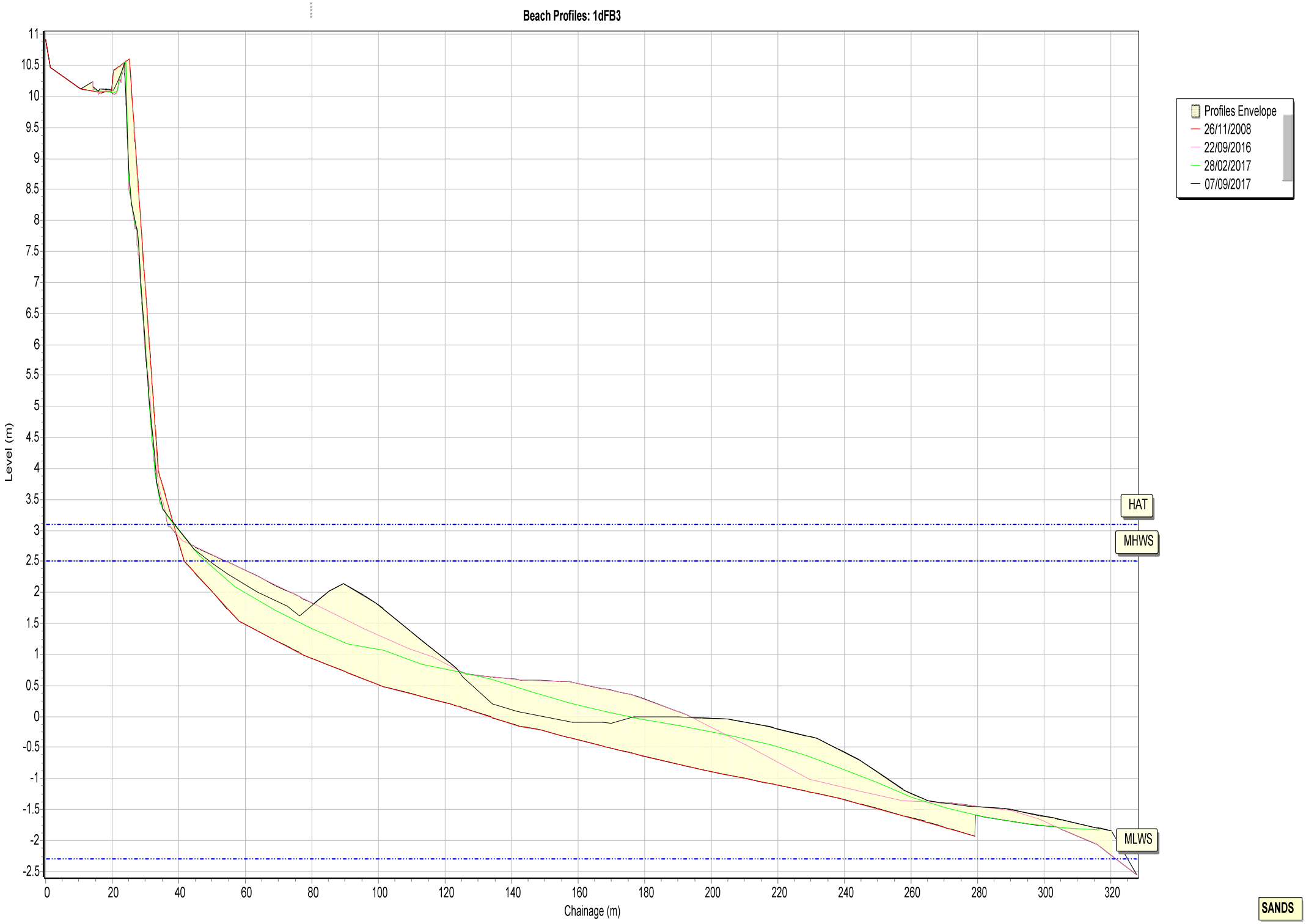
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Chainage (m)
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9
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6
5.5
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-1
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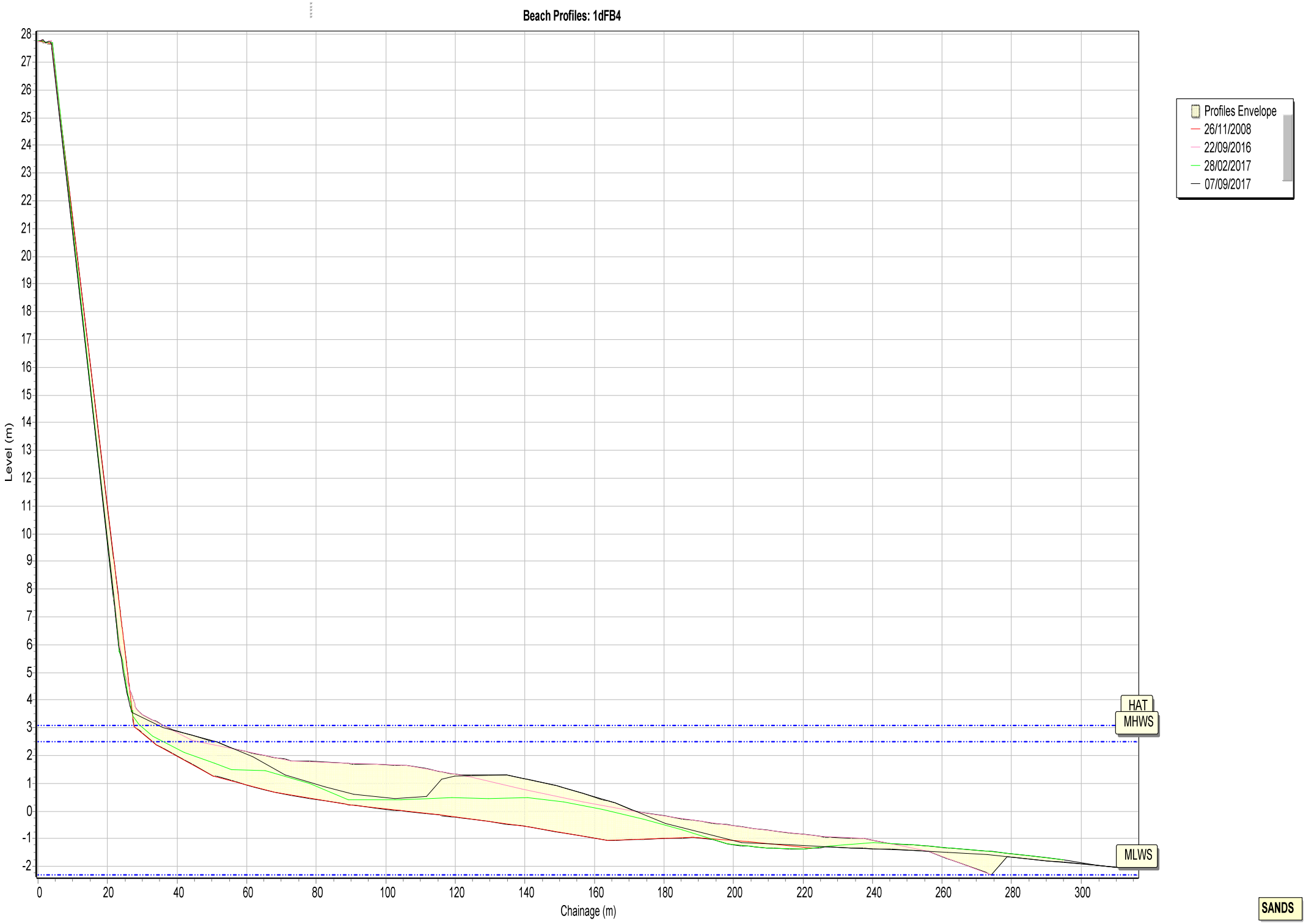
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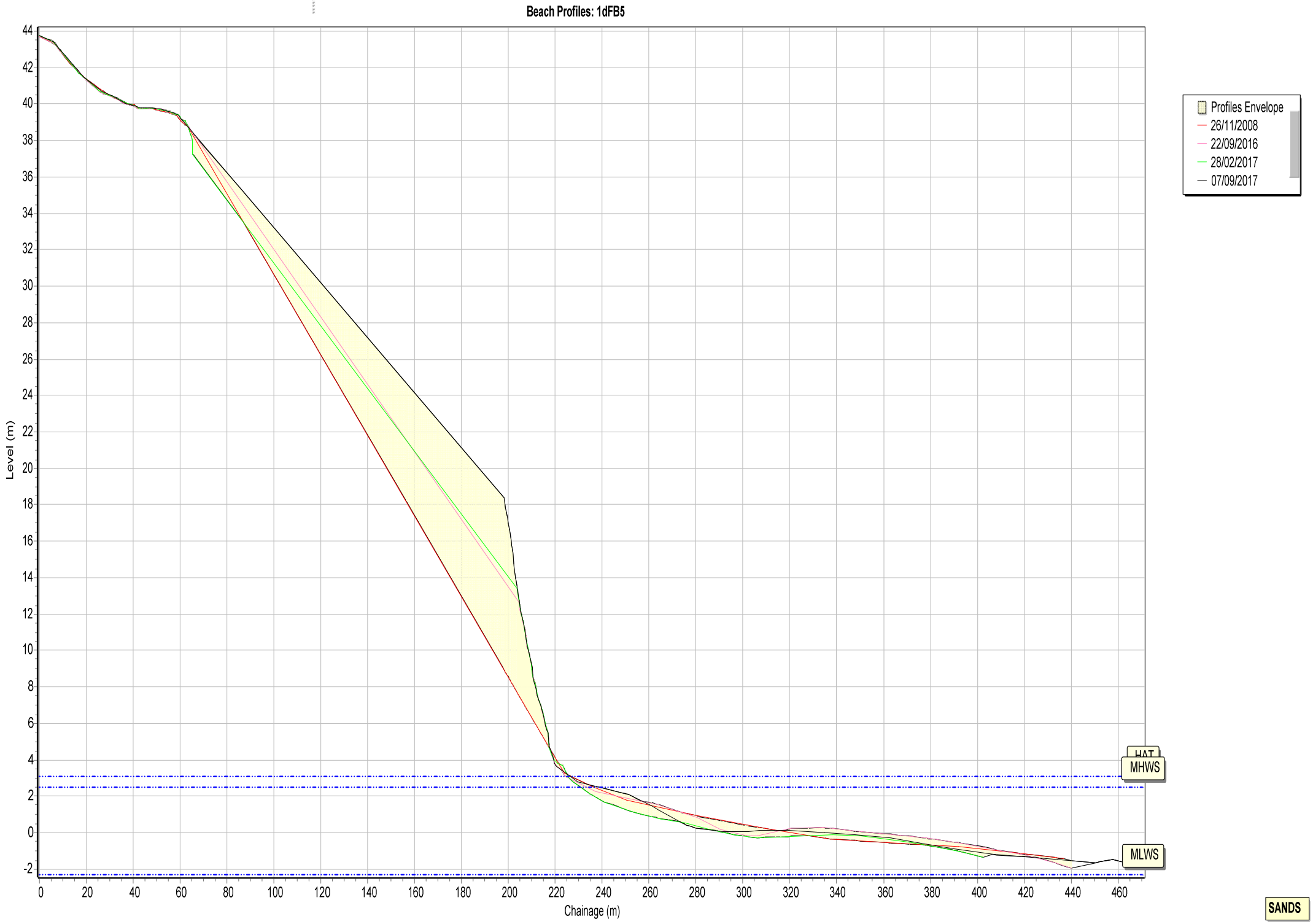
SANDS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Level (m)
Chainage (m)
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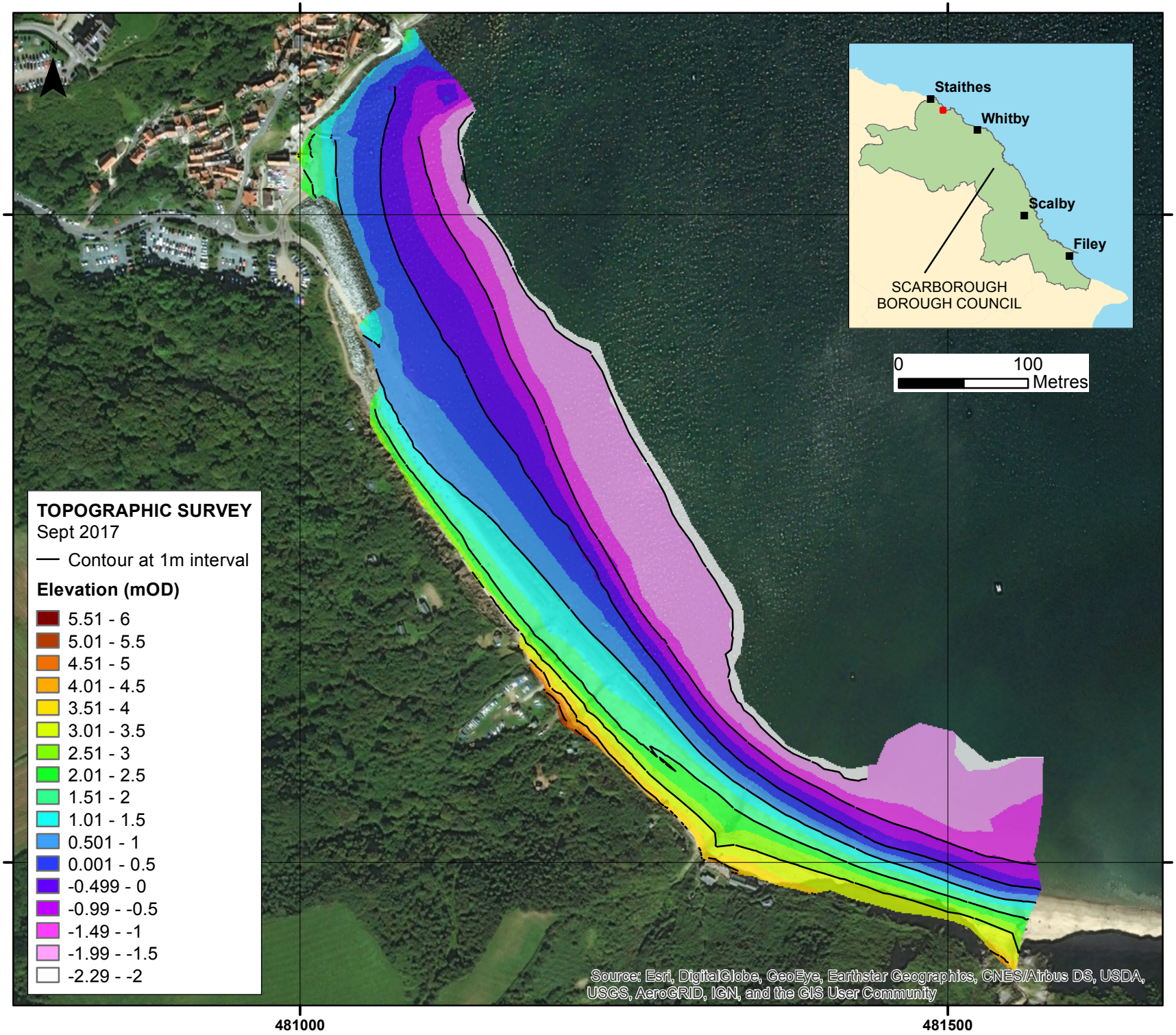
MLWS
SANDS

Appendix B

Topographic Survey



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1

RUNSWICK BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:4,000

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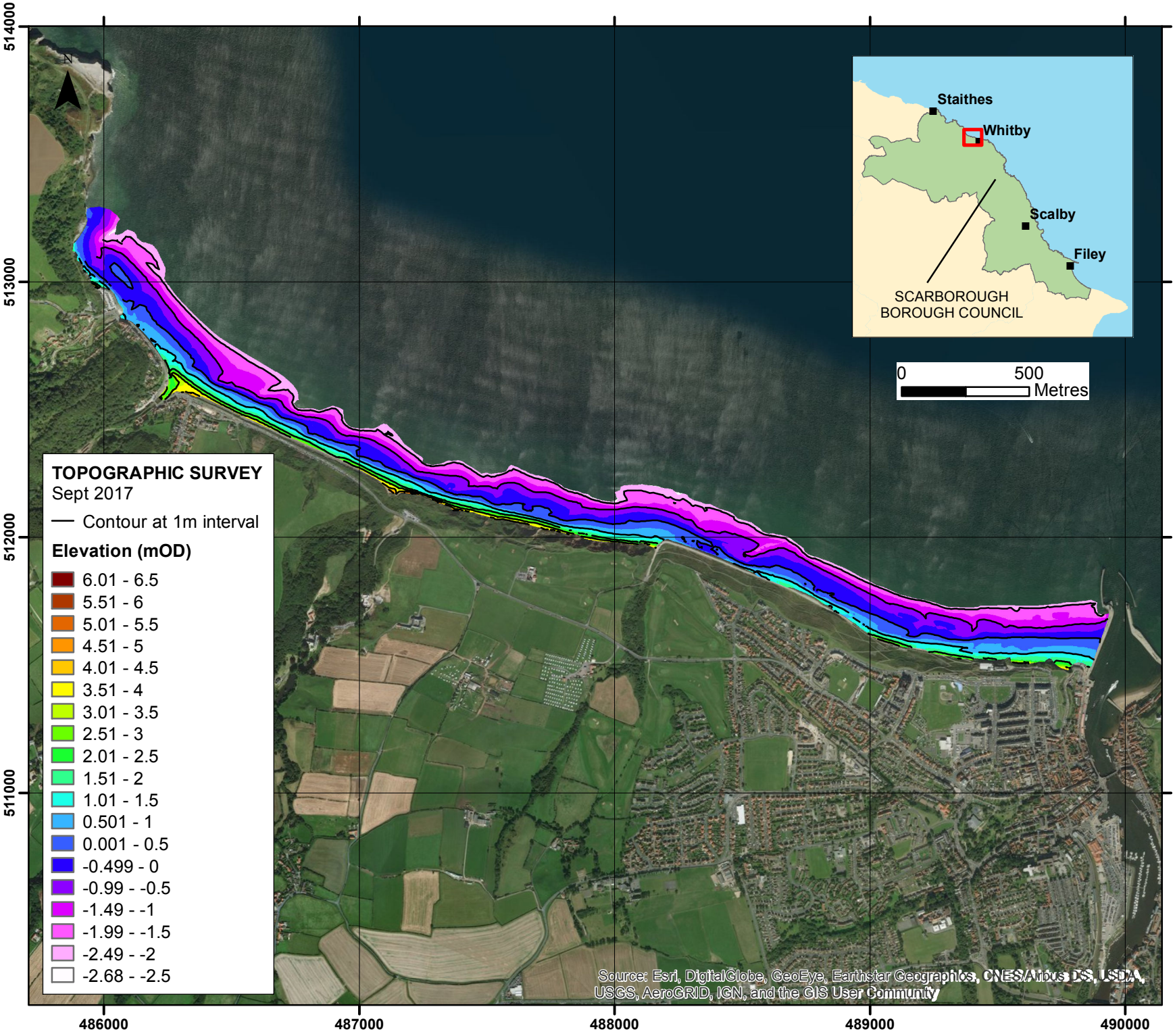

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2

SANDSEND

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:20,000

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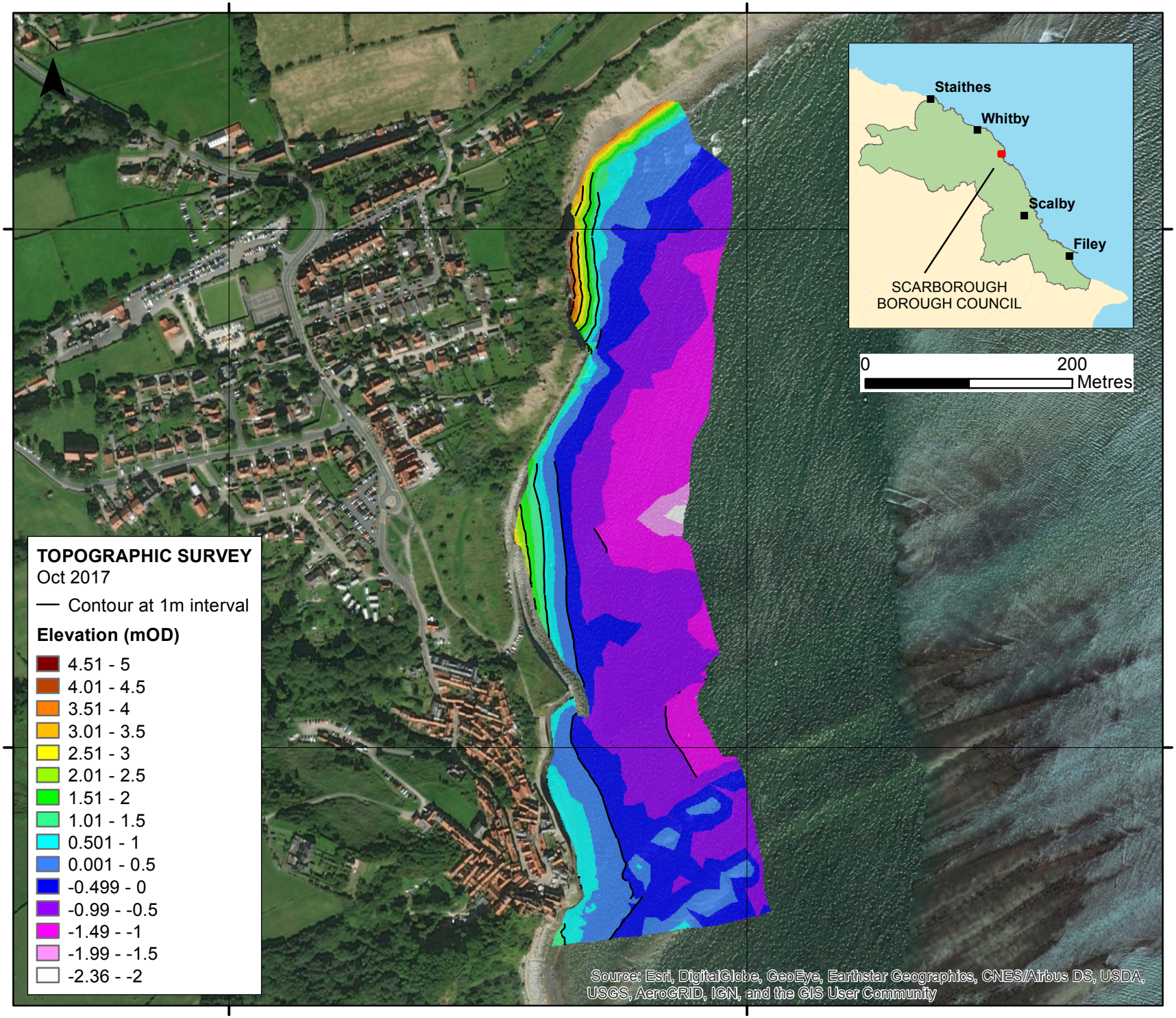

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3

ROBIN HOOD'S BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:5,000

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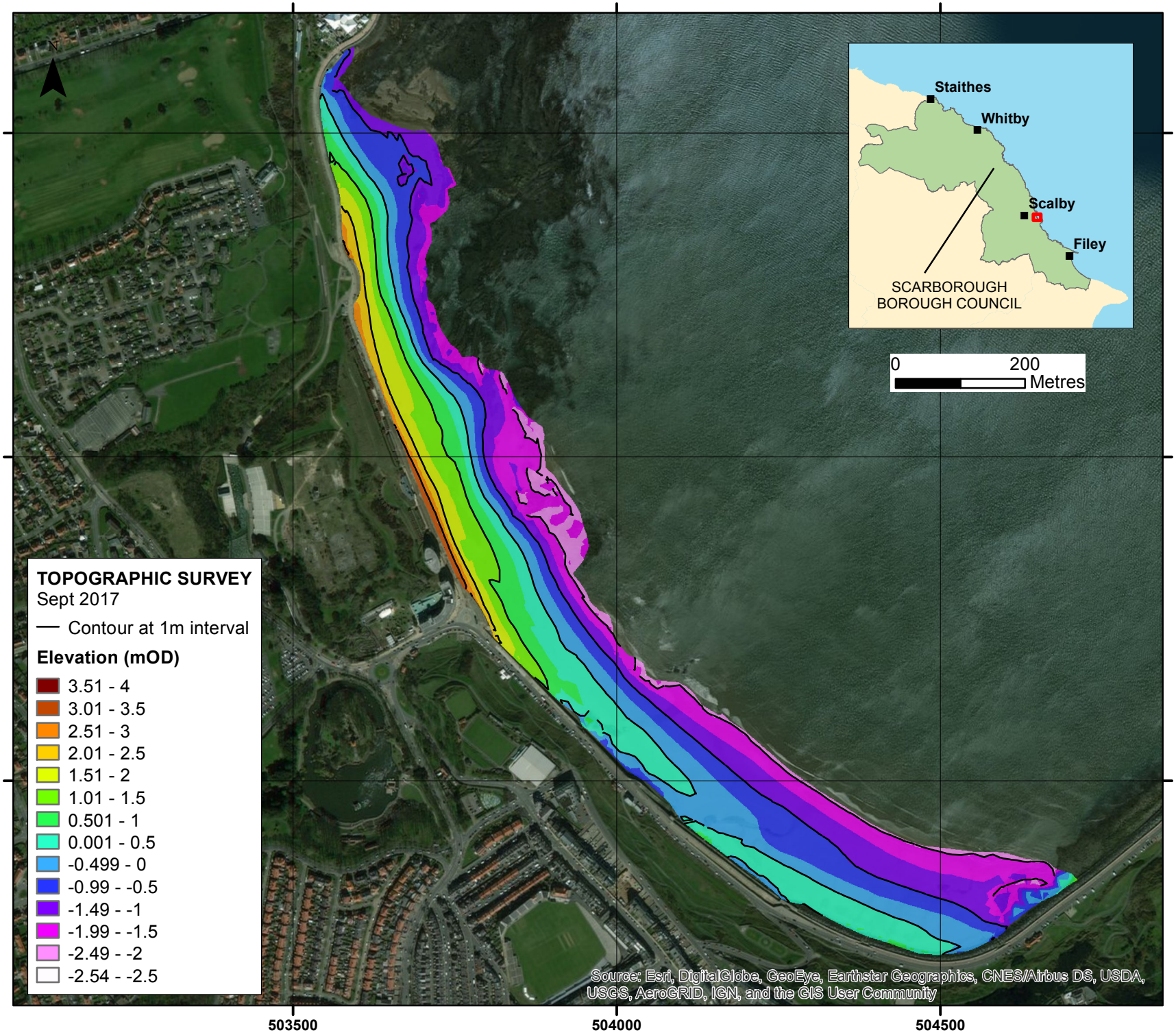

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

SCARBOROUGH NORTH BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:8,000

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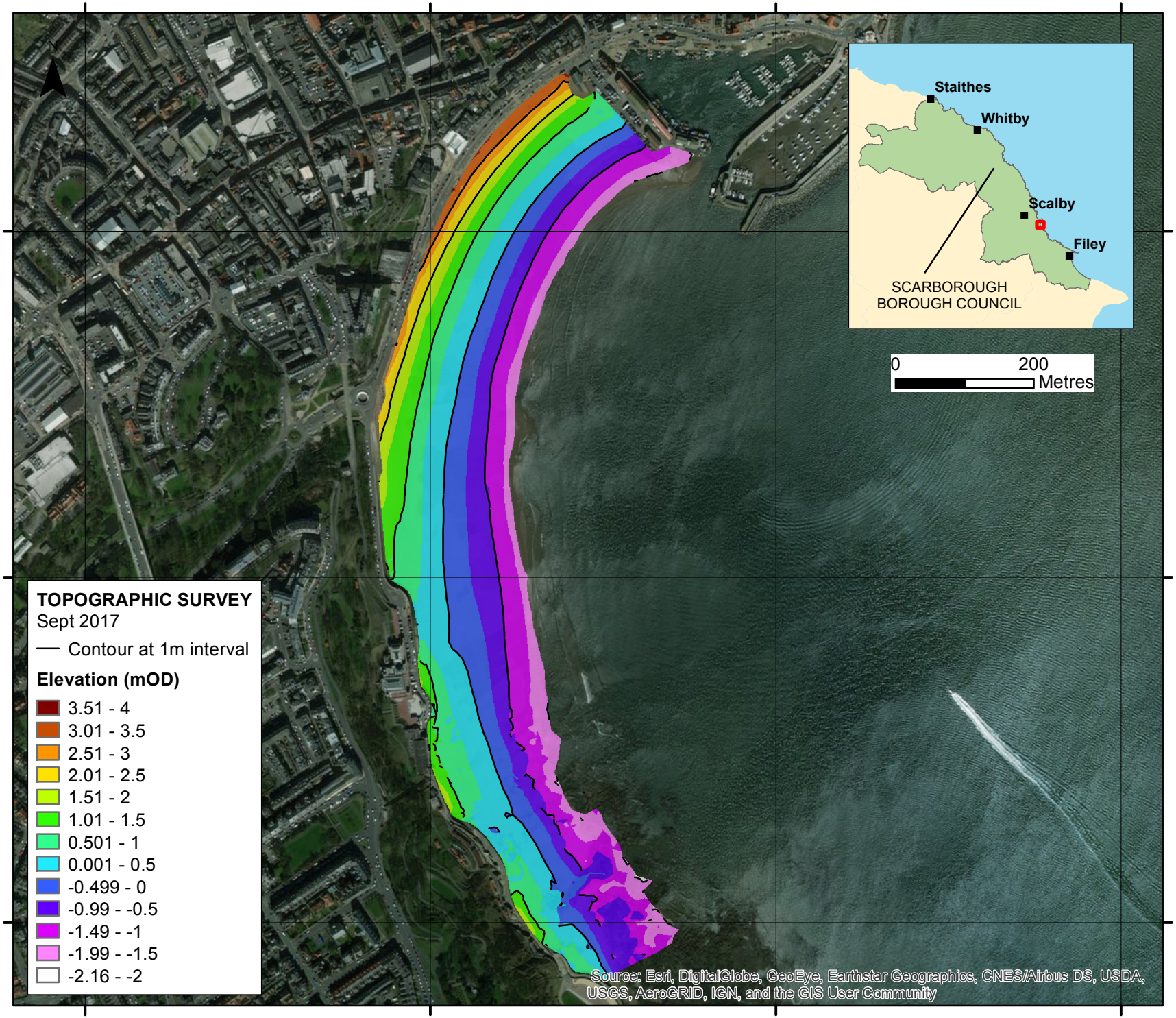

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 5

SCARBOROUGH SOUTH BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:7,500

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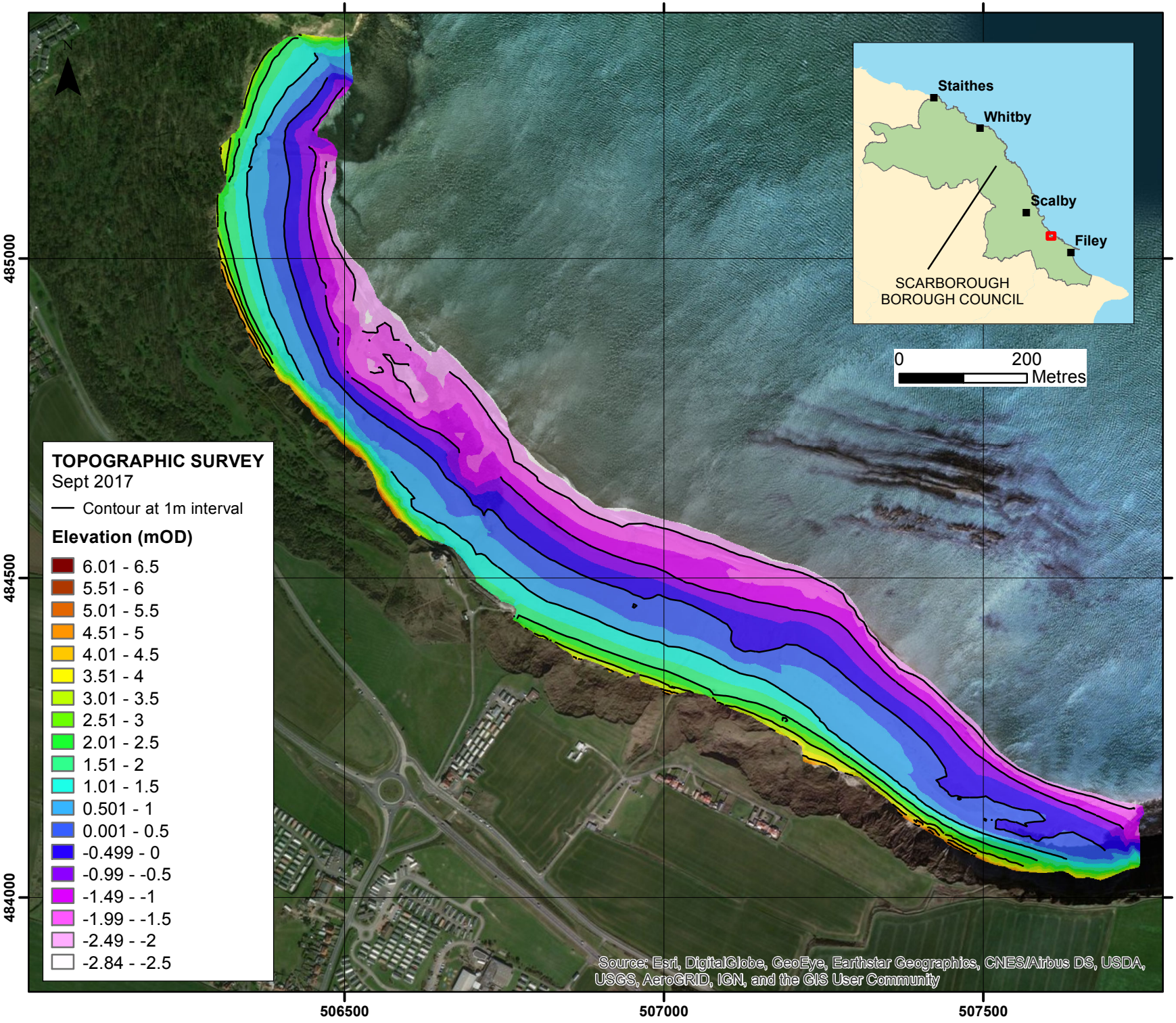

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 6

CAYTON BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:8,000

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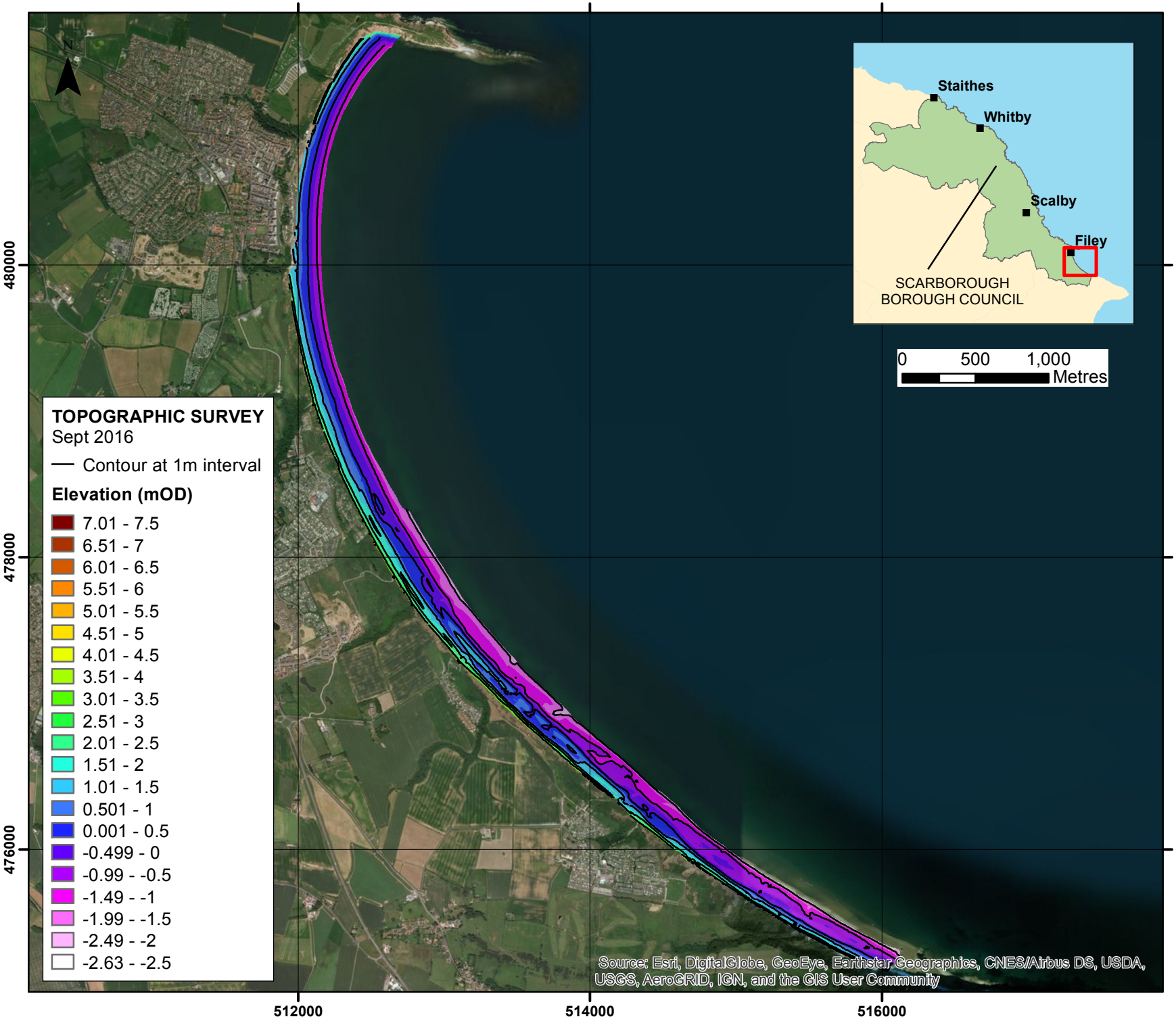

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 7

FILEY BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:35,000

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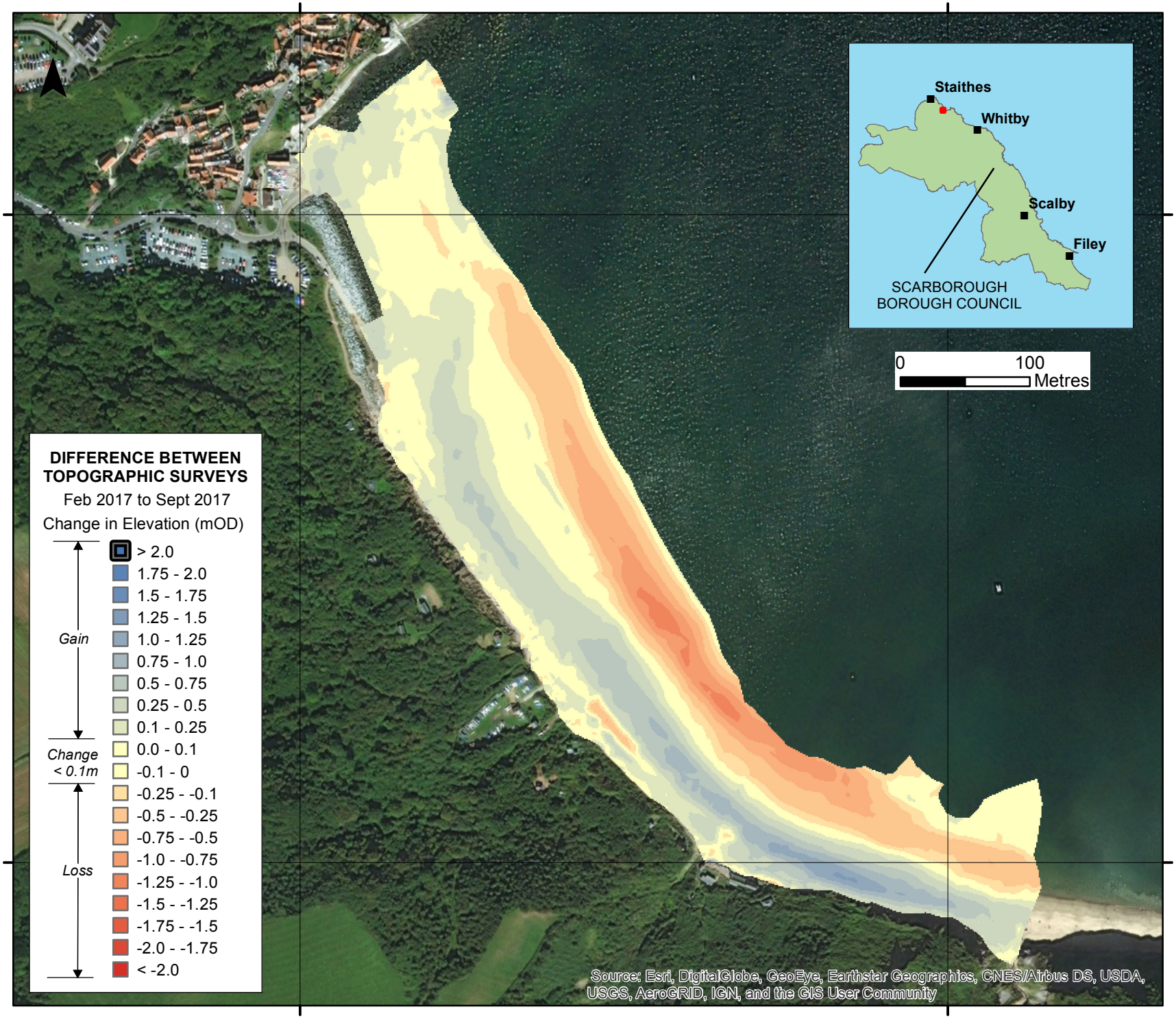

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 8

RUNSWICK BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:4,000

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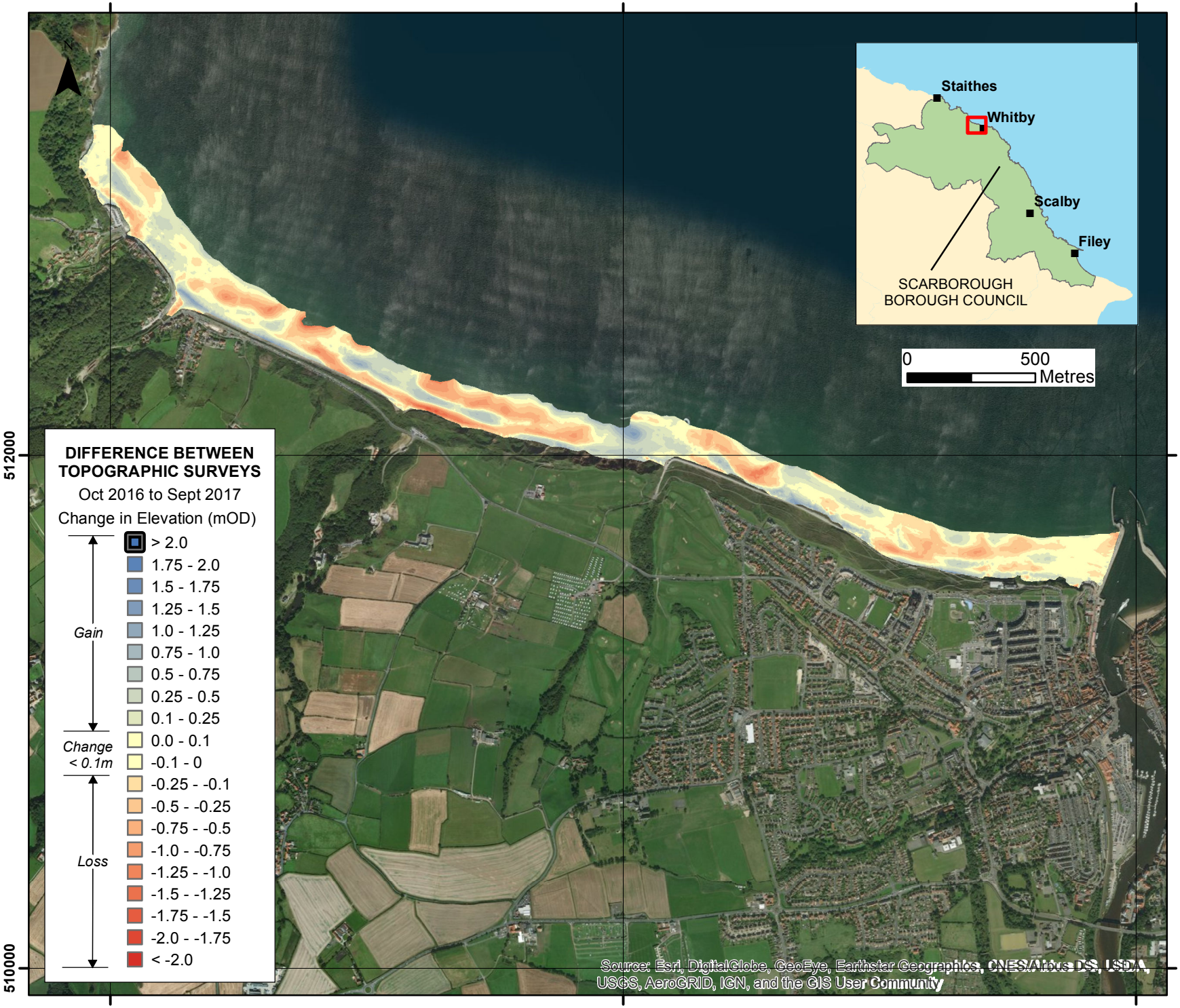

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 9

SANDSEND

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:20,000

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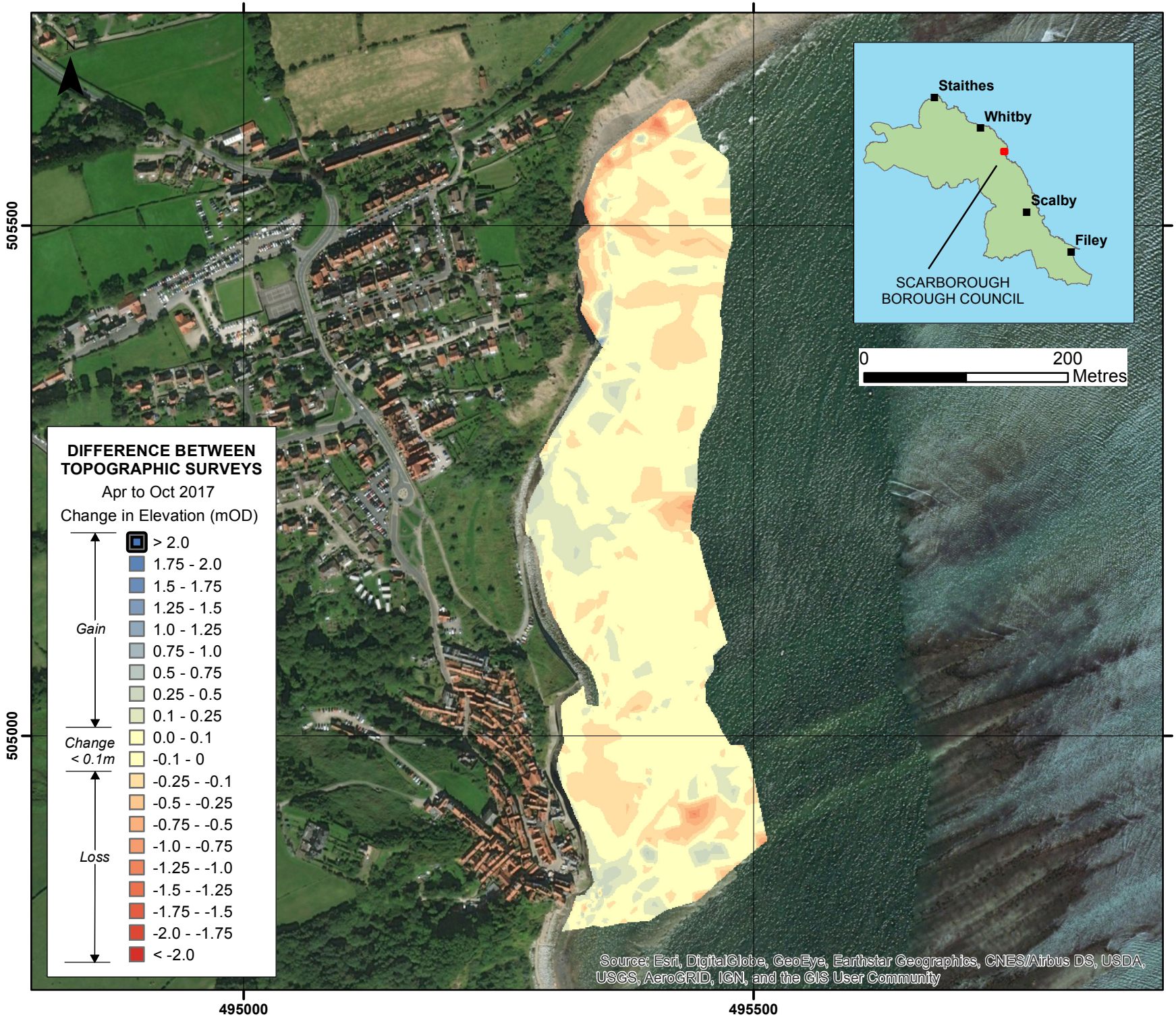

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 10

ROBIN HOOD'S BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:5,000

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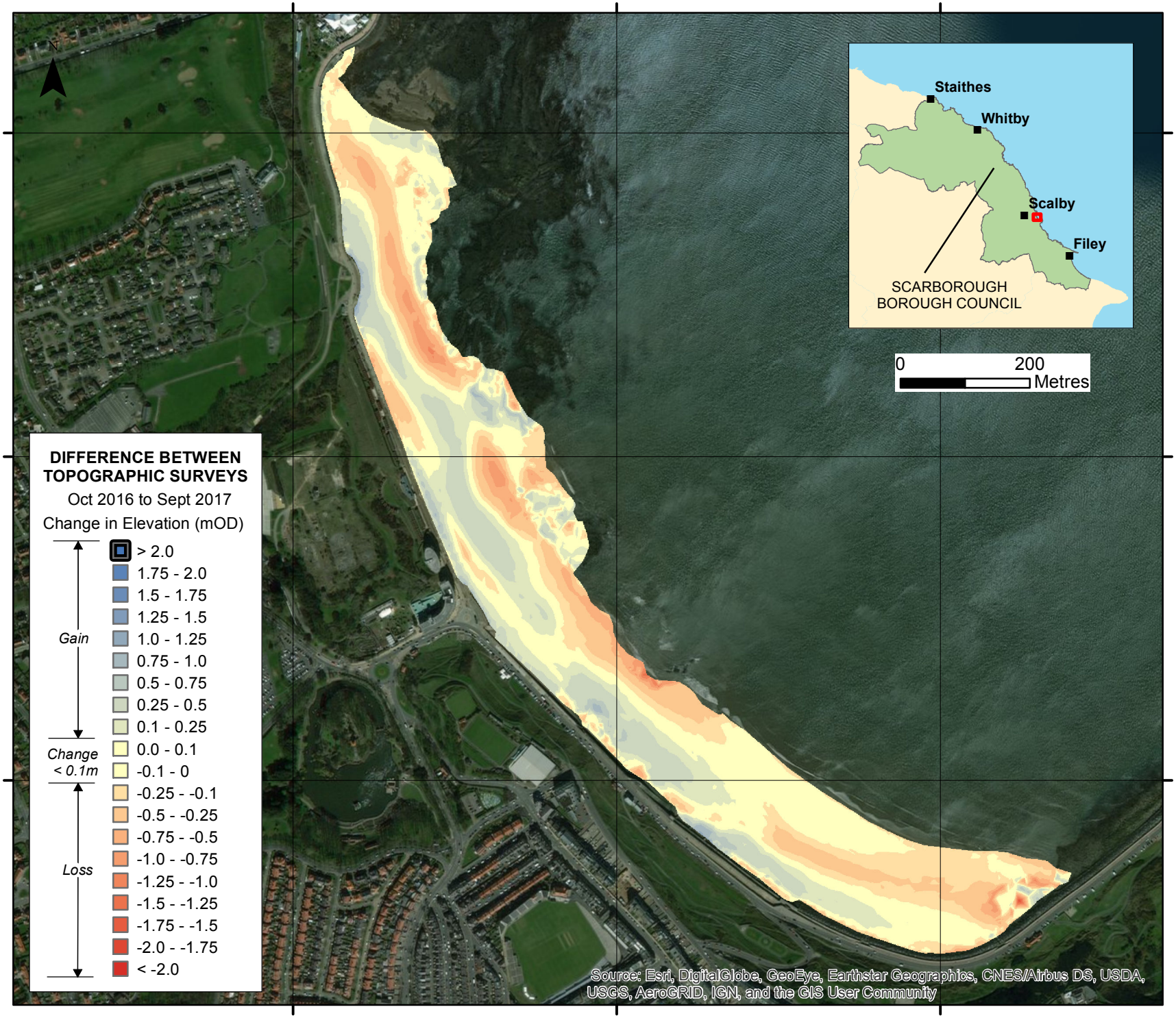

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 11

SCARBOROUGH NORTH BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:8,000

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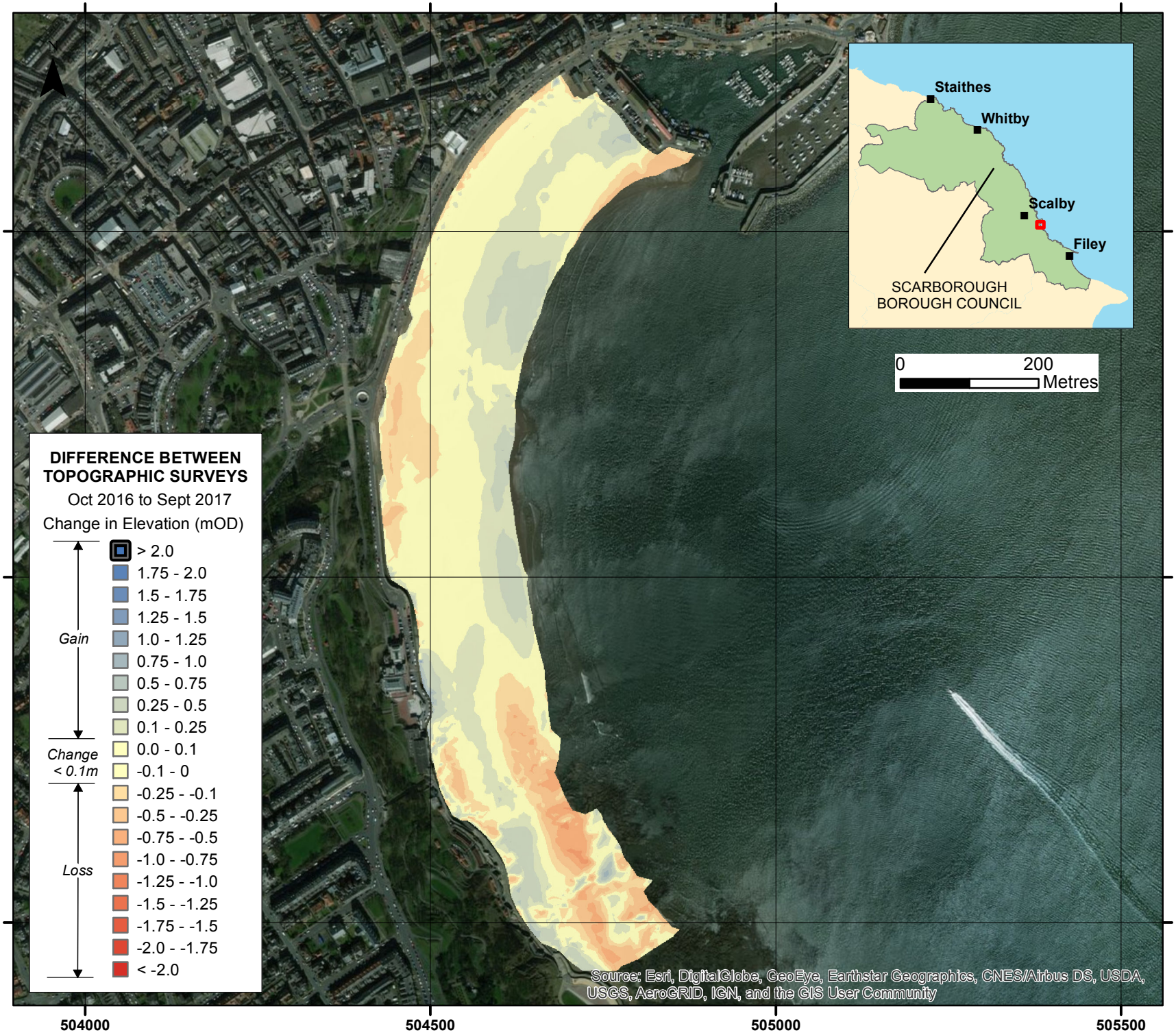

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 12

SCARBOROUGH SOUTH BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:7,500

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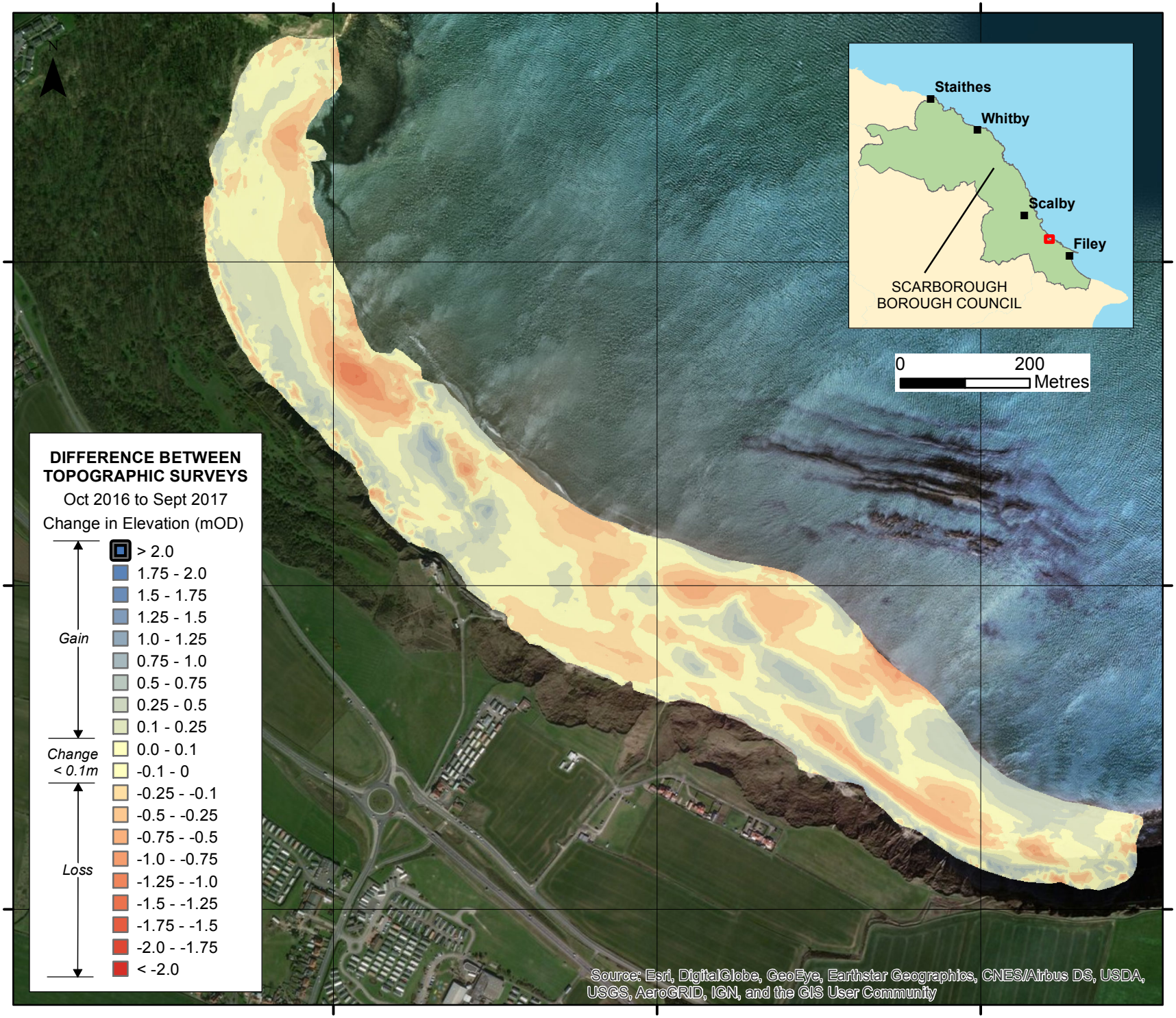

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 13

CAYTON BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:8,000

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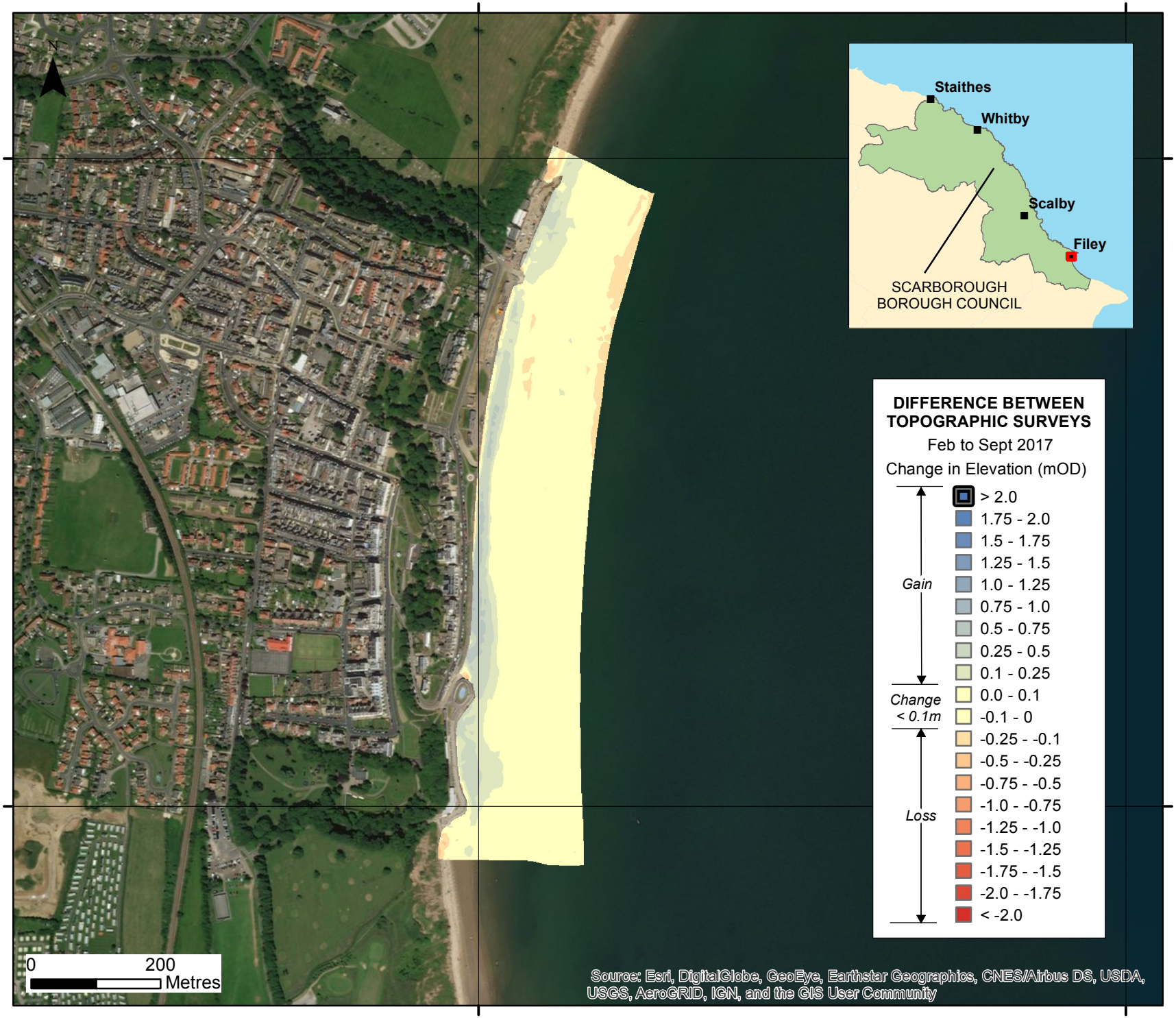

DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Feb to Sept 2017

Change in Elevation (mOD)

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
	-0.1 - 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

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 14

FILEY BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:8,000

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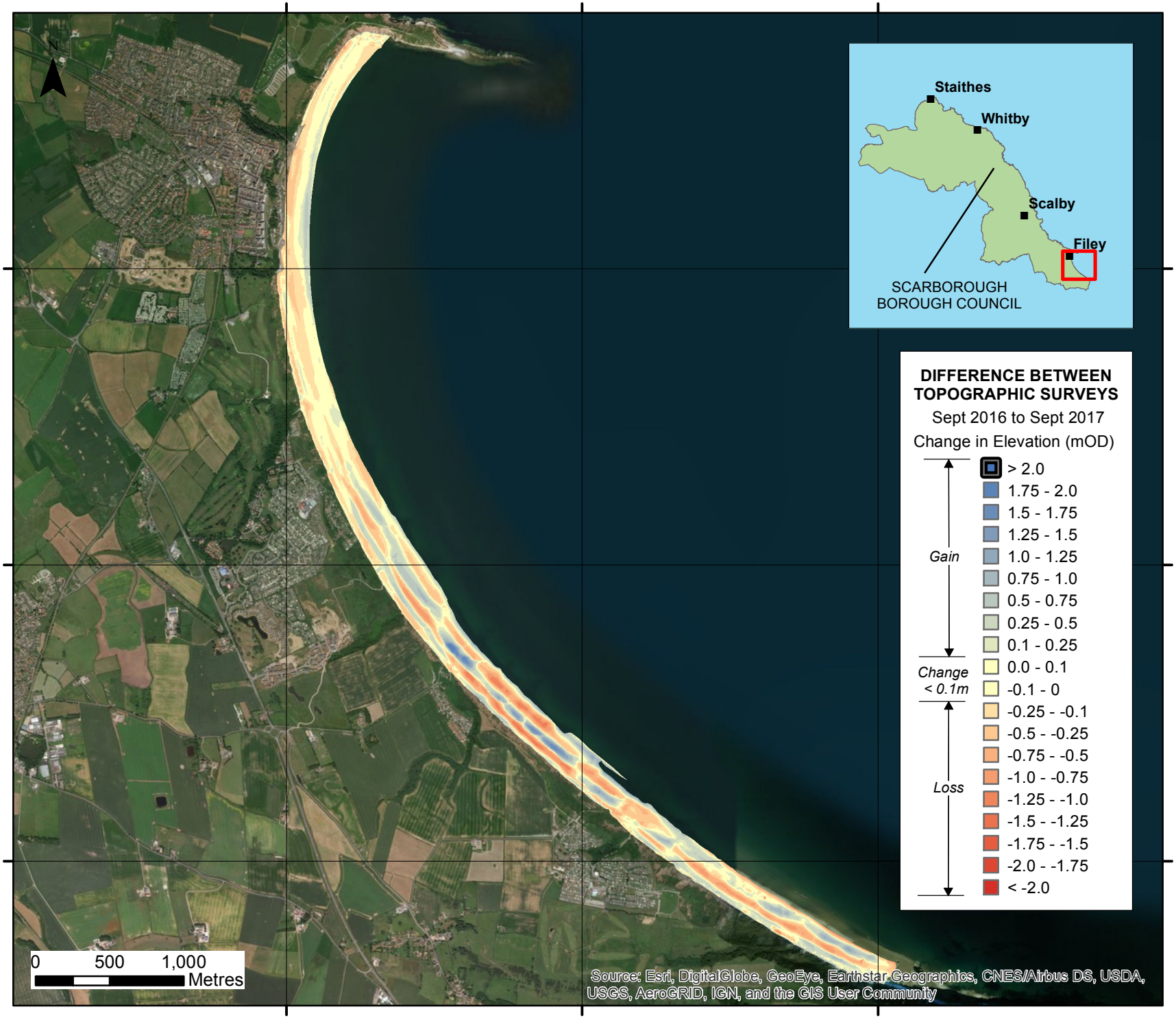

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 15

FILEY BAY

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:35,000

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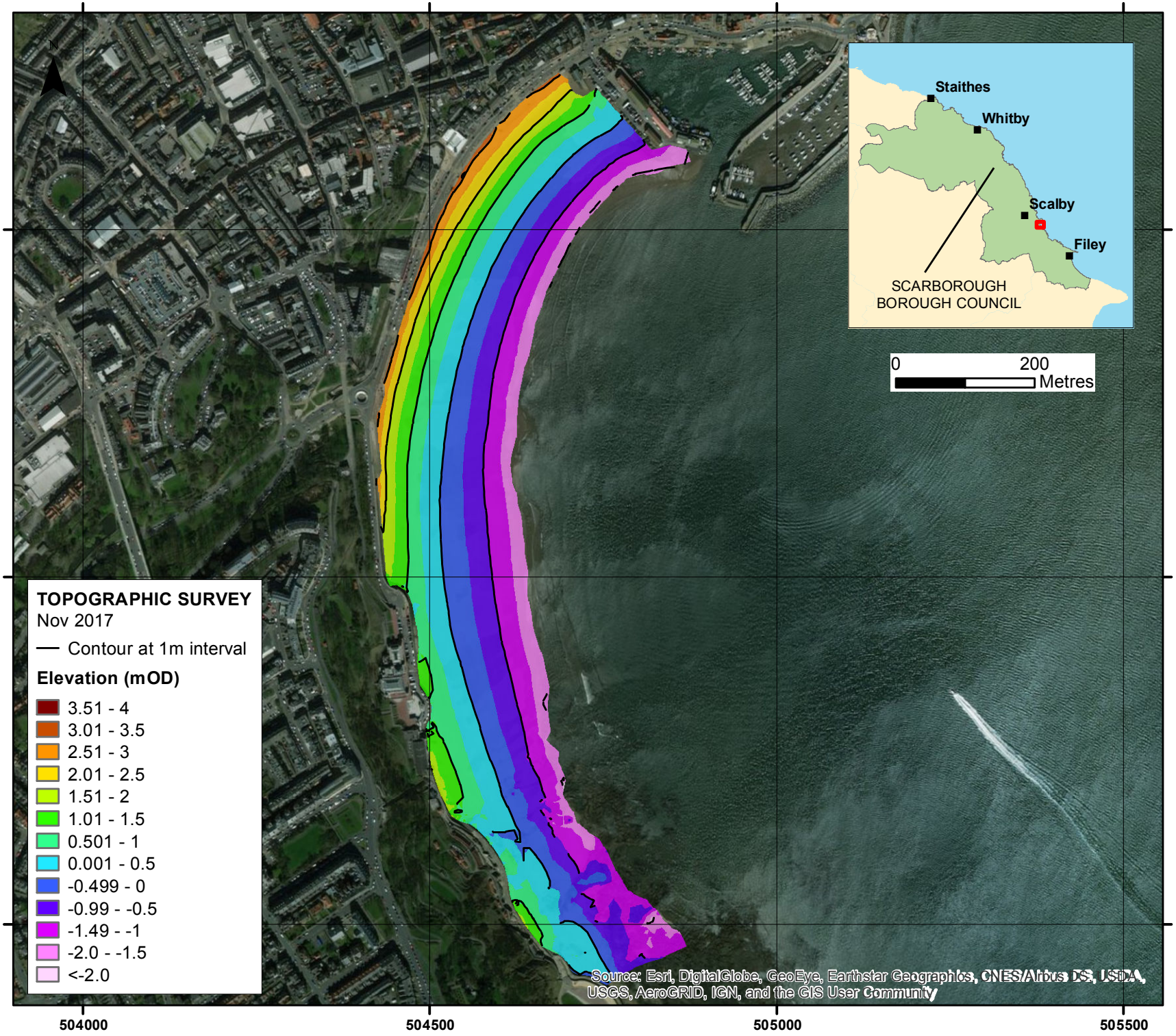

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 5

SCARBOROUGH SOUTH BAY

Post Sand Movement

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:7,462

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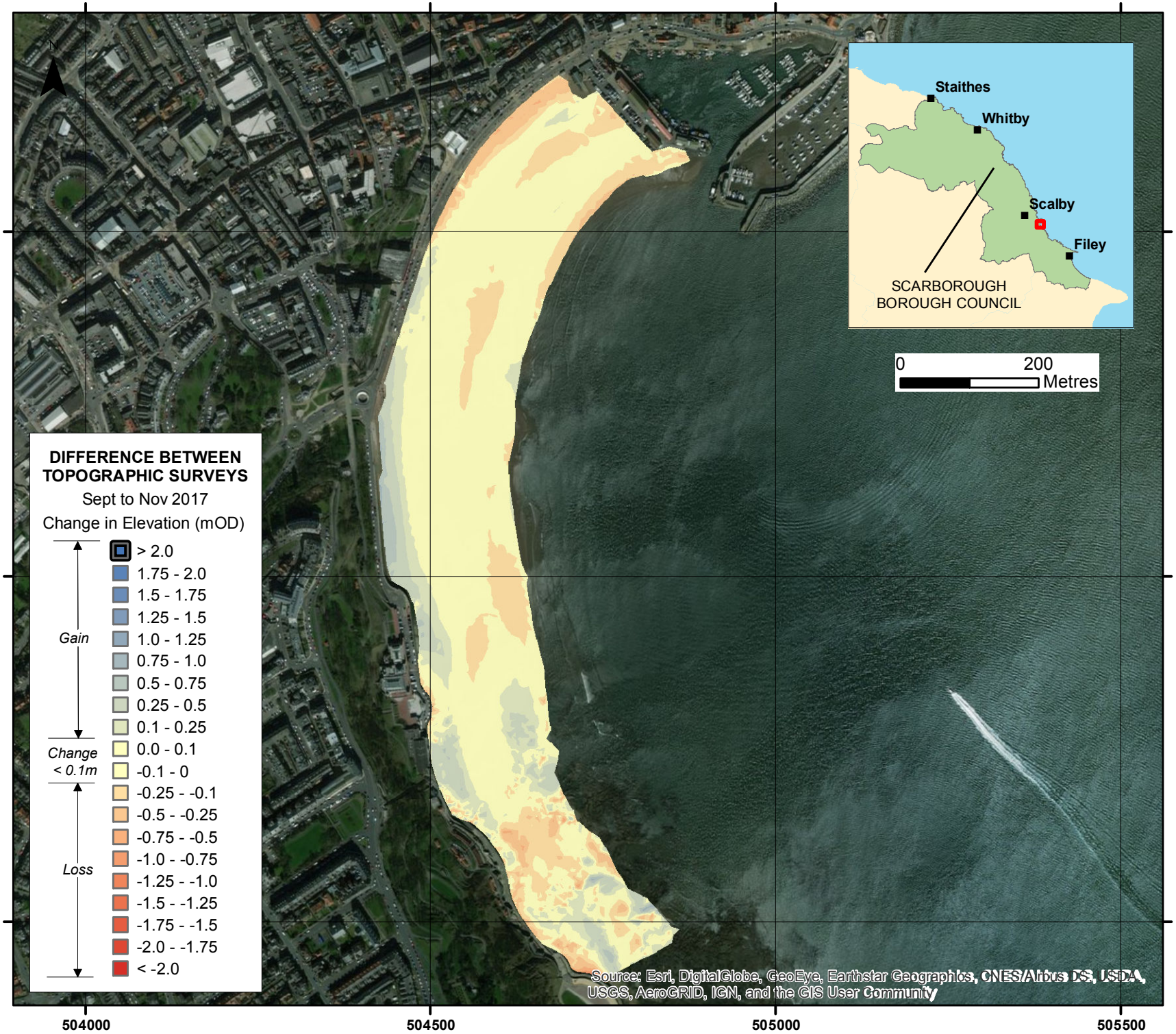

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 17

SCARBOROUGH SOUTH BAY

Post Sand Movement

Scarborough Borough Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:7,500

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Appendix C

Cliff Top Survey

Cliff Top Survey

Staithes

Twenty ground control points have been established within Staithes (Figure C1). The maximum separation between any two points is nominally 100m. The cliff top surveys at Staithes are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Table C1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C1 – Cliff Top Surveys at Staithes

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
STAITHES				Nov 2008	Mar 2017	Sep 2017	Nov 2008 - Sep 2017	Mar 2017 - Sep 2016	Nov 2008 - Sep 2017
1	477228	518769	320	1.9	-0.13	-0.15	2.05	0.02	0.23
2	477334	518798	0	10.9	10.74	10.74	0.16	0.00	0.02
3	477487	518789	350	7.1	8.35	8	-0.90	0.35	0.00
4	477594	518801	340	5.9	4.35	4.26	1.64	0.09	0.18
5	477683	518911	350	8.4	8.73	8.73	-0.33	0.00	0.00
6	477792	518867	30	8.6	8.35	8.41	0.19	-0.06	0.02
7	477891	518828	60	7.7	7.31	7.34	0.36	-0.03	0.04
8	477959	518873	350	8.7	9.61	9.64	-0.94	-0.03	0.00
9	478088	518950	350	7.6	No Access	No Access	No Access	0	-0.06
10	478191	519023	340	8.4	No Access	No Access	No Access	0	-0.04
11	478237	519007	60	6.9	No Access	No Access	No Access	0	0.02
12	478213	518988	150	6.1	No Access	No Access	No Access	0	-0.14
13	478501	518809	15	11.4	9.07	9.03	2.37	0.04	0.26
14	478624	518807	20	7.5	7.51	7.46	0.04	0.05	0.00
15	478737	518858	60	6.1	6.23	6.16	-0.06	0.07	0.00
16	478823	518757	60	8	8.65	8.67	-0.67	-0.02	0.00

17	478944	518671	30	9.3	9.29	9.21	0.09	0.08	0.01
18	479052	518630	20	9.2	9.36	9.25	-0.05	0.11	0.00
19	479147	518610	0	14.2	14.41	14.37	-0.17	0.04	0.00
20	479274	518618	20	11.4	11.4	11.33	0.07	0.07	0.01

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.

Note: Shaded cells use the April 2016 Partial measures survey data for calculations as access was unavailable for the 2016 full measures survey.

Robin Hoods Bay

Thirteen ground control points have been established within Robin Hoods Bay (Figure C1). The maximum separation between any two points is nominally 200m. The cliff top surveys at Robin Hoods Bay are undertaken 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 Robin Hoods Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
ROBIN HOODS BAY				Mar 2010	Apr 2017	Oct 2017	Mar 2010 - Oct 2017	Apr 2017 - Oct 2017	Mar 2010 - Oct 2017
1	495799.5	506002.2	130	11.6	7.19	7.27	4.33	-0.08	0.62
2	495549.2	505807.3	135	9.3	8.93	9.03	0.27	-0.10	0.04
3	495456.3	505740	130	5	4.98	4.93	0.07	0.05	0.01
4	495389.9	505683.7	140	6.3	5.98	6.04	0.26	-0.06	0.04
5	495259.4	505342.5	130	11.3	11.81	12.04	-0.74	-0.23	0.00
6	495231.2	505315.7	95	5.9	5.78	5.75	0.15	0.03	0.02
7	495184.8	505210.7	85	6.4	6.7	6.76	-0.36	-0.06	0.00
8	495206.5	505153	75	5	5.16	5.16	-0.16	0.00	0.00
9	495287.8	505060.5	80	4.3	4.58	4.59	-0.29	-0.01	0.00
10	495187.8	504708.8	70	3.1	2.42	2.48	0.62	-0.06	0.09
11	495226.2	504615.7	120	3.8	3.88	3.64	0.16	0.24	0.02
12	495297.5	504380.2	80	11	10.91	11.08	-0.08	-0.17	0.00
13	495350.4	504193	55	3.7	3.77	3.75	-0.05	0.02	0.00

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.

Scarborough South Bay

Thirteen ground control points have been established between Scarborough South Bay and Cayton Bay (Figure C1). The maximum separation between any two points is nominally 300m. The cliff top surveys at Scarborough South Bay are undertaken 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 2010 (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 Scarborough South

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
SCARBOROUGH SOUTH BAY				Mar 2010	Mar 2017	Sep 2017	Mar 2010-Sep 2017	Mar 2017 - Sep 2017	Mar 2010-Sep 2017
1	504339.5	487887.3	70	7	6.93	6.93	0.07	0.00	0.01
2	504422.3	487603.7	80	4.8	4.8	4.8	0.00	0.00	0.00
3	504534.8	487318.3	40	15.1	15.02	15.03	0.07	-0.01	0.01
4	504730.2	487137.9	55	9.6	9.62	9.6	0.00	0.02	0.00
5	504922.9	486837.8	60	8.8	8.71	8.7	0.10	0.01	0.01
6	50571.1	486652.1	75	3.8	3.69	3.68	0.12	0.01	0.02
7	505284.3	486480	35	7	6.72	6.7	0.30	0.02	0.04
8	505597.9	486363.4	30	8.6	8.48	8.45	0.15	0.03	0.02
9	505758.6	486005.1	45	9.1	8.71	8.58	0.52	0.13	0.07
10	505896	485889.6	15	14.8	14.83	14.84	-0.04	-0.01	0.00
11	505990	485657.1	80	4.7	1.32	1.33	3.37	-0.01	0.48
12	506024.9	485421.8	55	6.1	3.31	3.27	2.83	0.04	0.40
13	506036	485315.3	90	7	7.1	7.08	-0.08	0.02	0.00

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.

Cayton Bay

Eight ground control points have been established within Cayton Bay (Figure C1). The maximum separation between any two points is nominally 300m. The cliff top surveys at Cayton Bay are undertaken annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Table C4 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 C4 – Cliff Top Surveys at Cayton Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
CAYTON BAY				Nov 2008	Mar 2017	Sep 2017	Nov 2008 - Sep 2017	Mar 2017 - Sep 2017	Nov 2008 - Sep 2017
1	506325.5	484849.7	50	4	3.61	3.6	0.40	0.01	0.04
2	506459.4	484715.9	65	5	-0.08	-0.02	5.02	-0.06	0.56
3	506597.4	484538.6	65	5	6.26	6.25	-1.25	0.01	0.00
4	506778.1	484345.5	21	9	5.97	5.96	3.04	0.01	0.34
5	507018.6	484221.6	342	7.7	7.89	7.88	-0.18	0.01	0.00
6	507242.3	484121.7	2	7.4	6.2	6.17	1.23	0.03	0.14
7	507518.2	484008.2	25	7.5	7.65	7.64	-0.14	0.01	0.00
8	507818.7	484006	1	5.5	5.47	5.46	0.04	0.01	0.00

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.

Filey Bay

Twenty-seven ground control points have been established within Filey Bay (Figure C1). The maximum separation between any two points is nominally 300m. The cliff top surveys at Filey Bay are undertaken annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Table C5 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 C5 – Cliff Top Surveys at Filey Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
FILEY				Nov 2008	Mar 2017	Sep 2017	Nov 2008 - Sep 2017	Mar 2017 - Sep 2017	Nov 2008 - Sep 2017
1	512444.9	481630.9	130	8.7	8.42	8.41	0.29	0.01	0.03
2	512306.7	481490.3	144	7.6	7.87	7.92	-0.32	-0.05	0.00
3	512153.6	481234.6	122	8.3	8.14	8.2	0.10	-0.06	0.01
4	512029.2	480959.9	115	7.4	7.27	7.27	0.13	0.00	0.01
5	511895.4	479888	89	7.1	0.66	0.65	6.45	0.01	0.72
6	511908.5	479597.1	48	6.7	5.66	5.6	1.10	0.06	0.12
7	511991.4	479310.4	69	6.7	4.37	4.26	2.44	0.11	0.27
8	512083.4	478981.5	66	10.2	10.12	10.16	0.04	-0.04	0.00
9	512121.3	478786.3	76	8.3	8.39	8.35	-0.05	0.04	0.00
10	512226.2	478547.9	74	7.5	7.17	7.13	0.37	0.04	0.04
11	512471.4	478153.5	53	6.6	7.54	7.81	-1.21	-0.27	0.00
12*	512558.9	477901.9	66	7.7	7.17	No Data	No Data	No Data	No Data
12A*	512655.8	477822.4	67	13.9	13.33	12.97	0.93	0.36	0.10
13**	512697.6	477719	34	4.2	No Data	No Data	No Data	No Data	No Data
13A*	512805.5	477572.1	32	13.42	13.35	13.38	0.04	-0.03	0.00
14	512939.4	477400.9	66	8	6.51	6.45	1.55	0.06	0.17
15	513157	477192.7	51	5.2	4.59	4.61	0.59	-0.02	0.07
16	513299.5	477024.6	30	7.7	7.05	7.05	0.65	0.00	0.07
17	513507.7	476821.1	34	10.7	10.5	10.51	0.19	-0.01	0.02

18	513721	476602.3	31	7.2	6.16	6.25	0.95	-0.09	0.11
19	513916.6	476354.1	51	6.6	6.15	6.15	0.45	0.00	0.05
20	514174.8	476179.4	32	7	6.73	6.86	0.14	-0.13	0.02
21	514471.5	475965.7	66	7.6	7.44	7.42	0.18	0.02	0.02
22	514656.2	475728.8	101	8.1	8.15	8.07	0.03	0.08	0.00
23	514889.5	475537.6	60	9.1	8.47	8.06	1.04	0.41	0.12
24*	512603.7	481665.9	14	19.9	19.85	19.82	0.08	0.03	0.01
25*	512607.1	481648.9	184	17.2	17.01	17.06	0.14	-0.05	0.02
26*	512301.9	481825.5	18	11	10.88	10.86	0.14	0.02	0.02
27*	512475.8	481712.1	20	11.6	11.45	11.51	0.09	-0.06	0.01

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.
*baseline for 12A and 24-27 is March 2011.

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